February/March 2018

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- Innovation Awards 2018
- Kai Feldkamp from RWS
- Smart Mobility Schiphol

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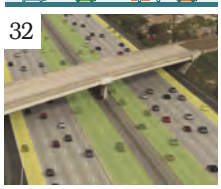
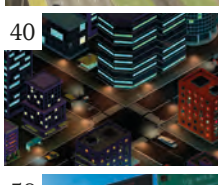
Cover story

48 Information highways

Radical changes are afoot in the way infrastructure assets are managed

Paul Willis looks at how the Internet of Things is shifting the focus away from planned maintenance schedules to an array of smarter options





Editor's letter

Two years ago, I attended my first Intertraffic Amsterdam, so, as I prepare for my return visit this year, it's natural to take stock and think about what has changed in the industry during that time.

One statement that rings true in this issue is that of Kai Feldkamp of RWS, the Dutch road and waterways authority (page 16). He mentions that two years ago the smart mobility department he heads was brand new and still finding its way. Fast-forward two years and practical trials are working slickly, delivering meaningful results. The trials include the international C-ITS corridor and Smart Mobility Schiphol – near Amsterdam's famous airport (read more on page 4).

One battle that remains in deadlock, however, is the 'face off' between cellular and wi-fi-based technologies for connected vehicle services. Feldkamp expresses some frustration at the fact that the C-ITS corridor must continue with a two-tier approach so as to accommodate both potential futures. Over in the USA, there is further evidence of the ongoing split. The USDOT continues to fly the flag for wi-fi, with DSRC solutions being very much in evidence in its Connected Vehicle Pilot Program (there's more on latest developments in Tampa, Florida, on page 58). Meanwhile, the private sector – not already heavily invested in DSRC – has been much quicker to embrace cellular solutions. Matt Ginsberg is one such entrepreneur, whose company, Connected Signals, has developed a smartphone app to provide drivers with signal phase and timing data using only cellular communications. He's even found a way to do this in Manhattan without any direct data feed from NYCDOT – find out more on page 8.

Of course, smart technology has applications beyond enabling traffic managers to communicate directly with drivers and cars, or allowing cars to communicate with each other. With the advent of the Internet of Things, it is now possible for roadside infrastructure, and even roads themselves, to broadcast their state of repair to those responsible for their upkeep. While, as you can discover on page 48, road authorities are sometimes reluctant to embrace this technology just yet, such solutions have the potential to dramatically reduce maintenance budgets while providing better, safer roads. With such useful and compelling reasons to roll out these systems, it can only be a matter of time before they become commonplace throughout the world.

More than ever before, Intertraffic Amsterdam will provide a glimpse of the future. The event's Innovation Awards once again showcase the best new products in the industry – we profile all 15 nominees from page 20. What's more, an all-new area at the event, called ITSUP, will be dedicated to innovative startups that will be vying with each other to prove they are the next big thing. Looking back can be interesting… but looking to the future is way more exciting.

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Dutch smarts

The Netherlands' Smart Mobility Schiphol project, which is being directed by Noord-Holland province, is testing next-generation systems for connected and autonomous vehicles. Here we get the latest updates from the testbed that will also be showcased at Intertraffic Amsterdam

Practical trials of connected and autonomous vehicle technology are underway on public roads near Amsterdam in the Netherlands, and there is now a plan to upgrade roadside hardware in the coming months.

The trials are being conducted in daily traffic conditions within a testbed area called Smart Mobility Schiphol, named after Amsterdam's nearby Schiphol Airport. The testbed contains regional roads and arteries with different characteristics including a bus rapid transit (BRT) lane.

14%
The reduction in congestion levels after Noord-Holland's TMC opened in 2012

In 2018 all 48 traffic lights in the testbed will be upgraded to ITS G5 (wifi-p) functionality and will also communicate with connected vehicles through 4G LTE. These traffic light controllers (TLCs) are known as iTLCs. Two of the important day-one use cases, as specified by the European commission, have already been tested, namely GLOSA (green light optimization speed advise) and TSP (traffic signal priority).

Smart foundations

The beginnings of the project can be traced back to 2012, when the province of Noord-Holland opened its traffic management center (TMC), from which 270 traffic signals, 150 cameras and 25 variable message signs are controlled. "Through collaboration with other road operators like the City of Amsterdam and the highway operator Rijkswaterstaat we were able to analyze road and canal networks as one traffic system," says Jeannet van Arum, director smart mobility for Noord-Holland province. "By focusing on handling traffic incidents, roadworks, events and daily congestion we created a more efficient traffic system that reduced traffic congestion by more than 14%."

With the rise of intelligent transportation systems and everyday connectivity of road users, the province is now investigating new opportunities to enhance safety, traffic efficiency and reduce emissions. Private companies in the telecommunications and automotive

As part of the Smart Mobility Schiphol pilot, Daimler's Futurebus drove autonomously through a 1.1-mile (1.8km) tunnel without any GPS or roadside information beacons

48
The number of Smart Mobility Schiphol traffic lights that will be equipped with ITS 5G in 2018

industries are investing heavily in R&D for ITS. As a road authority, spatial developer and provider of public transportation, Noord-Holland province plays an important role in the mobility chain. Therefore it now has a proactive attitude to learning and collaborating with private companies. To do this, the province has created the Smart Mobility program that includes not only theoretical studies, but also the Smart Mobility Schiphol practical pilot, which is being conducted in cooperation with private companies.

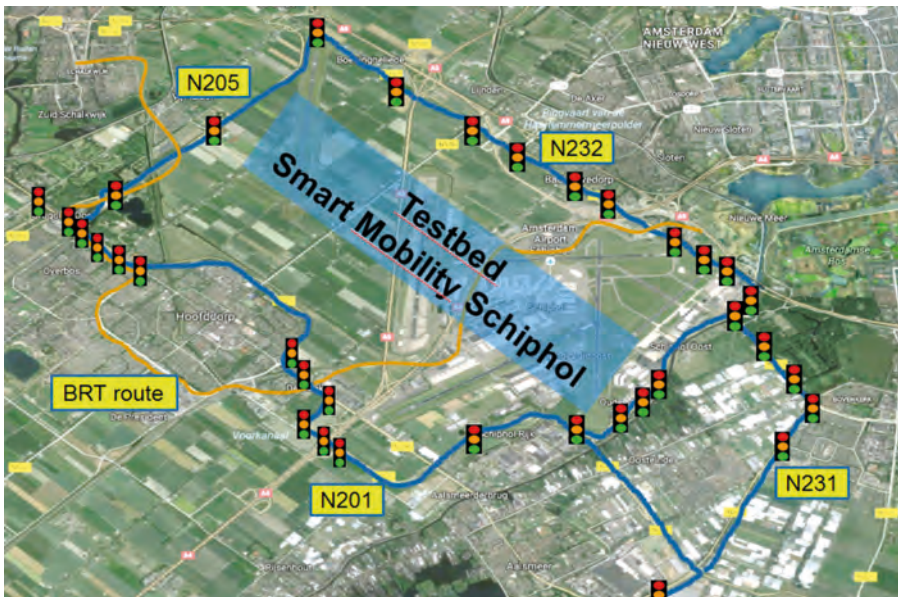
Autonomous, connected bus

In 2016 Daimler tested its concept Futurebus at Smart Mobility Schiphol, which used connected and autonomous features to drive between the airport and Haarlem, negotiating 19 traffic lights and 11 bus stops, without the driver once touching the wheel or pedals.

To enable this, the traffic lights on the route had been upgraded by Vialis, a Volker Wessels company that used ITS G5 to communicate with the bus's onboard unit. Using this wi-fi based communication in practice gave new insights into distance, signal interference and traffic control algorithms and supported further standardization of the ITS G5 messages for SPAT (signal phase and timing) and MAP (road layout data). A Dutch profile for SPAT and MAP is now available for implementation in all traffic lights in the Netherlands.

Traffic signal recognition based on the onboard cameras alone was not sufficient for a safe and comfortable

> "Through collaboration with other road operators, we were able to analyze road and canal networks as one traffic system,"
>
> *Jeannet van Arum, director of smart mobility, Noord-Holland province*



The pilot scheme, taking place at the Smart Mobility Schiphol testbed, aims to keep traffic flowing more efficiently by providing trucks with information about traffic signals' exact green times

crossing of intersections. The radio beacons ETSI G5 (European Telecommunications Standard Institute G5) were needed to create a redundant and safe system.

Another new feature within the Daimler pilot was an automated drive through a 1.1-mile (1.8km) tunnel. During the drive, the location of the bus was determined by using map-matching technologies without any GPS and without any other roadside information beacons. Extra facilities for communication in the tunnel were not needed. On the other hand, test rides showed that road markings are very important for driving safely in automated mode.

20
The percentage of traffic that is freight-related in the Schiphol area

Traffic signal priority

In the spring of 2017 a collaboration with six private companies resulted in a pilot with two ETSI-based use cases – traffic signal priority and green light optimization speed advisory (GLOSA) – on the road. Its main goal is to reduce stops of trucks near traffic lights by giving them information about green lights. The current onboard systems of Dobbe Transport trucks were adjusted to communicate with traffic lights through 4G LTE. This was done with the cooperation of KPN, Vialis, Dynniq and Rietveld fleet management. The results of this pilot convinced the province that 4G LTE is useful for time-critical (<300ms) use cases such as GLOSA and traffic signal priority. Transportation provider Dobbe is satisfied with the service and the potential fuel savings.

"Although introducing 4G LTE in traffic lights will further complicate the chain of data, it is promising for the future," says van Arum. "Different transportation providers in the Schiphol area are willing to adjust their onboard systems to the new features if the coverage of traffic lights is close to 100%. Therefore the next step is to scale up these use cases to the 48 traffic lights in the Smart Mobility Schiphol area. In this area 20% of all vehicles are freight-related, so the impact will be substantial.

Future solutions

As a regional government, Noord-Holland province has the option to set up traffic management systems. By collaborating with over 20 private companies for learning and testing new mobility and traffic management features, it has the tools to get to know the users and improve their travel experience. Another important result is the reduction of travel costs for society. In a world of connectivity, mobility operations (demand) and traffic operations (supply) have to benefit each other. Therefore the province focuses on the interfaces of those worlds. In the center are many cloud services that will provide parts of the mobility puzzle. Researchers focus on the parts in which the province has an important role: delivery of road capacity, traffic management rules and user policy strategies.

"Will future mobility services grow and make our traffic system smoother and more reliable? Or do we have to add a few rules and policies to reduce negative external effects such as the growing distance between work and home?" asks van Arum. "In the end it is the user we have to focus on."

For all parties involved, the first question in the conversation will naturally be: "What's in it for me?" Noord-Holland province is convinced it has use cases that will boost business development and also have a positive societal impact.

> "Transportation providers in the Schiphol area are willing to adjust their onboard systems to the new features if the coverage of traffic lights is close to 100%
>
> *Jeannet van Arum, director of smart mobility, Noord-Holland province*

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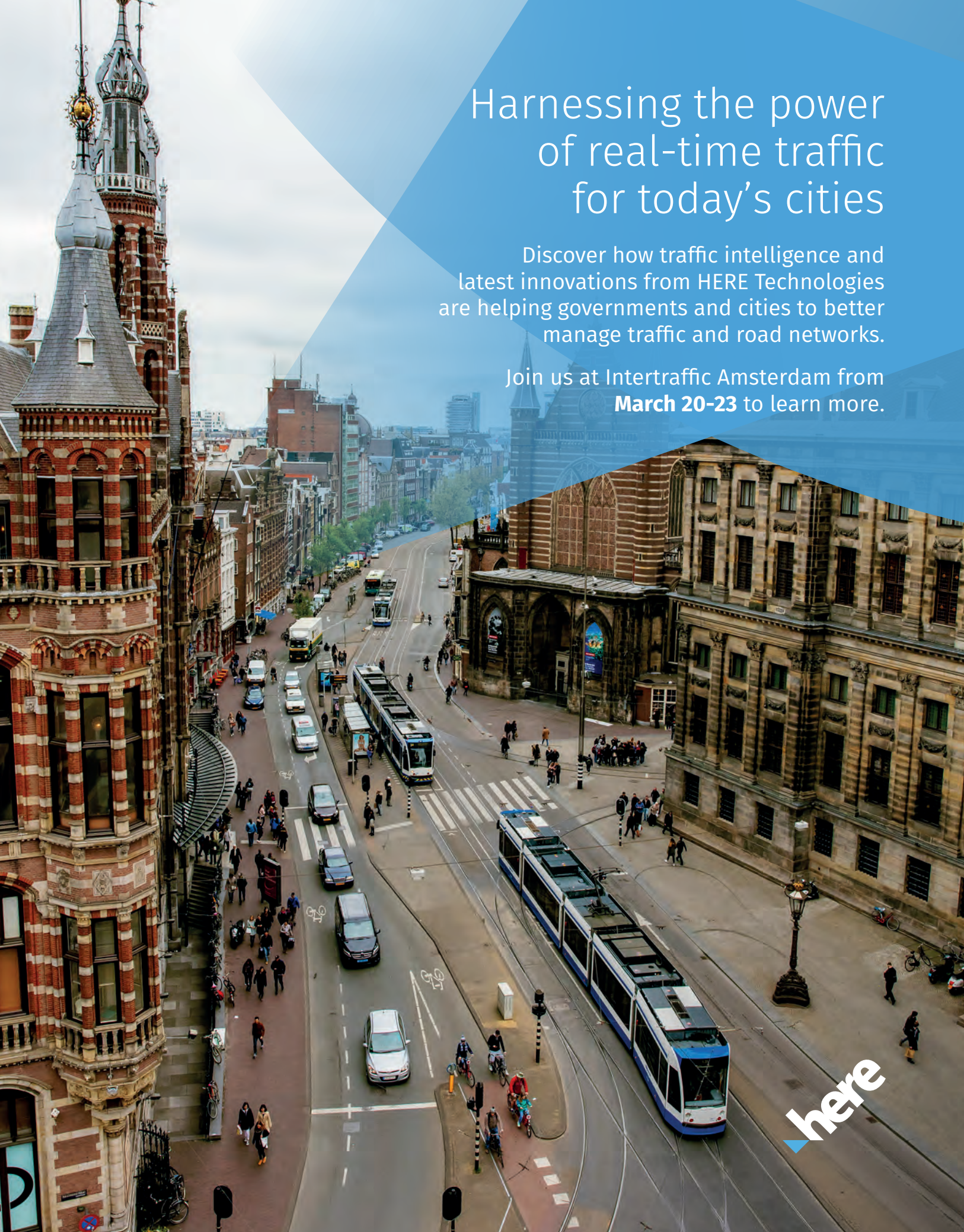
The Smart Mobility Schiphol project will be showcased at Intertraffic Amsterdam on the Metropolitan Region of Amsterdam stand in the Smart Mobility Hall (08.308)



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Mystery tech makes Manhattan signal data public

A new system can establish accurate signal phase and timing in Manhattan – without any direct input from NYCDOT. **Tom Stone** finds out a little more about supersourcing – the breakthrough that could dramatically speed the roll-out of V2I services in the near future

Connected Signals is an Oregon-based startup that, over the past four years, has been partnering with city authorities around the world to get access to their signal phase and timing (SPaT) data feeds.

The company uses this data, in conjunction with its EnLighten app, to inform drivers of the status of the signals they are approaching.

"If you stop at a red light, the app tells you how long you're going to be stuck there," says CEO Matthew Ginsberg. "Five seconds before it turns green, it sounds a bell to alert you. If you see a green light in the distance it tells you if you're going to make the light, so you don't speed up and drive like a crazy person before it changes. So it makes drivers more fuel efficient and keeps them safer."

US cities that now offer the system include Portland, Salt Lake City and Las Vegas, with Phoenix slated to come online in the near future. San Jose, Montreal in Canada, Melbourne in Australia and Christchurch in New Zealand have also had system architecture built using direct data feeds from road authorities. But now Ginsberg and his team have found a way to extract SPaT data without the need for a direct data feed. With a patent application filed and due to be published in March, Ginsberg is still secretive about exactly how his system – which he calls supersourcing – works, but he is

> We have not hacked into the New York traffic system and we have not installed stuff at the intersections. This is totally driven by cleverness
>
> *Matthew Ginsberg, CEO, Connected Signals*

Above: **Lights at one of Manhattan's 2,820 signalized intersections**

Main: **A low-tech way to inform the public about signal timings (not currently thought to be in use by Connected Signals)**

2,795
The total number of signalized intersections in Manhattan, NYC

able to reveal a few details exclusively to *Traffic Technology International*.

"We have found a way to bring New York online, just like we've brought all the other cities online," he says. "One of the nice things from our perspective is that once cities are online, they're all the same. So even though the source of the Manhattan data is different, from that point on, it looks just like all the other large cities we've worked with."

Ginsberg is at pains to point out that there is absolutely nothing underhand or illegal in the way he is getting this data. "We have not hacked into the New York traffic system or installed stuff at the intersections, which is also illegal," he says. "This is totally driven by cleverness."

Advanced vision

One of the company's other products is an advanced vision system for connected and autonomous vehicles, which recognizes the status of traffic signals in real time. It uses 4K, 30 FPS video on standard CPUs and has a reported 98% accuracy under all conditions, including night-time.

The system can identify signals without having to be programmed with their location, and can even identify flashing lights, due to the high operational frame rate.

When asked if this product could be involved in the supersourcing on Manhattan, Ginsberg is enigmatic: "We have this vision system as well, but you're making assumptions if you think that's how we do NYC. I'm not saying if they're right or wrong. I'm just pointing them out!"

Green lights for the future

While the immediate aim of the EnLighten app is to improve the driving experience for individuals, as uptake of this technology increases, Ginsberg envisages wider benefits.

"Eventually there will be knock-on effects for congestion," he says. "As more people get traffic light aware navigation, the flow gets more time efficient. Even what we currently have keeps the traffic flowing just that little bit more smoothly."

As we went to press, Ginsberg was in the finals stages of testing the Manhattan signal data. He reveals that supersourcing requires the most effort at the start of the process. "Getting the first 21 lights was 90% of the work," he says. "There are a few lights we've not reached yet – but we're getting there as fast as we can."

Ginsberg has promised to reveal full details of how the system works once the patent application has been published. For exclusive updates on this story, check out our website, **www.TrafficTechnologyToday.com**, which is updated every weekday with all the latest traffic news.

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Future focused

Above: **The impressive Messe Wien conference center in the Austrian capital is the venue for this year's Transport Research Arena**

This year's Transport Research Arena in Vienna, Austria, promises to bring together key industry decision makers. **Mark Hall** reports

Transportation experts, industry chiefs, representatives from NGOs and public authorities, as well as policymakers from all over Europe, will meet in Vienna, Austria, at Transport Research Arena (TRA) this April. Taking place on April 16-19 in the city's Messe Wien, the seventh edition of this event will provide a forum in which all the challenges and opportunities facing transportation professionals today can be discussed.

Under the heading 'A digital era for transport', attendees will focus on developing a consolidated comprehensive vision. One goal of TRA is to enable a better alignment of political objectives and to provide an open arena for representatives of politics, industry and research to debate on the latest trends and transformation processes. These include digitization, automated driving, shared mobility, electrification and multimodality.

More than a conference

To set the tone and to lead Europe into shaping this change at a global level, this year the TRA offers an Industrial Round Table on the topic 'Europe on the move'. High-level representatives including Carole Desnost (chief innovation officer of French train operator SNCF) and Helmut List (CEO of the independent research institute AVL) will focus on questions surrounding visions for the future of the industry and for European global leadership.

600+
The number of technical presentations planned for the TRA in Vienna this April

But there will be a lot more to explore besides: four plenary and 12 strategic sessions, as well as more than 600 technical and scientific presentations, will cover topics such as data security, automation, road safety, decarbonization, logistics, transportation infrastructure and enabling technologies.

Ideas exchange

One of the key aims of the event is to foster the interoperability of ideas via early exchanges between industry experts, politicians, researchers and users. Accordingly, the four-day scientific conference will be complemented by a 75,000ft² (7,000m²) exhibition, which will also house the Interactive Zone, where research results and solutions can be experienced first-hand. It will include more than 40 indoor and outdoor demonstrations and live showcases, as well as presentations and discussions.

The event is organized by the Austrian Ministry for Transport, Innovation and Technology, the Austrian Institute of Technology and AustriaTech, and is supported by the European Commission.

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Far left: **Intelligent cat's-eyes were first used in the UK at Sheriffhall Roundabout in Edinburgh, Scotland**

Left: **Intelligent cat's-eyes are illuminated with LED lighting and can be seen from up to 1,000m away**

A brighter path to safer roads

James Allen reports on Highways England's project to make a notorious motorway junction safer, with the inclusion of clever cat's-eye technology

Intelligent cat's-eyes are being introduced by Highways England to improve driver safety at one of the most notorious motorway junctions in the UK.

The advanced LED road studs respond to changing traffic lights, lighting up when the green signal appears, to clearly indicate lane markings.

1933
The year the cat's-eye was invented, by Englishman Percy Shaw

Minimal drift

Part of a £3m (US$4.2m) investment project to protect drivers at the Switch Island junction in Merseyside, the installation of the innovative technology will help to cut the number of vehicles drifting out of lane.

Following 49 collisions at the junction in the past two years – equating to an average of one accident every two weeks – approximately 170 of the new cat's-eyes will be installed where the M57, M58 and three A roads converge in Sefton.

Phil Tyrrell, project manager at Highways England, said, "We're always looking for new ways to further improve journeys and safety for drivers, and I hope the new intelligent cat's-eyes will help better guide drivers around Switch Island."

An England-first

Produced by Oxfordshire-based Clearview Intelligence, these new LED cat's-eyes – unlike traditional systems – are visible from up to 1,000m and have already been introduced at Hindhead Tunnel in Surrey. However, the Switch Island project will be the first time they will be linked to traffic lights at a motorway junction in England.

> "The innovative light-up road studs, along with the other improvements we're introducing, will make it much easier to navigate the junction"
>
> *Highways England project manager Phil Tyrrell*

Whereas traditional cat's-eyes merely reflect the light from a vehicle's headlights, these ones light up themselves, so are visible regardless of whether vehicles have their lights on or not.

The UK government has contributed £220m (US$310m) to the project and the intention is that traffic flow will improve and road safety will be enhanced.

Additional improvements

In addition to the cat's-eyes, traffic lights over 5m (16.4ft) in height – taller than heavy goods vehicles and double-decker buses – will be installed to ensure they are clearly visible for all drivers approaching the junction.

New barriers between carriageways, a 400m (0.25-mile) shared cycle path, colored high-friction surfaces and improved road signage will also be introduced as part of the project.

Jerry McConkey, Sefton Council's transportation and highway infrastructure service manager, said, "We have worked with Highways England and Merseyside Police to look at the issues at Switch Island and develop improvement proposals.

"We are delighted that these safety measures are about to be introduced with Highways England implementing the latest technology solutions. This will further improve safety and give drivers a much higher level of confidence when negotiating this busy junction."

The project began at the start of February this year and is expected to take around 12 months to complete.

Highways England has stated that it will also consider rolling out the studs at other locations in the country, although no further plans are currently scheduled.

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At Rijkswaterstaat, the Dutch highways authority, **Kai Feldkamp** is exploring the potential around connected vehicle technology even as the direction of future communications channels remains unclear

By James Allen

As the Netherlands gears up for Intertraffic Amsterdam 2018 (March 20-23), the host nation is proving to be a leading example in the pursuit of better, smarter transportation infrastructure.

The country's highways authority, Rijkswaterstaat (RWS), will be present at the event beginning on March 20 at the RAI Amsterdam, and Kai Feldkamp, RWS program director for smart mobility, is anticipating that it will be well worth a visit.

"There is going to be a big focus on smart mobility – it will be a great opportunity for people to experience what the Netherlands is doing in that field," he says.

"Sessions will be given over to discussion with experts on everything from data sharing and new traffic management concepts, to how we adjust infrastructure for connected and autonomous vehicles."

A smarter approach

RWS is committed to relieving congestion and improving road safety for travelers in the Netherlands. But rather than simply building more roads, two years ago the organization created a team specifically devoted to the aim of using existing infrastructure more efficiently.

"We are looking at innovations and trying to incorporate them into, for example, our traffic management services, working out how smart mobility can really contribute to our primary goals of greater safety, accessibility and sustainability," explains Feldkamp.

"Two years ago, it was just about finding out what smart mobility means, what is its scope, and how can we handle it? From there,

The C-ITS corridor is incorporating both cellular and wi-fi communications technologies

it has moved on to implementing the elements of smart technology that can be used now – that's basically where we are today."

This understated description of RWS's recent activities fails to do justice to the breadth and depth of projects the offshoot of the Dutch Ministry of Infrastructure and Water Management is involved in.

Collaborative connected corridor

One major example extends even beyond the nation's borders. The Cooperative Intelligent Transportation Systems (C-ITS) corridor is a collaborative endeavor between the Netherlands, Austria and Germany.

The 870-mile (1,400km) testbed from Rotterdam to Vienna is exploring the potential of providing road users with traffic updates on their journey by connecting vehicles to roadside systems.

With the use of wi-fi signals and smartphone apps, the project is focusing initially on the provision of workzone warnings for drivers, with a view to extending this to a wider range of traffic updates, once the system has bedded in. Such a service is an obvious boon for road users.

"In the Netherlands, it is a little bit more complicated because we already have so much roadside messaging technology," explains Feldkamp.

As early as 1979, variable messaging signs were introduced on Dutch roads and, by 2004, 609 miles (980km) of motorway had some form of electronic signage.

Research in Germany has shown that traffic safety trailers last an average of only two years before being hit by a vehicle – endangering lives in the process.

"If road users are warned that these trailers are on the road, the number of crashes will be reduced enormously, saving lives, as well as money on replacing the equipment," adds Feldkamp.

So, given the level of road infrastructure available in the Netherlands, one V2X application Feldkamp and his team are addressing is the feasibility of introducing collision risk warnings

Being so technologically advanced has, however, posed some additional, unique challenges to the Dutch end of the smart mobility project.

"Many of our highways already tell you when a road ahead is closed, or that there are traffic jams for instance, so we are now working on integrating that service into one that can also be received in the car," he says. "The difficulty is making sure that when there are messages above the roads, they are the same as what's displayed on the dashboard."

> The technology behind the C-ITS corridor can either be cellular or wifi-p – both are possible

If that were not challenging enough, matters are complicated further by the hybrid nature of the project.

"To have these signals appear on a smartphone app or on the vehicle's dashboard, the technology behind it can either be cellular or wifi-p – both are possible.

"We're calling it a hybrid strategy as we plan not to exclude one or the other, but to try to find out which one works best in which situation.

"Discussions in the industry are still ongoing about whether it'll be G5 [wi-fi], 5G [celluar] technology, or a mix of both. There has been so much dialog shared about which is preferable or which will be ready first, but it's still hard to say.

"The manufacturers of these systems are also not very clear on the speed of when they're going to deliver this technology, as it's quite a complex thing, and even last year in Montreal at the ITS World Congress, there was no clarity at all," says Feldkamp.

Bridge openings have a major affect on journey times in the Netherlands

Part of the aim of the C-ITS corridor is, as road authorities, to be prepared for 2019 when Volkswagen Group has confirmed it will begin phasing-in vehicle-to-vehicle and vehicle-to-infrastructure technology.

So, the clock is now ticking for the project partners to be ready for the large number of connected vehicles to be on the roads, and the uncertainty around the communications channels is not helping.

Projects closer to home

Feldkamp and his team are also being kept busy by a number of projects closer to home. The distinct geography of the Netherlands means that canals play an important role in the transportation of people and cargo around the country.

Given that many of the waterways cross paths with Dutch highways, traffic levels can be heavily affected by bridge opening times. In Amsterdam alone, there are over 60 miles of waterways and more than 1,500 bridges.

Feldkamp adds, "We're working on getting data from the bridges – when are they open and for how long? It's very practical for the road traffic, but also for the waterway traffic, because you can imagine a vessel traveling from one city to another can cut its CO_2 levels dramatically when it travels at one speed without the need to stop at bridges and, of course, journey time uncertainty can be reduced.

"We already apply tried-and-tested innovations and that will increase in the coming years."

For more on the projects RWS is involved with, you can meet representatives at Intertraffic Amsterdam, March 20-23. Visit them in Hall 8, Stand 08.416

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Mobility innovations

Intertraffic Amsterdam is a hotbed for traffic technology development. Whether you're planning to attend the event or not, there are certain new products you need to know about. **Tom Stone** reports

This March 20-23, the Intertraffic trade fair makes its biennial visit to its home city of Amsterdam, in the Netherlands. Visitors and exhibitors from over 140 countries will converge on the famous RAI exhibition center, where they will not only get the chance to meet one another, but also experience demonstrations, attend presentations and find out what the future holds in the all-new ITSUP area – which will showcase startup businesses for the first time at Intertraffic Amsterdam.

A further not-to-be-missed highlight of the event is the Intertraffic Innovation Awards, the nominees for which are showcased over the next five pages. The winners will be announced at the Intertraffic Amsterdam opening ceremony.

"I believe that innovation and entrepreneurship are what drives improvements in global mobility and transportation, and by putting the spotlights on innovation we aim to help accelerate the connecting match between today's challenges and technological solutions," says Peter van der Knaap, who is chair of the Innovation Awards Jury and MD of SWOV – Institute for Road Safety Research, The Hague.

Considering trends within the industry, gleaned from his role as Innovation Awards chairman, van der Knaap continues, "Traffic technology is becoming more and more integrated and I believe this is a good thing. Fewer products are standalone solutions: smart integration, focusing on what people actually need is the norm."

Once the Innovation Awards ceremony is over, van der Knaap is looking forward to plenty of other highlights during his planned week at Intertraffic Amsterdam. "Apart from meeting old colleagues and friends, I look forward to discovering new products and improvements in existing technology – mobility is becoming increasingly connected and smart," says van der Knaap. "Personally, I will particularly focus on systems that can help to increase road safety, both for car occupants, vulnerable road users and – a very important but often overlooked subject – improving safety for road construction workers."

Turn the page to find out more about the Innovation Award nominees and other not-to-be-missed exhibitor highlights.

Innovation Awards 2018: Infrastructure nominees

Weighing the benefits

OptiWIM by Cross Zlín (Czech Republic)
Stand 10.111

Weigh-in-motion (WIM) is an important technology for protecting infrastructure from excess wear and tear from overweight vehicles. The all-new OptiWIM sensor combines free-flow capability, accuracy to 3% (even in free-flow), temperature compensated readings, and RF immunity. A single sensor row can detect vehicle width, number of tires and tire pressure. Non-invasive maintenance and replacement assures a 10-year life.

Flexible friend

FlexyLight Bollard by Saedi (Italy)
Stand 05.337

The pioneering FlexyLight Bollard can be bent up to 90° in any direction without damage. In addition, there are various rigidity setup options. It is illuminated and has a color-change function. There is the option of either solar or network power supply and it is removable in under 20 seconds. Applications include bus stations, turnings and parking garages.

Looking good

Asura Recognition Unit by Asura (Hungary)
Stand 11.107

The Asura Recognition Unit (ARU) is a newly developed plug-and-play solution enabling high-accuracy license plate recognition (LPR) in any existing or new visual data collection system. ARU is camera-independent, works with any IP camera, and delivers high recognition rates with its sophisticated validation algorithms. ARU can store and push LPR results to any application in either MySQL, XML or CSV format.

Intertraffic Amsterdam Highlight
Kistler – Stand 10.315

Multifunctional WIM

Kistler Group will be showcasing KiTraffic weigh-in-motion solutions

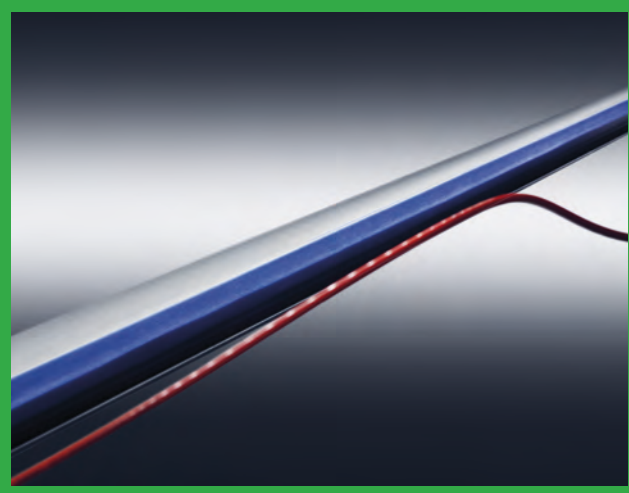
Increasing traffic and heavy vehicles put a strain on infrastructure the world over. Damage to driving surfaces increases exponentially with higher axle loads, which means road owners and operators need to monitor usage carefully.

Kistler's advanced, durable weigh-in-motion (WIM) solutions automatically gather traffic and load data without intervening in traffic flow. This provides a reliable basis for weight enforcement for overloaded vehicles, the calculation of toll fees, and the determination of maintenance intervals. The Swiss measuring specialist now additionally offers tailor-made WIM services, such as road analysis and calibration services.

Kistler's solutions enable road and traffic monitoring, weight enforcement and weight-based tolling. The extended KiTraffic service package facilitates a wide range of applications and ensures high performance.

KiTraffic Plus is a new WIM solution for automated road monitoring. Applications include weight enforcement and toll-by-weight. With its Lineas quartz sensors, KiTraffic Plus can measure vehicle loads at different speeds and on a virtually infinite number of lanes.

The completely open and scalable system now operates using two to eight sensors per lane. KiTraffic Plus is a flexible and expandable solution, which can be combined with camera systems for vehicle identification, among other applications. The data is processed in a protected roadside cabinet. The results and analyses are available in real time via web-based HMI or API interface transfers.



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Innovation Awards 2018: Traffic Management nominees

Smarten up
Sprinx Traffic AID
Sprinx Technologies (Italy)
Stand 12.316

Based on the innovative 3D tracking technology, Sprinx Traffic AID running on board Hanwha Techwin WisenetX cameras has considerably enhanced the ability to detect incidents and keep traffic on the move. It offers distinctive advantages over normal cameras by performing not just image capture, but also image analysis and event detection, turning a standard CCTV camera into a smart CCTV camera for professional traffic systems.

Multifunctional counting
CITIX 3D
Eco-Counter (Canada)
Stand 12.328

CITIX 3D, Eco-Counter's latest innovation, is a wide-range counter capable of automatically counting and differentiating pedestrians, cyclists and vehicles, simultaneously. It is extremely easy to set up and can be positioned almost anywhere. Its unique technology is the result of five years of research and development in partnership with a top European Research Lab (CEA).

Road marking maps
Signs to Lines TRO Mapping
AppyParking (UK)
ITSUP Hall

Signs to Lines Mapping is the latest technology that creates the world's most accurate map of all the paint on the street related to traffic and parking management. These regulatory maps are required by law to be kept up-to-date by local authorities. The Signs to Lines mapping technology uses a combination of state-of-the-art vehicle-mounted lidar scanners, photography, AI and machine learning.

Customizable solutions

Intertraffic Amsterdam Highlight
Tecsidel – Stand 12.314

Tecsidel is showcasing diverse traffic management and tolling technology

Tecsidel is a multinational company focused on development and integration of advanced information systems specialized in stop-and-go tolling, multilane free-flow, back office applications, and turnkey ITS management. Thanks to the quality and innovation of its customizable projects, Tecsidel has become a leading company in the industry.

One of the most important projects it was awarded in 2017 was a free-flow single-gantry in Sweden, which includes new algorithms applied in the processing of data obtained by the antennas, laser scanners and cameras installed on a gantry.

Tecsidel runs a continuous R&D investment for state-of-the-art solutions such as its Maintenance Management System (TMMS+), Intelligent Traffic System (ITS+) and system for Management of Electronic Payments (MEP). Such innovations will be showcased in Amsterdam.

Intertraffic Amsterdam Highlight
Lumenera – Stand 07.319

Advanced enforcement

Lumenera's cameras are ideal for tolling, red light and speed enforcement

Visitors to Lumenera's stand at Intertraffic Amsterdam will be able to see the company's ITS imaging demo.

High speed: The Lumenera Pregius Global Shutter CMOS cameras, including the Lt345R, Lt545R, Lt945R and Lt1245R, will capture still images via a software trigger from their own video feed – ideal for self-triggered video tolling and multilane red light enforcement.

High resolution: The Lumenera Lt16059H full format CCD camera with 16MP, 12fps, and Canon EF Lens mount for iris and focus control will be hardware-triggered to simulate infractions reported by external sensors such as ground induction loops or a lidar system – these features make these cameras are ideal for multilane red light and speed enforcement.

Innovation Awards 2018: Safety nominees

Safe, smart cities

TrafficCam3D
Viion Systems (Canada)
Stand 07.322

TrafficCam3D is a revolutionary lidar smart camera with onboard processing and telemetry for traffic safety and security applications. The camera-processed data can include vehicle classification, average speed, and origin/destination. TrafficCam3D constitutes a critical component of safe and smart cities and highways, delivering actionable intelligence as well as video camera functionality from a single fully integrated, low-cost platform.

Intelligent road studs

SR-90
Sernis Tecnologic Solutions (Portugal)
Stand 01.336

SR-90 is an intelligent system for physical speed reduction of vehicles in controlled speed zones, for instance in the vicinity of pedestrian crossings. It works with hardwired road studs with two levels of elevation from the soil and corresponding LED signals, which are controlled electronically. The speed control measures are the result of an intelligent algorithm; the level of elevation and the LED's color will change accordingly to the speed that the car approaches the control area.

Speed awareness

SpeedWatch+
Traffic Technology Ltd (UK)
Stand 08.120

Traffic Technology's Community SpeedWatch system is a portable roadside radar that enables volunteer members of the public to take part in non-confrontational speed monitoring surveys. SpeedWatch+ is a roadside VMS that wirelessly interfaces with the SpeedWatch device to let the volunteers inform drivers of their disregard of community road safety. Messages can be selected by the operator including, 'Cell phone use!', 'Fasten seatbelt!' and 'Excess speed!' – providing a direct warning to violating drivers.

The bigger picture

Intertraffic Amsterdam Highlight
Vitronic – Stand 12.407

Complete solutions for safety, security and tolling

Safety, security and road-user charging together help to form the backbone of a smart road network – these are the topics that will be addressed in Amsterdam by German machine vision specialist Vitronic.

The company will showcase how its product range can be applied to a host of applications including speed and red light enforcement, average-speed enforcement, wanted-cars search, border control and electronic toll collection. Vitronic solutions are also provided with clever back office solutions to round off the portfolio.

The pole-mounted Compact City Housing for lidar-based traffic monitoring and the gantry-less Tollchecker Roadside tolling system will be Vitronic's highlights, since they will be presented in Amsterdam for the first time.

Weather problems solved

Intertraffic Amsterdam Highlight
Vaisala – Stand 12.822

Improving road safety in adverse conditions

Vaisala, a world leader in weather solutions for every application, has been supporting road and highway authorities for over 40 years. Detecting road weather conditions is a big challenge requiring a great deal of experience. Vaisala has this, and regularly consults with customers to improve its understanding. It is currently looking at how road weather information will become part of connected and autonomous vehicle solutions to improve surface transportation networks.

To tap into this wealth of knowledge, and prepare for the future, you can consult with some of the world's best weather experts on the Vaisala stand at Intertraffic Amsterdam.

Innovation Awards 2018: Parking nominees

Wireless power
Self-powered Parking Sensor
ParkHere (Germany)
Stand 07.410

Parking sensors register whether a car is parked in a spot. This is the first parking sensor that doesn't need any kind of external power supply. It uses kinetic energy harvesting to produce the energy it needs to send a signal to the base station, which forwards the data to a cloud server. It can also inform drivers of the size of a parking space on-street.

Fighting congestion and fumes
The Urban Mobility Control Management Hub
ParkNow, Parkmobile Group (Germany)
Stand 02.105

ParkNow has delivered an integrated parking ecosystem for Paris with its new urban mobility control management and parking system. The total digitization of parking combines cashless apps, parking meters, permits and enforcement data to optimize traffic flow. It processes penalties, and helps reduce emissions during pollution days via dynamic pricing. A unified on-demand dashboard provides hands-on control for a real smart city.

Advanced space reservation
Imapark
Sernis Technologic Solutions (Portugal)
Stand 01.336

Imapark is an on-street intelligent parking management system that helps drivers find and pre-reserve a free parking space on public roads more quickly using sensors, road studs, electronic displays and mobile app. In the app, it is possible to visualize, in real time, parking spots available, reserve a parking space for a certain time, and pay for the service. Solar powered road studs illuminate red to indicate when a space has been reserved.

Model cities

Q-Free to demonstrate solutions with model cityscape on biggest stand ever

The Q-Free stand will feature a combination of the physical and virtual. The centerpiece of the 1,290ft² (120m²) display will be a table-top model of a cityscape, upon which model cars will roam and trigger videos on surrounding screens. These will demonstrate the company's comprehensive range of solutions for parking, tolling and traffic management.

A key product focus will be the new ParQSense in-ground sensor for on-street parking applications. This uses new mass-market NB-IoT communication protocols to reduce the cost and complexity of deployment and operations.

Visitors will also be able to learn how the company has been producing and delivering backbone solutions for the major Cooperative ITS (C-ITS) pilot schemes.

Intertraffic Amsterdam Highlight
Q-Free – Stand 12.309

Innovation Awards 2018: Smart Mobility nominees

In-dash parking solution
On-Street Parking Info (OSPI)
by ParkNow (Germany)
Stand 02.105

BMW's new On-Street Parking Information (OSPI) feature and ParkNow's in-dash payments solve parking pain for drivers. OSPI forecasts space availability based on historic traffic flows, parking meter data and transactions from parking apps. Color-coding on the navigation map shows the likelihood of finding a free spot. Payment is made in-dash.

Cycle priority app
CrossCycle
Dynniq (Netherlands)
Stand 08.524

The CrossCycle app identifies cyclists when they approach an intersection and gives them the green light more quickly. In addition to extending the green light for individual cyclists, the app also makes it possible to give priority to groups of cyclists.

Parking navigator
Find&Pay
EasyPark Group (Sweden)
Stand 02.312

The EasyPark Find&Pay app is the first of its kind in the world to offer payment and turn-by-turn navigation directly to find available parking, on- as well as off-street. The service is based on millions of datapoints that together form an algorithm calculating the optimal route to find available parking as close as possible to your final destination.

The Intertraffic Amsterdam Innovation Awards 2018 jury

- **Dr Peter van der Knaap** (Chairman of the Jury), Managing Director – SWOV
- **Tom Stone**, Editor – *Traffic Technology International*, UKi Media & Events
- **Jorrit Weerman**, CEO, Parking Network
- **Adam Hill**, Editor – *ITS International*, Route One Publishing
- **Dr Ben Rutten**, Program Manager – Strategic Area Smart Mobility, Eindhoven University of Technology

Intertraffic Amsterdam Highlight
Here – Stand 08.319

Unlocking location

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

Here, the open location platform company, enables people, enterprises and cities to harness the power of location. By making sense of the world through the lens of location, it empowers its customers to achieve better outcomes – from helping cities to manage their infrastructure or enterprises optimize their assets, to guiding drivers to their destination safely.

At Intertraffic Amsterdam 2018, Here will demonstrate its portfolio of next-generation mobility, transportation and infrastructure services for tomorrow's smart cities.

Intertraffic Amsterdam Highlight
Dynniq – Stand 08.524

Energizing mobility

Dynniq will be showcasing smart, efficient and sustainable transportation solutions

Dynniq is a dynamic, high-tech and innovative company offering integrated mobility, parking and energy solutions. Its mission is to enable people, data and goods to reach their destinations efficiently, sustainably and safely.

Dynniq provides technology solutions under its own name, but also using the name Peek by Dynniq and its subsidiaries YSP and WPS. At Intertraffic Amsterdam, Dynniq will be showcasing the very latest in intelligent infrastructure and traffic systems, as well as reliable and future-proof parking solutions.

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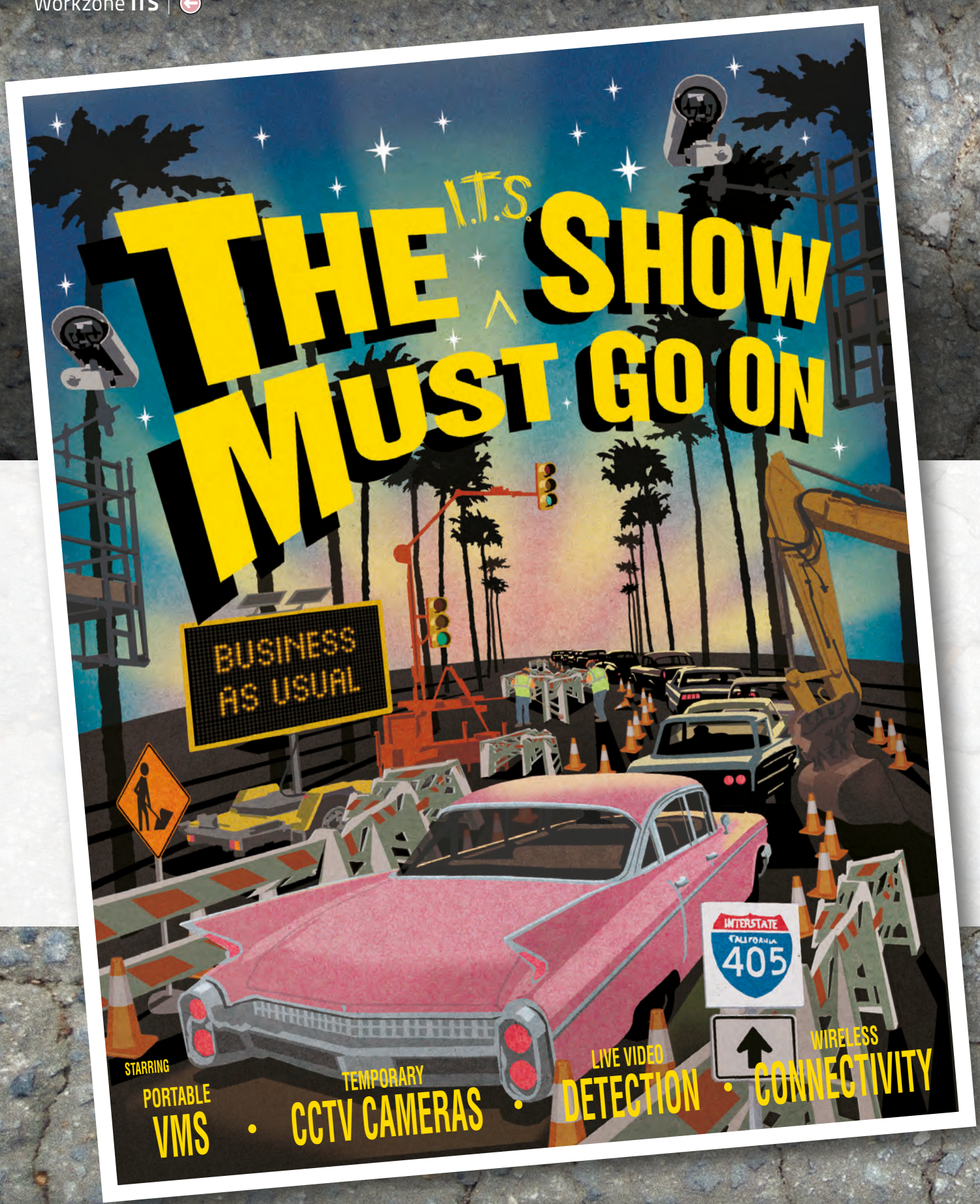
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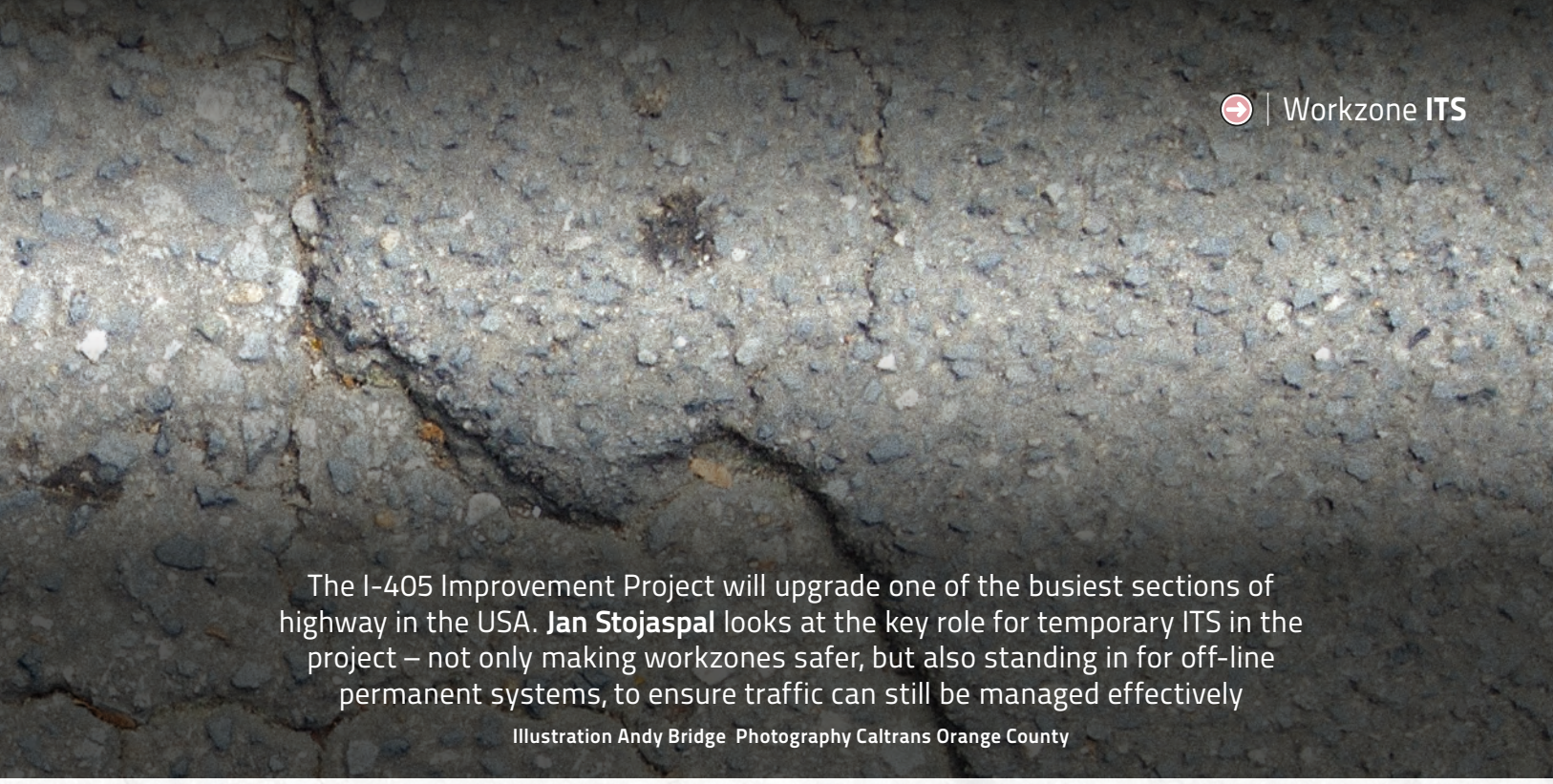


The I-405 Improvement Project will upgrade one of the busiest sections of highway in the USA. **Jan Stojaspal** looks at the key role for temporary ITS in the project – not only making workzones safer, but also standing in for off-line permanent systems, to ensure traffic can still be managed effectively

Illustration Andy Bridge Photography Caltrans Orange County

As workzone ITS solutions mature, their contribution to road safety and effective traffic management during major construction and maintenance projects grows. Still, there are limits to what they can achieve, either on their own or alongside more traditional traffic management strategies.

California's upcoming I-405 Improvement Project, which will see the addition of four new lanes to what is considered one of the busiest highway sections in the USA, is a case in point.

"Right now, the big thing with ITS and ITS in workzones – and the main focus that we use in Caltrans – is to provide traveler information so that the traveler can make informed decisions on where and when they are going to drive," says Joe Horton, Office of Safety Innovation and Cooperative Research chief, which at Caltrans is the department responsible for research into more effective and safer operation of the state highway system. "That is pretty much the limit of ITS at this time.

"In the future, we see changes coming with the advent of connected and automated vehicles, and we see some changes in the smart roadway," he adds. "But we don't have connected ITS that can tell vehicles where to go yet."

> The big thing with ITS in workzones is to provide traveler information, so the traveler can make informed decisions about where and when they are going to drive
>
> **Joe Horton, Office of Safety Innovation and Cooperative Research chief, Caltrans**

The I-405 Improvement Project, which begins construction this year, will focus on some 16 miles of the I-405 freeway in Orange County, Southern California – between State Route 73 and Interstate 605.

In addition to the new lanes – one new express lane and one regular lane in each direction – it will also include the conversion of an existing high-occupancy vehicle (HOV) lane into a second express lane, the replacement of 18 bridges, and multiple ramp and local street improvements.

Permanent ITS substitutes

Currently, the recurrent and non-recurrent congestion on this section of road is managed with the help of five permanent variable message signs (VMS), 24 closed-circuit television (CCTV) cameras, 24 traffic signals at main arterial intersections, video detection systems covering traffic at off-ramps, and ramp meters for on-ramps.

SEVEN

The number of minutes it takes for an incident blocking I-405 to create one mile of backed-up traffic

Some 12 miles of fiber-optic cable is used to relay traffic information back to the local traffic management center (TMC).

Infrastructure benefits

For recurrent congestion, the ramp meters and traffic monitoring stations smooth out traffic and thus minimize shockwaves, a common cause of rear-end accidents. For non-recurrent congestion, the infrastructure is typically used to detect and confirm incidents and to provide alternative routing information.

During construction, the objective will be to maintain "as closely as possible the operational capabilities that Caltrans has in the existing system", says Glenn Murphy, senior project manager at Parsons, the program management consultants on the project.

And this will require wireless connectivity between permanent ITS infrastructure and the TMC every time the fiber-optic cable is severed, such as when bridges are taken down and rebuilt, but also temporary ITS elements to provide additional visibility on traffic conditions and work in progress.

According to Lindsey Hart, chief of public affairs at Caltrans Orange County, in addition to the five permanent VMS, the contractor will, for example, have to install at least as many portable VMS to provide continuous coverage during construction.

For cameras, Caltrans will have 24 temporary CCTV cameras on a wireless system during construction, she adds.

"It's critical that our detection systems are maintained and operated so that the speed data is accurate," says James Pinheiro, deputy director of traffic operations and maintenance at Caltrans Orange County. "If we have accurate speeds posted on the mainline and the arterials adjacent to the mainline, then traffic will be constantly rebalanced in order to minimize congestion. It all comes back to whether or not those detection systems are working.

"What's more, video detection with temporary cameras and

Worker safety ITS

Physical barriers are still essential to ensuring workzone safety, but more high-tech solutions are beginning to be deployed and considered

When it comes to ensuring worker safety during construction projects in California, it is still pretty much truck-mounted attenuators, concrete temporary barriers (K-rail) and human spotters.

"Positive barriers are pretty much the best thing – having a truck out there between the workers and the traveling public, or K-rail," says Joe Horton, Office of Safety Innovation and Cooperative Research chief at Caltrans. "After that, it's having one eye to the work and one eye to the traffic."

But this is beginning to change. Caltrans' Division of Maintenance is currently piloting two types of remotely operated automated flagger assistance devices (AFAD) that are capable of replacing human flaggers during one-lane closures on rural roads.

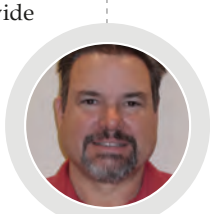
One – called ROSA (Remotely Operated Safety Attendant) – is a remotely operated, pedestal-mounted slow and stop sign, with sound and light alerts. The other is a trailer-mounted slow and stop sign with a remotely operated mechanical arm to direct traffic around workzones.

Meanwhile, research is advancing on things like wearable worker alarms or traffic cones that make noise and trigger individual worker alarms when knocked over. But those solutions are still some years from regular deployment, according to Horton.

"All these are pretty much still in the proof of concept, or people building them have not found how to incorporate them into our business practice," he says. "There are sensors out there; there are alarms out there; but how you make it work so that it's dependable enough to balance someone's life on, is the challenge," he adds.

"That's a risk we want to make sure we get right," he adds. "But it's coming. We are leaning forward, we have money dedicated, we have research going on. It's just that I can't say this is the product we are going to set our standards to at this time, besides the AFAD."

> During construction, we wish to maintain as closely as possible the operational capabilities that Caltrans has in its existing ITS
>
> **Glenn Murphy, senior project manager, Parsons**



One regular lane is being built and an HOV lane will become an express lane in both directions

temporary wireless communication systems is going to be essential to removing incidents," he adds, explaining that incident congestion could be up to half of the congestion that will be faced during construction.

According to Pinheiro, dispatching the right responders as soon as possible is critical to keeping traffic moving, as for every seven minutes an incident is not responded to, one mile of backup forms on a freeway like the I-405.

"In half an hour, you have four miles of backup. That's significant," he says.

Next-generation comms

Also important is to have a multichannel communication strategy to ensure that motorists receive accurate and actionable information – both in advance and during closures, and when incidents occur.

"From our perspective, it's a combination," says Jeff Mills, program manager for the I-405 Improvement

Project, Orange County Transportation Authority (OCTA). "The workzone ITS does not just work on its own. To us, it's a combination of workzone ITS, public outreach efforts, and the other applications such as Waze and others that we are trying to work with."

Pinheiro agrees. "It's really challenging," he says. "You have a variety of users with different tech capabilities, and we need to make sure that we are getting the information out to everyone, so that each group is seeing it multiple times for a major planned closure. And also if there is a major incident, we need to scramble and make sure we are blasting the information out to as many of those information sources as we can so that people will avoid it.

"I think you are going to see a more effective, more efficient usage of Waze and social media on this project than you have seen on any other in the area because we always get smarter," he adds.

Leveraging lane closures

According to Pinheiro, Caltrans will also leverage an existing lane closure system that is designed to clear any lane closure requests in order to avoid potentially dangerous situations.

Other, more traditional traffic management strategies will include closing down lanes only at night or paying close attention to the sequencing of construction work so as to minimize traffic disruptions.

"When it comes to the lane closure system, it's very important that all of this information is integrated so that we don't double lane closures, or so that we don't set up what I'll call an S-type closure," Pinheiro says.

The S-type closure is a scenario where a right-lane closure is immediately followed by a left-lane closure, and "People have to do a high-speed snake type of movement up and down the corridor, which is more difficult to navigate," he says.

To be sure, workzone ITS is nothing new for Caltrans. "We use ITS in all of our projects – it's very common," Horton says. "We use portable message boards, permanent message boards, the 511 communication system that gives travel information, we use the web, we have the Caltrans QuickMap app

Workzone ITS success

The US statistics that prove intelligent transportation systems are worth the investment in order to keep traffic in workzones moving safely

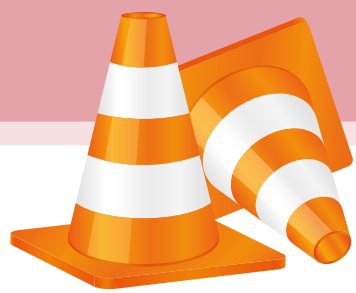
50-80% The proportion of drivers who changed their routes at least some of the time in response to information on travel times, travel delays or alternative routes, according to a Federal Highway Administration study of a variety of workzone ITS deployments. The study also showed that speed monitoring displays resulted in reduced speeds through workzones by between 4mph and 6mph.

14% The reduction in queuing crashes reported during work to improve the crossroads of the I-57 and the I-70 freeways in Effingham, Illinois, after ITS was deployed at the site. There was also an 11% reduction in injury crashes. Both reductions occurred despite a 52% increase in the number of temporary lane closure days recorded.

85% The reduction in the number of vehicles traveling 12mph or more above the workzone speed limit in the state of Maryland following installation of an automatic speed enforcement program that makes use of cameras to fine speeding drivers. Called SafeZones, the program has been deployed since 2010.

82% The proportion of Arkansas drivers who reported in a survey that an automated workzone information system helped them better respond to slow or stopped traffic.

20 minutes Reduction in average incident response and incident clearing times in New Mexico due to the use of a traffic management system that, among others, made sure that no redundant emergency or motorist assistance vehicles were dispatched.



> If there is a major incident, we need to scramble and make sure we are blasting the information out to as many information sources as we can
>
> **James Pinheiro, deputy director of traffic operations and maintenance, Caltrans Orange County**

A total of 18 bridges will be replaced as part of the improvements to the I-405 freeway

Left: **Approximately 16 miles between Route 73 and Interstate 605 will be the focus of the improvement project**

For videos detailing the I-405 Improvement Project visit **trafficTechnologytoday.com/405-1** and **trafficTechnologytoday.com/405-2**

that tells people about lane closures and traffic conditions, and we use these for all maintenance and construction zones."

What makes the I-405 Improvement Project unique is its complexity and size: "It would dwarf projects in probably 35-40 other states in the USA," says Brian Simi, transportation system performance manager at Caltrans.

According to Hart, the addition of new lanes is crucial as northbound travel on the 16-mile stretch during afternoon peaks already takes 54 minutes in regular lanes and 51 minutes in the HOV lane. For southbound travel, morning peaks are critical, with 67 minutes being the average travel time for regular lanes and 44 minutes for the HOV lane. Without the I-405 Improvement Project, those travel times could exceed two hours by 2040.

> The Caltrans QuickMap app tells people about lane closures and traffic conditions for all maintenance and construction zones
>
> **Joe Horton, chief, Office of Safety Innovation and Cooperative Research, Caltrans**

Travel times on the 16-mile stretch of I-405 could exceed two hours by 2040

According to Horton, the next big advance in workzone ITS will come with the arrival of the connected automated vehicle.

"It's going to be the connected automated vehicle that is going to have the biggest impact on both normal ITS and workzone ITS," he says. "We are seeing the possibility for major reductions in deaths and accidents. [Today] we are limited because the only thing we can communicate to is the driver. And hopefully what we foresee is that we will be able to communicate with the vehicle and the driver, and we will have better decisions, and by having better decisions, the risks and the deaths will be reduced or go away."

2 HOURS

The projected peak travel time for the 16-mile stretch of I-405 by 2040 if the Improvement Project had not been implemented. Currently the journey takes up to 67 minutes in regular lanes

Tailor-made models

We are now in an age where city planning is increasingly influenced by new automotive technologies and the data sets associated with them. Fortunately, these influences can be incorporated into specialized modeling software packages that are tailored to each planners' requirements. Jack Roper explains more

There is a hidden substratum of traffic technology, a whole realm of data, mathematics and computational simulation whose existence the average road user might never suspect in a lifetime, but which underpins nearly all advanced infrastructure and decisions relating to traffic management. Whether it be improving intersection signal timings, forging an effective urban low-emissions zone (LEZ) regime, or building and designing a bridge to meet projected capacity while providing reliable journey times, over 95% of intelligent transportation systems (ITS) are shaped by the esoteric science of traffic modeling. Four-dimensional virtual worlds of vast detail and humbling complexity are created, set in motion and replayed to gauge in advance the impact of proposed changes on road networks and human environments.

"Traffic models are tools used to evaluate scenarios and conditions not necessarily observed in the field," explains Dr Hesham Rakha, professor of civil and environmental engineering and director of the Center for Sustainable Mobility at Virginia Tech Transportation Institute (VTTI). "Models are imperfect; they have margins of error because they attempt to replicate reality using our understanding of reality abstraction. They make projections of the future."

> Models are imperfect; they have margins of error because they attempt to replicate reality using our understanding of reality abstraction
>
> **Dr Hesham Rakha, director of the Center for Sustainable Mobility, Virginia Tech Transportation Institute**

Model styles

They fall into three broad categories: macroscopic and microscopic models

Maximizing modeling with data

City planners should only create 'digital twin' city models with relevant and essential data, according to the UK's Transport Research Laboratory (TRL)

In an evermore connected world, the sophisticated capabilities of traffic control, optimization and modeling solutions provide a rich set of tools for use operationally and in strategic planning. Connected and autonomous vehicles (CAVs), new and emergent detection technologies, and 'bigger data', all give rise to the abundant availability of data on what, where and when.

A key underlying element is the need not only for the validation of solutions, but also for them to be verified. For example, the modeling of CAVs must be underpinned by a solid foundation of understanding across the range of sensors and datapoints created, which are not based on generalized assumptions and are aligned with real-world systems and behaviors. The concept of the digital twin – a digital replica of physical assets, processes and systems – is ever more relevant for the development, deployment and use of systems in urban areas. A challenge of creating an urban digital twin is finding the correct, yet cost-effective, tools, systems and data from the real-life urban area that result in the digital twin providing a positive return on investment.

In the context of modeling there is a need for tools to go further in making use of the right data at the right time and for a much more joined-up approach in multivendor environments, which enables collaboration and data exchange.

Smart cities will use smarter tools, data, systems and processes where there is joined-up thinking, greater engagement with the users of the systems and the questions – of why are we doing this, how we can make it better and what can be achieved today and in the future – being fully answered.

at opposing ends of the spectrum, with mesoscopic models somewhere in-between. "Macroscopic models do not track the individual entities," continues Rakha. "Rather than modeling individual cars they model the aggregate flow of traffic – like water in pipes. Traffic becomes a compressible fluid: when roads are congested, it gets compressed, decompressing when congestion clears." Although seen as computationally fast, macroscopic models are, he says, less accurate, providing limited scope for analyzing individual vehicle behavior and interactions.

"At the other extreme is the microscopic model, where you actually track individual vehicles – typically every one-tenth of a second." Meanwhile, mesoscopic models track vehicles, but at much lower resolution, perhaps predicting a vehicle's speed between two fixed points on a link. While microscopic models are most analytically useful, Rakha has experimented with a combined method. "We looked at a hybrid approach. On local streets where you're not concerned about interactions because it's typically not congested, you could model traffic mesoscopically to speed up the simulation. For highways and arterials, where you are concerned with detail, you could model them microscopically."

> We are still in the infancy of connected vehicle and autonomous vehicle applications, where we must represent the entire vehicle system and the entire infrastructure
>
> **Dr Nagui Rouphail, professor of civil engineering at North Carolina State University**

Predictive pictures

Traffic models use data gathered from a given road system to construct a dynamic representation of actual traffic volume and flow. This is used to predict how traffic will behave on that system when a given parameter is varied, enabling informed planning and traffic decisions. In the 1950s, embryonic models relied on what rudimentary data could be harvested manually at the roadside, perhaps using tube counters or radar guns. The 1970s ushered in infrastructure-based data acquisition through sensors, video imaging and loop detectors, while the 1990s saw the advent of vehicle probe-based data from AVL, GPS and toll-tag technologies. While this enabled microscopic models to represent and predict individual vehicle behaviors, the last decade has seen data from mobile devices, Bluetooth readers and telematics systems such as second-generation onboard diagnostics offering the potential to track individual travelers as never before.

Today, with the dawning of machine autonomy, the volume, variety and quality of data available have begun to multiply exponentially. "We are still in the infancy of connected vehicle [CV] and autonomous vehicle [AV] applications, where we must represent the entire vehicle system and the entire infrastructure," said Dr Nagui Rouphail, professor of civil engineering at North Carolina State University, speaking to traffic experts during a recent industry webinar.

Above: **Transport for London uses modeling to monitor emissions levels**

Traffic emission simulation

Traffic emission simulation options are now available in the latest version of Aimsun Next mobility modeling software

Aimsun Next 8.2.2 includes options for modeling CO_2 and NO_x emissions, at both the microscopic and mesoscopic levels, from configurable fleets of European vehicles, to extend to North American fleets in the near future.

Traffic emission simulation first involves a detailed understanding of the composition of the fleet: vehicle and engine types, age and, in Europe, the Euro emission standard proportions. A generic interface specifies the mix of old and new, powertrain type (gasoline and diesel ICE, hybrid, EV) for all vehicle types and the model includes default fleet mix proportions for the UK (outside London) and London for 2017, 2020 and 2025.

Transport for London (TfL) has developed an average-speed London Emissions Model (LEM) matched to London driving conditions (central, inner and outer London). The model is underpinned by real-driving emissions (RDE) data, which includes on-road and laboratory data of passenger cars (gasoline, diesel and gasoline-hybrid), taxis, buses, and rigid and articulated HGVs. The average-speed emission functions for the entire European fleet of old and new (including Euro 6/VI) light- and heavy-duty vehicles, have been developed using a micro-trip approach. Unlike commonly applied average-speed models such as COPERT, which forms the basis of the UK Emissions Factor Toolkit, the functions can be applied to short road links or sections and are reliable at low speeds. The model can be applied to both microscopic and mesoscopic simulation results.

Current developments include an Instantaneous Emissions Model (IEM) that relies on Aimsun Next micro-trajectory simulations to take into account periods of acceleration, deceleration, cruising and idling.

The Aimsun team hopes that these advances will make vehicle emission models more accessible to Aimsun software users and help to clean the air in our cities.

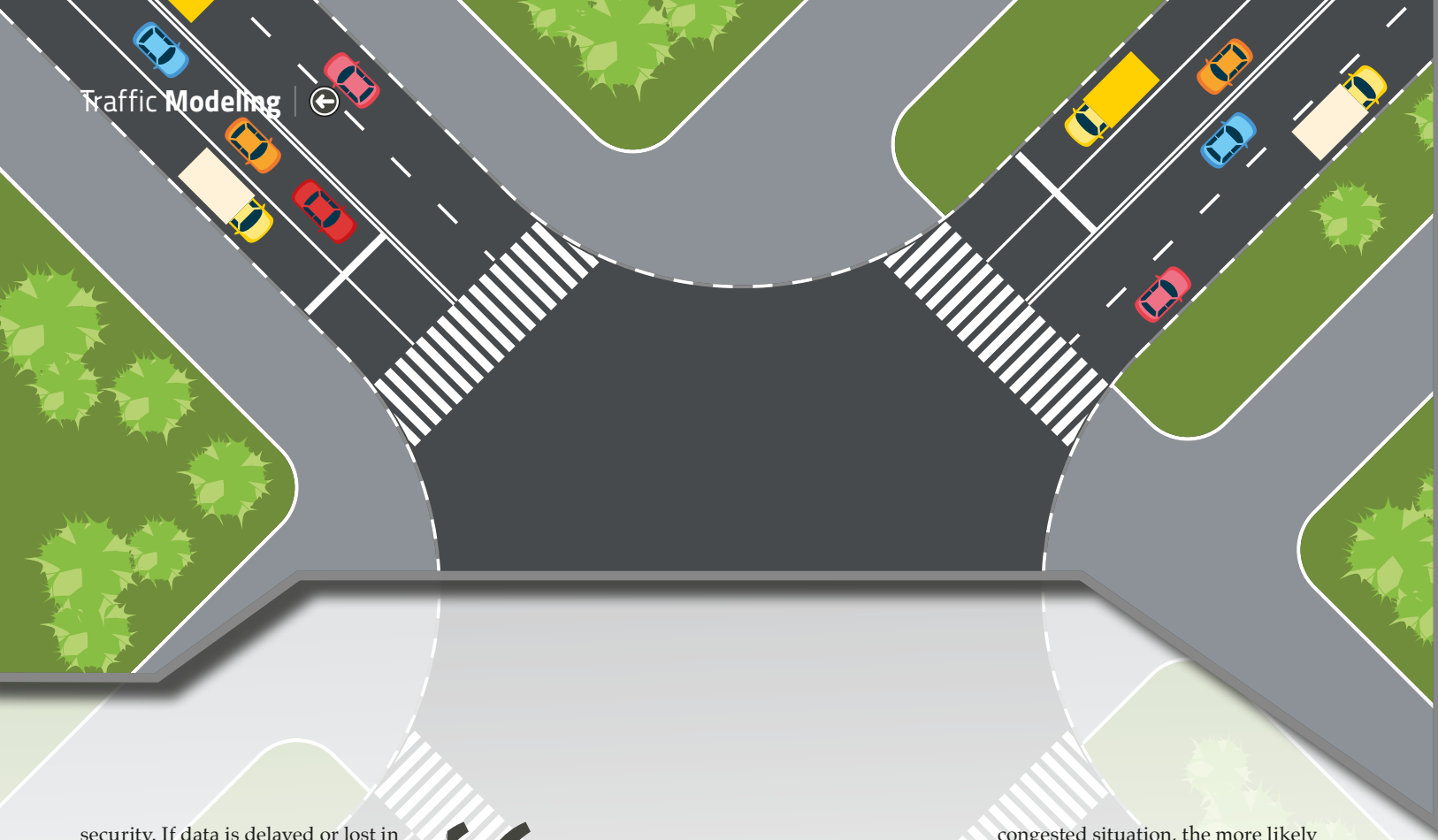
Full digitization of road networks will be prerequisite to AV deployment, with HERE data sets capable of generating high-definition lane models and giving full, 360° representation of the infrastructure. In turn, AVs will generate inordinate volumes of sensor data and continually transmit detailed positional data, both to the infrastructure and each other, along with hundreds of files covering braking and acceleration events, trip distance, duration and speed, every few seconds.

"There may be a lot of data, but we should be interested in the data that can provide value for us," observed Rouphail. He outlined a number of opportunities that the high-resolution data explosion presents. New forms of data will improve microscopic simulation of driver behaviors such as car-following, lane-changing and gap acceptance. They will allow real-time shockwave prediction to feed in to effective queue-warning responses. They will facilitate signal timings based on real-time vehicle probe data. They will allow assumptions about standard driver responses to road events long embedded in traffic models to be tested. Driver behavioral data will enable predictive models of high-crash locations – for instance, where there is a high density of severe deceleration events. New data may also trigger an increase in naturalistic driving studies that plot driver posture and facial expression against road behavior.

> "You need some means to communicate all that data; between the traffic and the data is the communication. It could be cellular, wi-fi or 5G
>
> **Dr Hesham Rakha, director of the Center for Sustainable Mobility, Virginia Tech Transportation Institute**

But Rouphail believes CV-AV big data will provide manifold challenges, too. Modelers must learn to manipulate unfamiliar elements such as positional data, which automated vehicles generate in the form of 100 latitude-longitude pairs every 10 seconds through their basic safety message. They must understand the data's limitations while identifying the new predictive abilities it presents. Crucially, they must winnow the wheat from the chaff, choosing those data elements from which value can be extracted. They must avoid unthinking reliance on artificial intelligence and machine learning to sift data and crank out results. And they must devise new visualization schemes to render models of mushrooming complexity meaningful to non-specialist clients. "When you have those levels of data, visualization is going to be very important because this is how you convey insights as well as anomalies."

To accurately simulate real-world traffic, models must replicate not only the behavior of individual vehicles, but all interactions between drivers, vehicles and the infrastructure, which will become infinitely more sophisticated through CVs. "You need some means to communicate all that data; between the traffic and the data is the communication," says Rakha. "It will be wireless communication – it could be cellular, wi-fi or 5G. With it comes latency, loss of packets and data



security. If data is delayed or lost in communication, it will affect the performance of your transportation system." It will thus become vital to integrate communication and traffic models in order to accurately portray overall system performance. "As network congestion builds there are many more vehicles communicating," he adds, "which means more loss of packets and delays in your system. That mutual interaction is important to capture."

The Mobility as a Service (MaaS) movement is driving the emergence of multimodal models that track individual travelers across several transportation modes for the entire length of a trip. Rakha is currently working on a project in Greater Los Angeles with the US Department of Energy. "We have to model over three million travelers across all the modes," he says. "We've developed models for trains, for buses, for bicyclists, for pedestrians. We're looking at ways to modify people's driving to reduce fuel or [in electric vehicles] energy consumption."

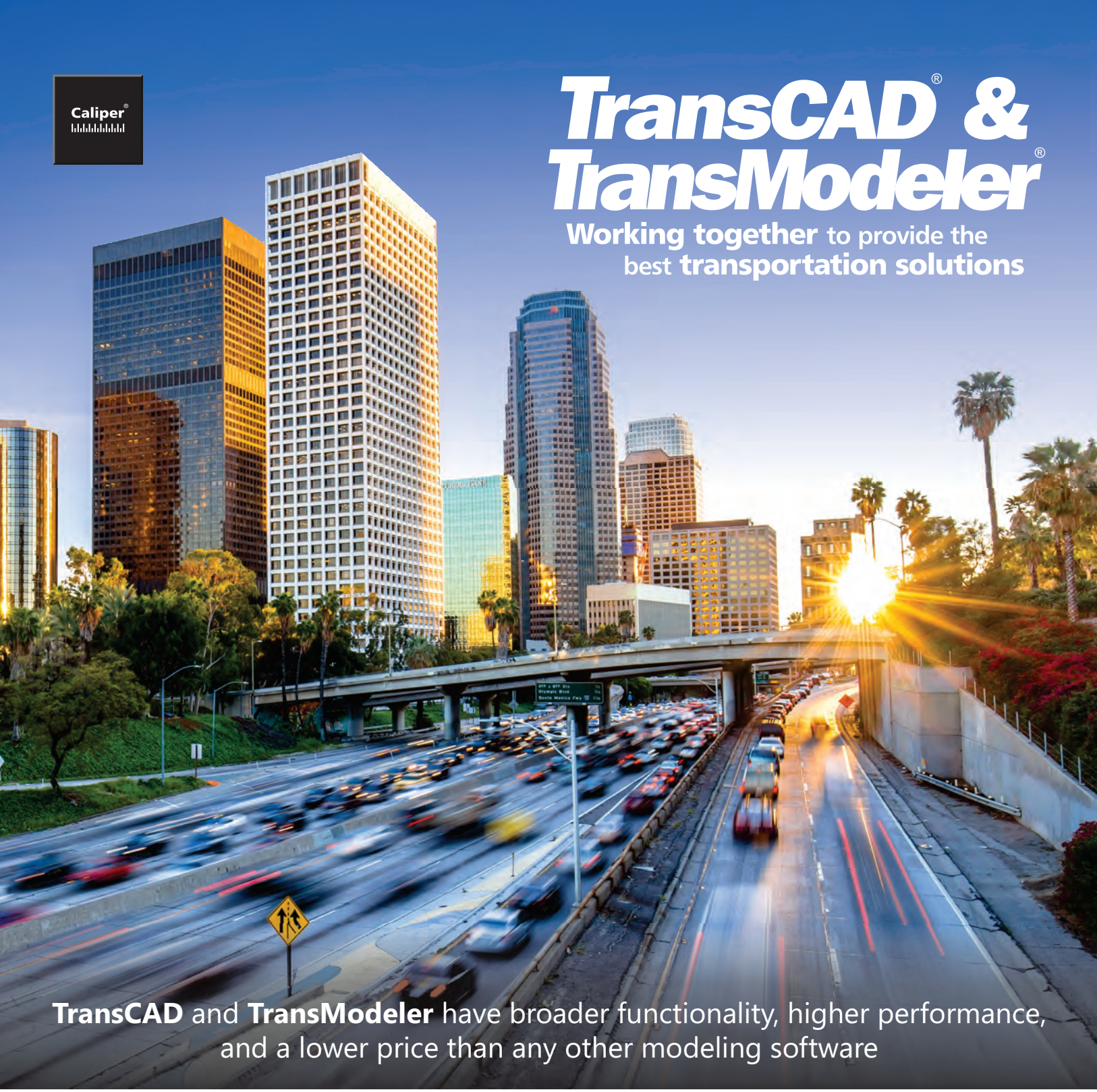
> "Lane changes are critical to bottleneck activation. The more lane changing there is in a congested situation, the more likely you are to reach a breakdown in capacity
>
> **Dr Nagui Rouphail, professor of civil engineering at North Carolina State University**

Perfect for the job

Around the world, specialized models simulating the long-term effects of traffic on urban air quality are being used to shape metropolitan LEZ regimes charging or excluding vehicles based on emissions. Much of Rakha's work concerns the environmental impacts of traffic – so how can these be mitigated? "One way we've found is rerouting people to minimize their fuel or energy consumption," he answers. "Another way is by sharing information: if a red light can tell an approaching vehicle it will turn green in 10 seconds, then it could delay you for those 10 seconds in a fuel-efficient manner, reaching the stop-line at the highest speed possible."

One project at North Carolina State University has used a model integrating digital road infrastructure with vehicle-based positional data to detect and characterize lane changes. "Lane changes are critical to bottleneck activation," explains Rouphail. "The more lane changing there is in a congested situation, the more likely you are to reach a breakdown in capacity." One aim was to characterize specific lane changes as either passive or aggressive based on the lateral speed involved. "This will enable us to do some clustering of driver behavior," he says. Another aim was to emulate the ways in which AVs will navigate in the future. "There may be new intersection control schemes based on projected individual CV arrivals – virtually a scheduling and reservation exercise in order to maximize throughput."

Does the mind-boggling complexity of traffic modeling in a connected, autonomous age leave you feeling confused? You wouldn't be the only one. But fortunately, any number of commercial providers are on hand to offer specialized software packages increasingly tailored to a range of diverging customer requirements. While some suites emphasize their user-friendly interface, others are optimized for large-scale urban planning or designing signalized intersections in compliance with local or national guidance. And although predicting future events must ever remain an imperfect science, there seems one gleaming certainty: that the parallel worlds of traffic models will continue to blossom and flourish unseen, both mirroring and molding the realities they show.



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Information highway

Managing infrastructure assets used to be all down to planned maintenance schedules. Now, as we enter the age of the Internet of Things, road managers have a growing array of smarter solutions at their disposal, as **Paul Willis** discovers

The Internet of Things (IoT) – meaning objects and devices fitted with some manner of smart technology and internet-enabled – is proliferating at an astonishing rate. According to some estimates it will consist of 30 billion objects by 2020. Among these are more and more devices devoted to road maintenance.

In the UK, for example, a number of local authorities and Highways England, the body that oversees England's Strategic Road Network (motorways and A-roads), has begun installing wireless road sensors to aid gritting operations in winter. Similar sensors are being used to control traffic flow in French cities and measure deterioration on bridges. A separate project by US technology giant Harris Corporation is leveraging data from traffic cameras to predict adverse road conditions in North America and Europe.

These technological advances are in large part due to the plunging cost of IoT hardware, says Lee Chapman, professor of climate resilience at Birmingham University in the UK. "The big problem in the area of highway maintenance is that we've never had enough data on weather and road use," he says. "But we only ever put out a limited number of weather stations and traffic counting devices, simply because the cost, until recently, has been deeply prohibitive.

"If you want to install traffic-counting data, for example, you have to power it, which probably means digging up the road to install power lines. You also need some way of back-hauling the data, which might be a modem or a satellite phone, which have a monthly cost associated with them.

"IoT does away with these types of cost. With IoT we tend to use low-powered sensors that can run on lithium batteries. We can put a sensor in a city and back-haul data using citywide area networks, so you don't need a modem or satellite phone."

> We only ever put out a limited number of weather stations and traffic counting devices, simply because the cost, until recently, has been deeply prohibitive
>
> **Lee Chapman, professor of climate resilience, Birmingham University, UK**

These cost reductions, brought about by the miniaturization of electronics, also lead to greater scalability. "Now you can put 10 if not 100 sensors where you put one sensor in the past," says Chapman.

Management of Things

1 Bridges

As Birmingham University's Prof. Lee Chapman explains, monitoring a bridge's condition involves putting "multiple sensors on it to measure the various strains on the structure". The sensors available to monitor bridges include accelerometers, strain gauges, and wind velocity, temperature and potentiometer displacement sensors. These IoT systems have already been deployed on some bridges in the USA.

Management of Things

2 Traffic volumes

At present, traffic volume is most commonly measured by pressure points embedded in the road, but there's no reason you can't do it using an IoT lamppost monitor, according to Prof. Chapman. The monitor has a simple motion sensor like the one used in domestic burglar alarms. Chapman says, "The usefulness of this data to road maintenance is that you can use it to work back to find out the likely impact of traffic volumes on wear and tear."

Wintersense sensors are helping transport authorities in the UK plan de-icing strategies

"So the granularity of what you can understand about what's going on in the road network is available now at an unprecedented scale. That has exciting consequences for how these maintenance regimes are dealt with."

Chapman has spun his own research in this area into Wintersense, a road temperature sensor now used by transport authorities in the UK to help them plan their winter de-icing strategy.

"The sensor quantifies temperature differences on a nightly basis," he says. "That sounds pretty straightforward. But on a typical winter's night in a city like Birmingham you would have a 10°C [50°F] temperature difference between the outskirts and the city center. These sensors allow you to target that treatment so that you can save money by not putting it down where it's not needed." The extra layer of data also provides a cushion against potential litigation. "You've got an audit trail to show that you took all necessary steps to make the roads as safe as possible," he says.

> There are innovators in the sector but since the credit crunch budgets have tightened up
>
> **Lee Chapman, professor of climate resilience, Birmingham University, UK**

Similar road sensors have also been installed in the French city of Troyes by IoT startup Hikob. The sensors monitor road surfaces and identify road hazards by measuring changes in temperature, traffic volume and humidity.

A long road ahead

The examples quoted above might give the impression that IoT is taking over road maintenance. But in reality they are the exception, a few small-scale projects run by startups, and for the most part road maintenance regimes remain trapped in the old model of doing things.

"It's quite a conservative industry," says Chapman. "There are innovators

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Management of Things

3 Snowplows

GPS has existed on snowplow fleets for some years. Originally it was fitted to plot vehicle location but over time it has developed into much more sophisticated systems that can collect information on road conditions, how much salt has been put down and even the position of the plow's blade. According to Harris Space & Intelligence's Sheldon Drobot, IoT technology can be leveraged to "feed this data in real-time back to the maintenance shed, so that they can better manage their assets out on the road".

Management of Things

4 Gullies

UK-based startup InTouch has developed IoT sensors to work out when gullies are blocked, to prevent localized flooding on roads. The system uses on-the-ground sensors in conjunction with real-time weather data to help predict floods and send out automated alerts when necessary.

in the sector but since the credit crunch, budgets have tightened up. It means it's a challenging time to push all this through but it also underlines that we need an intelligent approach to tackling it."

Chapman's thoughts are echoed by Richard Hayes, chief executive of the UK's Institute of Highway Engineers, who believes that part of what is feeding this conservatism is a fear that "if you start looking into these things you will get too much information".

"The attitude is: It's best not to know how much of a bad state things are in because then you have to do something about it," he says. "So at the moment we're tending to just paper over the cracks."

Sensor data can be used to build a clearer picture of road conditions

But this attitude is unsustainable in the long run, according to Chapman. "If you don't know about a problem, is it still a problem? Well, of course it is. If you can make the business case that fixing a problem before it becomes critical is going to cost you less in the long run, then hopefully that attitude changes," he says.

In the USA, the failure to address the problem of crumbling road infrastructure has caused a crisis on the country's roads. The starkest example of this was the 2007 collapse of the I-35W Mississippi Bridge in Minneapolis, which cost the state millions of dollars in repairs and resulted in 13 fatalities.

A 2014 study by the Federal National Bridge Inventory showed that over 65,000 of roughly 600,000 US bridges were classified as "structurally deficient", and of these nearly 21,000 were classified as "fracture critical", meaning the failure of a single, major component could lead to their collapse.

In response to this crisis, various small-scale efforts have been launched

using IoT technology. For example, Michigan University's Center for Wireless Integrated MicroSensing and Systems has fitted the new Carquinez Bridge in San Francisco with a range of IoT sensors including tri-axis accelerometers, strain gauges, and wind velocity, temperature and displacement sensors. The data collected is used to build a picture of the bridge's response under high-stress conditions such as high winds and earthquakes, and to determine in real time when the structure needs repairing.

These early intervention strategies challenge the existing approach, which is characterized by Hayes as "a worst-first strategy".

"The standard inspection of a bridge might be to look at it and say, 'It looks okay. There's a bit of paint coming off'. But the person doing the inspection doesn't realize that the paint is the bridge's first line of defence," he says. "We're stuck in a funding cycle that says it's better for a thing to fall apart before we do anything about it."

Opportunistic sensing

One potential way around this funding gap is to leverage IoT technology that is already out there – so-called opportunistic sensing. An example of this is the Harris Corporation's Helios project, which automatically classifies images from tens of thousands of traffic cameras on roads all over the world to determine the presence of weather conditions such as fog, snow and rain as well as measuring traffic density. The information is fed back to road authorities to tell them when conditions are changing. An alert can be sent out in the case of extreme weather.

> By sourcing the data from cars you can build up a more detailed picture of the roads. You could use this data to detect potholes
>
> **Sheldon Drobot, principal for noble causes, Harris Space & Intelligence**

"In this case we don't own any assets," says Sheldon Drobot, principal of noble causes for Harris Space & Intelligence. "We're simply getting the camera image from the departments of transportation and running big data analytics on it. So there's no added cost."

This last factor is surely a major determinant in the technology's big rollout – it's operational on 45,000 cameras in the USA and about 10,000 in the UK. An even richer potential harvest of opportunistic sensing data is from road vehicles, according to Drobot, who has authored a Ted Talk on the subject.

"By sourcing the data from cars you can build up a more detailed picture of the roads," Drobot says. He gives the example of 3D accelerometer data available on many modern cars. "You could use this data to detect potholes. If there's a sudden dip in one of the axes, for example, it could indicate a pothole."

The technology already exists to do this. The main obstacle Drobot sees to its rollout is a lack of standardization. "The worst thing in the world would be each car manufacturer having its own standard for data collection and transmission and none of them working together," he says. "We need a common language so that road managers don't need 50 different translators to bring everything together.

"The other area of concern is data privacy. We need to make sure we don't give away personal information about drivers."

Management of Things

5 Embankments

IoT devices are being used to track embankment stability. "There are lots of sensors in there to monitor things like soil moisture to work as a warning system for landslide risk by the side of the road," says Prof. Chapman.

Big data challenges

Increasing amounts of data from multiple sources mean we must develop smarter ways to analyze it and turn it into usable information

The hope is that by deploying IoT technology across the road network a wealth of much-needed data will become available to help better inform decisions about road maintenance. But as Birmingham University's Prof. Lee Chapman puts it: "It's not data that you need, but information."

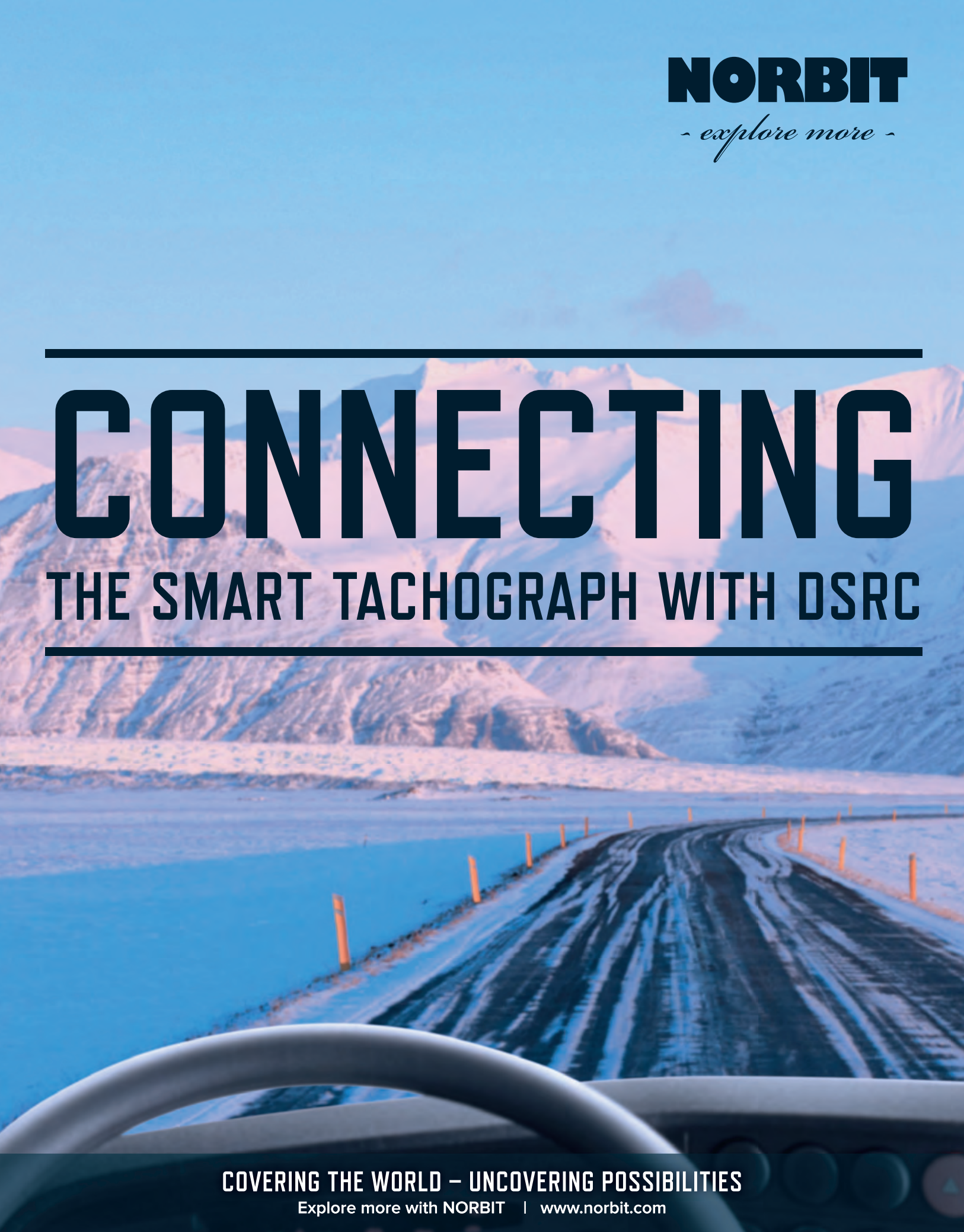
In other words, data on its own is useless unless you can understand from it what action is required. Given the vast troves of potential data sources that IoT technology offers the sector, there's a risk of drowning in data. To avoid this problem, Sheldon Drobot of Harris Corporation believes, the industry can draw inspiration from the development of satellites.

He says, "About 50 years ago we had just a couple of satellites sending down a small amount of data. Fast-forward to today and we have vast amounts of data every minute. There's so much that no human can make sense of it in real time. Instead we rely on the research community to produce sophisticated algorithms to trawl that data for usable information."

But no matter how sophisticated the filtering software, Drobot says that for critical things "you'll always need a human in the loop".

But these concerns about big data are not a reason to reject it, especially given the alternative, which means staying with a current model that relies for a large part on localized knowledge, which is necessarily circumstantial and easily lost.

Chapman says, "It's fascinating if you chat to the people on the ground who do the maintenance. What they have in their head is an encyclopedic knowledge of the road network they are dealing with – they know the network; they know where the problems are likely to be. But if they move on, that information is not necessarily retained. So you can think of the IoT as replacing or providing that knowledge."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Cellular V2X trials begin in Japan

New 5G-based Cellular V2X promises non-line-of-sight, low latency awareness combined with cloud capabilities

A consortium comprising Continental, Ericsson, Nissan, NTT DOCOMO, OKI and Qualcomm Technologies is to carry out its first cellular vehicle-to-everything (C-V2X) trials in Japan.

The project will aim to demonstrate the complementary benefits of network-based communications using LTE-Advanced, as well as show the enhanced range, reliability and latency benefits of C-V2X direct communications operated in the 5GHz waveband.

The trial results will help develop the ecosystem by providing inputs to the relevant stakeholders, including ITS-related organizations and government agencies, as they prepare for the future widespread deployment of connected and autonomous vehicles, and the industry's evolutionary transition toward 5G New Radio (NR).

While complementing other ADAS sensors, such as radar, lidar and camera systems, C-V2X provides non-line-of-sight low-latency awareness with longer range and cloud capabilities, and is designed to extend a vehicle's ability to see, hear and communicate further down the road, even at blind intersections.

C-V2X radio technology is state-of-the-art cellular technology that is being validated for global deployments, and makes use of the upper layer protocols developed by the automotive industry over years of research to support new advanced end-to-end use cases.

C-V2X direct communications, on the other hand, provides enhanced range and reliability without relying on cellular network assistance or coverage.

58: Project update
The Tampa Hillsborough Expressway Authority (THEA) connected vehicle project in Florida is the largest project of its kind, utilizing 1,600 vehicles. Find out what's been achieved so far


REDUCE
40

Tried and tested

As the THEA connected vehicle project reaches its second of three 'design-deploy-test' stages, **James Gordon** speaks to those working on the project to find out how initial challenges were overcome and how the results can be applied to real-world applications in the future

It is one of the largest projects of its kind and includes 1,600 private vehicles, 10 commuter buses, 10 Tampa Electric Company (TECO) streetcars and a minimum of 500 pedestrian safety devices. But as the Tampa Hillsborough Expressway Authority (THEA) connected vehicle project reaches the third and final demonstration stage – in what is a crucial juncture in its development cycle, THEA, the lead agency for the pilot, "continues to work diligently with both private and public sector organizations to ensure that the pilot not only meets US Department of Transportation's [USDOT] requirements, but also lives up to the expectations of the public", says Bob Frey, THEA's planning director and project manager for the Connected Vehicle Pilot Program.

With the design, deployment and testing phase completing in four months' time, Steve Novosad, a senior member of HNTB Corporation, who is assisting with the pilot program, provides a progress update: "In terms of building and testing in-vehicle mobile devices and roadside technology, so far, we have installed more than 20 of the 46 roadside units [RSU]," Novosad says. "We began recruiting volunteer drivers in August 2017. To date, we have equipped nine 'friends' of the pilot, with plans to install an additional 10-15 in early December. Full installation activities are planned to ramp up in January. The 10 transit

buses and 10 street cars are planned for installation in Q1, 2018. We hope to complete the equipment roll-out by May 2018."

But the pilot, which also includes Siemens, which is responsible for systems engineering and roadside infrastructure deployment, has encountered many challenges. Take compatibility, for example. Dave Miller, a systems designer at Siemens, says it is "one of the greatest hurdles centered around creating a safe, secure and robust system infrastructure that is interoperable throughout North America. For example, the private vehicles equipped in Tampa must also operate in the New York and Wyoming pilots as well with future new vehicles."

"This point is important not only for the pilots, but for the future of connected vehicle [CV] deployment nationwide," says Frey. "CVs will have to reach the point where local jurisdictions can be deployed in an economical, efficient manner. We will get to that point by creating and utilizing standards."

Proven performance

In order to ensure conformity in the project early on, Miller, who is responsible for all of Siemens's US CV initiatives, and the THEA team, decided "that it could only rely on published Society of Automotive Engineers (SAE) standards, not ever-evolving standards development." The project, therefore adopted a baseline of SAE, National Transportation Communications for ITS Protocol (NTCI) and Institute of Electrical and Electronics Engineers (IEEE) standards published on January 1, 2017. But as the technology that Siemens is working on is so new and leading-edge, Miller and his engineers quickly discovered that there were instances where no US standard existed. So, what then?

"Whenever we encountered a scenario like this, we simply used internationally recognized standards," explains Miller. "Although each pilot has common applications, they also include unique applications, such as reversible lanes in Tampa, heavy truck safety in Wyoming, and over-height warnings in New York. By adhering to a baseline of adopted standards, common applications are interoperable within all pilots, while unique applications produce no unexpected behavior by vehicles operating within other pilots."

> Connected vehicles will have to reach the point where local jurisdictions can be deployed in an economical, efficient manner. We will get to that point by creating and utilizing standards
>
> **Bob Frey, planning director and project manager, Connected Vehicle Pilot Program, THEA**

Miller believes that aligning technology with proven industry standards has laid the foundations for a stringent program of testing. He points to the fact that from day one, the pilot was managed as "a systems engineering project" and not as "a procurement outsource project". Miller is also keen to single out the enhanced visibility provided by the 'enterprise view', which he says includes 30 stakeholder organizations and groups of individuals contributing user needs that trace to requirements, realization and test.

With each project phase separated by a quality gate, where Miller and

Right: **An in-vehicle speed limit warning, displayed on a rearview mirror, that could be used in post-pilot operations**

Security passes

Cyberterrorism risks threatening connected vehicles can be reduced with the use of trusted vehicle certificates

With the world on the cusp of a connected vehicle revolution, the risk of succumbing to cyberattack grows.

To eliminate the chances of vehicles and their owners falling victim to cyberterrorism, all three of the connected pilot programs have developed advanced security certificate management systems (SCMS) in place. All of these use digital certification to ensure that the basic security modules and traffic incident management that drivers receive are valid and are not intercepted or manipulated by fraudulent actors.

HNTB Corporation's Steve Novosad confirms that over the next month, "The THEA CV pilot team will obtain the device certifications necessary to access the SCMS through the OmniAir Consortium", an industry-leading association seeking to advance interoperability and certification in connected vehicles. After receiving the certifications, the devices will be registered with the SCMS to obtain its root certificate and to have the capability for receiving certificates.

Dave Miller from Siemens thinks that this is a landmark moment for the project, as "it will enable all connected vehicles and roadside equipment to trust others that have trusted certificates."

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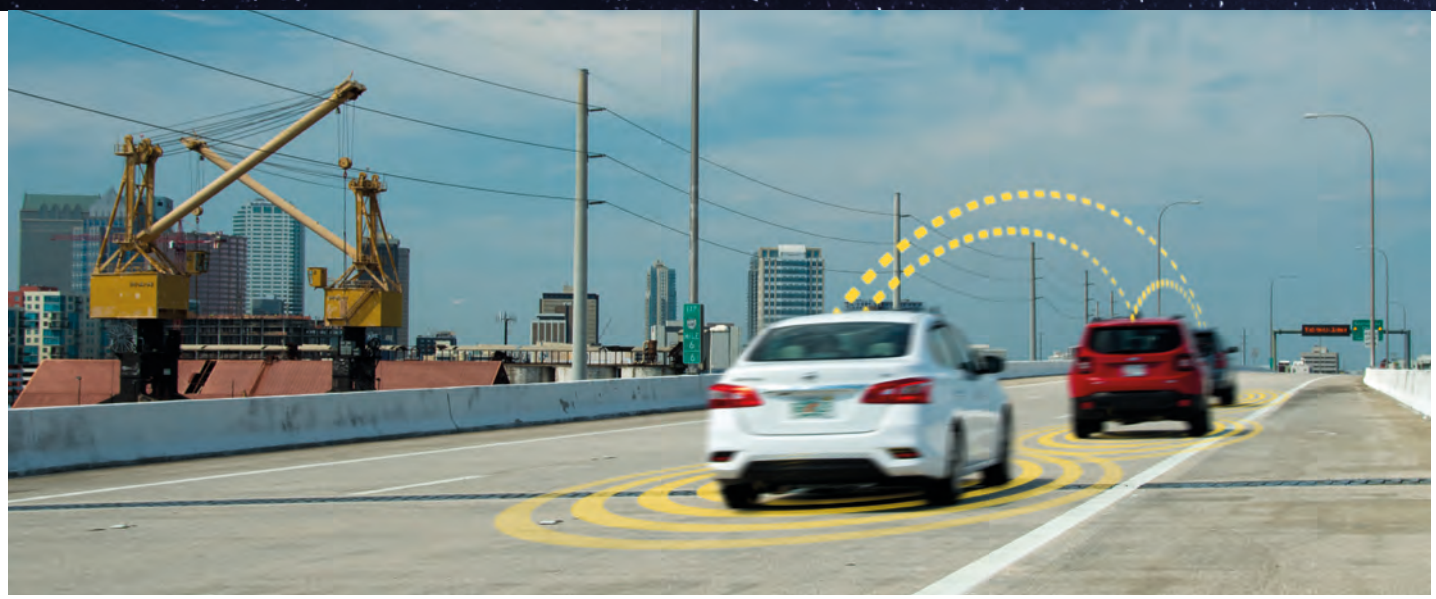

his team have the freedom to adjust requirements – which are then approved by a change control board of stakeholders – the needs of the long-term owner/operators are fulfilled. However, in order to create this enterprising and innovative testing landscape, the traditional design phase was replaced with an investigation phase, where Miller says that, "Requirements were compared with existing applications developed for earlier USDOT testbeds."

But how exactly does the rigorous and robust testing environment that has been created bridge the gap between the stated requirements and the technology being tested?

> A belt-and-suspenders approach ensures that vehicles receive the location, direction and speed of all moving objects ahead, 10 times a second, every second
>
> **Dave Miller, systems designer, Siemens**

"At Quality Gate 1, we adjusted the requirements based on investigation," says Miller. "At Quality Gate 2, we adjusted the requirements based on the first article test of each hardware and software object. Quality Gate 3 occurred after an integration of software into hardware objects as vehicle, infrastructure or personal device subsystems. Quality Gate 4 occurred after integration of subsystems into field tests of the final system. Finally, Quality Gate 5 occurred after validation of the final system in Tampa with actual configuration data."

But can the project be confident enough for test results to be used in real-world applications?

Take the line-of-sight from the RSUs for instance. How can the team be sure that the RSUs provide full coverage for the westbound section of the recommended exposure limit (REL), and also the other one-mile catchment areas covered by the project?

Dave Miller says, "Siemens has a specialist survey team that visited the test site for 10 days and carried out an extensive survey. The team evaluated and checked the line-of-sight for each of the 41 RSUs. It found each one had a range of well over 300m [984ft], meaning that the

Above and below: **Vehicles in the pilot are using connected technologies to optimize traffic flow and improve safety for road users**

Left: **An OBU used in the THEA pilot, which contains the DSRC and CPU**

catchment area has full coverage. The RSUs have the capability to allow multiple RSUs to behave as one if a single RSU cannot cover all approaches, but in this case, that capability was not needed."

"But if we take an individual RSU – for example, the RSU 1 which is located on the apex of the western-bound section of the Selmon Expressway – a range of 300m encompasses all the roadway from the inbound approach to the tunnel underneath the underpass.

Intersection tech

Miller is keen to speak about the pedestrian-to-everything (Ped-X) and pedestrian-to-signal (Ped-Sig) applications, which help pedestrians cross busy intersections, most notably at the George E Edgecomb Courthouse, where 400 people gather each Monday.

> The app differs from traditional pedestrian detection in that a warning is not issued if the pedestrian is walking within the crosswalk, but will clear before a vehicle arrives
>
> **Dave Miller, systems designer, Siemens**

Above: **Demonstrations of collision avoidance, using the connected technologies involved in the pilot project**

Below: **In-vehicle forward collision warnings could help reduce the number crashes on roads**

"When we began pre-certification testing in the Siemens parking lot, we realized that if the crash avoidance element of the technology was going to work at a crosswalk, the smartphone's GPS location needed to be supplemented by a lidar system in order to determine whether the pedestrian is walking near the crosswalk, or entering the crosswalk," says Miller. "We have since installed them at ground level outside the courthouse and at other key intersections." So how does the technology work?

Miller says, "A belt-and-suspenders approach ensures that vehicles receive the location, direction and speed of all moving objects ahead, 10 times a second, every second. The app warns the driver only when the vehicle predicts a potential collision. It differs from traditional pedestrian detection in that a warning is not issued if the pedestrian is walking within the crosswalk, but will clear before vehicle arrives [false positive warning].

"Likewise, a pedestrian walking toward the crosswalk will issue a driver warning if the vehicle and pedestrian are predicted to crash, which would be missed by a traditional pedestrian detector [false negative, absence of warning]."

That is not to say, however, that the smart phone location service is not effective in saving lives."While it cannot identify that a pedestrian is on the curb about to walk out onto a busy road, it can identify a pedestrian or a cyclist ahead that has the application on his or her smartphone without need for the lidar," says Miller. "The PED-X app will communicate in real time though an RSU to a vehicle, which will create an emergency electronic brake lights (EEBL) or a forward collision warning message to a driver that a pedestrian or cyclist is close by."

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Using WIM to charge tolls according to vehicles' weights

The future of toll collection lies in weigh-in-motion (WIM) technologies. In recent years, transportation infrastructure has faced a dynamic challenge. The volume of vehicles on roads continues to increase and authorities have had to deal with the seemingly never-ending number of vehicles that violate the rules of the road as they try to save resources. Exceeding the load's weight limit is a common violation, and can damage road surfaces, which then require additional maintenance, leading to extra repair costs. The cost of road maintenance and repairs is often covered by toll fees and, as a result, these have become unfair toward law-abiding drivers. This situation has created a high demand for technological solutions that can cut costs, automate processes and help with direct penalization of violators.

Toll-per-ton WIM

Weigh-in-motion is an up-to-date solution for regulating and monitoring traffic flow, and it is particularly useful for capturing and recording the axle and gross weights of vehicles on the busiest roads. Automated WIM systems help authorities to detect load violations and save on human resources, time and costs that would otherwise be spent on maintenance and carrying out the procedure manually. WIM technologies have the potential to enable vehicles to pay tolls according to their weight in the near future. With the toll-per-ton concept, a vehicle would pay a certain amount for each metric ton of its load, which would make pricing strategies conditions much more fair and transparent than at present.

Need to know

The CrossWIM system can be used for...

- Vehicle classification
- Detecting overweight/ overloaded vehicles
- Monitoring traffic across single or multiple lanes
- Double-tire detection

Eventually, it might lead to fewer overloaded trucks.

Thanks to a combination of hardware and software components, current dynamic WIM measurement units, such as the CrossWIM control unit, detect the gross vehicle weight, axle load and the wheel load. The system can measure moving vehicles with high accuracy, as well as gauging the size of the vehicle and enabling subsequent classification of the vehicles' types. Another advantage is its ability to detect the proper usage of twin tires.

Limitations of current WIM

Despite WIM's indisputable advantages, current, widely used sensors in dynamic weight measurement applications have limitations. In most instances, the sensors are arranged in two or more rows, which allows the repeating of measurements for higher accuracy. However, to take measurements, the vehicle must be moving forward in a straight direction. The sensors are unable to accurately measure if the vehicle moves in a skewed direction. Another limitation is the inaccuracy of measurements taken at the edges of the sensors. This limitation reflects the design of the sensors themselves, as they are positioned horizontally in each lane when taking measurements. However, they are not equally distributed across the width of the lane. While the measurement is very accurate at the center of the track, it is not sufficiently so on the sensors placed at the ends. Therefore if the vehicle moves between the two lanes, the measurement is not reliable. This, of course, creates an opportunity for dishonest drivers to avoid weighing their vehicle and subsequently to avoid penalties.

System requirements

Even though the most widespread WIM systems on the market provide measurements with the emphasis on the highest accuracy possible, tolerance in even the most precise units is about 5%.

In order to prevent potential court disputes caused by inaccurate toll-per-ton weight assessments, specific classifications, including various degrees of tolerance, would have to be established. The exact procedure for

Left: **Cross Zlín's CrossWIM helps road authorities to ensure trucks and freight vehicles are not causing damage to road surfaces by being overloaded**

classification assessment is still under discussion, but the need for it is evident.

Future challenges for WIM

The limitations of current WIM systems need to be addressed if toll collection is to be more efficient and the toll-per-ton solution is to be established as a major system for keeping road surfaces in good, safe conditions while using adequate resources. One particular area for improvement is the accuracy of the measurements, as the current 5% tolerance is too high. In addition, sensors will need to cover the entire space between measurement lanes so that the system cannot be cheated – otherwise it could become widespread practice for drivers to pay lower toll fees than required if they figured out how to bypass the system. The last area that requires improvement is that of lane coverage adjustment. Sensor units must be able to measure the vehicle's weight, regardless of its location on the lane. When these challenges have been overcome, the road will be clear for establishing an efficient, time- and money-saving, fair system for toll collection.

Richard Butter

Automated and connected technologies will be in widespread use in freight vehicles long before consumer vehicles

"Daimler, Volvo, Uber and Apple are all testing automated trucks"

January 3, 2018, 4:15am. My alarm sounded – it was time to get up. I slept on a couch downstairs, as I didn't want to wake up my family at this crazy time. But what was an unusually early start for me was just another day at the office for one of my friends, a truck driver. He works for a large confectionery company, which is a main supplier for Aldi and Lidl, the big German retail chains, and based in the city of Alkmaar, the Netherlands. I decided to join him on the road to experience road traffic from a different point of view. We spent the day driving to the company's distribution centers in the southern part of the Netherlands to deliver its products. As well as being great fun, it provided some food for thought for my next column – killing two birds with one stone.

If you have been following developments in Silicon Valley – specifically news concerning the Semi, Tesla's spectacular, aerodynamic, futuristic-looking fully automated truck – you will know that autonomy and logistics are serious businesses. Having hosted the Truck Platooning Challenge at Intertraffic Amsterdam 2016, I had been aware for some time that logistics is a hot topic. Surfing the web, however, made me realize what giant leaps have already been made in this industry, with regards to autonomous driving in particular. Daimler, Volvo, Uber and Apple are all testing automated trucks, and at last summer's Automated Vehicle Symposium in San Francisco the conclusion was that "heavy-duty trucks that don't need a driver behind the wheels could be on the road in as little as three years".

In the past, I must admit that when I spoke about autonomous driving, I more or less only considered autonomous consumer vehicles.

The Consumer Electronics Show (CES), which took place in Las Vegas in January 2018, once again highlighted the progress we still have to make in the fields of smart mobility and autonomous driving. But after my desk research and 'live experience' on the road, I am convinced that autonomous features, such as driver assist and safety enhancements, will be integrated into logistics and freight fleets much faster than into consumer vehicles.

Two things have really influenced my opinion how autonomy and logistics in Europe will progress the next five years. First, EU trucks not being allowed to drive faster than 90km/h (56mph) – and therefore having tachographs built into them. Second, convenient and efficient driving, due to drivers' extremely good visibility of the roads.

• *Richard Butter is director of traffic technology at RAI Amsterdam and is responsible for Intertraffic worldwide events,* ***www.intertraffic.com***

Regional microsimulation and dynamic traffic assignment

Traffic microsimulation is one of the most powerful tools for analyzing the efficacy of proposed transportation solutions. The benefits of microsimulation include reliably capturing individual drivers' behaviors, decisions and interactions, thereby enabling a model of the system's performance to respond appropriately to traveler decisions in such a way that respects the operational capacity. This would include, for example, those that arise from inter-vehicle interactions, such as in merging or weaving segments of a roadway.

Whereas microsimulation is well established in practice, transportation agencies are increasingly exploring dynamic traffic assignment (DTA) as a tool for addressing transportation problems that require a detailed handling of driver behavior and network performance that is not afforded by traditional static traffic assignment approaches. When microscopic fidelity is required for a specific application, such as traffic signal optimization, traffic operations planning or managed lanes performance evaluation, microscopic DTA is desirable.

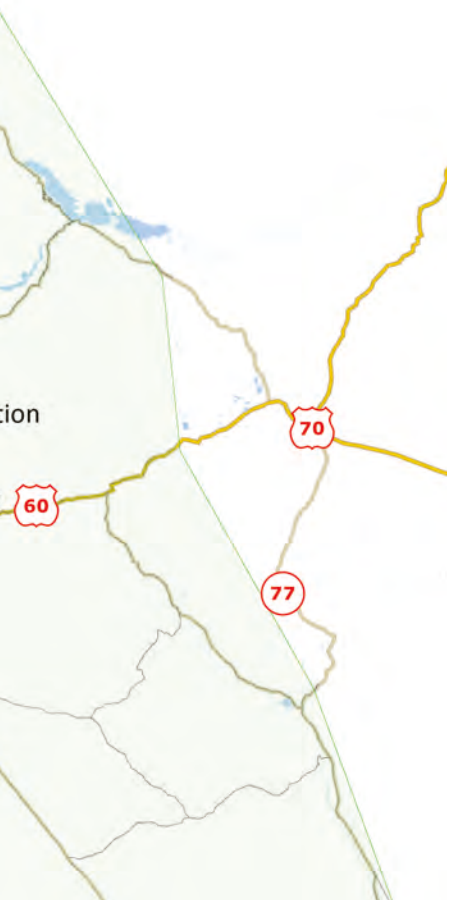
Despite this, theoretical DTA developments have long focused on mesoscopic simulation, primarily motivated by the perceived computational inefficiencies of microsimulation. However, current hardware and software technologies make microscopic DTA feasible and practical. Caliper provides evidence of the successful application of a microsimulation-based DTA of the Phoenix, Arizona, region.

Above: **Caliper's software was used to simulate congestion and travel times in Phoenix, Arizona, during peak and non-peak hours throughout the day**

Study methodology

The microscopic DTA tool used in the Phoenix study is TransModeler, which features a native geographic information system (GIS) that models transportation networks in four dimensions – three spatial and one temporal. TransModeler explicitly simulates the most complex traffic control systems, ITS infrastructure and driver behavior models.

DTA model development often begins with static trip tables – those defining origin-destination (OD) volumes of trips for a single period spanning an hour or multiple hours – from a traditional regional travel demand model. This initial estimation of demand serves as a seed to be adjusted later in a demand-calibration step. A DTA is run initially with the seed demand



to calibrate the supply in a way that reconciles driver route choices with the initial estimate of demand patterns.

A demand calibration step, often entailing a technique known as OD matrix estimation (ODME), is performed using the current calibrated supply metrics (travel times and delays) to simulate the estimate of demand and adjust the volume and temporal distribution of trips to better match traffic counts.

Because the demand adjustments made during ODME will result in shifts in congestion patterns, DTA is run again to recalibrate supply so that updated link travel times reflect the new demand pattern. Thus model calibration is iterative, moving between ODME and DTA until reasonable consistency is achieved.

The DTA step also solves for congested network travel times iteratively. Drivers make route choice decisions based on perceived congestion patterns. Trips are then simulated, and experienced travel times and delays recorded. A learning model updates their perceptions as new routing options are explored and congestion patterns evolve collectively. The iterations continue until drivers in every departure time interval as small as 5 to 15 minutes can't improve their travel times by switching to another route. The simulation-based network loading in each iteration is microscopic, fully capturing the dynamics and fidelity of real-world phenomena on both the demand and supply sides.

Case study: Arizona

A study was carried out in Phoenix, Arizona, where a regional microsimulation-based DTA model was developed for the Maricopa Association of Governments (MAG), the Metropolitan Planning Organization (MPO) for the Greater Phoenix region. The network (left) covers an area of about 28,000km² (10,800 square miles) and was augmented to include access to all major demand centers through an extensive coverage of driveways and cross-streets, including 4,142 intersections with traffic control ranging from pre-timed and actuated signals to ramp meters and stop signs. In the morning and afternoon peak periods respectively, 2.5 million and four million trips were simulated.

The model, calibrated against 15-minute traffic counts, demonstrates a very good fit between modeled and observed traffic data, indicating its ability to replicate measured real-world conditions.

The model was further validated along critical corridors in downtown Phoenix to match bottlenecks identified in observed 15-minute speed data. Matching speed or travel time observations is a much harder problem than matching only counts, because multiple calibrated OD patterns can result in the same (or a similar) fit to traffic counts, while only a subset of these patterns may yield a realistic match with congestion patterns.

Since its development, the model has been used by MAG and its partners as a platform for initiating small and large simulation studies evaluating a wide range of projects in the region.

Conclusion

These results demonstrate the practicability of high fidelity traffic microsimulation on a regional scale and the feasibility of leveraging time-varying network performance estimation through microsimulation-based DTA to study the benefits of major projects of regional import. It is no longer inconceivable, for instance, to contemplate the microsimulation of a network of tolled managed lanes or a tolled urban center. Transportation engineers and planners may no longer have to compromise modeling accuracy and fidelity for computational expediency.

Need to know

Caliper's TransModeler is a versatile traffic simulation package that can carry out planning and modeling tasks

- It is suitable for large and small networks
- It can simulate car, truck and transit movements
- It is built on a GIS platform and can be integrated with demand software
- It can visualize traffic flow and signal operations and it can display simulations in 2D or 3D
- It supports hybrid (simultaneous meso and micro) simulation
- It incorporates microsimulation-based dynamic traffic assignment (DTA)

Optimizing Mobility as a Service with pre-deployment algorithms

Passengers demand it, startups supply it: Mobility as a Service (MaaS) has become the most disruptive innovation in the transportation sector. And for some time now cities and automotive companies turned mobility providers have been test-running on-demand projects.

To ensure these new business models are here to stay, they must be user-centric and cost-effective. Given the financial and other risks of moving from concept to deployment, measuring fleet performances first can be beneficial. But which software tool calculates exactly the key performance indicators (KPI) defined by the mobility provider tailored to an operator's unique business case? Which tool simulates MaaS projects with a traffic transportation model that draws on existing infrastructure, as well as the operator's plans for how their service will be run?

In these instances, PTV MaaS Modeller software can analyze how MaaS fleets affect the entire mobility ecosystem of a city, solidifying new business models before launching them.

Starting with the model

Customers are the key to every business's success. This is why MaaS providers need to optimize their service before they make it available to end users. The planning stage is crucial to define ideal vehicle routes and to minimize the time, distance and number of vehicles used.

"The best approach to evaluate the performance of a potential MaaS fleet in a city's complex ecosystem is to start with the transportation models that the city in question uses already", explains Ralf Frisch, solution director of MaaS at PTV Group. "Often such models are generated with PTV Visum, which has become the standard software in the field of transportation planning with about 10,000 licenses worldwide."

In order to evaluate a MaaS business case, data, such as the basic link network and the existing demand matrices, can be imported from a variety of transportation models, into PTV MaaS Modeller. As a second element, this web-based solution consists of the tour optimization algorithms that have been tried and tested for over three decades in PTV Group's logistics solutions.

To solve the so-called vehicle routing problem and consequently the dial-and-ride problem, MaaS fleets have to transport passengers from the pick-up to the drop-off locations within a certain time window. The tour optimization technology built into PTV MaaS Modeller brings journey requests and optimized routes together to accommodate as many users as possible. Before a mobility provider's fleets go into operation, these efficient algorithms calculate the exact duration, distance and number of vehicles needed. The tour optimization technologies of PTV MaaS Modeller stand out because of their high capability for calculating distance matrices. "In various test instances, the algorithms of PTV solve complex distance matrices 13,000 times faster than conventional methods," explains Frisch.

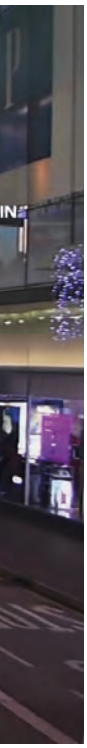
Need to know

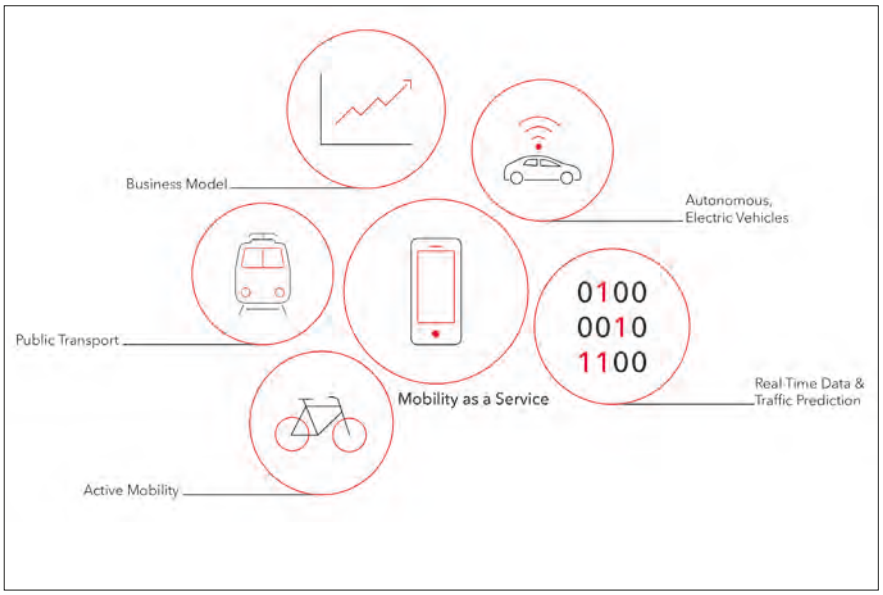
PTV MaaS Modeller enables city and transportation planners to...

- Calculate the potential impact and performance of MaaS within their city
- Model and plan MaaS operations
- Calculate their revenue and costs
- Compare models, and determine and evaluate business plans

Defining the MaaS fleet

For operators to have an analysis of their specific business case ready, PTV MaaS Modeller runs different scenarios in parallel, all characterized by a set of parameters. 'Acceptable waiting time' and 'Maximum detour





Far left: **MaaS enables its users to make seamless journeys using different means of transportation, including public transit**

Left: **PTV Group's vision of future transportation systems**

factor' belong to the set of the so-called service parameters, with the latter having a strong influence on the number of vehicles needed for a MaaS service. It defines the maximum ratio between the actual and the direct travel times, including acceptable wait times for users.

A set of different operating parameters is equally important for analyzing how MaaS fleets will impact cities. The total number of vehicles needed to serve the demand is calculated with the 'Fleet size' parameter. Since, in many cases, the resulting number turns out to be quite high, operators introduce their service, at first, only in a certain area. In PTV Visum, these service areas can already be predefined before the model is imported into PTV MaaS Modeller.

The same holds true for the pick-up and drop-off points. Depending on the operators' KPIs, providing more pick-up and drop-off points typically reduces passengers' walk access time, but it also enhances the detours. Running different scenarios with PTV MaaS Modeller calculates which solution is best for which business model. With the software, operators can make a more confident decision – for example, whether it is efficient to locate pick-up and drop-off points only at stations or other specific intersections.

In the demand parameters, 'Demand time series' stands for the matrix or a set of matrices that have been imported from the transportation model and represent the passenger potential for the MaaS scenario calculation. Consequently, they define the travel demand between network zones per time interval. PTV MaaS Modeller disaggregates the demand for individual trip requests. With, for instance, the 'Time interval' parameter , it is possible to limit the demand to a certain interval, in case the service should only be available during peak traffic hours and operators want to know the maximum number of vehicles to serve the highest demand. As the number of passengers for one and the same trip request can vary, PTV MaaS Modeller includes a 'Group size' parameter.

Having defined all parameters, PTV MaaS Modeller carries out the analysis based on the set of different scenarios. As the software runs in Microsoft Azure Cloud, the scenarios run in a parallel fashion to keep the amount of time this process takes to a minimum. Once completed, operators can decide how they want to customize the dashboard with their relevant KPI. To evaluate the results in less time and to obtain insights more quickly, they can arrange datasets to be visualized according to their needs.

The need to simulate

Working with car manufacturers and public transportation operators has shown how essential it is to simulate MaaS fleets before going live with the service. Although operators can meet the majority of travel demands with a reasonable number of vehicles, the remaining, less homogeneous trip requests are crucial, as they consist of particularly long journeys to and from more remote drop-off and pick-up locations. These often call for a high number of additional vehicles – a major expense factor.

A cost-saving alternative

The more economically sound solution is to simulate the service with PTV MaaS Modeller. The results might show that it is more efficient to start with a MaaS fleet that does not serve all existing trip requests, but only those in a specific service area. This might impose a risk on the system's uptake. "The key is to find an adequate balance between the operator's objective to minimize the number of vehicles and the passengers' desire to reach their final destinations quickly," says Frisch. "PTV MaaS Modeller is a very accurate tool to investigate this trade-off before introducing MaaS in any city."

What's more, the software saves all trips for every scenario that is calculated in the analysis, ready to be exported into the transportation model. This makes integrating on-demand services in a city's mass transit network quick and easy because the overall goal is to offer sustainable yet individualized mobility for an ever-growing number of city dwellers.

High-speed focusing for ITS

Many ITS applications require rapid sequences of images to be captured from differing distances. Ensuring all of the images are in focus requires maximum depth of field, which needs the camera aperture to be set very small. Since a short exposure time is also needed to reduce motion blur, it can be very challenging to obtain enough illumination for a high-quality image.

Shape-changing liquid lenses, mounted behind a traditional fixed-focus lens, make rapid fine-tuned focus possible in traffic applications. The focal point of the liquid lens can be changed in just a few milliseconds and enables the camera to achieve fast, accurate focusing over a wide range of distances. For instance, where a liquid lens is used in conjunction with a 200mm (7.8in) macro lens, the focus can typically be adjusted anywhere from 100mm (3.9in) to infinity.

Lens technology

Liquid lenses from Optotune use robust, electrically controlled actuator coils to deflect the lens into a precise concave or convex shape in milliseconds. The TR-CL Series from Gardasoft are single-channel, industrial lens controllers developed in close collaboration with Optotune and provide the accurate current control necessary to get high performance from tunable liquid lenses.

The lens controller can set the liquid lens to any required optical power, and modify the focal length in less than 10ms. It can also program a rapid sequence of optical power settings using an analog drive to the liquid lens. For example, a laser displacement sensor can be used to monitor the distance of an object in real time and send an analog signal to the lens controller, which then drives the lens to the correct optical power setting. It means macro changes in lens settings can be done in less than 8ms, accurately and with repeatable focus. The lens controllers from Gardasoft can even access calibration data stored on an embedded electrically erasable programmable read-only memory (EEPROM) inside the liquid lens, automatically adjusting the current drive so the system calibrates automatically to the characteristics of each individual lens.

Optotune's liquid lens (right) **works well with Gardasoft's lens controller** (below)

Above: **The VTR6 generates pulses of light of varying intensities and intervals**

Need to know

The lowdown on Gardasoft's TR-CL Series of lens controllers

- Gardasoft's range of single-channel lens controllers have been developed in collaboration with Optotune
- They offer precise control of the current to help deflect the liquid lens into a convex or concave shape
- It takes less than 10ms to modify the focal length
- The lens controllers automatically calibrate to each individual lens

It is common in traffic management for several images to be captured from the camera in quick succession. This presents difficulties both in getting sufficient illumination and focus. Differing illumination intensities may be required to image the same object at different distances, for example, license plate imaging, or different areas of the same vehicle, screen-mounted permits, or even road markings. Using dedicated LED strobe lighting, such as Gardasoft's VTR6, generates pulses of light of different intensities at different intervals within a very short space of time.

Such imaging tends to be carried out using a fixed focus lens, stopped down to give sufficient depth of field to be in approximate focus at all of the required distances. This severely cuts the amount of light reaching the camera sensor, and means images are not in precise focus at all distances. By adding a liquid lens to the setup, much more light is accessed, and perfect focus at all distances is achieved.

For systems integrators, a new embedded version of the Gardasoft liquid lens controller is available either as a design module to be cut and pasted into PCB (printed circuit board) design files, or as a compact lens controller, supplied as complete tested, enclosure-free, miniature hardware that can be fitted into the user's equipment.

The future is loop-free

Staffordshire County Council in England, UK, wanted to improve the effectiveness of speed detection measures at a busy intersection near a major technology park. Speed detection has traditionally been used on all roads with approach speeds greater than 35mph (56km/h). The authority opted for a non-intrusive solution, using the AGD 318 traffic control radar.

For double-extension applications, dual inductive loops in the road at 260ft (79m) have, until now, provided detection, with the controller calculating vehicle speed based on the time taken for the vehicle to travel between the first and second loops. But with AGD radars mounted at the stop line, detection is provided by a single input – a non-intrusive, safe and cost-effective detection of all vehicles traveling over 35mph.

Frequently, where existing speed discrimination (SD) deployments are due for replacement, damaged road surfaces or ducting can add costs even before loop replacement work begins. New sites require long periods of road occupancy and ducting along the side of the road, which can be impossible in some locations due to cost, verge space or surface material.

Staffordshire County Council had SD loops at the junction of the A0240 Beaconside and Dyson Way, near a busy technology park. While the site had originally worked well, the cost of recutting the loops, with associated traffic management, was estimated at over £1,500 (US$2,100), and the road surface – already in poor condition – would have been further compromised.

Ideal detection solution

Martin Fenlon, principal signals engineer at Staffordshire County Council, says, "Because the road surface was in poor condition where the loops were installed, the AGD 318 radar gave us an ideal, non-intrusive, solution for detection. It saves us time and money because it is pole-mounted, easy to configure and maintenance-free."

The AGD traffic control radar detects the speed and range of all approaching vehicles, and can be set up quickly and easily using a simple graphical user interface on a laptop or tablet. Users can set up zones or virtual loops to provide straightforward I/O outputs into controllers both old and new.

Users can also make their virtual loops 'smart'. In addition to setting a basic detection zone, the zone can be filtered using criteria such as size of vehicle, direction of travel and speed.

A loop-less future

The success of the solution has led to Staffordshire County Council's decision to avoid in-ground detection wherever possible in the future.

"We think it is only a matter of time before everyone is loop-free," says Fenlon. "It seems to be the direction of travel where the UK's Department for Transportation (DfT) is concerned. Road surfaces are not being maintained as well as they once were, due to budget constraints, which can result in problems for intrusive detection solutions. And of course the traffic management costs when you cut loops into the road are huge. Loop-free technology is the only way to go, as far as we're concerned."

Left: **AGD Systems' 318 pole-mounted radar replaces traditional loops**

Below: **The AGD 318 traffic control radar is easy to install and maintain**

Need to know

A single-lane loop replacement, the AGD 318 traffic control radar has multiple functions

- Speed detection for traffic control at intersections
- Microprocessor optimized vehicle actuation (MOVA) intersections
- Cycle detection
- Bus and heavy goods vehicle (HGV) detection and discrimination
- Speed discrimination
- 'Green wave' applications
- Wrong-way detection on highways
- Sign activation

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Optimal traffic flow with smart traffic signals

The Netherlands is the first country in the world to choose a comprehensive, standardized approach for smart traffic signals. Soon, every car, navigation system and smartphone can be connected to intelligent traffic light controllers (iTLC) – a win-win situation for road users, industry and government bodies alike.

The iTLC is a traffic signal connected, via the internet, with individual road users, facilitating smarter traffic management. With its ability to link smart products and applications, the iTLC makes it possible to display new information on road users' smartphones, telling them, for example, the time period before the traffic signal changes from red to green.

The iTLC can also remain green for longer to allow some vehicles, such as trucks, to drive through in order to ease congestion. The iTLC delivers an extensive data flow that can be supplemented with other data. This facilitates the development of new functionalities for road users, such as faster green lights for cyclists in the rain.

Need to know

Dynniq offers mobility solutions across the globe

- It shapes, engineers, builds and manages intelligent transportation systems (ITS) and infrastructure
- It connects urban, regional and national network systems to each other and makes it possible to control them
- It enables its clients to maximize their road network capacities and improve safety

iTLCs can be connected to, and interact with, apps that function in drivers' vehicles and with pedestrians' smart devices

Optimal traffic flow

Talking Traffic is an innovative partnership in the Netherlands between the Ministry of Infrastructure and Water Management, local governments, and national and international companies. The partnership was formed so that the partners can develop and supply innovative traffic applications throughout the next five years.

Dynniq has installed one of the first iTLCs, in Deventer in the Netherlands. After a period of intensive testing, the communication and interaction between the three components of the iTLC – the controller, the application and the information system – has been proven to work in practice.

Being able to commission the entire iTLC system as one of the first parties in the Talking Traffic initiative has been a complex project for Dynniq. Bas Heutinck, a technology manager at Dynniq, says, "It involves real innovation – with new technology, new components and new ideas. Furthermore, we have to ensure that road users can connect interchangeably, so that the communication between them and the iTLC is smooth."

Traffic policy optimization

Haye Mensonides, a member of the management team at Dynniq, sees commissioning as the next logical step in implementing the company's vision for smart mobility. "The iTLC is necessary to enable smart apps to function and to develop smart cities," he says. "By using this technology, municipalities have more resources to achieve their policy goals relating to citizens' quality of life, safety and sustainability, in urban and out-of-town areas. Smart data models make it easier to predict exactly how traffic will behave, enabling traffic signals to have the flexibility to adapt to a variety of road-use scenarios."

Indispensable link

The iTLC is essential within the Talking Traffic partnership, in which parties like Dynniq work alongside cloud service providers, developers of information services and government bodies. There is still only limited data available about congestion statuses at traffic signals, even though traffic signals are often the point where congestion builds up. Cloud services can combine new iTLC data with other kinds of data, thus improving current applications and helping to develop new ones. In turn, service providers can advise their customers more accurately via information services at traffic signals about the fastest routes and recommended vehicle speeds.

Key advantages

The benefits of innovative traffic signals are not limited to the suppliers of iTLCs and controllers, information technologists and road managers. Transportation, leasing and public transit companies, as well as insurers, also benefit. A simple calculation for the transportation sector shows that one fully loaded truck can use up to 1 liter of diesel when braking and accelerating at a traffic signal. Avoiding that at 10 intersections on a daily basis could save around

500 liters (which equates to around €650 (US$803)) per day for a transportation company comprised of 50 vehicles. This is without considering the time gain, improved safety, and reduced emissions for local residents.

The effect of badly adjusted traffic signals on social damage every year is significant. The Talking Traffic initiative, which uses iTLCs, enables traffic to be controlled more smartly and managed more effectively. By the end of 2018, around 1,268 TLCs will have been converted into iTLCs. The aim is to modify other TLCs (5,500 in total in the Netherlands) soon.

by **J J Eden**

Electric vehicles are better than ever – and they're here to stay

The 2018 Consumer Electronics Show (CES) in Las Vegas (which took place from January 9-12, 2018) did not disappoint in providing 'techie sensory overload'. This year, transportation was a key focus, with electric and technology-packed vehicles from vendors such as Tesla, Toyota, Xpeng and Munro taking center stage.

Among the hottest exhibits were: Hyundai's hydrogen-powered vehicle, the Nexo; autonomous vehicle concepts from Intel/BMW and Toyota; Sigma Integrale's remote-operated control for trucks; Bell Helicopter's air taxi concept; Qualcomm's cellular vehicle-to-everything (C-V2X) implementation demo; and Internet of Things application platforms from companies such as IBM, Ericsson and Bosch.

We all love the toys, but how will they impact the future? During the Q&A sessions, and at many of the hundreds of booths dedicated to transportation, there were spirited conversations about how automated vehicles and Mobility-as-a-Service are set to disrupt the industry. General Motors has announced plans to launch a steering-wheel-free vehicle in 2019, while Nissan claims that by 2021 self-driving cars will be mainstream.

Connected vehicles was another prime focus at CES 2018. With the capability of being able to talk to other vehicles and the infrastructure around them with factory-installed equipment, connected vehicles are set to be a game-changer – but questions remain.

Over the next three to five years, how will technology disrupt our approach to tolling? Will there be a need for connected vehicles to use transponders or roadside tolling equipment? Could equipment built into connected vehicles simply execute toll transactions instead, and will we still need tolling-agency-run back offices? Who will own the data that vehicles produce? How will we bridge the gap during the transition to connected technologies? How will roadside systems and classifications need to be changed in order to accommodate direct connectivity? How will vehicle manufacturers and their product offerings interface with our current back office systems and how will we need to change operational procedures to accommodate them? How will transactions be audited?

The tolling industry is in a unique position. It is the only transportation system with existing over-the-air high-speed transactions, data management, and back office and billing systems. There is no industry better suited than tolling for this undertaking – and now is the time to engage in the discussion of data collection, integration, and standards development.

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"Over the next three to five years, how will technology will disrupt our approach to tolling?"

The right vehicle detection technology for the right job

Reliable vehicle detection can improve asset management, resource allocation, site safety and traffic control. Identifying the right technology for your vehicle detection application can be challenging. This article describes five types of vehicle detection technology, as well as the advantages and disadvantages of each.

Left: **Magnetometers measure changes in the ambient magnetic field**

1. Wireless magnetometer

A magnetometer detects large ferrous objects (for example, a truck or automobile) by measuring changes in the ambient magnetic field. When a vehicle alters that magnetic field, the sensor detects those changes. The range of the magnetometer will depend on the target. To reliably detect when the magnetic field is disrupted, a magnetometer must first be attuned to the typical ambient magnetic conditions when there is no vehicle present.

Magnetometers can be either wired or wireless, but the latter offer important advantages. Compared with inductive loops, wireless magnetometers are small, self-contained, much less invasive and often less expensive. A magnetometer must be rigidly fixed at the time of installation to ensure reliable long-term functioning. If the sensor moves out of alignment over time, it may cease to function properly.

Wireless magnetometers should be encapsulated in epoxy to prevent moisture penetration and ensure long-term reliability even in adverse weather. Wireless magnetometers should be completely self-contained, including the battery. The long life of the battery ensures continuous performance for years.

Typical applications include vehicle detection in parking lots and car washes.

2. Wireless ultrasonic sensor

A wireless ultrasonic sensor is often an ideal solution for indoor or covered parking applications. It can be mounted on the ceiling of a parking garage to detect vehicles in the parking space below. A distinct point (e.g. the ground) can be set within its sensing range and it will detect any object, regardless of shape, size or reflective angle, that crosses between the sensor face and the set point. A time-delay filter can be used to prevent pedestrians from falsely triggering the sensor.

A wireless ultrasonic sensor with integrated battery reduces the cost of installation by removing the need to run wires and conduits. Target color and/or reflectivity do not affect ultrasonic sensors, which are able to operate reliably in high-glare environments.

However, ultrasonic sensors may not be the best solution for outdoor environments, as wind and other conditions can disturb the path of the ultrasonic wave. Since temperature fluctuation affects the speed of sound waves, an ultrasonic sensor may not function reliably when exposed to extreme changes in temperature. For applications where temperatures do vary,

look for an ultrasonic sensor with built-in temperature compensation capabilities.

3. Radar sensor

Radar sensors use frequency modulated continuous wave (FMCW) radar to reliably detect moving or stationary targets, including cars, trains, trucks and cargo. Unlike photoelectric or ultrasonic sensors, radar sensors are not affected by conditions such as wind, rain, fog, light, humidity or air temperature. They can also detect objects up to a specified distance, ignoring objects beyond the set point, resulting in higher accuracy. While inductive and capacitive sensors can detect only moving targets, radar sensors are capable of detecting both moving and stationary vehicles.

Need to know

Key benefits of different vehicle detection technologies

- Magnetometers can be wired or wireless
- Wireless ultrasonic sensor systems can reduce installation costs
- Radar sensors can detect both moving and stationary objects
- Infrared optical sensors can detect through mist
- Light grids are commonly used at tollbooths

It can be challenging for radar sensors to detect smaller targets, as well as vehicles with little separation between them (such as in bumper-to-bumper traffic).

4. Infrared optical sensor

Optical sensors are not often used for vehicle detection, but can be a good option for some applications. An opposed-mode optical sensor detects objects when they interrupt a light beam between an emitter and a receiver. An opposed-mode optical sensor requires mounting for both an emitter and a receiver unit.

Above: **Radar sensors can reliably detect moving and stationary targets**

Some optical sensors use infrared light that can penetrate mist and steam, making them reliable in environments with high water temperatures, such as car wash bays. Optical sensors are often more affected by weather conditions than other technologies are, so they are usually better suited for indoor applications. For applications where the sensor will be exposed to high pressures, temperatures or rainfall, a sensor with an IP69K-rated housing is required.

Tolling applications often require a sensor to detect whether a vehicle is too tall. A rugged optical sensor with sunlight immunity can provide reliable detection in fog or mist.

5. Measuring light grid

Measuring light grids are often used for vehicle detection to start and stop a transaction (for example, paying at a tollbooth). A sender and a receiver are installed on either side of a toll lane, transmitting an array of light beams across the lane.

Measuring light grids are composed of multiple synchronized emitter/receiver pairs at defined distances. They can be used to sense the profile of a vehicle, detect vehicle separation, and sense even the smallest parts, such as tow bars. A measuring light grid provides fast profiling of moving vehicles, accurately detecting vehicles regardless of their speed.

Tollbooth applications are becoming more automated to eliminate human error. It is important to get reliable data when a vehicle enters the toll station, in order to define the correct category, which is directly linked to the toll charge. The main challenge is that a wide variety of vehicles can come through the station – motorcycles, cars with or without trailers, trucks, etc.

A light grid with robust housing is a must to protect the array lights from damage in the event of collision at toll booth detections. For climates with cold winters, installing a light grid in a heated enclosure enables the light grid to operate reliably even in variable weather.

Double duty

Due to the varied demands different environments place on sensors, applications that require the highest possible accuracy could benefit from combining two sensor technologies.

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An independent DSRC supplier

As the requirements of the tolling industry continue to evolve, dedicated short-range communications (DSRC) system integrators can benefit from the versatility and choice provided by independent CEN (Comité Européen de Normalisation/European Committee for Standardization) DSRC suppliers.

As smart digital tachographs and an increasing number of EETS providers enter the market, more use cases for DSRC become obvious.

Electronic toll collection (ETC) has been used for decades to regulate traffic and finance infrastructure. With an ever-increasing volume of road traffic, ETC will continue to play an important role in regulating the flow of traffic and securing toll operators' income.

Europe's preferred ETC

CEN DSRC is the most widely used technology for ETC in Europe. Across the globe there are many suppliers of vehicle-mounted onboard units (OBUs) and roadside units. One of the advantages of CEN DSRC standards is that products from different manufacturers are interoperable, which means that customers are free to purchase products and solutions from different suppliers.

Part of the Norbit Group, Norbit ITS has been designing, manufacturing and supplying DSRC products for more than a decade and has been involved in developing DSRC-related standards since the 1990s. As an independent DSRC supplier, it has focused on manufacturing DSRC products, not integrating them. This enables system integrators to provide DSRC-enabled solutions without having to purchase equipment from competing companies. Norbit ITS customers are also provided with a choice of compatible and OBUs.

"CEN DSRC standards enable system integrators to concentrate on what they do best – projecting, installing and maintaining tolling and enforcement systems – without needing to focus on DSRC technology," explains Per Jørgen Weisethaunet, CEO of Norbit Group. "Furthermore, from us OBU customers are able to procure economical products."

Functional and flexible

Norbit ITS has a range of CEN DSRC products that includes OBUs and remote switching unit (RSU) solutions. The company's current OBU generation has the functionality and flexibility required of today's market, including self-contained OBUs for windscreen installation and DSRC modules that can be integrated into, for example, its global navigation satellite system (GNSS)-based OBUs.

Norbit ITS's current generation of OBUs support CEN DSRC and the Italian standard ETSI 200674-1:2013 (UNI) on a per-transaction basis, for full European electronic toll service (EETS) compliance. In addition to data encryption standard (DES) security, the OBUs also support advanced next-generation security using AES-128 cryptography. Norbit ITS's OBUs and DSRC modules employ state-of-the-art application specific integrated circuit (ASIC) technology to ensure a compact size, long life and a high degree of flexibility. RSU solutions cover both single lane and multilane use, as well as various modes of redundancy.

Norbit ITS DSRC products are compliant with relevant standards, and have been homologized in a number of countries including Slovakia, Germany, Austria, France, Spain, Norway, Sweden, Denmark, Portugal, Chile, Thailand and Belgium.

As DSRC products evolve and OBUs get smaller, they support more applications and are expected to have longer battery lives. The use of GNSS-based OBUs, which use DSRC technology for enforcement and DSRC tolling compatibility, has been on the rise for a while. They require higher capacity, increased flexibility and more advanced functionality in DSRC components. RSUs are required to support multilane systems and redundancies, while being easily integratable, and easy to install and maintain. Developing, maintaining

Need to know

Norbit ITS is a Norwegian company that provides CEN DSRC products

- It has been supplying CEN DSRC products to its customers for more than 10 years
- Its products are suitable for applications inside vehicles such as trucks, at roadsides and at service stations/offices
- It is the largest supplier of DSRC OBUs and RSUs to the Norwegian AutoPASS system

Above: **DSRC for usage in digital tachographs**

Left: **With high traffic volumes, electronic toll collecting has a role to play**

and supporting successful DSRC products requires substantial resources, as well as a team that fully understands DSRC technology and the practical aspects of its use. This may be the reason why, in recent years, there seems to have been a reduction in the number of DSRC product suppliers active in the market.

An upcoming EETS provider

Upcoming EETS providers demand DSRC systems that work seamlessly across Europe. Norbit ITS supports EETS providers with the newest generation of DSRC OBUs and DSRC modules. The product design enables providers simply to add new contexts and new applications for additional countries. Norbit ITS is collaborating with Siemens, which already provides EETS GNSS OBU, to an upcoming EETS provider in Germany..

By 2019, the EU plans for all existing digital tachographs to be replaced with smart versions. The recent EU Implementation Regulation 2016/799Annex 1C is a move to make digital tachographs smarter by integrating GNSS functionality to prove the geographical position and enable remote enforcement, using DSRC technology, for tachograph units. Taking effect in 2019 and following ratification by the EU member states, every new truck in Europe will have to be equipped with a smart tachograph.

A smart tachograph requires DSRC technology which will enable trucks to be checked while the vehicles are on the road, without interfering with driving. Their deployment will enable devices in trucks to be checked while the vehicles are on the road, without interfering with driving. This means compliant trucks and drivers will avoid being diverted to costly and time-consuming tachograph spot checks at dedicated check points and will be an incentive for drivers to follow the rules.

The DSRC device in the truck must be mounted on the windshield or dashboard and will either be connected direct to the tachograph unit or via an existing onboard CAN network.

Norbit ITS already has several smart tachograph solutions available, including a DSRC module (DSRC-VU) that communicates via the CANbus, and a detached antenna solution. In the latter case, the DSRC functionality is split into an antenna module and the tachograph unit.

Recent market success

In Norway, Norbit ITS has delivered more than 70% of the 1.7 million OBUs in operation. Last year, it was one of two vendors that entered into a four-year framework agreement with the Norwegian Public Roads Administration for the delivery of EN15509-compliant OBUs. So far, more than 4.5 million DSRC OBUs, and nearly two million DSRC modules, based on Norbit's state-of-the-art DSRC technology are in operation

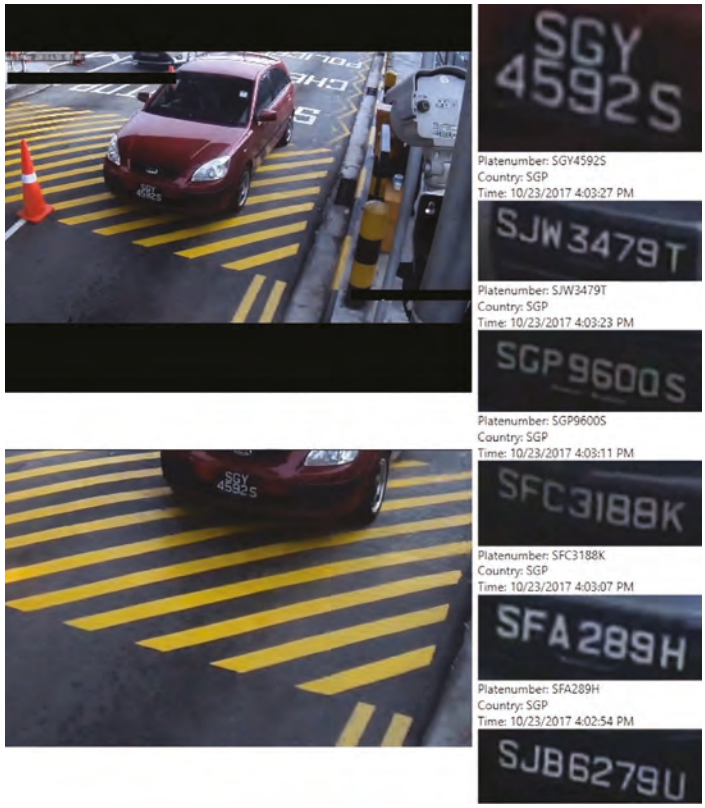
What is plug-and-play LPR technology and do we really need it?

LPR (license plate recognition) systems are often promoted as easily integrable software products or easily integrable smart cameras with onboard LPR. Yet when talking with operators who build their applications around LPR technology, almost all will complain that most LPR solutions are expensive, inflexible, too complicated or hard to integrate. Full integration of LPR camera functions, including analysis of video streams, optical character recognition (OCR) and the translation of data for specific business applications, is a hurdle that requires serious development time.

Consumer demands

LPR technology providers need to realize that consumers are needy, but won't go to great lengths to satisfy their needs. They expect solutions to be lean, simplified, ergonomic and of course easy to handle and to understand. It is a risky business strategy to overlook these needs. The patterns are clear in all aspects of people's lives: they prefer preprocessed information instead of books, expect ergonomic design instead of having to rely on complicated manuals, and often opt for prepared food instead of cooking from raw materials. All in all, the stage is set for easy-to-integrate LPR solutions: plug-and-play LPR.

A recent case of a parking provider in South Korea will offer more insight. The company has been operating in the parking industry for 15 years. It has developed a parking management system (PMS) of its own and is a manufacturer of parking ticket machines and barriers. Facing an increasing demand for smarter parking systems, managers decided it was time to embed LPR into the company's PMS. For this they needed LPR working in the Korean environment that could easily be fitted to existing CCTV. Six months of development to implement LPR technology was out of the question for their projects. What they needed was LPR technology that can be set up on any camera system and optimized for great performance in a matter of days. Asura Technologies provided the answer: plug-and-play LPR.



Left: **Asura Technologies' Asura Recognition Unit can turn normal CCTV cameras into smart LPR units**

Need to know

Why plug-and-play is so important in LPR

- Costs are kept to a minimum as existing vision hardware can be repurposed
- Data can be customized for specific business uses
- Easy-to-integrate solutions help streamline the implementation of new systems, so they are up and running quickly

Smart solution

The technology business Asura Technologies is driven by a single mission: to create easy-to-integrate, camera-vendor independent LPR systems. It has more than 20 years' experience in OCR software engines used for license plate recognition in traffic and parking management. Dedicated to developing innovative LPR technology based on customer insight to provide the highest level of user experience and maximum efficiency, Asura's LPR solution, the Asura Recognition Unit (ARU) is a plug-and-play system to enable LPR technology in any new or existing traffic or parking data collection system. ARU is a nominee for in the 2018 Intertraffic Innovation Awards.

LPR's natural evolution

Back in the 19th century Ada Lovelace created the first computer program. She realized that there is much more potential in 'computing machines' than simply running calculations. Nowadays, using computers and software are part of everyday life. Plug-and-play LPR is the natural evolution of LPR technology. Just as computers and programs have taken over a huge portion of menial tasks in our lives, an 'LPR machine' will make integrators' lives easier and allow them to focus on higher level processes.

The future of weigh-in-motion lies in direct enforcement

This, its 40th anniversary year, looks set to be an exciting one for USA-based Intercomp and its vehicle weighing products.

For example, Intercomp's in-ground strain-gauge strip sensors (used in low- and high-speed weigh-in-motion (WIM) applications) have now successfully passed OIML initial verification testing with the OIML R134 certificate in progress.

A widely recognized international WIM standard, OIML R134 defines the metrological and technical requirements for weighing vehicles in motion and measuring axle loads. The OIML standard has been referred to in, or used in conjunction with, the development of legislation and other standards for use around the world. Products certified to this standard can more easily be accepted into use for applications in OIML participating countries.

Building on the past

Intercomp has incorporated strain-gauge technology into its fixed and portable WIM scales and sensors for four decades, and this technology has been continually developed and enhanced to provide users with accurate wheel, axle, and gross vehicle weights at both low and high speeds.

WIM technology generates weights without having to stop traffic, but traditionally it has only been used for pre-selection purposes, with actual enforceable measurements being taken on more accurate static scales in weight stations off the main highway.

However, now that WIM technology is becoming accurate and consistent enough for enforcement, regulations, which have historically been created with reference to static weighing technology, need to be updated to recognize other weighing methodology. "Legislation in many countries has already recognized, or will soon recognize, weigh-in-motion technology for vehicle weight enforcement," says Eric Peterson, vice president at Intercomp. "This is a direct result of the advancements in the quality and accuracy that WIM scales and sensors are capable of providing."

Left: **The LS-WIM axle scale is suitable for weight enforcement**
Below: **The strain-gauge strip sensor handles 80mph speeds**

Need to know

Intercomp's products are pushing boundaries

- Strain-gauge strip sensors can be used for many applications, including direct enforcement for speeds up to 80mph (130km/h)
- Intercomp strain-gauge strip sensors have passed OIML initial verification testing with OIML R134 certificate in progress
- The in-ground LS-WIM axle scale has also passed initial verification testing, with another OIML R134 certificate pending

Product specifics

Intercomp strain-gauge strip sensors are grouted into 3in (76mm) channels cut into the pavement, with configurations of these sensors used in data collection, screening and direct enforcement, tolling, and industrial applications at speeds ranging from 2-80mph (3-130km/h).

Installed in a vehicle lane in a single day, with minimal civil works required, lane closures are kept to a minimum while incorporating sensors into systems and updating WIM sites. The sensors are supplied within a complete system or integrated with existing electronics and software platforms, giving users the flexibility to incorporate the WIM sensors at standalone sites or within current ITS locations.

In addition to the strain-gauge strip sensors, Intercomp's in-ground LS-WIM axle scale has also successfully passed initial verification testing with another OIML R134 certificate being processed.

Accurate weighing system

The LS-WIM axle scale has a 12in (305mm) deep frame installed into the pavement, and provides highly accurate axle and gross vehicle weight (GVW) for enforcement and industrial applications at lower speeds.

The axle scale requires modest civil works over a few days, and can be incorporated with a variety of equipment, such as gate arms, displays, indicators, and software.

Intercomp invites visitors to the Intertraffic Amsterdam 2018 show to stop by its stand to view vehicle scales and sensors, and celebrate the product certifications and long history of the Medina, Minnesota-headquartered company.

Visit Intercomp at Intertraffic Amsterdam 2018, stand 12.617.

Choosing hardware for embedded vision systems

Embedded systems are computers designed for integration with larger pieces of equipment. The computers built into cars, medical instrumentation, and consumer devices such as smart TVs are all examples of embedded systems. The current hardware trend for embedded computing is compact single-board computers (SBC) based on ARM processors running Linux. Systems on modules (SOM) paired with application-specific carrier boards are also popular, and for applications requiring a powerful small-form computer, SBCs and SOMs built around x64 processors are a great choice.

x64 versus ARM

Choosing x64 or ARM hardware can have a big impact on other aspects of a vision system for use in traffic monitoring. x64 processors, including the Intel Core series, are standard for desktop computers. They support Windows and Linux operating systems, as well as all major third-party libraries. x64 processors have more computing power than typical ARM processors, but they also consume more power.

The ARM processors used by SBCs are usually packaged as a system on chip (SOC). In addition to CPU cores, SOCs contain memory, signal processing, networking, USB and other I/O. Many of the SOCs used in embedded systems were originally designed for cell phones. ARM SOCs are less powerful than x64 processors, but much more compact and energy efficient. Software support for the ARM architecture is limited (for example, Windows is not supported on ARM). Many Linux distributions are available for ARM, although not all software and device drivers are supported.

The Flir Spinnaker SDK (software development kit) for traffic cameras supports ARM and x64 hardware.

Above: **The GigE Blackfly S is ideal for a range of applications, including intelligent transport systems**

Need to know

Key advantages of embedded systems

- Compact and inexpensive
- Additional connectivity possible using GPIO pins
- Systems on modules (SOM) can be paired with carrier board for greater flexibility
- Processing at the edge reduces reliance on central servers and cloud computing

Below: **Accessory boards quickly expand functionality on the popular Raspberry Pi**

Embedded advantages

Compared with traditional PC hardware, embedded systems are compact and inexpensive. While individual components of SBCs can't be replaced, additional connectivity can be added using expansion boards connected to GPIO (general purpose input/output) pins. A wide range of accessory boards that can quickly expand functionality are available for the popular Raspberry Pi. Many SBCs that share the same GPIO layout are also available.

For more demanding applications, SOMs paired with carrier boards provide even greater flexibility. The Nvidia Jetson TX2 is an SOM. It has a powerful ARM processor, 256 core CUDA (Compute Unified Device Architecture) enabled GPU, memory and I/O controllers, packaged on a compact module. A carrier board is required to supply power to the SOM and provide connectors for USB, GigE (gigabyte Ethernet) and GPIO.

The computing power of embedded hardware can reduce a vision system's dependence on central servers or cloud computing platforms. By performing image processing on embedded systems positioned near the cameras,

latency and bandwidth consumption can be reduced and throughput and information security increased.

Switching from traditional PC hardware to an SBC or SOM and carrier board enables the creation of smaller, more power-efficient, less-expensive systems.

Superior compatibility

Flir's Spinnaker SDK supports Windows 7/8/10 and Ubuntu 14.04/16.04 on x64 hardware, and Ubuntu 14.04/16.04 on ARM hardware.

Flir cameras streamline the development of vision applications for the edge. Flir cameras reliably capture detailed images in challenging lighting conditions by pairing the latest CMOS sensors with advanced auto-control algorithms for color correction and exposure. Flir Blackfly S cameras feature Sony Pregius sensors with high quantum efficiency and low read noise, enabling clear image capture in low light. Wide dynamic range ensures details will be captured in shaded and brightly lit regions of high-contrast scenes.

Flir cameras' powerful onboard image processing includes color interpolation, sharpening and gamma correction, reducing host-side processing requirements. Support for the IEEE 1588 Precision Time Protocol makes it easy to synchronize the GigE Blackfly S to a common time base with other IEEE-1588-enabled devices.

by **Don Hunt**

How do cities pick where to get smarter?

Transformational mobility technologies are being increasingly discussed as part of the smart cities movement rather than as standalone transportation components.

Perhaps the first major linkage of smart mobility and smart cities was the USDOT Smart City competition in 2016, resulting in a US$50m grant award to Columbus, Ohio. Columbus is conducting a wide range of projects, from integrated data exchange and connected vehicles, to delivery zone availability systems and interstate truck parking.

Fast-forward a year-and-a-half since the USDOT grant award and in early January 2018, Ford CEO Jim Hackett delivered a keynote vision at CES in Las Vegas that ranged well beyond what might be expected from an auto maker's chief. Hackett talked about not just Ford's transition to mobility services, but also its plan to develop a connected vehicle/connected city platform, reaching residents in, and managers of, the urban environment in order to improve safety and efficiency of transportation. Hackett even set an objective to take back urban streets for livability. That's a bold vision for Ford, a company whose major profit center is selling F-150 pickup trucks.

Whether it's the medley of Columbus projects or Hackett's vision for Ford, it's hard to see through the futuristic clutter to understand how vehicle automation and connected cities will make our lives better. The Internet of Things, robotics and AI are combining to make the unimaginable possible, and city and state governments will have multiple opportunities to take advantage – but they might not always have the money.

Several regions are working on these challenges, and my home metro area of Denver is one. It has put together a public-private partnership called the Mobility Choice Initiative. The initiative has brought together the business community, the metropolitan planning organization, the metro transit agency and the Colorado Department of Transportation to identify how the Denver area can best guide public investments and incorporate new technology to produce benefits for all residents. The partners have engaged a technical team to develop likely scenarios, identify agency actions to improve mobility, determine how to best engage the private sector, and avoid any negative outcomes of new mobility.

"Ford CEO Jim Hackett's vision goes well beyond what might be expected from an auto maker's chief"

The task at hand is daunting. Doing nothing could result in slow adoption of new mobility benefits, or alternatively allow private mobility services to emerge with negative impacts on public transit, congestion or social equity. However, trying to quickly adopt smart city opportunities could waste resources and yield little to improve quality of life.

All of this is even more confusing for government because the private sector will largely control ride-hailing services, data connectivity and data insights. And although the private sector will collaborate with government, at the end of the day, companies need to sell products and services. A major task for the Mobility Choice Initiative will be to sift through the most productive areas for government to engage with business to begin to shape the trajectory of the mobility transformation, and at the same time, make sure there are real net benefits to urban quality of life.

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

Saving lives with red light cameras

One of the largest and most successful programs improving traffic safety in North America is the red light camera program in Ontario, Canada. As part of the Vision Zero Road Safety Plan to reduce traffic-related fatalities and serious injuries, more than 200 Jenoptik red light systems have been deployed in the Greater Toronto Area for over 10 years. Due to its success the program has been extended.

Reduced traffic fatalities

Roger Browne, manager of the Traffic Safety Unit in the City of Toronto, states, "Where red light cameras have been installed in the city, we have seen, on average, a 40% reduction in traffic-related fatalities. Given the long-standing success of the program, in May 2017 the council approved an expansion of the program to double the number of red light cameras in operation."

Jenoptik's end-to-end solution provides equipment, service and personnel as well as image-processing hardware and software to operate the red light cameras cost-efficiently, based on the quality of service provided and not on the number of infringements recorded.

"In working with the City of Toronto and surrounding municipalities we've developed a solution that leverages our core expertise in optical technologies, scalable software, operation and service to deliver a complete solution that improves traffic safety," says Mike Seidl, operations manager at Jenoptik Traffic Solutions.

With the multi-year extension, the scope of the program is expected to increase to about 250 systems, with various municipalities in Ontario participating. These systems will be used for replacing and modernizing existing sites as well as for establishing additional ones. They allow monitoring of up to four traffic lanes at a time.

Left and above: **The City of Toronto has cut traffic-related fatalities by 40%**

All systems are equipped with digital cameras that can take high-resolution images and capture at least two pictures to document incidents occurring at an intersection.

Incident processing is managed through a centralized back office, allowing authorized provincial offence officers to evaluate incidents.

When a vehicle runs a red light, the camera will take two time-stamped photographs: the first as the vehicle approaches the stop line and the second as it moves through the intersection. The camera uses a 29MP imager to ensure tag legibility across all four lanes. For effective night-time operation, an external flash is used to illuminate the intersection. It can be placed on a separate pole and is automatically controlled by the main camera system. Equipment installation is optimized for minimal obstruction of traffic and pedestrians.

Accurate and secure

All service and operation is performed by fully trained Jenoptik Traffic Solutions staff, thus maintaining a high level of system accuracy and data security. Additionally, all images are encrypted at source, ensuring data integrity throughout the system.

Jenoptik's TraffiDeskPro software allows for efficient evaluation and processing of traffic offenses.

The TraffiDeskPro software has various functions for evaluating, processing and visualizing speed and red light violations. Many processes are fully automated and images can be optimized in seconds, using predefined filters.

The evaluation software has been designed in order to be versatile and scalable – from a single workstation to large departments that comprise many operators.

TraffiDeskPro is deployed in installations worldwide and is currently processing about 30 million incidents per year.

Need to know

Key benefits of Jenoptik's red light enforcement systems

- Four lanes can be monitored at once with one 29MP imager
- Two time-stamped photographs are taken per violation
- The City of Toronto achieved a 40% reduction in traffic-related fatalities after the installation of Jenoptik red light cameras

Minimizing road damage from overloaded vehicles

Unquestionably, funds collected through fines for overloaded vehicles will never be enough to cover the cost of repairing road networks damaged by said vehicles. Therefore, the major goal of weight enforcement must be to discourage road users from overloading in the first place.

A mobile patrol team using mobile wheel load scales is the most efficient way to perform an official weighing control, once it increases the social interaction between drivers and enforcement officers.

Violation rate effects

It is evident that countries with efficient weight enforcement measures in place have a lower violating rate than those where it is yet to take off. Nevertheless, when the violating rate is minimal, enforcement officers can begin to neglect the practice, risking the possibility that would-be transgressors perceive a lack of control and so proceed to overload.

Pre-selection of suspect vehicles can be a good reason for this neglect. On one hand, mobile weight enforcement is an easy task to perform; on the other hand, pre-selecting vehicles can be much more arduous. Highly skilled state authorities are required to select the trucks that should be weighed. The decision is normally based on evidence, such as the compression vehicle's suspension, its tire contact length, the type of the load, or even the driver's driving performance. In addition to that, in developed countries, normally the overload is not high enough to be visible to the naked eye. The lower the overload is, the more difficult it is to detect it visually. If the pre-selection method does not succeed, the numbers of transgressors caught might be somewhat disappointing and the enforcement officers might have the feeling that the hard job done was not worthwhile.

Above: **Overload violation rates in Germany are one of the lowest in Europe due to effective measures in place**

Right: **Haenni's WL 104 system has a thickness of just 17mm, and can be quickly installed on roads**

Haenni Instruments, a manufacturer of mobile weighing control equipment, has a solution to help authorities optimize pre-selection of vehicles.

Need to know

Benefits of Haenni's mobile wheel load scale WL 104

- It can be used as a low-speed weigh-in-motion system
- It is an effective system for accurately screening trucks with limited resources available
- The WL 104 is capable of measuring any vehicle, regardless of its wheel configuration or axle type
- It is certified to OIML R76 class IIII, making it appropriate for direct enforcement static measurement

The mobile wheel load scale WL 104 can be used as a low-speed weigh-in-motion system for pre-selection and it is ideal to screen trucks more effectively with a high accuracy and less personal resources. The equipment has no display and can therefore be overridden. Its large active area allows for several scales to be strung together seamlessly, enabling the measurement of any vehicle, irrespective of its wheel configuration or axle type. In some countries, where the dynamic measurement is accepted for direct enforcement, the certification according to OIML R134 is in progress.

The WL 104 is also certified to OIML R76 class IIII, guaranteeing its use for a precise static measurement in direct enforcement. The whole system can be set up by a solitary traffic officer and is ready to be used in less than three minutes. Due to its low height of only 17mm, the leveling of the non-weighted wheels and axles is an easy job, either with leveling mats or by placing them into the asphalt, in a semi-fix installation. Having modern fieldbus technology in place, the system ensures fast and reliable data transfer.

The German perspective

In Germany, one of the countries with the lowest overload violation rates in Europe, there are currently more than 50 WL 104 systems in use. The weight enforcement is carried out with a system consisting of three WL 104s connected via interface to a personal computer with the EC 200 processing software, for further processing and printout. A pre-selection is performed in dynamic mode and only the overloaded vehicles are required to be weighed in static mode. All done with only one system, it is a simple and valuable solution for a major issue.

Contact

Advanced smart flashes for traffic enforcement applications

For traffic enforcement, a flash is needed to correctly expose a scene and to freeze motion. Advanced flash functionalities are required to adequately capture complex scenarios for enforcement purposes. These include:

– **Multiple vehicles that are close to each other.** For speed enforcement, a camera and flash system should be capable of capturing fast target vehicles. Advanced Xenon flash can generate bursts of high-power shots that are 10ms apart.

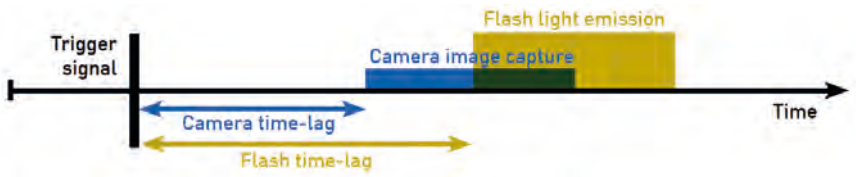
– **The same vehicle at different distances.** In a red light enforcement scenario, a system may have to capture the same vehicle at two or more distances – at a red light signal and across an intersection. An advanced flash device can be set up so that successive shots are emitted at different exposures, to provide even exposure on pictures.

– **Dynamic adjustment of emitted light.** To configure exposure parameters to external conditions, such as ambient light or distances between the camera and the car, an enforcement system may use an advanced flash where the energy can be adjusted so that in less than 10ms, a flash can illuminate the car at a required exposure level, thanks to a standard communication interface.

– **Remote system maintenance.** Thanks to a communication interface, a flash device can be maintained remotely. This means that diagnostics, preventive maintenance scheduling and operating parameter adjustments can be carried out remotely.

Above: and right: **A flash reveals details otherwise invisible**

Right: **The flash emission and shutter opening overlap**



Need to know

Phoxene is a specialist manufacturer of flash and illumination devices

- Flashes with a fast repetition rate, remote control and dynamic light adjustment are critical for developing smart and efficient enforcement systems
- Such flashes can help improve the quality of images captured in challenging situations, such as where vehicles are traveling at high speeds
- By using a high-quality and reliable flash, system costs can be reduced because a medium-priced and average-sensitivity camera can be used to deliver images of an adequate quality, rather than an expensive camera

In photography, flash-camera synchronization is defined as synchronizing the firing of a photographic flash with the opening of the shutter, thereby admitting light to photographic film or image sensor. The resulting exposure of a picture is dependent on how the synchronization is managed. To capture clear images of moving vehicles for adequate enforcement, it is important for the shutter time and flash to be properly managed.

In a flash unit, there is a time lag between the trigger signal and when the light is emitted. Cameras also have a time lag before they capture an image.

Triggering a flash

The most common synchronization method is to use a camera output signal as a command to trigger a flash. In that approach, special care has to be taken so that the time lag between the trigger signal and the actual light emission is considered. Consequently, camera settings have to be adjusted with camera latency in mind.

Another approach involves using a flash signal output as a command sent to the camera in order to start capturing the image with a latency. This is possible thanks to the use of equipment with advanced features. For example, the flash unit can detect its own light emission before sending an appropriate trigger signal to the camera. This second approach is the most reliable in terms of synchronization management.

Advanced system benefits

An advanced smart flash can reveal details that are otherwise invisible. During daylight, the sun can reflect off a windscreen, making the driver appear invisible. In such cases, an advanced smart flash is an ideal light source for enforcement.

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Bridging security gaps

Transportation links are the lifeblood of an economy. If disrupted, an entire region – or even a whole nation – could come to a standstill with far-reaching financial and safety repercussions. In today's environment, transportation control centers must be on a high state of alert against hackers, cybercriminals and technical issues.

This is a challenge that companies are facing across the country, with organizations putting basic measures in place to tackle the issue.

For example, rules may be in place for employees to regularly change their passwords and companies may invest in powerful firewalls to protect the parameters of their systems.

However, not only do companies need to protect themselves against a security breach, but they also need to ensure their systems are resilient enough to be up and running again if any such a breach or any other disruption does occur.

Yet the whole purpose of a traffic control room is to provide easy, real-time access to information, when it is needed and to whoever requires it to enable fast, well-informed decisions. How can the accessibility versus security challenge be addressed?

Creating efficiency

Increasingly, traffic control centers are implementing IP-based keyboard, video, mouse (KVM) solutions as part of their infrastructures. KVM solutions allow operators to access and switch between multiple computers and applications from a single, remote location. They are often seamlessly integrated within existing workflows and processes and they can deliver considerable benefits to improve overall security.

KVM solutions improve security in traffic control centers by making it possible for computers to be housed remotely – accessible only with secure logins

Need to know

The AdderLink Infinity is a high performance, IP-based KVM solution

- Unlimited distance and end-points
- Multiple variants, including Zero U, dual head or dual link
- Redundant network and power options available

These include being able to move all physical computers away from the working environment and into a dedicated, secure external room, such as a rack-mounted server room, and separating secure networks from unsecured networks, a process referred to as 'air gapping'. This can be done with no disruption to the operation and performance of the computers themselves. In fact, situating the machines in an optimal environment often improves their lifespans.

Not only does this separation provide more space for users in the control room, but it means that only those with sufficient access privileges can get to the computers. This greatly reduces the risk of workstations and the confidential information within them being compromised.

The other major security advantage of KVM solutions is that they offer controlled USB access. This means traffic control rooms can introduce a tiered system of USB access with the option of giving full access only to those with certain security credentials, and limited access to others. This provides total control of the data and technology for those that require it.

Reliable operations

As far as resilience and future-proofed technology are concerned, high performance IP-based KVM hardware manufacturers such as Adder Technology use the investment of large hardware manufacturers such as Cisco, HP and Juniper. This investment in optimizing networking equipment is one hundred times greater than that made by proprietary hardware manufacturers. Users can, therefore, be confident of continuity of service despite almost any challenge or threat to normal operation.

IP-based KVM solutions also make it possible for the operator to use multiple subnets that can enable very large-scale matrices with additional points of redundancy, resilience and improved network traffic management. These can operate across multiple locations within a single installation on the same network through multi-cast routing. Having a single matrix manager to act as the primary – while additional managers sit as backup in the event of a hardware or network failure – ensures operational continuity.

These are just some of the ways investing in IP-based KVM technology from Adder can help provide extra security and resilience to the traffic control room, complementing the more traditional data protection measures. Unfortunately, the need for utmost security in areas such as traffic control is unlikely to disappear at any time in the near future, and any way to control access while still ensuring the right information is available to the right people at the right time will always be welcome.

3D visualization and mixed reality models

As a result of dynamically changing economic and political synergies across the globe, investments and decision making regarding infrastructure have become increasingly challenging for city planners. For such decisions and investments to be made with confidence, certain projection tools are required. Such tools can help city planners to anticipate human behaviors toward infrastructure that has not yet been built, effectively manage and plan measures for resolving traffic congestion, make plans for new infrastructure and transit links that are both safe and environmentally friendly, and justify investments and their returns.

With it being difficult – and arguably impossible – to create a single city planning solution that best fits the needs and requirements of all cities, uncertainty is created among city planners and this lack of confidence in available solutions can prevent them from making important decisions altogether. Traffic and congestion may worsen as a result of this.

Need to know

Sunovatech specializes in the development of virtual-reality solutions for applications such as...

- Traffic simulation modeling
- Infrastructure virtual reality
- Immersive virtual reality
- Augmented reality
- Mobile application development
- Software development
- Road safety education

Above: **3D infrastructure visualizations provide city planners with a unique insight into the impact of new infrastructures on their surrounding environment, even before the project has been implemented**

Transportation links and their supporting infrastructures are essential components of cities. Although businesses and people rely on transportation links to an extent, the survival of links in any given area depends on its surrounding ecosystem; for example, if there are enough people available to pay for and use the links, if the economy is strong enough, and if ticket prices are profitable.

Visualizing ideas

Simulation solutions offered by Sunovatech provide 3D visualization, plus mixed and augmented reality, to show the impact of transportation links on their surrounding environment. Sunovatech's solutions consider and incorporate all elements of transportation infrastructure – from the operating of roads and highways and public transportation, to ITS, as well as road safety and the environment.

Sunovatech's solutions enable city planners to effectively carry out transportation logistics, traffic engineering, urban development, urban formation, utilities management and the monitoring of driver behaviors

Left: **All elements of transportation infrastructure are incorporated into the solutions developed by Sunovatech**

on a 3D modeling platform, thus creating enhanced imagery in a virtual environment that depicts future operations and the impact of any transportation infrastructure on its surroundings.

In a fast-growing industry, Sunovatech's engineering background sets it apart from competitors. By layering mathematical analyses and visualizations of operations, the company can virtually implement projects before they have become a reality. By using 3D modeling, the company's solutions can accurately predict how successful a project is going to be in terms of ergonomics and social dynamics within the area.

Sunovatech processes accurate data from traffic and its related infrastructures by using the Sunovatech virtual reality 'SVR engine' a multi-core data processing and amplifier tool that processes the outcome of engineering simulation software and simplifies vast, complex statistical information into dynamic animation key frames. These frames are then integrated with 3D models that produce a powerful tool that visually analyzes the holistic impact of the infrastructure proposal on its surrounding operations and associated stakeholders.

The company also creates mixed and augmented reality simulations by connecting public infrastructure management systems (where governments can track and manage their public infrastructural assets) with the virtual models of entire infrastructure networks. The platform will be capable of connecting real-time information from several stakeholders to a single unified platform that provides layers of information suited to the needs of the user. Such technology is expected to be a game-changer for city planners.

Serving city planners' needs

Human lives have dynamically changed since the introduction of smartphones, which are now not only considered a lifestyle asset, but a necessity. This, in turn, has steered us into an era of data-dependent civilizations, where priorities and lifestyles are, to some extent, based upon the artificial intelligence (AI) offered by applications.

When developing its mixed and augmented reality solutions, Sunovatech has focused on providing its users with a common platform on which to manage infrastructure operations. The company's current developments are focused on creating tools that connect users to a persistent layer of reality – for example, virtually notifying a user or communter about the occupancy and the route of a public transit service; or notifying a driver about road hazards well in advance, without obstructing their view of the road. The possibilities are endless, and in the future, users will be able to take full advantage of augmented layers in real-world scenarios.

Mixed reality solutions have the potential to change how people commute, work, communicate and relate to the world. With the help of Sunovatech's solutions, decision makers will be able to assess their city's elements, thereby helping them to make swift and efficient decisions and ultimately resulting in smarter and more sustainable transportation infrastructure for generations to come.

Sunovatech will be showcasing its 3D visualization and mixed reality solutions at Intertraffic Amsterdam, taking place from March 20-23, 2018. Visit them in Hall 08, on Stand 08.411.

Preparing roads of the future with today's technology

Future advanced traffic management systems (ATMS) will need to be able to accommodate a variety of data sources.

The disruptions, current and impending, can be societal, technological, or both. In many cases they are symbiotic. Take, for instance, the societal influence of smart device technology: the delivery of accurate, real-time, multimodal travel information combined with common, secure, wireless payment systems challenges traditional notions of vehicle ownership. Many travelers realize there is little sense in using a private vehicle, adding to already existing congestion when it is possible to take advantage of shared-use mobility and ride-sourcing. The more widespread availability of multimodal mobility services will have a profound effect and will need to be underpinned by the delivery of accurate and timely data to service providers and users alike.

Existing road infrastructure and geometries will have to cope with the arrival of connected and automated vehicles (CAVs). Automated vehicles in particular will require major changes. For example, the communication of local ordinances, both fixed and temporal (such as rights of way and speed limits that change throughout the day), will have to be digitized. International efforts for the management of electronic traffic regulations initiatives are underway and Q-Free is already involved at the highest levels of standards definition. Further decisions also need to be made as to how communications and data services will be delivered in the CAV era – or at least the evolutionary paths need to be considered. In particular, the roles of ITS 5.9GHz dedicated short-range communication (DSRC) and 5G cellular telephony will require close scrutiny if interoperability and the near-zero latency performance of safety applications is to remain uncompromised.

Influences on city design criteria for new and regenerated neighborhoods are long-term and will give rise to the use of different metrics to justify returns on investment when allocating funding. The will encourage 'active mobility', such as walking and cycling, as well as the use of automated shuttles for first-/last-mile delivery. Again, real-time data needs will be significant and the focus of transportation system management and operations (TSMO) strategies will need to be expanded and adapted to incorporate these changes.

With so much change taking place, it can be tempting to adopt a 'wait and see' approach. Nevertheless, as policy, regulatory, cybersecurity and technological frameworks evolve, there is a need for more external collaboration and developing of new partnerships.

Proactive partners

Fortunately, many road authorities and other jurisdictions are proactive. Several are working with Q-Free to provide improvements today while preparing for further, incremental improvements in the future.

Non-proprietary solutions are a necessity given the current change of pace. They must also be able to support applications that were previously technologically or geographically discrete. Recognizing these trends,

Above: **A variety of data sources will need to be included in the future**

Need to know

OpenTMS is Q-Free's advanced traffic management system

- It is modular and scalable
- It interfaces with a wide variety of ITS devices
- It can be customized to suit different users' needs
- It offers the user a truck parking solution
- It is web-based and can be run in web browsers, independent of any other platforms

as well as the real possibility of hitherto unknown disruptive influences, Q-Free continues to look ahead to create future-proof and open standard solutions for changing the movements of life.

Complete ITS solutions

By integrating data, devices and solutions, a society with less congestion, pollution and accidents is achievable. At the center of this, Q-Free has developed the OpenTMS ATMS platform. Initially for strategic road management, it allows users to adapt and scale interchangeable solutions based on their unique business needs.

The platform now includes parking management and guidance (including urban and truck parking) and road pricing information from congestion charging systems. It can also cater for information exchanges with cooperative ITS and connected vehicle infrastructure. This includes roadside and onboard units supporting multiple communication protocols, such as 4G and 5.9GHz DSRC, that can be easily upgraded to support 5G when it becomes available. Q-Free is also incorporating traffic signal control software to allow fully integrated urban and inter-urban system management.

Globally, Q-Free's systems are helping road authorities to improve their networks' safety and environmental performance while reducing congestion by interconnecting formerly standalone systems.

by **Larry Yermack**

Transportation must take the lead in this era of technological change

Every January, for the past 97 years, Washington DC has hosted the largest gathering of transportation professionals in the world at the Transportation Research Board's (TRB) annual meeting. This year, well over 13,000 people attended and I was proud to be among their numbers.

I can count myself as a TRB participant for only about a third of that time. I've attended the annual meetings, off and on, for more than 30 years and have seen many important trends arise and sometimes fade away. A fond memory – that many of you may share with me – is when the TRB met for its annual meeting at the three hotels near the zoo. There were just a few thousand of us as we shuttled between the hotels, where we would discuss everything from transit to highways to the new kid on the block, ITS. And the restaurants weren't as crowded, or at least that's how I remember it. It seemed for its size an intimate gathering because we all seemed to know one another. Maybe we've lost some of that.

The other thing I am nostalgic for, as a former public official, is when the government was in charge of the transportation system. The DOTs managed highways and signal systems, transit operators ran trains and buses and the vendors came to describe the latest advances in concrete and asphalt, and trains. They were public systems supplied by private companies.

Then ITS came along and shook things up. I remember well the wringing of hands when DOT engineers just wanted to build new roads and were indifferent to improving capacity on existing roads with ITS technology. But we persisted. We kept making the efficiency and safety arguments for our systems and eventually a new generation of public leadership embraced it – but not without paying a long-term price.

ITS began as systems for governments, as well as the consumer. It was the beginning of automotive automation and traveler information. That exploded after 2007 with the introduction of the smartphone. Today the two most important sets of ITS technology reside on the phone and in the car. Less and less is deployed on the roadside.

> "Planning departments need to step up and assert their leadership"

I have written extensively about how the government has practically lost the ability to procure technology, but there is an even bigger problem emerging: the government has lost control of the transportation system. Decisions about what goes into cars and how they interact with other vehicles and the environment are all made privately. Tools that the traveler uses are also provided privately. (How many public apps do you have on your phone?)

It seems to me that planning departments need to step up and assert their leadership in the emergence of the 21st century transportation network, because if they stay quiet for much longer, they will be silenced. Market economics may be best for product sales but I don't think it's best for a transportation system designed to serve everyone.

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

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Applying embedded vision systems to ITS

Computing technology is getting smaller, faster, and more powerful. A wide range of industries now benefit from these developments and embedded systems (also known as edge computing) are already proliferating in the ITS market.

These small but powerful computers can run the latest versions of popular operating systems (OS) such as Windows 10, Android, iOS and Linux.

When designing an ITS system with embedded technology, the OS should be chosen to ensure compatibility with software and hardware.

Linux's collaborative open sourced Yocto Project allows for customization of its systems, so only the elements of the OS that are required are selected.

For automatic license plate recognition (ALPR), software capable of optical character recognition (OCR), such as OpenCV, is required to run on the embedded system. OpenCV is an open source computer vision library with a community of more than 47,000 contributors. It is supported on Windows, Linux, MacOS, Android and iOS, and has interfaces for C, C++, Python and Java.

Enough power to perform

Hardware selection based on system functionality ensures enough processing power is available to perform ALPR as well as any other image editing or compression. Proper network connectivity (Ethernet, wi-fi, cellular or Bluetooth) should be available for networking with a centralized processing center and sufficient onboard storage is useful if the network becomes unavailable for an extended period of time or for transmission in off-peak hours.

A computer on module (CoM) is worth considering for large-scale edge computing system deployments. It is a single-board computer without interface ports such as USB, Ethernet or HDMI, and only the basics required for computing: CPU/GPU, RAM and an SSD.

The CoM is then paired to a custom carrier board containing only the interfaces required for the system. This allows the design to be cost-effective and to maintain a smaller profile with smaller enclosures and less overall weatherproofing needed for outdoor systems. CoMs are also built with product integration in mind and are available for a number of years to avoid a system redesign each time an embedded system manufacturer upgrades/changes its product.

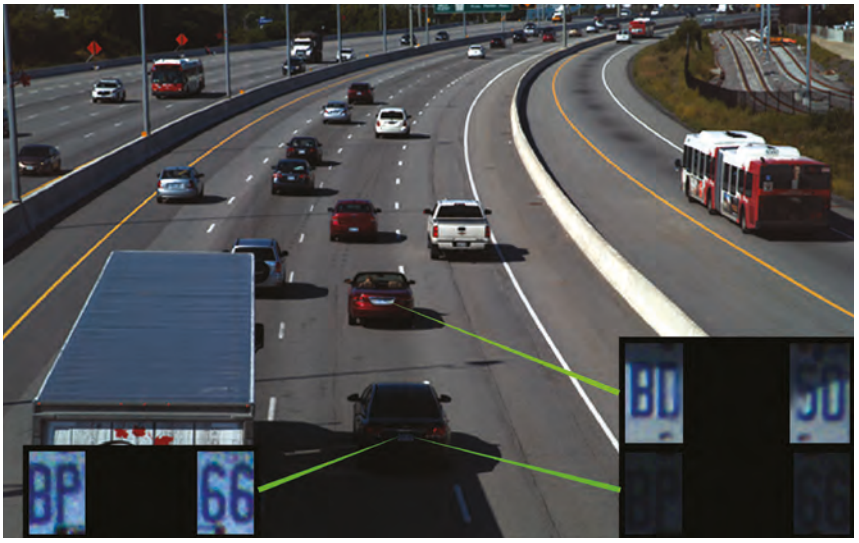
Compatibility is essential

When choosing a camera, compatibility with the selected OS and software is essential. The camera should have an application programming interface (API) that will reliably run and its specifications should be tailored to the deployment.

In ITS applications, horizontal resolution is more critical than total megapixels because it allows for imaging of more traffic lanes. Typically, 1,000-1,400 pixels are required to image one lane of traffic and then run computer vision algorithms. High frame rates allow for software-based analytics triggering and remove the need for additional infrastructure such as ground induction loops. A wide dynamic range is essential for extracting detail such as a car's licence plate in the shadow of a large truck on a sunny day, as pictured above.

The selected camera should also have an electronic global shutter. The lack of a mechanical shutter as found in DSLR cameras increases the lifespan of the camera, and the global shutter will freeze motion and avoid distortion when imaging rapidly moving vehicles.

Embedded systems are a game changer for ITS applications. They can decentralize computing resources and reduce bandwidth consumption by processing images on-site and only transmitting licence plate data to a centralized location.



Left: **Optical character recognition is required to run on an embedded ALPR system**

Need to know

Things to consider when choosing an embedded system for ALPR

- Software and hardware compatibility should be considered when choosing the operating system
- A computer on module is worthwhile for large-scale system deployment
- Compatibility is also an important issue when deciding on a camera
- A camera's horizontal resolution is more critical than total megapixels

Workzone data is critical for safe AV operations

Accurate real-time workzone information and data not only provides safety benefits for workers and drivers – it will also be extremely important for the successful deployment of autonomous vehicles (AVs) in the future.

Gewi has been involved in the research and deployment of smart workzones since 2010, in a demonstration project called Diana2, working with BMW and Hessen Mobil, a traffic control center in Hessen, Germany.

Need to know

Gewi's TIC software for workzones enables operators to collect and share accurate workzone data

- It can save operators time with predefined templates, automated processes and prompts for each stage of a workzone project
- The software can also connect data from multiple workzone projects. This can help operators to avoid conflicts
- Workzone data can be used to create traffic update reports, distributed via VMS, email apps and websites

The Diana2 project demonstrated the local hazard warning (LHW) capabilities of transportation protocol expert groups (TPEG) by using Gewi's traffic information center (TIC) software to collect data from roadwork vehicles. This data included vehicle positions and speeds, lane closure details and the positioning of arrow signs.

Above: **Gewi's TIC software helps identify workzone locations and lane closures in real time**

The information was then transmitted direct to the vehicle's navigation device to provide advance warnings of workzone conditions.

Nowadays companies have commercially released technology that can be used to provide real-time data from workzones, including identifying when workers are present, lane restrictions from impact attenuator trucks, and the precise location of flaggers (staff manually directing traffic with help from a handheld sign) in workzones.

Making data public

In Germany, Gewi is working with the Ministry for Regional Development and Transport of Saxony-Anhalt, together with representatives of German automobile club Allgemeiner Deutscher Automobil-Club (ADAC) and the accident research department at Dresden University of Technology, to implement measures to reduce the number of workzone accidents.

Gewi's TIC software collects data from construction vehicles and warning trailers to identify workzone locations and lane closures in real time. This information is then delivered to navigation devices and variable message signs (VMS) in construction areas. The goal is to increase workzone safety by distributing this information across a wide range of information channels.

Gewi's TIC software can easily be configured to collect smart workzone data, as well as data from cameras, VMS and crowdsourcing, to help public authorities manage workzones more effectively.

As AVs become more widely deployed, precise real-time data will be required to ensure that vehicles can respond safely to changing workzone conditions. In future TIC software could be used to collect and distribute pavement marking data to certify which roadways are suitable for level 4 and 5 AVs.

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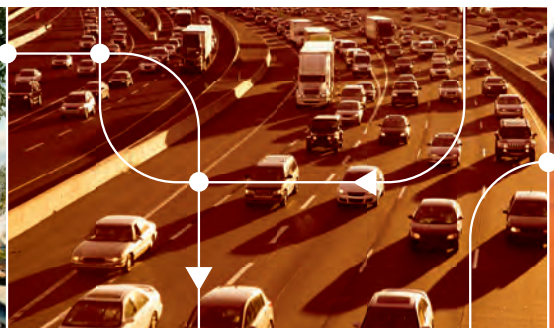


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Your shortcuts to some of the big stories in this issue – and beyond!

"If we have accurate speeds, then traffic will be rebalanced to minimize congestion. It all comes back to whether detection systems are working"

James Pinheiro, deputy director of traffic operations and maintenance, Caltrans Orange County, ***on the need to maintain functioning ITS during the I-405 Improvement Project in California***

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"We've found a way to bring New York online, just like we've brought all our other cities online… it is totally driven by cleverness"

Matt Ginsberg, CEO of Connected Signals, ***on his new system that can establish signal phase and timing patterns, without any direct DOT data feed***

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"We want to enable electrification and autonomous and connected vehicles through pilots and investment"

Elliot Shaw, executive director at Highways England, ***reveals just one of the objectives for his organization in the 2020-2025 timeframe. To hear more plans from the recently published*** **Strategic Road Network Initial Report** ***visit trafficktechnologytoday.com/srnir***

"V2V and V2I technology is going to help us to maximize the utilization of the capacity that's already out there"

James Bass, executive director at Texas DOT, ***on his ambitions for smarter use of highway capacity. Watch the full interview at trafficktechnologytoday.com/txdot***

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