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EXCLUSIVE INTERVIEW

PLUS

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How the latest virtual models take driving styles into account to help traffic flow more freely

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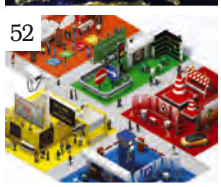
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Editor's letter

Amsterdam is a city that's smarter than most when it comes to transportation, and the primary reason is that it can be said to be truly multimodal. Rather than trying to squeeze ever-greater numbers of cars onto its roads, it has a 21st century public transport system that integrates trams and buses with high-speed trains and metro links. Moreover it recognizes the importance of travel by water – and of course by bicycle. As you'll discover on page 10, an astonishing 58% of Amsterdammers use a bike on a daily basis. And they've been doing it for decades. It's a model that cities around the world are now trying to emulate. So what better aspirational setting for one of the key events in any transportation professional's calendar? Intertraffic Amsterdam.

As this issue goes to press I have just returned from an overnight stay in the Dutch capital, where I was part of the jury that decided the winners of the Intertraffic Innovation Awards. The results are, of course, a closely guarded secret, but what struck me more than anything, while hearing presentations from the shortlisted entrants, was that it feels as though transportation technology is reaching a tipping point. We are now witnessing the democratization of ITS. Falling component prices, solar power, better batteries and reduced setup costs all mean that hardware can be installed by growing numbers of road authorities around the world, so developing nations will soon be reaping greater rewards from advanced traffic management systems. Furthermore smart software is being created that, through the analysis of big data, makes even better use of existing infrastructure, meaning cities that already have advanced traffic management capability can make it even more powerful at minimal cost. It's an exciting time to be in the industry. Don't miss 27 highlights of Intertraffic starting on page 52.

Of course there's always room for more expensive hardware… Elsewhere in the issue we take an excited look at the near future where infrastructure assets will self-report damage and a possible distant future where robots will repair our roads. It might sound farfetched, but a team at Leeds University, UK, has already won £4.2m (US$6m) funding for a project that aims to make "Leeds the first city in the world to have zero disruption from street works… with an infrastructure that can be entirely maintained by robots." Find out more on page 24.

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- Public road testing
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- Traffic scenario testing
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- Safety and crash testing
- Fail-safe testing
- Cyber threat testing
- Validation and verification
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EXCLUSIVE

Central intelligence

Lauren Dyson finds out how smart parking systems currently being trialled in Berlin and London are impacting congestion and on-street parking management

In September 2015, a pilot project was launched in Berlin aimed at simplifying the search for a parking space, by not only assessing current availability but also predicting what it will be in the future, enabling smarter journey planning. Funded by the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB), the City2.e 2.0 research project comprises five partners: SenStadtUm, VMZ, IKEM, DFKI and Siemens.

"On average, German motorists spend 10 minutes searching for a parking space in an overcrowded city center," says Marcus Zwick, head of the innovation management mobility division at Siemens. "This costs time, gas and nerves. To put that into perspective, at any time around 30% of drivers in city centers are searching for a parking space. A search ranging over 4.5km [2.8 miles] will blow around 1.3kg of CO_2 into the air."

Sensing the solution

As part of the project, Siemens has installed radar sensors on streetlights along a 656ft (200m) section of the Bundesallee in Berlin. "The sensor circuits, which are about the size of a fist, send microwaves toward a predefined surface. Any obstacles in their path reflect the waves back to the sensor, which uses an algorithm to calculate if and in what position an object is parked in the space," says Zwick. The sensor comprises an antenna, analog electronics, an analog-to-digital converter and signal processor. It can be built into the lamp fixture on a street light and supplied with electricity. Sensors can also be fitted to a lamppost or the wall of a building. They can survey a cone-shaped area of around 30 x 9m (100 x 30ft) – equivalent to between five and seven cars parked in a line.

"Radio signals are used to transmit the measurement data to Berlin's traffic management control center," Zwick continues. "The center

Photo: Siemens

> An optimal reduction of parking-search traffic is only possible if the space availability at the time of arrival is already known when a trip is planned
>
> *Dr Tim Tiedemann, senior researcher at the Deutsches Forschungszentrum für Künstliche Intelligenz (DFKI) Robotics Innovation Center*

(Far left) **Radar sensors can be built into a lamp fixture or fitted onto to a lamppost or wall**

(Left) **Drivers can use their smartphone or navigation device to check parking availability**

processes the data and prepares it in an accessible format, calculating which parking spaces are full, in real time. Drivers can then use their smartphone or navigation device to enter a destination and receive information on whether and where parking spaces are available nearby."

Prediction technology

A key feature of the system is the software application, developed by the DFKI's Robotics Innovation Center, which goes beyond real-time space occupancy and uses intelligent learning to predict future availability. "An optimal reduction of parking-search traffic is only possible if the space availability at the expected time of arrival is already known when a trip is planned," says Dr Tim Tiedemann, senior researcher at the DFKI Robotics Innovation Center. "We have developed a software prediction system that collects occupancy data from Siemens' parking space sensors 24/7. The system then searches for groups of similar parking occupancy behavior using adaptive machine learning methods. When a user asks for future parking space occupancy information, the system tries to identify the current occupancy behavior class and gives an estimate of the future occupancy."

"The software works with adaptive systems," Zwick adds. "It recognizes patterns in the parking situation – for example, if it comes under particular pressure at certain times of day or on certain days of the week. The software then predicts for particular road users what the parking situation is likely to be when they reach their destination."

The system benefits both road users and city authorities. "Smart infrastructure saves time, protects the environment and ultimately improves quality of life for city dwellers," says Zwick. "The result is an end to superfluous and hazardous traffic searching for a parking space, and optimum use of parking spaces within the city."

> Smart infrastructure saves time, protects the environment and ultimately improves quality of life for city dwellers
>
> *Marcus Zwick, head of innovation management mobility division, Siemens, Germany*

Asset optimization

A new research project in the UK is determining optimal deployment patterns for ground-based parking sensors on the basis of survey data. It is enabling councils to cover a wider geographic area than before with smart parking schemes – without need for any extra budget – as the occupancy in some streets can be estimated using just a few key indicator spaces.

The project is a collaboration between three companies: Thingslearn, OpenSensors.IO and Ethos.

"Finding a parking space is probably going to become a good deal easier in the future," says Boris Adryan, founder of Thingslearn. "Imagine telling your satnav your rough destination on your next trip to the city, but your final destination is automatically determined only during the final approach to your designated, available parking space."

1,824

The vehicle miles traveled per parking space per year by vehicles trying to find it

(based on 10 cars occupying the space per day, spending 3 mins each to find it)

Source: Donald Shoup

City success

A successful test project in the London borough of Westminster in 2013 showed that freely available occupancy information increased parking compliance and occupancy, while reducing the time drivers spent looking for a space. Westminster City Council commissioned the deployment of 3,000 sensors in central London. These ground-based sensors sent occupancy information using a proprietary radio protocol to hub devices mounted on lampposts, which then relayed the data through a central server to a phone app.

In the busy London borough of Camden, the demand for parking spaces considerably exceeds capacity. The stress this puts on the local area in terms of congestion led Camden Council to thoroughly assess parking conditions and respond to them proactively. A smart parking trial went live in November 2015.

"Residents require permits for parking in Camden and currently more permits are required than we have spaces for," says councillor Meric Apak, Camden Council cabinet member for sustainability and the environment. "We decided we wanted to trial smart parking sensors in 2013, but the project only progressed last year due to the impact of other key projects."

An estimated **500,000** vehicles travel through Camden every day

Space for visitors

It is not only residents that are affected by parking – the council's approach needed to also recognise the needs of the many people who work in or visit Camden every day.

The trial involves 367 RFID-equipped SmartEye vehicle detection sensors from Smart Parking, linked via SmartLink data transmitters. "The sensors are installed in the carriageway to monitor parking-bay usage," explains Apak. "Communications equipment is installed on existing streetlighting columns, from where it also receives power."

Real-time occupancy data is fed into RingGo, a parking app, which provides this information to motorists – enabling them to easily identify available parking in less occupied streets close to their destination, which reduces congestion.

Streets ahead

"This ultimately results in an improved customer experience," says Apak. "Motorists will spend less of their time looking for available parking spaces and they will have the ease of parking compliantly, with payments that they can make via the app."

The current trial aims to identify the impact and benefits of the system to visiting motorists, residents and to Camden Council itself, and analysis is still being completed. There has been no decision yet as to whether the authority may progress to using bay sensors on a permanent, widespread basis, but the experience so far has been positive.

"With the bay sensors we are able to direct motorists to available spaces more efficiently, understand occupancy at a glance and manage the road space accordingly," says Apak. "This will reduce car journeys and thereby curb CO_2, NOx and PM10 emissions, to help support improvements in air quality."

> "With the bay sensors we are able to direct motorists to available spaces more efficiently, understand occupancy at a glance and manage the road space accordingly

Meric Apak, Camden Council cabinet member for sustainability and the environment

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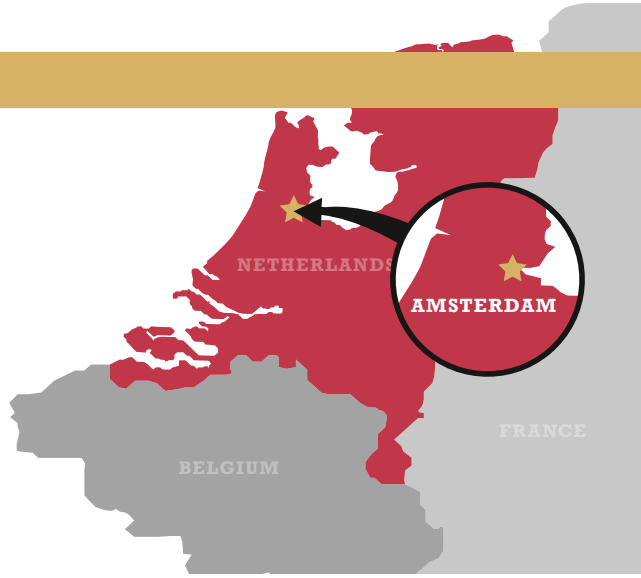
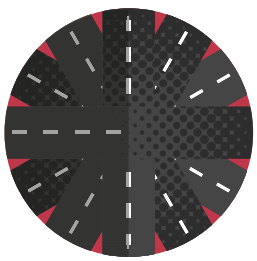
Urban cycles

Known as one of the most bicycle-friendly cities in the world, **Amsterdam** is constantly investing in sustainable transportation infrastructure in an effort to combat congestion, reduce emissions and improve quality of life

Infographics: Ben White



Amsterdam's roads are governed by the Ministry of Infrastructure and the Environment



The Amsterdam road network comprises

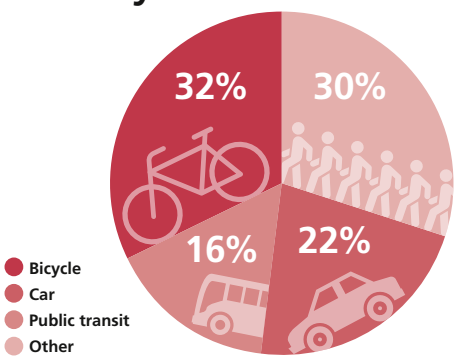
2,893 miles

(4,656km) of asphalt

Amsterdam is home to

811,000 people

Journeys in Amsterdam



There are

311 miles

(500km) of cycle paths and

250,000

public bicycle racks around the city

Amsterdam's roads are most congested on

TUESDAY MORNINGS

and

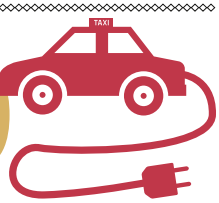
THURSDAY EVENINGS

DID YOU KNOW?

Amsterdam has the highest density of electric vehicle charging stations in the world – there are currently 1,300 spread across the city. Amsterdam City Council aims to increase this number to 4,000 by 2018

More than

200



fully electric taxis drive around Amsterdam every day

There are an estimated

881,000

bicycles in Amsterdam

58%

of Amsterdammers use their bikes on a daily basis

The cumulative delay for an average commuter with a daily 30-minute trip is currently an extra

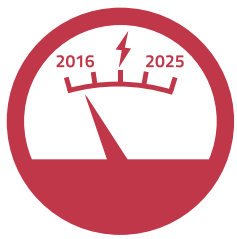
60 hours per year

The number of cars registered in Amsterdam is approximately

263,000

Amsterdam's public transportation operator, GVB, has promised to make all its vehicles emissions-free by

2025



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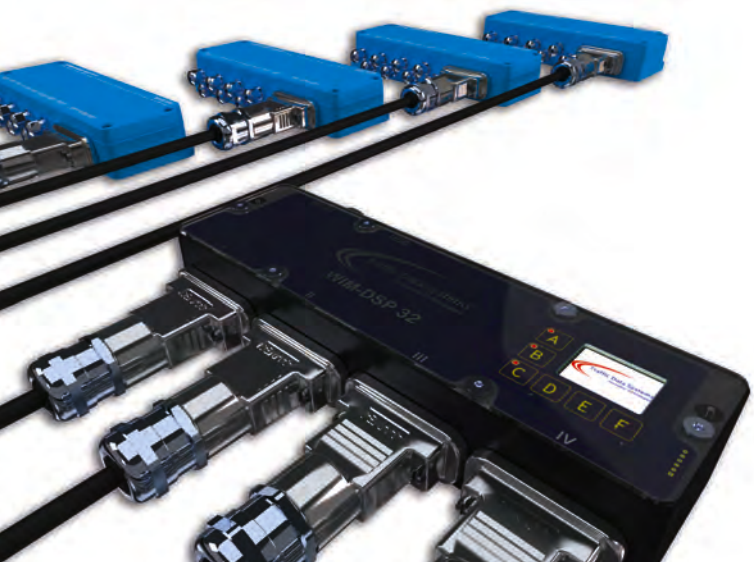

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Electric dreams

Lloyd Fuller takes a look at initiatives and investments that are improving the availability and interoperability of EV infrastructure

Peak performance

The 'electrification' of vehicles in the UK reaches a new high

The UK government's initiatives for the 'electrification' of the country's roads appear to be paying off, with the news that plug-in electric vehicle (PEV) registrations reached a record high in 2015, as 28,188 new ultra-low emission vehicles (ULEVs) were licensed. The switch to electric power marked a 94% annual rise compared with the previous year, while the popularity of plug-in vehicles shows no sign of slowing, with an even greater selection of ULEVs due to be launched in 2016.

Analysis by government and motor-industry-backed organization Go Ultra Low reveals that ULEV registrations for 2015 eclipse the 21,486 total of PEVs sold between 2010 and 2014. Plug-in power is becoming a mainstream option for UK drivers alongside gas- and diesel-powered cars, as more PEVs make up a greater proportion of the 2.6 million new cars registered in 2015.

Fueling the demand is a greater choice of models, with 30 pure electric or PEV cars now available in the UK, ranging from high-performance sports cars to capable family vehicles – and many more are on the way in 2016.

The government's Plug-in Car Grant (PiCG) is seen as a contributory factor in the increase, along with the Go Ultra Low campaign, which aims to increase purchase consideration of ULEVs by helping motorists understand the benefits, cost savings and capabilities of the vehicles on the market. The government anticipates that 5% of new car registrations (around 100,000 units) will be ultra-low emission by 2020.

Seamless experience

Standard specification aims to ensure interoperability across EV products and services

An open group of players from the global EV market has launched its first standard specification. The e-Mobility ICT Interoperability Innovation Group (eMI3) has released the specification as a major boost to its vision of unlocking seamless EV driver experiences by enabling interoperability across all EV products and services. Focused on presenting the EV marketplace with a first set of industry-agreed standardized use cases and business objects, the coalition behind eMI3 hopes to deliver an innovation and interoperability boost to this important and growing sector.

Interoperability matters to the sector because it means the speed at which new products and services that enrich an EV driver's experience can be accelerated. In practical terms, interoperability means EV users should be able to use any roadside charging point, in any country, and benefit from any service, from any supplier, with ease and simplicity, because cross-device communication will be enabled.

Business acumen

EV users to gain better access to charging facilities at workplaces in the USA

As part of the US government's long-term aim of reducing vehicle emissions through the ever-increasing use of carbon-neutral transportation, the US Department of Transportation (USDOT) has joined the US Department of Energy's Workplace Charging Challenge (WCC), which will support USDOT efforts to make workplace charging for plug-in electric vehicles increasingly available to employees across the country.

Participation in the WCC scheme will position USDOT to successfully launch a comprehensive workplace charging program, and increase the number of PEV charging sites that are found outside its buildings nationwide. The department's goal is to provide 500 electric vehicle supply equipment units by 2025.

Will most new cars be self-driving by 2030?

Autonomous cars will soon be gracing the roads in small numbers. But what – and how long – will it take for them to become the norm? **Todd Litman** and **Alexander Hars** debate costs, risks and customer preferences

Todd Litman is founder and executive director of the Victoria Transport Policy Institute, an independent research organization dedicated to developing innovative solutions to transportation problems

NO!

It will be 2040 before sales of autonomous vehicles are above 50%

"During the 2020s and early 2030s, self-driving cars are likely to be expensive novelties with restrictions on the conditions under which they may operate"

Autonomous (self-driving) vehicle technology is developing rapidly, and may eventually provide great benefits. However, it is important for policy makers to be realistic when evaluating their impact. Recent announcements that major manufacturers aspire to sell such vehicles soon, and optimistic predictions of their benefits, have raised hopes that this technology will soon be widely available and solve many transportation problems, but there are good reasons to be cautious when predicting their future role.

For the foreseeable future, vehicles will be able to operate autonomously only under limited conditions. Major technical and economic obstacles must be overcome before most households can rely on them for daily travel. If they follow previous vehicle technology deployment patterns, autonomous vehicles will initially be costly and imperfect. During the 2020s and early 2030s, they are likely to be expensive novelties with restrictions on the road conditions under which they may operate. It will probably be the 2040s or 2050s before middle-income families can afford to own self-driving vehicles that can safely operate in all conditions, and even longer before lower-income households can purchase them on the used-vehicle market.

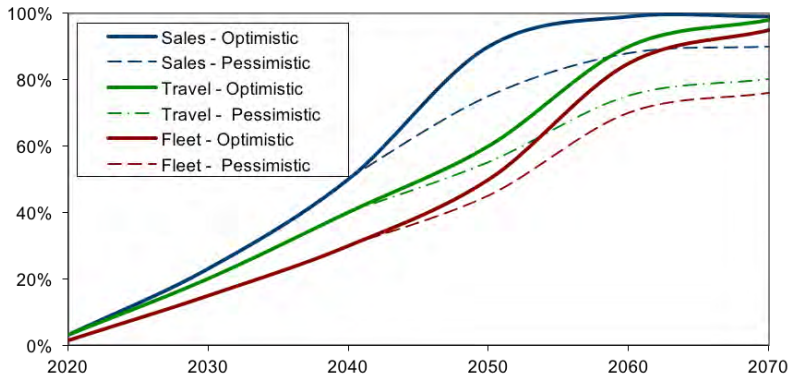
A large portion of motorists may resist such vehicles, just as some motorists prefer manual transmissions, resulting in mixed traffic that creates new roadway management problems.

Some expected benefits, such as increased traffic speeds, reduced congestion and automated intersections, and therefore roadway and public transit cost savings, require dedicated autonomous vehicle lanes. This will raise debates about fairness and cost-efficiency, and human drivers may be tempted to use such lanes by, for example, following a platoon of self-driving vehicles, introducing new risks, regulations and enforcement requirements. Similarly, to reduce the need for public transit services, self-driving vehicles will need to be affordable to lower-income non-drivers – which may take decades.

Costs and risks

Vehicle innovations tend to be implemented more slowly than other technological changes due to their high cost, slow fleet turnover and strict safety requirements. An average automobile typically costs 50 times more and lasts 10 times longer than an average cell phone; consumers seldom purchase new vehicles just to obtain a new technology. Autonomous vehicles will have relatively costly equipment and service standards, similar to airplanes, which may discourage some users. Large increases in new vehicle purchase and scrappage rates would be required in order for most vehicles to be autonomous before 2050.

Self-driving taxis may be somewhat cheaper than human-driven taxis, a fact that will promote



This graph uses historical data from implementation rates of other vehicle technologies to predict the uptake of autonomous vehicles. New car sales cross the 50% barrier around 2040

100

The number of autonomous cars Volvo is planning to test on public roads in Gothenburg in 2017

Source: Volvo

(Above) **Volvo has announced that it will take full legal responsibility for the 'actions' of its vehicles, while they are driving in autonomous mode**

shifts from vehicle ownership toward more vehicle sharing, but that can only be cost-effective in compact, multimodal urban areas. In automobile-dependent, sprawling communities, owning a personal vehicle will probably continue to be more convenient and cost-effective. Taxi drivers provide various services – they help frail passengers into vehicles and to their destinations, load and unload luggage, and give advice to tourists, so some travelers will remain willing to pay a premium for the human touch.

A shift in dynamics

While autonomous vehicles are likely to reduce some problems, they may increase others. They are likely to stimulate some types of vehicle travel, including long-distance commutes, non-drivers' vehicle travel, and empty backhauls by self-driving taxis, which may increase external costs including congestion, accidents, energy consumption and pollution emissions. They may encourage some longer-distance commuters to purchase larger, heavier vehicles to serve as mobile offices or bedrooms ('commuter sex' could become a marketing concept). Although autonomous vehicle technologies may reduce driver error accidents, they are likely to increase computer error accidents and possibly risk from hackers and terrorists.

This analysis suggests that autonomous vehicles should not be considered a major solution to transportation problems for at least another one or two decades, and possibly even longer.

For more information see: Autonomous Vehicle Implementation Predictions: Implications for Transport Planning *(www.vtpi.org/avip.pdf)*

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YES!

The autonomous vehicle market will grow rapidly in the 2020s

Dr Alexander Hars
is editor of the website Driverless Car Market Watch and managing director of software development firm Inventivio

Driverless cars will not, I think, take long to be adopted for two reasons. Firstly, although in the past it has taken decades for new automotive technology to catch on, that is because it was initially costly and the benefits were not always obvious. Take antilock braking: it reduces risk, but it's hard to quantify. In its early years, if you valued your life highly – and had a lot of money – then you'd be more likely to pay for it. Eventually safety functions trickle down. People who are well-off purchase them first, then the cost goes down and eventually, everyone gets them.

But with self-driving cars it will be very different, because they provide an immediate benefit: they give you back your time. It's easy to put an hourly value on your own time based on your earnings, so it is much easier to quantify the value of autonomous driving. Therefore people will be more willing to pay. For early adopters these cars will quickly become a status symbol: they can arrive at the office having worked, or relaxed, in their car. The benefits are much more immediate for a larger part of the population than traditional auto upgrades, so people will adopt them more quickly.

Fleets on the streets

The second reason they will become common is that fleets of autonomous vehicles will change the way mobility is provided. There will be lots of autonomous taxis driving around that will provide mobility very cheaply, so you can quickly ramp up the number of trips taken and miles driven in self-driving cars. We will see the first fully self-driving cars on the roads in the next two years. They will be operating within fleets and we will see fleets picking up until 2020 and really building up a good head of steam by then.

Fleet vehicles are going to be the first type of fully autonomous car that we will see in large numbers. For safety, it's better initially to deploy fleets of cars that are fully autonomous so that the fleet operator has full control over them. No one can tamper with them easily, and the operator can be sure that necessary updates are made.

As far as private cars go, most new vehicles sold will have autonomous ability by 2030, but there are aspects of this equation that are difficult to calculate. Fleets of autonomous taxis will mean car ownership will significantly drop which means that manufacturing capacity will be much too high by 2022. What will that mean for the auto manufacturers? On one hand, they will have to quickly reduce their output of conventional models. They'll have to close plants. They will also try to jump on the autonomous fleet bandwagon, which means they may shift any overcapacity to build up their own fleets of self-driving cars. That will accelerate the adoption of fleets and further reduce the demand for cars. So the model mix of cars targeted at individual users versus those that go into fleets is hard to predict.

> "The first five years of the next decade will be very hard on the auto industry as it adjusts to a shift in the demand for cars"

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(Above) **Google's Self-Driving Car, which has no steering wheel or pedals, is already being tested on public roads**

The auto industry will have quite a few difficulties in adjusting to this new market. The first five years of the next decade will be very hard on the industry as it adjusts to this shift in the demand for cars.

Customer choice

Of course a significant number of people will still purchase their own cars. Luxury models will remain in demand as the rich will still want their own 'cocoon on wheels'. Others will have different ideas on how to spend their cash (and may want to avoid the hassle of owning a car). Everybody will use ubiquitous, cheap self-driving taxis at least some of the time. Families will think twice about owning multiple cars. The young generation will grow up appreciating hailing a ride in a self-driving car anywhere, anytime.

In addition, people will choose their cars differently. They will focus on their preferred use – be that commuting or driving for pleasure – because they know that they can easily get a larger car or a car that is better suited for long-distance trips for the few cases where they really need it, via autonomous mobility service providers. A trend that we have observed in many industries is finally arriving in the auto industry: the transition from selling a product – the physical car – to providing a service – autonomous mobility as a service. ○

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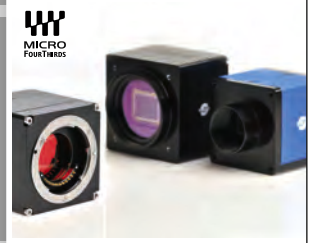

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In his first interview as CEO of MaaS Finland, **Sampo Hietanen** reveals his ambitions to transform the whole concept of mobility as we know it

Interviewed by Tom Stone

When the history of this decade comes to be written, it may well include references to it being the period that marked the beginning of the end for the private car. And it will no doubt identify one of the key instigators of this radical shift in ownership and mobility as Sampo Hietanen.

The former CEO of ITS Finland is already credited as the man behind the concept of Mobility as a Service (MaaS). Now, as CEO of the world's first dedicated MaaS company, MaaS Finland, he stands on the brink of making that concept a reality, encouraging drivers to swap their private cars for a monthly subscription that fulfills their mobility needs.

Why on earth would they do such a thing? Because it will not only be as convenient as owning a car (thanks to near-instant access to services via smartphones), it will be cheaper too. And why will transportation companies also be clamoring to provide services? Because they could also make a lot more money this way.

It seems almost too good to be true. How can Hietanen possibly hope to create these huge efficiency gains? Put simply, he will be freeing up capital tied up in the private vehicles that sit idle 96% of the time.

We want to prove in 2016 that from one subscription, you can have access to all

> We want to prove in 2016 that from one subscription you can access all mobility services and that we can beat the service level of a car

> I went to some of the former big leaders of Nokia and it took them about a minute to understand. They said, 'Wow! This is huge'

mobility services," says Hietanen. "We're also going to prove that we can beat the service level of a car. Or at least be comparable to it. We get to use all the pieces in the puzzle, including public transport, taxis, car share, bikes and home deliveries. We end up with a nice-looking package which we have to turn into a service-level promise for the end user."

A handful of MaaS trials have run in European cities over the past couple of years, however Hietanen is keen to point out that – thanks in part to a new round of funding led by French transportation giant Transdev and Turkey's Karsan Automotive – 2016 will be the year that Maas Finland goes beyond the pilot stage. "We are going to aim for a minimum viable product," he says. "We want to show that people really want to pay for this, not just that we can do it."

Network coverage

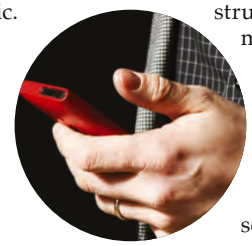
Hietanen is well aware of the enormity of the task ahead. But he takes inspiration from changes to the telecom industry in the 1990s, as users began switching from fixed lines to cell phone contracts. "Just like in telecoms, you need good coverage," says Hietanen. "You wouldn't get a cell phone if it worked only in London. I'm not sure if we can get to all corners of Finland, but we're convinced we can cover the major cities and industrial areas, and include city connections to make it viable. Car rental will be vital. If you do not have access to a car then it's hard to guarantee mobility. Therefore, we are hoping to partner with car sharing schemes like DriveNow or Car2Go."

Despite the fact that MaaS is an inherently green concept – it encourages use of public transit and ride sharing – the main driver of mass adoption will be economic. A true businessman, Hietanen states, "The concept can only scale if we can prove profits are rising. And where does that come from? Wider use.

"The cell phone industry talks about average revenue per user (ARPU). In Europe this is about €30 [US$32] a month per mobile user," says Hietanen. "In transport, ARPU is about €300 [US$328] in Europe. So we're freeing up potential, because around €240 of that is the cost of owning and running a car. Just €60 makes up the rest of average expenditure. So there's a big market. That €240 of ARPU is based on assets that are used roughly only 4% of the time. So there is a lot of available productivity we can take advantage of.

"That was actually what got me to thinking of this. The whole idea was, what if mobility were to change in the same way as telecoms? I went to some of the former big leaders of Nokia and it took them about a minute to understand. They said, 'Wow! This is huge. You have to do this.'"

And just like the cell phone industry, it will be possible to personalize subscriptions to personal needs. "There will be different prices. I'd be able to charge according to the accuracy of the pick-up time, for example. Or you have a package where you take public transit, but if it rains we'll get you a taxi. There are so many alternatives once you start thinking about pricing differently."



Looking to the future

As MaaS grows, it could also promote more unusual modes of transport that might struggle to catch on in a traditional mobility market. Hietanen uses the example of a hypothetical Segway service launching in a big city. "You might have a hard time getting customers because they wouldn't be looking at your app. But if you are offering that service through MaaS operators, you might have a chance. It's a bit like how apps didn't really work until Apple came up with the App Store. In a way it could become a marketplace for mobility, although not for comparing prices. All people want is someone to take care of mobility in a cool, nice way." Which is, of course, exactly what Hietanen intends to do.

"Two years ago even I, the father of the concept, would have said: 'Yeah, it's doable in 2020 or something'," he concludes. "But, in fact, dreams can come true way faster than you think." ○

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Self-fixing infrastructure

Can the Internet of Things help infrastructure assets monitor themselves – and more besides? **Saul Wordsworth** looks to a future where human intervention may no longer be needed when it comes to assessing the need for – and even carrying out – road repairs

Illustration: Magictorch

Imagine a future where lengthy delays caused by road repairs are a thing of the past; where infrastructure is managed and maintained autonomously, and repair work is carried out only in the dead of night on a little and often basis. Impossible? Farfetched? Not for Professor Phil Purnell from the School of Civil Engineering at the University of Leeds, UK, who is leading research to create road-fixing robots, and already has £4.2m (US$6m) of funding from the Engineering and Physical Sciences Research Council (EPSRC) to help turn the dreams into reality.

"We want to make Leeds the first city in the world to have zero disruption from street works," says Purnell of the project, which is developing new robot designs in three areas: 'perch and repair' drones that can perch, like birds, on structures such as streetlights to repair them; 'perceive and patch' droids able to inspect and repair potholes; and 'fire and forget' robots which will operate indefinitely within live utility pipes. "Our robots will undertake precision repairs and avoid the need for large construction vehicles in the hearts of our cities," says Professor Robert Richardson, director of the UK's National Facility for Innovative Robotic Systems.

Exactly what the robots will look like is hard to say as the project only began in earnest at the beginning of this year. However, the Robotics Department at Leeds University has already created a search-and-rescue 'Wormbot' that can be used to navigate collapsed buildings, and 'Djedi', a droid which has been used to explore the Great Pyramid of Giza, Egypt. Both of these ground-

> "Our robots will undertake precision repairs and avoid the need for large construction vehicles in the hearts of our cities
>
> **Robert Richardson, professor of robotics, Leeds University, UK**

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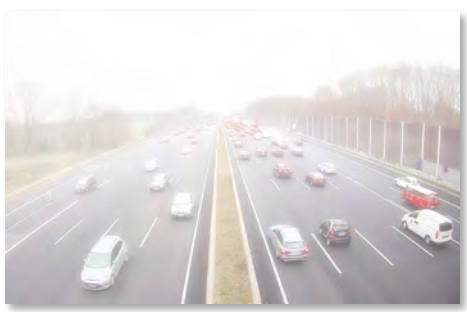

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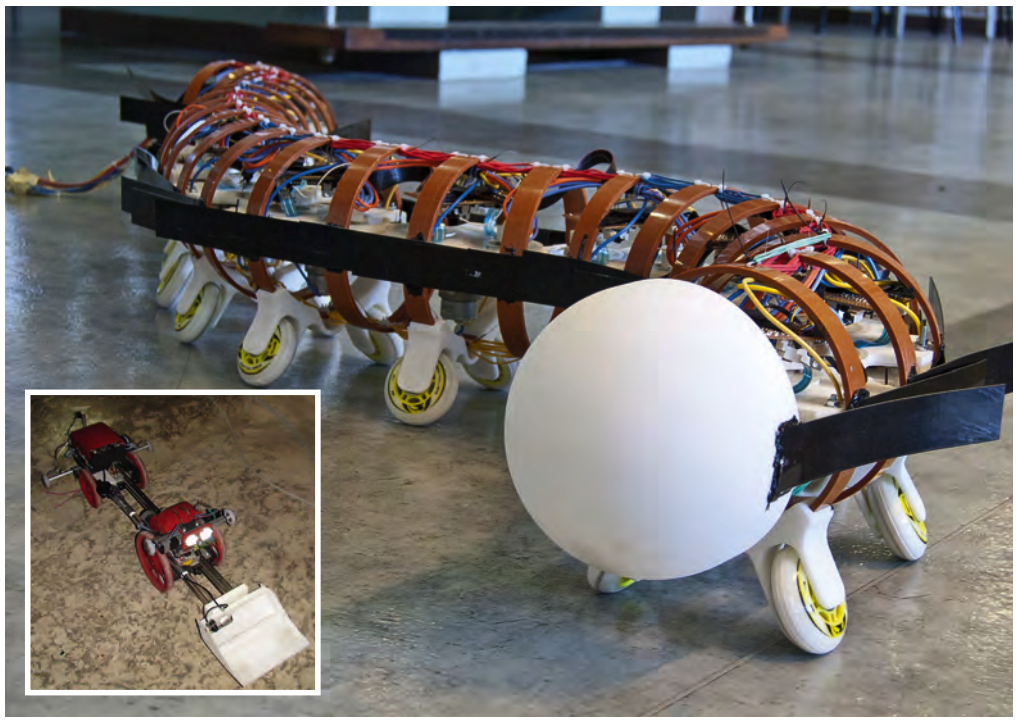
breaking robots are set to provide considerable inspiration for the road repair project.

But, before the day dawns when road construction workers can hang up their hard hats for good, technology that will lighten workloads when it comes to infrastructure surveys is already at an advanced stage. In the UK two major players, the Transport Systems Catapult (TSC), the UK's center for intelligent mobility, and TWI, one of the world's leading technology research bodies, have created a strategic partnership to focus on what they jointly term "condition and structural health monitoring in transport infrastructure". The goal is to develop self-sustaining transportation infrastructure using the principles of the Internet of Things (IoT) – i.e. equip roads with hardware that will enable them to self-report problems.

> "Roads could manage their own maintenance, ensuring they are operating optimally… without the need for constant maintenance checks"
>
> **Steve Yianni, CEO, Transport Systems Catapult, UK**

(Below) **Road repair inspiration: Leeds University's search-and-rescue Wormbot, and Djedi** (inset) **that has been used to explore the Great Pyramid of Giza**



Photos: Leeds University

"Infrastructure costs and the limitations of legacy infrastructure are key factors for any mobility provider," says Steve Yianni, TSC's CEO. "The smart asset management unit we are setting up will seek to promote the use of structural health monitoring sensors in transport infrastructure and use internet connectivity to enable the centralized collection and use of data. TWI is extremely advanced in this area and we believe that coupling this expertise with TSC's transport knowledge will yield some exciting and profitable solutions that could really change the way assets are managed in the transport network."

The key to improving transportation systems of any type, be they traffic flows, train journeys or, in this case, the design and maintenance of the infrastructure, increasingly lies in the intelligent use of data. There are vast amounts of data being produced in the transportation network every day, but the reality is that much of it is stored away in silos or used for specific purposes without consideration of how it could possibly be of value to others. IoT has the potential to make this data available live, as well as opening up new sources of information that reveal the status, condition and location of infrastructure. The hope is that this will soon will enable much smarter transportation solutions to be developed, as well as making assets more adaptable to the conditions in which they operate.

Data driven

"In one of our projects at TSC we are developing a modeling and visualization system that can accurately reproduce an entire city's traffic network based on real data, including traffic flows and pedestrian behavior as well as weather and pollution sensors," says Yianni. "Solutions can be implemented into this 'living world' immediately to see their outcome. IoT could enable this system to be linked to live data, allowing a control-room operator to access a live model of the system being managed and manipulate it at will. This gives the ability to test something like a road closure and see

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Autonomous assets

IoT will be essential to the safety of self-driving cars, which will need to be managed remotely, or even without any human interaction at all

One likely outcome of IoT will be to enable smarter control over autonomous vehicles. Self-driving vehicles will reduce traffic and its resulting costs. Cars already produce data concerning their status through onboard computers, but much of it is only used when the vehicle is connected to a diagnostic device by a mechanic. When you are managing a fleet of vehicles, having this data readily available in a centralized location could help you make better, more cost-effective decisions about the maintenance of vehicle assets.

"When you start talking about autonomous vehicles this area becomes of vital significance," says Steve Yianni, CEO of TSC. "The work we are undertaking could be crucial to the monitoring of these vehicles, when a continuous, accurate appraisal of their condition at all times could be a matter of life or death. Structural sensors and connected systems could, for instance, warn if a driverless car has sustained damage to the chassis and needs to be taken off the road, something that would normally be detected by the driver."

"IoT will assist the rise of the autonomous car," says Boris Adryan, founder of IoT specialists thingslearn. "With cars 'knowing' where they are going in terms of destination, real-time analytics could help to streamline traffic and/or divert it away from congested or ecologically strained areas. Whether that happens by machine-to-machine communication or just as a recommendation to the driver will depend on people's attitudes, which may change over time. I don't think there's going to be much need for road changes as GPS tracking and triangulation from communication towers are sufficient to inform cars and external coordinators about the whereabouts of every vehicle."

the likely outcome in seconds, before actually implementing it in real life."

There is the potential to feed information about the status and structural condition of the road network and its assets into these models, warning control-room staff of emerging problems that could affect traffic flow and enabling smarter planning of maintenance. A new era is dawning.

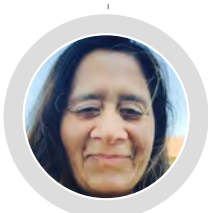
The future is now

"We can envision a future where the addition of internet-enabled sensors on bridges and new road surfaces could lead to a situation where elements of the road network can actively warn relevant agencies when excessive wear becomes apparent, or unexpected damage has been sustained through impact or flood damage," continues Yianni. "In this manner, roads could manage their own maintenance, ensuring they are operating optimally and safely throughout their life without the need for constant maintenance checks or regular servicing for its own sake."

There is already some movement in this area. The town of Winchester, UK, has stretch sensors in situ to monitor cracks on its historic cathedral. This is the tip of the potential IoT iceberg where technology can be migrated to the road and help protect infrastructure.

"Bridges, dams and the like are beginning to monitor themselves using sensors," says Sudha Jamthe, IoT business instructor at Stanford University, California, USA, and member of the IoT Council. "This helps predict the need for repairs. I can see this being introduced to road technology as vendors who offer these and other road-related assets build in sensors and connectivity."

> Bridges, dams and the like are beginning to monitor themselves using sensors. This helps predict the need for repairs
>
> **Sudha Jamthe, IoT business instructor, Stanford University, USA**



"Rather than experts being sent to climb down specifically erected scaffolds and manually assess the situation, sensors are being accessed remotely on bridges to assess whether maintenance is required," says Boris Adryan, founder of IoT specialists thingslearn. "In urban areas, anything that is beneath the road, such as pipework, would be a good candidate to remote censoring."

All of this points to the possibility that at some time in the future infrastructure problems will not only be flagged up but also fixed without human intervention.

"This very much depends on the state of robotics in the future. I think what you have in mind would more be more suited to the state of robotics in 2050," says Adryan.

Street robots

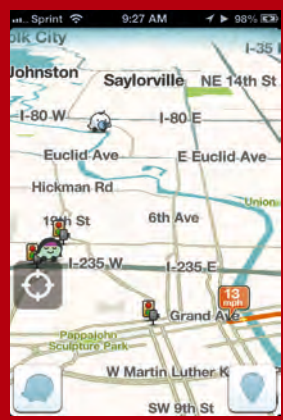
Indeed, 2050 happens to be the year which the Leeds University project has set as its target date for the

Social machines

Not all asset management via the internet is automatic – traffic apps such as Waze enable road users to report problems

Hand-in-hand with the rise in sensors has been the increase in mobile systems that contribute to IoT on the roads. Mobile app Waze features road and sensor data but also receives real, live updates from the public regarding traffic incidents, making it a community-driven navigational tool. It was purchased by Google for US$1.3bn and is regarded as the world's largest community-based traffic and navigation app. It was named App of the Year at the 2013 Mobile World Congress.

"Systems like Waze and other kinds of 'social machine' contribute to the IoT traffic mix," says Sally Applin, member of the IoT Council and author of the paper *Making Sense of IoT Complexity*. Social machines are computational entities governed not only by automated input but also by social processes. They exist based on exchange between both parties and are usually characterized as collaborative online projects. Perhaps the best-known example of a social machine is Wikipedia.



elimination of disruptions due to roadworks. In the meantime, Purnell and his team of academics and engineers have much closer deadlines for the completion of prototypes that will form part of their city-wide system of robots, sensors and autonomous systems.

"In 24 months we hope to be able to demonstrate the world's first lab-based perch-and-repair maneuver, where a robot approaches a streetlight or pipe defect, assesses it and repairs it without human intervention," says Purnell. "You can think of it like the natural repair mechanisms of our bodies, such as our inflammatory responses and immune systems.

"We're liaising with a wide variety of stakeholders in government, industry and others including TWI and TSC," continues Purnell. "We hope to get a stakeholder workshop going in the next few months to work out what each can contribute."

The project is intended to be ambitious and, in the words of Purnell, "out there". The university has expertise in infrastructure systems, monitoring, robots, computer vision and social science that will need to be bolted together in new ways to address this challenge.

"We hope to demonstrate prototypes in a couple of years," says Purnell. "We ambitiously suggested that we might get the technology to a tipping point, similar to where self-driving cars are now, by 2026. We're very good at this sort of cross-sector work at Leeds University, so we're confident we can do a good job."

(Above left) **IoT sensors installed on the walls of Winchester Cathedral self-report damage**

For now, perhaps, it is enough to concentrate on the benefits that IoT infrastructure monitoring could bring.

"Theoretically IoT could revolutionize traffic planning," says Yianni. "Through connected infrastructure, decisions to improve traffic flow could be made instantly without the need for lengthy analysis, backed by live data and systems that can accurately predict the likely outcome of an action within moments. In terms of infrastructure maintenance, the structural health monitoring work we are doing with TWI could massively reduce delays and pain points by eliminating unnecessary repair work and improving the quality of roads. Rather than relying on static servicing schedules, we can ensure that issues are addressed before they become major problems and resources are used where they are most needed." ○

> In 24 months we hope to be able to demonstrate a robot that approaches a streetlight or pipe defect, assesses it and repairs it, without human intervention
>
> **Professor Philip Purnell, School of Civil Engineering, Leeds University, UK**

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5 ways smart lighting

From cost efficiency and improved safety, to intelligent lighting on demand and even works of art, **Jan Stojaspal** looks at how the latest illuminating technologies are transforming the future of our streets

is changing the world

The coming of LED technology to street and roadway lighting is turning out to be about much more than impressive cost savings, which can go beyond 80% when compared with traditional luminaires. In many ways it is transforming the very idea of lighting in traffic infrastructure. It is driving the rise of traffic-sensitive lighting. It is at the core of projects aiming to make cyclists safer and emergency services more responsive. And it is inspiring artists to combine the functionality of road infrastructure and art.

But LEDs are not the only technology transforming the world of lighting. They have inspired the development of the phosphorescent materials being tested for glowing road outlines. And the automotive industry is now exploring the potential of high-powered laser beams to reinvent the car headlight. What follows is five ways next-generation lighting is changing how we live today…

1. IT ENABLES HUGE EFFICIENCY SAVINGS

There is a curious dichotomy when it comes to how far North America and Europe have progressed in modernizing streetlighting. While North America is ahead of Europe in the adoption of LED streetlights, with 8.5% of the installed base converted versus Europe's 4.1%, it is lagging behind in the adoption of networked streetlighting control systems, with roughly 60% more streetlights being controlled by networked systems in Europe, according to Navigant Research.

This is largely because North America's lighting systems are more dated, and solely converting them to LED brings substantial energy savings – in the 50% to 60% range. "As a result there is less incentive to push for more savings through dimming," says Jesse Foote, senior research analyst at Navigant Research. "Acting as a further disincentive is the fact that utilities in the USA own most of the streetlights, typically billing a set tariff and often not even metering the electricity."

Another factor is that there are hesitancies around dimming, in part due to minimum luminance levels roadways have to meet, but also because of a fear over liability. "Whether or not you are strictly required to light a certain area, the concern over litigation can prevent things that might actually be a good idea," says Foote. "If something bad happens, they can say it happened because you dimmed the lights."

> If something bad happens, they can say it happened because you dimmed the lights
>
> **Jesse Foote, senior research analyst, Navigant Research, USA**

In Europe there is more tolerance for dimming, and municipalities typically own the streetlights, which means there is more incentive to maximize savings. "Also, there is a greater proportion of modern, non-LED luminaires, such as PLL compact fluorescent lamps," says Foote. "And because these are only 20-30% less efficient than LEDs, the majority of energy saving is realized through dimming. "

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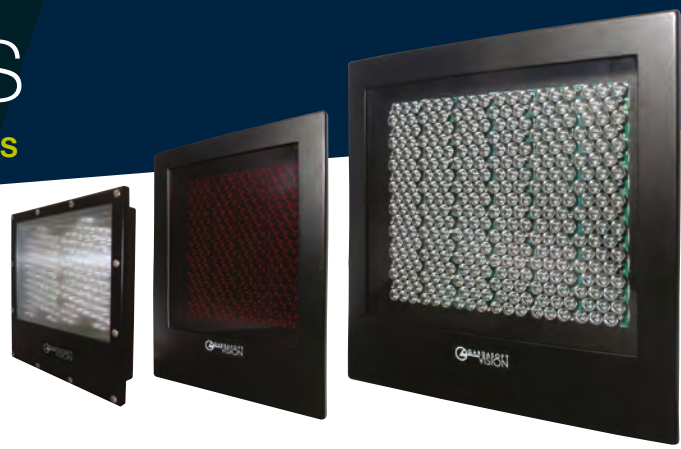

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2. IT ENABLES BETTER COMMUNICATION

There is a slew of additional applications that become possible with LED streetlights controlled by networked systems. Navigant Research's Foote cites systems that create a networked system of strobe streetlights to guide people out of a city in an evacuation. Another option is to use flashing streetlights to mark a house that emergency responders are trying to get to.

Chintan Shah, CEO of Tvilight, a three-year-old Dutch company specializing in intelligent lighting controls, is excited about using flashing streetlights to warn of an approaching ambulance in urban settings without dedicated emergency lanes, and plans to develop such a system within two years.

Networked lampposts can carry wi-fi access points to provide passers-by with on-the-go connectivity. And they can collect traffic information data by detecting road users' cell phones and triangulating their location.

"They can also carry sensors to transmit data about air pollution, monitor parking availability and listen for the sounds of a car crash," says Flemming Madsen, head secretary of DOLL Living Lab, Denmark's experimental space for developing LED lighting, adding that in the event of a car crash, the network could brighten lights in the vicinity to highlight the scene and prevent people from running into it. Madsen also envisions intelligent streetlights supporting urban services, such as by watching storm drains for overflow or recycling containers for need of emptying.

"That's the beauty of LED technology," Madsen says. "With LEDs, lighting went from being an electrical article to electronics, and with electronics you have embedded software with the option of bonding it closely to ICT, and in that respect it does not really have any limits. You can recreate daylight, you can adjust it, and you can make it respond to data input in real time."

The day may not be far off when LED light itself becomes an everyday carrier of data. The technology, known as li-fi, which uses rapidly pulsating light imperceptible to the human eye, already exists, and is being tested for use on the Paris metro.

> With LEDs, lighting went from being an electrical article to electronics
>
> **Flemming Madsen, head secretary of DOLL Living Lab, Denmark**


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3. IT IS HELPING TO CREATE SAFER CARS

> LEDs are the next big thing of the near future, and laser technology may also be a big deal, but it's still under development
>
> **Cornelius Neumann, director of general and automotive lighting at the Light Technology Institute of the Karlsruhe Institute for Technology, Germany**

If the future is anything like Audi imagines it, automotive headlights are in for quite a transformation. Already its matrix LED headlights, which consist of 25 individually addressable light-emitting diodes, make it possible to drive with the high-beam on at all times, as automatic detection of oncoming and preceding vehicles ensures that only LEDs that do not dazzle other drivers are on. In addition these headlights use navigation data to shift the beam toward upcoming bends in the road and, in combination with a night-vision system, can detect pedestrians and pick them out with flashes.

But that is nothing compared with the high-definition, matrix laser headlights that Audi showcased in a concept video earlier last year. Much like a movie projector, the headlights paint footsteps in front of pedestrians to indicate when they are free to cross. The video goes on to show how the same headlights could fill in missing road outlines, precision-mark pedestrians and help drivers judge the width of their vehicle while driving through an obstructed road. The high-definition of the beam is achieved by a digital micro-mirror device the size of a fingernail that is currently capable of projecting an image consisting of 400,000 pixels, according to Audi. The company hopes to have matrix laser headlights in commercial use in about five years, assuming it can work out such issues as high energy consumption and reducing the excessive heat generated by the assembly.

"In the meantime, matrix LED headlights will continue to evolve," says Cornelius Neumann, director of general and automotive lighting at the Light Technology Institute of the Karlsruhe Institute for Technology. According to him, there are matrix LED headlights in development with between 80 and 100 LEDs, which promise to further enhance the precision of the adaptive high beam and perhaps also enable new functions such as the projection of guiding lights through narrow road sections.

"Whether laser makes it commercially remains to be seen," Neumann says. "All OEMs are working on LED technology. LEDs are the next big thing of the near future, and laser technology may also be a big deal, but it's still under development. Some OEMs are heavily working on lasers while others are merely looking at the possibilities."

4. IT IS ENABLING LIGHTING ON DEMAND

With modern streetlights receiving upgrades to networked control systems on both sides of the Atlantic, a path is opening up for a broader deployment of traffic-sensitive lighting systems that not only adjust their brightness to traffic volumes but can also save lives.

With lighting systems that adjust to traffic volumes, the most common approach involves sections of lights that regulate their brightness according to overall traffic density. "This approach is well-suited to highways and trunk roads that are busy at most times of the night," says Tvilight's Shah. San Francisco trialled three such systems last year and the county of Suffolk in eastern England has plans to implement traffic-sensitive lighting of this kind on as many as 10,000 LED streetlights by mid-2017.

> [Lights that adjust according to traffic density are] well-suited to highways and trunk roads that are busy at most times of night
>
> **Chintan Shah, CEO of Tvilight, the Netherlands**

But for quieter areas, such as residential streets and ring roads, sensing technology is now available to produce what Shah calls light on demand – lighting that only brightens when the presence of a car, cyclist or pedestrian is detected and only illuminates the immediate surroundings. It never turns off completely, to maintain a feeling of safety. In the Netherlands, among other places, the adoption of light on demand has accelerated, with Tvilight alone having installed it in some shape or form in 35 cities, 27 railway stations and a section of Amsterdam Airport Schiphol's outdoor parking lot.

Finally, when it comes to enhancing the safety of cyclists and pedestrians, the City of Copenhagen has been running a series of pilots that aim to address the fact that one-third of all traffic accidents happen after dark, despite much lower traffic volumes, according to Bahar Namaki Araghi, ITS project manager for the technical and environmental administration of the City of Copenhagen. Two-thirds of the people badly injured or killed in these accidents are cyclists and pedestrians.

The first pilot, which concluded last year, took streetlights at one particularly dangerous intersection from a 50% dim mode to full brightness when cyclists had the green light. And by next summer, five more intersections will be piloted with more sophisticated systems that brighten lights only when a cyclist or pedestrian is detected.

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5. IT IS MAKING SAFETY BEAUTIFUL

Roads, bicycle paths and dark underpasses are rarely thought of as spaces where utilitarian practicality and artistic sensibility could reinforce each other, but a couple of Dutch artists are looking to change that. And they are doing it with light.

"I have always wondered why it is that when we talk about innovation in mobility there is always a tendency to focus on the car. Billions of R&D dollars go into new models every year, but somehow roads are disconnected from this creative thinking," says Dutch artist and innovator Daan Roosegaarde, who is the founder of Rotterdam-based Studio Roosegaarde.

Roosegaarde is best known for using phosphorescence to produce road outlines that charge by day and glow by night, and the Van Gogh bicycle path near Eindhoven, which is lit by thousands of phosphorescent pebbles arranged to resemble Van Gogh's *The Starry Night*. But he is also experimenting with liquid crystals for use in dynamic lane lines that can go from broken to full at the push of a button, and dynamic road paint that becomes visible as, for example, snowflake pictograms if icy conditions develop.

The second artist, Amsterdam-based Herman Kuijer, has recently transformed a couple of underpasses in the Dutch town of Zutphen with colorful light installations, which he hopes will make the spaces safer and more aesthetically pleasing for pedestrians and cyclists.

> "Why is it that when we talk about innovation in mobility, there is always a tendency to focus on the car?
>
> **Daan Roosegaarde, founder of Studio Roosegaarde, the Netherlands**

He is guided by the same goals in his plans to reinvent the lighting of a bicycle path in Schiedam, a city in the south of the Netherlands. But in this case, he also plans to add an element of playfulness. According to Kuijer, each cyclist will be assigned their own color of light, and this light will move with them from pole to pole until they meet another cyclist and their lights mix for the duration of their encounter.

"There is a lot of attention on safety in public spaces, and in Holland we have a tradition of art in public spaces, so a lot of people want to combine the two," says Kuijer. "It is very interesting to have a huge canvas to create something that has a poetic but also a functional layer. The combination of these two things tells you something about life – that there is more to do than just go to the supermarket, buy food, eat it, sleep and work."

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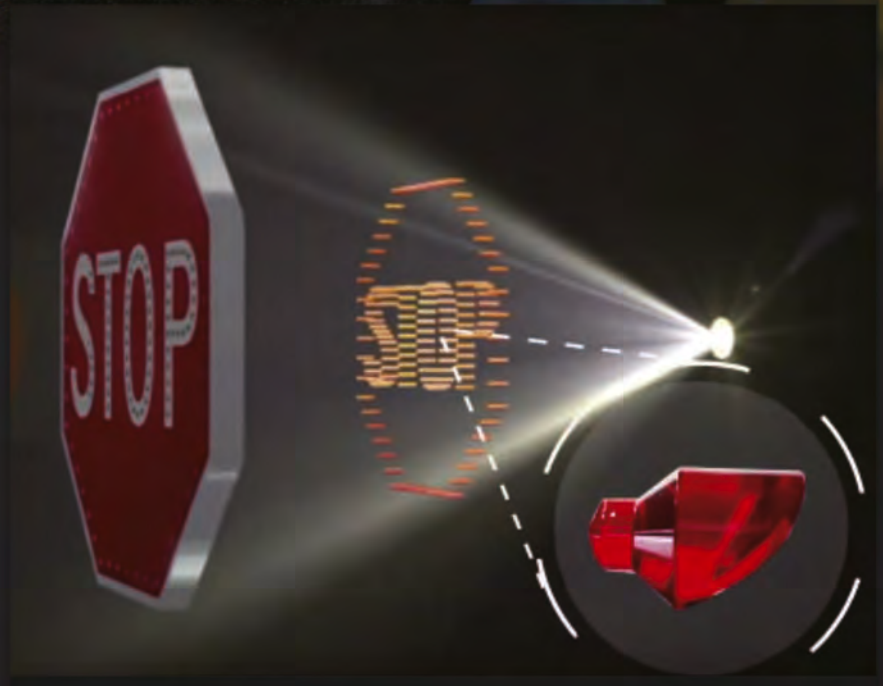

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Dangerous crossings

Bridges are hugely expensive, yet also potentially unsafe pieces of infrastructure. **Max Glaskin** discovers how new technologies, including drones, are being deployed to improve safety on them in the face of everything from overloaded trucks to earthquakes

Bridges are naturals for ITS. They're expensive to build and maintain, compared with a standard section of road, and are vulnerable to earthquakes, wind, lightning and, often, to water below, so are obvious candidates for the installation of the latest safety systems to protect both users and the structures themselves. Moreover, as bottlenecks they are prone to traffic chaos and can be hard for emergency services to access, so smart use of the existing and emerging technologies can help to make journeys safer and travel times more predictable.

Take some of the most famous bridges – San Francisco's Golden Gate, Tokyo's Rainbow and Istanbul's Bosphorus. The cities they serve depend on them, and their value to communities and national commerce is huge. Yet they all stand in known earthquake regions and even modest seismic activity might lead to catastrophe.

Experts predict that a major quake in Istanbul is likely soon. A recent lull in seismic activity could indicate that stress is building between tectonic plates, which will be released in a devastating earthquake.[1] Accordingly, academics are now looking at the best way to harness early warning systems. Researchers at Sakarya University, Turkey, have published a study[2] that investigates

Linking earthquake early warning systems to traffic management networks minimizes fatalities

how traffic technologies could help save lives on the city's major river crossing when the ground shakes.

"The amount of traffic on the Bosphorus Bridge is almost beyond description," says Dr Hakan Aslan, one of the team that produced the report that analyzes the safety benefits of linking the region's earthquake early warning system (EEWS) to the traffic management network. Without a link, hundreds of people in vehicles on the bridge will perish when the quake hits, the report cautions. With a link, bridge traffic fatalities would fall by a massive 95%.

Why would an EEWS link to traffic management systems have such a dramatic impact? Well, the Bosphorus Bridge is an eight-lane suspension bridge, with a 1,200-yard (1,071m) main span and a load of 190,000 vehicles a day, peaking at 6,200 per hour and traveling at about 28mph. It would take up to 86 seconds for all vehicles to leave the bridge at peak times, Aslan's colleagues calculate. Currently that's too slow because the EEWS, under the nearby Sea of Marmara, will probably give less than 14 seconds' notice of impending disaster. So many vehicles would still be on the bridge when the quake hits.

Yet by focusing on the most vulnerable section, fatalities would be minimized if the bridge's traffic

106 million

The approximate number of vehicles that use New York's George Washington Bridge each year – making it the world's busiest crossing

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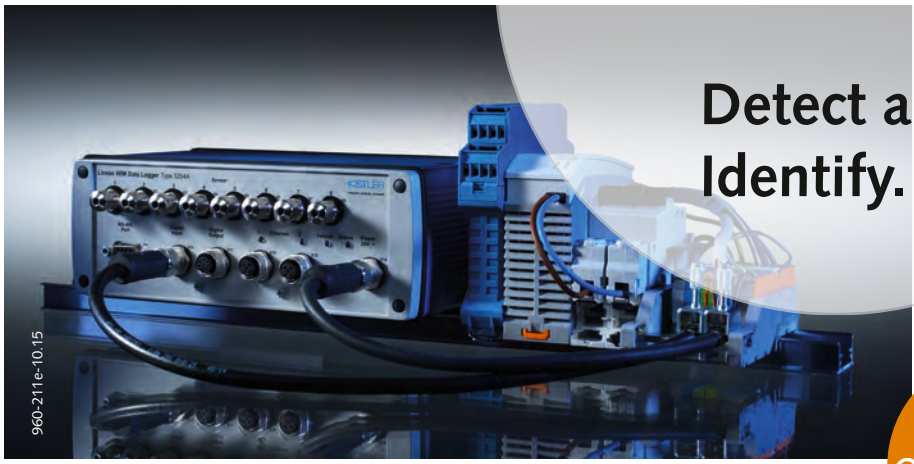

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(Above) **Earthquake damage to a bridge in Sichuan, China**

management center has a fast, automatic link with the EEWS. "Most damage will happen in the central span," writes Aslan, with the most dangerous zone 100-200 yards (91-182m) either side of the middle.

The strategy would be to get vehicles off the danger section as quickly as possible and stop others entering it. A dynamic information system, whether using variable message signs or color-coded LED lighting, would prompt drivers to move rapidly away from the most vulnerable sections. Those behind them, on a safer section, would be told to stop, turn around and evacuate to the approach roads, which would be kept clear by automated red traffic signals placed up to 2.5 miles (4km) before the bridge.

The impact of natural disasters is always hard to predict, but complex calculations show that if no steps are taken and a quake destroys the central 200 yards (182m) during peak traffic, as many as 360 lives could be lost. However, the researchers believe there will be fewer than 16 fatalities if the traffic technologies are put in place and triggered by the EEWS.

1.2 miles

The length of Japan's Akashi Kaikyo Bridge – the longest suspension road bridge in the world

> We're looking at the feasibility of covering all 10 lanes [of the bridge] with a WIM and ALPR system
>
> **Ian Leach, ITS delivery manager, Auckland Motorway Alliance, New Zealand**

Getting vehicles off the Bosphorus Bridge and to safety is the researchers' first step. Now they want to apply their methods to a wider network. "We're planning to consider the traffic and geometric conditions of the connecting roads. This will provide more comprehensive strategies," Aslan tells *Traffic Technology International*.

Under pressure

In New Zealand Auckland's Harbor Bridge was strengthened in 2000 to meet seismic engineering standards, but steel reinforcements cannot protect against all the risks posed by unpredictable humans. Therefore an ALPR system was added to the bridge's weigh-in-motion (WIM) site in 2013 to attempt to ramp up enforcement and deal with the problem of 'clip-on' lanes – added to the bridge in 1969 and refurbished in 2010 – carrying unsafe loads.

"The aim was to identify vehicles in two southbound lanes that exceeded the 44 ton limit," says Ian Leach, ITS delivery manager for Auckland Motorway Alliance. The alternative route to the crossing is eight miles long, which explains why some truckers may be tempted to breach the limit. "The bend-plate WIM showed that about 10% of the trucks on the clip-ons were overweight, peaking at more than 700 a day. We wanted to be able to inform them, which is why we needed ALPR, to be able to identify them," says Leach.

It all sounds simple, but there were challenges. The first was


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Spanning the knowledge gap

The installation of ITS on the Piscataqua River's Memorial Bridge, in the northeastern USA, is spearheading a drive for transportation education

The vertical lift Memorial Bridge, between Portsmouth, New Hampshire and Kittery, Maine, over the Piscataqua River, is being upgraded with a plethora of sensors to make it a 'living bridge'. As well as systems for self-monitoring the structure and self-diagnosing any changes, and for tidal energy harvesting, ITS is going to be put in place – and not just to count vehicles. It will also be monitoring cyclists and pedestrians.

"A program that can accurately count traffic, bicycles and pedestrians on the bridge using traffic cameras and machine-learning algorithms is being developed," says Erin Bell, chair of the Department of Civil and Environmental Engineering at the University of New Hampshire.

It could be a trendsetter to raise interest in ITS among the population at large, because all the data acquired will be made accessible and understandable. Educators will be supported in sharing the information with the public and there will be a kiosk at the bridge to do likewise. The ethos is that the more people understand the benefits of traffic technologies, the better.

hardware – the moveable lane barrier that facilitates tidal flow for peak periods meant that it was impossible to build a gantry for the cameras. A cantilever pole had to be designed for the job. The second was data – the high-speed WIM has an error margin of up to 10% for 95% of the time.

"The strategy had been to write to operators of trucks recorded as being overweight at least three times in a set period. It became apparent that the margin of error in the WIM meant it was possible for a vehicle to be underweight while still producing an overweight record," says Leach. Auckland Motorways didn't want to upset any hauliers by suggesting their trucks were overweight when they weren't.

Statistical analysis has provided the solution and letters are now only sent if the WIM records a truck weighing more than 46 tons (2 tons above the limit) at least four times during the monitoring period. This careful and tolerant approach has helped reduce the number of overweight vehicles to about 200 a month. "Now we're looking at the feasibility of covering all 10 lanes with the WIM and ALPR system," says Leach.

Assessing the damage

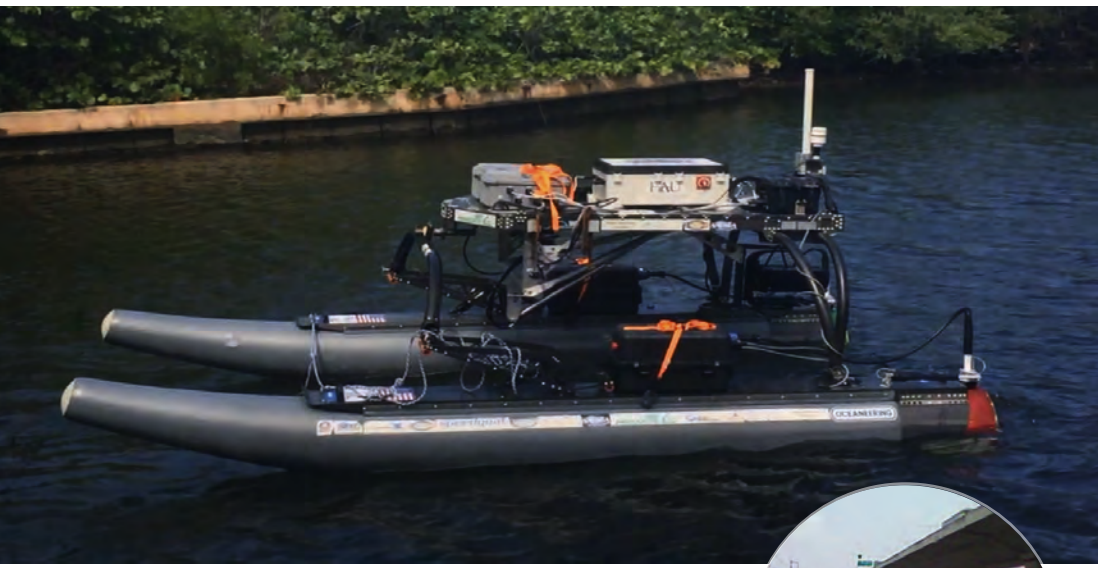
Inspection of exposed structures such as highway bridges always comes at a cost and it is often a difficult equation to balance because it can be expensive to put engineers safely into places where they are working at height and open to the forces of nature. Nevertheless, timely inspections will reduce maintenance and extend the longevity of a bridge. Two current US projects aim to do the job and keep the inspectors on terra firma by using remotely operated craft.

(Right) **With just 600 inspectors available to assess 20,000 bridges, drones bridge the gap**

(Above) **Minnesota DOT staff trail a Skyranger drone to inspect three road bridges and a railway bridge**

The projects are both assessing the suitability of different types of drones for surveying work. The state has more than 20,000 bridges and only 600 inspectors. A small bridge can be inspected in a day but a large one requires several weeks. 'Snooper' trucks, with articulated arms that reach from the road surface to under the bridge deck cost US$750,000, so a radio-controlled drone costing no more than US$140,000 would help balance the books.

Minnesota DOT spent US$33,500 trialling a Skyranger drone to inspect three road bridges and a railway bridge for the first phase of its



(Below) **An unmanned surface vehicle can 'see' bridge footings through silt, sediment, debris and algae**

research. Now it is assessing two others. "We used the senseFly eXom drone during our inspection of the Blatnik bridge in Duluth," says Jennifer Zink, bridge inspection engineer for MnDOT.

"We're planning to use an infrared camera on a drone to image a concrete deck of a bridge that borders North Dakota and is currently closed due to deck deterioration. We'll compare the UAV infrared camera results with our own handheld ones and chain-drag," Zink tells *TTI*.

"We'll be using the drones to inspect additional bridges and culverts in the spring. Also included in this project will be the development of a set of best practices and safety guidelines to be added to our State Bridge and Structure Inspection Program Manual. The best practices will include a decision tree to indicate when the use of a drone for bridge safety inspection is more safe and/or cost-effective, according to the type of structure and location," says Zink.

This phase will continue through to the end of June 2016, when the numbers will be crunched. "Out of this inspection, a cost comparison will be developed for drone versus traditional inspection access methods," says Zink. "We are finding that using drones instead of under-bridge inspection vehicles can mean major cost savings of over 50%."

River view

Meanwhile, Florida DOT is funding remotely controlled vehicles for bridge inspection that can look beneath the water surface. A team from Florida Atlantic University's College of Engineering, led by Professor Karl von Ellenrieder, is developing water craft to check the parts of bridges that divers currently have to inspect. They are controlled wirelessly and have the potential to be autonomous. Apart from the human safety benefit, the right equipment on the unmanned surface vehicle (USV) could 'see' through silt, sediment, debris and algae to the bridge footings.

(Above) **Florida DOT is providing funding for unmanned surface vehicles to inspect bridges from beneath the water surface**

34 miles

The length of Thailand's Bang Na Expressway, an elevated viaduct considered by many to be the world's longest road bridge

> We are finding that using drones instead of under-bridge inspection vehicles can mean major cost savings of over 50%
>
> **Jennifer Zink, bridge inspection engineer, MnDOT**

"We've installed a real-time imaging sonar on our USV and have tested it in North Florida, on Carrabelle and St George Island, and South Florida, at Dania Beach," von Ellenrieder tells *Traffic Technology International*. "This spring we plan to conduct joint field tests with local bridge inspectors, who work for the Florida Department of Transportation here in South Florida." Future work is planned to include enhancing advanced robotic techniques, including cooperative sensing/multisession mapping, map building, exploiting 3D obstacle avoidance and trajectory planning, and improving the human-robot interaction to enable for easy and continuous switching between remote control operation and complete autonomy.

Trials last fall were disrupted by the remnants of Hurricane Patricia, where sustained winds of 27-30kts, gusting to 40kts, created swells as high as 7ft in the Gulf of Mexico.

While such storms may temporarily halt the testing of ITS, in the long term it is hoped that the effects of such natural phenomena on our road networks will be lessened by the judicious installation of the latest warning, monitoring and surveying technology, and that this will keep traffic crossing divides.

1) http://www.livescience.com/47827-turkey-seismic-gap.html

2) Bosporus Bridge traffic operation techniques using real-time earthquake information to mitigate the risk involved, by Huseyin Serdar Kuyuk, Hakan Aslan and Muharrem Aktas, published in Disaster Science and Engineering, *vol 1, 17-24 (2015)*

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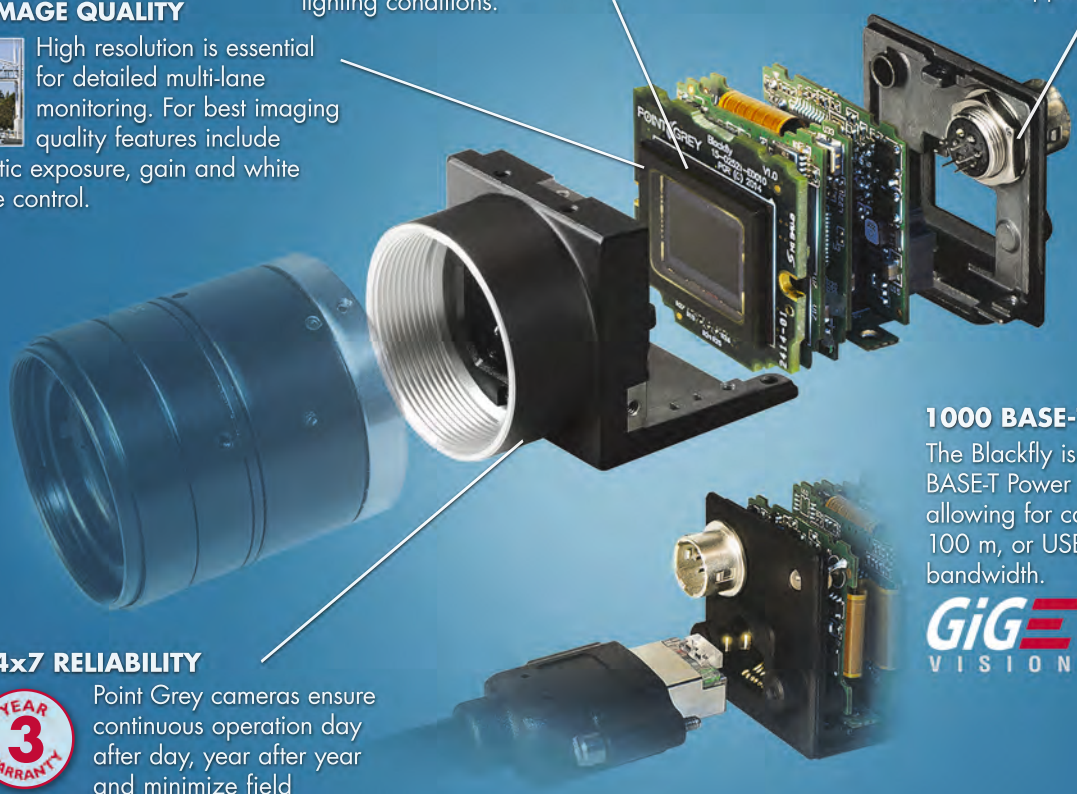
High resolution is essential for detailed multi-lane monitoring. For best imaging quality features include automatic exposure, gain and white balance control.



1000 BASE-T POE or USB 3.0

The Blackfly is available in 1000 BASE-T Power Over Ethernet (PoE), allowing for cable lengths up to 100 m, or USB 3.0 with 5 Gbit/s bandwidth.

GiGE VISION USB VISION

24x7 RELIABILITY

3 YEAR WARRANTY

Point Grey cameras ensure continuous operation day after day, year after year and minimize field maintenance time and cost. Supported by a 3-year warranty.

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Point Grey is a global leader in the design and manufacturing of innovative, high-performance digital cameras for industrial, traffic and surveillance applications. Founded in 1997, Point Grey serves its customers from 5 offices and a network of distributors around the world, is ISO 9001 quality management certified, and offers a comprehensive range of cameras from VGA to 12 MP.

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POINT GREY
Innovation in Imaging

1. SMART MOBILITY EXHIBITORS

Exhibitors in Intertraffic's newest category are certain to draw crowds. "Interest in the Internet of Things reflects a desire to take ITS to the next level of automation. Making products smart allows for greater efficiency for authorities and easier use for citizens."

Dr Ben Rutten, smart mobility program manager, Eindhoven University of Technology, Netherlands

2. MODERN TRAFFIC MANAGEMENT

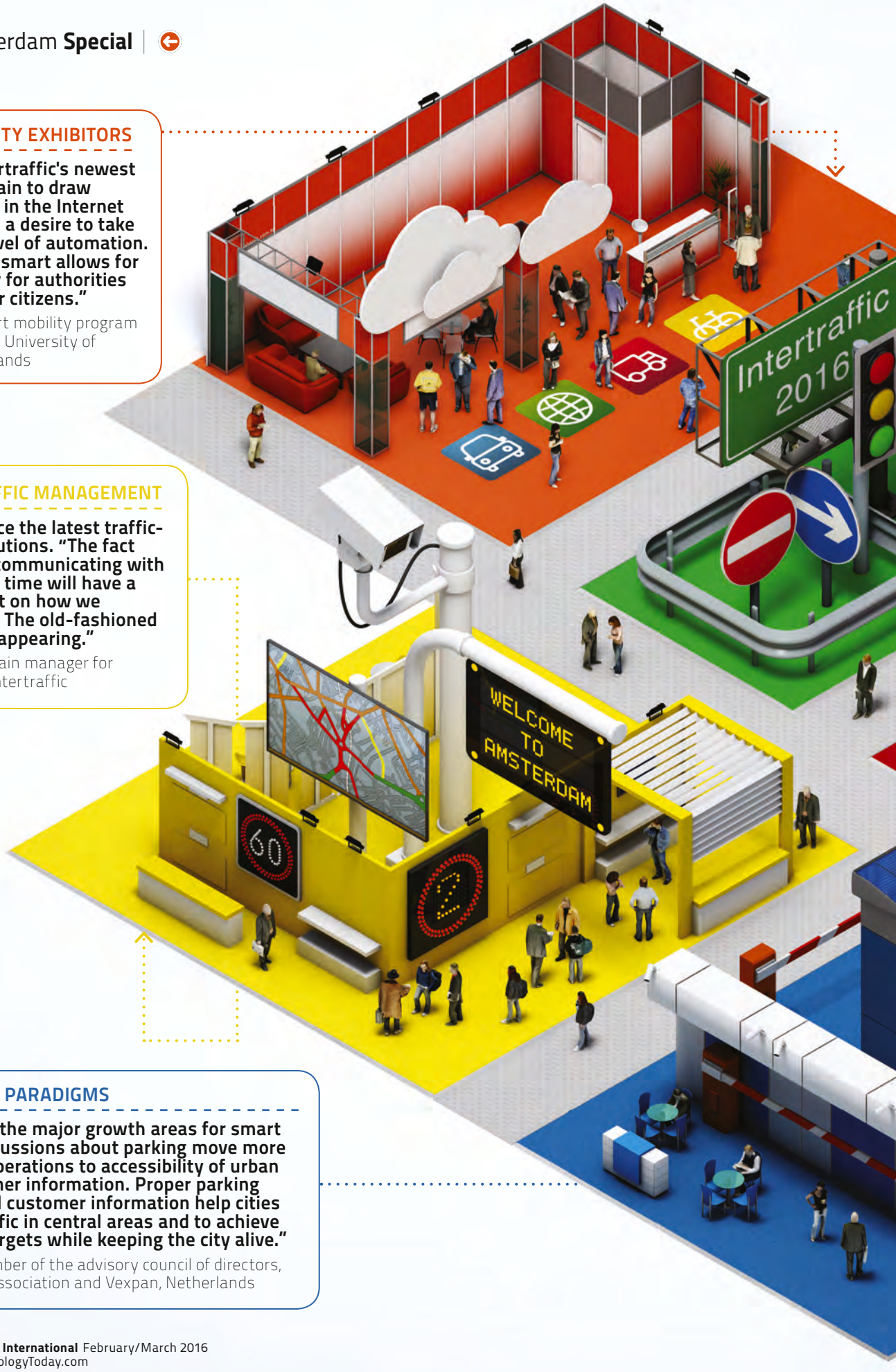
You can experience the latest traffic-management solutions. "The fact that cars will be communicating with each other in real time will have a significant impact on how we manage mobility. The old-fashioned ways are fast disappearing."

Richard Butter, domain manager for worldwide events, Intertraffic

3. NEW PARKING PARADIGMS

Parking is one of the major growth areas for smart technology. "Discussions about parking move more and more from operations to accessibility of urban areas and customer information. Proper parking management and customer information help cities to reduce car traffic in central areas and to achieve environmental targets while keeping the city alive."

Peter Martens, member of the advisory council of directors, European Parking Association and Vexpan, Netherlands



27 not-to-be-missed highlights of Intertraffic Amsterdam

5,6,7,8 APRIL 2016 Intertraffic AMSTERDAM

Intertraffic Amsterdam will be taking place at the Amsterdam RAI Exhibition and Convention Centre, 5-8 April, 2016

4. INFRASTRUCTURE UPGRADES

New infrastructure breakthroughs will be on show. "Intertraffic Amsterdam will cover the transition from traditional infrastructure solutions to those that connect with cooperative and autonomous vehicles."

Richard Butter, domain manager for worldwide events, Intertraffic

5. NEXT-GENERATION SAFETY

Intertraffic is a hotbed of safety innovation. "Products that make traffic safer are increasingly smart and connected, allowing for greater efficiency. Apart from innovations in products that improve the safety for road users, many also improve the safety of construction and emergency workers."

Peter van der Knaap, managing director, SWOV Institute for Road Safety Research, Netherlands

6. Flash point

"We will be introducing our S series intelligent, compact LED light source, which can be used for several traffic applications including law enforcement, ALPR, e-tolling and traffic monitoring. The S series adopts the latest high-power LED and intelligent MCU technology, which is integrated with a RS485 interface, with pulse input and pulse output. The technology supports multiflash and dual-angle operation for multilane use. The key features of this device are a long lifespan and low maintenance cost. Its compact IP66-rated housing is suitable for harsh environments and outdoor installations."

Rick Huang, KOMOTO Enterprise, Taiwan

Stand 11.409

7. SIGNALS OF THE FUTURE

"Swarco will be present on two exhibition stands, where we will be showcasing the latest software solutions for public transportation management and smart city traffic management.

A premiere will be an LED traffic signal with a digital driver, which enables individual and accurate setting of the light output and the power consumption for all operating modes during the manufacturing process. Swarco will also be displaying its latest road-marking systems and high-performance glass beads. Eurotac is a novel, easy-to-apply, pre-formed cold plastic guidance system for pavements to support mobility and orientation of visually impaired and blind people in public spaces."

Richard Neumann, Swarco, Austria

Stands 10.103 and 04.310

8. Keep a fly on traffic

"At Intertraffic, Point Grey will be showing its latest imaging cameras for use in the traffic sector. Demo highlights will include the Blackfly cameras featuring the latest Sony Pregius global shutter CMOS technology. The IMX264 and IMX265 sensors set new benchmarks for global shutter CMOS imaging performance by reducing pixel size and lowering temporal dark noise. In addition, Point Grey will be demonstrating the high-performance Grasshopper3 cameras featuring the Sony Pregius IMX250/252 sensors, ideal for ALPR applications due to their excellent low-light sensitivity and high dynamic range."

Renata Sprencz, Point Grey, Canada

Stand 11.916

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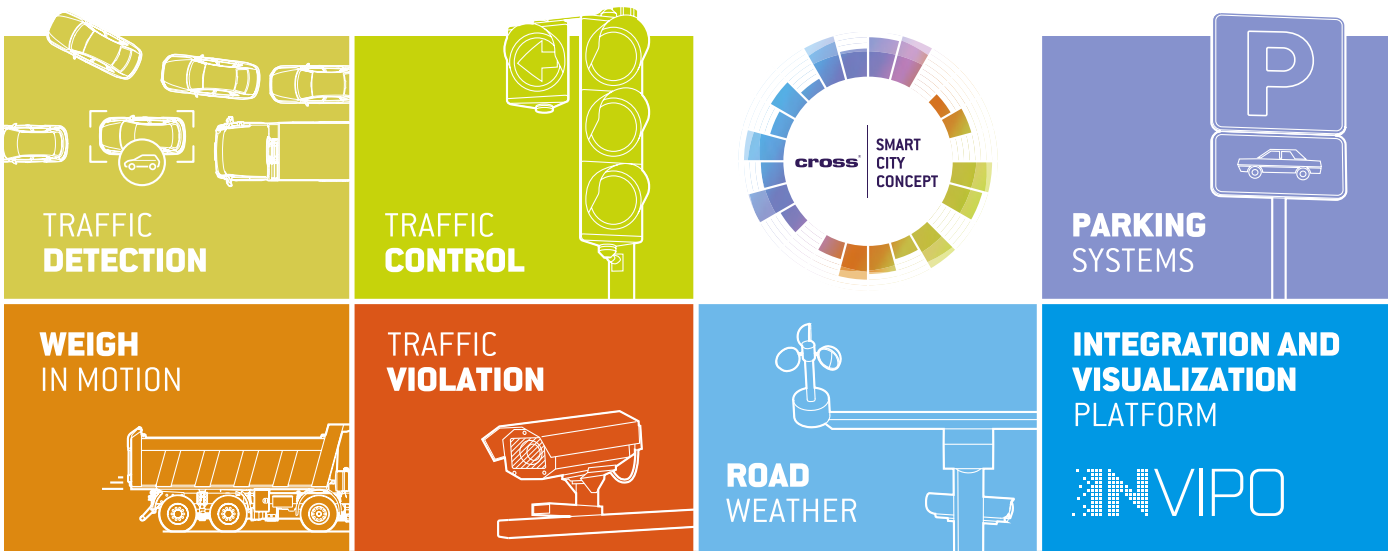

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www.cross.cz

5.6.7.8 2016 Intertraffic AMSTERDAM

stand 10.111

9. Running with cheetahs

"Roseek's Cheetah1 series smart cameras will be shown for the first time at Intertraffic Amsterdam. The cameras are equipped with an Intel ATOM E3845 processor, and they support Windows 8.1/10 and Linux. The Cheetah1 cameras are ideal for ITS, security and machine vision applications. We will also be showcasing our TreeFrog1 series integrated camera housing. As an all-in-one camera housing that integrates an IP66 full metal casing, LED flash and power supply, TreeFrog1 provides a high-reliability and cost-effective solution for field applications."

David Shi, Roseek, China

Stand 11.234

10. VIRTUAL PERFECTION

"PTV Group will be taking the opportunity to demonstrate mesoscopic simulation with PTV Vissim 8 and to showcase real-time traffic management with our PTV Optima software."

Miller Crockart, PTV Group, Germany

Stand 11.401

11. Smart Mobility Theater

Throughout the week at Intertraffic, the Smart Mobility Theater, located in the Innovation Hall (Hall 9), will offer free presentations covering a wide range of themes: ITS developments, automated and cooperative driving, test beds, big data, mobility as a service and traffic and transport efficiency. Each presentation will have 'connectivity' as a linchpin, as it is the essential ingredient necessary to achieve mobility targets. The program on Friday, April 8 will be focused on Dutch national, regional and local road operators. The program overview is available at Intertraffic.com.

12. SLICK REVENUE GENERATION

"Visitors to our booth will have the opportunity to find out more about our advanced systems for electronic toll collection, ITS, automatic toll terminals and free-flow solutions. With more than 2,000 toll lanes installed over the past 35 years, Tecsidel has extensive experience in this area."

Michele Ganz, Tecsidel, Spain

Stand 11.415

Tecsidel toll systems & ITS is an independent, international company focused on development and integration of advanced information systems for Electronic Toll Collection, Intelligent Transport Systems, Automatic Toll Terminals, Free Flow and customized product solutions. Within more than 35 years Tecsidel has installed over 2.000 lanes, using all existing technologies and therefore become one of the leading companies.

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13. Innovation LAB

The Innovation Lab is another highlight you won't want to miss in Amsterdam. Here's a taster of what you'll be able to find there:

- **15 Intertraffic Innovation Award winners and nominees;**
- **Incubator area** for students and young professionals for the Urban Data Hackathon, organized by AMS-Institute, DiTTLab, NDW and CGI;
- **Solutions** such as open-source multiscale traffic simulation based on open traffic and transport data from DiTTLab;
- **Intelligent public space solutions** from HR Groep;
- **InnovationLAB Experience and Social Hub Area** powered by HR Groep;
- **Start-up Area** with a variety of mobility solutions presented by startups powered by Dow Science and Sustainability;
- **Fun and Experience Area** with mobility games, virtual reality and driver simulations.

There will also be an **InnovationLAB On Stage** program to complement the presentations taking place at the Smart Mobility Theater, with a mixture of pitches and demonstrations from Intertraffic Innovation Award nominees and startups, as well as product launches, mobility debates, interactive presentations and discussions with end-users.

Full details of the completely free program, including the opportunity to pre-register for specific sessions, is available at Intertraffic.com. **Located in Hall 9**.

14. AN EYE ON EVERYTHING

At Intertraffic Amsterdam, FLIR will be showcasing TrafiOne – an all-around detector for adaptive and responsive traffic control. Detecting and counting vehicles, bicycles and pedestrians at one intersection or across multiple intersections, FLIR TrafiOne helps traffic engineers determine travel behavior, measure travel and delay times for different transport modes, and monitor congestion and signal performance of your road network 24/7.

FLIR Europe, Netherlands

Stand 10.403

15. High-performance recognition

"Tattile has chosen Intertraffic 2016 for the world launch of its new ALPR range of products. The technology is revolutionary, with features and performance capabilities that identify these products as the future of the ITS industry. The products have a futuristic and completely new design, a compact size and modularity. Their application fields include parking, free-flow tolling and enforcement."

Massimiliano Cominelli, Tattile, Italy

Stand 11.603

16. POSITIVE ID

"Intertraffic is the ideal platform for us to present our whole traffic technology portfolio, including push buttons, acoustic devices and classification systems. We will also introduce our latest innovations in the parking sector, such as pay and display machines and our new parking sensor. In the classification sector, we will show our new bicycle-detection system that uses a combination of a 3D and radar to detect every single bicycle."

Marc Rummeny, RTB, Germany

Stand 11.301

17. Look smart

"Cross Zlin, a developer and producer of road traffic technologies for more than 20 years, will present two new products at Intertraffic Amsterdam. They are: Pavis, a system for detecting illegal parking, which is designed for simple and effective monitoring of parked cars in selected, precisely defined zones on streets; and InVipo, a smart integration and visualization platform that can be defined as 'middleware' between on-field technology and end users. InVipo is also nominated for an Intertraffic Innovation Award, in the Smart Mobility category."

Libor Sušil, Cross Zlin, Czech Republic

Stand 10.111

18. TRIED AND TRUE

"Truvelo will be showing its D-CAM digital speed and red light camera for fixed and mobile operation, and the VIA-Cam spot speed radar camera for the industrial market. Also on show will be the Kustom Signals range of handheld and mobile speed detection products including ProLaser 4, PL4 Video, LASERwitness and Falcon HR, plus the new Vantage body-worn video."

Calvin Hutt, Truvelo, UK

Stand 11.810

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- Traffic-actuated LED street lighting
- V2I communication: Traffic Light Assistant
- Public transport fleet management and smart ticketing solutions
- City Cycle Meter promoting the use of bicycles
- Brilliant road marking systems, also to increase pedestrian safety
- OMNIA: the integrated software platform to manage traffic in smart cities

If you seek the partnership with an experienced industry player who follows the integrated approach to road safety and sustainable traffic management, then SWARCO is your first choice. **Talk to us first.**

COME AND SEE US AT INTERTRAFFIC AMSTERDAM

5 - 8 APRIL 2016

STAND 10.103:
TRAFFIC MANAGEMENT

STAND 04.310:
ROAD MARKING SYSTEMS

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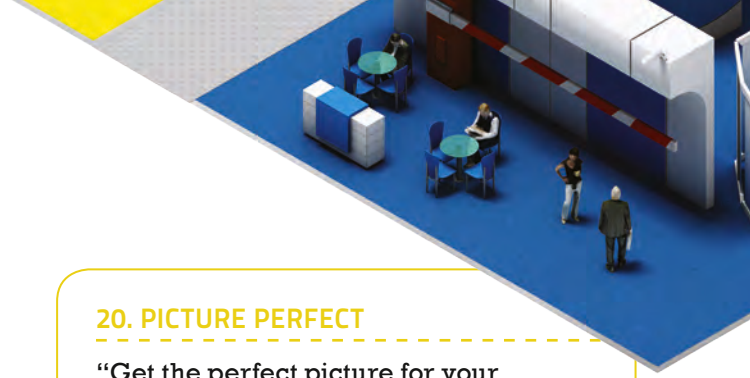
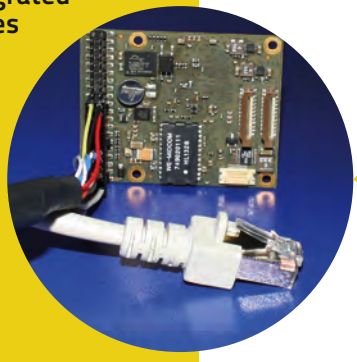


19. Time to get on board

"Vision Components will be showcasing its new Q-Board for quick and easy conversion of already installed IP cameras into intelligent ITS systems. Q-Board is a novelty for Vision Components, our first product that is not a complete smart camera, but a circuit board that can turn standard cameras into intelligent cameras. It can be connected to any conventional IP camera and now supports streaming thanks to the recently integrated FFmpeg library. This enables a comfortable and easy integration into a user's own data network – Q-Board supports almost all standard IP streaming protocols, video codecs and container formats."



Jan-Erik Schmitt, Vision Components, Germany

Stand 03.232

20. PICTURE PERFECT

"Get the perfect picture for your demanding traffic applications! Image fidelity is critical to successful solutions in traffic management systems and SVS-Vistek is dedicated to this every single day. Perfect camera solutions for multilane observation – i.e. 16MP camera hr16050, offering hyper-sensitive 5.5µm pixels – will be shown at Intertraffic Amsterdam. Furthermore the new robust EXO Camera Series (Sony's IMX Sensors from 2-9MP + NIR) for speed enforcement plus ultra-high resolution up to 47MP in the SHR Series providing optimized imaging performance for high-end traffic and security tasks will be on display."

Roland Maier, SVS-Vistek, Germany

Stand 09.505

21. METROPOLITAN REGION OF AMSTERDAM

The stand of the Metropolitan Region of Amsterdam will focus on five main projects:

- **Accessible South Axis Amsterdam** – using ITS to ensure an area remains accessible during massive construction works;
- **Cooperative Traffic Management** – with Nissan Research;
- **Amsterdam Practical Trial** – a large-scale program of field operational trials putting the newest innovations to the test, both in cars and on the road;
- **Bridge Management System** – 'Blauwe Golf';
- **Regional Roadmap** – the four road authorities working together on traffic management in the Metropolitan Region of Amsterdam will explain the transition toward smart mobility in a changing world.

Stand 09.201

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- Pulsing range can be adjustable.
- IP66 enclosure for outdoor installation.
- Signal / Dual Camera casing available.

S series

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- Support Multi-Flash function.
- Extra long life & very low maintenance.
- IP66 enclosure for outdoor installation.
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- Compact & integrate LED Light source.
- Pulsing range can be adjustable from 3K~600Hz.
- Stack effect design for reduce heat more efficiency.

H series

- LDP up to 1280W.
- Support Multi-Flash function.
- Extra long life & very low maintenance.
- IP66 enclosure for outdoor installation.
- Compact & integrate LED Light source.
- Pulsing range can be adjustable from 3K~200Hz.

C series

- Composite design for various applications.
- IP66 enclosure for outdoor installation.
- Negative Pressure design to avoid the oil and dust pollution.
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SECURITY SHOW
8 - 11 March
Booth at:SS3112

Intertraffic AMSTERDAM
5 - 8 April 2016
Booth at:11.409

security essen 2016
27 - 30 September

itsaustralia Intelligent Transport Systems
10 - 14 October
Booth at:14

22. Free rein for technology

"At this year's Intertraffic, Q-Free's large-scale presence will reflect its large-scale ambitions. The company's trademark red will adorn some 100m² of stand space, within which it will set out how it can make journeys safer, cleaner and more efficient.

"Q-Free provides single-source ITS solutions. Within its portfolio, the company differentiates the six main areas – tolling, parking, urban, inter-urban, infomobility, and homeland security – which in combination can help transportation network owners and operators address all of their smart mobility needs. The solutions across the portfolio are underpinned by an open systems approach. This greatly simplifies deployment and integration, and provides a greater degree of future-proofing. It also means that investments in deployments are protected as new and more complicated applications emerge."

Jenny Simonsen, Q-Free, Norway

Stand 11.309

23. SIGNS OF INNOVATION

"This year, we will showcase our Triplesign (rotating prism) VMS (variable message sign) – a rotating prism sign that can be configured to display up to 12 different messages.

"Based on new prismatic sign technology, the Triplesign VMS is a cost-saving, energy-efficient alternative to LED VMS units, which need a constant power source to serve their purpose.

"Key advantages of the Triplesign VMS include its low installation cost and power consumption, being solar powered when in standby mode and its adaptability to different communication systems, such as the Siemens SCADA."

Hans-Ivar Olsson, managing director, Triplesign, Sweden

Stand 11.525

24. Monitoring Europe

Neavia will present its new roadside unit V2I Station at Intertraffic Amsterdam. It is part of the infrastructure that is being used in the connected vehicle project, Scoop@F, which Neavia has been selected to equip. Scoop@F is a predeployment project of road cooperative systems. It is a European project involving automotive manufacturers and infrastructure managers from France, Spain, Austria and Portugal. Neavia has been selected to equip the largest part of the French network with more than 200 vehicle-to-infrastructure roadside units. Work began last fall, and the first installations have already been made. They will continue during 2016 and beyond.

Jean-Hubert Wilbrod, Neavia Technologies, France

Stand EL.218

Outdoor Solutions

Wireless sensors for parking occupancy optimization

Parking Guidance

Guide drivers to the nearest available parking space

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Thomas Osburg, Tamron Europe, Germany

Stand EL.104

26. DUTCH EU PAVILION ON SMART MOBILITY

At Intertraffic Amsterdam, the Netherlands will present itself as a testbed, a sales market for smart mobility services, and a provider of new breakthrough solutions that are ready-made products and services available on the market. The Netherlands will demonstrate what it has to offer to governments, industry and knowledge institutes that are willing to put their smart mobility solutions to the test. This ranges from simulations, to controlled test environments, to tests on public roads.

traffic TECHNOLOGY INTERNATIONAL
Come and meet the *TTI* team at Stand 10.001

27. Intertraffic Innovation Awards

Don't miss the announcement of the winners of this year's Intertraffic Innovation Awards. An international jury selected a shortlist of products from the 91 entries for the 2016 competition. They then went on to choose category winners in five sectors: Parking, Traffic Management, Infrastructure, Safety and Smart Mobility. The winners of the individual categories and the overall winner will be announced during the official opening of the event on Tuesday, April 5.

Intertraffic INNOVATION AWARD 2016

NOMINEES IN INFRASTRUCTURE

- **Silca Traffic Systems Europe BV** (Netherlands) – Quick-Cube – Stand 05.345
- **Aisico Srl** (Italy) – ADD_C – Stand 01.337
- **HR Groep** (Netherlands) – Smart Ultimate Lighting – Stand 01.409

NOMINEES IN TRAFFIC MANAGEMENT

- **Houston Radar** (USA) – SpeedLane – Stand 11.123
- **APM PRO sp. z o.o.** (Poland) – OnDynamic – Stand 11.531
- **Ortana** (Turkey) – Ortana Meteos 251 – Stand 11.101

NOMINEES IN SAFETY

- **EBO van Weel** (Netherlands) – Vehicle-mounted VMS – Stand 01.339
- **WheelRight Ltd** (UK) – WheelRight Tire Condition Management – Stand 10.321
- **Safer Place** (Israel) – SaferTraffic Platform – Stand EL.209

NOMINEES IN PARKING

- **Park Assist LLC** (USA) – M4 Smart-Sensor System – Stand 03.203
- **HR Groep BV** (Netherlands) – MB multilayer parking – Stand 01.409
- **Parkmobile Group** (Netherlands) – RingGo – Stand 02.105

NOMINEES IN SMART MOBILITY

- **Parkmobile Group** (Netherlands) – ParkNow – Stand 02.105
- **CROSS Zlin, a.s.** (Czech Republic) – InVipo – Stand 10.111
- **Siemens AG** (Germany) – Sitraffic SiBike – Stand 11.209

ortana

ORTANA Offers METEOS, a New Line of Weather Station Solutions

METEOS is a new line of meteorological sensors within the ORTANA family which can be integrated into ITS systems to detect and measure functional microclimate conditions on the roads.

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Virtual construction

New computer traffic models of workzones are improving predictive accuracy by taking into account different driver behaviors. **Max Glaskin** takes a look at how surveys and crowdsourced data are helping to keep traffic moving, and finds out why V2V systems could actually *decrease* safety around construction sites

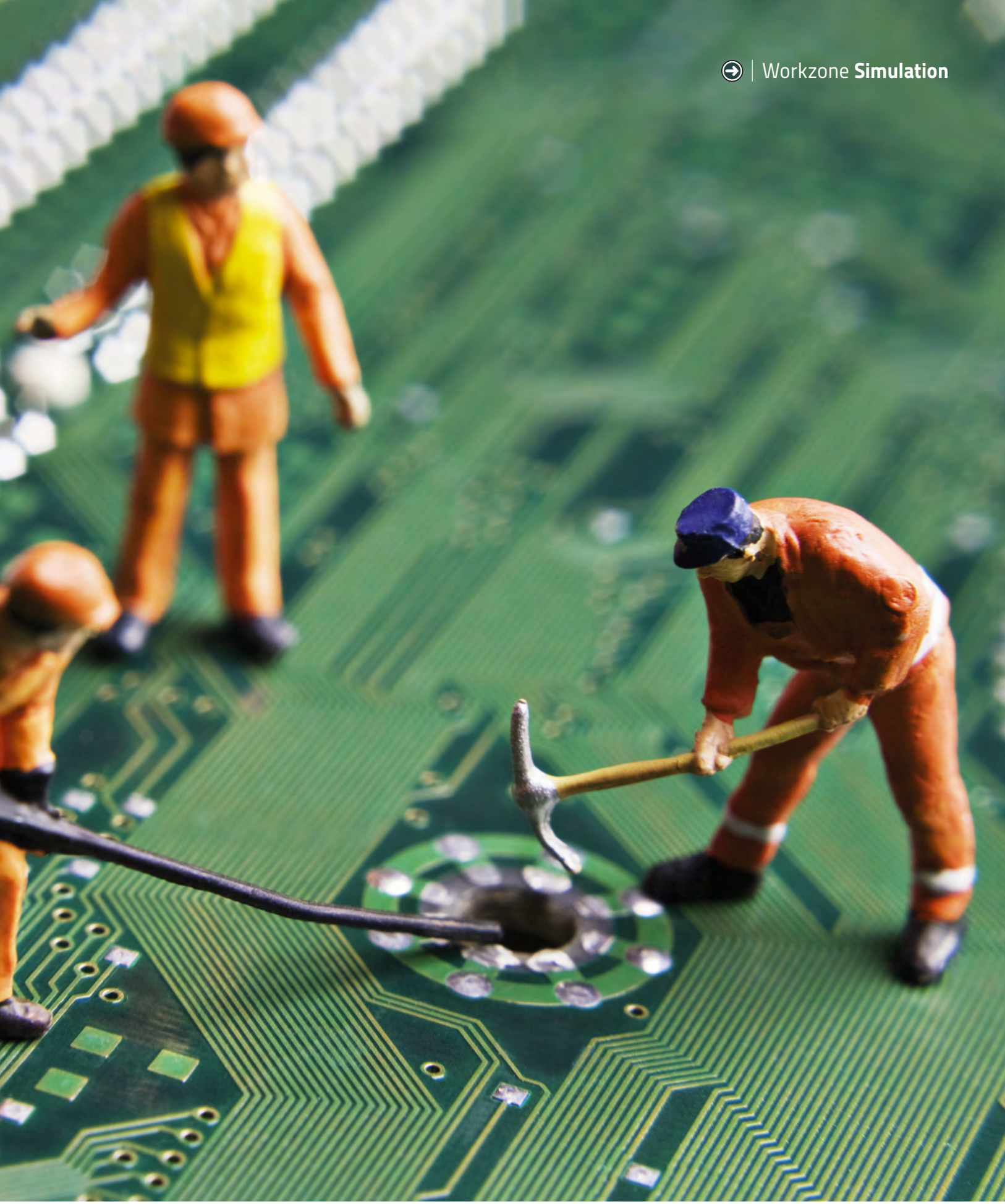
Patience is a virtue – but try telling that to a driver sat in congestion at a workzone, drumming their steering wheel with increasing irritation. A 2015 survey showed the median delay duration tolerated by travelers in Michigan, USA, is a mere 10 minutes. So most would be seething with frustration by the time you've finished reading this feature.

Annoyance from drivers at being delayed is one way in which highway managers are put under pressure to keep the traffic flowing freely at workzones. However, there's a more serious reason that they need to do so – the majority of fatal crashes at workzones happen at the end of a line of waiting vehicles.

Maintaining traffic flow is paramount, but lane closures inevitably reduce capacity, so traffic slows or stops. Calculations as to how quickly this happens aren't always simple. The tipping point from free-flow to go-slow varies according to the design of the workzone. In Michigan, for example, average workzone travel speeds are relatively stable up to about 1,700 vehicles per hour per lane, according to a study across 14 workzones in the state.[1] However, if a contraflow is in operation, the free-flow maximum capacity is lower, at 1,550 vehicles per hour, according to the Transportation Research Board.[2] There are three main factors that influence flow, and two of them can be predicted quite accurately from historical data – traffic volume and speed. It's the third factor, the human element, that is less well understood. Unexpected driver behavior can trip the switch and turn a smooth flowing highway into a crawling, choking mess.

Getting inside drivers' minds

Technology is being harnessed to improve the computer simulations, of which enhance the experience and intuition of operations managers when designing a workzone. The way they model traffic is being refined. "Different drivers behave differently at workzones, and micro-simulation models of traffic flow at workzones may not be accurate unless the driver behavior is characterized correctly,"



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Computer models are helping to stop workzones from becoming traffic bottlenecks

says Dr Taylor Lochrane, research civil engineer for Operations R&D at the Federal Highway Administration's (FHWA) Turner-Fairbank Highway Research Center, Virginia, USA.

Lochrane has set out to characterize driver behaviors. "Our aim was to collect real-time behavior data of drivers and figure out how that changes when they come to a workzone," says Lochrane. He equipped a car with radar units front and rear to record both its headway and the gap left behind by a following vehicle. Then he recruited 64 volunteers, young and old, male and female, and asked them to drive the car 50 miles on a freeway. The route included a workzone. To make sure they didn't modify their usual driving behavior, they weren't told the real reason for the trial.

The volunteers delivered a large set of radar data, as well as speed and video information. "I evaluated it and developed a framework to characterize four models that would simulate the change in driving behavior at workzones," says Lochrane. Some drivers tailgate closely, attentively matching the speed of the car ahead. At the other extreme in a queue, some stop-start, not moving until there is a wide gap before pulling up to the fender they're following. Some drivers hesitate as lanes merge and other drivers don't accelerate at the end of a workzone.

The framework that accommodates these behavior variables is now being translated into open source code so that researchers elsewhere can apply it to simulations in their regions, because there are regional variations in driving behavior. "They'll be able to calibrate the behavior data for their region before using it to simulate traffic at a workzone," says Lochrane.

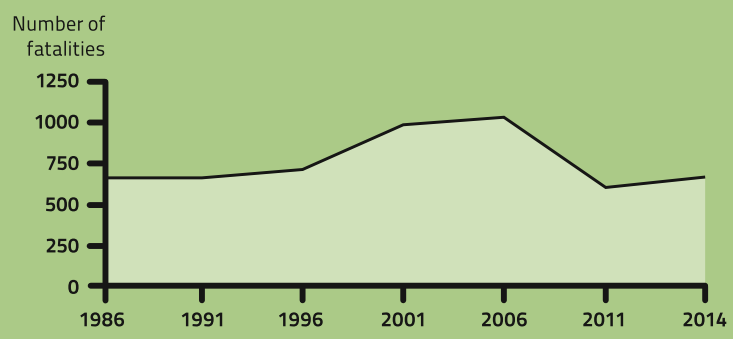
> Different drivers behave differently at workzones and simulations may not be accurate unless behavior is characterized correctly
>
> **Dr Taylor Lochrane, FHWA's Turner-Fairbank Highway Research Center, Virginia, USA**

Characterizing driver behavior at workzones may become even more

Danger zones

Technology has made cars and roads safer over the past 30 years, but has failed to do the same for workzones

The annual tally of workzone fatalities caused by vehicle crashes is similar to the count three decades ago in the USA. However, as the overall road death toll has fallen by more than 25%, this shows that workzone safety has not benefited from improvements to vehicles and highways during that time. In 1987 workzone deaths were 1.5% of the total number of road deaths. In 2014 they had risen to 2.1%.



accurate this spring because Lochrane is making the entire dataset available to everyone. "The anonymized data from all 64 drivers is going to be released from our website for public download so that others might analyze things we haven't been able to look at," he says.

The wisdom of crowds

Crowdsourcing analysis is another way to glean knowledge that can be used to plan better workzones. Collecting data from vehicles in real time is being tested to see if it can help mitigate the impact of workzones on current traffic. To that end the FHWA and the Midwest Smart Work Zone Deployment Initiative have prototyped a smartphone app that helps traffic managers and travelers.

"It creates a feedback loop between travelers and responsible agencies that enables the state to effectively collect, fuse and analyze crowd-sourced data for next-generation transportation planning and management," says Professor Yue Liu, who led the development team at the University of Wisconsin-Milwaukee.[3]

For the traffic manager whose center adopts such a system, it would be possible to see how traffic flows around the workzone from the aggregated data collected by the apps on drivers' smartphones. Software on the traffic management center (TMC) server could calculate when it is appropriate to advise drivers to take another route. The rerouting information is shared with drivers in real time using the same app.

Field tests of the app took place on the four-lane I-94 from Madison to Milwaukee. Then three workzone scenarios were simulated to estimate the potential benefits of the app. By helping reroute traffic to minimize congestion in each scenario, the total time-saving was calculated. When the zone closed two lanes for 15 minutes and there was relatively light traffic on both the freeway and the detour route, 1,637 hours that would have been lost to delay were avoided. The results were even more impressive when three lanes were closed for 150 minutes. In that simulation, 2,874 hours of vehicle delay were avoided.

Those figures have been translated into savings of between US$47,000 and US$83,000 – all from one app plus server software. It's no surprise that Professor Liu concludes, "Tests with various scenarios have demonstrated major overall benefits with system application and effective information provision to travelers in real time."

> Our app enables crowd-sourced data to be used for next-generation transportation planning and management
>
> **Yue Liu, professor of civil and environmental engineering, University of Wisconsin-Milwaukee**

The downsides of V2V

While apps can connect drivers to a centralized information system, the connected vehicle concept has a distributed architecture for acquiring

Armed and ready

Stenciling complicated markings onto roads can be dangerous and time-consuming – making it a perfect job to hand over to robots

Road markings make travel safe, but putting the paint on the highway is just one of the many tasks that can reduce safety – for travelers and workers alike.

Enter a new robotic message painter in the form of a robot arm, which is mounted on the front of a vehicle and driven to a position on the pavement in front of the area that needs to be painted. The driver doesn't need to get out of the cab because a pre-programmed computer controls the arm to sprays the required symbol or message.

"It takes about one minute to paint the word STOP," says Domingo Anguilar of Minnesota DOT, which is funding the prototype. "When a worker does it with stencils it usually takes 15 to 20 minutes, so they occupy the road for much longer. What's more, it usually takes two people, whereas the robot requires only one operative who isn't exposed to any risks of slips, muscle strain or worse."

The robotic message painter still needs more development. There are plans to add a vision system so that it can automatically locate its nozzle over the exact starting point. Another unit is also needed so that reflective glass beads can be added to the paint. MnDOT is seeking partners to turn the prototype into a vehicle that will minimize road marking costs and maximize safety.

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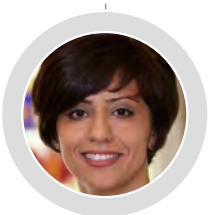
The vast majority of accidents at workzones occur when vehicles collide with a line of waiting traffic

and sharing information locally, from the infrastructure and other vehicles. It's commonly assumed that this will improve safety because warnings of danger will propagate quickly through the local traffic. Yet engineers at McMaster University, Ontario, Canada, have shown how connected vehicle systems could actually reduce safety at workzones.

> Our workzone V2V simulations show that market penetrations above 40% *decrease* network safety
>
> **Dr Saiedeh Razavi, assistant professor of civil engineering, McMaster University, Ontario, Canada**

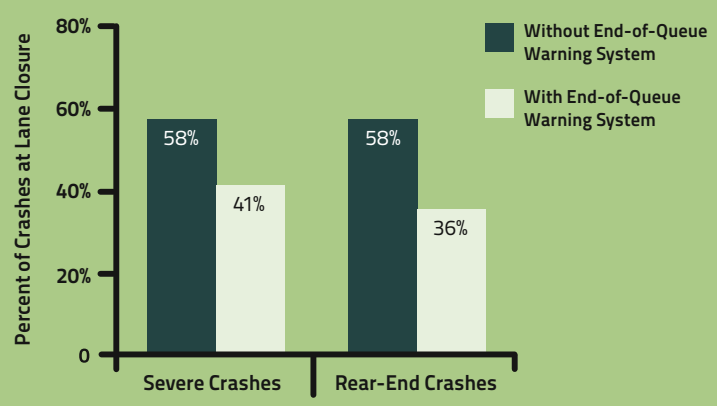


Wade Genders and Dr Saiedeh Razavi simulated traffic passing a workzone with rates of connectivity ranging from zero to 100%. They assumed each vehicle would have a connectivity range of 1,000m and drivers would always comply with dynamic route guidance. Not having the benefit of Dr Lochrane's driver behavior characterization, they chose three archetypes to span drivers' reactions to workzones.

Initially they found that, not surprisingly, the V2V dynamic rerouting around workzones improved safety, even though the longer journey time increased drivers' exposure to potential crashes. "The results show that connectivity rates under 40% contribute to a safer traffic network," they say.[4] Their model, though,

Warnings that work

Texas DOT's end-of-queue warning system of advance rumble strips and speed sensors connected to portable VMS (*above*) has dramatically reduced the number of severe and rear-end crashes at workzones



reveals unexpected consequences if V2V levels go any higher. "Market penetrations above 40% actually decrease network safety."

With more vehicles rerouted, more miles will be traveled. As journey distance is one factor influencing the risk of collision, they calculate that any safety benefits would be outweighed when the 40% V2V threshold is exceeded.

Nevertheless the Connected Vehicles Research Lab at the University of Minnesota Duluth is working on a US$750,000 project to see how Dedicated Short Range Communications (DSRC) can be used to send traveler information messages from workzones with roadside equipment, made by Savari of Santa Clara, California, via a TMC to onboard units.

The same lab has another project for workzones and DSRC, though it is intended to protect workers from dangers presented by their colleagues driving construction vehicles. If it works, each worker would wear a GPS receiver with DSRC capability to broadcast their location to the construction vehicle, helping the driver to give them a wide berth. For long workzones, the technology could link to dynamic speed limits, permitting construction vehicles to travel faster in sections where there aren't any workers.

It's clear that there's scope for many existing and emerging technologies to be applied to improve workzones. Since the financial and human resources required will be minimal compared with those being used to complete the work, let alone those that will be saved by the improvements, there's no excuse now to have workzones that don't work.

1) www.michigan.gov/documents/mdot/RC1630_491364_7.pdf

2) Highway Capacity Manual, Transportation Research Board (2000), chapter 22, section 8

3) A Smartphone-Based Prototype System for Incident/Work Zone Management Driven by Crowd-Sourced Data by Yue Liu, Xin Li, and Yi Hu, 2015, University of Wisconsin-Milwaukee

4) Impact of Connected Vehicle on Work Zone Network Safety through Dynamic Route Guidance, by Wade Genders and Saiedeh N. Razavi in J. Comput. Civ. Eng., 04015020, American Society of Civil Engineers.

Tunnel vision

It's often impractical to replicate emergency lane closures for training purposes, especially in confined spaces like tunnels. Now simulation can help

When there's an accident, road operators can be called on to coordinate lane closures via highway patrols, emergency responders and breakdown services. If the incident happens in a tunnel they may also be required to oversee evacuations. Such events are rare on the open road, but rarer still inside tunnels. Consequently it's not usually possible for operators to get adequate training from observing real-life events. Moreover, operation contracts will not often tolerate the closure of lanes in key locations for the purposes of training.

Now simulation software is beginning to fill the gap. Any road layout can be replicated using Forum8's 3D VR design studio, with events then played out in real time. The software will even simulate telephone and radio communications, enabling exchanges between operators.

The software is currently being used by Egis Road Operation (ERO) for training new staff. ERO has incorporated the use of such training tools into its *Best Practice in Tunnel Safety* guidelines, which state, "Using a simulator is an efficient support tool to: theoretical training, procedures learning, table-top exercises and assessment, that are the basic elements of staff training, but which must be completed with live exercises.

"In the pre-operational phase, a simulator may be used to familiarise operators with their future job and procedures. Training sessions can therefore take place without the need to access assets.

"In the operational phase, a simulator allows training in situations close to reality, but without asset mobilization. This is very important for tunnels, which are often traffic hot spots and where the opportunities to close for training are limited. Moreover, maximum lane availability is often required in new operating contracts, which rarely allows O&M services providers to close assets to organize live exercises."

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Multiscale traffic simulation: a new paradigm

Transportation planners and traffic engineers are required to respond to increasingly complex travel demand and network management mechanisms under increasingly congested road conditions. The requirements placed on modeling software to enable the realistic simulation of larger metropolitan areas have never been greater.

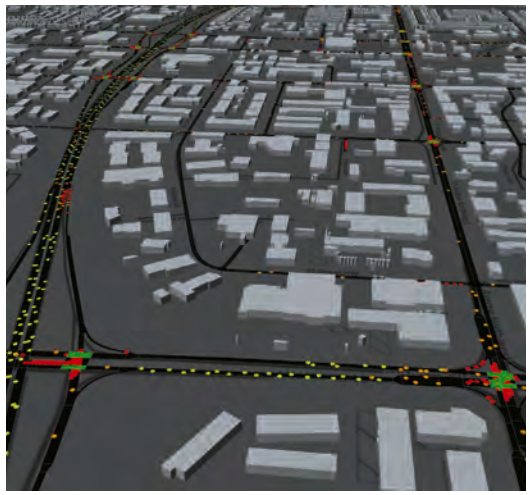
Computational scalability of these models is one obvious challenge, but there are others.

"There is the fundamental question of model stability and robustness," says Michael Mahut, vice president of traffic simulation at INRO. "The typical approach for larger-scale applications has been to adopt two distinct models, microscopic and mesoscopic, in what may be known as a 'multiresolution' or 'hybrid' approach. The underlying models are distinct and each operates at only one scale. However, model outputs can change substantially depending on where interfaces between the 'micro/meso' boundaries are drawn, and the lower fidelity of some mesoscopic models may mean that important details are ignored."

The multiscale approach

To address these challenges, INRO is introducing a new multiscale traffic simulation model that promises scalability to metropolitan-wide applications while preserving the detail and physics of individual vehicle interactions normally associated with microscopic simulation.

"Once you have a sufficiently fast simulation model, the real challenge for larger scale is the model stability, and this is mainly a factor of traffic congestion," says Mahut.



(Above) **A city-wide multiscale traffic simulation of Edmonton, Canada, permits consistent analysis at varying scales**
(Above right) **This model of Seattle, WA, USA enables toll analysis of congested parallel freeways and a dense city center arterial network in a single, unified traffic simulation**

Need to know

A new modeling tool provides a consistent level of detail for enhanced scalability

- Dynameq 4 will be available from Q1 2016
- A new multiscale traffic simulation adapts continuously throughout the network and over time to keep models running even when congestion spreads
- A single, consistent level of detail for metropolitan-scale traffic simulations
- Detailed 3D visualizations illustrate individual vehicles over the entire simulation

"The innovation here is to modulate the rapid spread of congestion when demand greatly exceeds capacity. This enables us to address scalability within a single unified traffic model and at a consistent level of detail over the entire network."

The new multiscale traffic simulator provides stable results, even in cases of extreme congestion where demand may be overestimated. In areas where congestion levels are too high, model fidelity automatically mitigates congestion propagation, while always respecting the saturation flow of links, lanes and turning movements. In addition, lane- and turn-based outputs help quantify the model response and alert the analyst to major demand/supply imbalances. These improvements and others will be made available within the Dynameq 4 traffic simulation software.

"Dynameq 4 also introduces parallel computing techniques which, when combined with the continuously adaptive traffic simulation, substantially improve dynamic traffic assignment convergence and reduce model run times,"

says Daniel Florian, INRO's vice president of software. "We've also included our technology for visual analytics of large-scale mobility data so that individual vehicles can be animated, analyzed and queried in 3D, and across time even at the metropolitan scale. Taken together, we believe these features will be indispensable to the modeler for effective and reliable simulation of the next generation of metropolitan-scale traffic simulation models."

Dynameq 4 is intended as a tool for planners and engineers who want to leverage a single, adaptive traffic simulation at a consistent level of detail across the entire network for enhanced scalability with larger geographies, under higher demand and in more congested conditions.

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by **Neil Hoose**

Maintenance should be a key consideration in new ITS investments

I am guessing that no one actually got an intelligent transportation system for Christmas; not even those that are fans of slot cars or model trains. However, the old saying that 'a puppy is for life, not just for Christmas' has some relevance to those who are expecting to install new – or expand existing – ITS investments.

Throughout the working life of an intelligent transportation system there is a need for repair and maintenance of physical assets, particularly those that are exposed to a range of temperatures, humidity, dust and vibration. Electronic equipment is sensitive, even when 'hardened' components are chosen. The word 'systems' in ITS is important in this context as a complete solution is made up of numerous subsystems all working together. A fault in one component in one subsystem will often manifest itself as an apparently unrelated symptom in a completely different subsystem.

Tracking down the fault from a symptom is often a piece of detective work. Add in the layers of software that put the intelligence into ITS and the level of complexity is raised again. Worse, the old 'switch it off and on again' method will often result in the symptom disappearing, only to reappear at some point in the future, but in a slightly different form. Often maintenance is just the suppression of symptoms and not the solution. The upshot of this is that the cost of ownership of ITS can be higher than expected. Unfortunately ITS generally falls into the revenue budgets that are continually being reduced. In the UK, where there is currently a very aggressive political drive to cut public spending, it can be difficult to sustain the resources needed.

Design for maintenance needs to be given much more emphasis in ITS. There are three parts to this: designing out the sources of faults and building in resilience; improving tools and techniques for tracing faults from symptoms; and designing in features that enable repairs to be carried out safely, quickly and effectively. All need to be addressed. Bearing in mind that we are talking about systems, these stages need

Paying for quality in operation is a good move in the long term

to involve their associated supply chains. Systems are only as good as their weakest link. Software embedded across a system is a particular challenge as seemingly minor incompatibility can manifest itself as a major loss of function. Standards are important in improving quality, but do they place enough importance on the maintainability of systems compared with, say, interoperability?

A key challenge is how to achieve these changes while keeping the capital costs competitive. There will always be some maintenance required and repairs due to external damage are also inevitable. However, much more attention to maintenance and repair during the requirements phase will reduce the whole-life cost. Bear in mind that an ITS is often quite visible to the traveling public and systems that always seem to be under repair quickly lose credibility. Paying for quality in operation is a good move in the long term. The key question is how do we get that outcome to be properly recognized in the procurement process?

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

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

ALPR cameras: Big Brother or safety guardian?

Wherever we move in public, whether in supermarkets, on the roads, at petrol stations or at ATMs, we are being watched by cameras. For some areas, it is widely accepted to use surveillance cameras, for others, less so. Installed in subway carriages, cameras give passengers a sense of security and deter violent behavior. However, when installed on our roads, these cameras can sometimes be viewed as an intrusive way to monitor our movements.

Automatic license plate recognition (ALPR) enables license plates to be captured and read in real time, allowing computer databases to be used to make intelligent decisions, quickly. It remains the most effective way to manage the vast numbers of vehicle journeys that take place every day. As such, it is clear to see why so many highway authorities rely heavily on the technology.

Quality and experience

The effectiveness of ALPR depends on: the quality of image acquisition technology (camera, illumination); the quality of the license plate recognition software; and how the license plate data is used to make decisions. All three elements are equally important and must be considered together in order to realize the benefits of this technology.

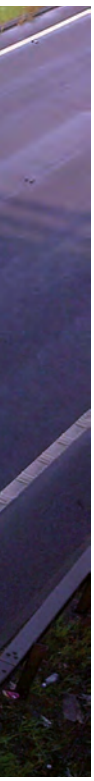
For example, the best plate reading software in the world is wasted if the images come from an old, low-resolution camera. Similarly, if an optimized ALPR camera delivers a brilliant, well contrasted image, poor plate reading software could deliver a high level of misreads. Finally, if the back office systems that receive the data do not contain the appropriate software tools needed to make data-lead decisions, a vehicle of interest may be missed while there was still a chance for it to be intercepted. Where these three elements are appropriately married together, the power and effectiveness of an ALPR-based system can be greatly increased.

An example of this integrated approach is the Vector ALPR camera. This intelligent license plate recognition camera from Jenoptik incorporates an ALPR processor and software. It combines decades of experience into a single, highly capable and compact integrated unit. Two high-resolution cameras combined with built-in IR illumination provide ALPR and scene overview images, including day/night mode enabling capture on a dark road. A GPS clock, compass, accelerometer and two light sensors enable Vector to adapt dynamically to a changing environment, supporting the most challenging enforcement applications.

Following each plate read, an evidential record can be created for the vehicle, comprising data and images. Data includes the vehicle registration number (VRN), read confidence, time, date and camera location. The images include a plate patch and one or more overview images. Data can be encrypted using the latest standards, stored locally, and sent with the plate patch via public communications networks. Vector works in all weather and lighting conditions and is able to read most countries' plates at maximum vehicle speeds.

The Vector camera can be mounted on a wide variety of fixtures, from traffic signals and street lighting columns to gantries and bridges. It can operate with a wide angular offset, enabling installation some distance away from the monitored lane. A range of mounting fixtures, including a three-axis adjustable bracket, means the camera can be installed rapidly and prepared for operation. A single cable is used for power, data and video, with no requirement for an additional roadside cabinet.

Once Vector is powered up and capturing data, it will automatically monitor its performance and the environment around it. Image optimization adjustments are made automatically in response to ambient lighting conditions.



(Right) **Vector is central to many ITS applications, in this case for HGV levy monitoring**

(Above) **The fully integrated design requires no roadside cabinet**
(Left) **A Vector camera mounted on a bridge, providing police ALPR**

Onboard movement sensors can detect excessive camera movements due to vibration or vandalism, and trigger alerts to the operator. If plate reads fall below a configurable threshold value, an alert can be sent to the operator. Remote monitoring via a wireless local area network (WLAN), 3G or an asymmetric digital subscriber line (ADSL) means the camera can be viewed at any time without requiring physical access.

The UK experience

The Jenoptik UK-based ALPR experts (formerly known as Vysionics ITS) have years of experience of a highly developed ALPR market. ALPR was first conceived and delivered in the UK, with Vysionics' history stretching back to the very first active ALPR solution at the Dartford Crossing in 1979.

Need to know

ALPR can be integrated to provide a highly effective safety and enforcement solution

- Parking is one of the most common ALPR applications. This sector includes automation and security, ticketless parking, vehicle location guidance and theft prevention
- Average speed enforcement is an advanced form of ALPR-based journey time measurement. By identifying a vehicle at two known locations a measured distance apart, a very accurate speed calculation can be made
- The data collected from journey time measurements can be used to increase traffic safety, support law enforcement, optimize traffic routes, and reduce costs and time

Applications for ALPR in the UK are widespread, with many thousands of cameras currently in operation. Right now, Vector cameras are being used for many applications including: average speed enforcement, journey time through workzones, HGV levy charging, parking lot access control, and police and security cordons. An increasing trend is the 'dual use' of data, where data feeds from a single camera are shared by multiple authorities, for example providing journey time measurements for highway authorities and live police feeds that assist with the detection of criminal behavior.

ALPR applications are highly beneficial for the police in terms of combating crime and terrorism. As a vehicle passes an ALPR camera, its registration number is instantly checked against database records of vehicles of interest. Police officers can then intercept and stop a vehicle, check it for evidence and, where necessary, make arrests. A record for all vehicles passing by a camera is stored, including vehicles that are not known to be of interest at the time of the read that may, in appropriate circumstances, be accessed for investigative purposes.

ALPR cameras can also reduce crime by deterring criminal behavior and using tools to build up models of behavior – identifying links and pre-cursors to crime. Security cordons are an example of how, in some situations, a sensitive location can be protected by a network of ALPR cameras. Vysionics was responsible for the ALPR elements of the first City of London 'Ring of Steel' in the 1990s. The London 2012 Olympic Games were similarly protected though the use of the company's cameras. Following the introduction of the Vector camera in 2013, many more UK police have started operating large networks of these cameras; in fact, six forces have recently confirmed triple-digit installations.

The global ALPR market continues to grow rapidly, with the benefits of this technology being used in more and more traffic-related applications. The Vector camera further demonstrates that ALPR is now a commodity item, with a standard 'off the shelf' product increasingly being used both as part of larger integrated solutions, but also as a high-volume data-capture device. As our roads and highways become busier, they must also become smarter. The use of ALPR data helps to drive this, facilitating decisions that make roads safer and more efficient.

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FMCW radar sensors overcome multiple vehicle detection challenges

Vehicle detection technologies are integral to intelligent transportation systems (ITS). These technologies are constantly improving to enhance vehicle presence detection, counting and classification capabilities in a broad range of traffic and parking applications. The data that these technologies gather is used by public authorities around the world to meet increasing demands on surface transportation systems.

While many technologies are capable of basic vehicle detection, inductive loop detectors are one of the most widely used solutions. Deployments are typically in the ground, so installation and maintenance is often disruptive, time-consuming and expensive. Some over-roadway sensor technologies, such as video image processing, ultrasonic and passive infrared sensors, can replace inductive loops. However, environmental factors can have a major impact on the effectiveness of over-roadway sensors and their initial cost can be prohibitive.

Efficient and cost-effective

R-GAGE radar sensors from Banner Engineering are capable of solving a more diverse range of vehicle detection applications than inductive loops can, and are more robust than photoelectric, ultrasonic and magnetic sensors. They use frequency modulated continuous wave (FMCW) radar to provide reliable detection of moving as well as stationary objects and have a rugged IP67 rated housing to withstand harsh conditions. They are easy to use, offering simple sensing field configuration and are available in adjustable-field as well as retroreflective models.

(Opposite) **Charging stations equipped with R-GAGE radar sensors**
(Left) **R-GAGE FMCW radar sensor from Banner Engineering**

These all-weather sensors are highly effective at detecting cars, trucks and trains, even in challenging environmental conditions where other technologies fall short.

"Magnetic sensors may be affected by nearby electric currents, and ultrasonic sensors are susceptible to interference caused by gusts of air from passing vehicles," says Ashley Wise, development engineer for Banner Engineering. "Dirt and dust can inhibit an optical sensor's ability to deliver accurate results. Banner radar sensors have proved to be an effective and efficient solution. The functionality, utility and cost efficiency of the R-GAGE set it apart from other competing solutions."

An adjustable-field R-GAGE radar sensor emits a well-defined beam of high-frequency radio waves from an internal antenna, which processes the signal reflected back to the receiving antenna. The sensor is designed to detect objects within a user-defined distance, ignoring objects and any background further away. The sensors are commonly used to detect vehicles in motion on the open road or as they approach an intersection, to count vehicles entering or leaving a parking facility, and to detect vehicles at gates or drive-throughs.

"One of the most exciting successes we have had with this sensor has been equipping thousands of electric vehicle charging stations in Paris," says Mathieu Raffin, business development manager at Banner Engineering. "The goal for this application was to prevent unauthorized vehicles parking in spaces reserved for EVs. We simply embedded a radar sensor into each charging station, avoiding the time and labor associated with installing an inductive loop into the ground at every EV parking space in the city. The sensor has an adjustable field, so it will ignore objects passing outside the parking space and can differentiate between vehicles and pedestrians as well as other objects that may enter the sensing zone."

Need to know

A radar-based approach to vehicle detection promises accurate and effective results

- The maximum sensing range of the R-GAGE depends on the size and shape of the target; however, the standard adjustable-field radar sensor peaks at 24m
- Customizable sensors are also available with ranges up to 40m and advanced capabilities, including two independent sensing zones, a range of beam patterns, heartbeat for health monitoring, and higher gain antennas for more sensitive detection

Reliable detection

The retroreflective model of the R-GAGE radar sensor detects stationary targets with poor or no radar reflection through the use of a reference signal. The sensor emits the same high-frequency waves as the adjustable-field model to deliver a narrow, effective sensing beam. It ignores objects in the background beyond the retroreflective target, creating a more focused sensor. Additionally the retroreflective model is able to sense targets right up to the face of the sensor, thus eliminating any dead zone.

R-GAGE retroreflective models are commonly used for a number of vehicle detection applications. Increasingly these sensors are being used to facilitate free-flow vehicle detection and greater levels of automation at roadway toll stations and similar applications. Every vehicle passing through a toll station – motorcycles, cars with or without trailers, trucks, etc – must be detected to ensure that the correct fee is charged.

Banner's retroreflective R-GAGE radar sensors are well suited to this task, providing consistent, highly reliable vehicle detection, helping to eliminate human error and increasing vehicle throughput.

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Ensuring longevity in traffic control center display systems

When our cars become too expensive to maintain and run, it's usually time to think about replacement. The same is true for an outdated traffic control display system, although the costs involved are considerably greater. A time comes when refurbishment is no longer a feasible option.

This is precisely what faced the Cenatra traffic control center in the Principality of Andorra, in the eastern Pyrenees. Andorra is one of Europe's major tourist spots in winter by virtue of its many ski slopes. High traffic volumes of up to 27,000 vehicles daily, combined with the need for special vigilance dictated by winter conditions, such as advisories on the use of chains and other safety equipment, make the center's main display system and its network of 60 cameras vital in safely managing the 90 miles of roads under its jurisdiction.

For many years the center had relied on a rear-projection video wall based on mercury lamp technology. While the system was state-of-the-art when installed, the advance of technology in subsequent years had gradually eroded its performance edge.

In particular, it suffered from its reliance on incandescent lamps for a light source. Mercury lamps have a lifespan of only 6,000 hours, meaning that in a mission-critical environment like Cenatra they needed to be replaced at least annually. At a cost of around €1,000 (US$1,090) each time, this represented a considerable running expense – even at a time when mercury lamps were widely available.

Modern lighting solutions

In more recent times LED lighting has become the technology of choice for rear projection, and its growing use has meant that replacement lamps were becoming harder and more expensive to source. Scheduled replacement meant additional maintenance costs and downtime, increasing running costs still further and impacting the center's vital 24/7 operational capability.

Of even greater concern was the availability of spare parts. Mercury lamp-illuminated digital light processing (DLP) projectors rely on a rotating color wheel to create a full-color image on the screen. As a moving part, color wheels also need periodic replacement and are product-specific. Once the manufacturer of the screen system had taken the inevitable decision to curtail spares support, the writing was, figuratively speaking, on the wall for this installation. The Andorran authorities therefore began to search the market for a suitable replacement.

Modern rear projection screens now typically employ LED light sources. The chief benefit of LED lighting is its vastly increased lifespan compared with mercury lamps. LED light sources can operate continuously for long periods – in the case of Mitsubishi Electric, up to 100,000 maintenance-free hours, resulting in a dramatic reduction in part requirements and running costs. But this long life brings with it the familiar problems of technology redundancy and the need for confidence in the ability of a manufacturer to support its products far into the future. Mitsubishi Electric's long term commitment to maintaining a clear upgrade path for future technology developments

Need to know

Investments in LED technology ensure versatility and long-term operability

- Mitsubishi Electric's focus is on reliability and sustainability, as opposed to rapidly moving, cutting-edge innovation
- The firm invests substantial time and development to understand the stability and performance of display technologies as a long-term solution
- Mitsubishi produces LED-based replacement projection engines for its earlier mercury lamp-based systems
- Not only does this give older systems a new lease of life, but it also means that future improvements in display technology and the demands placed on it do not automatically spell the end of the road for a video wall installation

(Above and left)
Rear projection LED screens at Cenatra traffic control center

played a major part in the Andorran authority's decision to choose the Mitsubishi solution.

Quality and efficiency

Local systems integrator Intecom impressed Cenatra with the speed of installation and the performance of the Mitsubishi video wall, which consists of eight VS-PE78UA, 50in diagonal DLP rear projection cubes, in an 8x1 configuration 8m long. Along with the dramatic reduction in maintenance costs, the new technology brings with it improved image quality, reduced power consumption and greater energy efficiency.

Free reader inquiry service

Mitsubishi inquiry no. **504**
To learn more about this advertiser, please visit: www.ukipme.com/info/tfm

by **J J Eden**

2016 will be the year of revolution. Are you ready?

2015 was a year of transition for the tolling industry. National toll interoperability progressed, particularly in southern and central USA: several interoperability hubs are now in development in Texas, California and Florida. The E-ZPass Group, the long-time defender of peer-to-peer connectivity, is studying hub architecture.

RFID technology continued to incite riotous disagreement and litigation over the 6c standard and intellectual property. Meanwhile, the 5.9 technology that was shunned by the toll industry several years ago has returned in V2V and V2I, and may end up being the ultimate standard by default. Mercedes' 2017 E-Class sedans, for example, will include V2V and V2I along with the capability to be fully autonomous. Google, Ford, Chrysler, Tesla and Toyota are also investing in V2V and V2I.

This year's Consumer Electronics Show was packed with other new vehicle technologies that have potential tolling applications. TransCore and Gentex are offering their multiprotocol RFID-equipped rearview mirror, for example.

On the back office side we saw continued interest from insurance companies and new or revived interest from the likes of MasterCard and Visa, as the toll industry works to reduce its cost of operations by seeking payment solutions that are more commercial and less customized.

Now that the industry has become fully engaged with managed lanes, operators are becoming familiar with public transit operations, too. And as drivers become more familiar with all-electronic tolls and managed lanes, the need to develop and improve reciprocal violation enforcement has begun to develop.

So, after 'Transition 2015', what will we get in 2016? Revolution:

1) Autonomous vehicles won't just arrive on the scene – they'll explode onto it! We will see some high-end cars sold this year with much of the technology leaking down into some lower models.
2) IBTTA will pick a national transponder standard, which will be irrelevant by the time a 'victor' emerges.
3) The Alliance for Toll Interoperability (ATI), Florida, Texas and California will launch their tolling hubs. E-ZPass member agencies will look hard at these hubs and may even participate in some.
4) Several commercial hubs, including cell phone-based systems, will be launched with models similar to Bestpass.
5) Toll operators will work with the auto and banking industries to include in-car payments as part of future in-vehicle and commercial technologies.
6) Financial institutions will offer commercial back office solutions that will make some agencies question the need and cost of home agency solutions.
7) Parking, fast food and other commercial services will merge into the in-car payment system.
8) The toll industry will collaborate with transit and ITS sectors.
9) Toll agencies in Texas, Maryland, Rhode Island, New Hampshire and Illinois will launch new back office systems.
10) At least two states will decide to convert free interstates into toll roads.
11) Rhode Island will start statewide truck tolling, and tolling on the Ohio River Bridges will go live.

Toll operators will work with auto and banking industries to include in-car payments

What do you think 2016 will bring? How will we adapt to the changes? Email your thoughts to ***james.eden@aecom.com***

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

ITS provides a solution to the USA's truck parking problem

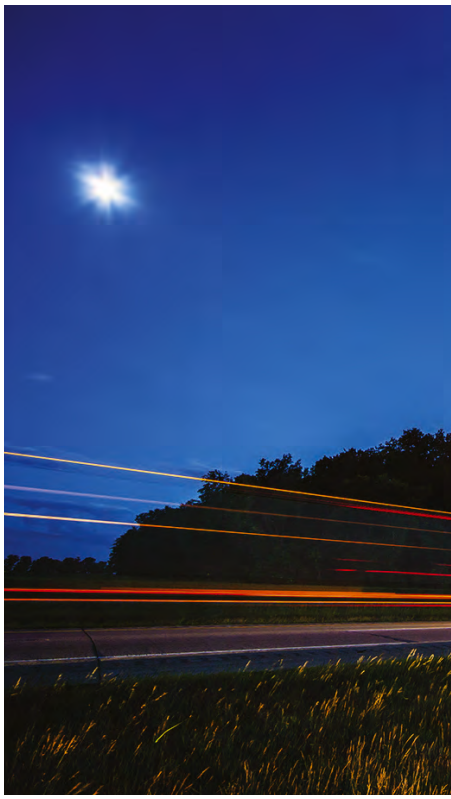
For as long as truckers have been driving long distances, they have had to find a place to park overnight. And for just as long, finding parking has been a problem. Today in the USA it continues to be one of the priority issues with many drivers, most trucking companies and government transportation agencies – and demand for parking continues to increase. Commercial vehicle travel has grown dramatically over the past decade (5% annually and 60% over the decade in truck ton-miles), and is projected to grow more than 200% over the next two decades. However, as the associated demand for parking rises, the inventory of available spaces actually appears to be falling; public funding for highway infrastructure is focused on repairing and maintaining infrastructure and not adding parking capacity for trucks. In fact, as budgets tighten many states are closing public rest areas, reducing their hours of service, or prohibiting trucks from parking overnight.

The search for a rest

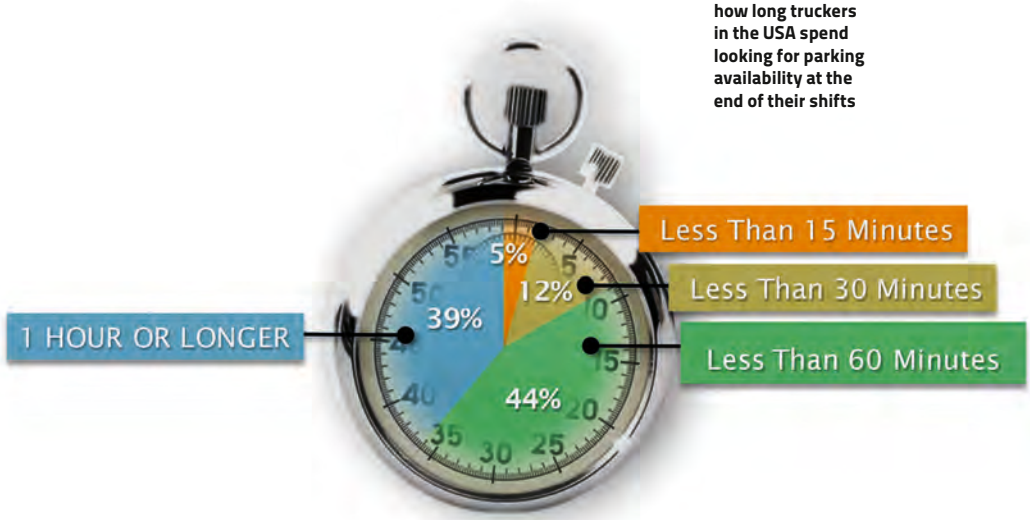
During any 24-hour period, several hundred thousand commercial-vehicle drivers in the USA spend time behind the wheel looking for a place to park. Some estimates have the number at more than 500,000. These drivers are regulated by federal rules that define the hours of service (HOS) that a trucker can be on the road. These HOS rules are designed to address concerns about driver fatigue and associated truck accidents. HOS limit driving to a maximum of 11 hours, after 10 consecutive hours off duty. HOS also require a driver to take a 30 minute rest break after eight hours of driving.

Obviously driver concern and anxiety is simply that there be space available when and where they need it along their route of travel to assure compliance with the HOS regulations. "Where can I park legally and safely?" is a question often heard from truckers.

Parking searches waste time and money for the trucking industry. A recent survey found that most truck drivers shorten their productive driving time on a route to give them time to find parking before violating HOS rules. It is common for truckers to spend 30 minutes or more searching for parking. Research also suggests that driver fatigue causes about 12% of all truck crashes resulting in injury or death, and a lack of truck parking is largely associated with the frequency of these crashes. Situations over the past few years where drivers have been physically accosted while parked in a non-authorized location in order to comply with HOS rules are well known among drivers. A federal law to address the situation was passed by Congress several years ago; it provides new



(Below) **A recent survey revealed how long truckers in the USA spend looking for parking availability at the end of their shifts**



Need to know

Real-time parking information for truckers helps to improve safety and increase efficiency

- Truckers regularly spend 30 minutes at the end of each shift looking for a safe place to park
- Truck Smart Parking Services (TSPS) provides real-time data on parking availability at 18 locations along I-94
- A parking reservation system is to be integrated into the TSPS service in the second half of 2016

(Above and left) **TSPS provides parking availability data on roadside VMS and via an easy-to-use smartphone app**

funding to research solutions and develop an approach to address the problem.

Intelligent solution

With the maturing of ITS technologies, Michigan Department of Transportation undertook a program to make the parking situation better for drivers traveling along I-94 in Michigan. The DOT identified more than 30 locations along the interstate – public rest areas and private truck stops – and proceeded to define technologies that would monitor in real time the inventory of spaces at each location, report the information to a central data-management platform and provide the real-time status via a variety of media to truck drivers and the state highway management. The state hired a team that included Truck Smart Parking Services (TSPS) to develop and operate a network at 18 locations along I-94. Sensor technology, including camera and automated validation processes, was put in place. All design was done to ensure that the technology was agnostic, so that any hardware available today, or in the future, could be considered as the network was expanded.

A real-time audit function was put in place to provide validation of the camera and sensors that were reporting the live status. Real-time parking availability data is provided to drivers on highway signs well in advance of any parking area; it is also provided on a smartphone app and to the state traffic-control centers so that drivers have access to real-time availability for the next few locations at all times and can decide whether to continue on to the next area or pull into the nearest one.

Designed for truckers

According to Rick Warner, president and CEO of Truck Smart Parking Services, interviews were conducted with drivers before the technology deployment was finalized, to make sure the system as deployed would have value to the intended user community. It was important that the listed parking locations include a list of the facilities available, such as restrooms, restaurants and showers. Most important was driver concern that there not be multiple formats and message protocols along the corridor; network consistency was an absolute demand from the trucker community if there was to be any expectation of use.

The service went live during the ITS World Congress in Detroit in 2015. Since then more than three million accesses to information on the network.

According to Jeff Lorino, president of JTL Carriers, "This system helps our drivers make better decisions about parking. They feel more relaxed as they get closer to their drive time limits and can keep on driving knowing they can find a good spot to park rather than driving blindly and facing uncertainty about parking availability and tough decisions."

Many truckers also indicated an interest in some type of reservation system that would relieve some of the anxiety about availability when they start their trip. According to Warner, TSPS will begin offering a reservation service on a limited basis during the second half of 2016.

MDOT plans to expand the network to include 15 more locations. "The real-time truck parking program has been a success in Michigan and we are pleased with our partnership with TSPS," says Collin Castle, connected vehicle technical manager at MDOT. "We appreciate the USDOT's recent sponsorship of the initiative to expand truck parking deployment across the Midwest."

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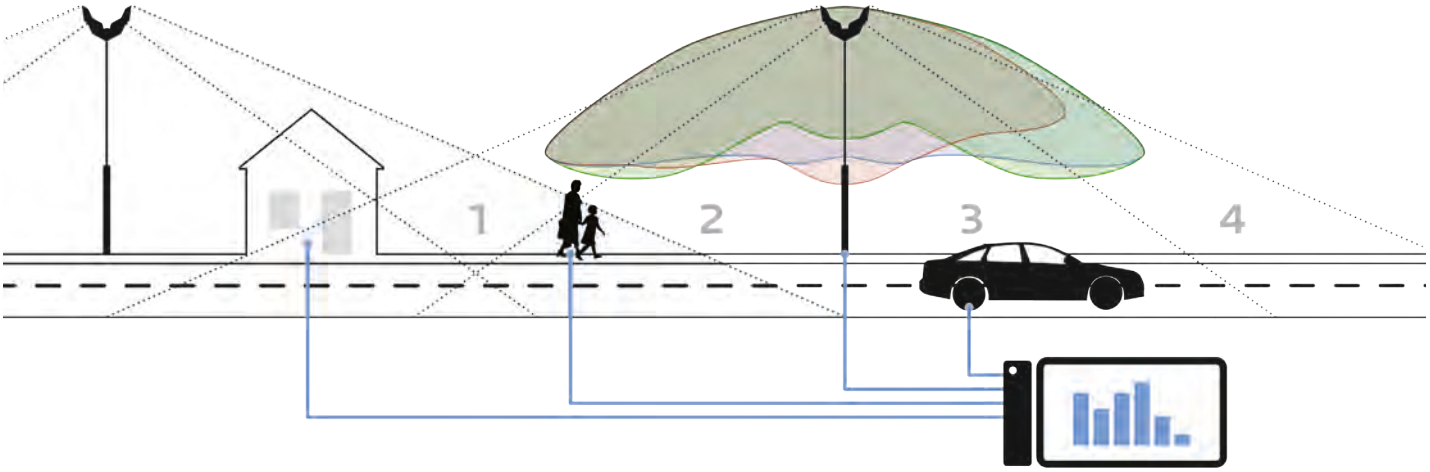
Using smart LED systems to improve streetlighting quality



Sophisticated technology, intelligent systems, the Internet of Things… long gone are the days when simple offline systems were sufficient to solve transportation problems. Lighting is no different, and with the possibilities of LED technology there seems to be nothing that cannot be done within the realms of lighting. However, there is also much confusion in the field, brought about by hundreds of companies all offering their own best thing, not to mention lobbying for completely unnecessary specifications for luminaires, such as IP68 ingress protection ratings for parking garage lighting. Often customers are left trying to decipher a huge amount of technical jargon and data that has very little to do with luminaire performance, and even less with the end result – illumination.

Road to the future

In the road-lighting sector, the same applies to both luminaires and their control systems. There are sales people walking around towns with smartphones, showing how wonderful it is that those responsible for the town lights can walk down the street and turn the lights on and off wirelessly. While this is of course 'cool', questions can be raised as to whether or not this is sensible, needed, or even legal. On the other hand, there is wide consensus that lighting control systems, together with LEDs, are the key to achieving substantial energy savings, and that smart lighting is going to be one of the next big things in the streetlighting sector.

So how should we really control streetlighting? Oy MTG-Meltron, a Finnish company specializing in diffractive optics for general lighting, and dealing in the highly technical areas of lighting such as Atex lighting, and road and streetlighting, has a concept in mind.

Instead of developing wirelessly dimmable luminaires to improve energy efficiency, Meltron's main target is to improve road and pedestrian safety by improving lighting quality. The current streetlighting standards, namely EN13201 and IESNA RP-8, provide a good basis for setting minimum quality criteria for road lighting, although with the onset of LEDs there has been some debate as to whether these requirements could or should be updated as well.

All around the world

Ensuring that lighting systems conform to these standards on a global scale and on all types of roads, requires a wide portfolio of luminaires, considerable lighting design efforts, and information from the field that rarely is available during the design phase. The road asphalt type alone plays a major role when luminance-based lighting design criteria is applied. Luminance-based uniformity and light levels for road lighting are highly dependent on road-reflectance properties, which can change drastically depending on asphalt type, not to mention rain and snow.

Meltron believes that to provide high-quality energy-efficient lighting everywhere at all times, you need a dynamic system with which you can not only dim the lights, but also provide adjustable optics, or dynamic luminous distribution control. The ability to adjust the luminous distribution after installing the luminaire on a

Need to know

When changing the brightness of lighting, quality is more important than quantity

- Meltron uses standards EN13201 and IESNA RP-8 to help define minimum quality criteria
- Dynamic luminous distribution control enables not only the dimming of lights, but also the adjustment of optics
- Meltron's MRSL system enables lighting changes to be made wirelessly, avoiding road closures

(Above) **Dynamic luminous control: operators can adjust lighting and optics in their vicinity, wirelessly**

(Above) **Poor quality light can leave dangerous shadows that leave pedestrians in the dark**
(Left) **Melton provides luminaire technology that can be adjusted to provide high-quality, evenly distributed light**

lighting column has many advantages, one of the most obvious being that it enables many lighting design problems to be fixed online. Meltron's goal is that one day you will be able to install the luminaires, hop in a car equipped with a luminance imaging video camera, drive through all your lit roads measuring them, and then feed the data to a self-adapting system that will optimize each luminaire's output for each road. Luminance imaging cameras have come a long way, and measuring road lighting quality is almost as simple as going for a drive. The problem with most luminaires, however, is that if the measurement results show that the illumination does not conform to the requirements, there is nothing you can do about it other than send a crew to replace the fixtures. With Meltron's MRSL system equipped with an additional multichannel wireless control system, you will be able to apply changes wirelessly, and never have to worry about closing roads to traffic or booking aerial work platforms.

The right light

It is one thing to dim lights to achieve energy savings, and another to meet the lighting quality, safety, aesthetics and energy-efficiency targets for different types of roads. Much of the discussion on smart streetlighting is about using motion-detection systems for dimming, but there are many companies that firmly believe that, when it comes to road and streetlighting, one should be able to monitor traffic volumes, driving speeds and weather conditions, and adjust not only luminance levels but also other lighting quality parameters, accordingly.

"We see a true need for combining optics with lighting control systems, and lighting control systems with the latest sophisticated traffic surveillance systems," says Jaana Jahkonen, CTO at Meltron. "The optics are our specialty, but the rest we leave for others to provide solutions for. The current-generation MRS system is built with light source units and power supply design supporting luminous distribution control via our partner's compatible control systems."

There is a lot of research to be done, and technical as well as responsibility issues to solve, before this kind of approach can be applied on a large scale. Cooperation between customers, systems providers and authorities is key in developing a truly sophisticated system.

Free reader inquiry service

Oy MTG-Meltron inquiry no. **506**
To learn more about this advertiser, please visit: www.ukipme.com/info/tfm

Change is in the air

The main source of pollution in UK urban areas is road transportation, and in particular, nitrogen dioxide (NO_2) emissions from modern diesel engines. Fore Consulting and the Institute for Transport Studies (ITS) at the University of Leeds have recently completed a UK Defra-funded project for Wakefield Council to model emissions in four Air Quality Management Areas (AQMAs) in Wakefield District, where the EU standards for NO_2 have been breached.

As part of this work, Fore Consulting has developed Aimsun microsimulation traffic models for each of the AQMAs in order to predict realistic second-by-second trajectories for each vehicle passing through the study area during the day, including detailed information on vehicle speed, acceleration and deceleration. These trajectories are combined with detailed information on the local vehicle fleet and used by ITS to determine second-by-second tailpipe emissions using the PHEM emissions model.

Crucially, the method is based on realistic driving conditions and not laboratory tests – an important consideration in light of the recent vehicle emissions scandal. This provides more accurate predictions of emissions, including those from the new generation of Euro 6/VI vehicles.

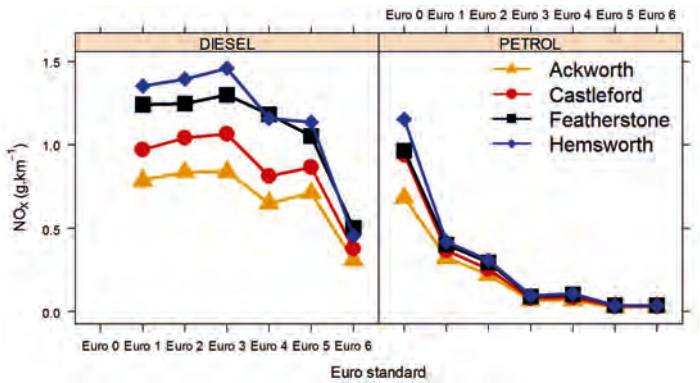
Trustworthy modeling

The methodology, which has been pioneered by ITS on several projects in recent years, was further enhanced in this project. In particular, the networks were fully simulated over a 24-hour period rather than factoring from peak-hour data. This provides more accurate emissions predictions that take into account important fleet changes over the period, such as changes in bus service frequency as well as the ebb and flow of daily traffic. The models represent the most accurate emissions modeling to date, with the results generated from simulations of some 2.1 million vehicle-miles, second by second.

The models have been used to predict future vehicle emissions taking into account traffic growth, planned new development and predicted fleet changes, as well as highway infrastructure schemes. The modeling shows that while buses completed only a very small proportion (around 1%) of the total vehicle-miles over a typical weekday, they contribute a disproportionate amount (around 11%) to the total nitrogen oxide (NOx) emitted across the networks.

Diesel cars and vans also make substantial contributions (around 55%) to the total NOx emitted over a typical weekday, and an even greater share of the primary NO_2 contribution (around 90%). The latter is particularly important as the emission of primary NO_2 will add directly to roadside concentrations and background levels, rather than forming through secondary reactions in the atmosphere.ds

(Left) **Screenshot from the Castleford Aimsun Model**
(Below) **Modeled NOx emission factors for cars, showing notable reductions for Euro VI diesel**



Need to know

Accurate emissions modeling provides a realistic picture of transport pollution

- Air pollution increases the risk of heart attacks, strokes and respiratory diseases and contributes to 3.7 million annual premature deaths worldwide
- In the UK, 30,000 premature deaths per year have been attributed to air pollution, which is more than the fatalities caused by alcohol and obesity combined

by **Larry Yermack**

With the intelligent transportation market thriving, what's next for ITS America?

ITS America (ITSA) was born 25 years ago and I've been privileged to be a part of it from the beginning. It has gone from being a lone voice in the wilderness to one voice in a rising chorus. You might think that ITSA has fulfilled its mission now that transportation technology is so prevalent, but I believe its challenge today is similar to the challenge it faced 25 years ago: how to integrate independent technology into the greater service. Along with this is the challenge of cooperation between various levels of government and the independent corporate world.

In 1990 we were developing traffic management systems and were thrilled if we could deliver poor-resolution images to a traffic control center, which would then let the media know where the incident was, via fax. Personalized traveler information was a dream. Consumer products were still awaiting good maps. The car companies that were there at the beginning soon lost interest.

What a difference low-cost, high-speed data, personal devices and the internet have made. Now, everyone is in the business, from local governments to the largest corporations on the planet. We have in our hands the most powerful traveler information device ever created. Governments have access to traffic information not only from their own network, but also from multiple independent providers. Car manufacturers are working on vehicles that can't crash.

In this new environment, what is ITSA to do? It needs a new path to save itself from obscurity. It needs to lead and not just bring folks together. The last ITSA national ITS plan was on my watch as board chair 15 years ago. It's time for a new national vision.

The good news is that ITSA is stepping up to the plate to lead. The organization's president, Regina Hopper, and Jill Ingrassia, board chair, have initiated a wide-ranging review of what ITSA is and what it could be. There were extensive discussions at board meetings and council meetings, and they held several regional forums. The synthesis of it all is a new national plan.

> We have in our hands the most powerful traveler information device ever created

ITSA is going to create 'Vision 2025: Moving from A to Z without delay, harm or death'. That's a good goal to believe in. To support this, it will develop a roadmap for policymakers, public officials, corporate leaders, academics, and public safety and other groups to maximize the benefits of ITS. To go beyond the plan, ITSA will educate and communicate with diverse groups.

The truth is that while business in transportation technology is good, that does not necessarily translate into a better transportation system. It translates into better parts of a transportation system, but we need a vision to guide us. Think of it as the Interstate of the 21st century. Who wouldn't want to be a part of that?

Larry Yermack is strategic advisor to Cubic Transportation Systems, USA. ***lyermack@gmail.com***
Illustration: Ian Parratt, the-caricatureartist.co.uk

Diesel cleans up its act

Diesel vehicle emission control technology is finally delivering reductions in NOx driving emissions. NOx emissions from Euro VI diesel cars are approximately half that of previous generations and petrol car emissions of NOx are also at a low level. NOx emission controls on Euro VI heavy goods vehicles and buses do now control tailpipe emissions well, with emissions presently notably lower than older vehicles.

As these newer vehicles come into the fleet, they are forecast to reduce emissions of air-quality pollutants in the AQMAs studied, with the NO_2 concentrations in the Ackworth area of Wakefield expected to fall below the $40\mu g/m^3$ annual mean EU standard by 2020 and at or just above the standard in the other areas.

Despite some recent improvements in real driving emissions, it is only a holistic approach and range of sustainable transportation policies that will manage demand levels and accelerate the uptake of truly low-emission vehicle technologies to meet air-quality objectives. Detailed network emissions modeling can be used to test scenarios, forecast and help focus efforts to measures that will deliver the biggest reductions in emissions and improvements in air quality.

By Andrew Bradshaw of Fore Consulting Limited and Dr James Tate of the Institute for Transport Studies, University of Leeds

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Signs that are 'powered' using ambient light sources

The basic requirements for a traffic sign are for it to be legible and visible enough for drivers to be able to read at a distance, enabling them to respond appropriately. Most signs perform this function well under normal conditions, however if vehicles are driving toward bright sunshine, legibility can be compromised by glare. But of course, this is a situation that is impossible to avoid, which is why a solution has been developed that makes signs safer under all conditions.

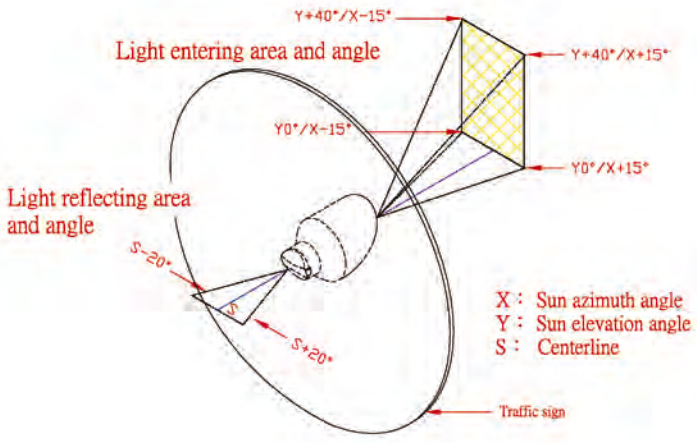
A very basic way to make signs more visible when light is behind them might be to simply cut out the shape of the sign's symbols or text to allow the sunlight to shine through and convey the message to the driver. However this is clearly far from ideal as it would only work effectively when the sun is at a suitable angle. At other times it may shine through such a traffic sign unevenly, or create an additional glare effect around it as a result of the light's direction.

Need to know

Sunmade Signs provide a low-maintenance, low-cost solution for improving safety

- No power source is required. Sunmade Signs are illuminated using specially designed lenses that focus existing light sources
- Sunmade Signs are even effective in artificially lit environments such as tunnels
- The light from Sunmade Signs is visible at a distance of up to 100m

(Below) **How the Sunmade Sign works: light entering it from behind is refracted to illuminate the front of the sign**

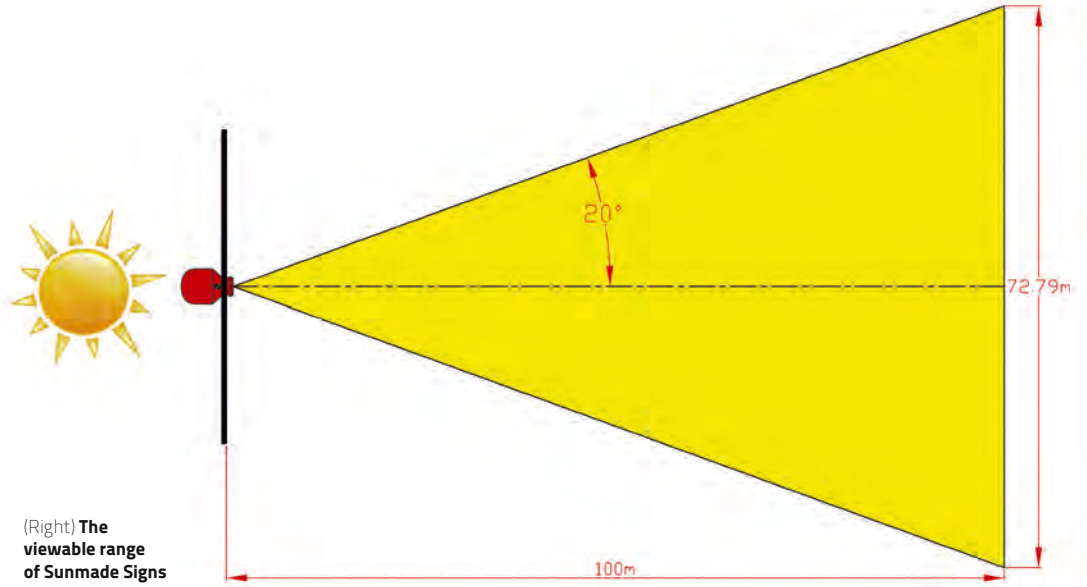


Stray artificial light may also interfere with legibility.

Power behind the sign

The purpose-designed Sunmade Sign takes the concept of using natural light hitting the back of a sign to improve visibility and turns it into a practical and safe on-road solution.

The Sunmade Sign enhances the brightness and clarity of a sign's display by using lenses with a high refractive index to provide a cost-effective and eco-friendly approach to 'powering' traffic signs. It is made simply by adding these high-performing lenses to



(Right) **The viewable range of Sunmade Signs**

a sign. The lenses focus both direct and 'stray' light hitting the back of the sign from almost any angle, and use it to illuminate the message on the sign effectively and clearly, enabling drivers to see it from every lane, whatever the light conditions.

When the sign is illuminated by direct light from behind, the excellent optical performance of the Sunmade Sign means the light entry area is up to 15° to either side of the central axis, with an elevation of 40° from the horizon.

If the sign is lit by stray light from different angles, the light's entry point increases, resulting in the sign being better illuminated. In this case, light is able to be absorbed from up to 65° from the central axis and at a horizontal elevation of up to 50°.

On the other side of the sign, once the light has passed through the lenses, the light reflection area is 20° to either side of the sign's center, and is visible at a distance of up to 100m (330ft) and at heights between zero and 72.79m (235ft). Viewing distance varies depending on the source of the light.

Sustainable construction

Today, as well as being responsible for improving road safety, the transportation industry has a duty to consider the environment. Built using a simple yet innovative concept, Sunmade Signs meet the demands for environmentally friendly, low-powered technology.

Sunmade Signs are made from eco-friendly materials that comply with EU manufacturing standards. They have also passed the tests for luminance and UV light, and are certified as dust-proof and waterproof. The lenses are available in red, amber, cyan, green and white.

The materials that Sunmade Signs are made from are suitable for all weather conditions, are UV resistant and will not discolor. More importantly, being electricity-free and 'powered' only from refracted light from the environment, they are eco-friendly.

Sunmade Signs are versatile. In addition to being easily illuminated on roadsides by direct light, such as sunlight, or in environments with bright artificial lighting, for example in road tunnels, they are also suitable in areas with extreme climates, such as deserts and snowy mountain ranges.

Wherever there is light, Sunmade Signs can be used.

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Evaluating traffic sign performance for optimized safety

Safe traffic flow is highly dependent on properly performing traffic signs and road markings. At night-time on dark roads, the retroreflection of traffic signs and road markings are essential in guiding drivers to keep vehicles safely positioned on the roads, thus avoiding or at least reducing the number of traffic accidents. During wet and rainy weather even high-performing traffic signs and road markings present a challenge, as water often covers the reflective surfaces of the elements partly or fully and reduces or eliminates retroreflectivity.

According to the US Federal Highways Administration, "Inadequate and poorly maintained signs and markings are often cited as the contributing factor to accidents. While only 25% of travel occurs at night, about 55% of fatal accidents occur in the night."

Road owners are responsible for ensuring that traffic signs and road markings perform according to standards. In the EU, for example, the minimum retroreflection requirements are laid out in EN 12899 for traffic signs and EN 1436 for road markings. A third standard, EN 20471, provides the minimum retroreflection level for high-visibility clothing.

A vital tool

Retroreflectometers are a vital tool for road owners to ensure that traffic signs and road markings meet the minimum requirements. Such instruments come primarily as handheld devices for spot measurements. However, mobile units for ensuring a full performance overview at traffic speed are a small but growing segment. Retroreflectometers usually come with software that facilitates basic data processing and storage. In addition, modern tools offer the use of a tablet for advanced post-processing of data, including comparing results with previous measurements, sign library function with pass/fail options and a database search function, acting partly as an asset management tool.

(Above and left) **The new RetroSign GRX can capture seven observation angles in a single measurement**

Need to know

An advanced tool provides road owners with the data required to make informed decisions

- Measuring the performance of traffic signs is important for ensuring compliance with standards and to improve safe traffic flow
- New technology used with RetroSign GRX enables road owners to capture more information on each measured sign as well as provide better data processing and presentation tools

A modern approach

In the second quarter of 2016 Delta will launch a new traffic sign retroreflectometer: RetroSign GRX. This camera-based tool offers a number of new functions not found in the company's current models GR1 and GR3. For example, it can capture seven observation angles in a single measurement. In addition the RetroSign GRX will provide color recognition, sign contrast assessment, a pass/fail function and the ability to identify sign orientation and instrument rotation.

A vital new function is image acquisition – capturing pictures of the measured sign with the option of marking and noting comments.

RetroSign GRX is not just a retroreflectometer. The instrument provides easy capture of all relevant data for performance evaluation of traffic signs. Furthermore, an optional app features an asset management solution for advanced data processing and presentations including visual overview using Google Earth or other software mapping tools.

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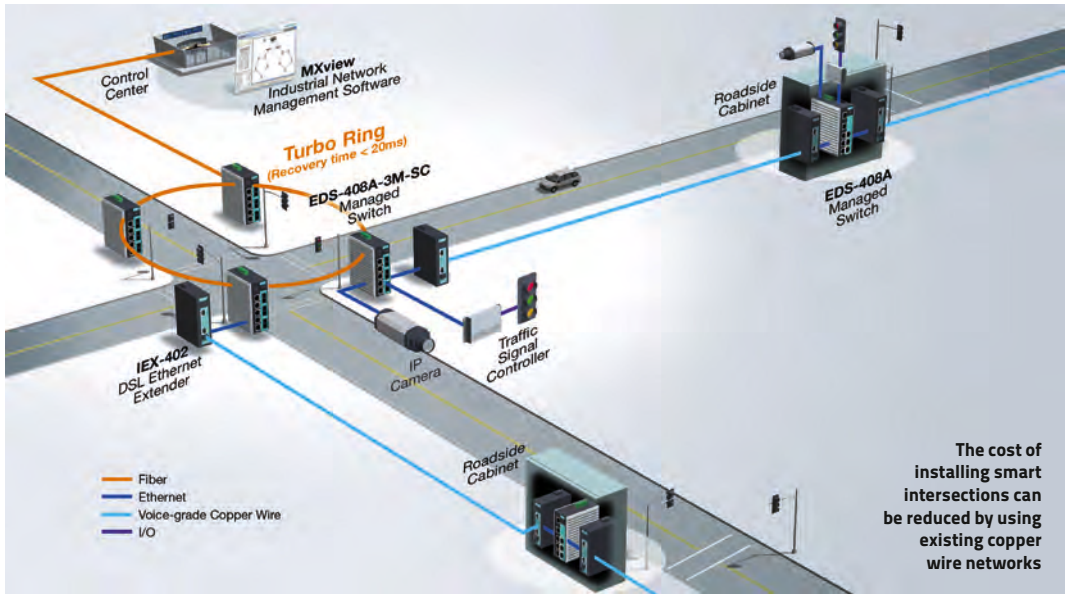
Transforming roads with technology: the IoT in ITS

Combining ITS with the Internet of Things (IoT) offers a solution to the challenges of modern traffic management, promising greater safety, greater efficiency, reduced emissions and happier road users. Future transport requires smarter roads, not more roads or bigger roads. But how can transportation administrators achieve their goals, in the face of tightening budgets? By making clever use of existing infrastructure resources, such as legacy copper wiring, huge improvements are possible at a relatively low cost, while saving time, avoiding wastage, and winning support from road users.



The cost of installing smart intersections can be reduced by using existing copper wire networks

Safer intersections

Making intersections safer is a major ongoing task, but the expected payoff for investment in new technology comes in the form of lives saved, fewer injuries and less stress, as well as lower fuel expenditure and a reduction in wasted time. Such is the promise of the IoT in ITS that for municipal managers, eradicating serious accidents is now a plausible target. The IoT makes it possible to add intelligent communication, signaling and CCTV systems to intersections, which can benefit travelers and the general public in many ways. Benefits include reduced delays, safer travel, more efficient fuel use, and reduced air pollution. Indeed, such upgrades to traffic systems are already being rolled out globally.

ITS intersection systems generally include traffic lights, roadside radars and sensors, video surveillance digital signage and information subsystems. Hitherto, most of these intersection subsystems have been implemented and operated somewhat independently, and with less cooperation between them than is desirable. In the worst case, different subsystems may sometimes offer distracting or conflicting information that confuses road users. A truly intelligent intersection traffic control system includes similar subsystems to those used in the past, but organized to work together much more efficiently.

At the ideal intersection ITS controls the right-of-way for all vehicles arriving at it, regulating when and how vehicles or pedestrians move through the intersection, with signaling and timely information. This reduces traffic delays and conflicts that tend to cause accidents.

No need for new infrastructure

Fortunately, in most cases the decision is much simpler, because the basic infrastructure already exists. There are miles of telephone-grade copper wire already installed underground for telegram or telecom communication systems, and for old-fashioned serial-based traffic signal control systems. Although the extent and capability of the wire varies, the fact that it is already there is a huge advantage.

It's always easier to repurpose existing wires than to install new ones, particularly as few transportation budgets are healthy enough to support the cost of overhauling the entire communication system with new copper wire or fiber.

The question is: how can we most effectively reuse these telephone-grade copper wires to enable IP-based networks and ensure fast and reliable data transmission? If we can achieve this, the cost and time savings can be immense, compared with the installation of new infrastructure.

This is where Ethernet over long-distance copper wire comes to the rescue. Thanks to digital subscriber line (DSL) technology, we can now make use of the telephone-grade copper wires that are already in place and paid for, and use them

Need to know

Intelligent use of communications technology results in cost-effective upgrades

- Moxa makes a comprehensive range of products, addressing all the networking needs of ITS builders, including industrial Ethernet switches, industrial video networking, NPort, and wireless devices
- Moxa's IEX-402 managed DSL Ethernet extenders seamlessly connect to Ethernet devices and networks, extending their range from tens of meters up to several kilometers by carrying the Ethernet data over a DSL link
- As the extenders are plug-and-play, engineers in the field benefit from easy installation

by **Don Hunt**

to set up an IP-based network. Most importantly, the maximum 100m point-to-point distance limitation of RJ45 Ethernet copper connections no longer applies. Instead, a range measured in kilometers is achievable between devices.

Upgrading is not an easy job. As well as budgetary limits, there are challenges due to legal and geographic constraints, as well as uncertainty about the real-world effect of upgrades on intersections. Reducing the complexity of the installation will therefore make work easier. One promising approach is finding ways to reduce the amount of construction required, with the aim of saving money and reducing the complexity of the task for engineers.

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Transportation authorities must not neglect investment in communications infrastructure

To take advantage of the best in new advanced traffic management systems and big data analytics, it is increasingly necessary for authorities to ensure that communications infrastructure is kept up to date. Transportation systems management and operations (TSMO), for example, is a program to optimize the performance of existing facilities through systems, services and minor projects targeted at preserving capacity and improving reliability and safety.

As feedback on system performance becomes more available from big data analytics, the ability of agencies to actively manage the highway system will grow. Active traffic management capabilities are emerging to smooth system flow and increase reliability. They include elements such as integrated ramp metering, variable speed limits, lane control for incidents, peak-period shoulder-running and congestion-priced managed lanes.

Big data analytics will also help to identify the source of specific congestion by analyzing the origins, destinations and timing of specific trips. Projects and programs will be better targeted to reduce congestion at favorable cost-benefit ratios, including travel demand management. Improved TSMO capabilities will also position road authorities to respond to future trip-making needs, which will focus more on efficient intermodal journeys and less on personal vehicle dependence.

Therefore, the need to encourage enhanced communications along transportation corridors is a constant. Almost all road authorities have implemented fiber backbone systems as part of their ITS investments over the past two decades. Many departments have extended their reach through public-private partnerships, trading right-of-way permits for the right to use a few strands in a privately owned fiber bundle.

Finding the funds to install fiber during reconstruction will be money well spent

At present these broadband communications support various ITS installations such as cameras, weather stations and message signs. In the future this backbone could be critical in the capture of connected-vehicle short-range data. This will provide vehicle communications to fixed infrastructure such as traffic signals, and provide data for better active traffic management. Finding the funds to install fiber during reconstruction – either department-owned or through partnerships – will be money well spent.

Likewise, cellular communications will continue to play an important role in traffic safety and mobility. DOTs should evaluate coverage in heavy traffic corridors and ensure coverage is adequate to provide real-time traveler information, especially during heavily congested periods. Agencies should work with cellular providers to enhance tower coverage and capacity, and also explore the introduction of micro-cells on street lights to extend coverage where towers are not feasible.

Don Hunt is a transportation consultant and former director of Colorado DOT ***dhunt@anteronet.com***
Illustration: Ian Parratt, the-caricatureartist.co.uk

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Reducing traffic noise with intelligent technology

Street traffic noise can be a problem in urban areas and several municipalities in Germany are looking at ways to reduce it, especially at night. One way to achieve this is to reduce the speed of vehicles.

German company RTB has achieved positive results in terms of noise reduction through the installation of its Dialog-Display system. One large display was installed in a workzone on the A9 highway in Bavaria where the construction workers needed to be protected from excessive noise. The message on the display resulted in a substantial reduction in speed and noticeable relief in terms of noise pollution.

Motorcycle dilemma

Spring is the beginning of the motorcycle season. In every country there are roads that are perfect for bikers, but their popularity makes for unhappy residents. Over the course of a weekend during the spring and summer there can be several thousand bikers on a single road. Even though they are not out to disturb or bother anybody, they create a lot of noise just by revving their engines.

RTB's first project in 2013 was to appeal to the conscience of motorcycle drivers, to encourage them to reduce their speed by reminding them of the speed limit. This was achieved by installing static signs and Dialog-Displays in the affected areas. In one location a combination of Dialog-Displays saying 'Slow down' and 'Thanks' was combined with a 3m high mirror, which enables drivers to see themselves. The displays are still active today and deliver consistently good results.

The technology has now gone one step further. Todtmoos, in the Black Forest area of southern Germany, recently began a pilot project in collaboration with RTB for noise reduction. The approach combines RTB's classification system, Topo, with messages on a Dialog-Display.

The Black Forest is a favorite for motorcyclists. Along with the high speeds being ridden there, motorcyclists produce almost unbearable noise with their riding style. It is not only the residents who are disturbed by this, but also tourists, who want to spend a few relaxing days in Todtmoos.

Here, Topo.slp counting devices (integrated into a guide post) with acoustic identification are being used to instantly determine if a passing vehicle is a motorcycle. Simultaneously the speed and the noise volume (in decibels) are measured. If the device determines that the motorcycle is too loud (more than 84dB), they gets feedback within 70m. This is achieved via a Dialog-Display, which shows a child holding its hands over its ears and demanding, 'Please drive more quietly'. When the driving style is appropriate, the biker gets a 'Thanks'.

The pilot began in early September 2015. Operation at several locations within the city limits of Todtmoos is planned. The year-long project will be supervised and evaluated scientifically. The Baden-Württemberg Ministry for Transport and Infrastructure is relying on the understanding of bikers for a successful outcome.

(Left) **Combination of a Dialog-Display system and a roadside mirror**
(Below) **Interactive speed control system in Todtmoos**
(Below left) **Dialog-Display system in a workzone on the A9 highway**

Need to know

Drivers can be persuaded to slow down with measures that promote self-awareness

- Many scientific studies have verified that excessive noise leads to illness, with problems particularly affecting the circulatory system and brain
- Noise also triggers stress reactions; hormones such as adrenalin, noradrenalin and cortisol are released in increased amounts, which in turn leads to an increase in blood pressure, an acceleration of the pulse and activation of blood coagulation
- An estimated 4,000 heart attacks a year in Germany can be traced back to street traffic noise

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The dawn of automatic weight control

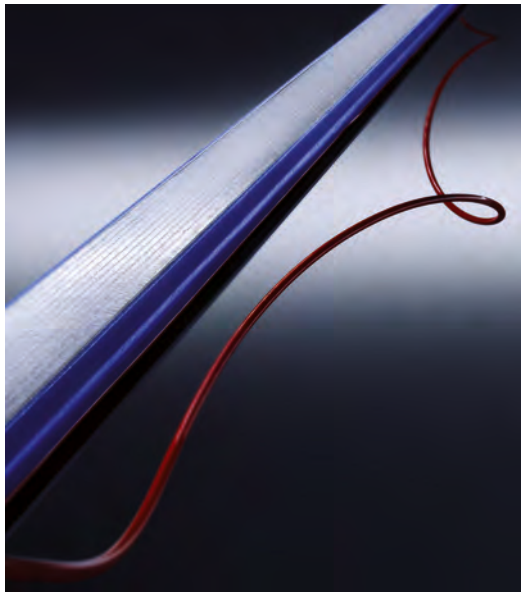
The industry is witnessing rapid development in the field of intelligent transportation systems and is seeing a vast array of sensors and measuring technology emerging on the market each year, enabling formerly unimaginable monitoring of traffic flow. Weight control is an important part of this trend.

Last year, Kistler became the first manufacturer in the world to announce the successful certification of its weigh-in-motion (WIM) system according to OIML (Organisation Internationale de Métrologie Légale) recommendations. As international standardization of WIM technology – especially when talking about high-speed applications – is yet to be fully defined, the OIML R-134 standard is a very useful norm that can open the door to using WIM systems for fully automated vehicle weight control.

The certified Kistler Lineas strip sensors and Kistler's WIM Data Logger provide the necessary base for any system that demands highly accurate weight data, full reliability of measurement, flawless operation and proven long life of components installed directly in the road.

Many vehicle weighing applications will benefit from OIML-certified technology delivering legally compliant data – technology that is unparalleled for medium and high speeds. WIM is an integral part of any ITS, providing essential weight information that is very difficult to get from other sources.

With these new possibilities in mind, some projects that a couple of years ago seemed too ambitious to many authorities are now becoming reality. Thanks to the performance and accuracy of today's WIM systems, applications such as automatic direct enforcement, legal-for-trade industrial weight control and toll-by-weight applications are now in operation. In the Czech Republic and Russia, for example, the legislation enables direct automatic penalization of overloaded vehicles based on the data from a high-speed WIM system with Kistler quartz strip sensors. In several other European countries, the necessary legal background is in preparation, and new projects are being designed to stop road damage caused by overloading.



(Above) **Kistler's WIM system meets the OIML R-134 standard for weighing goods at low and medium speeds**

Need to know

Accurate, certified WIM systems can facilitate ambitious weight management projects

- Kistler's modular WIM systems can also be used to eliminate fraud caused by inaccurate vehicle categorization or tax evasion
- This is of interest to tax authorities seeking to optimize tax collection, as live vehicle weight data collected by WIM systems can be directly compared with other databases
- Some authorities have even started talking about indirect collection of VAT

The next step

High-speed WIM automatic enforcement is a fairly new process and is still facing some challenges regarding location-specific legal requirements and certifications, and the corresponding know-how is scarce. Kistler's OIML-certified technology and its experience from many applications around the globe help the company to provide qualified support and expert advice in consideration of local requirements.

Another area that has great potential for highly accurate certified WIM systems is industrial truck weighing. When weighing vehicles are leaving or entering industrial plants, mining facilities or ports and terminals, measurement speed and overall efficiency play an important role. This is particularly true for sites with a high density of traffic, where weighing is time-consuming and expensive. Kistler's certified WIM system meets legal requirements for weighing industrial goods at low and medium speeds, ensuring a quick return on investment and a guaranteed output.

To sum up, delivering legally compliant data is at the core of it all. Automatic direct enforcement, legal-for-trade industrial truck weighing and toll-by-weight applications will become reality only with completely reliable, 100% waterproof weighing data. Kistler is convinced that OIML certification will lead the way.

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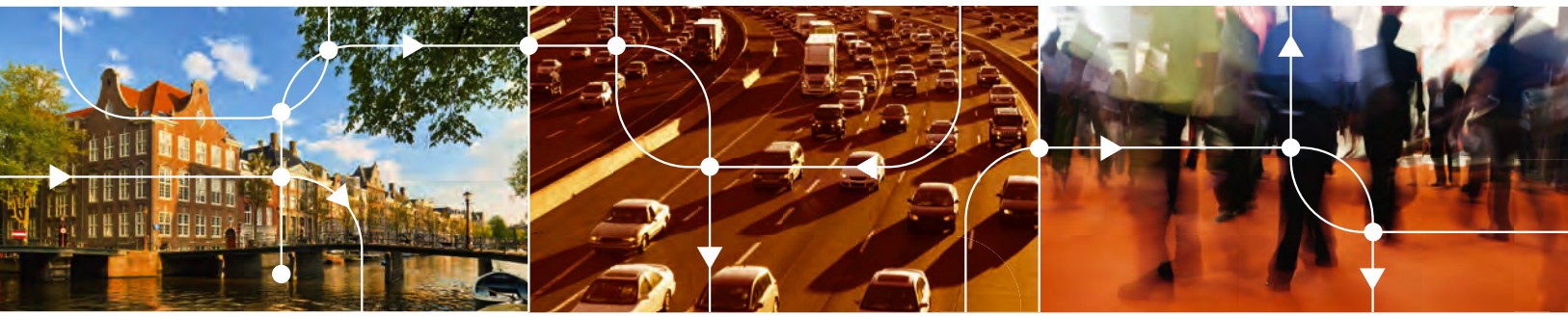

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TRAFFIC INDUSTRY HIGHLIGHT

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Express lanes

Your shortcuts to the highlights you will find in this issue – and beyond!

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"We really want to show that people want to pay for MaaS, not just that we can do it"

Sampo Hietanen, CEO, MaaS Finland

"In 24 months we hope to be able to demonstrate the world's first lab-based 'perch and repair' maneuver, where a robot approaches a streetlight or pipe defect, assesses it and repairs it without human intervention"

Professor Philip Purnell, School of Civil Engineering, Leeds University, UK

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"We believe our customers will embrace and trust autonomous vehicle technology more if they don't feel they are being driven around by a robot. This will increase the driver's confidence in the automation and help them to relax"

Richard Holland, group leader, validation and verification, ADAS & chassis electronics, JLR

Find out more about the Move_UK autonomous vehicle project in a video at trafficTechnologyToday.com/move_uk

"We wanted to be the country that had the best infrastructure in the world. The only way to accomplish that was to have a dedicated agency, known as the Department of Transportation"

Ray H LaHood, US Secretary of Transportation 2009-2013

As USDOT celebrates 50 years, transportation secretaries take a look back at what has been achieved: trafficTechnologyToday.com/usdot50

"In the past it has taken decades for new automotive technology to catch on. With self-driving cars it will be very different"

Dr Alexander Hars, editor of Driverless Car Market Watch and MD of Inventivio

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"We need to program cars so that they don't need any help from their headquarters at all"

Mike Hearn, software engineer and Bitcoin developer

Watch Hearn contemplating an autonomous future at trafficTechnologyToday.com/hearn

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A unique benefit of Jenoptik's solutions is the choice of sensor types used to trigger image capture, including; video, radar, laser and loops. Combined with highly capable, proven cameras and processors, this flexible approach provides a low-risk, modular approach to virtually any monitoring or enforcement application.

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- **Police & Security ANPR** – following the acquisition of Vysionics, Jenoptik now offers VECTOR license plate reading cameras to rapidly monitor and identify vehicles of interest, such as 'red flagged', uninsured or stolen.
- **Traffic Data Management** – the intelligent use of ANPR data to control vehicle movements, including travel time information and access control.
- **Traffic Safety Services** – making the most of the roadside technology, through consultancy, back office operation and support, benefiting from Jenoptik's regional service centres and international network of experts.

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