October/November 2017

traffic TECHNOLOGY INTERNATIONAL

Face recognition
The new AI techniques that will aid future traffic enforcement

The game changer

Blazingly fast, next-generation mobile communications are now being tested for V2X applications. We look at how the coming revolution will affect your roads

FEATURING

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Connected corridors
The roadside hardware that transportation departments are already installing to 'talk' to vehicles

Truck platooning
Could the UK's new trial be the one that ultimately leads to full-scale real-world deployment?

Unlocking the power of location data in today's cities

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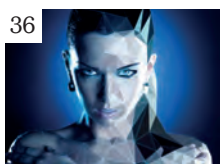
Join us at **ITS World Congress** from **October 29 - Nov 2** in Montreal to learn more.

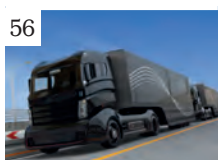
Cover story

20 The need for speed

How next-generation mobile communications will transform traffic technology

Jack Roper reports on how a team in one of the coldest parts of the planet is testing the hottest new technology around





Technology Profiles

Editor's letter

Living, as we do, in the midst of the digital revolution, it is easy to forget how quickly our lives, or at least the technologies in our lives, are changing. But we only have to look back a few years to see quite startling differences in the way we do things.

Take, for example, the television-watching habits of my two children, Emily (six) and Samuel (two). When Emily was Sam's age, just four years ago, her bedtime routine was complemented, conveniently, by the television schedule. Our TV, admittedly not the latest model (purchased in the 'dark ages' of 2010!) had no 'on demand' capability and picked up its signal from an antenna on the roof, just as my parents' set did when I was a child. But a few short years later, and a 'dongle' plugged into the back of that same screen means Samuel picks and chooses what he wants to watch (usually cartoon monster trucks) thanks to online streaming and, being two, is becoming quite adept at taking the phrase 'on demand' quite literally. The surreal and soporific *Night Garden* characters helpfully suggested by the BBC schedule at bedtime are currently getting short shrift…

It's just one more thing to add to the growing list of cutting-edge technology that Samuel will simply take for granted – music streaming (no more need for racks of CDs or any worries about being able to find new music), voice-controlled everything (Alexa, write my Ed's letter), 24/7 social media (did I really just get sucked into *that* for half an hour?) and superfast home wi-fi (this café connection is *so slow*) are already the norm. Plus, around the corner we can clearly see, hurtling toward us at great speed, connected and autonomous vehicles (not literally, and in any case, there's built-in emergency stop), face recognition technology (yes, the new iPhone already has it) and 5G. These last three, and the impacts they will have on traffic technology, are investigated in detail in this issue.

Many transportation professionals (including our esteemed columnist Larry Yermack, who opines on the subject on page 63) firmly believe that if we deploy autonomous vehicles without V2X technology, we will have missed an important trick. The challenge, however, is for road authorities to install connected infrastructure hardware at the right times and in the right places, operating, as all do, on a limited budget. It's a challenge that is being met head-on by the Vehicle to Infrastructure Deployment Coalition (V2I DC) in the USA, which is working with state DOTs to provide guidance on the subject (you can find out more on page 48). DSRC is a technology very much still on the table for V2X applications; however, there is an increasingly interested eye on improving cellular latencies, looking at what 4G is now delivering, and wondering what 5G might be capable of in this realm. We won't have to wonder much longer because tests of 5G communications on road networks are already underway. On page 20, our cover story focuses on one such pilot, being conducted in rural northern Finland, where real-time road weather data is a key aim.

Face recognition on traffic cameras is perhaps a more distant prospect than 5G, but as our *Future facing* (p36) investigation reveals, it's not quite as far off as you might think. And, quite possibly, by the time Samuel is reckless enough to ride his bicycle through a red light, it will just be another normal part of getting a nasty fine.

Tom Stone,
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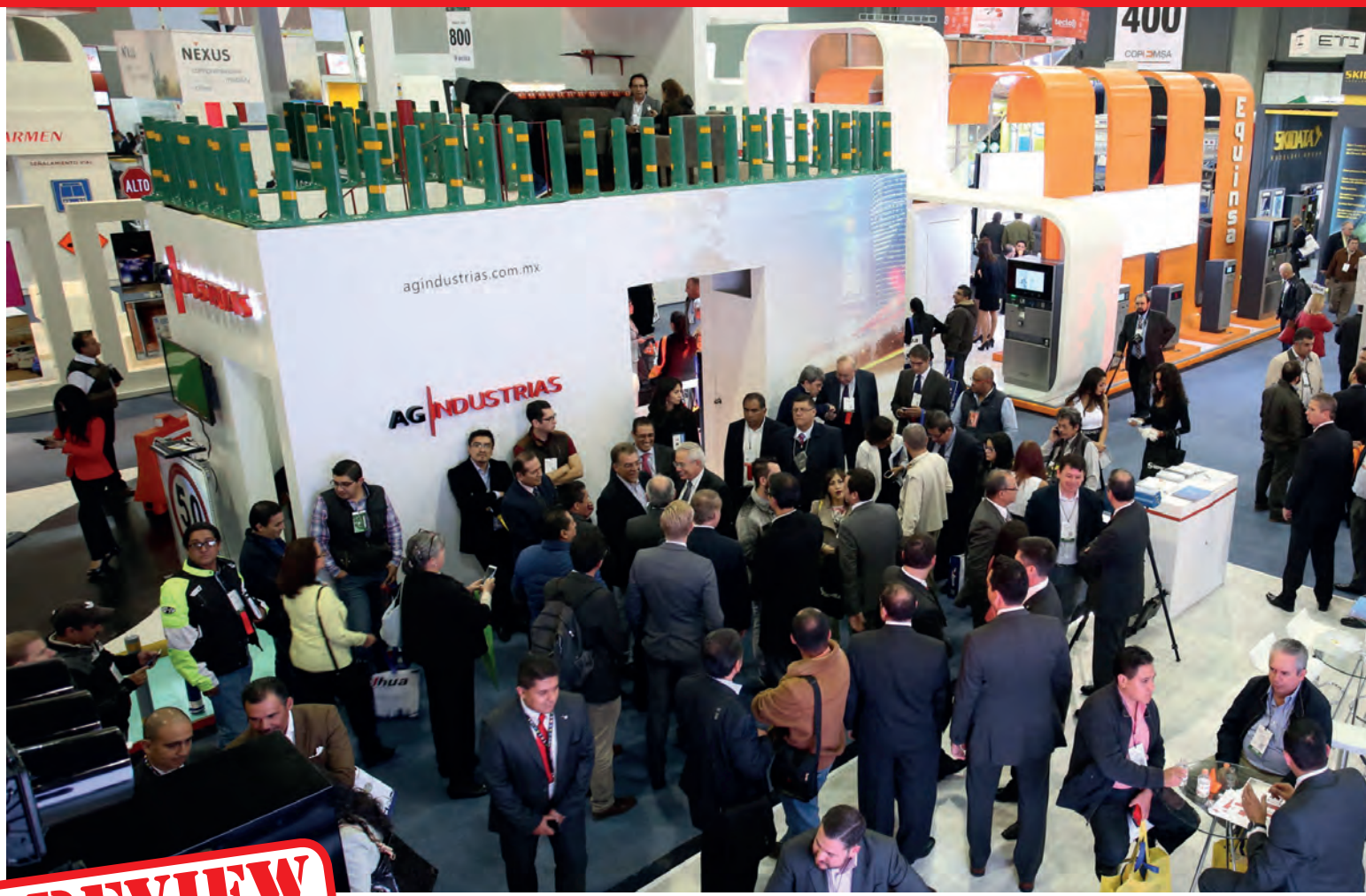


PREVIEW

15.16.17 NOV 2017 Intertraffic MEXICO

Following the runaway success of its inaugural Latin American event last year, Intertraffic is returning to Mexico City once again this November for an event that promises more than ever before, with a bigger exhibition hall, packed conference program, and even its own awards ceremony. **Tom Stone** gets the inside story from the organizers

At the time of going to press, the clean-up operation following Mexico City's worst earthquake this century is already well underway, with much of the city declared safe and rebuilding projects being planned and beginning.

While the quake itself was, by its very nature, shocking and unpredictable, the renewal of infrastructure is a familiar theme for locals. The Mexican capital is one of the fastest-growing cities on Earth and its roads have long been underdeveloped and overcrowded. But, in the past few years, there has been a drive to change all this, with a new focus on transportation investment leading to both more construction and a greater deployment of ITS.

Last November, the inaugural Intertraffic Mexico show was a landmark event in this new dawn for Mexican transportation, becoming a runaway success, attracting more exhibitors and visitors than even the most optimistic predictions. No surprises, then, that the event is back again this year, bigger and better than before.

Mexico City's future focus

Intertraffic Mexico's venue, Centro Citibanamex will throw open its doors to the international

Over 180 exhibitors!

Left: **Last year's event in full swing**

Above: **Event venue Centro Citibanamex**

transportation community once again on November 15.

"I am very proud that we present a marketplace with hundreds of local and international brands such as HUB Parking Technology, T Signs, Punto Rojo and international leading players as Noptel, Hofmann, and Scheidt & Bachmann," says Intertraffic exhibition manager Editha Hoogenberg-Derksen.

Alongside the exhibition hall, there will be keynote addresses in the venue's auditorium from some inspiring and visionary speakers. One expert whom Hoogenberg-Derksen is particularly looking forward to is Diana Zhou, market strategy manager for Hyperloop One – the only company in the world to have built a full-system prototype for Hyperloop, the futuristic airline-speed train concept.

"It is great that we can share the latest developments of Hyperloop with our audience at Intertraffic Mexico," says Hoogenberg-Derksen. "We will get to find out how this new mode of transport could impact society, economies and the environment."

Other VIPs will travel from across Latin America. "Associations like, for example, Federación Colombiana de Municipios and Brazilian Association of Traffic Engineering Companies will be in attendance," continues Hoogenberg-Derksen. "I am looking forward to welcoming policy and decision makers and technicians from Latin America, and offering them quality content and valuable business contacts at Intertraffic Mexico."

4,500
Predicted number of Intertraffic Mexico 2017 attendees

Knowledge forum

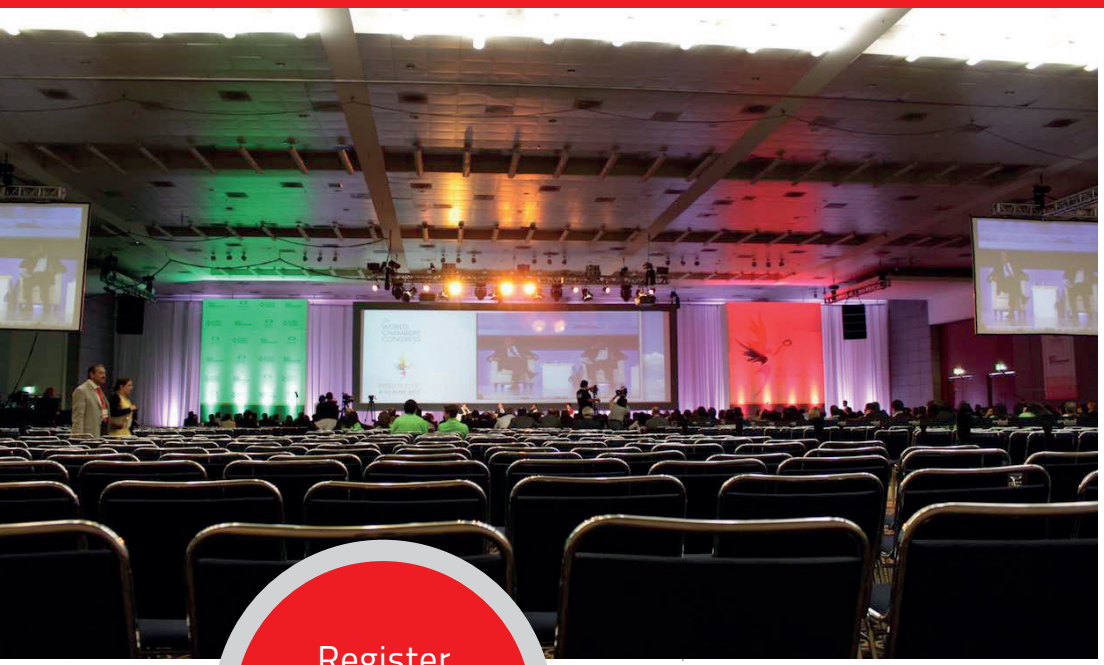
As well as keynote speakers, Intertraffic Mexico has a wider, three-day conference program, which will cover the five subject areas that Intertraffic events focus on: parking, road safety, infrastructure, smart mobility and traffic management.

"I would like to highlight three sessions in particular," says Hoogenberg-Derksen. "Firstly, Jorge Martínez, CEO of Zacua, the manufacturer of the first Mexican electric car. He will talk about the challenges of developing zero-emissions mobility and the green industry in Mexico.

> "I am looking forward to welcoming policy and decision makers and technicians from Latin America, and offering them quality content and valuable business contacts at Intertraffic Mexico
>
> *Editha Hoogenberg-Derksen, exhibition manager, Intertraffic*

"Secondly, Patricio Sepúlveda, business development engineer at Trinity Highway International, will present on procedures for certifying road safety systems in Latin America," continues Hoogenberg-Derksen. "This session will inform attendees about the situation in Latin America regarding the implementation of international regulations for road safety systems, helping them to understand the importance of quality control and of certifying road safety systems."

Hoogenberg-Derksen's final, not-to-be-missed selection from the conference program is *Systems applied to Mobility in the Olympics and future*



Register for FREE at **intertraffic.com**

15.16.17 NOV 2017 Intertraffic MEXICO

challenges in the city of Rio de Janeiro, Brazil, presented by traffic information analyst André Ormond.

Long-term challenges

While the infrastructure rebuilding projects being undertaken following the earthquake are clearly defined and self-contained, the longer-term challenges facing transportation in Mexico City, and the country as a whole, are far more wide-reaching, complicated and interconnected. Nevertheless, each of these challenges can be viewed as an opportunity for anyone in the industry. And these are opportunities that Intertraffic Mexico is well positioned to begin to uncover.

"As the international marketplace for smart mobility, infrastructure, traffic management, road safety and parking, we are connecting professionals in the traffic technology industry worldwide with events in Amsterdam, Mexico City, Shanghai, Beijing and Istanbul," says Hoogenberg-Derksen. "At Intertraffic Mexico we aim to connect today's and tomorrow's mobility in this country and the Latin American region. It is our aim to facilitate valuable local, regional and international business contacts at Intertraffic Mexico.

"All our initiatives are focused on business, knowledge, network and hospitality. With a list of leading local, regional and international key players, a dedicated conference program highlighting vital topics, and quality visitors from Latin America, we will definitely take their business to the next level."

Intertraffic Mexico is jointly organized by RAI Amsterdam and E J Krause

Recognizing innovation

Brand new this year at Intertraffic Mexico will be the Intertraffic Award Latin America. "Traffic technology and mobility are fast-developing markets worldwide," says Hoogenberg-Derksen. "Intertraffic Mexico will highlight the success and best practices in this industry in Latin America with the launch of the Intertraffic Award."

The Intertraffic Award Latin America 2017 will provide recognition to innovative organizations in the traffic technology and mobility industry.

Entry is now closed, but was open to any company breaking new ground in one of the five Intertraffic segments: infrastructure, traffic management, road safety, parking and smart mobility.

At the time of going to press, entries were being compiled for consideration by the Intertraffic Award Latin America jury, which includes: M I Francisco Javier García, mobility and transportation director for the National Commission for The Efficient Use of Energy (CONUEE); Nicolas Rosales, institutional liaison officer at the Mobility and Transportation Mexican Association (AMTM); Enrique Salcedo, president of the Association of Mobility and Transport Engineering (AMI); and M C Miriam Tellez, researcher and academic at the National Autonomous University of Mexico. The jury also includes representatives from the Ministry of Communications and Transportation (SCT); the Secretariat of Public Security (SSP); and the Mexican Institute of Transportation (IMT).

The Intertraffic Award Latin America ceremony will take place at on Thursday, November 16, 2017, at Hall D, Centro Citibanamex, Mexico City

Big wins

Entering the awards has given companies a chance to showcase their achievements and celebrate their success. The announcements of nominees and winners will receive recognition from across the industry, both through media coverage and at the awards ceremony itself. All nominees will have the exclusive right to use the Intertraffic Award Latin America logo as part of any marketing campaigns and will become part of an extensive social media campaign dedicated to the event. The overall winner will also get free publicity in the Intertraffic Mexico media and via a dedicated announcement to the international press.

For more info visit intertraffic.com

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Future car blueprints

As more autonomous systems are deployed in the real world, there is an even greater focus on safety than ever before, as **Rachelle Harry** discovers as he rounds up the latest headlines

Tesla crash report

The USA's National Transportation Safety Board (NTSB) has found that the causes of the May 2016 fatal Tesla Model S crash, which occurred while the vehicle's Autopilot function was engaged, included an over-reliance on vehicle automation technologies and a lack of safeguards. As a result of its investigation, the NTSB has issued seven new safety recommendations and reiterated two previously issued safety recommendations.

Find out more at:
trafficTechnologyToday.com/TCrashReport

Steering ahead

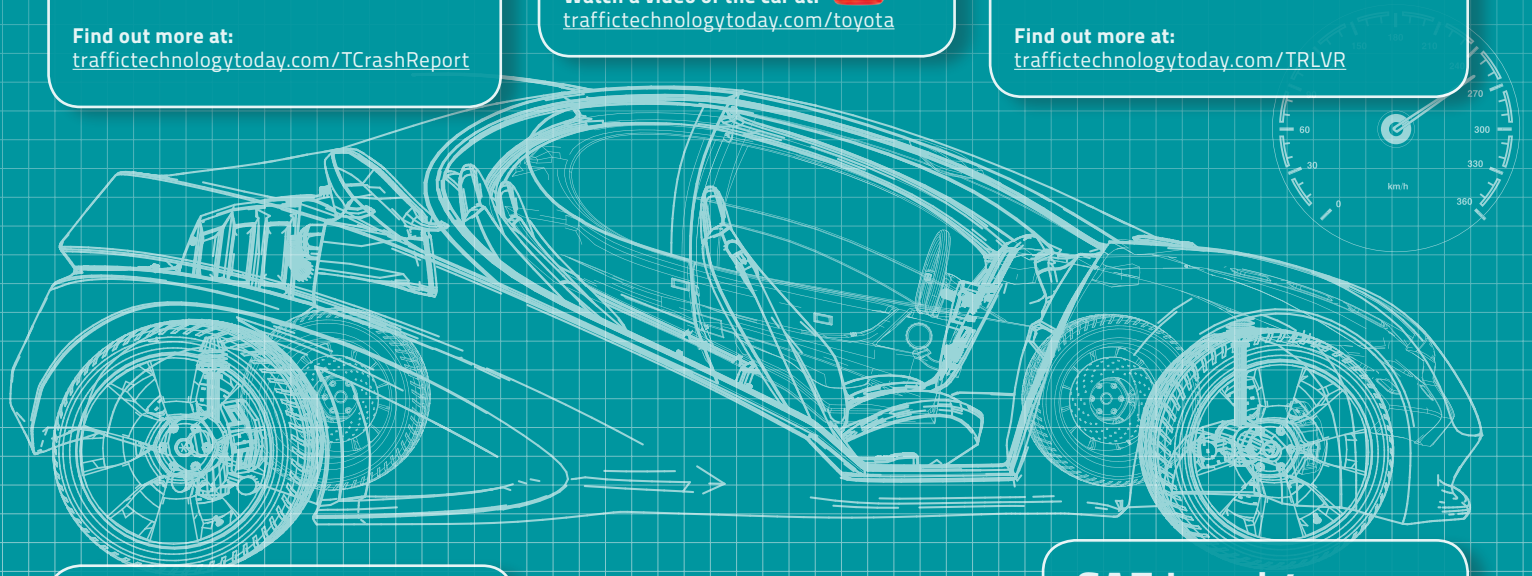
Toyota has created a new autonomous test vehicle that has two steering wheels, rather than just one. This is to enable a 'driver' to sit in the main control position paying no attention to the vehicle functions, while a second driver monitors the systems, thereby enabling closer to real-world testing of safety functions.

Watch a video of the car at:
trafficTechnologyToday.com/toyota

VR simulations

A UK government-backed research project, led by the UK's Transport Research Laboratory (TRL), is using 3D Repo's virtual reality visualizations to simulate driverless vehicle routes. The project is part of the Smart Mobility Living Lab, located in Greenwich, London, which provides a real-life environment where connected and autonomous vehicles can be developed, evaluated and integrated with the local community.

Find out more at:
trafficTechnologyToday.com/TRLVR



All-weather sensors

In collaboration with the Oxford Robotics Institute at the University of Oxford, UK, Navtech will develop a sensor for autonomous vehicles that will provide 360° high-resolution coverage in all weather conditions. Existing sensors used cannot accurately function in heavy rain, snow or fog. Therefore, this research will be pivotal in ensuring that autonomous vehicles can safely perform in all environments.

Find out more at:
trafficTechnologyToday.com/NavtechORI

World-first vehicle

Colas, the UK highway services provider and subsidiary of the French Colas Group, in partnership with US companies Royal Truck and Equipment and Micro Systems Inc., has developed the world's first Autonomous Impact Protection Vehicle, especially designed to protect the lives of road workers.

Find out more at:
trafficTechnologyToday.com/AIPV

SAE Level 4 platform

Canadian automotive supplier Magna has unveiled MAX4, a fully integrated, customizable self-driving sensing and computing platform that can enable up to SAE Level 4 autonomous driving in both urban and highway environments. MAX4 combines cameras, radar, lidar and ultrasonic sensors with a computing platform that is designed for easy integration with auto makers' existing and future platforms.

Find out more at:
trafficTechnologyToday.com/MAX4

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Cutting congestion

Rachelle Harry looks at the new steps being taken by road authorities around the world to keep traffic on their roads moving as smoothly and efficiently as possible

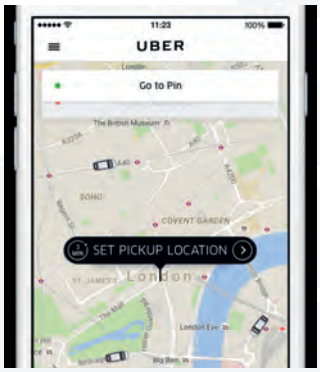
Uber under fire in London

TfL refuses to renew Uber's London license amid fears of the vehicles increasing congestion

On September 22, Transport for London (TfL) informed Uber London that it will not renew its private hire operator license. The reasons given surrounded alleged flouting of corporate responsibility. However, the news followed a report in July by a cross-party group of Members of Parliament, which raised concerns that Uber vehicles were contributing to congestion and pollution.

The report, which was backed by a study from the UK's Department for Transport, said the number of private hire vehicles in London had doubled to 120,000 since 2010.

TfL's decision to outlaw Uber is supported by many,



including London Mayor Sadiq Khan.

Uber has launched an appeal, but at the time of going to press, no resolution has been reached. It can continue to operate in London until the appeal process is exhausted.

Sky-high investigations

Maryland to use drones to help reduce congestion caused by crashes

Two planning authorities in Maryland – the City of Annapolis and Anne Arundel County – are teaming up to minimize traffic congestion on one of the state's most congested corridors, known as Forrest Drive.

A key aim is to reduce congestion directly after crashes. This will be achieved with the use of new portable VMS and two new drones.

It it hoped that the drones will be able to be piloted over accident scenes to carry out comprehensive investigations, lessening police officers' time spent analyzing incidents on-site and enabling them to open roadways faster.

Meanwhile, drones can be linked to portable VMS to notify drivers that an accident has happened and suggest possible alternative routes.

Smarter intersections

Miami-Dade County uses an adaptive system to reduce congestion and costs

The Miami-Dade County Department of Transportation and Public Works (DTPW) is using a new, adaptive ITS to upgrade the region's traffic signals.

DTPW will use ITS company Econolite's technology, including adaptive signal control technology in order to help reduce traffic congestion.

Econolite will upgrade 300 intersections along 12 congestion management

corridors in the county with new traffic controllers and its Autoscope video detection sensors. Additionally the company's route priority, navigation data integration, and cybersecurity features will be embedded into the system.

Getting results

Report shows targeted improvements help counter growing congestion on Oregon freeways

The recently released *Portland Region 2016 Traffic Performance Report* has found that highway initiatives can significantly improve highway performance.

In certain corridors, Oregon Department of Transportation (ODOT) improvements have stabilized or improved levels of congestion. Such improvements include ODOT's real-time traffic information signs, and the

introduction of auxiliary lanes – dedicated lanes from an on-ramp to the next off-ramp, which reduce crashes caused by vehicles merging and weaving between exits.

Busy streets

The second Intertraffic Mexico event will take place in Mexico City from November 15-17, 2017 – and it is set to highlight solutions for the city's well-known traffic problems. We present the stats...

Inner-city population:
8.6 million

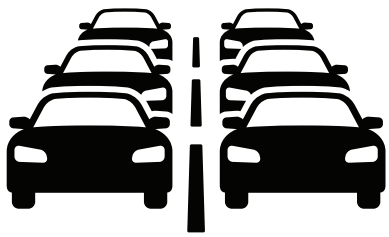
Inner-city size:
733km²
(283 square miles)

59 minutes
per day extra travel time as a result of congestion
(This equates to 227 hours per year)

Greater Mexico City population:
21.2 million

Greater Mexico City size:
2,330km²
(900 square miles)

14 million cars
in Greater Mexico City



46%
of households own a car

Length of all Greater Mexico City's roads:
55,419km
(34,436 miles)

5 national highways
connect Mexico City to the rest of the country

7%
increase in travel time as a result of congestion, from 2015 to 2016

#1 most congested city in the world

Sources:
Mexico 2010 census
TomTom Traffic Index
www.globalmasstransit.net
mexicocity-mobility.devpost.com
www.citypopulation.de/Mexico-Cities

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As delegates prepare for Gulf Traffic, the Middle East's leading transportation expo, exhibition manager **Claudia Konieczna** gives exclusive insights into how the show is tailored to keep up with industry trends

Interviewed by Rachelle Harry

The emirate of Dubai is known for its quick take-up of new technologies (such as autonomous vehicles and people-carrying drones, which have completed initial testing phases) and its luxurious extravagance, centered around making the lives of both inhabitants and tourists as convenient as possible. Its traffic congestion and high number of traffic-related deaths, however, are noticeable issues that authorities are still trying to address.

As Dubai prepares for Expo 2020 and beyond, the need to provide services – including efficient transportation – for visitors is paramount. From the policy and infrastructure side, the time to act is now, to ensure that regulations are in place to support progress, while ensuring safety and security for all.

Having rebranded itself with a new strapline 'Where smart cities find intelligent solutions', Gulf Traffic 2017, the Middle East's leading transportation expo, taking place in Dubai from December 4-6, aims to help the development and implementation of traffic-related innovations and intelligent transportation systems (ITS), in order to ultimately function as a safe and sustainable collection of smart emirate cities.

What's new?

Informa Exhibitions has been running Gulf Traffic for 16 years. Each year, the event has got larger – and this year, some 150 exhibitors from 30 countries are expected to attend.

GULF TRAFFIC

> In the Gulf state, regional and local governments have an appetite to lead the global movement in transportation technology innovations

"Of this year's exhibitors, 34% are new to Gulf Traffic, which means more new products, innovations and solutions on the market," says Claudia Konieczna, exhibition manager for Informa Exhibitions.

By working closely with industry leaders, Informa is able to ensure that Gulf Traffic drives innovative growth within the sector.

"This year, Gulf Traffic is being supported by a number of government bodies," says Konieczna. "We are excited to announce that the Integrated Transport Centre [previously Department of Transport Abu Dhabi], the Ministry of Infrastructure and Development, Abu Dhabi Police and Dubai Police, are all involved in and supporting the event."

"Delegates will be able to attend announcements from UAE government authorities about their upcoming projects and tenders, as well as the latest technologies that they have invested in," says Konieczna.

"Delegates, supporting companies and key exhibitors are also all an integral part of the industry, and it is our open line of dialog with these people and companies that helps us to ensure that we are offering our visitors market-leading, relevant solutions."

Industry trends

"In the Gulf states, regional and local governments have an appetite to lead the global movement in transportation technology innovations," says Konieczna

A drive for smarter solutions in cities has led to an increased demand in surveillance systems, ITS and cyberprotection solutions. Some 20% of Gulf Traffic exhibitors promote security and surveillance systems, and this figure is expected to increase next year.

"The focus at Gulf Traffic this year is still very much on technologies that aid smart mobility," says Konieczna. "Innovation in the context of mobility takes shape today in many forms, but generally it involves using technologies such as mobile apps to improve everyday tasks, such as ride sharing, parking, electronic tolling, vehicle registration, wayfinding, and unified payment methods.

"However, such innovations are moving beyond our smartphones, as technologies start turning to big market disruptors such as autonomous vehicles."

Exclusive product launches

"This year we have been far more targeted in terms of what solutions are being offered at

Left: **Traffic managers mix with government officials at Gulf Traffic in 2016**

Gulf Traffic highlights

1 **Gulf Parking**
This year, for the first time, Gulf Parking will operate as an exhibition alongside Gulf Traffic. "Gulf Parking will further widen the focus of the event to support other key industry sectors, as well as catering to smart payment and intelligent access control solutions from across the world," says Konieczna.

2 **Haenni Instruments** will be showcasing its unique, patented mobile weigh-in-motion systems at Gulf Traffic. Haenni's scales are among the thinnest on the market and are light and robust, and able to withstand virtually unlimited loads because of their special flat, oval tube-sensing elements.
Stand F29, Trade Centre Arena

3 **International Road Dynamics** (IRD) is a Canadian organization that provides ITS and traffic management solutions across the globe. At the Gulf Traffic exhibition, it will display its diverse range of systems and products for advanced traffic control, weight enforcement, bridge protection, toll management technologies, fleet telematics, and more.
Stand G20, Trade Centre Arena

the show," says Konieczna. "A number of products, systems and apps will be exclusively revealed.

"Delegates will be able to learn about cutting-edge technologies in the field of traffic management – from the latest ALPR devices useful for smart surveillance, to automated incident detection systems such as thermal cameras and smart traffic radar sensors that can be used to detect major accidents on highways and in tunnels within seconds."

Visitors to the show can also take advantage of the all-new Gulf Parking exhibition, which will run alongside Gulf Traffic this year.

"Those who are planning to integrate smart parking technologies into their existing projects will be able to find smart on-street parking guidance systems and green valet parking (GVP) management systems, which can help to reduce traffic congestion," says Konieczna of the new exhibition. "This and many more products, systems and apps will be launched at this year's event."

Conference program

As well as its Traffic and Parking exhibitions, Gulf Traffic will offer international thought-leadership conferences led by high-level government and industry professionals from across the world – including speakers from Hyperloop One and Uber.

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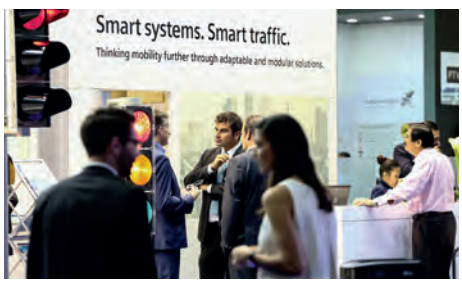

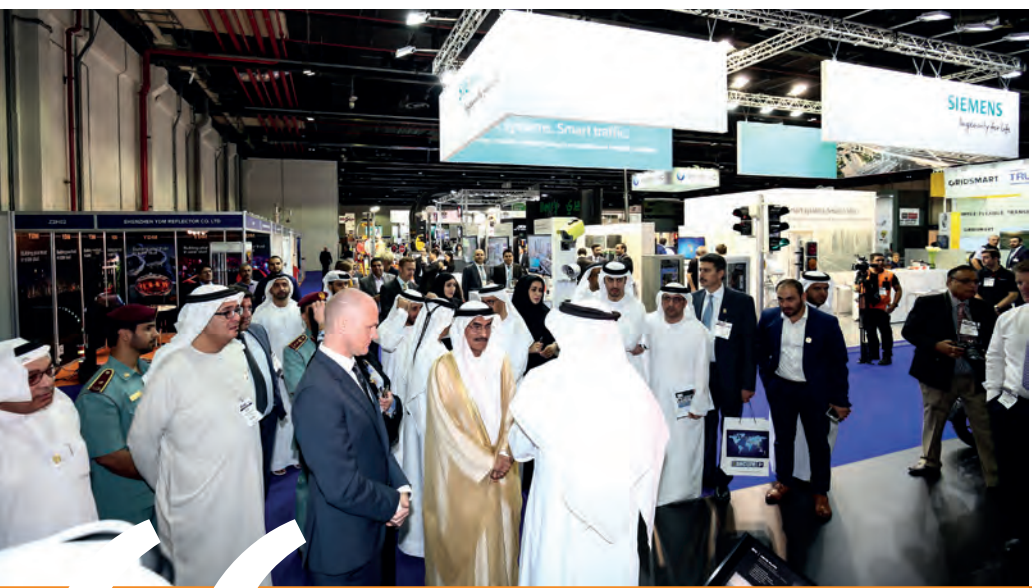

> Those who are planning to integrate smart parking technologies into their existing projects will be able to find smart systems to reduce traffic congestion

Above: **Gulf Traffic 2016 was a huge success, bringing together traffic professionals from across the region**

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Everyone interested in connected vehicles wants to know exactly what the promised, blazingly fast 5G network will be capable of. Now researchers in Finland are beginning to find out as they build a prototype deployment, and investigate potential real-world road traffic use cases. **Jack Roper** reports

10Gbps

Theoretical upper limit of 5G download speeds (equivalent to an HD movie in under a second)

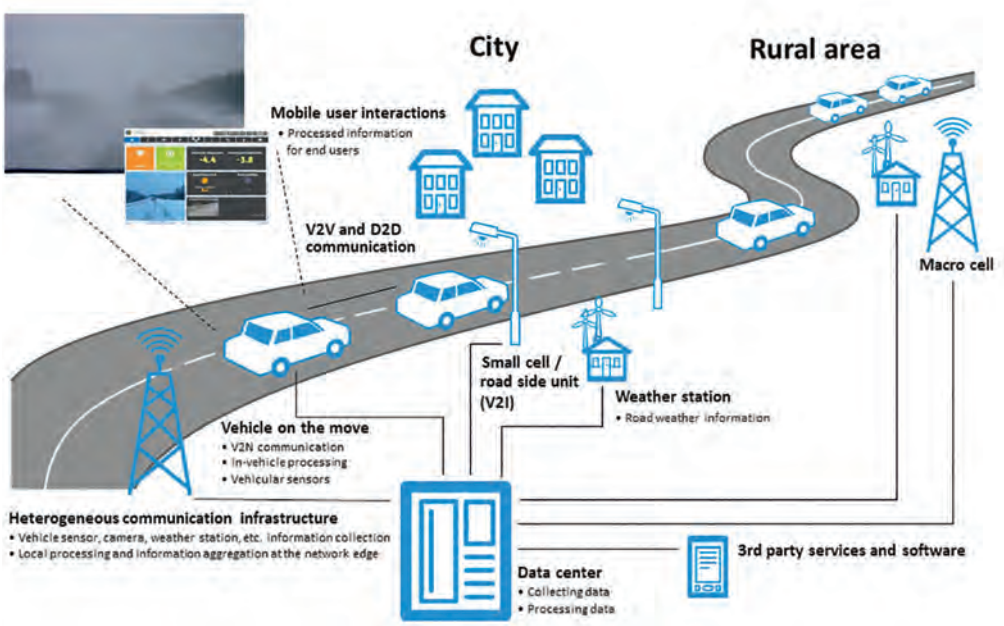
There's plenty of varied weather in Finland, so it's unsurprising to learn that, out on continental Europe's Arctic perimeter, Finland's computer scientists are pioneering the next generation of real-time road weather services. And, while current sensor-based driver information systems are essentially vision-based, a time is at hand when 5G-equipped vehicles will communicate almost instantaneously both with the infrastructure and with one another – effectively granting them the power of 'speech and hearing' and helping to herald an autonomous age.

This, at least, forms part of the vision of 5G-Safe, a two-year project being undertaken by VTT Technical Research Centre of Finland in collaboration with the Finnish Meteorological Institute (FMI) and a number of private-sector partners including Destia, Kaltiot, SITO, Unikie and Nokia, which are providing 5G test network equipment and software. The remit of 5G-Safe is broad and, with the project still in its planning stages, a disparate range of possible 5G use cases are being considered for pilot. However, the overarching aim of 5G-Safe is to develop real-time road safety solutions exploiting the potential of nascent 5G mobile network technology – while experimenting with network architecture to minimize system latencies and optimize the scalability of applications.

"We have the hardware and the idea is to develop prototype applications to run on top of that," explains VTT project manager Dr Tiia Ojanperä. "Our partners are very interested in seeing real 5G use cases – or this sort of industrial-use case being built on the test network.

Right: **The Finnish Meteorological Institute 5G-Safe test site, in Sodankylä, northern Finland**

Below: **Schematic for basic V2X communications infrastructure**



Cool, real-life tests

Finland's extreme winter weather conditions make it an ideal testbed for winter vehicle and tire testing

The Finnish Meteorological Institute's Sodankylä Research Station is sited high above the Arctic Circle in Lapland, the largest, northernmost and most sparsely populated region of Finland. Amid silent vastnesses of forest pine, it is subject to polar night at the winter solstice and midnight sun during the nightless nights of its other-worldly summertime. Eight distinct seasons are recognized: deep winter, frosty winter, crusty snow, departure of ice, midnight sun, harvest, colorful autumn and first snow. While annual snowfall averages 337cm (11ft), the lowest-ever recorded temperature at Sodankylä is -49.5°C (-57°F).

"That's a really tough number – but luckily we do not experience that every winter," says FMI's Timo Sukuvaara. "Typical winter temperatures are between -10°C [-14°F] and -30°C [-22°F] and there's a decent amount of snow – up to 1m (3ft) depth in winter. But, more importantly, between November and April, there are always snowy conditions on the road surface.'

Such reliably harsh winters make Lapland a major center for vehicle and tire testing. "With static winter conditions, road weather service testing here at Sodankylä is more beneficial than in southern Finland or mid-Europe, where somehow winter conditions have to be artificially generated," says Sukuvaara. "There is a winter testing track hosted by the municipality of Sodankylä. We also have a test network for 5G operations and a mobile traffic testing laboratory. Combining these facilities brings extra benefits and the possibility to test research advances in practice." Just take an extra jacket or two and don't forget to pack a nice, hot flask of coffee.

We are considering what kind of information we can collect from vehicles to distribute to a cloud environment and provide back in the form of real-time services. We have vehicles that are connected in different ways: they are connected to each other, to the roadside infrastructure, and then to the network and the cloud."

Where large-scale atmospheric forecasting provides a general picture of prevailing weather conditions, it is hoped that 5G vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications will facilitate highly localized road weather and surface information. But why is such microcosmic data needed? "We are considering various end users," says Ojanperä. "Of course, this includes normal road users, but also fleet managers, who can optimize their operation based on conditions. Another case is road maintenance, who can optimize snowplowing or detect any problems on the road surface and optimize repairs. This will help the digitization of road maintenance. A third use case is automated driving: using this localized information in assisting automatic vehicles."

> We have the hardware and the idea is to develop prototype applications to run on top of that
>
> **Dr Tiia Ojanperä, project manager, VTT Technical Research Centre of Finland**

Who will pay?

With 5G still at the standardization phase, the opportunity exists to experiment with possible network solutions and to pilot scenarios that push the limits of current network technology, so justifying the need for 5G. Yet, with 4G already providing ample data speeds for most cell phone users, who will pay for 5G to be rolled out? "I think the main driver of 5G will be industry services such as the automotive vertical industry, which we are studying," Ojanperä speculates. "But also healthcare, factories and other verticals with their own challenging use cases, which either can't be supported, in terms of delays, by 4G, or don't scale too well in the existing infrastructure because of the increase in data traffic they bring."

Where will 5G be deployed?

There seems a certain paradox in the 5G-Safe project taking place in rural Finland, whereas the earliest deployment of 5G is predicted to be in large cities. But advantage of the

Early 2020s

Predicted time period for mass introduction of 5G communications

location is that a heterogeneous communications infrastructure is envisaged that will ensure services can be delivered anywhere, with vehicles switching between 5G and other networks depending on location.

"We want commercial results, so we have to consider this transition and provide services that are available over 5G, but also 4G and other technologies; in rural areas, vehicles might have to resort to satellite communications," she says. "One target of the 5G standard is to integrate with the previous generation so they work together seamlessly. We're focusing on the co-use of terrestrial networks – 4G, 5G and ITS-G5 – to get really ubiquitous coverage."

However, an ultimate aim of general coverage doesn't mean researchers want to simply test 5G's effectiveness at providing faster versions of existing services. "In 5G-Safe we aim to exploit the possibilities of 5G," says Dr Timo Sukuvaara, senior research scientist at FMI. "It's not a case of just using the old applications in 5G. Instead we would like to have new services that consume the bandwidth and put the 5G network to a real challenge in providing the capacity it's supposed to give. Our specialty is providing road weather services based on vehicular data; we are aiming to collect data from vehicles, exploit it and provide it back to those same vehicles in real-time services."

Below: **Roadside V2I units are being tested for compatibility with 5G and across legacy cellular networks**

En-route reporting

Based at the FMI 5G-Safe test site at Sodankylä in northern Finland, Sukuvaara will be working with an intelligent mining truck fleet. These vehicles, equipped with friction measurement instruments, will collect point-based friction information, which Sukuvaara hopes will provide advanced and cost-effective weather information for the routes they use.

"In northern Finland, especially in wintertime, the roads are icy all of the time, but not necessarily slippery," he explains. "A large-scale meteorological model can forecast friction to a certain level, but we would like to have our large-area model supported by local, point-based information, so we can forecast road friction for every kilometer of road and give warnings for particular positions, not just the whole road stretch." Although Sukuvaara stresses that it will be up to third-party commercial providers to

Getting 5G up to speed

Distributed cloud technology could make 5G connectivity as speedy and reliable as its rival, DSRC

While FMI scientists are out on the road developing network content in the shape of road weather services, their 5G-Safe research partners at VTT are primarily focused on developing 5G networking solutions upon which such services can be built. One key strand of the 5G-Safe project will involve researching cloud computing technologies and experimenting with service architectures to minimize delay and optimize scalability.

"We are considering a distributed cloud technology and distributed processing of vehicular information to have scalability and reduce delays in service delivery," explains VTT's Dr Tiia Ojanperä. "We would do as much data processing as possible in the vehicles themselves and at the network edge." Ojanperä's team will be experimenting with multi-access edge computing (MEC) servers provided by Nokia.

"An MEC server is placed close to the base stations. If we collect vehicle sensor data and want to deduce road conditions, we can process it close to the vehicles themselves at the edge of the mobile network. This reduces delay, so the vehicles will get instant warnings of prevailing conditions, but it also improves the scalability of the whole system. If we collect a lot of video data from large numbers of vehicles, we don't push it all to some central cloud server; we process it locally."

For now, USDOT has taken the view that DSRC provides the only reliable technology for safety-critical communications, but Ojanperä is upbeat about 5G's potential as a viable alternative. "5G is in the standardization stage, and they are talking about radio interface or internet latencies of less than one millisecond," she says. "If vehicular services require latencies lower than that, then connected vehicles may need to resort to a different technology. It's difficult to foresee all vehicular services and their various usage contexts being supported by a single network technology, which is why we are considering heterogeneous access technologies in the 5G-Safe project."

Left: **Some processing will be done at the network edge to optimize efficiency of future 5G networks**

develop user applications after the project has finished, he has a definite vision of how the end product might look to a driver. "I would like to see a final application combining a map image of the whole road stretch with a traditional navigator view where the color of your route denotes the slipperiness of the road. Right in front of you it's green, but you can see already, way ahead, there is red, telling you the situation is changing."

Eyes on the road

5G-Safe will also explore the use of vehicular cameras, with vehicles communicating video data back to the infrastructure and possibly even engaging in V2V camera image exchange when queuing – thus fully consuming the anticipated 5G bandwidth. "One possible service relates to drifting snow," Sukuvaara explains. "The radars and weather forecast might be saying it's sunny with no snow at the moment, but if it's cold and there has recently been icy snow, this may lift up from the road surface, reducing visibility to virtually zero. The idea is to recognize drifting snow with images coming from cars and provide point-based visibility information."

> It's not a case of just using the old applications in 5G. Instead we would like to have new services that consume the bandwidth and put the 5G network to a real challenge
>
> **Dr Timo Sukuvaara, senior research scientist, Finnish Meteorological Institute**

According to Sukuvaara, point-based, real-time weather services are also a prerequisite of autonomous vehicles. "Without accurate road weather information, it is impossible to have automatic driving in variable weather conditions. Of course, you can do automation when the sun shines 365 days per year, but even in southern Europe you need more detailed information."

A major obstacle to developing these services is the reluctance of car

1ms

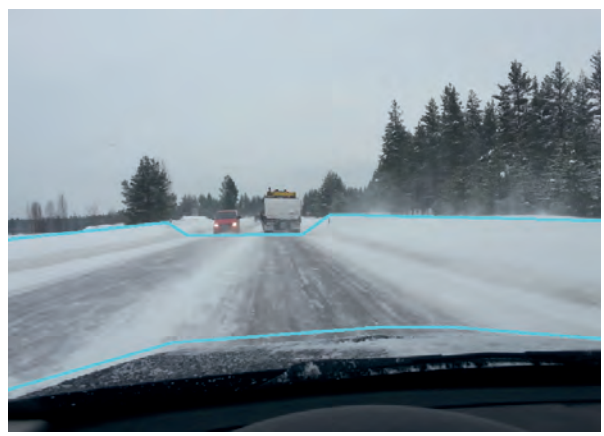
Theoretical lowest possible latency of 5G (equivalent to DSRC). 4G is around 40ms

manufacturers to share observational data from vehicles – something that Sukuvaara's team are currently working around by basing their system on a small fleet. "In CANbus, there's a lot of information about gas consumption, braking and wiper use, which is not directly meteorological, but I'd like to get my hands on it! But even if car manufacturers are working together to develop harmonized V2V communications, this data is seen as part of their commercial product. In order to share it, they want to see something that will benefit them." And there are other reasons for winning over the automotive industry; the heterogeneous network envisaged by Ojanperä is, according to Sukuvaara, not so complicated to construct, but would depend on cars carrying a device with multiple radios, which would ultimately need to be fitted as standard.

Above: **Future dash-mounted weather information systems could deliver meter-by-meter real-time surface condition information**

Left and below: **Video can capture drifting snow, which reduces visibility – 5G will have the bandwidth to share this kind of data widely**

So, as well as testing the many different possibilities of 5G for V2X, is a secondary aim of 5G-Safe convincing car manufacturers to take notice of the potential services on offer? "I think it's the most important goal of the project," answers Sukuvaara. "To show that, with 5G and the FMI road-weather palette, we can really improve road safety, traffic convenience and the logistics of commercial driving." And he hopes that, out of this work on the frozen margins of the world, some truly pan-European and global benefits may spring.



Intelligent lights

Saul Wordsworth finds out how Milton Keynes in the UK is introducing traffic signals with artificial intelligence, and what it means for traffic management

If you live in Milton Keynes – and we accept there's a strong chance you don't – you may have noticed white V-shaped boxes springing up on lampposts across your hometown. These boxes are an attempt to streamline traffic in one of the UK's most car-dependent towns.

"Following extensive trials, we are deploying a city-wide network of sensors to monitor the road transport system," says Mark Nicholson, CEO of Vivacity Labs, a startup technology company that has partnered with Milton Keynes Council. "Our network will be made up of 450 of our traffic sensors that are able to distinguish between multiple vehicle types, and which will provide highly accurate and comprehensive traffic coverage at all of Milton Keynes' major junctions across 50 square miles [130km^2]."

Each box is made up of a video camera, a processor and an internet connection. Using the latest research in machine vision and learning, the box records real-time data to optimize traffic light changes, direct traffic more dynamically, prioritize emergency vehicles, buses and cyclists, and even identify empty parking bays.

Nicholson is a Cambridge University graduate who found fleeting fame in 2012 when he and his student team raised £500,000 (US$677,000) for the annual World Solar Challenge, powering a lightweight vehicle from Darwin to Adelaide. His latest venture is inspired by a large-scale demonstration project in Pittsburgh, Pennsylvania, that deployed intelligent signals that can adapt to changing traffic conditions. The company behind it, Surtrac, claims to have reduced travel time for Pittsburgh drivers by 25%, idling time by 40%, and emissions by 21%.

Advanced technology

"Pittsburgh is using traditional induction loops that gather very coarse and primitive data," says

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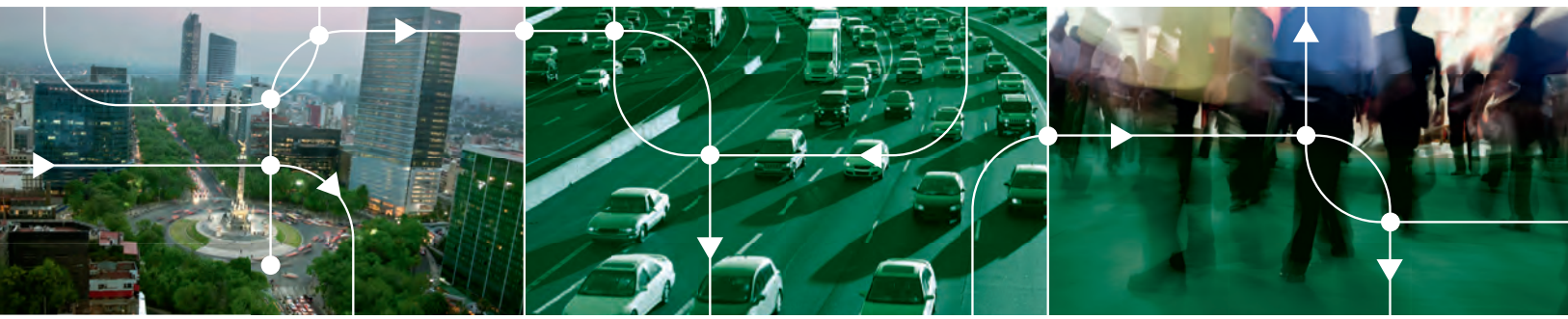

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Nicholson. "Ours gather data about vehicle movement, classification, speed and behavior, and uses artificial intelligence (AI) to learn on the job. With that in mind we should be able to beat their numbers. Although, because Milton Keynes is not quite a city at full capacity, we will quantify our results in terms of reduced congestion rather than reduced travel times."

As part of the project, an app has also been developed. Known as 'MotionMap', it enables users to find available parking spaces, check for congestion and plan alternative routes.

"The underlying technology in the sensors is highly adaptable, and will learn and improve over time," Milton Keynes Council said in an official statement. "The AI of the sensors will mean that they remember daily traffic patterns, which will help the overall traffic flow around the city. They may 'learn' that certain locations have more congestion at specific times, for example, after an event at the MK Dons Stadium, and plan in advance for large volumes of traffic moving within a specific area. The council will also be using the data from the sensors to reduce the costs of providing transport services, including supporting decision making about transport infrastructure and planning new roads."

> The AI of the sensors means that they remember daily traffic patterns, which will help the overall traffic flow
>
> **Mark Nicholson, CEO, Vivacity Labs**

Below: **Intelligent sensors deployed in Milton Keynes, UK, enable signals to react to traffic congestion**

According to Inrix, traffic congestion cost the UK **£30bn** (US$41bn) in 2016. TomTom estimates the figure to be 10 times greater

Traffic management centers (TMCs) use a standardized format called DATEX (data exchange). All data will be provided in the DATEX format, although the level of data provided to operatives has yet to be determined. The ultimate aim is for the new data to be at the heart of all decisions made at the TMC. Previously, video footage was captured for human analysis. With AI, the system can autonomously report the exact level and make-up of traffic. Depending on Milton Keynes Council, the new system could be used either as a means to streamline costs, or to deploy existing resources more efficiently, for instant repurposing of staff who are, in the words of Nicholson, "currently out on the roads with clipboards". The system will be installed through £1.3m (US$1.8m) of private investment raised by Vivacity, with a further £1.7m (US$2.3m) from Innovate UK, a public body. No local government funding has been needed.

"The sensors have been deployed on a much smaller scale in a variety of other locations, including Manchester, London, Suffolk, Dublin and Cambridge," says Nicholson. "The project began in April, we started installation in August, and the full city-wide sensor network should be operational by February next year [2018]. Integration with traffic signals may take a further six months. Our goal is to provide the ultimate in smart city data."

The skeptics

Since the mid-1960s, there have been efforts in the UK – particularly in London – to get signals to minimize delays in traffic. Many of the early attempts came to nothing, although since 1984 the UK capital has been deploying the SCOOT (split cycle offset optimization technique) system, and many other major towns and cities have followed suit. While

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Florida DIVAS

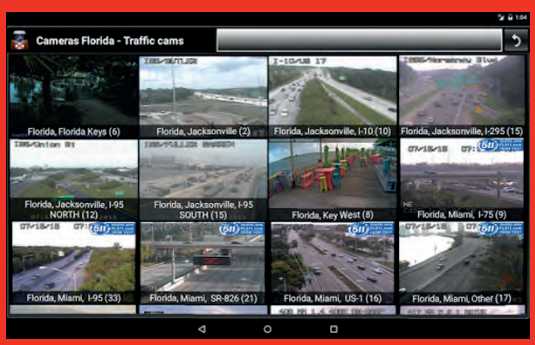
Florida DOT designs new software platform for integration of video and data systems

On the other side of the Atlantic, Florida DOT (FDOT) is aiming to improve traffic management, not primarily through deploying new hardware, but rather by designing a new software system.

FDOT's Transportation System Management & Operations (TSM&O) Central Office is launching a new Data Integration and Video Aggregation System (DIVAS), a near real-time system to aid traffic management. It is expected to be fully operational by spring 2018.

DIVAS will be FDOT's first centralized traffic data hub and will include live streaming video. It will be used internally by FDOT to support Regional Transportation Management Centers (RTMC). It consists of two subsystems: a data integration (DI) subsystem and a video aggregation (VA) subsystem. The VA subsystem will aggregate live video, so that it is available to users regardless of their specific location or device platform.

The DI Subsystem will use existing center-to-center (C2C) interfaces to obtain data . It will include data structures for FDOT's existing advanced traffic management system (ATMS) SunGuide, the National Weather Service (NWS), road weather information systems (RWIS), truck parking systems and connected vehicles, including basic safety messages and traveler information messages. DIVAS will eventually be capable of aggregating all relevant data and video for integration and dissemination.



Right: **The locations for the new traffic sensors in Milton Keynes, which, unusually for a UK town, has a grid-structure to its road layout**

SCOOT claims to reduce delays by 12%, it relies on extensive manual calibration, which becomes out-of-date over time, and is hardwired into induction loop hardware – so it cannot produce speed- or vehicle-specific data, both of which are useful in optimizing networks. SCOOT is also expensive, as installing induction loops on every approach to a junction requires a lot of roadworks and wiring, not to mention license fees and repeated recalibration.

"Since this is the latest development, I imagine it will be more effective than previous efforts," says John Elliot, traffic consultant and vice-chairman of the ITS transport committee for the local government Technical Advisers Group (TAG). "Milton Keynes is a very car-centric town, so compared with some bigger cities it probably has more relative advantages. However, there is a lot of historical research data that shows there is a danger that if you make car use too easy, you'll get more traffic. Making car use easier is likely to increase volumes, and therefore congestion, once people get to know of any improvement. In very big cities like London, anything speeding up vehicular traffic, including buses, could actually make congestion worse. It's a question of balance. Can you speed up traffic without adverse effects? In London, I'm not sure you can. Milton Keynes, probably yes, although I'm not sure by how much."

"I am skeptical that the headlines are achievable," says Paul Mew of Paul Mew Associates, a leading UK-based traffic consultancy.

1% GDP

Total cost of traffic congestion to the European economy as a whole

"I believe the benefits have been exaggerated in the minds of journalists to pique the interest of all of us who regularly get stuck in jams. With signals, there is only so much traffic capacity to be wrought from them. Green signal times are already apportioned in accordance with the competing demands of each approach road, pedestrian and cycle crossings. I would accept that valuable green time is sometimes lost by, for example, pedestrians who trigger a pedestrian phase and then end up crossing in a gap rather than waiting. Maybe this is one aspect where cameras can help identify if pedestrians are actually waiting when the button has been pressed. The gain in capacity and reduction in congestion is unlikely to be significant or noticeable."

Artificial intelligence at large

Clearly it would be unfair to judge the project before it gets underway. There are two sides to every story and in the end, the data will tell us whether the Milton Keynes pilot has been a success. What isn't in question

Wrong approach

An expert view on which types of road users should take priority at traffic signals

"When it comes to traffic lights, we are getting our priorities all wrong. Victoria in London (left) sees around 40,000 pedestrians per hour at peak times, but only 4,000 vehicles. Lights are timed to minimize delays to vehicles rather than pedestrians. If a pedestrian is delayed by a few seconds, they might miss a train, and be an hour late. If a car is delayed, it simply has an emptier road in front."
John Elliot, traffic consultant and vice-chairman of the ITS transport committee for the local government Technical Advisers Group

is the role artificial intelligence already plays on Britain's roads, and therefore its TMCs. Smart Motorways evolved from the M42 Active Traffic Management trial that opened up the hard shoulder during congested periods. Today, for example, we see the variable speed limit on the M25 triggered by traffic flow and real-time speed data. Traffic routing around bottlenecks is also possible from real-time data from satvnavs. AI is already built in to the system.

"Traffic data collection hasn't changed significantly in the last half a century," says Tony May, emeritus professor in transport engineering, University of Leeds. "Technologies like AI can change this, helping to dramatically improve our understanding of travel patterns and our ability to manage our road networks. With better management comes reduced pollution and travel time, as well as improved safety."

> Traffic data collection hasn't changed significantly in the last half a century. Technologies like AI can change this
>
> **Tony May, emeritus professor in transport engineering, University of Leeds, UK**

Further down the line, the development of vehicle to infrastructure communication (V2I), will further enhance the driving experience. In such a scenario drivers may be alerted to an impending red light ahead of their approach, eliminating guesswork and ruling out that extra spurt of speed, all of which leads to a more efficient and controlled driving experience, smoother traffic patterns and a minimizing of waiting times. In the longer term, it is hoped that the Milton Keynes system will talk directly to self-driving cars – the town coincidentally being one of the UK's autonomous vehicle testbeds. Using an array of long-range radar, lidar, short- and medium-range radar, cameras, ultrasound, Bluetooth and internet connectivity, the ultimate AI vision is for every vehicle and every piece of infrastructure to interact, to think for itself and to learn, just like the human brain.

Below: **Games at Milton Keynes' football stadium, home to MK Dons, can create traffic surges, which AI can now track and remember**

10 secs
After this amount of time idling becomes worse for a car engine than turning off and restarting

Paul Mew concludes with a word of caution. "A lot of research is being done to increase capacity of our roads and reduce accidents, but my warning is that there is only so much capacity you can get out of roads as they are. A bigger gain is to be had from reducing the demand for travel by the private car – a less sexy alterative, but one that now forms a big part of government transport policy."

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Future facing

With the launch of Apple's new iPhone X, facial recognition technology has been propelled into the mainstream. How long then, asks **James Gordon**, will it be before road authorities begin relying on it for traffic enforcement?

While it is yet to have gained a significant foothold in global traffic enforcement strategy, a number of state agencies in the USA have begun using facial recognition software as a tool to help support law enforcement on the nation's roads.

According to Georgetown Law's Center on Privacy & Technology, in Washington DC, which has conducted extensive research into how this groundbreaking technology impacts on the average American, at least a quarter of all law enforcement agencies in the USA have access to facial recognition technology "to run searches either on driver's license photos or on mugshots". The US seat of learning also found that 29 states – which are home to over half of the nation's drivers – allow police forces in these states "to execute or request searches of the driver's license databases for criminal justice purposes".

Clare Garvie, an associate at the Georgetown Law Center on Privacy & Technology, and co-author of *The Perpetual Line-Up: Unregulated Police Face Recognition in America*, says that this game-changing technology, where state-of-the-art, high-definition cameras are combined with pre-trained commercial off-the-shelf systems, is already being used, albeit in a limited capacity, by police forces in Michigan, Florida, Arizona and Pennsylvania on drivers, or in a transportation context.

Garvie says, "Police in these states have mobile facial recognition systems, which they can use in routine traffic stops. These devices are linked to the main police computer database and enable the police officer to identify or verify the driver's identity in seconds."

And with biometric imaging technology gathering pace and momentum, Andrew Cuomo, the Governor of New York, has pushed the envelope yet further, by announcing that face recognition and license plate reader cameras will be

Right: **Lawyer Clare Garvie is co-author of the paper *The Perpetual Line-Up: Unregulated Police Face Recognition in America***

installed on all the Metropolitan Transport Authority bridges by the end of 2017 to enable a system of frictionless tolling.

Clare Garvie believes that this major technology overhaul in one of the USA's largest cities could be a trailblazer that brings about profound change in traffic enforcement circles regarding the take up of facial recognition systems.

"I suspect that facial technology systems could become more prevalent in the future. Why? Because in some US states, red light camera systems that rely on automatic license plate recognition (ALPR) have actually been invalidated. In Missouri, at least, the system was deemed unconstitutional by the state supreme court because it linked the car to the traffic violation, but not the driver. So I would not be surprised if tolling and other traffic enforcement systems begin to employ face recognition technology, so that police forces can forensically connect the driver to the traffic infringement."

But, Garvie, who has been researching the potential effect of widespread use of facial recognition systems by local and state police for the past two years, says when it comes to installing the technology on traffic signals and other roadside infrastructure, "there are some major technical hurdles that put the technology out of reach for the moment".

> "Arguably the greatest challenge is capturing a clear facial image when a car is speeding
>
> **Jacques Lombard, chairman, British Security Industry Association's Video Surveillance Systems**

Challenges ahead

It is a view shared by Jacques Lombard, who acts as chairman of the British Security Industry Association's (BSIA) Video Surveillance Systems section.

Lombard, who is also the managing director of Syntinex Security Solutions, which specializes in providing CCTV systems for commercial, retail, education and the public sectors in the UK, says, "There are a number of creases to iron out before this technology can be rolled out. Arguably the greatest challenge is capturing a clear facial image when a car is speeding. Secondly, even if the car is moving slowly or is stationary, next-generation high-

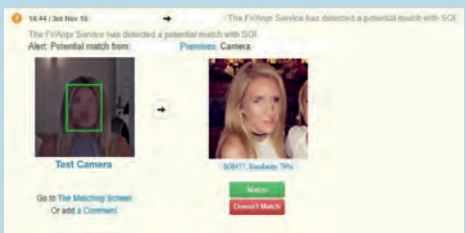
A face in the crowd

A facial recognition system is soon to launch in London's bars and shops. How well would such technology translate to the transportation sector?

Simon Gordon, the owner of one of central London's oldest and most celebrated wine bars, Gordon's, has raised £1.4m (US$1.8m) to create a new Facewatch product linking its watchlists to third-party facial recognition products which, when it is launched in October 2017, will warn businesses when subjects of interest enter their premises, better enabling them to deter or to prevent crime.

Gordon, who created the product to tackle the high level of petty crime in his bar and the surrounding area, believes that when Facewatch is adopted in retail outlets later this year, it could "cut shoplifting by at least 35%".

But can the system, which uses a combination of facial detection and recognition technology to match faces with those criminals already on a watchlist, be successfully deployed to help police Britain's roads?



Above: **Facewatch is a facial recognition system that has been developed to help identify potential troublemakers in London shops and bars**

Says Gordon, "I think law enforcement agencies could possibly make effective use of facial recognition technology for driving offenses where vehicles are stationary, for example at traffic lights, but not for speeding offenses, because the glare from windscreens and the speed that the vehicles are traveling would make facial recognition difficult.

"And looking further ahead to 2040, when autonomous vehicles begin to hold sway there may not even be a need for it as a tool to prevent red light infringements because the technology will make the decisions.

"However, that said, in the next decade or so, I do see it being deployed alongside ALPR systems in car parking areas, where it could help to stymie vehicle theft. Today, thieves are taking advantage of porous car lot security by, for example, driving in with one car and then

> Traffic enforcement systems may begin to employ face recognition technology, so that police forces can forensically connect the driver to the traffic infringement
>
> **Clare Garvie, associate, Georgetown Law Center on Privacy and Technology**

definition cameras are currently unable to successfully record facial images in extreme sunlight, in rainy conditions, or where light levels are low. But with facial recognition technology improving all the time, I believe we will reach a point where it may be possible."

And Elke Oberg, the operations manager of Cognitec Systems, one of the world's leading face recognition developers, says, "Such an application would raise privacy issues. People expect to drive in their cars without being watched by cameras. They can also wear large sunglasses, caps, veils, or other covers to prevent facial recognition. You would need roadblocks or security checkpoints along the road, similar to the security checks at airports, to generate images suitable for face recognition."

Oberg adds, "For this particular use case, the challenges for facial recognition technology include sun highlights in the facial area, reflective

stealing another. Facial recognition technology, which would take a photograph of the driver entering the car parking area and then match it with the person driving out, could effectively stop this at source."

Gordon also believes that facial recognition could be utilized effectively in petrol stations, and later this year is launching its new offering alongside its partner's product, Forecourt Eye, which uses ALPR to fight fuel crime.

Continues Gordon, "The Facewatch watchlists of both faces and license plates have been specially designed to combat and deter 'drive off' petrol thefts as well as theft from the retail stores attached to forecourts.

"As it is a topical issue, and, as long as the technology is used responsibly and civil liberties are respected, it is not beyond the realms of possibility too that traffic enforcement agencies could also use it to catch persistent rogue cyclists who consistently jump red lights and endanger pedestrians."

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glass surfaces, and the distortion of the facial image due to the quality, color and the curve of the glass. In addition, it is difficult to capture a suitable facial image at high speed. It is not possible to predict if and when these challenges will be overcome."

But, some 4,500 miles (7,240km) away in the almost incongruous setting of the Oak Ridge Reservation, a 30,000-acre (12,140ha) expanse in East Tennessee dominated by hardwood forest, cedar glades and wetlands is a state-of-the-art, next-generation facility which could hold the key to the future of facial recognition technology as a tool for traffic enforcement.

Tackling the problems now

The Oak Ridge National Laboratory (ORNL), which was built over 75 years ago and is part of the US Department of Energy, has spent the past year creating, developing and testing a suite of facial recognition software and hardware solutions, which it hopes one day will enable cameras to photograph vehicles traveling at speed, in different light conditions, and to capture faces through windshields.

Can Dr Hector J Santos-Villalobos, who is the Identity Sciences Business Development Lead for ORNL's Imaging Signals and Machine Learning Group, explain how his team is using scientific cameras alongside highly specialized and bespoke algorithms, artificial intelligence and machine learning techniques, to achieve this remarkable feat?

Santos-Villalobos says that while there are intellectual property rights restrictions around the face image technology for traffic applications that ORNL is developing, "such as the exact optical setup, the wavelengths required to penetrate a windscreen, and how we process the images", he is able to reveal how the team of seven scientists who worked alongside him have created a technology solution that enables the cameras to capture faces in low-light and starved-light conditions.

Says Santos-Villalobos, "We use an array of scientific cameras. I cannot specify the exact number, but each one is smaller than the palm of your hand. The cameras are positioned inches apart from each other. Crucially,

> We use an array of scientific cameras – each one is smaller than the palm of your hand – to capture a varied spectrum of light conditions
>
> **Dr Hector J Santos-Villalobos, Identity Sciences Business Development Lead, Oak Ridge National Laboratory, USA**

Left: **Dr Hector J Santos-Villalobos in the lab with some of the hardware his team is developing**

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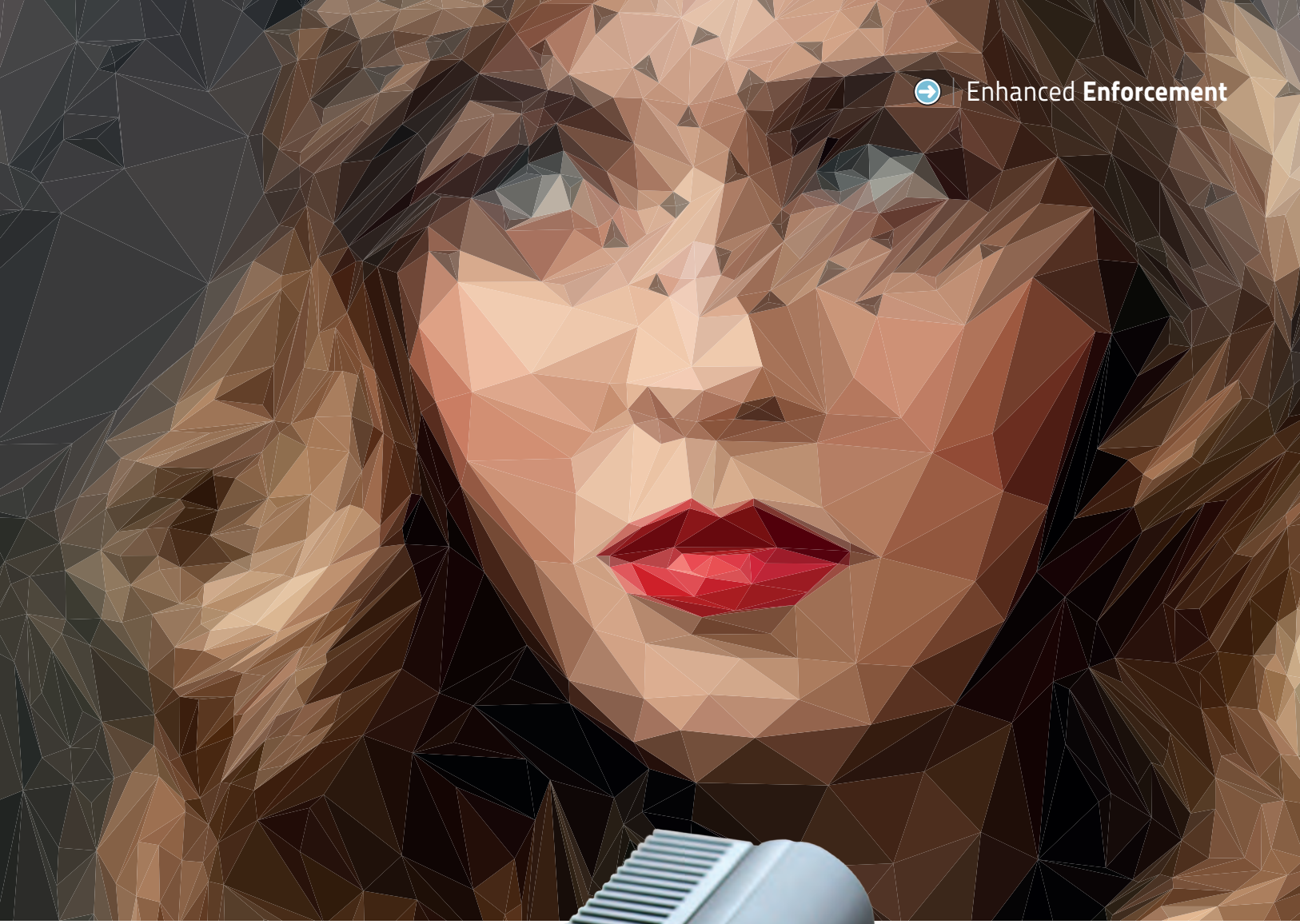

hours of rigorous testing in laboratory and field conditions have enabled us to fit each camera with a series of optical lenses and multiple aperture capability, which allows each one to excel in many different light conditions. By using this light filter approach, the operators can use multiple optics concurrently, which enables them to capture a varied spectrum of light conditions."

But taking advantage of optics and aperture to lay the groundwork for an image is only half the battle.

Santos-Villalobos continues, "As we follow an integrated imaging management philosophy, we develop software and hardware applications in equal measure, which enables us to optimize the imaging pipeline."

So, how does the interconnected and interoperable technology work to produce a clear, crisp facial image?

Santos-Villalobos explains, "A snapshot of the scene is captured with several cameras, which provides a set of synchronized and time-stamped images. The pictures are then analyzed by a tailor-made software package, which separates pixels that are rich in information from those that are not. When the algorithms have successfully identified all the superior pixels in all of the N images, it conflates them into one single composite image. The final result is a single shot, which will be a super-high-resolution, high-quality and high-contrast face image."

Above: **The Cognitec FaceVACS-VideoScan C5 camera, a specialized video camera with built-in face detection, supports real-time face recognition in casinos, retail facilities, stadiums and other event venues**

But can this revolutionary technique be used to photograph a driver of a speeding vehicle?

Santos-Villalobos says, "If a car is traveling at 50-60mph [80-97km/h], a trigger mechanism system would need to be fitted to each camera, which would be activated when a car comes into view. But, very often, given the speed that vehicle is traveling at, coupled with the distance to the camera, there is simply not enough light for the camera to capture a high-resolution, contrast-enhanced image.

"To address this challenge, we use a series of cameras, which is

When photos steal your soul…

Folklore would have it that ancient cultures believed photographs could steal your soul. Could a future reality begin to echo this fear?

He rarely gives interviews to the press, but in February 2015, the then Biometrics Commissioner for the UK government, Alastair MacGregor, chose to speak out about how facial recognition systems posed a potential threat to civil liberties.

In his 2014 annual report, MacGregor noted a "substantial development in automated facial recognition systems". He said that the "same issues and concerns" regarding the "retention and use" of DNA and fingerprints should apply when collecting facial biometric images. In an interview with the BBC, he revealed that police forces in England and Wales have around 18 million images on a facial recognition database.

For Clare Garvie, at Georgetown Law's Center on Privacy & Technology, MacGregor's stark revelation provides a revealing insight as to how biometric information could misused and abused: "There are major privacy concerns to consider, and all the privacy and civil liberties issues associated with surveillance-style facial recognition technology would apply when using the systems in a traffic enforcement environment too.

"If the technology were to be fitted to roadside infrastructure, and if it is not closely monitored by a regulating body, in theory, it could establish a person's whereabouts at any point in time without first obtaining their permission. And there would be no practical way to opt out."

Garvie also believes that if the technology is brought into use disproportionately, it could inhibit free speech.

"There is evidence to suggest that people are less likely to participate in certain activities in public if they think they are going to be tracked while doing them. And biometric image software is not infallible. If it was, therefore, used by traffic enforcement officers, it could mean that innocent people are investigated and arrested for offenses they did not commit. This could also make people more fearful of traveling by car, which could reveal sensitive private information, such as trips to a political rally or a drug treatment center."

It is an opinion echoed by Cognitec's Elke Oberg, who says that if such applications are misapplied, they could generate "an unreasonable amount of false identifications" and "raise significant privacy concerns".

And Facewatch chairman, Simon Gordon adds, "While facial recognition technology is extremely reliable in generating highly accurate percentage matches, it has been designed as a collaborative tool in which humans and technology work together to establish identities. All alerts are checked by people before any action is taken. But most importantly, the watchlist management processes we have developed comply with the Data Protection Act and so if a face doesn't match, it is deleted straight away. That is fundamentally important to our business, and any other organization pioneering this technology, because without public buy-in, facial recognition systems simply won't be accepted by society."

effectively a plenoptic camera, so we can increase the aperture of the system and collect more light. Also, by using a group of cameras, we are able to measure the light field of the scene being photographed. This means we can refocus the image to home in on the driver if necessary."

Santos-Villalobos, who has been working at ORNL for seven years, is waiting to see if the project will be extended so that the system can be tested in a real-world scenario.

"We have conducted extensive testing in a controlled laboratory setting, and some field tests too, but even without any further additional proving ground trials, I believe that the technology is ripe for a facial recognition specialist to take it past the proof-of-concept stage."

The waiting game

So how long will it be before these breakthrough facial recognition systems are widely adopted?

Speaking from his offices in Chessington, Surrey, UK, Jacques Lombard, who founded Syntinex Security Solutions seven years ago, believes that, "While there are a number of unanswered questions and concerns as to how the data is stored and used," purely from a technical perspective, with technology and software analytics developing at breakneck speed, "the systems could be put to use in traffic enforcement within the next five to seven years."

> There are no technical barriers that cannot be overcome. The scope of possibilities will be defined by budget alone
>
> **Dr Hector J Santos-Villalobos, Identity Sciences Business Development Lead, Oak Ridge National Laboratory, USA**

And Santos-Villalobos firmly believes, depending on budget and project scope, that the technology could be available in five years' time.

"Facial recognition technology can work for traffic enforcement agencies. There are no technical barriers that cannot be overcome. The scope of possibilities will be defined by budget alone. That is the only limiting factor."

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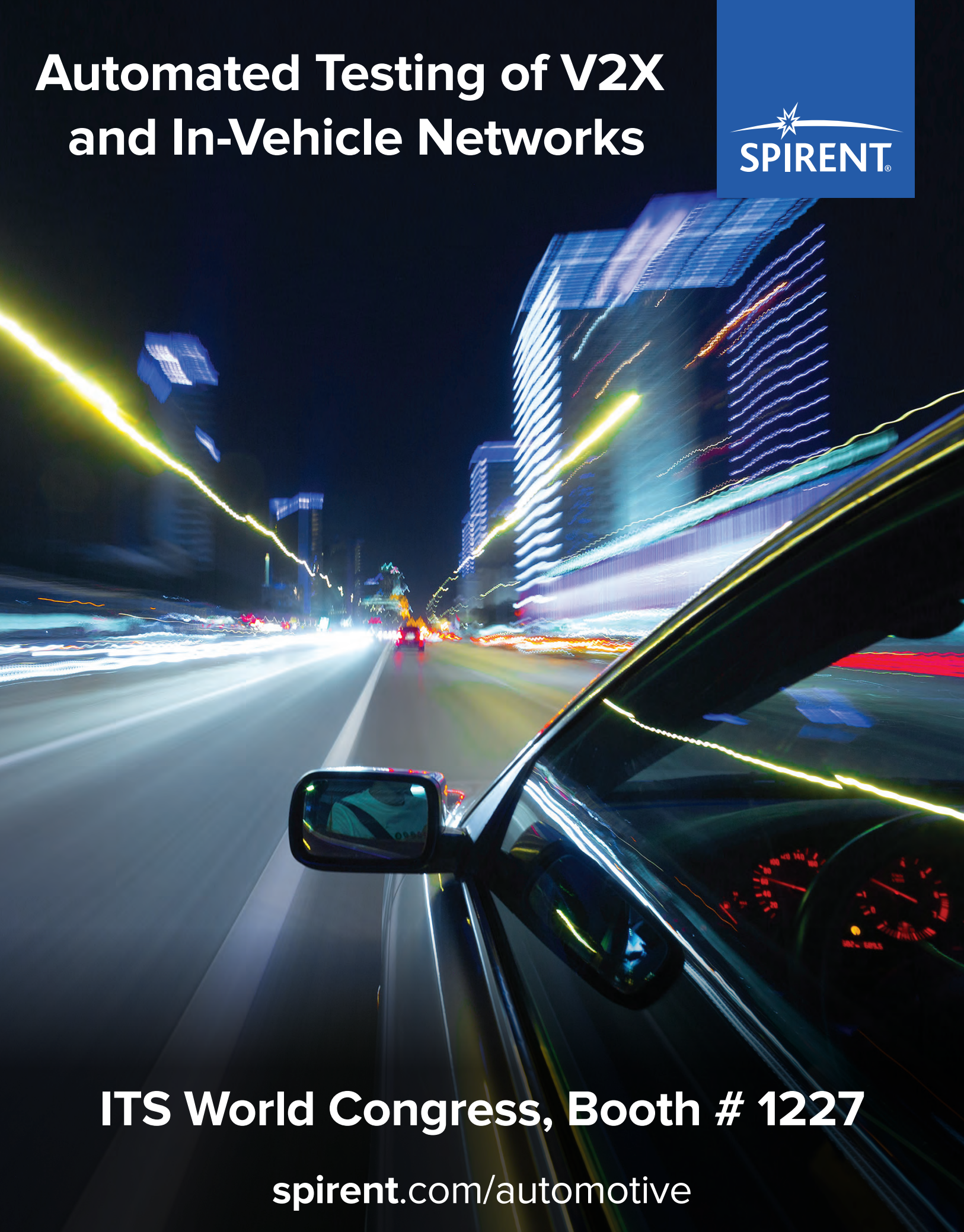

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V2V crash protection

The UK government is funding a new project to develop new V2V communications to improve safety

The UK's new Multi-Car Collision Avoidance (MuCCA) project will use artificial intelligence (AI) and V2V communications to help cars, and eventually autonomous vehicles (AV), make cooperative decisions to avoid crashes. Innovatively the MuCCA system aims to predict the likely movements of cars controlled by human drivers using AI methods. If an accident cannot be avoided altogether, the aim will be to minimize the consequences.

The MuCCA project is being led by the Spain-based automotive design and testing company Applus+ IDIADA, and also includes the UK's Cranfield University, Westfield Sportscars, Cosworth, Secured by Design consultancy, and the Transport Systems Catapult.

A simulated environment will enable AI systems to practice complex crash scenarios before being trialled on real-world test tracks.

"The beauty of connected vehicles is that they can share and combine sensor data with other vehicles, making them more than the sum of their parts," says Charlie Wartnaby, chief engineer at IDIADA. "We can use this ability to allow machine logic to take control of a group of vehicles so they work together in an emergency in order to avoid an accident."

48: New connections
Road authorities and departments of transportation across the world are facing up to the challenge of deploying connected vehicle infrastructure ahead of full implementation

56: Chain gang
Truck platooning pilots have been happening around the world over the past two years; now the UK is following the leaders, with hopes that real-world deployment could be just around the corner

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New connections

David W Smith speaks to state DOTs in the USA about the challenges of deploying connected-vehicle infrastructure, and finds out about the solutions that are being worked on now, and planned for the future

Blaine Leonard, Utah Department of Transportation's (UDOT) technology and innovation engineer, is fond of using the 'chicken and egg' analogy to explain a new dilemma facing transport planners. "The chicken and egg question is this: Will vehicle manufacturers build applications on cars if there is no infrastructure for the vehicles to talk to, and how can we justify spending public money to build infrastructure when there are no cars to talk to? Who steps into the water first?"

Fortunately, Leonard is not alone in worrying about the chicken and egg problem. At a Vehicle to Infrastructure Deployment Coalition (V2I DC) meeting, he and his colleagues discussed the issue and may have found a possible solution. The V2I DC is a collaboration between the American Association of State Highway and Transportation Officials (AASHTO), the Institute of Transportation Engineers (ITE), and the Intelligent Transportation Society of America (ITS America). Having considered the dilemma, representatives of the various groups came up with the 'SPaT challenge' (signal phase and timing) to inspire DOTs to be proactive.

"We challenged states to notify vehicle manufacturers that they are building roadside infrastructure for automated and connected vehicles," says Leonard. "We decided that a straightforward approach would be for each DOT to find a corridor of around 20 intersections, to implement DSRC (dedicated short-range communications) infrastructure, and to broadcast SPaT and map data.

"Signalized intersections already have poles, power, communications and other equipment in place," he continues. "So it's relatively easy to connect DSRC to the signal controller, grab the data describing the signal phasing and timing, and broadcast it."

Four states have SPaT systems up and running, a further 10 are at the

planning stage and many others are considering it. The divergent responses reflect a pattern in the USA, where some states are willing to spend money to test advanced technologies – even if they are unsure of their ultimate relevance – whereas other states adopt a 'wait and see' approach.

"It's an exciting time because some level of automation will happen and the changes will be as radical as going from horse to horsepower," says Leonard. "But it's also frustrating for planners allocating resources to be used 20 years from now. We could do preliminary design work and then might not build something for 15 years, by which time it's redundant. We have a lot of information and modeling, but our predictions are, ultimately, guesswork."

A potential tipping point would be a decision by the federal government to mandate DSRC for vehicle-to-vehicle (V2V) communications. The rule was proposed by the Obama administration, but is opposed by groups such as the Israeli start-up company, Nexar, which operates an app-based V2V network in New York City. Nexar believes that mandating DSRC would place it at a commercial disadvantage. Leonard admits that this is a controversial area. Right now, DSRC is much faster, but cellular works well for less time-sensitive data, and the cell industry is promising faster 5G soon.

It's worth remembering, too, that around 70% of cars already have cellular connections.

The strong possibility that DSRC will play an important role, however, has encouraged Leonard and his Utah colleagues to experiment with a permanent deployment on a fleet of buses traveling along the Redwood Road corridor in Salt Lake City. The system broadcasts SPaT and map data, facilitating communication

> It's an exciting time because some level of automation will happen and the changes will be as radical as going from horse to horsepower
>
> **Blaine Leonard, technology and innovation engineer, Utah Department of Transportation**

Above: **An aerial view of Redwood Road, Salt Lake City, where UDOT has deployed connected vehicle technology on signals to help keep buses** (opposite) **running on time**

between bus and roadside. Buses behind schedule can be allocated additional green light time.

The main aim is to learn how to deploy DSRC technology, but Utah is also carrying out a traffic engineering study of its effectiveness and the potential impact on cars. Afterwards, there is potential to expand across the state. Even further ahead, the corridor will allow Utah and its partners to start looking at applications in cars, such as red light running software, or eco-driving applications.

One topic that results in universal agreement in the V2I DC group is the value of fiber-optic cables. Leonard says Utah's ITS network has benefited enormously from putting in high-speed fiber statewide. "It forms an important backbone," he says.

A future for VMS?

More difficult to predict is whether future roads will require expensive overhead variable message signs (VMS). If vehicles are connected, then information can come directly into the car, says Blaine. A crucial question, he says, is how much penetration of new technology is required before DOTs decide not to invest in VMS. "If 70% of cars are connected, or even 90%, we may still need VMS. But we believe when we have 100% penetration of connected and automated technologies we won't need them," he says.

Such discussions foster more head-scratching about long-term asset management plans. It may make sense to install VMS for the next five to 10 years, because there won't be enough connected cars for another 15 or 20 years. But after that, DOTs might think about an 'end of life strategy' for existing VMS and stop replacing them, Leonard says.

However, it is fiendishly difficult to predict when there will be enough market penetration to justify such decisions. If the federal mandate goes ahead, it might clarify the situation. Cars would begin requiring DSRC in 2021. Leonard says the average turnover of cars is 12 years, meaning that by 2033 a significant number would be equipped. Older models could be retrofitted and the process accelerated.

Further debates center on the potential for 'platooning' lines of automated vehicles moving at the same speed, 20ft apart. "With platooning, we could dedicate a lane for these vehicles, and ultimately, when all vehicles are autonomous, put five narrower lanes on a highway instead of four wider ones. So, transport planners are discussing whether between now and 2040, we should be adding more width to roads," he says.

But making such decisions is hard when DOTs do not know whether

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there will be an increase, or decrease in vehicles on roads. "That's the biggest debate of all. Will people be happier to commute further as they are watching TV and not driving? If cars are driving themselves, how many will be empty as they travel between dropping someone off and picking someone up? Does that facilitate shared ownership models?"

Autonomous vehicle race

One of the most proactive states is Virginia, where Governor Terry McAuliffe wants to "bury those other 49 states" in the race to become the autonomous vehicle capital. Virginia DOT (VDOT) already runs the third-largest network of state-maintained roads, with 60,000 miles, ranging from plains to mountains, and in Virginia Tech Transport Institute (VTTI) it has found an ideal research partner.

VDOT is experimenting with connected and automated corridors. In 2014, VDOT and VTTI jointly introduced the Virginia Connected Corridors (VCC) initiative along one of the most congested US corridors, the I-66, and two parallel roads, the US-50 and US-29. Roadside equipment units broadcast DSRC signal and timing data. For vehicles not equipped with DSRC, an app allows smartphones to receive signal data.

In addition to live roadways, VDOT has already equipped signalized intersections along the two-mile Virginia Smart Road, in Blacksburg, with the same hardware.

One aim is to understand the feasibility of eliminating certain high-dollar infrastructure through connected-vehicle applications. VDOT says overhead guide signs cost US$100,000 apiece, while changeable message signs and traffic signals cost US$200,000 and US$250,000, respectively. Savings could run into hundreds of millions of dollars. "We're making investments to reduce investment in other areas," says Catherine McGhee, director of the

USDOT connected vehicle pilots

USDOT has awarded cooperative agreements, together worth more than US$45m, to three regional connected vehicle pilot schemes

At peak times in downtown Tampa, Florida, there are frequent delays and rear-end crashes, and conflicts between car drivers, bus drivers and pedestrians are commonplace. The Tampa Connected Vehicle Pilot is equipping 10 buses, 10 streetcars, and 1,600 privately owned vehicles with connected vehicle technology, enabling them to communicate vital information with each other as well as with transportation infrastructure. At least 500 pedestrians are also participating by using a smartphone app. The expectation is that drivers, transit riders, and pedestrians in the connected vehicle environment will enjoy a range of safety and mobility benefits, including crash prevention, enhanced traffic flow, and greenhouse gas reductions.

The focus is different for the other two sites although the safety considerations are similar. The Manhattan pilot is equipping 5,850 taxis, 1,250 metropolitan buses, and hundreds of other fleet vehicles, with connected technology. Roadside units are being placed at 310 signalized intersections.

In Wyoming, the focus is on the perilous 402-mile I-80, which has had numerous high-profile crashes, often involving trucks, which make up 30-55% of traffic. The Wyoming Pilot is deploying 75 roadside units and installing onboard units on 400 vehicles, a combination of fleet vehicles and commercial trucks. It is hoped that data collected from the equipped vehicles will not only support in-vehicle applications, but will enable better traffic and incident management along the I-80 corridor.

Left: **The Virginia Connected Corridors, on I-66, US-50 and US-29, communicate information to vehicles using DSRC units** (right) **and VMS**

Left: **Fiber-optic lines are an essential communication 'backbone' to enable V2X technology**

Below left: **Virginia's purpose-built Smart Road is putting the state at the forefront of autonomous and connected vehicle testing**

Wireless ways

Ohio is investing in fiber-optic cable to enhance its Smart Mobility Corridor

Ohio is another proactive US state that wants to build a reputation as a world leader in smart mobility, and in autonomous and connected vehicle research. This year, it is investing US$15m to install advanced fiber-optic technology along the Smart Mobility Corridor, a four-lane 35-mile stretch of US Route 33 located in central Ohio, running between Dublin and East Liberty, northwest of Columbus. State Governor John R Kasich says that his state's partnership with leading automotive research centers and local governments is now all set to create "an ideal proving ground to safely test innovative technologies that will change the way people and products are transported in Ohio and across the world".

The high-capacity fiber-optic cable along the Smart Mobility Corridor will enable analysis of data from embedded and wireless sensors along the roadway. These links will allow the automotive testing, research and manufacturing facilities to test smart transportation technologies on a highway that carries up to 50,000 vehicles a day through rural and urban settings in a full range of weather conditions. This data will also provide more frequent and accurate traffic counts, weather and surface condition monitoring, and incident management improvements.

Virginia Transportation Research Council. "For a relatively small sum of a few million dollars, out of a US$5bn annual budget, we're positioning ourselves for every eventuality. It could have large pay-offs down the road."

Following 2015 legislation, the Virginia Automated Corridors project opened up 70 miles of interstates and arterial roads to automated vehicle developers. The corridors allow connected vehicle capabilities enabled by dedicated DSRC and cellular technology. The VTTI is leading the automated corridor project. VDOT hopes to encourage OEMs to use the facility and enter into PPP initiatives.

> We're positioning ourselves for every eventuality. We want to be out there where the decisions are being made, rather than reacting afterward
>
> **Catherine McGhee, director, Virginia Transportation Research Council**

VDOT's embrace of new technology includes two other projects. The state has installed variable speed limit signs on a mountainous section of I-77 that drops for miles into North Carolina and has seen horrendous crashes in bad weather. Full color matrix displays adapt speeds to conditions. Though not connected yet, such technologies could certainly be equipped to talk to cars one day.

Secondly, VDOT has installed an active traffic management system on I-66 in Northern Virginia. A variable speed limit app can warn drivers of queues ahead and signs inform drivers when lanes are closed off. Most beneficially, dynamic shoulder running allows the breakdown lane to be temporarily opened in heavy traffic. Again, VDOT is studying different ways to bring information into cars, including dynamic message signs and smartphone apps. "We want to be out there where the decisions are being made rather than reacting afterward," says Rob Cary, district engineer in Richmond, Virginia.

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Calculate KPIs to create an effective business model for MaaS-Fleets within any city infrastructure

PTV MAAS SIMULATOR

Provide detailed visual of mobility scenarios, taking into account autonomous vehicles, pedestrians, bicycles, and public transport

PTV MAAS OPERATOR

Operate a multimodal MaaS-Fleet in real-time, optimizing the trips and capacity of vehicles related to the infrastructure and traffic data of the city

PTV MAAS CONTROLLER

Integrate all of the components to build an overall city operating system including real-time control of connected transport and traffic prediction

So while we're paving the way to smarter cities, it all starts with you. How?
Join us at www.ptvgroup.com/mobilitynext

Chain gang

As the UK becomes the latest country to instigate truck platooning trials, **James Gordon** talks to the head of the research team about the safety implications and hopes for the future

Following the lead set last year by the European Truck Platooning Challenge – when a truck platoon successfully navigated over 1,200 miles of public roads through Sweden, Denmark, and Germany to reach its final destination in the Netherlands – the UK government announced at the end of August that it would be providing £8.1m (US$10.5m) to fund a similar, but potentially more significant trial in the UK.

The pilot is set to begin next year and will be carried out by a consortium led by independent experts at TRL, the UK's centre for innovation in transport and mobility.

The 'vehicle to vehicle' (V2V) communication method of choice for the trial is wi-fi. To form a truck platoon, a local area network is set up between trucks, linking the vehicles through an access point in each cab. Initially in the UK up to three vehicles will be used, but in theory more could be added. The technology means that the two following vehicles respond automatically to the actions of the lead vehicle, so the lead driver controls the entire platoon. It is hoped such innovation could have major benefits for drivers and businesses through reducing fuel costs by improving the collective aerodynamics of the platooning vehicles and improving congestion by tightening the following distances between vehicles and discouraging unnecessary overtaking by trucks, leading to smoother and more efficient traffic flows.

"The systems driving trucks two and three will perform with a reaction time measured in milliseconds, much quicker than you or I could react, so we are able to safely drive the trucks within metres of each other," says Richard Cuerden, Academy Director at TRL. "This technology has already been proven in platooning demonstrations, the aim of our project is to develop and trial a system that's robust enough to work in the real world. When we reach the end of our project, we'll have run a trial with a real operator, with real goods, and on real UK roads. The outcome of the project will be an independent and impartial impact assessment, quantifying the potential benefits and dis-benefits for commercial platooning in the UK in the future."

The trial will be carried out in three phases, with the first assessing the potential of platooning. Once that has been successfully completed, initial test-track based trials will help decide on the specifics, such as the optimum distance between vehicles, and on which roads the tests could take place. The second phase – demonstrations on major roads – is expected by the end of 2018 and the third phase with a full trial will follow. Each phase of testing will only begin when there is robust

> When we get to the end of our project, we'll have run a trial with a real operator, with real goods, on real UK roads
>
> **Richard Cuerden, academy director, TRL, UK**

Above: **Truck platoons could soon be common on UK roads**

Inset: **Radar and video will maintain safe following distances, while the ITS-dedicated wi-fi will be used for cab-to-cab communications**

evidence that the technology conforms to stringent safety and security protocols.

With some automobile and road safety organizations raising questions around safety, Cuerden is keen to set the record straight.

"A collaborative culture of safety is at the heart of everything we do," says Cuerden. "It is important to stress that the program has been specifically designed not to be driven by any one individual. Rather, it is structured through iterative stages, with risk and safety assessments providing the necessary independent checks and balances. These are woven deep into the fabric of the project, that are most important.

"For example, while it is my responsibility to ensure the platooning project satisfies the requirements laid out by our key stakeholders (the DfT and Highways England), the program can only enter a new phase if it fulfils all of the conditions of the independent safety team, and also meets the safety standards of the client."

And in regard to the statement from British automotive services company the RAC, that a multi-truck convoy could potentially obscure and impair the view of other drivers who could be seeking to access key freeway entry and exit points, Cuerden, explains, "Firstly, we have already taken a number of key steps to address this particular issue, including running a number of simulator trials involving the public, who will be invited to drive in simulated environments alongside virtual truck platoons. The data gathered from these tests will enable us to identify any safety cases (which might, or might not surface) and will help to both shape and inform our real-world trials.

"But on a wider note, while I don't wish to focus on the views of any one particular organization, some of press column inches failed to take into account that the platooning technology that we are developing will create 'dynamic' convoys and not 'static' ones. The platoons will have access to real-time mapping technology, and will be able to receive information relating to busy junctions and slip roads ahead of time, and will have drivers ready to take control if required, enabling them to de-couple safely, efficiently and seamlessly as and when is required," he adds.

Safer autonomous vehicles: V2X interoperability for the connected car

Advanced driver assistance systems (ADAS) and autonomous technologies have the potential to make cars safer, because they can reduce the human factor. With US$3.9bn being proposed for autonomous vehicles by the US Secretary of Transportation, this technology is becoming a reality. An updated joint policy statement from the USDOT and NHTSA outlines Level 4 automation, where even fallback functions are automated.

To make a machine trustworthy, it must be better at decision making than a human. This means it will need to be equipped with sensors to receive and send information, with 100% reliability without distraction or interference. At the same time it must be strong enough to resist security threats and overcome radio impairments over a wide variety of platforms.

Spirent's V2X test solutions enable connected device vendors to check compliance to standards

Holistic V2X testing

Testing helps prove new vehicle features are safe and reliable. However, as advanced as they are, testing platforms have almost been exclusively centered on meeting manufacturers' own internal standards.

What's required is a more holistic approach to testing how vehicles receive and process information from other vehicles (V2V), from the surrounding infrastructure (V2I) and from other entities such as pedestrians or any associated equipment (V2X). All V2X architectures consist of elements spanning the tiers of the automotive industry, network infrastructure (from in-car devices and applications to the cloud) and sensor information, with seamless connectivity.

Unlike traditional automotive standards testing, direct interoperability testing is based on common messaging protocols – where the potential fallout of any problems is shared. Test protocols must be centered on ensuring safety, as these cars progress from labs and controlled environments to mass market adoption on public roads where lives are at stake.

To ensure message-level interoperability, regulatory authorities within each geographical region are coming together to establish a set of standard protocols, agreed upon internationally, for all manufacturers to use.

Need to know

Spirent Communications is a provider of testing, assurance, analytics and security solutions

- Verifies the performance of Ethernet networks, including automotive Ethernet
- Enables deployment of virtualization and cloud computing environments
- Tests and verifies 4G LTE/5G networks and location-based services

Power in numbers

In the USA and the EU, car makers, Tier 1 suppliers and technology providers are working on an agreement for key elements of an SAE Recommended Practice (RP) document covering wireless power transfer (WPT), automated parking alignment and the charging of electric vehicles. This taskforce is working toward accepted performance requirements and worldwide interoperability across automotive manufacturers, to ensure that charging systems and vehicles follow the same principles among all car manufacturers. This includes, for example, confirming that charging rates, efficiency and emissions meet regulatory guidelines as well as consumer expectations, to ensure standardization of the RP SAE J2954 test station.

As task forces like this determine a set of agreed upon protocols and messaging interoperability for manufacturers to use, test equipment manufacturers, in turn, are in tune with these requirements and are defining suites of tests to verify that their systems meet the relevant protocol requirements for each territory.

EU versus US protocol

In the USA, the agreed protocol stack is wireless access in vehicular environments/ dedicated short-range communications (WAVE/DSRC), which covers V2X. Asian standards are expected to follow the US model. In Europe, standards follow ITS-G5 and are defined by the European Telecommunications Standards Institute (ETSI).

Both ITS-G5 and WAVE/ DSRC are based on the IEEE 802.11p wi-fi standard. In the future this could potentially

by **Don Hunt**

expand for use at the cellular physical layer – such as LTE-V or 5G. Recently several projects have been launched, involving engineers working on different cellular-V2X (C-V2X) technologies, to meet automotive industry requirements for latency and performance – and in particular, for safety-relevant features such as ADAS.

V2X challenges

Interoperability and testing of V2X technologies is critical and will not be possible without standards-compliant key architecture components from automotive manufacturers. Engineers are still pulling together solutions from a wide variety of heterogeneous technologies, overcoming signal interference and developing crucial security systems. Nevertheless, as new standards are developed, engineers, manufacturers and standards bodies must remain flexible enough to leave room for future breakthroughs, innovations and improvements.

Our cars have long served us as symbols of freedom and valuable possessions that need our protection and maintenance. Autonomous vehicles are shifting that relationship – and safety, reliability and connectivity will become the drivers of our personal transportation systems. With the potential to make us safer, self-driving cars will create an entirely new type of relationship between man and machine.

Data, data everywhere

By 2021, around 380 million connected cars will be on the road globally, about twice as many as today. If a vehicle owner allows the manufacturer to turn on connectivity, the vehicle will become a probe for massive data capture. Estimates are that connected cars will generate 25GB of data per hour, which is equivalent to 12 full-length HD movies. Transmitted data will include engine performance, location, acceleration, speed, braking and even windshield wiper operation. Eventually vehicle cameras and sensors will transmit physical roadway and traffic information.

This connectivity will provide insights into traffic movement that have never been possible or even imagined by transportation agencies. Localized, real-time information could enable roadway operators to manage congestion and incidents in more effective ways. Trip information could help in planning for more effective transportation and mobility programs. The data may be extended to other smart-city applications, including land use planning, freight distribution and parking management.

Instantaneous and granular data is a critical need for transportation agencies. In last year's USDOT Smart City Challenge, data issues were the category most often identified by applicants as a barrier to effective decisions. In an analysis of the grant applications, the two largest impediments to creating smarter cities were limited data to monitor the transportation system, and limited tools to support data driven decision making.

There is one major challenge for governments: connected car data will not naturally flow to transportation agencies. Instead it will be controlled by auto makers, who will have an open field to manage the data for their own financial return. To this point, auto maker connected car data applications have focused on the driver – trip planning, audio entertainment and vehicle performance. There has been little consideration of bringing connected car data to less lucrative government markets.

Enter several companies with a business in developing services that leverage auto maker data to make money. Some of these data platform companies are owned by auto makers and others have auto maker investment. The companies' business model is to aggregate connected car data from multiple auto makers, devise customer applications, and share revenue with the auto makers. Industry observers claim that in a few years connected car data will be worth more than the cars themselves.

"Connectivity will provide insights into traffic that have never been imagined by transportation agencies"

As for transportation agencies, some of these third-party data aggregators will develop smart mobility applications for government. A new world of rich, real-time data services will be created, giving transportation system operators more effective ways to plan and manage public systems. But this data opportunity will require a new way of thinking.

Transportation agencies are used to collecting data with their own equipment. The new data paradigm will require annual subscriptions from private providers to access the best mobility information, and staff data scientists to bring the information into management decision making. Strong leadership will be needed to meet these opportunities head on, and to realize the benefits of connected car data for transportation system management.

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

Revolutionary sensor for road scanning

Higher demands for road weather monitoring and maintenance are being imposed, as a result of increasing traffic volumes and requirements for emergency prevention. Technological developments aim to find an elaborate solution that makes road monitoring more cost-effective and eco-friendly, and can increase traffic safety.

Two key types of sensors have been developed to monitor road weather conditions: intrusive sensors that require physical installation into the road surface, and non-intrusive sensors that operate remotely without causing any damage. Both types of sensors have limitations, however.

Non-intrusive monitoring

2DRoad, a new meteorological video camera developed by MetSense, has a unique non-intrusive sensor that provides a full multilane description of road friction and road surface conditions. In contrast to most widely used devices, the sensor can scan a broad road area instead of one particular point and it does not need to be physically installed in the surface of a road.

In a fast, easy process, the modern 2DRoad meteorological camera can take a number of near-infrared spectroscopy pictures, and a built-in flash can adjust light conditions in the area. Each picture is filtered to capture only part of the spectrum, and detection of the current state of the road is based on an analysis of the images. This complete process can be carried out from a remote location, so no adjustments to the road surface are required.

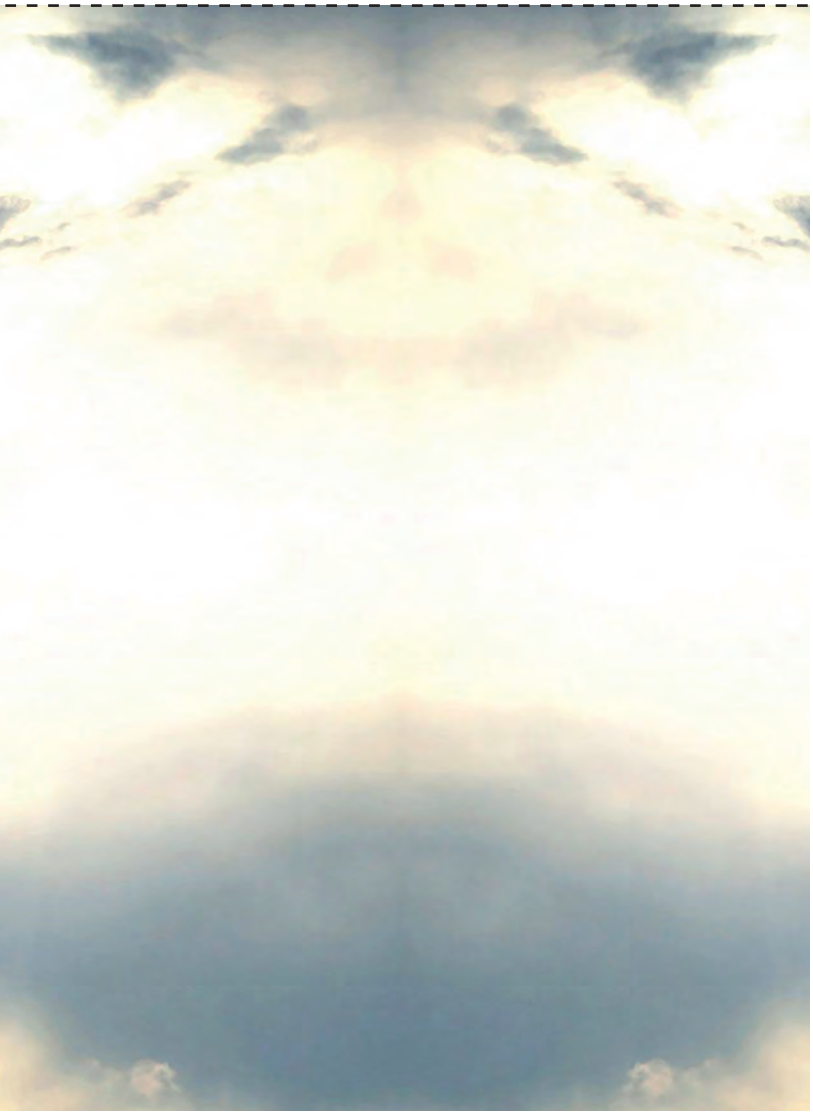
The 2DRoad sensor can provide information about a road surface area of 2m² (21.5ft²) to 6m² (64.6ft²). This area is divided into 64x64 points – 4,096 in total. The sensors of other non-intrusive devices can monitor only one point or just a few square centimeters. The area covered by 2DRoad can be set according to the requirements of the road. Subsequent outcomes can then provide an overview of the whole area selected.

For each point, the camera can determine whether the road surface is dry, wet or covered in snow or ice. This is calculated

Need to know

MetSense offers complete sensor solutions for winter road maintenance

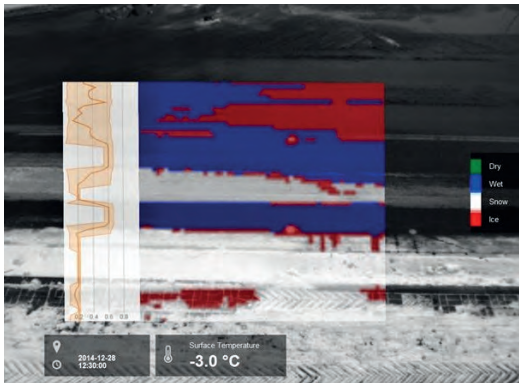
- The 2DRoad multipixel camera system can detect the status of road surfaces in two dimensions
- It can offer a visual image of one or several road lanes with a semi-transparent overlay of current road conditions at thousands of points on the road's surface



Above: **The 2DRoad meteorological camera device**

according to different wavelengths that correspond to a particular type of surface and its condition. The camera recognizes seven road surface statuses: dry, moist, wet, dark ice, bright ice, snow and slush. Using an integrated pyrometer, the 2DRoad platform can also remotely measure the road surface around the center of a point.

The outcome of a road scan is organized and structured into a simple, visual and data-based presentation with a clear view of the state of the road at each point that is monitored. These data presentations are useful for winter road maintenance contract dispatchers and other road maintenance workers.



Left: **An example of the visual output from a meteorological camera**

Saving resources

Implementing sophisticated meteorological information systems with well-equipped sensors, such as 2DRoad, is crucial for the sake of maintenance costs reductions, making winter road maintenance more efficient, increasing road safety and being kind to the environment.

Adverse weather conditions, whether snow, heavy rain or dry, can greatly influence the cost of road maintenance and affect overall safety. The potential outcomes caused by these elements can be reduced with the use of proper and up-to-date meteorological information systems. With adequate measures and suitable devices in place – for example, detailed weather forecasts – maintenance can be targeted at specific parts of the road. Prompt and efficient treatment of roads can lead to increased safety for road users.

Subsequent maintenance can be directed exactly to the area of road that is affected by natural, weather-related events and this in turn reduces the need for, and amount of, human resources required.

Another indisputable advantage of sophisticated meteorological information systems is that they are eco-friendly. With efficient road area targeting, which reduces the need for excessive and unnecessary interventions, a smaller amount of chemicals (such as road salt and brine) is needed to treat roads.

Saving lives in the Middle East with advanced traffic enforcement

According to Cicero: "We must be the slaves of laws, if we want to be free." You can be certain that even the visionary Cicero could not foresee the damage that humans do to each other with vehicles in our modern world. Yet, his wisdom is still relevant. Roughly one person dies every 30 seconds in road traffic accidents, resulting in 1.2 million deaths annually worldwide. Until autonomous driving is comprehensively implemented, accidents are certain to occur. The freedom to disobey speed limits is among the biggest risks for humans, providing a heavy burden on society as a whole.

The impact energy from collisions must be managed so it remains below the threshold likely to result in serious injury. Ensuring compliance with speed limits is a key objective in managing interactions between the environment, infrastructure and basic human vulnerability.

Kuwait roll-out

Smart engineering helps to enforce traffic regulations.

Need to know

Saudi Arabia's ATVAM is one of the most sophisticated traffic safety projects ever

- Over 60 stationary and 80 mobile speed-monitoring devices in Jeddah, Mecca and Medina
- Over 100 intersections with more than 400 red light monitoring devices
- Up to 140,000 incidents processed per day across the three cities

Above: **Greater Amman territory traffic law enforcement**

Below: **King Road Tower with TraffiTower 2.0 in Jeddah, Saudi Arabia**

Since the Gulf Traffic expo in November last year, various traffic law enforcement technologies have been installed in the Middle East.

Kuwait's Ministry of Interior (MOI) planned to increase traffic safety on Kuwaiti streets. Within six months, 40 non-invasive radar technology-based measurement systems, along with 120 external flashes, had been deployed by Jenoptik, contained within design award-winning housings.

"This solidifies Jenoptik's position as the long-term preferred and trusted partner to deliver more traffic safety in the region," says Dr Stefan Traeger, who has been Jenoptik's president and CEO since May 1.

Safer in Amman

Reduction of fatal accidents in Greater Amman territory was the aim of Jordan's Public Security Directorate. The goal was to implement an effective and low-maintenance infrastructure for speed and red light enforcement systems including an operational back office within six months.

Now, a total of 97 radar systems are used to monitor and evaluate the speed of vehicles traveling simultaneously in different traffic lanes. The 3D tracking radar sensors enable the measurement of traffic violations, even for vehicles driving in parallel or at a short distance behind each other. There are 36 systems to allow monitoring on several traffic lanes running in parallel. Using induction loops, these provide reliable and precise measurements to detect red light offences. Both the speed and the red light systems are equipped with modern high-resolution cameras to make the violation record robust and court-proof.

Saudi record breaker

In Saudi Arabia the Automated Traffic Violations Administering and Monitoring (ATVAM) project was one of the largest and most technically sophisticated individual projects in the history of global traffic safety technology. The objective was to build an efficient traffic law enforcement system with the aim of reducing traffic accidents and fatalities. Part of the ATVAM project covered the three cities of Jeddah, Mecca and Medina, with over 60 stationary and 80 mobile speed-monitoring devices. There are also around 100 intersections with more than 400 red light-monitoring devices.

The integrated back office processing helped handle the resulting high volume of violations. An experienced and

Image: Jenoptik

permanent on-site project team provided implementation support. A short time after the system went operational, and before all systems were in place, more than a million traffic violations were captured and processed.

"For the first time in 20 years, the city of Jeddah had a day with no fatal traffic accidents," said a delighted engineer after the system went live.

To give an impression of the magnitude of the project: the back office software runs on 1.2 petabyte hard drives with 96 processors and 960GB RAM. Currently, the traffic center in the Jeddah, Mecca and Medina region processes an average of 84,000 incidents per day. During peak times, there are 140,000 incidents to process every day. With powerful back office software, the necessary staff resources for processing can be minimized.

All these projects were successfully deployed by the German firm Jenoptik, which offers a choice of technologies in the fields of traffic law enforcement, police and security, traffic data management and toll enforcement. Jenoptik is an international solution provider for global traffic safety that has delivered over 30,000 systems and operates in more than 80 countries around the world, improving road journeys and communities – and saving lives.

by **Larry Yermack**

Joining the dots in our disconnected transportation world is becoming an urgent matter for attention

We decry the dreaded silo, just so long as it's not the one we live in. For several decades we have heard the mantra that just working within our own specialty was counterproductive to sensible management of the entire transportation network. ITS America, 20 years ago, after building a series of silos created cross-cutting issues. The Transportation Research Board (TRB) has long worked on issues across fields, however I'm not sure that we have made much progress within our traditional domains, and now that we are in the midst of radical technology disruption, the message to work outside our silos is more urgent and less attended to than ever.

Connected, automated, electric and pay-as-you-go (road user charging) vehicles all live within their own domains, and cross-pollination, let alone cooperation, is minimal. I've spent some time lately in the connected vehicle as well as mileage-based user fee worlds and I'm not encouraged. Let me first assert that in the near future our cars will be electric, connected, autonomous and pay-by-the-mile but here is the sad report from the front: electric and autonomous vehicle development is being driven by manufacturers who seek a competitive advantage. No synergy here, so no cooperation possible.

At a recent TRB forum on connected vehicles, several folks included the relationship to autonomous vehicles as a critical assumption, however it was not taken as a given. Delegates thought that we could see unconnected autonomous vehicles within a few years. If that happens and autonomous vehicles are deployed unconnected to other vehicles, they will require so much room as a safety buffer to make the road network less – not more – efficient.

At an autonomous vehicle conference I attended recently, a car company researcher was discussing an interesting problem. If an autonomous car is coming down a two-way street with one lane in either direction, and the lane is blocked by an emergency vehicle, what does it do? A driver would know to pull into the oncoming lane carefully but an autonomous vehicle has to be programmed to follow the law. He suggested that they might have to operate staffed traffic management centers to monitor the environment and send specific instructions to "their" cars. There was no mention of cooperation with already existing government-operated traffic management centers.

> "The message to work outside our silos is more urgent and less attended to than ever"

And then let's talk about payment systems. Recently several US states have raised the gas tax as a short-term fix to their funding problems but with the inevitable rise of electrics, the gas tax is doomed in the long run. The expectation is that some form of pay-as-you-go system will need to be instituted. With vehicles being produced with increasing built-in technology, ought we not utilize it for payment systems and not add another device? Again, the conversations across silos have yet to occur. It may be early in the development cycle but as Yogi Berra once said, "It gets late early."

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

The right partnership to build solutions for a sustainable future

Miller Crockart, vice president of global sales and marketing at PTV Group, talks here about the company's recent acquisition by Porsche Automobil Holding SE. He also explains how the combination of Mobility as a Service (MaaS), real-time traffic prediction, vehicle autonomy and public transport will pave the way for a more intelligent movement of people and goods.

This June, Porsche SE acquired PTV Group after having evaluated some 1,200 different candidates. What is it that made PTV Group stand out?
Porsche SE knows that the future of mobility is not about just vehicles, but also about the software that operates integrated multimodal Mobility as a Service. This decision by Porsche SE endorses the fact that PTV Group is a strong company in the field, for both the planning and real-time optimization of traffic and logistics.

> Owned, managed and operated by OEMs, MaaS is a potential business model for the future – it can fill gaps in current transport networks

Let's take, for example, our PTV MaaS Accelerator Program, a software that enables cities, fleet operators and automotive companies to model, operate and control shared mobility fleets. We brought together our traffic and logistics expertise to create this technology, meaning customers are well prepared for the future of mobility. Integrating MaaS intelligently with public transport and active mobility modes will be the crucial factor in market success.

Porsche SE supports our approach allowing us to work independently and confidentially with our customers. This is a key factor in our success and the reason we have collaborated with so many cities and automotive companies worldwide.

What does Mobility as a Service mean for the individual players in the market?
MaaS can fundamentally alter how we move about our cities. The younger generation no longer feels the need to have an automobile to demonstrate their wealth or position in society. They show a greater level of concern and interest in making urban environments sustainable. However, cities also require that people and goods are moved more efficiently. We are advising cities to continue to view integrated public transport as the backbone of their mobility platforms of the future.

Automotive companies also recognize that they have a positive role to play in the multimodal mobility solutions of the future. Owned, managed and operated by OEMs, MaaS is a potential business model for the future and it can fill gaps in current transport networks. Together with electric mobility and autonomous driving, it is a concept for future smart cities to cut emissions and reduce the number of cars on the streets. We believe we will really see a significant take-up of MaaS when full vehicle autonomy is a reality. It will drive behavioral change from vehicle ownership to usership.

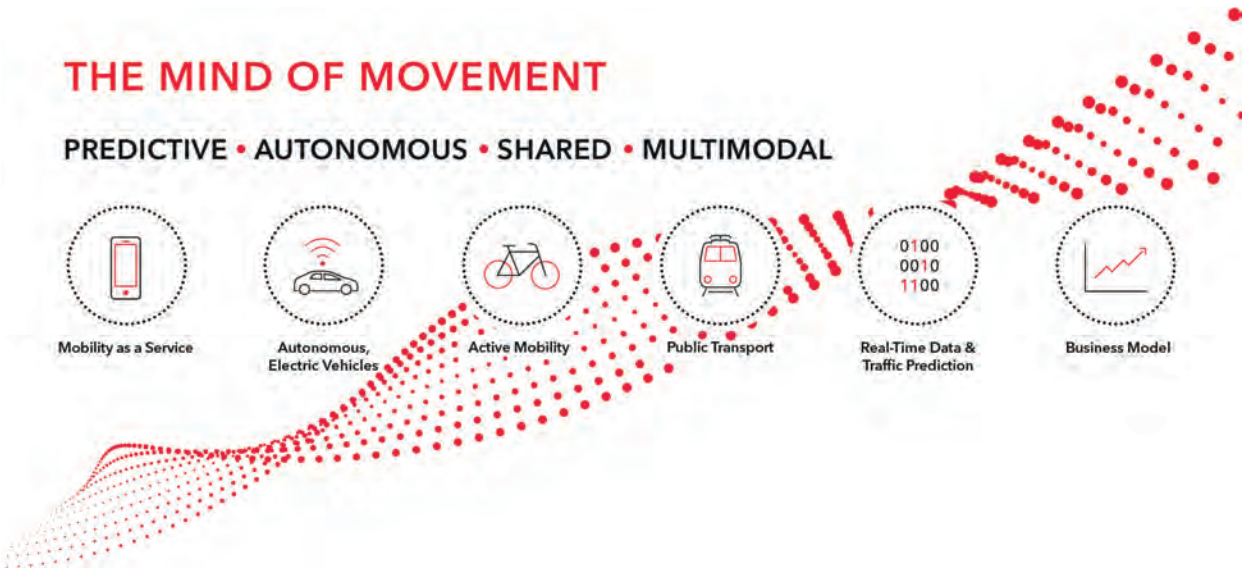
We see the potential of integrated MaaS operations to improve the livability of cities, and we have the technology to build the business cases and to operate the back-office systems required. In fact, PTV is in an excellent position. With four decades of experience, we have constantly improved our technology, for example by using real-time traffic data. With our partners, we also have the underlying mobility demand models of cities across the world – two important aspects of building a successful MaaS business case.

How can an automotive company draw up a successful business plan for MaaS?
As future MaaS providers, they need answers to a number

Need to know

Features of PTV MaaS Modeller software that make it ideal to manage the mobility revolution

- It models MaaS fleet operations to meet mobility needs with the minimum number of vehicles, thereby cutting congestion
- It reports fleet key performance indicators
- It models entire multimodal traffic system performances
- It integrates new business models into existing transport networks



Opposite: **Miller Crockart, vice president, global sales and marketing, PTV Group**

Left: **PTV software draws together elements vital to the transportation systems of the future**

of questions: How many vehicles do they require to run the service and what type of vehicles? How high are the costs and what should the pricing for the services be? What are the waiting and journey times? PTV can provide reliable information with PTV MaaS Modeller, giving OEMs, cities and service providers a solid business case to establish a competitive advantage: our software calculates the right number of vehicles to meet the demand while also running it at the right price. To be able to do that, keeping costs under control and maintaining the vehicles are further crucial factors. When combined with real-time traffic information, vehicles can be rerouted to avoid delays, reduce the frustration of passengers and restrict emissions.

How can this be transplanted into a real-world scenario?

Real-world scenarios rely on real-time data. Our PTV MaaS Operator offers traffic management centers and fleet operators real-time data and prediction to optimize dispatching and routing of vehicles. In this way, live traffic predictions help to coordinate trip requests as well as vehicle assignments, routing and even occupancy. To constantly improve the level of customer service provided by the operators, our software also ensures a dynamic dial-and-ride system. After a customer has booked a ride, the system monitors and optimizes the route to decrease the waiting time as well as the journey time.

Other parameters are also taken into consideration, of course; for example, the maximum number of detours, boarding as well as alighting times, and where the pick-up and drop-off points are located. Real-time traffic data is also deployed to ensure the optimum system is being run. What we need to avoid is encouraging too many vehicles onto the road because that deflects from the whole idea of an integrated MaaS within an overall multimodal mobility mix: meeting the demand with the minimum number of vehicles and integrating them with efficient public transport systems is key.

How many cities already use real-time traffic technology, and can it be deployed in any urban area?

PTV has already implemented real-time predictive traffic services in 14 locations around the world, several ranking as the smartest cities in the world. In our Mobility Lab at PTV Group's headquarters in Karlsruhe, Germany, future customers can see for themselves, how these installations benefit the mobility of people and goods in both small, medium and megacity-type environments. Austrian capital Vienna, for example, with just under two million inhabitants, uses our software. Here, PTV Optima provides current and future traffic information for up to 60 minutes, with proactive decision support for traffic operators and traffic management centers to react to unique and recurring incidents. Vienna, for the eighth year in a row, ranks highest in the annual quality of life survey conducted by Mercer. The consulting firm compared 321 cities in regards to different criteria, including infrastructure and public transport, which contribute to improved livability in urban areas. To achieve an equal or even higher quality of life in every city is what we work toward with our customers every day.

Accessing and managing ALPR systems by smartphone

With ITS systems becoming increasingly sophisticated, customers are more aware than ever of additional functionalities that enable ease of installation and access to the ALPR camera without being physically connected to the device or blocking traffic lanes. Tattile, while developing its new ALPR systems line, has found an innovative solution by taking the benefits of downloadable apps on smartphones and tablet devices and applying this technology to the traffic industry.

An installation facilitator

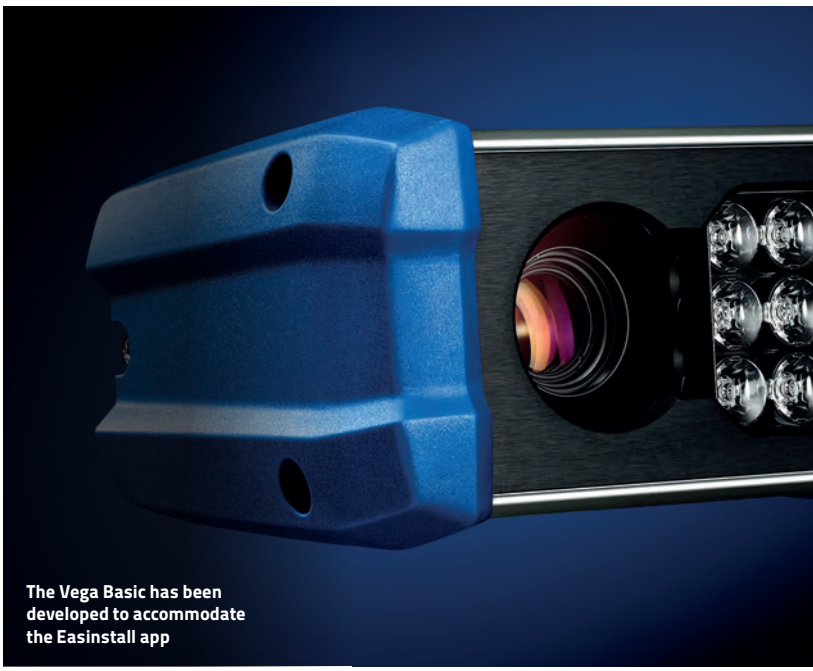
The ITS specialist has developed the Easinstall app, a safe, professional solution that facilitates the installation and maintenance of new ALPR cameras. This new Tattile proprietary app solution enables fast and easy installation of systems and is safer, since an operator is no longer required to climb up the gantry. The app allows any authorized user to be connected to the camera device without being physically close to it. Road lanes no longer need to be closed for maintenance, adjustment processes or to check the device status. Instead, the operator can remain safely seated in their parked vehicle at the side of the road.

Once installed onto any Android or iOS device, the Easinstall app uses wi-fi to detect all available cameras nearby, and automatically connects to them via SSID. The tablet or smartphone app is then able to create a hotspot connection in order to let the control room access the camera without any physical connection. In addition, the user on-site with the mobile device can take images from the ALPR cameras, scan the cameras' QR code and send this data by email directly to the technical support. The Easinstall app also supports web viewing, giving staff in the control room the opportunity to view the camera's footage in real time. Finally, the technicians can provide remote updates to the camera on their smartphone or tablet device.

Need to know

Key takeaways of Tattile's Easinstall app technology

- Any authorized user with the smartphone or tablet app can be connected to the ALPR camera without being physically close to it
- The app can detect nearby cameras using wi-fi and automatically connects to them via SSID
- The app works with the new entry level Vega Basic ALPR system by Tattile



The Vega Basic has been developed to accommodate the Easinstall app

The Vega Basic is a Linux-based 2MP ALPR camera

Camera options

The app has also been designed to update Tattile's new Vega Basic ALPR system, a robust and high performing system positioned at the entry level of the Tattile product range. It is ideal for license plate recognition during congestion charging, stop and go tolling, access control, urban road tracking and for access control to limited traffic areas.

The Linux-based 2MP ALPR camera is built around a small and compact case and available in a short-range version with a working distance of up to 8m and a long-range version that captures license plates up to a distance of 25m. Both models can be ordered in monochrome or color versions. The tailor-made illuminator with eight high-power LEDs and integrated infrared at 850nm wavelength can detect virtually all kinds of reflective and non-reflective license plates.

Installation is extremely easy, as the system has a Power-over-Ethernet (POE) interface that allows a single-wire connection for both data transfer and power

transmission. Vandal-proof connectors in the system enable safe and continuous operation even in areas accessible to unauthorized people.

As a reliable standalone solution with no need for additional processing power, the Tattile Vega Basic automatic license plate reader sets a new price/performance standard in the entry segment and, in conjunction with the Easinstall app, the system enables the user to configure the camera remotely while the system is already in operation.

Used together, these two Tattile products are helping to redefine the way ITS systems are handled.

by **J J Eden**

Implementing a tolling system is like starting a new business

Many leaders are financially struggling to maintain, improve or build new highway infrastructure. Tolls are always the least attractive financing option, but often there is no other option. But how do you reach that situation?

Tolling isn't just an application of ITS with the data in dollar signs. It isn't just another funding source to pile on top of gas taxes and it is not the least controversial way to get something built.

Tolling can be thought of as a new big business. A real big, capital-intensive business, with a lot of debt, and a lot of terms and conditions that come with that debt. A lot of customers who don't like to pay for it are willing to pay if they perceive a value or don't have another practical choice.

For any business venture, you need legal advice. And you need to figure out what to build and buy. Then you need financial advice. And, of course you need to know how to operate the business.

If you're building a pizzeria, you need to know food service regulations. You need to know how to build a pizzeria. You need to figure out how to get the money to build the pizzeria, and you better know how to make and sell pizza. Toll roads are the same.

They require market research – the role traffic and revenue consultants perform. How much money can you make, what do people really want and what will they pay? What non-toll-road competition is there?

Legal counsel is vital, as figuring out what is needed is not simple, and that also might change over time. Fortunately some recent examples help show a path forward,

There's the engineering aspect – can you afford to build what drivers want, for an acceptable toll rate that enough people are willing to pay? Of course tolls differ from pizzerias in that the toll business has to work over 30 or 40 years to make financial sense.

This leads to the importance of financial planning. Tolling is one of the most capital-intensive businesses there is. What kind of debt (bonds) or equity (P3) financing structures, with or without supporting tax revenues or in-kind government services, should be used?

And then there is running a toll facility. You need an operating plan and the ability to execute this plan. A five-step plan to building a toll operating business could be outlined.

"Tolling isn't just an application of ITS with the data in dollar signs"

First of all, you plan the design, developing toll policies based on traffic and revenue results coupled with today's best practices in toll system design, as far as tolling locations and strategies go.

You then plan the operation, developing a concept of operations with business rules, discount plans, payment rules and offerings, the enforcement and collections approach – all things related to interoperability.

The third step is procurement. There are lots of ways to procure toll systems and services, and they are changing rapidly with completely new technology and new companies emerging.

Executing the plan is next, to inspect and test throughout; and finally you operate the system – monitoring quality, accuracy, customer service and measuring key performance indicators to constantly find ways to improve.

Agencies have an advantage over private sector startups. They are not viewed as competitors so are willing to help you get started and with any problems along the way. They know the experts and there are also trade organizations like ATI and IBTTA that will help.

J J Eden is director of tolling at Aecom
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Why DLP rear-projection cubes are still a smart video wall solution

The past decade has seen considerable change in the technology used in control room installations at traffic control centers. This evolution has been driven, on the one hand, by investments in infrastructure, such as Smart City projects, and on the other, by growing demands placed on the centers by a general increase in mobility. In these modern control centers, operators have access to a range of new technologies to help them keep traffic moving and safe.

Above: **Technology relied on in the control room has quickly evolved**

Part of the furniture

Although the recent trend for a more human-centered design in control rooms has brought much of the information back onto operators' desks, a video wall providing all staff with a general overview is still an integral part of every control room.

It is therefore important to select the right technology for the screens and to choose the best possible way to manage the video wall, to make it a usable tool inside the control room.

Almost thought obsolete in 2010, data loss prevention (DLP) rear-projection cubes remain the leading choice today. Through its minimal use of bezel, immunity to burn-in effects from the prolonged display of static images, extreme reliability in 24/7 operation, and maintenance-free long-life LED light sources, the cube has overcome perceived drawbacks such as the cost of the lamps and unstable color appearance.

Those involved in the procurement may be wary of the initial cost of a video wall based on DLP cubes. But the investment will pay off, once the cubes' extended lifetime and long-term availability – which cannot be guaranteed in LCD screens – are taken into consideration.

With new versions, such as Eyevis's tilt and roll pixel (TRP) cubes, which are less expensive but still offer all DLP cube-related advantages, the amortization of total cost of ownership is possible in even less time.

The amount of space required – which represents a significant disadvantage due to the cost of space – was addressed by the invention of slimmer cubes that require similar installation depth to flat-panel displays, plus a wall-mount structure.

Installing LCD screens may be preferred to lamp-based cubes when refurbishing the video wall however, as they do not suffer from the disadvantages associated with the traditional technology.

Need to know

Factors to consider when choosing an appropriate control room display screen

- DLP rear-projection cubes continue to be relied upon in control rooms today because of their immunity to screen burn
- LCD and LED screens are now regularly replacing traditional lamp-based cubes
- When costing a video wall solution it is important to consider the entire life of the hardware

Cost incentives

The idea to switch to modular flat panel displays may further be encouraged through the initial cost of an entire new installation using new DLP cubes with long-life light sources. Here, an upgrade of the projection engines inside the cubes can often be an alternative to a complete replacement of the video wall, which may require additional construction work or even architectural redesigns to the room. In many cases, the housings and screens can remain in operation and in position, but the operators will

Left: **Control rooms are now more human-centered, but the video wall is still an important part of any setup**

benefit from brighter and more colorful images after a renewal of the projector.

Upgrading the light source

If upgrading the light source to a new LED-based system for example, users will still benefit from the minor bezels and ergonomic display appearance of rear-projection cubes. In order to keep upgrade costs low, Eyevis can now offer these based on the compact engine from their new TRP cubes. With an investment comparable to installation of new LCD screens, an existing cube wall can be quickly relit. In addition, these newly developed projection engines will reduce the power consumption of the video wall to previously unattainable values, still offering far greater brightness than is actually needed in a 'controlled' control room environment.

Despite all the benefits that DLP cubes can offer a video wall in a traffic control center, many installations still opt for thin-bezel LCD screens. As long as you follow certain guidelines, this can be a viable alternative. First, use a professional display version – don't combine it with devices you would use at home. Second, although today's LCD panels have become more robust and less vulnerable to burn-in effects, they should still be regularly switched off for a few hours or at least change content from time to time.

Image quality challenges

Static images displayed for a prolonged time still bring the risk of image retention effects, which will affect the quality of screen display. This is not only the case with classic static content, such as maps or grids, but also applies to static objects inside the video signals.

User-friendly control of the system is essential in processing the masses of information coming to a control room.

Collaboration with off-site services is no longer just an aspiration, it is essential to authorities responsible for traffic control and its security related aspects. In both cases, adequate answers can be provided by the implementation of up-to-date hardware for the distribution and control of incoming signals, and, probably even more importantly today, through the use of powerful software tools for the orchestration of the control room system.

The dominance of IP-based signals must be kept in mind when choosing the right components for the network and the hardware that handles the transformation of incoming IP video signals to their final representation of the video walls and local desktops. Efficient handling of video streams here can help maintain the performance of the system despite the massive bandwidth-load video cameras and other IP-based streams produced today. While ancient analog systems, or even more recent digital systems, needed massive hardware installations to handle the increasing number of camera signals, modern systems can be realized with graphic controllers with embedded decoding based on internal hardware or software applications, such as Eyevis's NetPix controller devices. These will require far less rack space than previous systems, or can alternatively be realized through localized small form factor PCs that are installed attached to the cubes or displays of the video wall, as with Eyevis's EPU-Wall concept, which is based on EyeUnify wall management software.

Need-to-know information for effective WIM management

The main danger for a road network is the destruction caused by overloaded vehicles, which can pose a very real safety risk to all those traveling on affected routes. To protect infrastructure investment, therefore, it is essential that effective weight enforcement takes place.

Balancing the costs

The resources collected with fines, even if they are very high, will never be enough to cover the damage done by overloaded trucks. The higher the overload, the faster the road is destroyed. Therefore the goal must be to minimize the number of vehicles with excessive weight. This can be only achieved by convincing drivers and manufacturers that overloading vehicles is not profitable. Performing weight control with static scales facilitates not only the interaction between drivers and police officers, but also the immobilization and unloading of the vehicle – strongly recommended when the load is too high. This measure, in conjunction with fair fines, will discourage drivers and manufacturers from promoting unfair competition by overloading vehicles. A mobile weight control adds to the effectiveness of the enforcement, as long as drivers don't know where they are likely to be caught.

A mobile weigh-in-motion (WIM) system can be a good solution for pre-selection. In cities with heavy traffic – such as São Paulo or Mexico City – the use of mobile WIM systems works particularly well when combined with static measurements.

The equipment itself is as important as the modus operandi. On the one hand, it must be easy to handle in order to meet the requirements of labor unions and be robust and reliable enough to fulfill the needs of the weight checkers. On the other hand, considering that drivers, aware of having an overloaded truck, will try to disturb or avoid the measuring procedure, the scales must have a low profile, to ensure drivers drive over them. They must also be big enough to accommodate double wheels. Software for storing, processing and printing the results completes the basic WIM system.

To avoid ending up in court, the whole weighing equipment must have type approval. In many countries type approval based on the recommendations of the OIML (Organisation Internationale de Métrologie Légale) is mandatory. Other countries have their own local regulations, which require time and money, leading to higher equipment costs. Accepting the OIML regulation parameters guarantees the reliability of the product and avoids unnecessary expenses and bureaucratic procedures.

Need to know

Points to remember when procuring a WIM enforcement system

- The cost of repairing damage to a road caused by overweight vehicles tends to outstrip the value of fines paid by drivers of those vehicles
- The WIM system must have type approval to avoid unnecessary legal challenges
- Writing the tender specifications should be done by someone with appropriate WIM experience

The acquisition challenge

A big challenge faced by countries inexperienced in the WIM process is acquiring the correct tool to perform the enforcement. Usually high-tech investment goods are purchased through tendering. Writing the tender specifications is a particularly sensitive task. Unfortunately, they are often written by office clerks who have never used the equipment or heard about weight enforcement. They will transcribe some randomly chosen data from data sheets and, in many cases, create a nonsensical document, full of inconsistencies and lacking in relevant information.

Incorrect technical specifications often create unnecessary administrative overwork, and waste huge amounts of time and money. The tender specifications should be written with the same care and attention as the laws that govern them. Manufacturers and end-users well versed in the process should be consulted. Testimonials from other countries can also help to formulate a clear, concise document, ensuring the resources are invested in the most suitable tool.

The factors listed here are just some of the points to observe when creating a concept for weight enforcement. There are

Richard Butter

Autonomous vehicle technology could do with assistance from bicycles

Left: **Haenni WIM systems are in use in countries all around the world**

many other issues that need to be taken into consideration, such as determining the maximum axle and total load, tolerance deductions, leveling of non-weighed wheels, fine charges, and so on. Of course, the money invested in good, reliable weighing equipment is very quickly recovered through use of an effective weight enforcement system – not forgetting the medium- and long-term benefits of the improvements to state of the road network itself.

Your man in Amsterdam, enjoying the good weather, was cycling to the office one minute, then the next, lying on the ground...

A Volvo XC70 had hit me from the side and, in the blink of an eye, my bike and I had parted ways and I'd taken a terrific bump to the back of the head. My helmet – thank God I was wearing it – had been crushed into several pieces.

Other than that, and the damage to my bike and clothing, I came away pretty much unharmed.

The driver of the car, however, was in shock, because, as he admitted, he hadn't seen me at all. Did I do something wrong? Did I, or did I not, obey the traffic rules? What about the safety situation on the road? Had I been hidden from view behind a hedge, for instance? Given my line of work, a lot of questions immediately popped into my mind, but I saved them for later.

At the office the following week, I was considering the future of Intertraffic and how the next decade will be all about autonomous driving. Thinking about my earlier mishap, this made we wonder what might have happened if my bike had told the driver that I was approaching. Reading around the subject, I found an interesting article by Margaret J Kraus on www.npr.org, titled *Bikes May Have To Talk To Self-Driving Cars For Safety's Sake*.

The article cited an experiment by Anthony Rowe, an associate professor at Carnegie Mellon University in Pittsburgh, who wants bikes to feed information to nearby cars to avoid collisions, and wanted to know how much information a car needs from a cyclist to trigger an automatic braking system.

Rowe achieved this by pedaling up and down a busy street in Pittsburgh's university district on a bike loaded with gear: with the antenna of a GPS unit extended above his head in a long plastic tube, a lidar laser range finder measured the precise position of everything around the bike, four inertial measurement units captured motion, a computer collected all that information, the water bottle contained a battery and every other spoke carried a speedometer.

"I would not be happy if I had to ride this every day," says Rowe. "But hopefully when all of this stuff just gets embedded in a cell phone on the front, then it should be no problem."

"Communication between cars and everything else will be the key to its success"

Rowe thinks self-driving cars will be much safer for cyclists and pedestrians. But while humans remain the primary pilots, he believes a little help from bikes could compensate for their weaknesses.

I agree with Rowe – the next decade will be very interesting. In my opinion, OEMs, suppliers, telecoms providers, ICT and big data will fully integrate with each other to make autonomous driving happen. It will only be a success if it causes fewer road casualties and that means that good communication between cars and everything else will be vital.

In the meantime, by the time of writing this column, during my summer holidays in Normandy, France, I had bought a new bike. And this one, made of carbon fiber, I hope not to crush.

Hopefully, then, I won't have to wait too long for these developments. I promise to keep a close eye on innovations and report on them as they happen.

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

Express lanes

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

"From 2018, we will investigate how emergency braking systems react to cyclists. They represent a very large group of people killed or injured in towns"

Andre See, head of the vehicle technology division at the German Federal Highway Research Institute (BASt)

Watch Euro NCAP lay out its 2025 roadmap
traffictechnologytoday.com/EuroNCAP

"There are no technical barriers that cannot be overcome. The scope of possibilities will be defined by budget alone"

Dr Hector J Santos-Villalobos, Identity Sciences Business Development lead, Oak Ridge National Laboratory, USA ***on the future of facial recognition technology***

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"On the I-270 corridor, we installed hard infrastructure and ITS… initial performance indicators show we saved 30 minutes on some commutes"

Gregory Slater, administrator, Maryland DOT's State Highway Administration (SHA)

Find out more about Slater's vision for his new role in a video interview, which you can watch at traffictechnologytoday.com/slater

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"It's an exciting time because some level of automation will happen and the changes will be as radical as going from horse to horsepower"

Blaine Leonard, technology and innovation engineer, Utah Department of Transportation ***on connected and autonomous vehicles***

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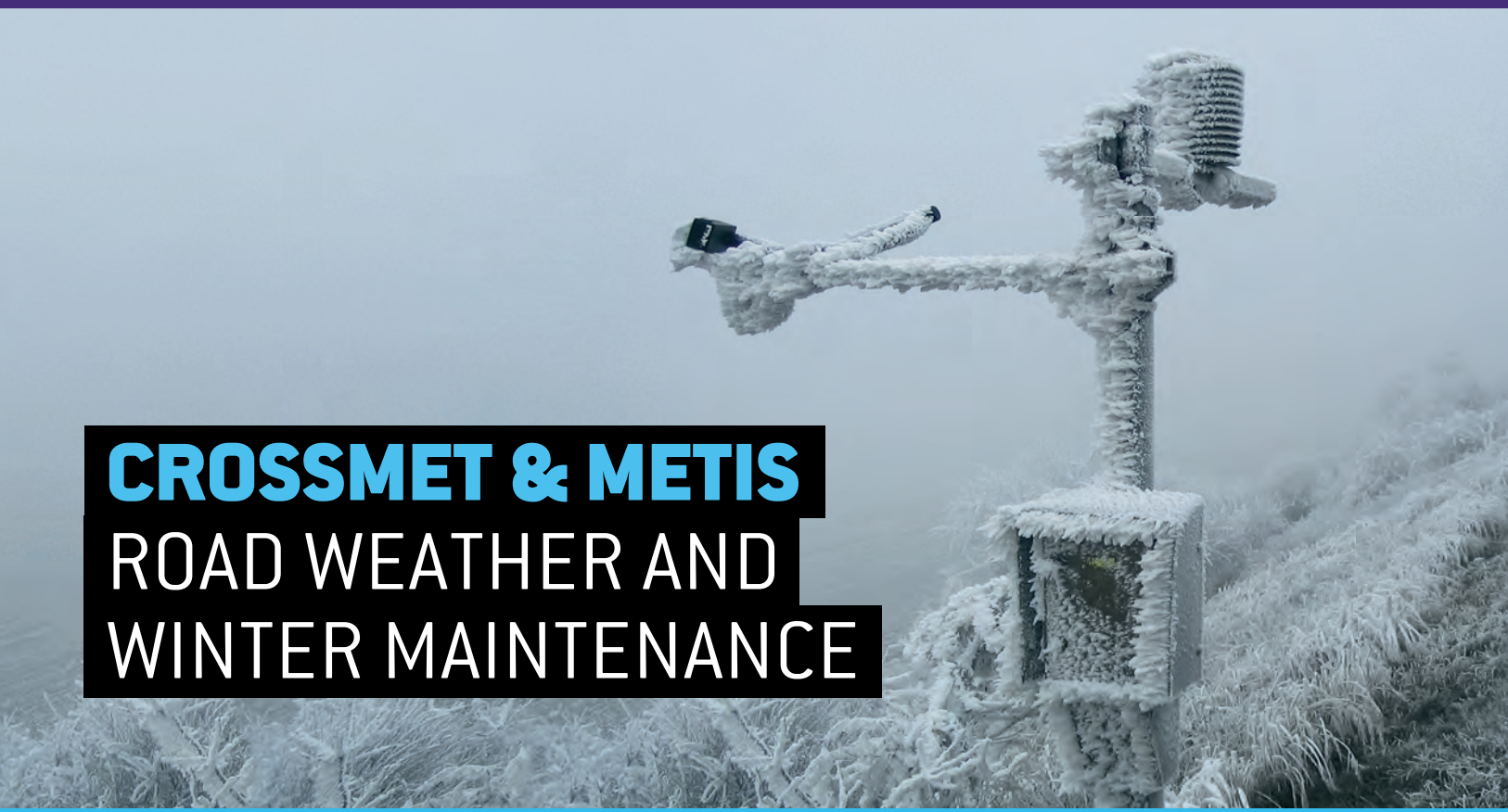
Road Traffic Technology



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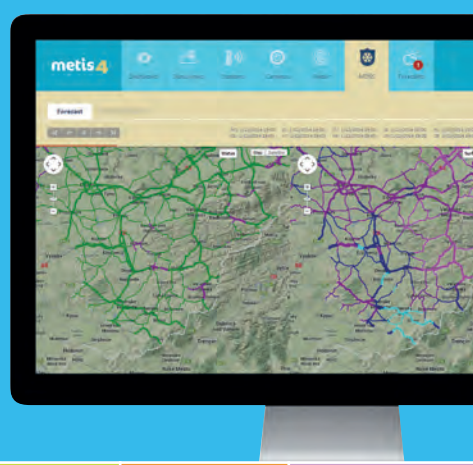

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