traffic
TECHNOLOGY INTERNATIONAL

Make VMS more effective
How the wording of a message could help improve road safety

Machine vision focus
The use of advanced AI can help reduce traffic offenses

WWW.TRAFFICTECHNOLOGYTODAY.COM

PLUS

Special **TOLLING TECHNOLOGIES** supplement inside!

Prepare for
Extreme
weather

When natural disasters are predicted, traffic managers must act quickly to organize mass evacuations. Discover the new technology that can help

FEATURING

comtrans
Your essential guide to the future of transportation communications

➡ | TMaaS revolution
How Traffic Management as a Service could transform the way transportation in cities is accessed and organized

➡ | Cellular beats DSRC
A new test has shown that V2X communications based on cellular tech beats DSRC for reliability

PTV GROUP

the mind of movement

You know the benefits of establishing a smart city.
We know how to realise it best.

With our traffic software, we help over 2,500 cities model, simulate, plan, analyse, and predict traffic and transport to optimize the flow of movement.

Take a virtual tour of our PTV Mobility Lab at ptv.to/mobilitylab or join the conversation, #MindofMovement.

www.ptvgroup.com
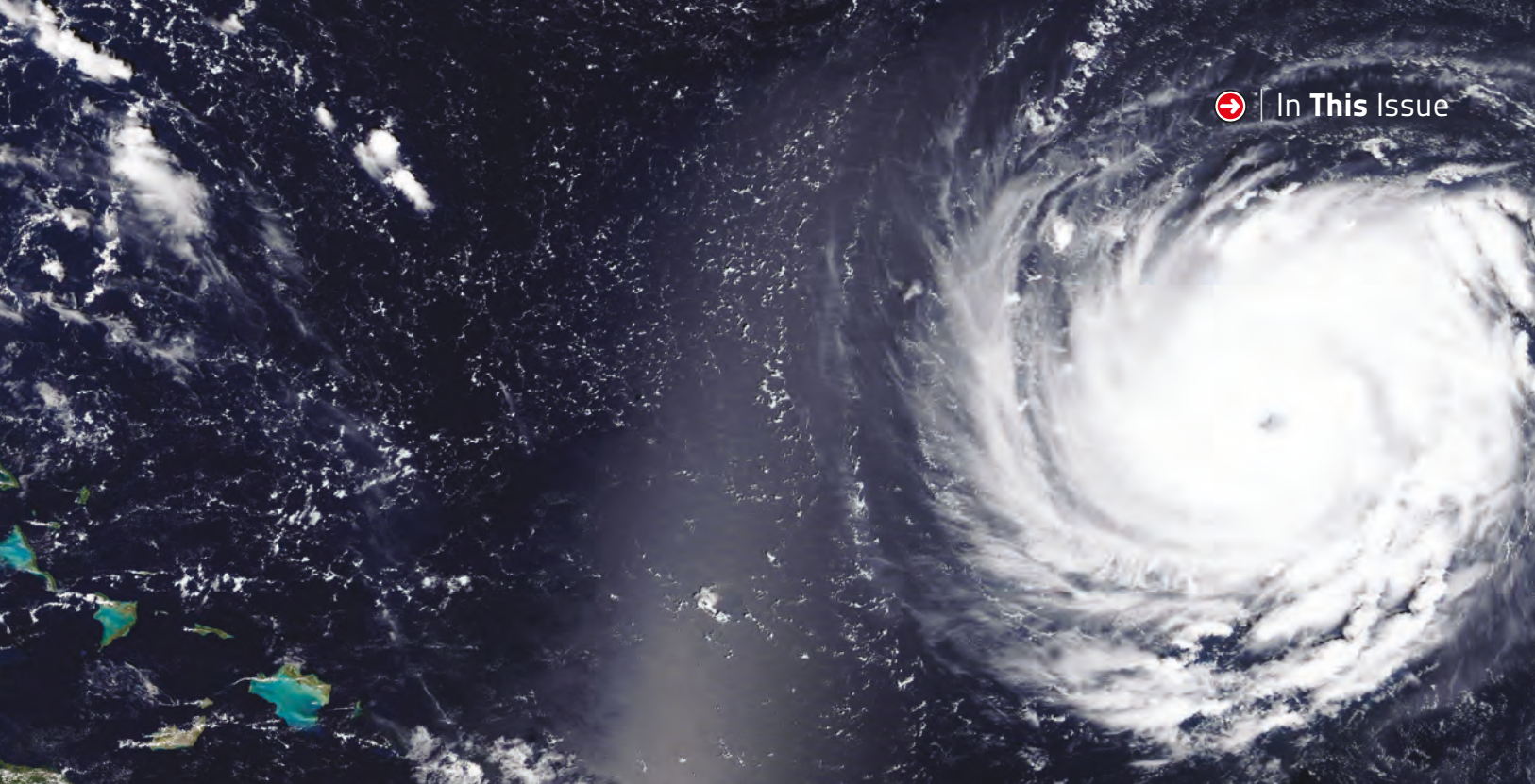
Cover story

26 Preparing for a storm

When Hurricane Florence approached the US East Coast, a full evacuation was needed

Paul Willis reports on how advanced GIS and real-time information tools enabled one million people to move out of harm's way

In **This** Issue ⊖

Don't miss our exclusive tolling technologies supplement!

tolltrans 2019

ALL TOLL ROADS!

ACCESS ALL AREAS

80 Full, tri-protocol interoperability is finally here! Find out how a new system in North Carolina will transform tolling in the USA forever

Linked in
Join our group via the banner at www.TrafficTechnologyToday.com

Editor's letter

In November, the world watched in horror as the wildfire season in California reached its deadly climax. It had already been a bad year for fire in the US state, with over US$432m spent on firefighting by the end of August. But it was the Camp Fire, which started on November 8, 2018, in Butte County, Northern California, that became the worst in the state's history. Covering 153,336 acres (62,053ha), it destroyed more than 18,790 buildings and caused at least 90 fatalities, with many more citizens still reported missing at the time of going to press. Evacuation efforts were sometimes hampered by gridlocked traffic, which forced some residents to either turn back or abandon their vehicles to flee on foot, but the situation would have been much worse had it not been for the latest real-time maps and updates provided online to local residents.

Over on the East Coast of the USA, it's not fire but wind that is the most common natural enemy. And, just a few weeks before the Camp Fire, the Carolinas bore the brunt of Hurricane Florence. It was the strongest storm ever recorded in the region as it approached the coast. Its winds may have weakened by the time it made landfall, but it was still the wettest storm in Carolinian history. Fortunately, around a million people had been evacuated from

their homes. In our cover story (p26), we take a detailed look at how traffic managers in the region planned for the extraordinary strain this put on the road network by using the latest smart GIS and real-time information systems. With extreme weather events on the increase across the globe, there are surely valuable lessons within for us all.

Of course, ensuring that traffic flows easily isn't just something that must be done in an emergency – it's an everyday task that challenges many types of traffic manager. One traditional bottleneck for traffic is tolling plazas. It used to be that time savings gained from using a toll road had to be offset against the time spent waiting to pay. Free-flow tolling has been gaining in popularity, but has been held back by a lack of interoperability between transponders. Now, at last, technology has, once again, come to the rescue, at least in the USA. You can find out exactly how in one of our features (p80) that makes up *Tolltrans* – our in-depth tolling special, which begins on page 65.

It's clear that technology is the only tool with which we can hope to overcome the major challenges facing the world today, whether they are natural or man-made. It's an important point to bear in mind as we start a new year and consider plans and investments for the future.

Tom Stone, editor

NEW: UMRR-11

4D/HD HIGH DEFINITION TRAFFIC RADAR

- ✓ Multi-Lane / Multi Object Detection
- ✓ Lane Specific, Up to 6 Lanes, Up to 180 m
- ✓ One Single Sensor for Stop Bar + Advance Detection

- ✓ Replaces Loops, Outperforms Video
- ✓ Detects Moving and Stopped Traffic
- ✓ Works Under All Conditions
- ✓ Maintenance Free

| INTERSECTIONS | ARTERIALS | ENFORCEMENT |
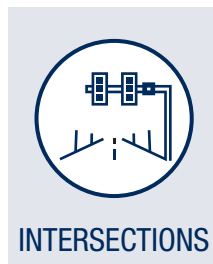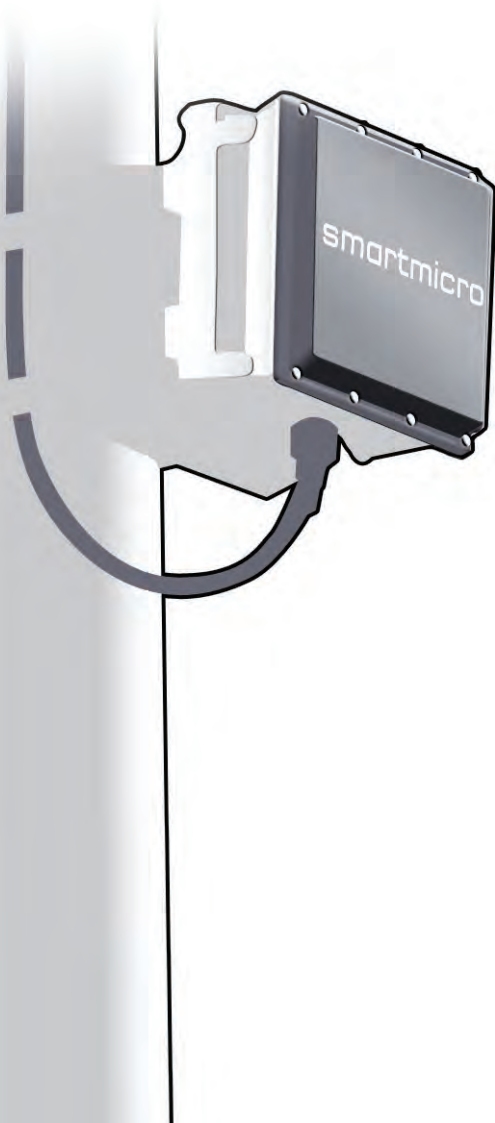
smartmicro traffic radars.
Engineered and made in Germany.

www.smartmicrogroup.com | info@smartmicro.de

TRB
in DC

The Transportation Research Board will host its 98th Annual Meeting in Washington DC from January 13-17, 2019, helping thousands of transportation professionals to keep up to date on key issues and trends in the industry

Washington DC serves as headquarters for a number of organizations that are key to the US transportation industry. Home, of course, to the White House, it is also the location of the US Department of Transportation (USDOT) and the Transportation Research Board (TRB).

The main event
From January 13-17, 2019, the TRB will hold its 98th Annual Meeting at the Walter E Washington Convention Center, in Washington DC. This year's theme is: Transportation for a smart, sustainable and equitable future.

"The TRB Annual Meeting provides the opportunity for participants to hear from, and interact with, the leading researchers and practitioners on the full range of issues in transportation," Neil Pedersen, executive director of TRB, tells *Traffic Technology International*. "There are expected to be over 13,000 attendees who will participate in more than 800 sessions and workshops, with dozens of sessions related to the latest developments in traffic technology, including connected and automated vehicles. There will be sessions featuring executives from the US Department of Transportation, as well as sessions from state DOT CEOs."

PREVIEW

TRB ANNUAL MEETING
CONVENING THE TRANSPORTATION COMMUNITY FOR 98 YEARS
January 13–17, 2019 › Washington, D.C.

Award winners

At the Chair's Luncheon, the TRB will present three of its prestigious awards

The Chair's Luncheon takes place on January 16. As the premier event of the Annual Meeting, it draws an audience of around 750 transportation leaders from the public and private sectors throughout the USA and elsewhere.

FRANK TURNER MEDAL FOR LIFETIME ACHIEVEMENT IN TRANSPORTATION

WINNER

Mary Peters
Former US Secretary of Transportation

WN CAREY, JR DISTINGUISHED SERVICE AWARD

WINNER

Dr Susan Hanson
Distinguished university professor emerita in the Graduate School of Geography at Clark University

ROY W CRUM DISTINGUISHED SERVICE AWARD

WINNER

Dr Daniel Sperling
Distinguished professor of civil engineering and environmental science and policy, and founding director of the Institute of Transportation Studies at the University of California, Davis

188
The total number of speaker sessions and workshops themed specifically around operations and traffic management

Topics covered in the sessions and workshops will be of interest to policy makers, administrators, practitioners, researchers and representatives of government, industry and academic institutions in all areas of transportation. "The Chair's Luncheon will feature the report that is about to be issued by the TRB on the future of the interstate system in the USA," says Pedersen.

As well as visiting a packed exhibition hall attendees can also look forward to the second annual Careers in Motion Networking Fair and the Young Professional Reception, both on January 13. ○

Book your pass at trb.org/AnnualMeeting/

Above: **Washington DC is home to the Transportation Research Board**

❝ The TRB Annual Meeting provides the opportunity for participants to hear from leading researchers and practitioners on the full range of issues in transportation

Neil Pedersen, executive director, the Transportation Research Board (TRB)

Capital
connections

Washington DC is hosting TRB's annual meeting in January 2019, and the ITS America community will descend on the city for its yearly gathering in June. Here is a selection of transportation facts related to the US capital

Infographics by Anna Davie

5 million
The number of riders on DC's **six bus routes** per year

DC's road network is categorized by letters (not numbers), but there is no
J street
in the city

29.6 minutes
Average commute time

37.8%
of DC's 306,336 workers travel by public transportation; 12.1% walk; 4.9% work from home

1,909
The number of underground passageways connecting the office buildings, Library of Congress, and Capitol Building reserved for staff and politicians' use

22.8 million
Number of visitors to DC in 2017 (two million travel from abroad)

2,205
The total number of streets in DC
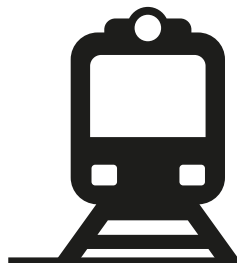
5 million
The number of passengers taking the city's Amtrak trains annually

3.1%
of DC commuters cycle to work, compared with a 0.6% national average

17,000
Metered parking spaces in Washington DC

69 million
The number of passengers served by the area's three airports every year

The Metro system is the nation's second-busiest, with **six rail lines**, 117 miles of track and 91 stations providing 204 million trips per year

Intertraffic

The leading traffic technology events
connecting traffic professionals worldwide

INFRASTRUCTURE • TRAFFIC MANAGEMENT • SMART MOBILITY • SAFETY • PARKING
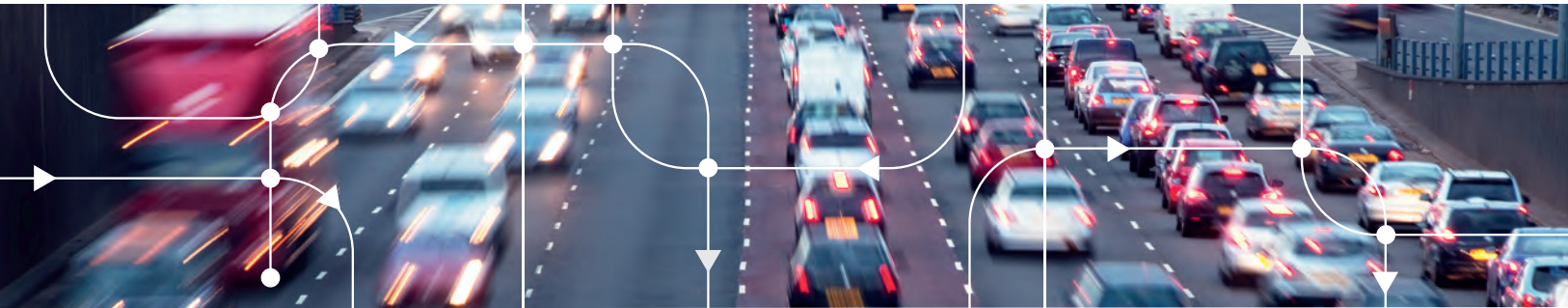
Save the dates
for our upcoming events

ISTANBUL - TR
10 - 12 APR **2019**

SHANGHAI - CN
27 - 29 MAY **2019**

JAKARTA - ID
6 - 8 NOV **2019**

MEXICO CITY - MX
12 - 14 NOV **2019**

AMSTERDAM - NL
21 - 24 APR **2020**

Organised by:

rai
AMSTERDAM

In partnership with:

TTEC

中国智能交通协会
ITS CHINA

UBM

Tarsus
MEXICO

Tarsus
INDONESIA

www.intertraffic.com

Toll
nations

How the world is paying for its roads now, and the new systems being delivered for the future

Time-saving travel

Kapsch and OMV increase European toll interoperability for trucks

Kapsch has partnered with Austrian petrochemicals and fuel services firm OMV to launch a standardized, continent-wide truck tolling solution.

In many cases, different transponders and different forms of payment are required for different European countries and even for individual freeways on the continent.

The Smart Toll system, however, is based on the European Electronic Toll Service (EETS) and enables users to make cashless payments at various toll stations, bridges and tunnels.

In the system developed by Kapsch, the fees and tolls paid through the transponder are handled centrally by OMV.

The billing service will be managed by a subsidiary of Kapsch that already operates in Austria and Hungary, with Germany, France, Spain, Portugal, Italy and Belgium due to follow shortly.

E-ZPass extension

Florida becomes the 17th state to join the world's largest road toll network

The Central Florida Expressway Authority (CFX) is to accept E-ZPass transponders on its Metro Orlando toll roads.

The toll agency's decision means that the E-ZPass Group toll road network – already the largest in the world – now covers 17 states across the USA.

Independent agency CFX operates a regional network of expressways for three million residents of Brevard, Lake, Orange, Osceola and Seminole counties and more

than 72 million annual visitors to central Florida.

On average, more than one million toll transactions are recorded daily, 85% of them electronically. CFX operates E-Pass, the first electronic toll collection system in Florida, with nearly 400,000 accounts.

With the addition of CFX to the E-ZPass Group, customers can now use their existing transponder on CFX's toll roads in central Florida and Metro Orlando, and will be billed for CFX tolls through their E-ZPass accounts, with no extra fees or charges.

118

The length in miles of Central Florida Expressway Authority's express lanes (190km)

"We want higher taxes!"

Survey reveals Americans are willing to pay more to fund infrastructure

A national public opinion survey shows US residents would be willing to pay higher tolls and taxes for improved infrastructure.

Commissioned and published by the HNTB Corporation consultancy, *Funding Congestion Solutions – 2018* found that 61% feel traffic congestion is noticeably worse now than a year ago, with 73% willing to pay to fund maintenance or new construction to help. Support increases to 82% if the taxes or tolls would be used only for infrastructure spending.

Should sufficient funds not be available from other sources, the survey found that 79%

of Americans support higher taxes and tolls for that purpose.

When investments from public-private partnerships were considered as means to fund infrastructure costs, 55% of those surveyed preferred repaying investors through tolls paid by the users of that specific highway or bridge, versus 45% who favored taxes paid by everyone.

Fleet tolling made simple

GPS tracking system for keeping on top of driver tolling costs has been released

New York City-based organization Coord is making it easier for carshare, car rental and fleet operators to understand the cost of tolls incurred by the vehicles they have used.

The new Tolls API (application programming interface) has a GPS trace (a series of timestamped latitude/longitude pairs) that covers all tolls along the route with their prices at the time they were incurred by the vehicle.

Typically fleet operators can already track the locations of their vehicles, so all they have to do is to call the Tolls API with the GPS trajectory (latitude, longitude and timestamp).

The Tolls API covers over 80% of tollways in the USA and Coord has spent time aggregating and normalizing this data, which is commonly housed as PDFs or images on tolling authority websites or, in the case of dynamic tollways, as live feeds of various specifications.

80%

The proportion of toll roads in the USA that are covered by the new fleet management software Tolls API from Coord
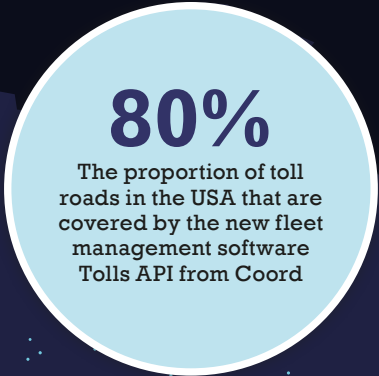
LA express lane upgrade

Automated tolling technologies introduced on LA County express lanes

Los Angeles County's express lane tolling system is to be modernized with the latest in automated technologies.

Digital services firm Conduent's tolling platform will enable LA County Metropolitan Transportation Authority (Metro) to use enhanced analytics and build on the ExpressLanes project along its busiest interstates. Upgrades will include installing overhead scanners and multiprotocol, automatic vehicle identification equipment that will communicate with transponders installed in commuters' vehicles.

Metro and Conduent had originally converted the LA County's high-occupancy vehicle lanes (HOV) to high-occupancy toll (HOT) lanes in 2012 as part of the ExpressLanes initiative. To help ease congestion, the scheme gives solo drivers the choice of paying a toll to travel on high-traffic corridors, with car pools, van pools, motorcycles and buses still able to travel for free.
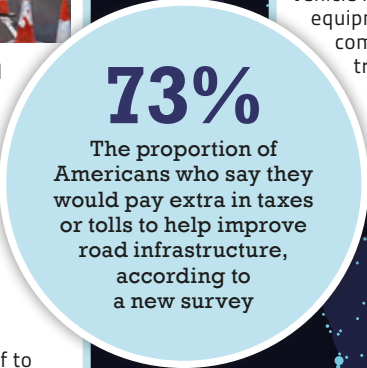
New plans for M6 Toll

A UK road authority is considering an ambitious plan to cut congestion

The UK's West Midlands Combined Authority (WMCA) is considering a congestion-busting plan to keep the region's traffic moving by optimizing use of a busy toll road.

According to the Congestion Management Plan being considered by the Authority, the region could be monitored 24 hours a day by its first Regional Transport Coordination Center (RTCC).

Included in the plan are proposals to make better use of the M6 Toll during peak times, the use of drone technology to help emergency services when responding to car accidents, and extending the Swift Card electronic ticketing scheme to include cycle hire, taxis and electric vehicle charging. Local businesses are also being asked to encourage staff to make more sustainable journeys, such as by cycling, walking, carsharing or scheduling their journeys outside peak hours.

73%

The proportion of Americans who say they would pay extra in taxes or tolls to help improve road infrastructure, according to a new survey

tolltrans

Turn to page 65 for Tolltrans – 40 pages devoted exclusively to the latest in tolling technology

Active Vehicle Counter ✕

MDOT SHA Active Vehicles in Map View

57

MDOT SHA vehicles with location tracking that are currently active across the State of Maryland. Near real-time vehicle current and past location does not necessarily imply active snow removal and/or treatment operations have occurred at those locations.

Plowing
ahead

Maryland Department of Transportation State Highway Administration has developed a web–based travel information system to enable the public to keep track of snowplows and plan journeys accordingly

Maryland's innovative STORM app shows drivers which roads have been treated and cleared by snowplows

30%
The reduction in salt use that MDOT SHA achieves by pre-wetting salt to help reduce bounce and scatter

Reducing delays during winter weather is a challenge for many state DOTs across the northern USA. But rather than leave its citizens to rely only on traffic reports or third-party navigation apps, engineers at Maryland Department of Transportation State Highway Administration (MDOT SHA) realized that they already had useful data that could be added to simple travel-time information to help drivers know where snow and ice is worst, and which roads have been treated. The key was snowplow location data.

MDOT SHA administrator Greg Slater unveiled the agency's newest tool – a mobile-friendly web application link called STORM (Statewide Transportation Operations Response Map) – at its recent annual Snow Show event.

STORM enables citizens to track – in near real time – MDOT SHA and contractors' pre-treating brine trucks in advance of a storm and plow trucks during a storm. People can enter their address to see where in their area trucks are operating. Each truck leaves a red line behind it on the map showing the route it has traveled, helping citizens to plan their travel on roads most likely to have been cleared. Equipment is visible only when moving at 10mph (16km/h) or more, which helps to eliminate screen clutter, especially near maintenance shops where trucks are moving at slower speeds.

"The STORM app is an innovative way to enhance the customer experience," says Slater. "An average snow route takes a plow driver approximately 90 minutes to complete. The new app will show where they are and where they have most recently traveled."

With Maryland bracing itself for a cold winter, MDOT SHA is fully stocked with road salt, but is also making strides to reduce its overall use by improving efficiency. Some of the methods being used to do this include pretreating roads with liquid salt brine to prevent the initial bonding of snow and ice to the roadway (with some routes classified as 'liquid only' in all but blizzard conditions) and also pre-wetting salt to help it stick to target surfaces more effectively. ○

" An average snow route takes a plow driver approximately 90 minutes to complete. The new app will show where they are and where they have most recently traveled

Greg Slater, administrator, Maryland DOT State Highway Administration

13th ITS EUROPEAN CONGRESS

FULFILLING ITS PROMISES

Brainport Eindhoven, the Netherlands | 3-6 June 2019

SAVE THE DATE

The 13th ITS European Congress 2019

Brainport Region - The Netherlands
3-6 June 2019

A unique opportunity to

- Exchange information with 3000 industry stakeholders and influencers
- Discover the latest mobility solutions
- Share experiences and lessons learned
- Monitor progress and measure results of implementation and deployment
- Exhibit and experience cutting-edge technologies and innovative products and services
- Enter business and partnership opportunities
- Experience the latest technology first hand through demonstrations

Visit **www.2019.itsineurope.com** for information on Call for Contributions and Commercial Partnership & Exhibition opportunities.

Organised by:
ERTICO ITS EUROPE

Hosted by:
EINDHOVEN
Gemeente Helmond

Supported by:
Connekt ITS Netherlands
Ministerie van Infrastructuur en Waterstaat
Brainport Development
Provincie Noord-Brabant

The ITM has been built into the Audi e-tron's rearview mirror, to maintain maximum visibility through the windshield

Smooth
operator

The first module of its kind built into a new Audi vehicle is making tolling more efficient and could have wider applications in the future. **James Allen** reports

Audi is simplifying the tolling experience for drivers and increasing road safety in the process. Built into the new e-tron, the Integrated Toll Module (ITM) will be the first automated payment system to feature in a commercially available vehicle.

The vehicle-to-infrastructure (V2I) technology relies on the fully electric SUV's onboard infotainment system to communicate with local tolling reader devices, allowing the driver to pay the charge without stopping.

Typically, to perform such an action, a stick-on toll transponder must be displayed on the vehicle's windshield. The ITM removes such a requirement – meaning the windshield can remain clutter-free.

50 million
The number of US drivers who use toll roads each year, who could potentially benefit from the new ITM module

Compatible with all the major US toll road operators, including FasTrak, EZ Tag, SunPass and E-ZPass, the module can store all necessary toll registration details, eliminating the need for drivers to hold separate accounts with individual operators.

Adjustable settings on the module mean occupant numbers for high-occupancy vehicle/toll (HOV/HOT) lanes can be changed. The system can also be switched off if cash payment is preferred.

Tolling manufacturer TransCore teamed up with electronics firm Gentex to build the module into the e-tron's rearview mirror to keep windshield visibility clear.

"This strategic partnership with TransCore allows us to develop an all-new product offering that helps auto makers seamlessly integrate toll collection into the car, just as they've done with navigation systems, satellite radio and other technologies that debuted in the aftermarket," said Gentex senior vice president and CFO Steve Downing. "The ITM offers the new car owner the ability to enjoy a hassle-free driving experience using managed lanes and toll roads across the country. But it also establishes a foundation for future car-to-infrastructure transactions."

The five-passenger, battery-electric e-tron is expected to be in showrooms in early 2019. ○

" The ITM offers the new car owner the ability to enjoy a hassle-free driving experience using managed lanes and toll roads across the country. But it also establishes a foundation for future car-to-infrastructure transactions

Steve Downing, senior vice president and CFO, Gentex

For more news on the move toward full tolling interoperability across the USA, see Tolltrans, p80

Left: **Indonesian President Joko Widodo, dressed in a hard hat and high-vis jacket, caused a stir as he arrived at Intertraffic Indonesia**

Below: **Host city Jakarta is being transformed into a modern metropolis**

Showtime in
Indonesia

Inaugural Intertraffic Indonesia opened by the country's President, Joko Widodo

The opening of the first ever Intertraffic Indonesia event, on October 31, 2018, was an auspicious one, with a keynote from the nation's president. The appearance of Joko Widodo underlined the significance of the three-day event, held at Jakarta International Expo, Kemayoran, through November 2.

The Indonesian leader used his speech at the opening ceremony to highlight the importance of implementing new technologies. "Infrastructure development is conducted not only to push economic development in Indonesia, but also to unite the entire country," said Widodo.

As part of the ceremony, the president also recognized the

34
The number of countries represented by the 3,830 visitors attending Intertraffic Indonesia

❝ Infrastructure development is conducted not only to push economic development in Indonesia, but also to unite the entire country

Joko Widodo, President of the Republic of Indonesia

achievements of some of the nation's construction workers, with 10,000 individuals having received a certificate for passing a government-backed training program.

Comprising 5,480m^2 (59,000ft^2) of exhibition space, Intertraffic Indonesia had 74 traffic technology businesses showcasing their products and attracted 3,830 visitors from 34 countries.

Richard Butter, director of traffic technology for event co-host RAI Amsterdam, said, "Indonesia has great potential in the traffic technology and Internet of Things industries since congestion is one of the main problems facing the country. Intertraffic Indonesia is a great platform to present new technologies that can be implemented to improve Indonesia's road transportation infrastructure and traffic management."

In addition to the exhibition, there were two full days of expert-hosted sessions from national and international speakers, which provided attendees with a source of informed smart city thought and debate.

Overall, the show was such a success that the plan is to make it an annual event, with Intertraffic Indonesia 2019 already confirmed for November 6-8 at the same site.

Nino Gruettke, CEO of co-host Tarsus Asia, said, "As a first edition, Intertraffic Indonesia 2018 shows huge potential to grow further and assume a pivotal role in Indonesia's traffic management and IoT industries. We are delighted to be involved with Intertraffic Indonesia and to play a part in Indonesia's traffic development." ○

2020-2030

AND BEYOND...

CHANGING THE WAY PEOPLE THINK ABOUT TRANSPORTATION & URBAN MOBILITY!

STREAMS & SESSIONS INCLUDE:

PATHWAYS FOR AUTONOMOUS VEHICLES

CHANGING LANDSCAPE FOR THE AUTOMOTIVE INDUSTRY

5G – THE ESSENTIAL BUILDING BLOCKS

MOBILITY AS A SERVICE

URBAN CITY AND INTERCITY AIR MOBILITY

WHY RAIL IS DEAD IN THE WATER

VISIT THE WEBSITE FOR MORE DETAILS AND TO REGISTER!

www.thefutureoftransport.com

The ITS World Congress in Copenhagen, in September 2018, was a significant event for the whole of the transportation industry, enabling some of the most influential and innovative figures to come together and plan the mobility systems of the future. However, for one man at least, it was also a chance to look back and reflect on an entire career. ERTICO's Paul Kompfner was the recipient of one of this year's Lifetime Achievement Awards. Three are handed out each year to inspirational figures from the major ITS regions. This year Dr Kent Kwo-Tsai Wang was honored by ITS Asia-Pacific, Jeff Paniati picked up the gong from ITS America, and the UK's Kompfner was recognized for his work in Europe.

The day after the awards ceremony, I bumped into Kompfner in the exhibition hall. I was soon beguiled by his generous and open manner, and what I thought would be a brief handshake and congratulations soon turned into coffee, Danish pastries and a really good chat…

"I've had two careers in my life," Kompfner tells me. "One was at the Transport Research Laboratory [TRL, in the UK]. I started my journey in ITS there. I was working on a project on automated data recorders – accident black-box recorders – in the mid-1980s. I also got into something called the Ireland-Rhineland Project, which was a modeling study of transport flows and traffic movements along a corridor between the Rhineland and Ireland."

Kompfner's pan-European work and outlook during his 21-year career at TRL put him in a prime position to be recruited to

Paul Kompfner is the ITS Hall of Fame's most recent inductee, but his work is far from being over – he's now looking at new ways ITS can fight climate change

Interviewed by Tom Stone

13th ITS EUROPEAN CONGRESS
FULFILLING ITS PROMISES
Brainport Eindhoven, the Netherlands | 3-6 June 2019

Left: **Eindhoven's Evoluon center, the venue for the 13th ITS European Congress**

13th ITS European Congress

The next big event on the ERTICO calendar is the 13th ITS European Congress, which will take place next year – from June 3-6, in the Brainport region of Eindhoven, in the Netherlands.

With the theme 'Fulfilling ITS promises', the event will showcase the latest technologies adopted in the local area. Brainport is part of Europe's technological backbone and enjoys global recognition as a center for innovation and automotive solutions. This, combined with ERTICO's mission and work on promoting and developing smart mobility services, means a fantastic program of innovative live demos will be showcased between the Evoluon center in Eindhoven and the Automotive Campus in Helmond.

The congress will also host sessions with top mobility experts addressing today's key issues. It presents a strategic opportunity for all mobility stakeholders to come together and make the necessary contacts to develop their businesses.

Follow the event on Twitter @ITS_Congresses and @ERTICO using #ITSNL19 and #TalkingITS. www.2019.itsineurope.com

Europe's first multisector ITS partnership – ERTICO-ITS – when it was set up in 1992. He went on to serve the organization for the rest of his career.

"The idea was to do real, practical projects," remembers Kompfner. "So they wanted ITS people – and I was the closest they could get! Eric Sampson, who was my mentor in the department, was also chairman of ERTICO, so he was one of the founders. He asked if I want to be seconded out to Brussels… so that's how it started.

"I arrived and started working in August 1992. We were doing a range of projects to support the Strategic Plan for Advanced Transport Telematics in Europe. I was looking after the working group on assessment methods, which is what I'd been doing at TRL. It developed from there – I stayed on as a temporary expert for what turned out to be 25 years!"

The evolution of ITS

Kompfner's long view of the ITS industry, having been involved from the very early days, has given him a useful perspective on what has been achieved so far and also what might be possible in the future.

"It was interesting to follow the evolution of ITS," he says. "The first project I started on my own was called ITS City Pioneers and that led to ITS Hamburg and ITS

> **Things got really interesting when cooperative systems began – an ERTICO-based consortium had 62 partners in the end**

Toolbox. It finished in 1998 and was quite advanced for its time.

"Things got really interesting when cooperative systems began," he says. "At that point there was an opportunity to pull together an ERTICO-based consortium that had 62 partners in the end, which was one of the biggest we have ever had, with a €40m [US$45m] budget. The CVIS [Cooperative Vehicle-Infrastructure Systems] project was the first real effort in Europe to look at what cooperative systems could do across eight use cases." It ran from 2006 to 2010.

In more recent years Kompfner has been involved in looking at how cooperative transportation systems can be used to benefit the environment. One such initiative was eCoMove, which promoted eco-efficient driving and traffic management. Kompfner has also been involved in Mobinet, a marketplace for mobility services.

Throughout his career Kompfner has always placed great value on practical demonstrations of ITS, being particularly proud of a traffic light-to-vehicle engine cut-off system he helped to develop and also, more recently, a real-time handover between ITS G5 and cellular communications. "I think we still have the only live demonstration without losing the connection. Q-free was our partner on that," he recalls.

Saving the world with ITS
Kompfner retired from his role as senior adviser urban mobility at ERTICO in March 2018, but he's still involved in the industry and taking inspiration from his earlier environmental work in his latest project.

In Europe, the transportation sector produces 24% of all greenhouse gas (GHG) emissions (Eurostat 2016). Road transport is responsible for more than 70% of that amount. The EU low-carbon mobility strategy (2016) identifies digital technologies as a key tool to make transport "safer, more efficient and inclusive". But how exactly can ITS help? Kompfner believes

that it is essential that such discussions and implementations are prioritized, which is why he is helping to plan a new event.

"We are organizing the ITS4Climate Symposium, which we think will be the world's first event dedicated to ITS for climate," he says. "It is always a theme at ITS congresses, but unfortunately it is usually the one that generates the least interest. But ITS can be a tremendous toolbox for reducing carbon emissions. The topic hasn't had the attention it deserves, at ITS Congresses or generally. The idea is that we will have six topic groups made up of experts who will present papers on each of the topics. It will be a really interesting event, with high-level, international support. The six green papers will be validated during the symposium in open workshops, and then edited together into a 'green book', collating everything we know about ITS for climate." See *ITS for climate in Bordeaux,* opposite, for more information.

A lifetime of achievement
For now, there is at least a little time to reflect on a successful career so far –

Kompfner receives his Lifetime Achievement Award at the ITS World Congress 2018

> ITS can be a tremendous toolbox for reducing carbon emissions. The topic hasn't had the attention it deserves, at ITS Congresses or generally

and there's a prestigious award for the mantelpiece.

"It was a total surprise," says Kompfner. "I got the news while on holiday and I just thought, 'Wow!' I knew I'd been nominated, as they ask if you accept the nomination, but it was a total surprise to win. You don't always know what you've achieved – I've had as many unsuccessful proposals for projects as successful ones! But I've always tried to push things forward.

"I didn't go to all the congresses, but I went to most of them and I certainly went to the first one and helped to plan it. I've been on the program committee
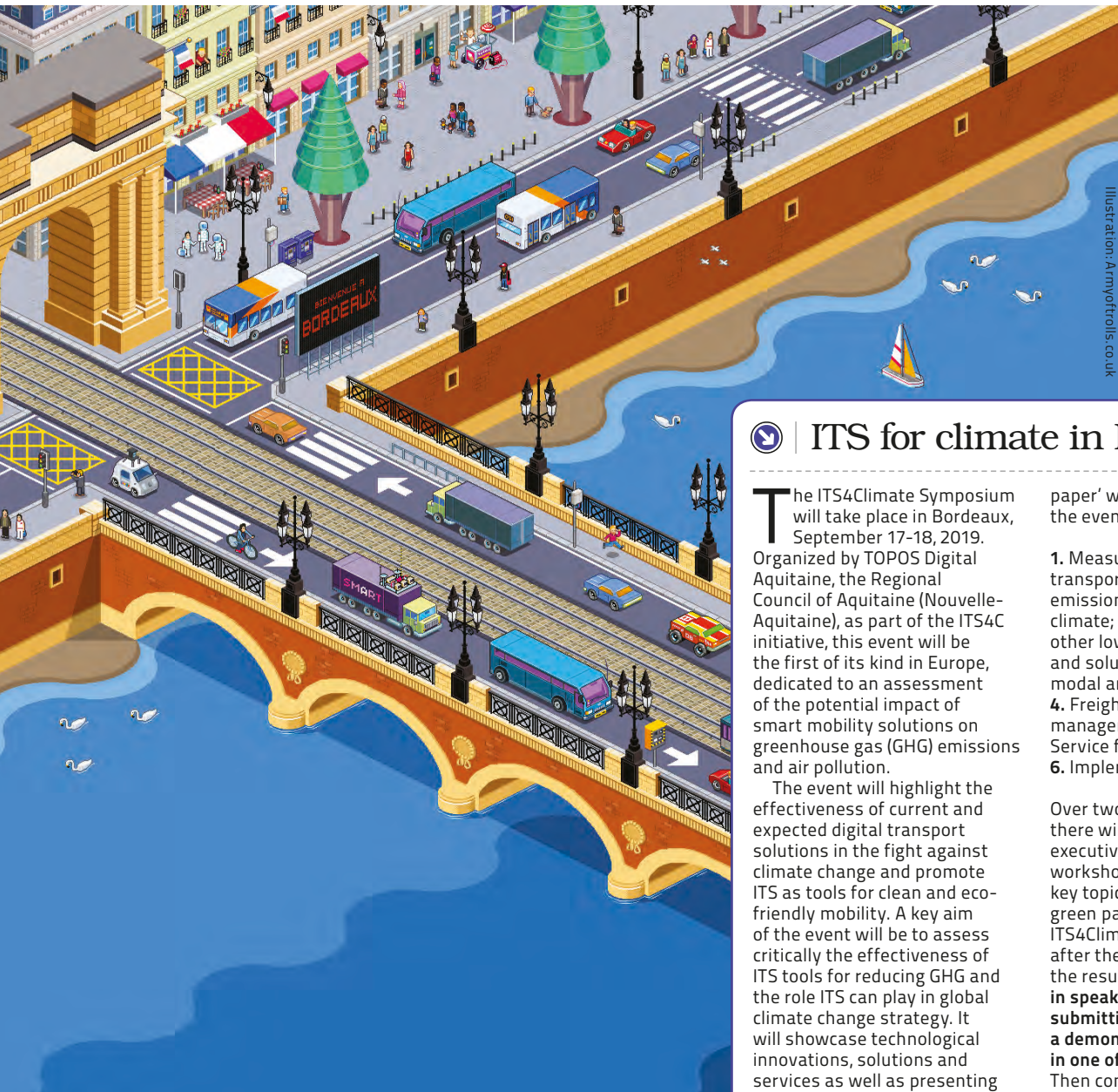
Illustration: Armyoftrolls.co.uk

Above: **Bordeaux is a city familiar with ITS, having hosted the World Congress in 2015**

and tried to innovate a bit. The problem is you can tend to meet the same people in the ITS community. But outside is the real community, and I've always fought for the congress to be more integrated with the host city. It should be on the local news, television and national news. ITS really is a terrific story."

And while modest and humble – "I feel I've helped to push things forward and that's enough for me" – Kompfner can afford to revel at least briefly in his new 'ITS legend' status: "It's just so nice to have so many people come up and recognize me. I'm a superstar for a day!" ○

ITS for climate in Bordeaux

The ITS4Climate Symposium will take place in Bordeaux, September 17-18, 2019. Organized by TOPOS Digital Aquitaine, the Regional Council of Aquitaine (Nouvelle-Aquitaine), as part of the ITS4C initiative, this event will be the first of its kind in Europe, dedicated to an assessment of the potential impact of smart mobility solutions on greenhouse gas (GHG) emissions and air pollution.

The event will highlight the effectiveness of current and expected digital transport solutions in the fight against climate change and promote ITS as tools for clean and eco-friendly mobility. A key aim of the event will be to assess critically the effectiveness of ITS tools for reducing GHG and the role ITS can play in global climate change strategy. It will showcase technological innovations, solutions and services as well as presenting existing initiatives. It will also act as a forum to showcase and exchange best practices, and launch a platform for ongoing debate and dissemination. The program will address six key topics for each of which a 'green

paper' will be prepared before the event:

1. Measuring and evaluating transport-sector carbon emissions and their impact on climate; **2.** Electro-mobility and other low-carbon technologies and solutions; **3.** Improving modal and system efficiency; **4.** Freight and logistics management; **5.** Mobility as a Service for Climate (MaaS4C); **6.** Implementation issues.

Over two full days of conference there will be keynote and executive sessions, and workshops addressing the six key topics and validating the green papers. A 'green book of ITS4Climate' will be produced after the event to summarize the results. **Are you interested in speaking, exhibiting, submitting a paper, running a demonstration or taking part in one of the expert workshops?** Then contact Paul Kompfner, ITS4C program coordinator, paulkompfner2@ gmail.com, +32 478 384 953 or Florence Ghiron, vice president Digital Aquitaine, TOPOS representative, florence. ghiron@topos-aquitaine.org, +33 673 443 575.

ITS4**C**
Intelligent Transport Sytems for Climate

Australian ITS giant Dean Zabrieszach has spent his entire career in transportation. Much of that – 31 years in fact – was as a public servant at VicRoads, the government agency that manages the highways of his home state of Victoria. But in the past few years there's been a change. Zabrieszach has moved to take on the very different pressures involved in heading up a commercial company – in 2015 he became CEO of HMI Technologies. But that's not to say he's now out of touch with state and federal affairs, because just over a year ago, in November 2017, he also became president of ITS Australia. A challenge, not least because, on taking on the role, he had a pretty tough act to follow in the shape of his successful and well-respected predecessor, Brian Negus. But if the pressure is getting to him, it doesn't show. Zabrieszach is happy and relaxed when we meet. And glad to take some time to chat about his hopes for the future, his career so far – and his old friend Brian.

"We met way back in 1984 when both he and I were working on the deployment of the SCATS system in Melbourne, for what used to be the road traffic authority in Victoria and then evolved into being VicRoads," remembers Zabrieszach. "So our careers have crossed over each other all that time. And having been ITS Australia's vice president for a number of years, including being vice president to Brian while we delivered the ITS World Congress

After a year as president of ITS Australia, and over 30 in transportation, **Dean Zabrieszach** is still brimming with enthusiasm for an industry that's evolving rapidly

Interviewed by Tom Stone

in Melbourne, it became my turn to be president, I suppose! You can only be president for so many years under our constitution. Brian did a marvellous job as president. And we've recognized him for that service by awarding him an ambassadorship – he's the ITS Australia Ambassador. And fortunately I was elected to president last November and here we are today. It's a great journey, it's a great industry to be involved in, and it's something that keeps us on our toes."

SCATS upgrade

As one of the first proponents of SCATS (Sydney Coordinated Adaptive Traffic System), working with Brian on its roll-out right across Melbourne – the first city other than Sydney to use the signal management system – I wonder what Zabrieszach makes of news that SCOOT, its rival system developed in London, is currently undergoing something of a revamp (see *Traffic Technology International* October/ November 2018 for more).

This intelligence isn't a surprise to him, not because he has a great deal of inside information on SCOOT, but because SCATS is also being updated in a similar way. "Right now, the government of New South Wales, through RMS [Roads and Maritime Service], is investing a lot of money into creating a major upgrade to SCATS," says Zabrieszach. "I believe they're working with Cubic, one of ITS Australia's partners, to come up with a better version of SCATS in the not-too-distant future. Personally, I think, as someone who worked with SCATS for a long time, it is in need of an upgrade. Nothing is perfect. That system is relatively old. It does need a massive upgrade because things have changed. Back in the day, when Brian and I and our colleagues were rolling out SCATS, it was very much an intersection-by-intersection approach, whereas hopefully this intersection could link with the other one. A few years down the track it was different routes that needed to be coordinated. Now it's networks and cities. And all of that to be

Left: **One of Zabrieszach's first jobs in ITS was rolling out SCATS across almost every major intersection in Melbourne, Australia**

A life in ITS

Dean Zabrieszach has been CEO of HMI Technologies since March 2015, a leading supplier of ITS solutions and signage in New Zealand and Australia. Prior to this, Zabrieszach enjoyed a 31-year career at VicRoads, the state road authority of Victoria, Australia. While at VicRoads he held a number of senior positions, including program development manager, maintenance program manager, ITS manager, director of road user services, and finally director of road operations.

Zabrieszach is also currently president of ITS Australia and was previously vice president and a board member. He is also a board member of ITS Asia-Pacific, and was a project director for the 23rd ITS World Congress in Melbourne in 2016.

He serves as a member of the AustRoads Cooperative ITS Program, as the Australian head of delegation and convenor of Working Group 9 on the International Standards Organization Technical Committee 204 (ISO/TC 204) for Intelligent Transport Systems. He is chair of Australian Standards Committee IT-023 for Intelligent Transport Systems, and a Club Melbourne Ambassador, promoting Melbourne as a world-class city and convention destination.

Zabrieszach has represented ITS Australia, VicRoads and Australia at numerous national and international meetings and conferences on transport standards and intelligent transportation systems.

Along with his extensive ITS and security management experience, he has helped to develop numerous road infrastructure projects in Melbourne for major events such as the Melbourne Formula 1 Grand Prix, the Melbourne 500cc/Moto Motorcycle Grand Prix and the 2006 Melbourne Commonwealth Games.

Zabrieszach emigrated to Australia in the 1950s with his Italian parents, learned English at school, and graduated from the University of Melbourne with a degree in civil engineering in 1979.

done efficiently requires much better and stronger data than what you get out of a loop, which might be damaged anyway."

With so many years of experience, Zabrieszach is confident that improvements can and will be made, and knows that even small changes can have a real impact. "We know that if you can just get that little 5% improvement it makes such a big difference," he says. "For example, when I was at VicRoads, during school holidays, the public would always ask, why is it so much better? The truth was that there was only a little

less traffic on the roads, but it makes such a huge difference to journey times to have that 5-6% reduction in volume.

"Congestion is the bane of everyone's existence. We're all drivers. We all enjoy driving in a way, but we all get frustrated by being stationary a lot of the time and the whole idea of these improvements is to make everyone's journey a little bit more efficient."

The ITS Australia success story

Zabrieszach is immensely proud of the work of ITS Australia, an organization he has

> "Personally, I think, as someone who worked with SCATS for a long time, it is in need of an upgrade. Nothing is perfect. That system is relatively old. It needs a massive upgrade because things have changed

> "I operate as a facilitator of things. I like to convene presentations. I like to coordinate and develop the implementation of technology

been involved with for many years, both as vice president and board member. But, even though he has now taken the top position of president, he doesn't see himself as an autocratic leader, more of an inclusive facilitator of collaboration. "That's the way I operate," he says. "I like to be a facilitator of things. I like to convene presentations. I like to develop the implementation of technology. I've gone well past the days of designing things and digging holes and building things myself. I'm closer to retirement than I am to starting. But it's a great gig and the board is really cohesive. We've never got to a point, whether in Brian's time or mine, when there's been an argument or a deadlock in terms of opinion. When we make a decision, it's a unanimous decision."

This is an impressive feat, especially when you consider how many great minds and differing opinions must come together in the ITS Australia boardroom. "It's a fairly large board in comparison to corporate organizations," says Zabrieszach. "We like to have representation from a number of different sectors, so it's a 15-16 person board, with road agencies, various industry

players, my company, HMI, included, and academia from right across Australia. They do a lot of strategic thinking and decision making."

However, important as the board is, Zabrieszach sees the real lifeblood of the organization as its members and he credits CEO Susan Harris as the person largely responsible for growing this membership considerably over the past eight years. "When we appointed Susan back in 2010-11, we had 60 members and Susan and one other lady as a team," he says. "We now have over 120 members so we've doubled in that time. And Susan has a team of seven with her and they do a great job with some of the events they've organized. The last few years have been about events, particularly the ITS World Congress [which took place in Melbourne in 2016].

"But events only carry us so far and what we decided to do after the World Congress is say, okay we'll invest back into the industry by creating positions like a policy manager – which we now have, a lady called Stacey Ryan. So her job is to link the issues that are happening around the world with our

members and government to whom we're advocating. We've also appointed marketing managers and communications managers. So we've now created a team which I think – I'm probably biased – is as good as any ITS association in the world in terms of our output, in terms of our reach, and in terms of our advocacy. Certainly we're not as big as ITS Asia-Pacific, ITS America, or perhaps ERTICO, but when you come to other individual country ITS groups, I don't think we have anyone that can stand up to us. And again, as I said, that's a combination of Susan's team doing a great job every day, and also the board, which does a bit of the strategic thinking."

Future focused

So, just what sort of strategic thinking is needed to address the demands of today's road managers and users? Zabrieszach is clear that needs and attitudes have changed somewhat since he first started in the industry. "When I began at VicRoads it was all about more lanes, more roads, more asphalt – bigger, better, wider. And if there's a bit of technology, chuck that in as well," he

Looking to an autonomous future

HMI Technologies, the company that Dean Zabrieszach joined as CEO in 2015, designs, manufactures and sells electronic signs for roadways.

"In 20 years' time HMI might not be selling so many electronic signs, because the cars of the future won't necessarily rely on a big hunk of steel in the sky, telling them what's going on," says Zabrieszach. "So we're now venturing into another product, in addition to the signs, and that's to develop our own autonomous shuttle.

"We've developed Ohmio, a platform that drives the vehicle. We're now setting up relationships with other partners to manufacture the vehicle with us, whether it's a cybersecurity system or braking system – whatever things are needed to make it work.

One particular area of technology that HMI is developing itself in relation to its new autonomous vehicle platform is artificial intelligence (AI) for machine vision. "Autonomous vehicles rely on a lot of devices to confirm where the vehicle is at any one time," says Zabrieszach. "Obviously, one device is a camera. What we're doing in the space of camera technology is instilling AI to allow the vehicle to understand what it's seeing; to understand that's a pedestrian and it's walking and it's about to cross the path. It collects data, stores it and remembers what it has seen, so that it recognizes it next time."

Such advances will help to make more traditional products even smarter. "It's not just related to vehicles," says Zabrieszach. "This type of technology can be installed in a sign that sits over a road and that sign can then be counting vehicles, measuring speed and occupancy of the lane. It can give you a lot of data that previously you'd only be able to pick up on a loop, and if the loop wasn't working you'd be in trouble. A sign can now give richer data and therefore becomes a more valuable piece of equipment."

Above and below: **Dean Zabrieszach is also CEO of HMI Technologies, which manufactures electronic signs for roads, and is developing autonomous shuttles that are driven by a platform called Ohmio**

says. "If you were to measure how much technology was going into roads back then, if it was 1-2% of the budget everyone was joyful. Nowadays we're seeing that through advocacy, and through greater learning, governments are realizing that technology can give them much better returns at a much lower spend. Technology is not the be-all and end-all, we know that, and it should only be used where needed – and appropriately. But ITS Australia advocates to governments and says, 'Look there's something really good gear here – you should consider this and go and look at that.' And that's what we're doing. We're talking to the Australian federal government all the time – we're very close to them. We're finding that the traction we're getting with government is so much better than it was in 2001. Back then, ITS was a minnow, now it's really developing in a really strong industry."

To illustrate his point, Zabrieszach gives the example of the ongoing evolution of speed enforcement, which is not only becoming more sought-after by road authorities, but is also generally more accepted by the public. "Back when speed cameras were first introduced, not everyone was thrilled about them. But now they are more commonplace and they're becoming better and better," he says. "Now you've got not only the location speed, but also the point-to-point speed checks. They're very big in Australia, and I think they're very effective." A point which, for Zabrieszach, has a much greater significance than simply managing traffic flows or generating revenue.

"The road death toll is not acceptable," he says. "Some 30,000 are killed in the USA on a yearly basis. In the 1970s in Victoria the road toll was over 1,000 per year, now we've got it down to 200 per year, and the size of the population has doubled in that time. There are also more cars per head and speeds are higher. But the death toll is lower. That's down to seatbelts, alcohol laws and enforcement. The three 'E's – education, engineering and enforcement. You've got to have the enforcement to back everything else up."

Looking back at how far the industry has come gets Zabrieszach exited about what might be achieved next. "Back in the 1970s, when I was at university, who would have thought that by the mid 1990s we'd have this thing called the World Wide Web? And in 1994 when the ITS World Congress started, who would've thought that we'd be sitting here doing what we're doing today? I wonder where we will be in the next 25 years? None of us has a crystal ball, but if I can be part of a long-term vision that takes us into the next 25 or 30 years, then I'd love to be. It's just amazing what we're going through in this period of human history."

Prepare
for the worst

As Hurricane Florence approached the USA in September 2018, it became the most powerful storm ever recorded in the region. Fortunately, winds had eased slightly by the time it made landfall, but that didn't stop a full-scale evacuation of over one million people. State DOTs used the latest real-time information tools as well as advanced GIS to aid the process, as **Paul Willis** discovers

Last September, as Hurricane Florence ravaged the USA's eastern seaboard, the North Carolina Department of Transportation put out an unusual plea via its social media platforms.

The DOT sent out an advisory to the public on Twitter, warning them against relying on Waze and other travel apps. "It is not safe now to trust them with your life," the tweet read.

Florence, which resulted in 53 deaths and massive flood damage in three states – North Carolina, South Carolina and Virginia – led to more than one million Americans being ordered to evacuate their homes.

Coordinating huge evacuations of this type along road networks is a massive logistical undertaking for the state DOTs involved and one that is being complicated by drivers' over-reliance on travel information apps, says Rob Perry, director of traffic engineering at South Carolina DOT.

"In the case of Florence, we had 35 clearly signed routes designated for

Main: **A dramatic satellite image of Hurricane Florence as it approached the USA's eastern seaboard, and** (inset) **one taken from the International Space Station**
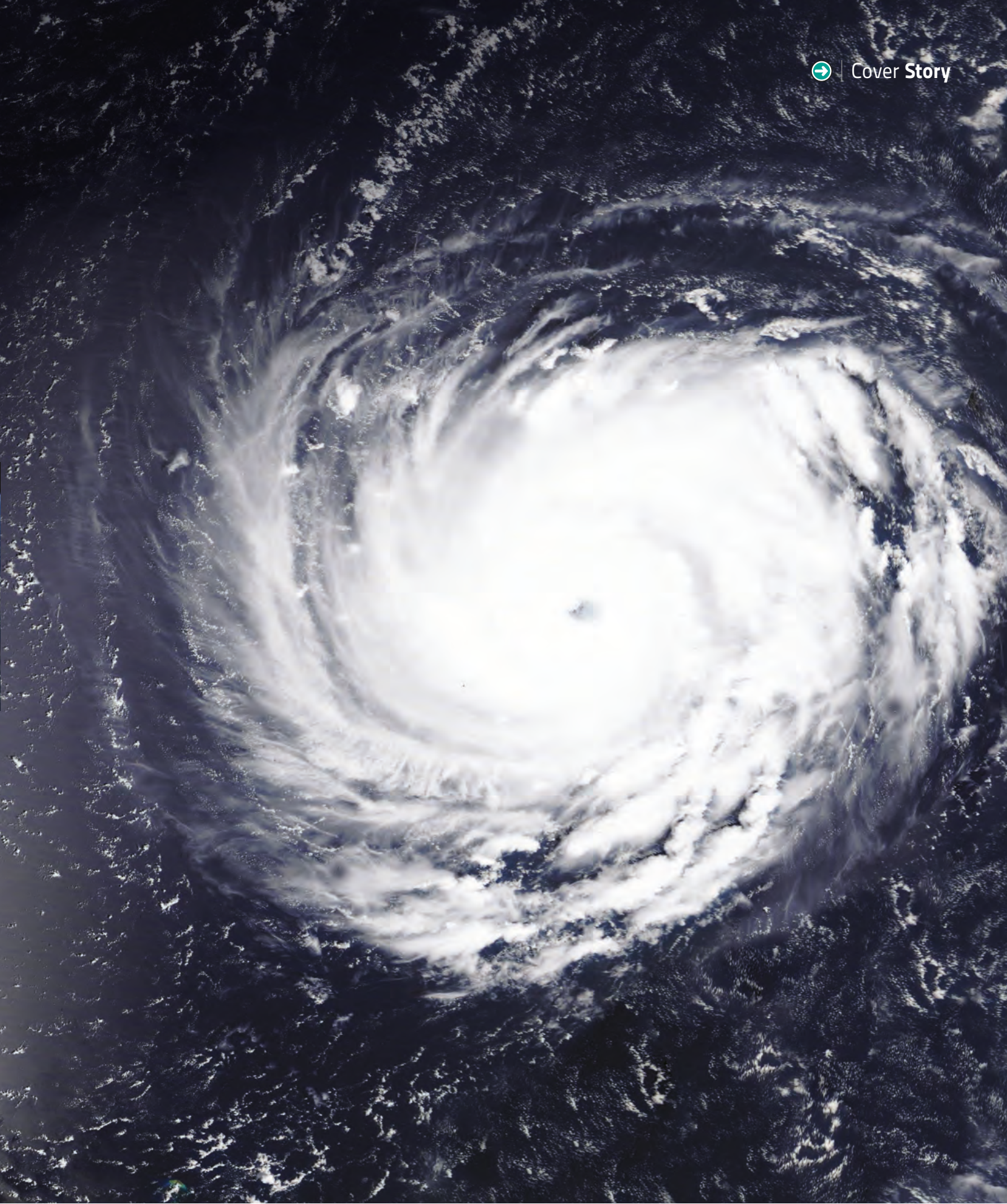
evacuation, but a lot of times we find that folks don't want to take those routes – they'll just follow where their driving app is telling them to go," says Perry. "It might be the shortest route, but it might put them across another evacuation route and cause congestion."

Perry says this prioritizing of driving app data has led to motorists being re-routed back to closed roads and in some scenarios "driving around barricades because their phone tells them the route is open".

Despite public information campaigns to educate drivers out of this behavior, Perry acknowledges that the DOT is fighting a losing battle. "It's almost like people trust their phones more than they do our signs," he says.

Joining forces

To counter this problem, more DOTs are now entering into data-sharing partnerships with app providers to ensure users have the most up-to-date information available during extreme weather events like Florence.

South Carolina DOT, for example, is planning to add a layer to its 511 road map app that will show updates from Waze. But, because of the community-based nature of the app, partnering with Waze poses certain challenges to DOTs.

"We're a government agency, and Waze might have information that we wouldn't want to put out," says Perry. "For example, it might notify drivers of law enforcement ahead, and of course we're not trying to

> **❝ We had 35 clearly signed routes designated for evacuation but a lot of times we find folks don't take those routes, they just follow their driving apps**
>
> **Rob Perry, director of traffic engineering, South Carolina DOT**

help those breaking the speed limit to get away with it."

Although Waze has its own in-built filters to sift out less reliable data, the onus is on DOTs themselves to verify the Waze data they ingest.

"We also have our own internal verification process," explains

As Hurricane Florence approached South Carolina, road blocks were put in place on Folly Island as part of the evacuation process

⊗ | How to move millions

Planning for evacuations due to extreme weather starts long before forecasters predict it – with advanced traffic modeling

Getting a million or more people out of harm's way before a hurricane hits is a daunting undertaking and one that government agencies can't achieve alone.

Among their major allies in the process are evacuation models. These are created by running computer simulations of several streams of raw data, including survey data, maps and road network data from DOTs.

The traffic congestion models produced predict how an evacuation is likely to unfold in real time. When a hurricane is close at hand, DOTs can weigh the models against the predicted storm strength and population numbers for the affected areas, to get a timeframe for how long the evacuation will take – and therefore when to order it.

The models are created well in advance of these events, and they are refined over the years to take account of changing conditions on the ground, such as demographics and alterations to the road network.

"Our emergency management division handles the models," says Rob Perry, of South Carolina DOT. "They're due to be updated soon because our coastal population has changed a lot in recent years."

The modeling can get very specific. In Georgia, for example, contraflow modeling is carried out on the state's freeways leading inland from the coast, in the event that they shut down eastbound lanes during evacuations, says Andrew Heath of Georgia DOT.

"We do models to ascertain where the best cross-overs are

located: in other words, the most efficient places to get people across the roadway and back on to the right side – the beginning and end of the contraflow itself."

Andrew Heath, state traffic engineer for Georgia DOT, which entered into a data-sharing partnership with Waze in 2017. "So as a Waze alert appears, staff here in the traffic management center use cameras and other tools to verify what's going on before we react. It's the same process as when a motorist calls in to report an incident."

In return, Heath's team passes on real-time information on road closures and other travel-related data to Waze. "We have an advanced management system platform that's connected to our 511 feed," he says. "So as things come in – either a report from the
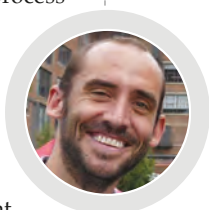
" During Hurricane Michael, we realized how critical it is to send out timely and accurate information

Andrew Heath, state traffic engineer, Georgia DOT

public, or something we spot on one of our cameras – that gets fed into the platform and this in turn is shared with Waze."

Real-time GIS
This system was road tested during the devastation caused by Hurricane Michael, the Category 4 storm that hit Georgia and Florida in October with the loss of 45 lives.

"During Hurricane Michael, we realized how critical it is to send out timely and accurate information. We rely on these apps to help us do that because, although we have a 511 system, we can't compete with these bigger apps just in sheer number of users."

Waze is not the only mapping provider that Georgia and South Carolina share data with. Both DOTs also work with Here Technologies, the Dutch-based multinational, which provides onboard navigation tools for a number of leading auto makers, as well as for Facebook, Yahoo! and Microsoft.

In the case of Florence, this close collaboration meant that Here was

The wrong Waze?

How the deliberate manipulation of crowd-sourced data on navigation apps can temporarily lead drivers astray

Back in March 2017, a bridge in Atlanta collapsed after a fire burned beneath it for several hours. What made the collapse even more problematic was that the bridge formed part of a major road – the I-85 interstate.

At the time of the incident, Georgia DOT had just entered into a data-sharing partnership with the community-based driving app Waze. Within minutes of the event, Waze's community of volunteer map editors notified the app about the collapse and the subsequent road closures. This enabled Waze to be one of the first services to push out notifications about the incident.

Waze's crowd-sourced traffic data is one of its biggest advantages over its competitors. But it is sometimes also its Achilles' heel, as the I-85 bridge fire later revealed. The closing of the interstate forced many motorists to seek alternative routes to work. And that's where the problems began, says Georgia DOT's Andrew Heath.

"Waze re-routed drivers through neighborhood streets," says Heath. "This obviously bothered some of the residents, because what we ended up seeing was a lot of folks going in and trying to manipulate the app by reporting false road closures to get motorists re-routed away from their area."

Since Waze's algorithms are created in such a way that closure reports are overwritten if the app detects the road is still being used, the erroneous information was soon taken down. Even so, says Heath, "It created a lot of turbulence in the app – because things were changing so dramatically because of all these false reports coming in."

able to put out timely information on road closures, especially in the crucial early stages of the evacuation, according to Mike Dekrell, senior manager of Here's traffic incident management team based in Chicago.

"For Florence, there were two major roadways that were turned into evacuation routes – I-26 between Charleston and Columbia – and a US route further north that also led inland," says Dekrell. "So, for a while, those routes were only allowing traffic heading inland.

"In conjunction with the South Carolina DOT," he continues, "we shut down the eastbound traffic lane entirely in our traffic feeds – meaning that if you were using our navigational device, you would have been routed away from those two roads. We kept that in place for the duration of the evacuation."

As well as being fed data directly, Dekrell's team also update their feeds with information put out on DOTs' websites and through their various social media platforms.

"We're also following the social media of a lot of the lower-level agencies in the area: local police and fire

Above: **Public input into traffic data apps can be incredibly useful for motorists, but can also be the apps' downfall**

departments," says Dekrell. "We track closures that are managed by them that might not be reported by state-wide authorities."

Here also shares probe data that it mass collects anonymously from smartphones. The data is made available to DOTs via a formalized relationship Here has with the I-95 Corridor Coalition, a group of transportation and law enforcement agencies along the North American eastern seaboard.

> " During Florence, South Carolina DOT used iPeMS to visualize ongoing traffic conditions and road closures in real time throughout the hurricane event

Scott Perley, vice president of performance analytics transportation systems, Iteris

"They give us real-time probe data from cell phones that gives us speeds on pretty much any road in the state of Georgia," says Heath. "We can also look at the data from other states too. So if folks are evacuating from Florida, then we can try to infer from their probe data what might be coming our way."

Right: **Motorists inspect a road flooded by rain from Hurricane Florence in Waxhaw, North Carolina, September 16, 2018**

Before it reaches the DOT's emergency management centers, Here's raw data is processed through a cloud-based performance measurement and data analytics GIS platform called iPeMS, which presents the data in easily digestible formats such as visual maps. The iPeMS software is developed and owned by the global traffic data company Iteris.

"iPeMS processes data every minute from Here to visualize and report on traffic congestion, route reliability, and to support before and after studies with dynamic route and map features," says Scott Perley, vice president of performance analytics transportation systems at Iteris.

"During Florence, South Carolina DOT used iPeMS to visualize ongoing traffic conditions and road closures in real time throughout the hurricane event."

Another company that leverages Here's traffic data to create spatial mapping useful in disaster response is Esri, the global GIS firm. As well as licensing agreements with Here, Esri has also entered into partnership with Google-owned Waze. This ensures that updates to Esri's GIS maps automatically appear on Waze a short time later. Esri also maintains its own interactive public information maps, accessible for free on its website as part of its disaster response programs.

Right: **Hurricane Florence hit the US East Coast in September 2018**

> "Nothing matches your models exactly. But what we do find is that the stronger the storm, the more adherence we get to the models"
>
> Rob Perry, director of traffic engineering, South Carolina DOT

On top of these public-facing platforms, Esri works behind the scenes with emergency responders including the US government's Federal Emergency Management Agency (FEMA).

"We work with FEMA and other agencies using our network routing technology to help the response personnel get where they need to go," says Terry Bills, Esri's global transportation industry director. "We have teams that we parachute in for these events to help set up command centers to do all the mapping and analysis."

Bills says that Esri's software is used in the "post-recovery phase" too, pointing to the aftermath of last year's Hurricane Irma, when Florida DOT used Esri's data to help it inspect about 2,000 bridges in the state in the 10 days after the event.

Iteris software is also involved in post-recovery. Perley says, "After the hurricane, the focus shifts to road closure reports and ensuring that both DOT staff and the general public

are aware of the rapidly changing conditions of the roadways, as well as flooding situations," says Perley.

The probe data provided to North Carolina DOT via iPeMS showed closures with higher accuracy and helped the DOT make operational decisions, which included recommending that law enforcement divert traffic and keep drivers away from flooded roads.

Iteris also works with DOTs during the planning stage for hurricanes, providing tools that show traffic anomalies and helping the agencies review traffic speeds and

Left: **In South Carolina, police patrol cars are involved in DOT trials for lane reversals, as part of its planning for hurricane evacuations**

Bottom: **Hurricane Florence from space**

Left: **Freeway capacity is doubled – but only in one direction – as a full-scale lane reversal trial takes place in South Carolina**

general traffic patterns: "This makes sure evacuation operations go according to plan," says Perley.

DOT evacuation planning

The DOTs themselves begin their preparations for hurricane season the previous winter. In South Carolina, they hold meetings with each region of the state, beginning in January, to go over their evacuation plan, explains the DOT's Perry.

"We ask ourselves things like: Does the plan still hold true if we have to evacuate? Are there any projects being carried out on the routes that are going to inhibit traffic flow if we have to evacuate?"

This is followed in early summer by a simulated full-scale coastal evacuation exercise. "We put all our staff on the edge of the road and put out the cones as if we were reversing an interstate," says Perry.

In the days leading up to a forecasted hurricane, Perry's team makes sure its staffing levels

are at 100% – this is usually about 36 hours out from the hurricane hitting landfall. "This is also the time we'll start contacting the mapping providers to tell them that we're closing routes," he says.

In these final days, a crucial decision must also be made about when to order evacuations. Perry says the decision is based on two factors: the category of the storm, and the seasonal occupancy level of the evacuation area. The two variables are correlated to provide an evacuation timeframe.

Once the evacuation is ordered, there is no guarantee that the public will heed the call, however.

"Nothing matches your models exactly," explains Perry. "But what we do find is that the stronger the storm, the more adherence we get to the models. In other words, if it's a Category 1 storm and it's heading for Charleston, they're not leaving. But if it's a Category 4 storm, then they're high-tailing it out of there in line with what we'd expect." ○

A new
era

As conversations about Mobility as a Service intensify, the question remains, can it effectively diminish our love of private car ownership? **Larry Yermack** argues that it can, so long as it is properly integrated with road user charging

The concept of Mobility as a Service (MaaS) has become central to the idea of change in transportation. Generally understood as a vision of future mobility where travel happens through a combination of public, private and shared transportation modes, initial evidence from MaaS efforts around the world is encouraging – suggesting that well-planned, properly implemented and responsibly managed MaaS initiatives can provide the answers to many issues affecting megacities, such as congestion and pollution.

By integrating many forms of transportation, improving the booking, ticketing and payment process, and enabling centralized mode management, MaaS has the potential to transform cities into more livable spaces, improve citizens' access to opportunities, and give travelers a more complete view of their transportation usage. In many

> **There's a need to establish a better way to measure and charge for private car usage and connect it to the other parts of the transportation system for a truly holistic transportation experience**
>
> **Boris Karsch, vice president of strategy, Cubic Transportation Systems**

cities where MaaS efforts are already underway, they have concentrated on the integration of public transit and alternative transportation services, such as rideshare and bikeshare. However, to offer cities and authorities a holistic perspective on the urban transportation network, those efforts will also need to incorporate private-car usage – and that is fraught with unresolved issues.
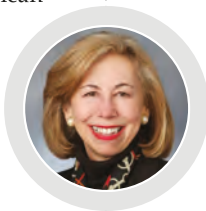
While the ultimate objective of MaaS is to encourage greater density

> **Car manufacturers may use different communication protocols, but the new technology using a plug-in device and GPS is extremely accurate and gives them complete access to all onboard data sources. With that information, mileage-based fees can be calculated and billed fairly and appropriately**
>
> **Barbara Rohde, executive director, Mileage-Based User Fee Alliance**

of travel and manage the number of cars on the road, given the popularity of private vehicle ownership, it's a vision that won't become a reality in the immediate future.

Motor vehicles remain a primary means of transportation for many Americans. According to estimates from the American Community Survey, in 2016, 91.3% of American households owned at least one vehicle. "There's a real need to establish a better way to measure and appropriately charge for private car usage and connect it to the other parts of the transportation system for a truly holistic transportation experience," says Boris Karsch, vice president of strategy at Cubic Transportation Systems.

This need isn't driven simply by a desire to make MaaS a truly comprehensive concept – there are other important considerations at play. The Federal and State Gas Tax – the main source of funding for

highway and road construction for decades – can no longer support the process of getting roads and streets back into shape, nor can it finance new, much-needed roadway infrastructure projects. The hard numbers paint a bleak picture: the proliferation of hybrids, the wave of plug-in electrics, and the overall improvements in fuel economy have led to an impressive infrastructure deficit. According to the American Society of Civil Engineers, the USA will need a whopping US$2tn (of which less than half is currently funded) to get its roads and streets back into shape. The US Department of Transportation (USDOT) claims

that simply maintaining current highways and bridges through 2030 will cost the economy US$65bn per year. And while short-term governments are tinkering with the funding mechanisms, that alone can't address the full scope of the problem.

A new solution
Roadway charging alternatives include tolling, high-occupancy toll lanes (HOT lanes), congestion charging and road user charging (RUC). And while all of these might one day become part of future MaaS systems, Rick Gobeille, senior principal at Stantec Consulting Services, believes that, at the

Projects in action

Different forms of road user charging have already been implemented in a number of countries

Oregon was one of the first states in the USA to officially launch a road user charging program in July 2015. Since then, several other states, such as California, Washington and Colorado, have implemented their own pilots. Globally, numerous RUC solutions are now used to collect incomes for infrastructure management and funding, impose regulation on demand to manage capacity or to remove cars from city centers to limit pollution.

Finland is considering pilot programs to manage traffic in and out of Helsinki, but also to help fund environmental initiatives to reduce greenhouse gas emissions. Meanwhile the Mayor of London, UK, has announced plans to introduce a new form of RUC in the city based on time of day and distance traveled,

to replace the current system of fixed-price congestion charges. Singapore has an effective free-flowing tolling to manage traffic going into the central business district, and in Brazil municipalities have implemented congestion pricing to reduce traffic flows and air pollution, and to encourage the use of public transit.

US$2tn
The estimated funds needed to repair all of the currently degraded highway infrastructure in the USA

moment, RUC offers great promise. "Tolling requires new tolling infrastructure – and although many countries already boast a vast tolling network, the costs of expanding it on a scale required by MaaS would be high," Gobeille says. "Amazingly, after 25 years, only 35% of the registered vehicles in E-ZPass states actually have a transponder affixed to them, and they account for more than 80% of toll trips. An overwhelming number of individual drivers on any facility do not have a transponder and must be identified, contacted and collected from – usually through the mail. In practice, image-based toll collection fails to

successfully collect revenue from a large number of vehicles – 25-45%. HOT lanes are similar to toll roads in that they are only applicable in limited locations. And while congestion charging can cover a large urban area, it is still fraught with political problems. This makes RUC the more promising funding mechanism so far."

For RUC to work, authorities will need a universal method of determining how many miles a vehicle has traveled each year to assess the mileage charge. Using existing toll tags isn't going to be effective because toll tags are only read when they pass an antenna.

Although authorities are looking at innovations such as tolling by smartphone, it will be some time before issues such as interoperability and functionality are fully resolved. In turn, methods such as odometer readings and onboard devices provide only a partial solution.

Barbara Rohde, executive director at the Mileage-Based User Fee (MBUF) Alliance, believes that a more comprehensive approach comes with the advent of connected and autonomous vehicles (CAVs). "Vehicle technology is moving very fast," she says. "Car manufacturers are in a race to develop and deploy a more advanced fleet of vehicles

US$65bn
The estimated annual cost of maintaining the USA's highway network until 2030

that communicate with each other to provide safety benefits and to upload a raft of user data. They may use different communication protocols but, in all cases, the new technology using a plug-in device and GPS is extremely accurate and gives car manufacturers complete access to all onboard data sources, which will include miles traveled as well as location data. With that information, mileage-based fees can be calculated and billed fairly and appropriately."

The advances in CAVs also open up an opportunity for the introduction of a truly universal account-based system to manage the transportation network and provide real customer value. Account-based systems in transportation already exist and offer travelers information that goes beyond a simple ticketing and billing service, including updates on current traffic conditions, delays, and the opportunity to offer cross-mode trips and accompanying incentives, as well as alternative travel suggestions.

Synching services
Similarly, account-based systems in tolling allow vehicles to enter toll lanes seamlessly, address issues of billing inaccuracy, and offer more dynamic mobile payment solutions that are both user friendly to drivers and less costly to toll operators.

"MaaS will start with rideshare companies, but it will expand to

" By linking Mileage-Based User-Fee tolling, congestion charging, public transit, ridesharing and other transportation services, we can arrive at MaaS to deliver a truly inclusive overview of one's travel choices

Chris Tomlinson, executive director, Georgia State Road and Tollway Authority

other services," says Chris Tomlinson, executive director of Georgia's State Road and Tollway Authority (SRTA). "By linking MBUF, tolling, HOT lanes, congestion charging, public transit, ridesharing, parking and other transportation services through a single account, we can arrive at MaaS to deliver a truly inclusive overview of one's travel choices."

From the user perspective, synching up private car accounts to public transportation accounts seems like an attractive offer. By having a complete view of their transportation use, individuals will

be able to easily understand their travel choices and accompanying costs. They could plan a complete route to a chosen destination while considering several alternatives; get an up-to-date schedule, price and real-time conditions information; pay seamlessly for the entire journey; and have a single record of all of their transportation use. Such an overview could also support the wider use of shared and/or public transportation, through incentive schemes and by painting a true picture of individual transportation costs.

For the transportation network, the potential benefits are even greater.

35%
The proportion of vehicles in E-ZPass states that have transponders attached to them

A comprehensive overview of the network infrastructure, including all roadways, could lead to a more efficient usage, minimize investment in and cost of shared infrastructure, and provide a much better way to manage the load on roads in the future. It could also present an opportunity to introduce different road-charging tariffs, allowing cities to recognize and reward road users with more environmentally friendly types of vehicles (for example, hybrids or electric cars) or those that travel in more socially desirable ways (such as avoiding peak times), and potentially offer perks for other city-

or region-run transportation services, encouraging a modal shift away from the private car. Will any of this happen quickly? Rohde doesn't think so. "With the average age of the fleet being 12 years, it will be a slow transition, but as soon as a small percentage of vehicles are properly equipped, benefits will accrue to all," she says.

The issue of our addiction to private car ownership isn't going to go away – at least not for the next couple of decades. To support the infrastructure of tomorrow, the industry must start looking at solutions that address roadway usage

and that could complement the overall vision of future MaaS. Successful pilots around the world have provided initial proof that RUC can be a progressive, fair and innovative proposition for raising funds for the maintenance of our road networks. It is now up to local authorities around the world to come up with regional RUC solutions that could reduce many transportation-related inefficiencies and take all riders a step closer to an ultimate MaaS experience. ○

Larry Yermack is strategic advisor to Cubic Transportation Services, USA

New
connections

Russia's Crimean Bridge opened for traffic in May 2018.
Eugene Gerden reports on its first few months of operation
and discovers some of the modern ITS that helps ensure that
traffic flows smoothly and safety standards are maintained

The Crimean Bridge – a brand-new crossing constructed to span the Strait of Kerch between the Taman Peninsula of Krasnodar Krai and the Kerch Peninsula of Crimea – is one of the most technically sophisticated pieces of transportation infrastructure in Russia, thanks to the ITS technologies installed on it.

According to statements by Yury Safonov, chief engineer of Taman subsidiary of the Russian Federal Road Transport Agency Rosavtodor, in the bridge's first six months (it opened in May 2018), almost three million vehicles used it, and it is predicted that traffic will increase in 2019.

Main image and above: **The 19km (12-mile) Crimean Bridge opened in May 2018**

The growth of traffic will be managed by unique ITS, which, according to Safonov has no analog in Russia. The overall length of the Crimean Bridge is 19km (12 miles). It is designed in the form of two parallel bridges, for rail and road transport. The road bridge is on the Azov Sea side and has four lanes (two in each direction). It has a capacity of 40,000 cars per day and a maximum permitted speed of 90km/h (56mph).

"Due to its strategic importance, the Crimean Bridge is equipped with some of the most powerful and sophisticated ITS ever to be deployed in Russia," says Safonov. "Its purpose is to control traffic flows, and monitor the engineering systems and structures of the bridge."

What ITS is deployed?

According to experts at Rosavtodor, the ITS complex includes three systems: the automatic traffic control system (ASUDD), the structure monitoring system and an engineering monitoring system.

The ASUDD is comprised of seven subsystems. One uses variable

Top 5 road bridges in Russia

Russia has some impressive crossings, including the largest cable-stayed bridge in the world

2 **The President Bridge** is a truss bridge that crosses the Volga in Ulyanovsk Oblast, connecting the city of Ulyanovsk with the east side of Ulyanovsk Oblast. It is the second-longest bridge in Russia and one of the longest in Europe at 5,825m (19,110ft). It has 25 spans of 221m (725ft).

1 **The Russky Bridge** in Vladivostok, Primorsky Krai, is the longest cable-stayed bridge in the world, with a central span of 1,104m (3,622ft). The bridge connects the Russky Island and Muravyov-Amursky Peninsula sections of the city across the Eastern Bosphorus.

message signs (VMS) along the sides of approach roads and across the bridge to inform drivers about the status of traffic on the bridge, expected delays and weather conditions.

The weather data collection subsystem is set up for the automatic observation of environmental and weather parameters on the bridge and in the local area. Information is collected using meteorological stations and contactless sensors, which measure the temperature of the roadway.

Meanwhile the video surveillance subsystem uses PTZ (pan-tilt-zoom) cameras to monitor congestion levels and watch for incidents.

> **"** The Crimean Bridge is equipped with some of the most powerful and sophisticated ITS ever deployed in Russia
>
> **Yury Safonov, chief engineer, Taman, Rosavtodor (Russian Federal Road Transport Agency)**

The main purpose of the traffic-flow monitoring subsystem is to conduct around-the-clock automatic calculation of the number of vehicles using the bridge with simultaneous vehicle classification. Data collection is carried out by the Strelka-Wave radar detector system, which was supplied by Russian ITS provider

Navigator Enterprises. In addition, this subsystem is able to detect moving and stationary vehicles in the controlled area of each lane, determining the average speed of the flow and the rate of congestion.

"Very important functions are assigned to the violations subsystem, which has the ability to automatically recognize road incidents," says Safonov. Its operations are provided by the Strelka-Plus road traffic control system, produced jointly by Stroyinvestproject Corporation and System of Advanced Technologies and distributed by Strelka KB.

Enforcement success

The installation of speed cameras on the Crimean Bridge has helped to reduce the number of speed restriction violations. Speeding is the main type of violation on the Crimean Bridge, but the peak of such violations occurred in the first two weeks after the opening. During that period, the automatic traffic control system recorded up to 4.5% of all traffic using the bridge violating the speed limit. However, by the beginning of the

3 **Saratov Bridge**, crossing the Volga in Saratov, was the longest bridge in the Soviet Union upon its inauguration in 1965. It is 2,804m (9,198ft) long. It connects Saratov on the west bank of the Volga with the city of Engels on the east bank.

4 **Khabarovsk Bridge** is a road and rail bridge built in 1999. It crosses the Amur River in eastern Russia, and connects the urban-type settlement of Imeni Telmana in the Jewish Autonomous Oblast with the city of Khabarovsk in Khabarovsk Krai. It replaced a nearby older bridge that was built in 1916.

summer the incidence had decreased to less than 2% of traffic. According to data from the Russian Ministry of Transport, more than 55,000 speed violations have been registered since the opening of the bridge. Speed enforcement is conducted using photo-radar and ALPR systems from Russian suppliers Arena and Kordon.

Asset management
A further subsystem monitors operations of road-maintenance machinery. This uses the Russian satellite navigation system GLONASS to ensure the provision of reliable information about the location of these vehicles and their operations on the bridge.

5 The first **Bolshoi Obukhovsky Bridge** opened on December 15, 2004, as an important part of the St Petersburg Ring Road. On October 19, 2007, a second bridge – the first's twin – opened alongside it, carrying another four lanes of traffic. Together they are the only bridges across the Neva that are not drawbridges.

According the Russian Ministry of Transport, ITS on the Crimean bridge also includes crucial elements such as the engineering structures monitoring system (ESMS) as well as engineering systems monitoring (ESM).

The ESMS sensor complex, which includes accelerometers, strain gauges, anemometers and GLONASS/GPS sensors, ensures compliance with the allowable range of deformation values, vibration frequencies and inclination angles of the bridge, caused by various loads. At the same time, the ESM sensors are responsible for the controlling engineering systems including power supply systems, lighting, etc.

The integrated management of all systems is carried out from the control center, where 12 operators work around the clock. Each of these operators can display graphic information on the video wall for collective viewing. ○

Eyes

on the road

To what extent can artificial intelligence do away with the need for humans to enforce the rules of the road? **James Allen** reports on the new technologies that are changing the way local authorities are keeping their roads safe and prosecuting offenders

The availability of cameras capable of not just recording, but also recognizing when an offense has been committed, is not new, and has been well documented with regard to speed enforcement. However, the prevalence of the technology is increasing as the scope of illegal behaviors it is tasked with capturing also grows.

In the UK, this has been in large part due to a change in the law,

explains Noel Frost, head of enforcement at Siemens ITS.

"The use of CCTV equipment to collect evidence and enforce parking, bus lane and moving traffic contraventions is highly regulated by the availability of legislation from the Department for Transport [DfT] and the Vehicle Certification Agency [VCA].

"In 2015, the Parking Deregulation Act was passed, changing the ways that local authorities can use their civil enforcement powers to deal

with parking in nuisance areas such as double-yellow lines and pedestrian crossings.

"There is also use of the London Local Authorities Act, now permitting London Boroughs to carry out the monitoring of moving traffic regulations such as banned turns, one way, no entry and yellow box junctions."

In light of the new legal framework, Siemens has developed an enforcement solution that combines ALPR technologies with video analytics. Designed to work autonomously, the LaneWatch system relies on two high-definition cameras working together: one captures a video recording of the contravention through a wide-angled color lens, while the second monochrome camera uses infrared lighting, alongside a cut light filter, to accurately identify license plates in all weather and lighting conditions.

Images of the incident, as well as date, time and location information, are then automatically collated to form a package of evidence for the prosecution of an offender. It is only at this stage of the enforcement process that human intervention is required, where an operator will carefully assess the evidence and ultimately make the call as to whether the owner of the vehicle is issued with a ticket or the case is dismissed.

Back to school

A growing trend for applying new machine vision technology comes in the form of ensuring car-free space directly outside of school gates.

In the UK, the zones are marked by yellow zig-zag lines as well as 'School – Keep Clear' painted along the curbside of the road. Vehicles are not permitted to stop for any period of time. Traditionally, the enforcing of such regulations was largely achieved by the physical presence of parking attendants, but a role is developing for unattended cameras to help share that load.

"The deployment of unattended equipment reduces the need to post civil enforcement officers into often-volatile environments, where the public perception can be unaccepting of the overarching traffic principles, usually in pursuit of personal advantage," says Frost.

> ❝ Even if we had an army of enforcement people, it still wouldn't have created the same degree of safety at the school gate as this project

Stuart King, cabinet member for environment, transport and regeneration, Croydon Council

"School drop-off and pick-up areas are a common problem across the UK, where on-street officers are ineffective due to the nature of driver behavior.

"The presence of either an officer or a mobile enforcement vehicle provides a very visual deterrent to drivers – but equally when they are absent, offending rates rise once more.

"The deployment of an unattended enforcement device will have a greater effect on both short- and longer-term decision making by drivers, in much the same way unmarked police cars have on major driving routes," he says.

Real-world deployment

Traffic managers in Croydon, a south London borough, sought to address some of the traffic-related issues outside three of the schools in the area.

Stuart King, the cabinet member for environment, transport and regeneration at Croydon Council, says, "There was a real problem and the conventional approach of having officers on-site would only be a sticking plaster because, with 88 primary schools – and most of them

Machine vision software from Videalert can be run on existing cameras, reducing the need for new infrastructure

having similar problems – we would have needed an army of parking enforcement staff to constantly maintain an on-site presence at each location.

"But like all local authorities, we've had drastic reductions in our government grant – 70% over the past 10 years – so we simply don't have the funds to employ the numbers of enforcement staff we would need."

Instead, Croydon trialled the installation of the Siemens cameras at opposing ends of the road, along with signs informing drivers that they weren't allowed entry during drop-off and pick-off times.

An approved list of registered vehicles, comprising those of local residents, school staff and a small number of parents with children who had mobility issues, are exempt from the new rules. Their details are fed into the system, and the cameras are designed to ignore them.

For every other driver accessing the road at the prohibited times, a £65 (US$83) fine – rising to £130 (US$166) if not paid within two weeks – is issued.

For the first month, penalties were not formally enforced, with only a warning letter sent to the offending party, notifying them of the change.

Subsequently, the fines issued have totaled £300,000 (US$383,000) across the three schools, which, King notes, has more than covered the initial outlay of installing the systems. Crucially, driver behavior has also been affected.

He says, "We had some amazing results. The schools have told us it has made a significant and immediate difference to the school gate environment."

Not only are there fewer drivers flouting the rules – many are even choosing to leave their cars at home altogether.

"Across the three schemes, there has been a significant reduction in the number of trips to school being made by car," says King.

"We expected – and wanted – it to encourage some behavior change, prodding some parents who live a walking distance from the school to decide that this is healthier and easier, but we didn't expect the numbers to be as impressive as they were.

"Even if we had an army of enforcement people, it still wouldn't have created the same degree of safety at the school gate as this project."

The extent of the ALPR-based enforcement pilot's success has led to it becoming a permanent addition at each of the three locations, while the council intends to roll it out to more schools in the borough.
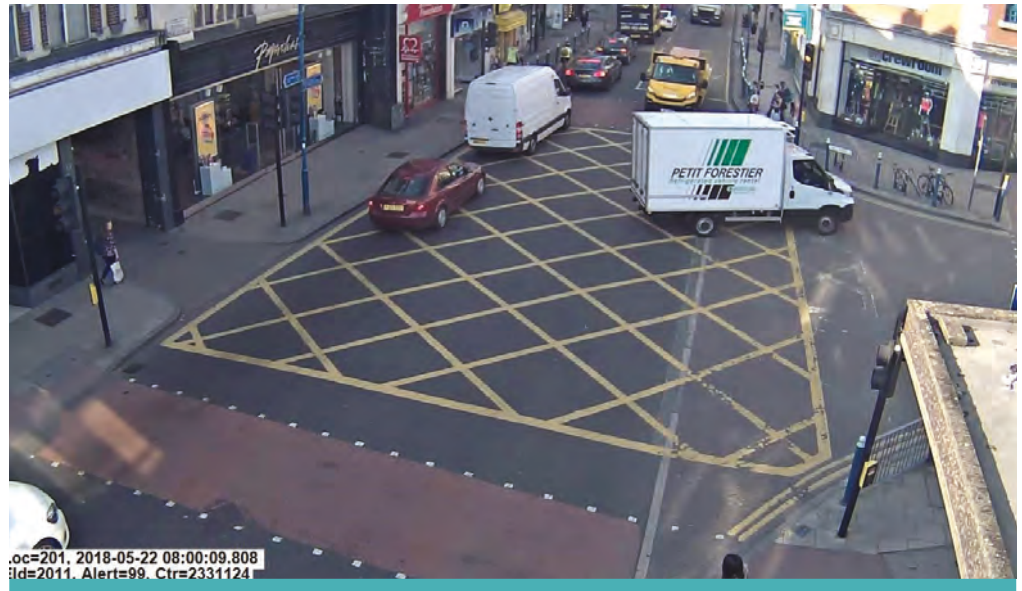
Alternative system

Another unattended camera system, developed by Videalert, addresses the same problem, but takes a different approach.

Much like the Siemens system, it relies on combining video analytics with ALPR technology, with a human required only to retrospectively check what's been spotted. The software that comes with Videalert's technology, however, means specific vehicle activity can also be picked up by the camera.

"With the software, a rule can be established at a specific location," explains Tim Daniels, sales director at Videalert. "For example, it might be detecting a vehicle that has moved in a particular direction or has stopped in a certain place for three seconds or more."

The system is fast making a name for itself in the world of unattended

cameras. Wandsworth, another borough in London, wanted to introduce such a system to deal with a number of traffic hot-spots. To choose the right technology, the council invited four suppliers to demonstrate the capabilities of their products.

Jim Marshall, head of parking operations for both Wandsworth and neighboring borough Richmond, was heavily involved in the procurement and saw a clear winner early on in the process.

Above and left: The London Borough of Wandsworth has unattended cameras for enforcing yellow box junctions and no right turns

"Two of the companies were not in a position to present, so that left Videalert and another manufacturer," he says.

"From the company's report, and from what I know from other boroughs, the other system may well have required additional street furniture. The council has progressively become more interested in the streetscape, ensuring the streets are aesthetically pleasing, so we would have struggled to get permission to place the cameras in some areas," says Marshall.

"Videalert is different, however, and Richmond has been using its systems since 2013. This equipment has the ability in almost all cases to work from the existing infrastructure and it simplifies everything because it's a very compatible system.

"The other part was its capture rates. Videalert's ability to pick up a range of contraventions – and the number of them – meant it came out way ahead of the other system that was tested."

Wandsworth installed the system on four cameras, and within the first month of them being implemented, the costs of procurement were already covered.

Therefore, Marshall is currently in the process of acquiring additional funding from the local authority to roll out the cameras more widely across the borough.

Multiple applications

On the south coast of England, Portsmouth City Council has also opted for Videalert. Initially using the cameras for bus lanes in several locations, the council then turned its attention to schools.

Matt Crowder, civil enforcement supervisor at Portsmouth City Council, says, "The thing we had to be careful of with the school locations is that some of the roads are really narrow, so a car might stop on the zig-zag lines, not necessarily to park or drop off kids, but because traffic is coming the other way.

"With this system installed on the cameras, the vehicle has to actually be stopped on the line for a certain amount of time before it kicks in, so if it stops because a car is coming the other way and then moves on, the system doesn't tend to pick it up."

Portsmouth now has 12 cameras with the Videalert system installed on them – seven specifically for schools and five for bus lanes. While the bus lane cameras are in place at

> " We should be careful because the place of enforcement is a last resort and it can only work when widespread respect for the rules that are being imposed is maintained

Richard Allsopp, emeritus professor, Center for Transport Studies, University College London
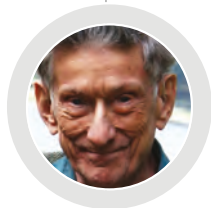
specific locations on a more permanent basis, those for schools are moved around between 30 locations earmarked as having the most prevalent safety concerns.

The effect has been dramatic, with compliance across the sites being as high as 90% in some places. The council even made the shortlist in the 'Road Safety, Traffic Management and Enforcement' category at the UK's National Transport Awards this year for the project.

Any concerns that the Videalert enforcement system is just a way to make money, or even cut jobs at the council, are dismissed by Crowder.

"It's actually had no impact on numbers of staff. It has just enabled us to cover more schools on a daily basis," he says. "We try to commit 60% of our resources to schools every day, so by using this system installed on the cameras we're just covering seven more schools than we did previously.

"They are also not really there to make money either; they were put in place to increase safety."

Regardless of how capable the Videalert system is, Portsmouth, like Wandsworth, Croydon and every other authority relying on unattended cameras in the UK, is legally required to have a human involved in the process prior to a driver receiving a ticket for a contravention.

There is currently no indication that a relaxing of the laws will be introduced any time soon, but the technology is continuing to develop regardless.

Centre for Transport Studies emeritus professor at University College London Richard Allsopp is in two minds about the direction in which unattended camera surveillance is heading.

"In principle, any potential error that the designer of the system can foresee can be dealt with," he says. "However, I think we should be careful because the place of enforcement is a last resort and it can only work when widespread respect for the rules that are being imposed is maintained.

"We really do rely on a large majority of people wanting to be compliant almost all the time – and if we were to start elaborating or multiplying the number of rules or situations where you might be caught out by a camera or find a fine coming through the post when you simply hadn't been aware of anything untoward, then that would begin to threaten this widespread general acceptance that we depend on."

Systems such as Videalert's are showing that this technology is already at the stage where errors can be phased out with only limited, or even no, human intervention. Now it's up to traffic managers to make sure they use the power at their disposal effectively. ○

How to...

WRITE A SAFETY

PERFECT MESSAGE

Variable message signs were invented to convey simple, empirical information about travel times or incidents. But now traffic managers in Iowa are getting creative in an attempt to improve safety, and in the process, reaching more members of the public than ever before. **James Gordon** finds out more about the art of engaging motorists – in 54 characters or less

In an attempt to improve road safety, Iowa DOT has started displaying humorous, eye-catching messages on its VMS

With rolling hills, dense forest, prairie and savannah, it's no surprise that the picturesque state of Iowa is a breeding ground for literary heavyweights. The late Robert James Waller, who wrote *The Bridges of Madison County*, hails from the Hawkeye State, and Bill Bryson – one of the world's most famous travel authors – was also born here.

But every Monday from Sioux City on Iowa's western border to Davenport on its eastern flank, it's the writing of two Iowa Department of Transportation traffic safety professionals that's drawing most attention.

You've probably never heard of Willy Sorenson or Tracey Bramble, but they're two of Iowa most-read and most-popular authors. While neither has written a best-selling book, if you happen to be driving in Iowa on a Monday you'll have certainly read their work.

That's because the pair co-author Message Monday, in which – as the name suggests – every Monday a safety message, with the latest road fatality figures, are showcased on every one of Iowa's 80 variable message signs (VMS). But you won't find any dull, clichéd, formulaic messages on Iowa's electronic display boards. Instead the messages are more imaginative and light-hearted.

Take, for example, the message Iowa DOT put out during National Distracted Driving Awareness Month on Monday, May 4, three years ago, which coincided with Star Wars Day. The message was a play on words used

> **"** Messages only ever go out on Monday. They must be thought-provoking and no longer than 18 characters per line. They can never be repeated, and of course they must always be related to safety

Willy Sorenson, traffic and safety engineer, Iowa DOT

by the Lucasfilm marketing team, with the safety message mimicking Yoda's back-to-front riddle-like delivery at the end. "May the 4th be with you. Text I will not," it simply read.

According to Sorenson, many of the messages like this one – which are inspired by Hollywood movies, pop songs and comedy shows – go viral.

But behind every witty one-liner, there are clear objectives and rules. Sorenson, who created Message Monday five-and-a-half years ago, explains: "In terms of our guiding principles, there are several we observe. Messages only ever go out on Monday. They must be thought-provoking and no longer than 18 characters per line. They can never be repeated, and of course they must always be related to transportation

IS THIS HEAVEN?
NO, IT'S IOWA
TRAVEL SAFELY

safety. To this end, we find that the National Highway Traffic Safety Administration calendar, law enforcement agency campaigns and national holidays, provide us with pegs for many of our headlines and stories."

Improving safety

Sorenson, who came up with the idea and the concept behind it while taking a shower, continues, "On a much deeper level, there are four safety goals that each message must fulfill. Each message must start a conversation. Each must trigger drivers to question their driving behaviors and, most importantly, our messages zero in on five dangerous driving habits: seatbelt usage, and distracted, impaired, aggressive and drowsy driving. Our chief aim is to effect positive change. So for example, during festivals such as Halloween where instances of drinking and driving tend to rise, our message read, 'You are not a pumpkin. Don't drive smashed'."

Another prerequisite is that Iowa's digital message boards must make the driver aware of fatalities in the state. "Therefore," says Sorenson, "we combine the latest fatality rate with the safety message in a two-panel message. At the time of writing, for example, there were 257 road traffic-related deaths in our state, and as our central goal is to achieve Vision Zero, putting the fatality count on the electronic board is a vital part of our strategy."

So too is compliance. Messages aren't thought up on the spur of the moment and sent to a board. Each

A wider audience

Message Monday is so popular in Iowa that messages are reviewed by media outlets and even reproduced in banks and schools

There is no doubt that Message Monday has caught the imagination of the public in Iowa. Iowa DOT's Willy Sorenson says that several radio and TV stations "profile, review and promote the message" before posting it on Facebook, which "takes it beyond the roadside". Moreover, the messages are showcased by schools, banks and highway rest areas.

He also thinks that the cutting-edge digital technology that traffic management centers have access to is making a difference. Iowa DOT, for example, exports all of its messages to any other state DOT that wants them. Currently it is sharing message content with Minnesota DOT and Colorado DOT, but having established a Facebook group, in which all 50 states are members, does Sorenson

think it is likely that the messages will find their way onto message signs across the country?

"Yes and no," he says. "What is interesting is that drivers in Iowa have grown with the messages. Therefore, if you compare our first six months of messages with the ones we run today, you'd see a marked difference in message. The first ones, such as "Driving long. Take a break", were tame. But five years on and with the public really buying into what we do, we have license to be much more edgy in the messages we put out. However, as states like Minnesota have only just begun this process, they have don't have the same relationship with their drivers as we do with ours. Therefore, because they don't have that rapport, they can't use half of the messages we send them."

one is carefully assessed by a dedicated team of senior traffic engineers, communications staff and the head of the Iowa DOT. So how does it work?

Sorenson explains, "Tracey and I sit down every six months and create an initial schedule that contains around 26 messages and five back-ups. We then pitch each message to a senior state traffic engineer, a state safety engineer, the director of traffic and safety, and the head of strategic communications. I'd say that around half of the messages are given the green light, while the other half are tweaked or discarded. When the message content has been approved, the final step is for it to be approved by Mark Lowe, the director of Iowa's Department of Transportation. Then they're ready to go."

Even then there's a clear strategy in place for how long each message is displayed. The first part of the message – which shows the number of recorded deaths – flashes for 2.5 seconds. It's then followed by the safety message, which is displayed for between four and six seconds, depending on how complex the message is for drivers to take in. The two then alternate for the next 24 hours unless the boards need to be "used for a higher purpose". "That could be anything from a crash, an AMBER alert, roadworks, or a weather warning," says Sorenson.

Messages in the UK

Could British traffic managers learn from their US cousins and improve safety by writing a bit of humor into their VMS information?

Could the UK, a nation famous for its love of wordplay, inject a little more creativity into the humdrum safety messages that appear on its VMS boards? Jack Cousens, the AA's head of roads policy, thinks so. "But safety needs to be the central focus on every message," he says. "They can be witty and contain puns, but it shouldn't be a case of drivers looking out for the next funny message on the VMS rather than concentrating on the road.

"It is a fine balance," continues Cousens, "but if one

could be found, then I think it would capture the imagination of the British public who love a good pun. They also love alliteration. And so safety messages such as 'Clunk, click, every trip', which dates back to the 1970s, remain very popular today."

But if more creative messaging and panache was allowed on VMS, how would it happen? "Think!, the DfT road safety campaign arm, would no doubt want to carry out controlled tests first," says Cousens. "But, if all went well, I imagine that the safety

messages would appear on highway VMS boards first before finding their way to villages, towns and cities. But it really depends on the public and also how interactive and inclusive organizations like Think! wish to be.

"So, for example, if a national road safety agency began an alliterative safety messaging campaign where it invited road users to think up messages, and then it put the best ones on the boards, it would certainly engage and enthuse the public, and might just encourage them to drive more safely."

However, with very little research published on whether initiatives like Message Monday actually save lives and prevent bad behaviors, can Sorenson and his team prove that traffic road deaths have decreased since Monday, August 5, 2013 when the first message was displayed?

"We cannot point to any direct or specific data that proves we are making a difference, but there have been some studies published – none have taken place in Iowa – and those

> "There are seven research papers I'm aware of that highlight the effectiveness of using VMS in traffic safety campaigns… on average the studies show a 9% reduction in crashes
>
> **Lisa Dorn, associate professor of driving behavior, Cranfield University, UK**

Left: **For now, VMS on London's M25 orbital motorway display only traffic information, as opposed to the more creative messages used in Iowa** (above)

studies came out more positive than negative. What we can say is that the public appreciate the fact that we've put a great deal of thought and effort into our safety messages."

Sorenson says that Iowa DOT has gathered "tens of thousands of likes, retweets, comments and mentions on social media", and receives emails every single week citing personal stories from the public as to how the messages have helped them drive more safely.

"Anecdotally," he says, "we're seeing a positive effect too. We know, for example, that safety messages spark a wider conversation – particularly the more cryptic messages, which sometimes people don't get immediately when they're driving. Messages like, 'Don't you forget about me as you drive on by' [Simple Minds lyric] or 'Surely you buckle? Yes and don't call me Shirley' [Taken from the film *Airplane*] pique people's curiosity. They want to find

out what the message means and in doing so, they perhaps don't realize it, but they're talking about safety in the office, or at home, and that's very empowering – both for them and for us."

Seeking academic support
But is there any scientific research that proves beyond doubt that schemes like these work? Who better to ask than Dr Lisa Dorn, associate professor of driving behavior at Cranfield University in the UK. She says that several studies have been published – "some measuring the benefits of using static messaging boards, and others examining the effectiveness of digital signage – all with varying results".

Dorn explains, "While I cannot comment on the Iowa initiative, there are seven research papers that I'm aware of that highlight the effectiveness of using VMS in traffic safety campaigns. While the methodologies used to measure the success of each one differed tremendously, on average – where variable message signs were used – the studies show a 9% reduction in crashes."

But, in regard to measuring the benefits of using light-hearted

messages over more prosaic forms of information delivery, Dorn says, "What the research reveals is that fear and shock tactics are limited in their ability to change people's behavior. But there are a couple of studies on the impact of humor and the findings were quite mixed. Some showed positive effects, while a couple have revealed that injecting humor into safety messages has a neutral effect – i.e. has little impact. However, the research so far – and further studies need to be done – seems to highlight that funny messages do no harm, whereas hard-hitting ones could have a negative effect on road safety."

Is it too funny?

Is there a danger that humorous messages could distract drivers, causing unnecessary congestion and increasing the chances of collisions? And with more US states rolling out light-hearted messages on their digital messaging boards, does there need to be a set of standards drawn by national transport bodies?

With there being more questions than answers, Dr Gerald Ullman, a senior research engineer in the Texas A&M Transportation Institute (TTI), is leading a study that is being funded by the Behavioral Traffic Safety Cooperative Research Program (BTSCRP) and will kick off in early 2019

"There have been many studies conducted by marketeers and local government agencies that clearly show that the driving public are fully on board. Some even reveal that drivers perceive themselves to drive more safely when they read these messages. However, the reality is that we haven't conducted any research that shows the psychological impact these messages have on drivers and their passengers.

"Therefore, our research will catalog all the different types of

66 It is entirely possible that some drivers were mentally distracted in trying to figure out what was meant by the message

Dr Gerald Ullman, senior research engineer, Texas A&M Transportation Institute

messages that agencies are using – both state and turnpike – in an attempt to establish a national set of guidelines for behavioral traffic safety messages on VMS."

But even before beginning his research, Ullman, who has been working for the TTI for 34 years,

SHIFT HAPPENS
ESPECIALLY IN
WORK ZONES

Many notices displayed on Iowa's VMS as part of their Message Monday initiative are inspired by movies and songs

WHO YA GONNA CALL?
NOBODY
YOU'RE DRIVING

has concerns about the use of humorous messages.

He explains, "Anecdotally, at least, there are reports of highway authorities experiencing lots of traffic operational problems around some of these messages. Some states, for example, are adopting the Burma-Shave gimmick, where the dynamic messaging board splits a safety message into two and display the punchline five or six seconds after the opening gambit. While this method certainly gets the attention of the driver, it can also distract him or her. If a motorist is eager to see the punchline – as most are – they might slow their vehicle to ensure they absorb the whole message. However, if a large swathe of drivers do this, it creates unnecessary congestion and, while there is no evidence that this form of messaging actually causes collisions, it is conceivable that crashes could occur."

And, on a subconscious level, Ullman also worries that there is a danger that the aim and objective of each campaign – which is to communicate powerful and succinct safety messages – falls by the wayside.

Says Ullman, "Recently, the Texas DOT developed and posted traffic safety messages during the college football season, which included slogans cheering on one of the major universities. Although the drivers that attended the game – or follow that particular university – understood the inspirational slogans and likely found the safety messages useful and engaging, non-familiar drivers were more likely to be confused or even irritated by the messages. In fact, it is entirely possible that some drivers were mentally distracted in trying to figure out what was meant by the message. It is also conceivable that some could have completely missed the actual safety statement contained in the message itself."

Dorn thinks that a greater level of research needs to be carried out by researchers with a psychology and road-safety background before more countries adopt humorous safety messages in their road safety campaigns. But she thinks, to some extent, focusing on the content "is a red herring".

"I don't wish to focus my comments on Iowa or any other state using these type of safety messages, as I'm not aware what research has been conducted. Generally speaking, though, research needs to be focused on three areas: the location of the boards, the length of the message and how long it takes for a driver driving at a certain speed to absorb the message. As a starting point, that's more important than the actual content of the message to make sure there is no negative impact on road safety. If the primary research is not done, without clear guidelines and national transport authority to regulate and police them, there is a danger that you put the public at risk."

But, with VMS safety campaigns showing the potential to reduce crashes by as much as 9%, it's not research that should be delayed any longer. ○

Safer
predictions

Where is it safest to design access points for highways and express lanes? **James Allen** reports on a unique traffic modeling software tool that has helped answer this question in Minnesota, and is even influencing policy across the USA

Transportation agencies have an abundance of tools at their disposal to help them manage the road network and reduce congestion. One such tool, the high-occupancy vehicle (HOV) lane, has been introduced by a number of state DOTs across the USA.

However, there are two contrasting approaches to implementing HOV lanes and, despite them having been in existence for close to two decades, there remains some debate as to which is better. Initially, closed access (restricting entry to the lane to only a few gates) was considered a safer option, but an alternative open access method favors maximizing opportunities for drivers to join the express lanes.

"With closed access, the theory is that you're not allowing much opportunity for people to jump into the lane and disrupt the flow of traffic, however on the flip side you're prohibiting some drivers from being able to utilize it who would have liked to," Brian Kary, director of traffic operations at Minnesota

> **With closed access, the theory is that you're not allowing much opportunity for people to jump into the lane and disrupt traffic flow**
>
> **Brian Kary, director of traffic operations, MnDOT's Regional Transportation Management Center**

Department of Transportation's (MnDOT) Regional Transportation Management Center, explains.

Choosing the right lane

When MnDOT introduced its first HOV lane in 2005, it opted for the closed access variety. This made sense, as 80% of traffic on Interstate 394

came from just three interchanges and, besides, a USDOT best-practice guide on HOV lanes also recommended the option.

Subsequent Minnesota HOV lanes (there are now three), however, follow the open access approach and even the original lane on the I-394 now has a more open flavor.

The change of tack can be directly attributed to the work of researchers at the University of Minnesota's in-house transportation laboratory, the Minnesota Traffic Observatory (MTO).

Attached to the university's Department of Civil, Environmental, and Geo-Engineering, MTO receives funding through the USDOT's University Transportation Center program to carry out traffic-related research.

"MnDOT wanted its second HOV lane to have open access," says MTO director John Hourdos. "The I-35W is a longer road, with 20-something entrance ramps from different suburbs, so making it closed access made no sense.

"But the federal government was raising hell, telling them they couldn't do it as they'd need more

> **"** This tool took theoretical ideas and made them usable. It is a very specific piece of software written to work with MnDOT that takes real-time data and diagrams each location separately for lane changes and reaction time

John Hourdos, director, Minnesota Traffic Observatory

infrastructure – more card readers, signage and charging instrumentation – and there would also be an impact on safety and mobility.

"It was a valid argument and, because the federal government was paying, it requested that at least 28% of the lane be closed. MnDOT did exactly that, putting closed access in places where either it made no difference or where they'd judged it was actually needed.

"They approached us and said 'We need someone to look at open access and see if it creates the chaos USDOT says it will do, and whether we will adversely impact safety and mobility compared with the closed access of I-394'."

Hourdos considered that the most reliable benchmark for assessing

HOV lanes was to look at disruptions in traffic flow.

Known in the industry as shockwaves, they are the moments when a driver's cruising speed is adversely impacted by activity ahead. According to Hourdos, when viewed from above, the appearance is wave-like, with a ripple effect observed as car after car slows down.

"They vary in the number of cars involved but the length of the shockwave is a measure of safety, because every time a driver has to react to disruption there is a chance they could be distracted, miss that the vehicle in front has braked, and have a crash.

"The more drivers involved, the higher the probability one of them does something wrong. But even if there's not a crash, shockwaves still negatively impact the service provided, as they mean it's not as smooth a driving experience as it should be," he said.

Compare and contrast
Hourdos, with his MTO colleagues Stephen Zitzow and Panagiotis Stanitsas, authored a research paper comparing the closed I-394 and the open I-35W. The results showed that in terms of safety the difference between the two methods was

MnDOT is using a traffic modeling tool that helps it efficiently visualize and manage traffic according to the demands of its HOV lanes

which sections of the HOV lane should be closed access. It can also work out how far from the ramp the gate needs to be for vehicles entering the freeway to cross the general purpose lanes and reach the HOV safely and without affecting traffic flow."

Relying on MnDOT's traffic sensors as well as historical traffic data, the tool is able to construct the most effective HOV lane for the roadway it is examining.

Assuming an open design, the software will only recommend closing the gates when not doing so would likely create shockwaves or even crashes.

Passing on the baton

The software was delivered to MnDOT earlier this year.

"Prior to this project, we didn't have anything to assist us, but this tool helps us develop HOV lane designs as well as monitor existing corridors," Kary says. "It's not something we would use on even a monthly basis, as it wouldn't be practical or possible to make changes to the physical lanes so regularly.

"But the plan is that it will form part of our annual reporting process, when we look at all the existing corridors to see how well they're operating and whether changes are needed.

"It has really driven our design practices for future HOV lanes, as when we built the third one, it had a much more open access layout. Then when we had a resurfacing project on the I-394, it enabled us to take a second look and make that more open access as well," says Kary.

Not only has the traffic modeling software reshaped MnDOT policy, but the federal government has also backtracked on its earlier preference for closed access HOV lanes.

Federal Highway Administration (FHWA) spokesperson Nancy Singer says, "Both operating schemes have distinct benefits, so it comes down to the project's goals and objectives as to which scheme best helps achieve those goals and objectives. Both have proven to be effective."

Given the success of the new modeling tool in Minnesota's hands, the expectation must surely be that a system could soon be scaled to benefit the whole nation. ⊙

minimal. The report's conclusion stated, "Traffic on both HOV facilities can be disrupted by deteriorating conditions on the adjacent general purpose lane, although in the current levels of HOV lane utilization such disruptions are minimal."

Having showed that the open access HOV was no more dangerous or adversely impacting traffic flow, the academics wanted to go further.

A follow-up paper by Hourdos, Zitzow and Gordon Parikh sought to address a concern that existing methodologies for designing HOV lane access were "limited to engineering judgment or studies that take into consideration a small cross-section of observations".

The first of its kind

The paper culminated in the development of what can legitimately claim to be the first traffic modeling software tool for the design of HOV lane access.

> ❝ Prior to this project, we didn't have anything to assist us, but this tool helps us develop HOV lane designs as well as monitor existing corridors
>
> **Brian Kary, director of traffic operations, MnDOT's Regional Transportation Management Center**

Hourdos says, "This tool took theoretical ideas and made them usable. It is a very specific piece of software written to work with MnDOT that takes real-time data and diagrams each location separately for lane changes and reaction time.

"It provides a way of monitoring the road in a more holistic way but it also allows you to make predictions as to what would happen should the demand for the lane change.

"The last thing about it is that it can decide, based on sensor data,

tolltrans

2019

ALL TOLL ROADS!

ACCESS ALL AREAS

SMASHING THE LIMITS
SHOULD TOLLING CAPS BE ABOLISHED?

US$10

SITUATION CRITICAL
CAN TOLLING SAVE THE WORLD'S BRIDGES?

300

"WHAT THE GENOA TRAGEDY REMINDED US IS THAT ROAD MAINTENANCE EXTENDS FAR BEYOND FILLING IN POTHOLES"

THE LONG VIEW
TOLLING LEARNINGS FOR THE FUTURE

E-470

PRODUCTS&SERVICES

US$10

The current toll
cap in place on
Washington state's
I-405 Express Lanes

by Jack Roper

SMASHING
THE LIMITS

SHOULD TOLLING CAPS
BE ABOLISHED?

Dynamically pricing express lanes is, in theory, a great way to guarantee journey times. But what happens when toll increases are capped and the maximum amount is not high enough to deter increased usage?

→ Across the USA, tolled express lanes continue to shoot forth like new tendrils on a plant, growing around overcrowded chokepoints on key arterials and offering travel-time predictability to those commuters willing to pay. You sit and wait in traffic-jammed general-purpose (GP) lanes – or opt for the express lane, pay a toll via your transponder, and speed on by. Most express-lane facilities exercise dynamic pricing to regulate uptake, so that rising prices progressively deter more motorists as demand increases, maintaining a guaranteed travel time on paid lanes. Demand-based dynamic prices are displayed at entry points, providing a time-value choice to drivers.

In many cases, rates are capped to preclude eye-watering peak-period charges and subsequent talk of 'Lexus lanes' for the wealthy. But once a US$10 cap is reached, the agency's one sure method of managing volume on the lanes is expended – leaving paid-up customers stuck in traffic. Atlanta has recently removed I-85 Express Lanes toll caps to counter congestion.

11 MINS
The average time-saving achieved using the 15 miles of I-405 Express Lanes in Washington state

Elsewhere, tolls approaching US$50 have been reported as a result of unbridled dynamic pricing. Where tolled lanes fail to deliver travel-time targets, more authorities are coming under pressure to revise their caps. Behind this debate dwells the deeper question of how specifically demand-based pricing's simple, linear algorithms can channel the complex and counterintuitive currents of population behavior.

DYNAMIC TOLLS IN ACTION

Inland from where Seattle abuts its Pacific Ocean inlet, the population is exploding north-south from Bothell down through Renton as burgeoning cities blossom east of Lake Washington. "The corridor has seen unprecedented growth, so that we have fixed capacity and an exploding population." says Reema Griffith, executive director of the Washington State Transportation Commission (WSTC). In response to escalating gridlock, the WSTC and the Washington State Department of Transportation (WSDOT) opened the I-405 Express Toll Lanes in 2015, which now provide an estimated 11-minute average journey-time reduction for paying users and carry 56,000 cars each weekday. Following some robust debate, law makers authorized the use of dynamic pricing.

"It was a proven and equitable approach that seemed like the right mechanism for this corridor," Griffith recalls. "An algorithm, responsive to real-time demand, adjusts the price, letting the market drive the price of access to that capacity." Signs

Right: **WSTC has brought in a 3+ occupancy requirement for free peak-period use of its Express Lanes**
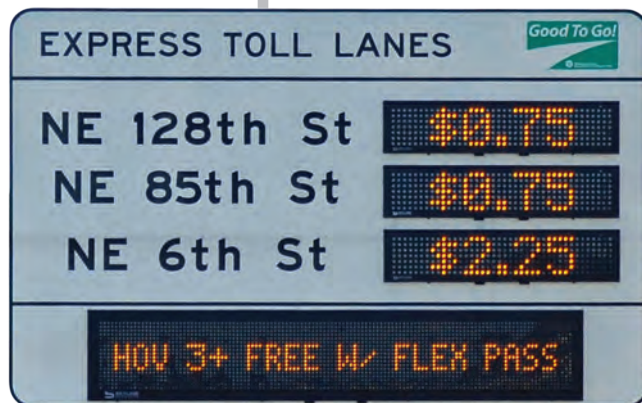
HOW HOV EVADERS SKEW PRICING MODELS

One factor distorting the price-to-volume equation on the I-405 Express Lanes in Washington state is their toll-free availability to drivers who declare high-occupancy vehicle (HOV) status by sliding over a switch on Good to Go! transponders.

"Operators with discounts or toll-free travel for HOVs are facing enforcement issues," says Nick Wood of Texas A&M Transportation Institute, in reference to drivers falsely claiming HOV status. "We've seen stats from regions where 25% of their volume have been violators; it can be as much as 50%." In such cases, performance and revenue are negatively skewed, as the ability to regulate congestion through demand-based pricing is diminished. "People are very determined. Drivers have been tracked getting three warnings in a month, saying, 'I'm still gonna do this!' In Washington state, insurance companies don't count HOV violations for increasing premiums."

Although the problem is widespread, products are available to help agencies detect wrongful HOV declaration. "Xerox [now Conduent] uses image-based processing to look at pixilation and determine HOV status," says Wood. "That alone gives a 90% accuracy rate, rising to 99% with human verification. Other managed-lane operators have a cop sitting near a toll gantry with a beacon looking at different indicators to check for invalid HOV drivers. The Carma Corporation is providing HOV monitoring by using travelers' smartphones and geolocation data to facilitate carpool occupancy verification."

"We've converted a once failing HOV lane into a paid lane and there was political debate around that," says WSTC executive director Reema Griffith. "We now have a three+ occupancy requirement for free peak-period use. Drivers have to self-declare and we're not allowed to videotape or take pictures of the occupants: that's the law in Washington state. It's a privacy issue, so we have to rely on on-road enforcement."

EXPRESS TOLL LANES — Good To Go!
NE 128th St $0.75
NE 85th St $0.75
NE 6th St $2.25
HOV 3+ FREE W/ FLEX PASS

567,000
The average number of cars carried each weekday by the I-405 Express Lanes, which opened in 2015

Above: **Dynamic tolls on the I-405 in Washington state usually stay well below the US$10 limit**

and gantries are coordinated to entry points where the current toll is displayed so that drivers can decide if the price is worth paying for reliable travel. Tolls are capped at US$10, a top rate pinpointed by modeling data as a sweet-spot, providing meaningful congestion management while remaining affordable and inclusive. "You're charging single-occupant drivers. They move over, freeing up space in the GP lanes, where drivers are saving three minutes in some locations. Everybody gets a benefit," says Griffith. "That's the theory."

But new tolled lanes initially exacerbated GP lane congestion at weekends, since drivers on less time-critical journeys balked at paying a charge, leaving tolled lanes virtually empty – which prompted WSTC to revise its policy, making Express Lanes free to use at weekends. "The Commission must look at the operation of those GP lanes," says Griffith. "We can't just make two lanes run

perfectly in isolation; everything has a counter-effect and you have to constantly balance factors, forces and outcomes." More centrally, Express Lane tolls have hit their cap during 15% of peak hours and one section remains prone to congestion, failing to deliver a target of 45mph (72km/h) travel over 90% of peak periods. This has led University of Minnesota experts, brought in by legislators, to suggest that the cap could

"AN ALGORITHM, RESPONSIVE TO REAL-TIME DEMAND, ADJUSTS THE PRICE, LETTING THE MARKET DRIVE THE PRICE OF ACCESS TO THAT CAPACITY"

Reema Griffith, executive director, Washington State Transportation Commission

US$47.50

The record toll for a 10-mile stretch of Virginia's uncapped I-66 Express Lanes, charged on February 28, 2018

be raised or removed, enabling market-driven congestion management beyond the present threshold.

"If you run with what makes purely mathematical sense, economic theory says you never cap something," Griffith explains. "In a free-market approach, you let the market set the price."

ABOLISHING CAPS

A handful of express lanes in the USA do operate uncapped tolls. On Virginia's I-66 Express Lanes, unfettered dynamic pricing has generated tolls up to US$47.50 for a 10-mile (16km) stretch. "There are caveats to that," says Texas A&M Transportation Institute researcher Nick Wood. "There's a lot of HOV [high-occupancy vehicle] traffic on I-66 – 68% of peak-period volume in May 2018 – so the proportion of that facility available for tolling is small to start with. Also, not everyone is using the entire 10-mile

stretch, so they're not paying that maximum. North Virginia is high in household income, so there's more willingness to pay."

But while raising Washington state's cap to US$15 has been debated, public opinion, politics and perception leave WSTC unlikely to abolish a cap outright. "Many factors contribute to congestion, so it's difficult to isolate the price or cap as the factor limiting performance," Griffith continues. "We frequently have bad weather and see different numbers in the winter and

"MANY FACTORS CONTRIBUTE TO CONGESTION, SO IT'S DIFFICULT TO ISOLATE THE PRICE OR CAP AS THE FACTOR LIMITING PERFORMANCE"

Nick Wood, researcher, Texas A&M Transportation Institute

Left: **There are 45 express lane facilities in the USA, including this one in Texas**

THE FUTURE OF EXPRESS LANES

Tolled express lanes that use dynamic pricing to regulate driver uptake have become core assets for many US tolling agencies. Currently, 45 express lane facilities provide some 650 center-line miles across the USA, according to a database maintained by Texas A&M Transportation Institute's Nick Wood. Around 75% of these use dynamic pricing. The remaining 25% operate variable tolls using fixed time-of-day pricing – a less specific tool that provides a degree of demand management, but is unresponsive to real-time traffic conditions.

"Demand-based pricing looks at vehicle volume in the express lanes," says Wood. "There's an algorithm and agencies look at both the speed and flow of traffic – and sometimes at the adjacent general-purpose lanes as well. If a lot of vehicles are traveling in the express lane, they will want to increase the toll; when there's lower demand, the toll will go down to incentivize usage. You're paying for speed and travel-time benefits."

As national interoperability takes shape and express lanes proliferate, they may become part of a more integrated road-user charging (RUC) model. "Right now, we're just looking at pricing on single facilities. That may expand to include other avenues like dynamically priced parking," Wood speculates. "Some entities are aggressively trialling mile-based user fees. Dynamic pricing for managed lanes could be just one part of a regional or statewide mileage-based user-fee system."

Wood also anticipates improvements in the data available to drivers when deciding whether to adopt a tolled lane. "Typically, managed lanes have overhead signs displaying the toll rates before each entry point. Travelers don't have real-time speed and travel-time information to tell them how bad congestion is. In the near-term future, you'll probably see that expanding out to Google and Apple Maps and more developers trying to integrate pricing information into third-party apps. Information will be shared and displayed through smartphones or technology embedded in vehicles."

summer months. Schools may be in or out of session – and an accident can certainly cause a blip in performance. But there is an engineering issue at the crux of our throughput problems." A natural bottleneck occurs where two express toll lanes merge into just one around Bothell. "We've got a perfect storm at that chokepoint," says Griffith. "There's been exceptional population growth and tons of apartments built in that area." With pricing alone unlikely to resolve congestion, WSDOT has fallen back on mitigation strategies. "They've adjusted the frequency of access points. Operationally, they adjust the algorithm from time to time. Was it too responsive – or lagging behind and raising the price too late? They're also allowing drivers to use the shoulder as a lane during peak hours. It's not paved to the smoothness of a regular lane, but people are happy with that option."

Building additional lanes may furnish a more long-term solution. WSDOT is assessing one-lane sections for a possible upgrade and legislators have authorized extending the express toll lanes south to Renton, creating a continuous 40-mile (64km) two-lane facility. Once operating costs are covered, says Griffith, any surplus revenue is dedicated by law to fund improvements in the corridor. "Over the first 30 months, we generated US$58.9m in gross revenue, of which US$27.6m is available for reinvestment," she reveals. "US$11m has already been invested back and you'll see more improvements to the

Left: **It is possible to pay express lane tolls by mail, though this method is actively discouraged by charging high transaction fees**

US$11M

The I-405 Express Lane profits invested back into the road network in the first 30 months of operation

GP and better interchanges, which will benefit all drivers on the corridor."

AN IMPERFECT SOLUTION?

"There are few true toll lanes where HOV car-poolers and single-occupancy vehicles pay the same," says Wood. "Usually, only a proportion of your traveler base is influenced by a dynamic toll rate; it can be a very high or low proportion."

Even if straightforward clarity of cause and effect were possible, demand-based tolls may only provide an imperfect mechanism for regulating the flow of human nature. High prices can trigger counterintuitive psychology. "People say to themselves, 'That's expensive – congestion must be really bad! I'd better use the toll lanes!'" Wood suggests. "Some individuals are inelastic and will take tolls no matter what. Our research suggests people are habitual and follow a pattern, as opposed to making daily changes."

The frequency of tolls hitting WSTC's cap fell in 2018, with US$10 tolls charged for only 8.5% of peak-period trips and charges averaging US$3.55. "There are plenty of Fords and Chevvies on those lanes," says Griffith. "Based on usage and account data, people are not using them every day; it's more occasional. If a single mom risks a US$30 fee for collecting late from day care, it's more costly than paying five bucks to be on time. Time is money – and people make a value of time trade-off."

If time was the only imperative, then caps might be dispensed with. But although

WSTC seeks to guarantee reliable 45mph (72km/h) travel, financial predictability must also weigh in the balance. "People have budgets," Griffith explains. "They can't really rely on lanes if they don't know whether they can afford them. The Commission avoided a pure market-demand approach because the public needed a limit. People are pretty smart and they know managing that corridor isn't always simple when there's so much demand and it just keeps rising. Improvements in both GP and paid lanes would be more evident if we had population stability." ✖

Left: Pricing alone is unlikely to resolve congestion; weather and human behavior are among the other factors behind it

NORBIT
- explore more -

CONNECTING
THE SMART TACHOGRAPH WITH DSRC

SITUATION
CRITICAL

CAN TOLLING SAVE THE WORLD'S BRIDGES?

As infrastructure ages, it's necessary to spend more on maintenance. But, amid a number of recent fatal disasters, should road operators be instigating or increasing tolls to fund the necessary repair work? Or should public money be leveraged to plug the gap?

300

The number of bridges in Italy deemed structurally unsound in the wake of the Genoa bridge collapse disaster

Left and far left: In August 2018, 43 people were killed when the Morandi Bridge in Genoa, Italy, collapsed

→ It was a day that many in the Italian city of Genoa will never forget. On August 14, 2018, a 260ft (80m) section of the Morandi Bridge, which was built in 1967 to strengthen connections between the port and France, fell 330ft (100m) to the ground killing 43 people. Nobody yet knows what caused the partial collapse. An investigation is underway, and the authorities are desperately hoping it is found to have been an isolated case. But worryingly, structural engineers in Italy have identified as many as 300 more bridges that could be unsound.

In other European countries there are also fears that hundreds of bridges, some of them built midway through the last century, could be at risk. Take France, for example. A recent government audit found that around 840 bridges – all under the control of the state – were "at risk of collapse".

In Germany the situation is no better. Last year the Federal Highway Research Institute delivered a report that stated that only 12.5% of the country's bridges were in good condition.

In the UK and USA many bridges are also in a state of decay. The American Road & Transportation Builders Association found more than 50,000 crossings in the USA to be "structurally deficient". Meanwhile, the latest bridge maintenance report from the UK's RAC Foundation found "almost 3,500 council-maintained road bridges in Great Britain" to be "substandard" – meaning they are unable to carry the largest lorries.

FINANCIAL BURDEN

But for many, an even greater concern is that the local authorities tasked with operating and maintaining bridges in the UK appear to be financially out of their depth.

Steve Gooding, director of the RAC Foundation, says, "It's important to clarify that our research does not suggest that

PICCARDO

"WHAT THE GENOA TRAGEDY REMINDED US IS THAT ROAD MAINTENANCE EXTENDS FAR BEYOND FILLING IN POTHOLES"

Steve Gooding, director of the RAC Foundation

London Bridge or any others are actually falling down. However, it is clear that many are being protected by weight restrictions or have been bolstered with props. What is also undeniable is the fact that the budgets available to local highway authorities for all aspects of highway maintenance, including highway bridges, are inadequate and under increasing pressure as the costs of other council-run services go up. The Genoa tragedy reminded us that road maintenance extends beyond filling in potholes."

This is best evidenced by RAC Foundation-compiled figures which show that the cost of completing the backlog of work on the UK's council-owned bridges would be £5bn (US$6.6bn). Even more revealing is the actual combined amount being spent by the UK's stricken councils each year. "The figure is £367m (US$471m), which equates to a mere 7.3% of the estimated total needed," says Gooding.

Below: **The Thousand Islands Bridge connects New York in the USA with Ontario in Canada**

The towers on the Queen Elizabeth II Bridge in London, UK, are 137m (449 ft) tall

"NOW THOSE IN CHARGE OF OPERATING THE BRIDGES HAVE TO WRITE A BUSINESS CASE TO THE DECISION-MAKING BODIES AND MAKE A CASE FOR FUNDS"

Prof. Gordon Masterton, Centre For Future Infrastructure at Edinburgh University

With this trend of bridges in need of urgent repair emerging across the globe, what is the solution? Are the current asset management models – many of which are created and administered by the state – fit for purpose? Is it realistic and fair that local, regional and national agencies should be responsible for the upkeep and renovation of bridge infrastructure? Many think not, so could more tolled bridges help fill the funding gap?

As far as the UK is concerned, Gooding, who was director general at the Department for Transport (DfT) before joining the RAC Foundation, believes that tolling does not necessarily hold all the answers.

ABOLISHING BRIDGE TOLLING
In Scotland politicians have had a large say in the future of road bridges. A decade ago the Scottish parliament passed the

Abolition of Bridge Tolls Act, which means that the tolls on the Forth Road Bridges, the Tay Road Bridge and the Erskine Bridge have all been removed. But without tolls, is there sufficient funding in place for maintenance and upkeep?

For Prof. Gordon Masterton, an academic with a business background who established the Centre For Future Infrastructure at Edinburgh University to help policy makers address large-scale challenges in infrastructure, this is not an easy question to answer.

"The future structural health of these bridges is very much in the hands of those who hold the purse strings. However, that is no longer the bridge masters, who in a time of tolling were guaranteed a pot of money that they would allocate to routine bridge inspection and maintenance each year. Now those in charge of operating the bridges have to write a business case to the decision-

making bodies and make a case for funds. But in a time of austerity, that often means they are competing at national level with spending on health or schools. The argument for bridge maintenance budgets is harder to make against other societal – and electoral – issues."

But while Masterton does not expect to see a return to bridge tolling in Scotland – in the current economic climate, in particular – he thinks that the future funding structures of bridges should not be viewed as discretionary. Instead he believes that government bridge owners need "to come up with a better solution to ensure bridges are properly maintained". (See *What value on bridges?.)*

BRIDGE TOLLING IN THE USA
Some 3,000 miles west of the UK, in the Canadian province of Nova Scotia, Steve

MAKING MAINTENANCE WORK

While public benefit not-for-profit organizations enjoy funding streams that help them implement round-the-clock maintenance programs, "it is how the work is carried out that really counts," says Robert Horr, executive director of the Thousand Islands Bridge Authority (TIBA).

Horr, who oversees an 8.5-mile (13.5km) set of suspension bridges connecting New York State to Canada, believes that "TIBA's highly skilled and experienced engineers are the reason the bridges – some of which were built in the late 1930s – are in such good shape.

"Every second year, hands-on in-depth bridge inspections are completed by consulting engineers who have a long history with our structures," Horr explains. "Institutional knowledge is very important, especially with older structures, for it is these in-depth inspection report recommendations that drive our ongoing bridge maintenance program."

Horr also thinks that another key factor for bridge safety is senior management always listening to, and acting on, the institutional knowledge of Bridge Authority staff, who have decades of experience on the structures.

"Management supporting the continuance of that knowledge sharing is paramount for success in our maintenance program," he adds. "Large structures such as suspension bridges each have a specific feel and sound. Knowing when something doesn't look or sound right is an important skill that helps to ensure problems will be found early."

Left: **The 'Big Lift' project involved the replacement of the road deck, floor beams, stiffening trusses and suspender ropes on the suspended spans of the Macdonald Bridge in Canada**

Snider, CEO of Halifax Harbor Bridges, also recognizes the benefits that big data can bring. However, the operating model in place for the two tolled suspension bridges – the MacKay and the Macdonald – that link the cities of Halifax and Dartmouth, does not rely on data to make a case for funding. What's more, according to Snider, the drivers who make a combined 32.5 million crossings each year enjoy some of the cheapest tolls in the whole of North America. Those who pay by electronic payment are charged just 80 cents, and anyone paying by cash pays a dollar. However, larger vehicles with more than two axles pay more.

Snider, who became CEO and general manager

US$6.6BN

The approximate price put on clearing the maintenance backlog on all UK bridges (£5bn)

of Halifax Harbor Bridges (HHB) 24 years ago, says, "In my tenure we've raised the tolls only twice – in the year I joined and again in 2011."

Low crossing charges haven't stopped Snider and his team improving the bridges as well as operating and maintaining them. The Big Lift Project – in which the entire suspended structure of the Macdonald Bridge was replaced – cost C$186m (US$142.8m), while in the past five years Snider estimated that the bridge authority has spent "in the region of C$24m [US$18.4m] on other capital projects".

But if the bridge authority's annual revenue is C$33m (US$25m) and the cost of the team that administers, operates and maintains the bridges is C$7.9m (US$6m), how is the extensive and ongoing bridge maintenance financed? The answer lies in the operating model, which enables HHB to leverage public loans on excellent terms that only ever need to be paid back with toll revenue.

Snider tells *Tolltrans* that HHB "is a government business enterprise, and not a private tolling company". He explains that it was formed by the provincial government under an act of commercial legislation in 1952. Over the past three years it has borrowed C$160m (US$121m) from the province of Nova Scotia to undertake capital

Left: The Erskine Bridge spans the River Clyde in Scotland

projects. Loan proceeds supplement toll revenues to enable HHB to finance projects such as the Big Lift.

Looking at this year's annual report, 39% of funds were drawn from the Big Lift Loan – that's C$20.5m (US$15.5m) – while the rest was generated by toll revenues (C$31.6m/ US$24m). So how does the HHB's financial operating model work?

"We have a loan from the province of Nova Scotia to complete the Big Lift but the terms of the agreed loan perhaps differ from the ones signed by privately run tolling companies," explains Snider. "First, the loan does not come from a toll revenue bond, or from a private bank. Instead, as we

are a crown corporation of the provincial government and have one shareholder – the Minister of Transportation – it comes direct from the province of Nova Scotia. Second, the rate – which is fixed and has been set at 2.8% over 25 years – is very manageable and has been factored into our forecasting. Third, we have an agreement with the province that the loan is only repaid from revenue generated by tolls. So this ring-fences and protects the bridge and all who travel on it and work for it."

Another vital difference in what Snider calls a "pretty slick operating model" is that HHB

C$186M

The total cost of the Big Lift Project which replaced the entire suspended structure of the Macdonald Bridge in Nova Scotia (US$142.8m)

WHAT VALUE ON BRIDGES?

→ Part of the argument for setting funding levels for bridge maintenance, whether from tolling or other sources, must come from assessing the true value of such assets.

"If these major road bridges were not in place, how would it affect business? What would happen to emergency hospital care? How would policing be affected?" asks Professor Gordon Masterton from Edinburgh University.

He suggests that to fully appreciate the value of bridges, economic modeling needs to be updated. Traffic flow data could help those in charge of funding to make informed, evidence-based decisions on appropriate investment in maintenance better related to the value of the asset and its current condition.

"However, most road bridges are not equipped with sensor technology," says Masterton. "Nor do they have data-savvy staff to collect this information. There is a danger that critical infrastructure will be left behind with the growth in smart, connected and autonomous vehicle technology. We would have smart vehicles riding on dumb bridges. The real value of the bridge, and the correct funding stream, may never be properly determined. But we should look to hybrid asset management models, where the private sector and government collaborate, and for next-generation schemes like asset-value modeling linked to some version of dynamic pricing to be finally realized."

Left: **The 'Big Lift' refurbishment of the Macdonald Bridge in Nova Scotia, Canada, cost US$205m**

20

The estimated maximum years of life left in the A Murray MacKay Bridge, Nova Scotia, before it needs rebuilding or replacing

bridges he oversees, which were built in 1955 and 1970, even when the original construction costs have been met.

"If we didn't spend a dollar more on renovation, then the bridges would be paid off in 23 years," he says. "The older the bridges, the more maintenance they require, and the cost of projects – such as the dehumidification of the main cables, or replacing the asphalt on the decks – becomes increasingly expensive. I expect that in the next 15 to 20 years we'll be spending a lot more money to either rebuild or replace the MacKay Bridge. So tolls will be necessary to service future renovations."

Snider is also concerned for bridge operators or tolling authorities that don't have access to the same asset management model. "In North America and further afield, some toll authorities compete with transit carriers for revenue," he says. "They don't have the money they need to maintain bridges. But bridges are unique and require dedicated funding. They are not like roads where potholes can be patched. They need round-the-clock maintenance, and as they get older they must undergo more finite and complex inspection programs. If this work is not carried out, you put the bridge at risk – and more importantly, the paying public who use it. The challenge for bridges – and I am not an engineer – is that the maintenance has to be done before it is required. If you wait until it is fully required, then you've waited too long."

Snider, who is one of the longest-serving bridge managers in North America, has one final piece of advice for those who manage, maintain and operate the world's bridges.

"If you let your dollars decide what you're going to do, your bridge is going to come up short. First define the work that has to be done and then ensure that you have the dollars to do it." ❌

"THE LOAN IS ONLY PAID FROM REVENUE GENERATED THROUGH TOLLS. THIS RING-FENCES AND PROTECTS THE BRIDGE AND ALL WHO TRAVEL ON IT AND WORK FOR IT"

Steve Snider, CEO, Halifax Harbor Bridges, Nova Scotia

has the power and authority to set tolls at arm's length from the province.

"We make an application to what is called the Nova Scotia Utility and Review Board," says Snider. "We demonstrate to that authority why we need the toll increase when we do, and give full disclosure on our financial statement and plenty of projection on our anticipated revenue. In short, if we clearly demonstrate why we need the dollars to maintain the bridges, then, for the public good, I'm not sure how it can deny us."

DO TOLLS COVER MAINTENANCE?
Not every toll bridge has access to an efficient, publicly backed finance model such as the one employed by HHB. So can toll revenue ever be enough to cover the cost of repairs? Take the Morandi bridge, for

example. The company that operates it, Autostrade per l'Italia, is a privately owned tolling company. It has been officially blamed by the Italian government for the collapse and there are calls for it to lose its operating license. The company, which is responsible for operating 2,500 miles (4,020km) of Italian toll roads, denies the charges. It says that it has actually spent more on renovation and repair than the bridge concession required. Should privately owned tolling companies with little access to government funding be allowed to oversee such a vast amount of critical infrastructure?
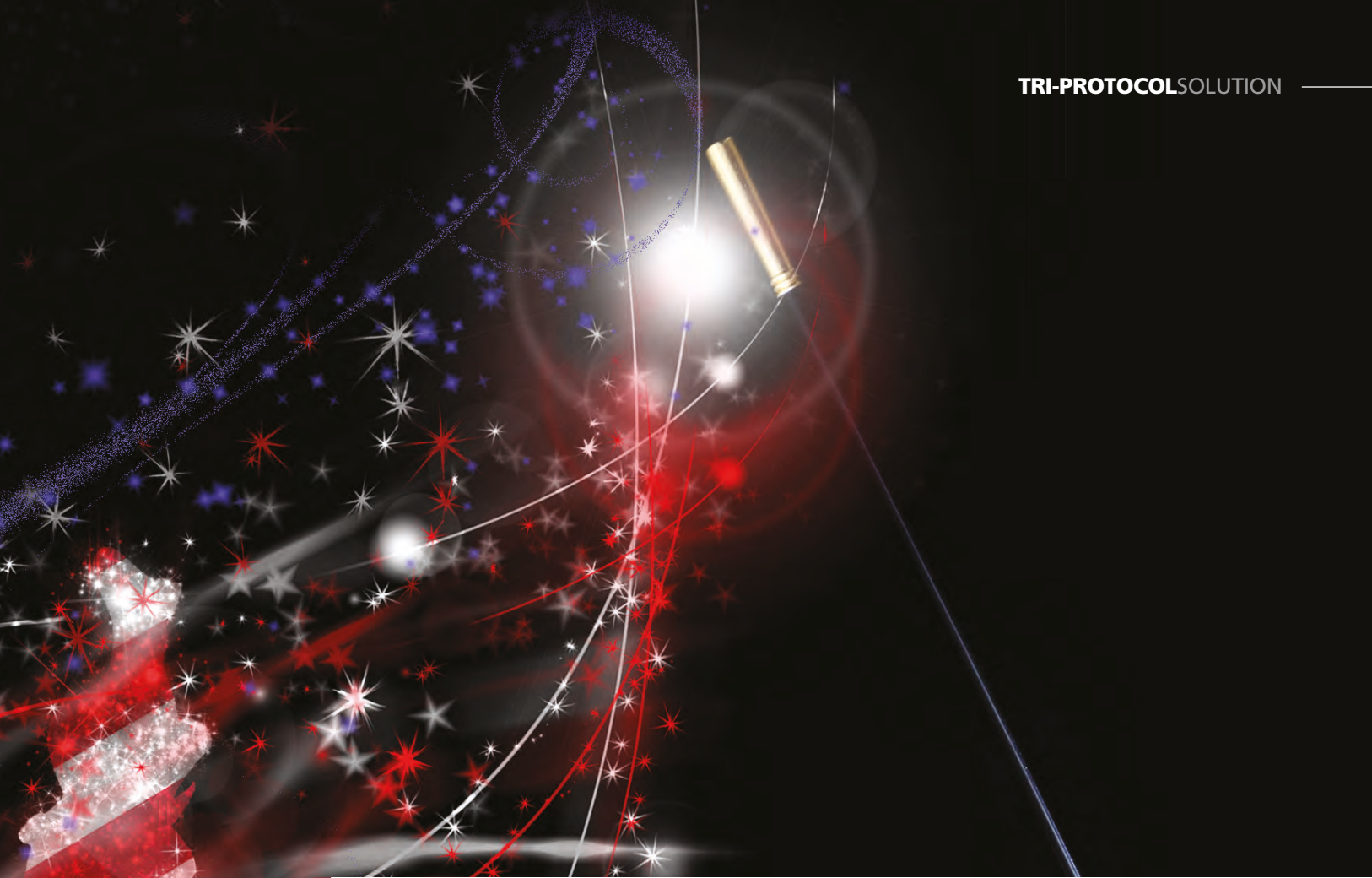
While Snider does not wish to comment on the asset management model employed by others, he says that "tolling will remain an important revenue tool to cover the huge maintenance costs" of the suspension

MAGICPASS
INTEROPERABILITY BREAKTHROUGH

The North Carolina Turnpike Authority has become the first tolling agency in the USA to crack the tri-protocol interoperability challenge, and in doing so is waving a wand that will change the future of tolling across the USA

ALL TOLL ROADS!

ACCESS ALL AREAS

Full, tri-protocol interoperability is finally here! Find out how a new system in North Carolina could transform tolling in the USA forever

2012

The year NCTA opened its first toll road, the Triangle Expressway, meaning it is relatively unhindered by legacy systems

Right now, the North Carolina Turnpike Authority (NCTA) must feel like a superstar among tolling agencies. Twice in only three years, NCTA executive director Beau Memory has taken the stage at the International Bridge, Tunnel and Turnpike Association's (IBTTA) Annual Meeting to accept the coveted President's Award. He first received the prestigious industry accolade in 2016 for a campaign promoting the interoperability of NC Quick Pass Transponders with toll facilities all down the East Coast. Memory collected top honors once more in 2018 for an initiative closely watched by tolling entities across the USA. In September 2017, NCTA retrofitted its Triangle Expressway with tri-protocol reader technology, enabling all three protocols under IBTTA consideration for national interoperability – SeGo, TDM and 6C – to be simultaneously captured in a dynamic tolling environment.

NCTA was uniquely well positioned to achieve the landmark success, both geographically and in the newness of its enterprise. "We've been at the forefront of interoperability, almost since inception," explains Memory. "That's largely because of where we're located in relation to other tolling states. We have E-ZPass to our north and Florida SunPass and Georgia Peach Pass to the south. We have lots of folks flowing through from those two regions with two different technologies. We're strategically placed in the conversation and have had to think hard about how to embrace transponder technology."

If Memory comes across as a youthful, energetic executive director, it reflects

"WE'VE BEEN AT THE FOREFRONT OF INTEROPERABILITY, ALMOST SINCE INCEPTION. THAT'S LARGELY BECAUSE OF WHERE WE'RE LOCATED IN RELATION TO OTHER TOLLING STATES"

Beau Memory, executive director, NCTA

35%

The savings offered to customers who switched to NCTA's dual-protocol transponders in 2013

Left: The Triangle Expressway gantries were retrofitted with the new technology at off-peak times, to minimize disruption

NCTA's status as a young organization, unfettered by pre-existing systems and practices. Although founded back in 2002, NCTA only opened its first facility, the Triangle Expressway, in 2012 – but already has several more projects in the pipeline. "We have the benefit of being new to tolling in North Carolina," says Memory. "We don't have the burden of trying to replace legacy systems or toll booths; we are dealing with new projects and systems."

NEW BEGINNINGS
NCTA first began looking at options for interoperability 10 years ago, before launching the Triangle Expressway. "At that time, two main tolling protocols were being used on the East Coast," recalls Memory. "The TDM or E-ZPass protocol to our north, and SeGo with Florida and Georgia to our south. We decided to go with a dual-protocol system, accepting both TDM and SeGo." This enabled customers to use their accounts along the eastern seaboard from Augusta, Maine, right down to Miami, connecting the northern and southern hubs for the first time.

There ensued a campaign in 2013 to promote NCTA's new interoperable NC Quick Pass transponders in partnership with a local baseball outfit, the Durham Bulls. Leaflets were distributed to 200,000 Bill by Mail customers, offering savings of 35% for switching to transponders. This outreach campaign duly garnered the 2016 President's Award. "It recognized our efforts on interoperability in general," Memory explains. "Becoming the most interoperable state – and successfully implementing that across our customer base. It's one thing that

technology works seamlessly – but another to meaningfully educate and engage customers in taking advantage of it."

By 2015, when Memory returned to NCTA as executive director following a period at NCDOT and as senior policy adviser at the North Carolina Senate, the story had moved on. "The landscape was changing," he says. "Georgia State Road and Tollway Authority [SRTA] had moved to the 6C protocol, which was a new dynamic. We could maintain interoperability because our systems relied on both transponders and license-plate reading capabilities – but that's a less efficient way to do it." Against this shifting backdrop the move to adopt tri-protocol technology took shape, as NCTA sought the most robustly interoperable solution available in time for the Monroe Expressway's 2018 opening.

"As North Carolina added new projects, we wanted to think about how the system needed to change for the next decade," Memory explains. "We had four main goals. We wanted to reduce the cost of transponders – to both customers and the agency. We wanted to support IBTTA's broad efforts over many years in advancing the interoperability debate. We also wanted to avoid a transponder recall, bringing customers into our service center to remove transponders we had just sold them. And we wanted all that done before we opened new projects this year."
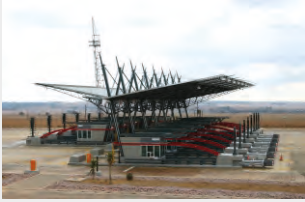
HARDWARE SOLUTION
The decision was made to pursue a solution enabling NCTA to simultaneously read

"AS NORTH CAROLINA ADDED NEW PROJECTS, WE WANTED TO THINK ABOUT HOW THE SYSTEM NEEDED TO CHANGE FOR THE NEXT DECADE"
Beau Memory, executive director, NCTA

9,000
The number of transponders distributed monthly by NCTA, double its previous monthly average

Left: The Triangle Expressway solution is based on Kapsch MPR2 hardware that reads SeGo, TDM and 6C protocols

all three candidate protocols. A competitive and multifaceted procurement followed, before NCTA executed three contracts with Kapsch TrafficCom to provide tri-protocol readers and both 6C and TDM transponders.

The task of retrofitting the Triangle Expressway gantries with Kapsch MPR2 readers across 80 lanes and 20 toll zones was accomplished off-peak, minimizing disruption to existing NC Quick Pass customers, since some 50,000 vehicles use the busiest section on average weekdays.

Following the system go-live in September 2017, NCTA began offering free 6C-based sticker transponders while also reducing the cost of E-ZPass interoperable units and continuing support of previous tags.

A NEW TOLL ROAD IS BORN

→ Part of the North Carolina Department of Transportation (NCDOT), the North Carolina Turnpike Authority (NCTA) was created in October 2002 to plan and develop new toll-funded infrastructure projects within the state. Its first facility was the Triangle Expressway, an 18.8-mile (30km) controlled-access highway in Durham and Wake Counties with all-electronic free-flow tolling. Built at a cost of around US$1bn, it opened to traffic in 2012.

NCTA is now preparing to open the 20-mile (32km), six-lane Monroe Expressway in late 2018 and work has begun on 27 miles (43km) of dedicated I-77 Express Lanes around Charlotte in the state's western Metrolina region. Seven more projects are lined up, in proposal or at the planning phase.

"Everybody's focused on making sure the Monroe Expressway opens successfully right now," says executive director Beau Memory. "It's an all-electronic facility and we'll be replicating what we've done on the Triangle Expressway. All the toll projects being planned and developed are going to be using the tri-protocol readers."

NCTA is now working on a solution to wrong-way driving. "We're fortunate that we have never had a wrong-way vehicle crash," says Memory. "But it's a problem on all control-of-access facilities. As an all-electronic toll facility, we have the technology to detect wrong-way vehicles. We've got an ongoing pilot project with four types of vendor technology now being evaluated. As we get into 2019, we hope to identify the technology we think is most effective and prudent to install. We'll put that into the Monroe Expressway and then the Triangle Expressway."

"THE IBTTA AWARD IS A SIGN THAT OTHERS ARE PAYING ATTENTION TO WHAT'S HAPPENING HERE"
Beau Memory, executive director, NCTA

With toll agencies nationwide watching the project's outcome, results so far have been auspicious. Ten months on, NCTA had distributed 9,000 transponders monthly, doubling its previous average. Weekday transponder transactions were up from 58% to 63%, reducing post-paid license plate billing-associated costs, while saving transponder-adopting customers 35% on tolls. For the first time in NCTA's history, transponder-based transactions exceeded 60% over a full quarter.

"So far, we've saved customers nearly US$1m in the cost of transponders and tolls," says Memory. "For the agency, we've

US$400K
The approximate back office savings made by NCTA in 10 months thanks to the uptake of tri-protocol transponders

saved almost US$400,000 to date. As new projects open, we expect our transponder base to grow, so that we will completely make up the investment in this technology within two years of installation."

CONSUMER CHOICE
NCTA can now offer a cost-efficient choice of transponder options, depending on whether customers only plan to drive in North Carolina, or also in states north or south. "It has moved our transponder system from a SeGo and TDM standpoint, to now mostly selling 6C and TDM," explains Memory. "The IBTTA award is a sign that others are paying attention to what's happening here. By the same token, an agency cannot hope to achieve interoperability alone – and support from partner entities has proven crucial.

"E-ZPass, SRTA and the Florida Turnpike Enterprise (FTE) were all incredibly helpful in making this happen. E-ZPass has strict standards to meet to be compatible with them – and we worked very closely with

Right: **Tim Stewart (left), president of IBTTA, presents the 2018 President's Award to Beau Memory, executive director of NCTA, and David Machamer, assistant executive director, PikePass; toll operations for the Oklahoma Turnpike Authority; and chair of IBTTA's Toll Excellence Award Committee**

IBTTA INTEROPERABILITY ASSIST

→ IBTTA has worked to advance national tolling interoperability for a decade, providing a safe space to discuss what is a complicated issue for member agencies, many of which are invested in their own unique tolling protocols and would have much to lose through a mismanaged transition.

IBTTA has engaged in the development and testing of candidate protocols through its Interoperability Steering Committee. It has also supported agencies across the USA in harmonizing business practices, formulating shared technical specifications and producing a master-list of steps that each agency currently takes

to execute a tolling transaction, so they can start working together.

It has helped shape the evolution of authorities into regional hubs, including the E-ZPass Consortium in the Northeast and FasTrak toll operators in California, who are now looking to link up with Colorado. Meanwhile, the Florida and Texas hubs are poised to become interoperable.

The 2016 and 2018 President's Awards recognized NCTA's pioneering work to become interoperable with East Coast groups both north and south.

"NCTA has set a standard in experimenting with different cameras and tolling systems," says

Tim Stewart, IBTTA president for 2018. "They've asked, 'What's the best way to streamline collection of toll revenues and continue to expand in the region?' Beau Memory saw an opportunity to look at how effectively tri-protocol readers could collect tolls in a high-speed environment. As an industry, we are watching with hope and curiosity to see if this can be replicated across the USA, as others install new equipment. Hubs that link transactional information through multiprotocol readers will probably be the main way that interoperability occurs – because the customer doesn't want to change to a different protocol."

we do, it's harder and more sensitive for them to replace." More entrenched tolling operators must factor in backward compatibility with legacy transponders as they seek new interoperable capabilities with adjacent providers. Hence the model of multiprotocol reader retrofitting provided by NCTA may prove singularly attractive, enabling differing protocols to continue coexisting as regional hubs grow and, as on the East Coast, intersect.

MOVING TARGET

Memory has no fond notions about resting on his laurels. "We're part of conversations with other agencies thinking about similar tri-protocol installations," he says. "But interoperability will continue to be a moving target, with technology evolving."

NCTA's eyes are already on the next phase, as it continues to develop back office

both E-ZPass and our vendors to ensure the technology was ready to go," says Memory.

A key predicate of NCTA's success has been the convening power of IBTTA, creating a climate in which tolling agencies, all invested in their own unique protocols, can navigate interoperability's turbulent currents collaboratively. IBTTA has been instrumental in trialling protocols – but also in shifting the discussion toward the development of common business practices that will allow interoperability to coalesce around expanding regional hubs. "It's so important that IBTTA has taken a lead," says Memory. "It was crucial in creating a set of standards, both in terms of communication and how we process transactions."

Memory acknowledges NCTA's advantage and privilege in beginning with a blank canvas. "Understandably, when agencies have older systems on a larger network than

"AS AN INDUSTRY, WE ARE WATCHING WITH HOPE AND CURIOSITY TO SEE IF THIS CAN BE REPLICATED ACROSS THE USA"
Tim Stewart, president, IBTTA

60%
The number of transponder-based transactions now taking place each quarter with NCTA

processes, ready to assimilate fresh changes in technology. Interoperability could evolve by increased adoption of cell-phone mobile tolling – NCTA is offering a mobile app for HOV declaration – or through technology embedded in cars, with Audi now producing models that can be paired with a tolling account (see page 16). "The tri-protocol readers were important, but they won't be the solution we're discussing in 10 years' time," says Memory. "It's an exciting time to be in the industry." ✕

TEAMS
WORK.

Benefit from our know-how and experience.
EFKON's expertise is based on extensive know-how on all major electronic tolling technologies and more than 20 years of experience in the ITS and ETC business. We offer a broad portfolio from single components to products, systems integrations and operations for nationwide tolling systems and congestion charge (City Tolling) solutions. We support our customers from the planning stage through the project handling to the after sales service – benefit from a one-stop-shop provider, tailoring solutions to your individual needs.

www.efkon.com

EFKON

EFKON GmbH, Dietrich-Keller-Str. 20, 8074 Raaba, Tel. +43 316 6990-0

Tim Stewart is the
executive director of the
E-470 Public Highway
Authority in Colorado
and served as president
of IBTTA for 2018

THE LONG VIEW

TOLLING LEARNINGS FOR THE FUTURE

IBTTA'S outgoing president, Tim Stewart, has 34 years of experience in the industry. In an exclusive interview, he reflects on his own achievements, and those of his peers across the sector, but warns against complacency in the face of future challenges

When a young Tim Stewart shouldered a shovel on his first day as a maintenance worker on the H E Bailey Turnpike in Oklahoma, it was only supposed to be a temporary job, a stopgap during a construction industry down-cycle. Thirty-four years on, Stewart can reflect on half a lifetime in transportation, during which he has reached the rank of executive director at Oklahoma Turnpike Authority and then at the E-470 toll road in Colorado, while having served as the president of the International Bridge, Tunnel and Turnpike Association (IBTTA) for 2018.

"It's been a long journey, with challenges but also opportunities to learn," says Stewart. "I've progressively tried to ask, 'What can get done better? What can I do better to serve the people I work for?'"

The IBTTA presidency – which lasts for one year – has enabled Stewart to address this philosophy to global transportation concerns. "It's exciting to be part of that bigger puzzle, serving a great association, which leads the advocacy of better transportation worldwide,"

Right: **The E-470 is an all-electronic tollway, featuring 16 interchanges and 96 bridges; it was completed in 2003**

US$1.5BN

The bond debt linked to the construction of the E-470, projected to be paid off via toll revenue by 2041

he says. "People told me the year would go quickly – and it has!"

According to Stewart, different regions currently face distinct, though interconnected, transportation challenges. "Our Asian partners have high demand and the challenge of moving high concentrations of people. In Europe, they are contending with environmental disciplines and how to manage cross-border trips effectively while protecting customers and their information. In the USA, we have the issue of improving funding to maintain aging infrastructure."

MANAGING INCREASING DEMAND

A core imperative is the need to harness technology to service ever-increasing traffic density. "Population will continue to explode," says Stewart. "Here in Denver, it's predicted to double by 2050. How do you handle twice the population, with the same infrastructure? The answer is, you don't."

"HOW DO YOU HANDLE TWICE THE POPULATION, WITH THE SAME INFRASTRUCTURE? THE ANSWER IS, YOU DON'T"

But despite formidable challenges, Stewart nurtures an optimism based on the potential for talented minds across transportation to innovate and work together. "We need to be progressive and thoughtful in how we advance – but we've got great operators and organizations that can provide phenomenal solutions, as long as we figure out how to cooperate effectively," he says.

He is full of admiration for the achievements of fellow tolling authorities, such as the North Carolina Turnpike

E-470 – A BRIEF HISTORY OF A TOLL ROAD

E-470 Public Highway Authority is a political subdivision of the State of Colorado, which operates a 47-mile (75km) non-stop, 75mph (120km/h) all-electronic tollway describing a crescent around Denver's eastern perimeter. It provides a transportation corridor serving adjacent communities and a link to both national and international travel via Denver International Airport.

The roadway, which has 16 interchanges and 96 bridges, was opened in sections between 1991 and 2003. Built without any tax dollars, it is operated and maintained solely through toll revenue, which will also go toward paying off US$1.5bn of bond debt by 2041.

E-470 hosts and operates ExpressToll, a back office service used by other tolling entities in the state, including Colorado Department of Transportation (CDOT).

E-470 has twice won IBTTA's prestigious President's Award, for implementing the use of statistical data to improve operations in 2006 and for introducing a solar-powered toll road in 2013.

An economic impact study, quantifying the benefits delivered by the E-470 roadway, was carried out in 2015. It concluded that, since 1986 (when funding bonds were first secured), E-470 has stimulated the development of US$38.4bn in real-estate value along its corridor, generating US$467m in property taxes for regional government annually. It is calculated that E-470 saves

Denver residents 14.8 million hours of driving time per year, equating to US$26.1m in annual travel time savings. It is also estimated that, through safer travel, E-470 provided value in terms of avoided incidents, to the tune of some US$24m.

"Our purpose is to improve your journey," says Tim Stewart. "We've accomplished that in our first 27 years and will continue doing so."

Authority, to which Stewart recently handed the IBTTA President's Award for its industry-first tri-protocol reader installation .

DELIVERING ON TRUST

The IBTTA's theme during Stewart's tenure as president has been trust and accountability, and he has a specific notion of what this looks like: "The bedrock of any great business is that you're trusted to deliver what you promised to deliver."

E-470 certainly has a track record of putting this into practice, and showing leadership through example. One recent instance was the Senate Bill 90 initiative, which saw E-470 organizing a cross-agency campaign to pass mutually beneficial legislation, sweeping up the IBTTA's 2018 Administration and Finance Award in the process (see *Catching toll evaders*).

"There were a couple of impediments – understanding at a legislative level why it was necessary, and funding," says Stewart. "E-470 stepped up and said, 'We'll fund the project, so it's not a burden on the taxpayer, because we're certain we will benefit long term, from a revenue standpoint.'" This confidence was vindicated, in the

US$38BN

The approximate value of the real-estate investment attributable to the opening of the E-470 corridor

Right: **The E-470 uses 22 solar arrays to power equipment including electric vehicle charging points, cameras, signage and lighting**

"THE BEDROCK OF ANY GREAT BUSINESS IS THAT YOU'RE TRUSTED TO DELIVER WHAT YOU PROMISED TO DELIVER"

new system's first year, by the recovery of more than US$6.7m in revenue previously lost through unidentifiable images, giving E-470 a 64-day return on investment.

E-470 is a tolling agency adept at articulating its benign contribution to the wider community, its 2016 economic impact study being a prime example (see *E-470, a brief history of a toll road*). It has impressive environmental credentials, having scooped the IBTTA President's Award in 2013 for installing 22 solar arrays along a 17-mile

US$6.4M

The lost revenue from toll evaders recouped by E-470's new temporary plate program in just 64 days, paying for the entire implementation

CATCHING TOLL EVADERS

Newly purchased cars in Colorado must display a temporary license tag until permanent plates arrive. Until recently, this was just a piece of paper that could be taped anywhere in the vehicle, unfortunately offering scope for counterfeiting and evasion of owner identification. As a result, auto dealers were encountering problems with fraudulent tags, the safety of law-enforcement officers dealing with traffic incidents was being jeopardized, and revenue was being lost at all-electronic tolling facilities.

In response to a shared need, in 2012 E-470 initiated an improved temporary plate program using standardized tag design, specified vehicle tag placement, and an owner identification database. To make this a reality, E-470 spearheaded a legislative effort in partnership with

Colorado government agencies, local auto dealers, law enforcement, county clerks, and the Colorado Department of Revenue. The system was signed into law in 2015 under Colorado Senate Bill 90, demonstrating how a local toll authority could partner with a range of state and government agencies and private stakeholders to pass legislation streamlining business processes for all. Through a one-time grant, E-470 spared taxpayers the implementation cost.

The new system gave pay-by-plate image-processing staff a new ability to identify tags in any ambient lighting conditions. After 18 months, rejected temporary tag images were down 22.4% and total revenue loss had decreased by US$6.7m, allowing E-470 to recoup its investment in just 64 days.

"Senate Bill 90 was a response to multiple needs," recalls Tim Stewart. "E-470 funded the project because we were certain of the revenue benefits. It resulted in improved safety, better identification of vehicle owners, a reduction in unreadable plates, and a

streamlined system for auto dealers. None of this would have been possible without the work of director of operations Dave Kristick and the E-470 board."

The achievement was recognized by IBTTA's 2018 Toll Excellence Award for Administration and Finance.

"HANDCUFFING JURISDICTIONS – WHEN TOLLING SECTIONS OF INTERSTATE MAKES SENSE TO REBUILD AND EXPAND CAPACITY – IS SHORTSIGHTED"

Left: **The E-470's photovoltaic system was honored with an IBTTA President's Award in 2013**

(27km) road stretch, and Stewart sees E-470 as a custodian of Colorado's green future. "It's important for us to set a standard of stewardship for our environment, showing how that can go hand-in-glove with good transportation," he says.

Capitalizing on more than 300 days of sunshine annually, E-470's photovoltaic system powers infrastructure such as cameras, lighting and signage, as well as electric vehicle charging points, which have seen an uptick in interest. "It cuts down our carbon footprint and we contribute to the grid for surrounding areas, making us self-sustaining to some extent," says Stewart.

Regarding IBTTA's Award for Social Responsibility, Stewart applauds Virginia DOT's (VDOT) groundbreaking toll relief scheme, providing means-tested discounts to less affluent residents hardest hit by tolls on the Elizabeth Rivers Tunnels between Portsmouth and Norfolk. Nevertheless, it is not necessarily seen as a readily transferable template for socially equitable tolling. "To

(Left) E-470's new temporary plate program enables vehicle tags to be identified in any lighting conditions

14.8 MILLION

The number of hours in travel time the E-470 saves Denver residents each year

and Tollway Authority in pioneering toll credits for customers in Atlanta opting to use BRT instead of driving on certain days. "They're transitioning people to buses because they have limited real estate and have to increase throughput," he says.

E-470's 47-mile (76km) ex-urban facility is not an obvious candidate for early adoption of high-occupancy vehicle (HOV) or BRT schemes. However, Stewart believes that E-470 is already supporting such schemes through its ExpressToll back office service, used by all tolling entities in Colorado, which allows CDOT to optimize operations as it develops HOV and BRT initiatives on its express lanes.

FIXING CRUMBLING ROADS

According to Stewart, US infrastructure will require US$3.6tn in maintenance funding through 2020. Lifting federal restrictions on tolling interstates may not be popular among taxpayers – but could it ultimately be the answer? "When I'm making a repair in my home, I don't take one tool; I take a toolbox," says Stewart. "I think any tool you can bring to address our infrastructure needs should be on the table: pay-per-mile, road user charging, tolling, tax increases on motor fuel – Colorado is considering a sales tax to fund transportation. Handcuffing states and jurisdictions – when tolling sections of interstate makes sense to rebuild and expand capacity – is shortsighted. It will mean leaving the next generation to resolve the problem."

Most days, Stewart must put aside his agenda, relying instead on an innate readiness to meet whatever his job throws up. "It's an ability to be adaptive," he says. "Not reactive – but a thoughtful reaction to the demands you are addressing."

Is there an air of serenity, as he gazes from his office at the peaks of the Colorado Rockies? I-70 has served for years as a bridge to Utah, but now needs reinvestment, providing challenges ahead. But looking back over 34 years, there is cause for satisfaction, too. "I've worked with some incredible people and learned from every one of them," says Stewart. "That's what I continue to enjoy: the people, the planning and the progress made." ◼

(Left) Tim Stewart has emphasized the importance of trust and accountability during his tenure as president of the IBTTA

borrow a phrase from [IBTTA CEO] Pat Jones: 'When you've seen one toll road – you've seen one toll road!'" Stewart laughs. "Every region, community and operator has different needs that drive decisions – including revenue requirements to continue repaying debts. VDOT saw a need and an opportunity to help an under-served segment. Could it be replicated? Perhaps through links and partnerships that could provide more of a bus rapid transit [BRT] type environment, with discounts for those using alternative modes."

He believes that promoting a multimodal ecosystem will prove crucial in responding to population growth and migration into already congested economic corridors in the coming years. Stewart praises the work of Chris Tomlinson and the Georgia State Road

VITRONIC
the machine vision people

Pimp your Road

TOLLCHECKER – high-tech upgrade for toll roads

Toll systems are about performance and reliability. VITRONIC's TOLLCHECKER delivers precisely that in a flexible, easy-to-service solution for collecting information about road usage, and processing it for billing. If you want to stay ahead in tolling, pimp your road with TOLLCHECKER.

www.vitronic.com

TOLLING IN TURKEY

The Turkish highway tolling market is being expanded with the addition of public-private partnership (PPP) tolled highway projects

→ In addition to approximately 2,200km (1,367 miles) of tolled highways operated by the state, Turkey has launched four highway projects that are operated by private concessions.

Two of the newly built highways are in the Northern Marmara region and have a combined length of 500km (310 miles). The third – measuring 450km (279 miles) – connects Istanbul to the city of Izmir. The fourth project is a tolled tunnel under the Istanbul Strait. And still more PPP tolled highway projects are in the pipeline.

PROJECT EXECUTION
The tolling systems on all the new projects were delivered by Turkish technology leader Aselsan in line with the country's existing electronic toll collection (ETC) platform.

With the addition of new tolled highways, Turkey's existing tolling scene has gone through a period of change. Private concessions in the tolling market collected the bulk of tolls, nearing €1bn (US$1.13) a year.

Another noticeable change is the increase in the number of multilane free flow (MLFF) ETC stations.
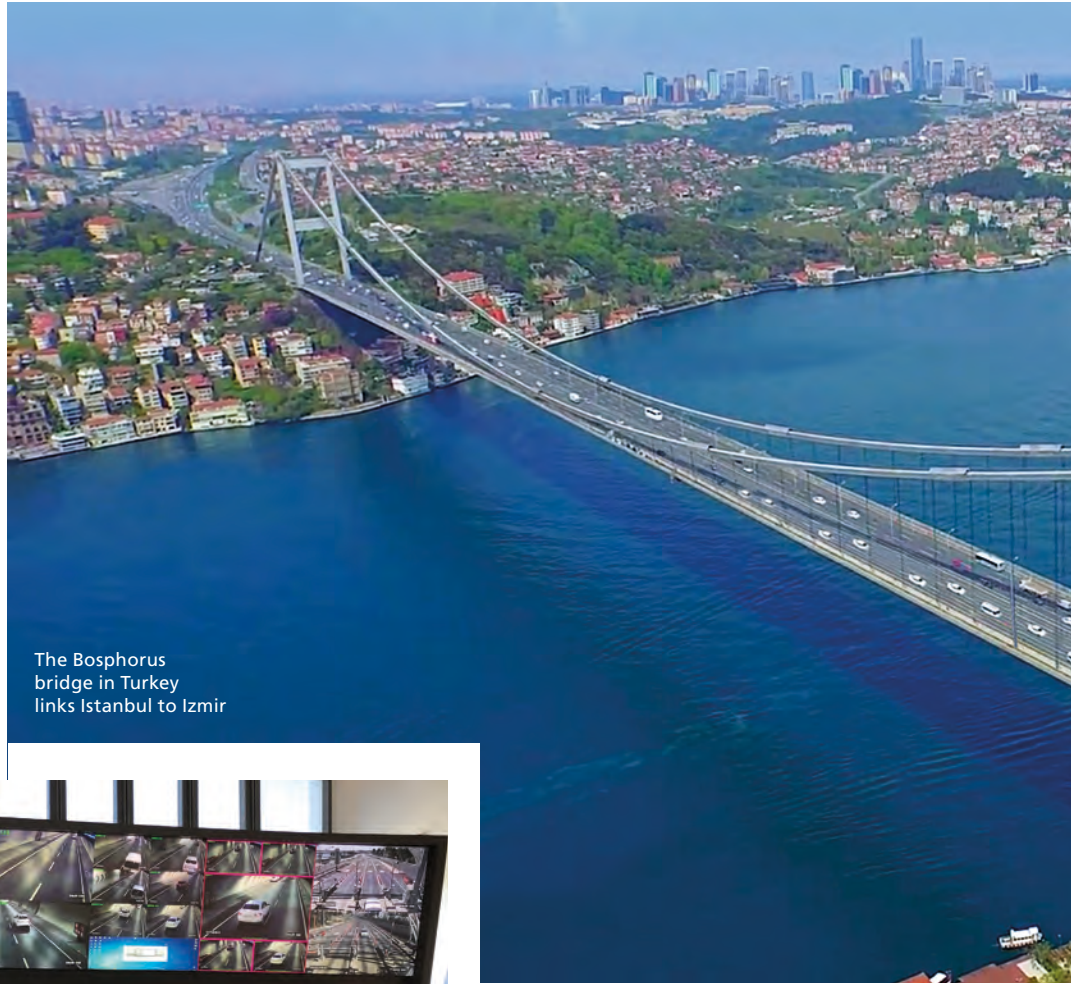
The Bosphorus bridge in Turkey links Istanbul to Izmir

Left: ALPR is used in Turkey for everything from toll enforcement to homeland security

of axles and the distance between axles.

VERSATILE TECHNOLOGY

Aselsan's ALPR technology is not only used in the company's tolling systems but also in Turkey's homeland security system on nearly 10,000 traffic lanes countrywide. The company's expertise in MLFF and video tolling comes from its experience in detecting vehicles and accurate recognition of license plates in free-flow traffic.

Another remarkable feature of Turkey's ETC platform is that subscribers' balances are kept in banks independent of any concession or highway operator. The 10 million subscribers choose one of six banks to carry out their toll transactions. Each toll highway operator is connected to all the banks involved in the system, and they receive the toll fee electronically in real time. As the account centers are independent of any of the PPP organizations, all electronic fund transactions are processed between concessions and banks without the need for any fund transfers between concessions. This feature of the platform makes it very easy for financial interoperability to be implemented for toll highways in Turkey.

It looks as if the tolling scene in Turkey will expand in the direction of private concessions and more MLFF. Turkish tolling technology expert Aselsan can help to make this possible. ✖

Dr Erkan Dorken is head of business line traffic, automation and medical systems at Aselsan

Far left: **The Eurasia Tunnel is beneath the Bosphorus Strait**

Left: **Turkey's Northern Marmara region has two new tolled highways**

The country now operates more than 60 MLFF ETC tolling stations – and conducts several million transactions – each day. MLFF tolling stations process both dedicated short-range communication (DSRC) microwave tags and passive RFID tags.

ALPR systems are used on both rear and front license plates for video tolling and enforcement purposes. Vehicles can also be classified according to the country's tolling classes, based on the number

ONE-BOX ALPR TOLLING

The integration of technologies for electronic tolling and enforcement can lead to new, cost-efficient and flexible appliances that are fit for the future demands of rural and urban road networks

In the segment of electronic tolling, enforcement and vehicle identification, many applications use a combination of similar technologies, such as image acquisition, dedicated short-range communication (DSRC) and radar or laser sensor systems. These components are highly specialized and mature, having evolved over decades.

As a result of highway free-flow systems becoming increasingly saturated, the industry is restricted by the lack of technologies that are suitable for smaller roads, secondary road networks and urban areas. Instead of massive gantry installations that are used for highway tolling and enforcement, these markets typically demand smaller structures for installations that have little environmental impact, offer higher flexibility, and can be installed with fewer components.

There is a need for the technical integration of multiple technologies that can offer flexibility and interconnectivity with other roadside systems – such as communication devices – as well as higher in-built intelligence and processing power. Integrated redundancy is also important. Finally, the processing and switching functionality of powerful external lane cabinets can be partly shifted into integrated products. Lane cabinets for highway tolling can often manage up to eight lanes, whereas an integrated product could be dedicated to managing two lanes in one box.

A MULTIFUNCTION SINGLE DEVICE

Image capturing and automatic license plate recognition (ALPR) are commonly used in road traffic applications. It therefore makes sense to base a one-box product around this technology.

In anticipation of the increased use of video-based tolling, often in coexistence with DSRC as a dual solution, there is a need for a highly integrated, camera-based, interconnectable, intelligent solution that will realize a variety of applications.

With such a device, services for electronic tolling, electronic toll enforcement, access management, vehicle identification, urban tolling – and more – could be realized. When used in certain applications, such products could further be dedicated and optimized to cover two lanes with a single device, allowing scope for upscaling in applications that require two or more lanes to be covered.

EFKON has developed a brand-new one-box device called N-FORCE AVT100. Thanks to its optimized camera components and field-proven software, this single unit is able to capture vehicle images, detect and

Left: **The N-FORCE AVT100 will be used in two projects in Norway in 2019**

Inset: **EFKON's standalone ALPR device is suitable for applications such as traffic surveillance and electric tolling**

classify vehicles, and correctly process and match vehicle license plates across two lanes.

LASER-FREE FUNCTIONALITY

Laser or radar technologies are often used in similar applications for vehicle detection and classification purposes. One objective in developing the N-Force AVT100 was to enable its image-capturing, ALPR capabilities while eliminating in-built laser technologies in order to make the unit more cost-efficient and to prolong its operational lifecycle.

EFKON achieved this optimization with a video-based application that operates in free-run mode to permanently capture image sequences. The device uses image analysis to map a virtual detection, and an observation zone is mapped onto the road's surface. Detected vehicles are continuously tracked through the virtual detection area, enabling the device to perform under difficult stop-and-go traffic situations, such as during rush-hour congestion.

The N-FORCE AVT100 uses an effective tracking algorithm that also captures valuable information, such as vehicle direction and speed. Integrated classification is performed simultaneously via the image data stream, according to vehicles' width,

height and shape profiles. Integrated list management is supported, enabling potential internal checks against exempted vehicles or black-listed license plates.

An aluminum-based, light casing encloses the camera sensors, powerful infrared flashes and processing units, to ensure hardware failover within the unit. Plugs to interconnect and integrate DSRC communication devices and WLAN (in-built) are also available.

The device is a self-contained box and therefore does not need additional expensive roadside cabinets. Nor does it require heating or climate control. The device can be installed on relatively small constructions, such as poles or cantilevers, along with cabling for power and a communication line. These installation requirements make the unit suitable for implementation in both rural and urban environments.

A variety of applications – such as electronic tolling with DSRC, video tolling without DSRC, electronic enforcement, access zone management, surveillance and more – can be realized with this versatile one-box appliance. As of the beginning of 2019, N-FORCE AVT100 will be in operation in two large toll road projects, in Oslo and Bergen, both in Norway. ⊠

Heimo Haub, head of sales, marketing and business development, at EFKON

A MARKET INTRODUCTION

The new smart tachograph will be introduced at the start of 2019. The new devices will enhance previous tachograph capabilities by enabling DSRC

→ Norbit ITS will introduce its new smart tachograph dedicated short-range communication (DSRC) units at the start of 2019. As well as global navigation satellite system (GNSS) integration, the new tachograph will introduce DSRC – a well-established technology for remote enforcement.

In order to improve working conditions for truck drivers and increase road safety in the European Union (EU), tachographs have long been used to record trucks' distance traveled, speeds and driver working hours.

In 1986, the EU introduced a Regulation with an Annex 1, creating an official requirement for heavy vehicles to use analog, paper disk-based tachographs. This first step was susceptible to fraud, because it was relatively easy to manipulate the paper disks used for printing vehicle movements. Therefore, in 2006 EU introduced Annex 1B (EU-Reg. 1360/2002) as the first generation of a digital tachograph, including chip cards and high-security devices. In 2011 and 2012, this annex was updated with independent motion detectors and new motion sensors.

The recent EU regulation 165/2014 has enhanced the digital tachograph toward a smart tachograph by integrating GNSS, which enables the geographical position, DSRC for remote enforcement, optional ITS integration via Bluetooth, and updated cryptography. Use of smart tachographs will become mandatory from mid-2019 for all new registered trucks in the European Union.

The main element of the smart tachograph is a vehicle unit that can typically be built into the dashboard of the truck. Connected to the truck CANbus, information from the motion sensor is used as a main source for recording the truck's movements. Via the optional ITS interface, data access for external devices can be permitted via Bluetooth as a standard interface. This allows the tachograph data to be used by external ITS services while respecting data protection rules. Such available data includes: driver activities, card and vehicle unit information, and continuous GNSS data. To verify compliance with social regulations, the geographic position provided by the satellite navigation system (GALILEO/EGNOS, GPS) at specific locations must be stored in the memory of the smart tachograph. To do so, the position at the start of a daily working period, current locations after three hours of accumulated driving, and the position at the end of the daily working period, will be recorded.

DSRC is a well-established technology that operates at 5.8GHz. It is used in road tolling and in compliance checks with GNSS-based tolling systems. The smart tachograph will use the same technology to provide information about potential misuse or manipulation while the vehicle is in motion. A predefined set of encrypted data is regularly sent from the smart tachograph main unit to the DSRC unit (DSRC-VU). This data set contains vehicle and calibration data and information about potential tampering of the device, as well as security breaches and malfunctions of the device. Authorities can use a roadside or vehicle

Above: **The detached antenna offers simple wiring to smart tachographs using a single cable**

DSRC transponder to retrieve this data from the DSRC-VU at any time, even in motion. After decrypting and authenticating the data, sufficient information is available to stop and check conspicuous vehicles only. This has the potential to make the checking process much more targeted, thereby promoting correct driving behavior and increasing road safety.

Businesses and truck drivers who meet all driving legal requirements and comply with the regulations can save time by avoiding being stopped.

In the future, truck checking points on highways, which are costly for road authorities, may become obsolete. Instead, enforcement vehicles around Europe will be equipped with mobile enforcement technology to carry out efficient on-the-road

Left: **The elements inside of trucks that enable smart tachograph use**

Inset: **The DSRC CAN can be used independently from the smart tachograph**

checks. Fixed enforcement sites at borders and junctions, or temporary sites for random roadside checks, may also be used. DSRC devices inside trucks must be mounted onto the windshield or dashboard. Norbit ITS has developed a device to fit into these small areas. A key feature of the device is a totally new design of the antenna.

Norbit ITS is very proud that two out of three suppliers of smart tachograph vehicle units will use its DSRC device. "Our technology for DSRC and our long-term experience as supplier for the automotive industry make it possible for our DSRC modules to be customized for this new application," says Per Jørgen Weisethaunet, CEO of Norbit. Norbit has developed two products for suppliers: a cost-optimized

detached antenna, where the communication functionality is split between a small antenna and DSRC processing, located in the tachograph itself; and a DSRC CAN solution, where the DSRC device is connected via CAN to the tachograph.

In addition to the cost advantage and a very small antenna design, the detached antenna concept offers simple wiring to the tachograph using a single radio frequency (RF) cable.

FUTURE OUTLOOK

The European Union's approach for the implementation of smart tachographs will offer several advantages for future applications. The devices will operate consistently around Europe, and installation in trucks will be standardized with all smart tachographs having access to the trucks'

CANbus. This will enable the devices to operate consistently around Europe.

Smart tachographs will also help truck weights to be better controlled. Overweight trucks are a hazard to traffic and they cause considerable wear on the roads. The standardized DSRC interface will be able to transmit onboard vehicle weigh data.

Smart tachographs also have the potential to reinforce the European Electronic Toll Service (EETS). ❌

Peter Tschulik is business unit director at Norbit ITS, Austria

USING ALPR TO TAILOR TOLLS

Analyzing drivers' behavior on roads by means of ALPR data enables road authorities to anticipate traffic volumes and ultimately reduce congestion by bringing in appropriate tolling services

While automatic license plate recognition (ALPR) devices are a critical part of a tolling system, they are sometimes seen as a secondary means of identifying vehicles, after radio frequency identification (RFID) tags. However, only about one-third of vehicles on US roadways are RFID-enabled, while nearly all vehicles traveling today have a unique identifier in the form of their license plates. With the right ALPR system, traffic authorities can identify a large majority of the vehicles on their roadways automatically, without enduring the large investment related to obtaining and maintaining RFID tags and surrounding infrastructure, and the steep – and often unpredictable – costs of manually reviewing images.

Today's vehicle data is collected through highly engineered, purpose-built components that match optics with illumination, including complex character recognition algorithms. This tight coupling of design elements produces the highest-performing imaging systems ever used in the transportation sector. In fact, imaging systems might just be the fastest and most affordable option for true national interoperability.

BEYOND LICENSE PLATE DATA

If a system can easily identify a vehicle by its license plate, imagine what other vehicle information can be collected too. Knowing more about drivers and their behaviors can help toll operators be more strategic when deciding to expand or convert new lanes, build new access points, construct travel plazas, or implement congestion-reducing programs such as carpooling. Mapping the toll customer's experience can also help agencies to evaluate pricing strategies and loyalty programs, and better reach customers with targeted communications. With the low adoption rate of RFID tags, license plate data is vital to providing this analysis.

What if a company known primarily for its ALPRs could provide a tolling operator with more insight into its customers than just a means for charging them to use the

Perceptics' license plate readers can be configured to capture certain vehicle data that is relevant to the operator

roadway? What if, while a vehicle's license plate data is being processed to collect a fee, it could also be analyzed along with millions of other transactions to catalog the customer's driving experience and learn more about their behavior? In a time when travelers have an increasing number of options to get from place to place, the data that can be gathered from license plates is imperative to keeping toll roads focused on the wants and needs of the customer.

Of course the quality of the data that operators receive is dependent on the quality of the ALPR system. High-quality images and a high-performance optical character recognition (OCR) engine are needed not only to identify the license plate, but also to be able to use it in analyses to build trips or to identify patterns of behavior over time. Operators should be able to match license plates at different points along the customer's journey, regardless of the time of day, availability of light, or position of the cameras. If the images are so poor that an OCR add-on, such as Perceptics' Unique Vehicle IDentification Module (UVID), is

unable to identify a license plate or other distinctive characteristics of the vehicle, then the transaction cannot be completed and the data on that customer cannot be collected. Additionally, when a large majority of images cannot be processed automatically with the ALPR system and must be reviewed manually, the process becomes more complicated and the cost of gathering customer data increases. Utilizing an ALPR system that regularly yields higher attach rates, higher accuracy rates and higher-confidence reads is essential to providing this information about customers.

It is time for the tolling industry to start thinking about how to maximize current technology to improve customers' experiences, as well as making more strategic decisions going into the future.

Casey Self is marketing manager at Perceptics

TRAFFIC-BUSTING TOLL PATROLS

Automatic license plate recognition technology can help keep traffic moving freely in congested metropolitan areas

Traffic congestion in major cities around the globe continues to grow, and so does the concern about its impact on commuters and the environment.

Home to approximately 4.5 million people, Atlanta, in Georgia, USA, is experiencing rapid growth. The city has committed to combating traffic jams in its area by planning to expand an existing program aided by automatic license plate recognition (ALPR) technology.

The Peach Pass Express Lane program is designed to keep vehicles flowing steadily along congested areas of Atlanta metro highways, decreasing travel time and emissions to create a better commute experience.

A study by USA-based company Inrix, which specializes in transportation cloud-based analytics, found that Atlanta's residents spent an average of 70 hours in congested traffic during peak travel times in 2017, costing each driver US$2,212.[1] The related vehicle emissions helped land the city in 23rd place on the American Lung Association's 2018 list of most polluted cities.[2]

CONGESTION REDUCTION

In 2012, the Georgia State Road and Tollway Authority began to explore ways of lessening the frustrating, stifling traffic jams that had become part of Atlanta's identity. The Peach Pass Express Lane program resulted from a collaboration with Leonardo, an Italian developer and manufacturer of advanced law enforcement ALPR systems. Peach Pass Express Lanes allow drivers with no passengers to use the high-occupancy vehicle lanes for a fee. Drivers can create an account through the Peach Pass website or mobile app and assign an automatic payment method, such as a credit card. They are required to display a transponder on their windshield, which is read by roadway cameras as their vehicle enters and exits an express lane, calculating tolls owed and triggering the payment transaction.

Leonardo's mobile ELSAG ALPR systems help to enforce Peach Pass Express Lane

Leonardo's mobile ELSAG ALPR technology helps ensure that only drivers who have paid applicable fees – and who have no passengers – use the Peach Pass Express Lanes during peak traffic periods
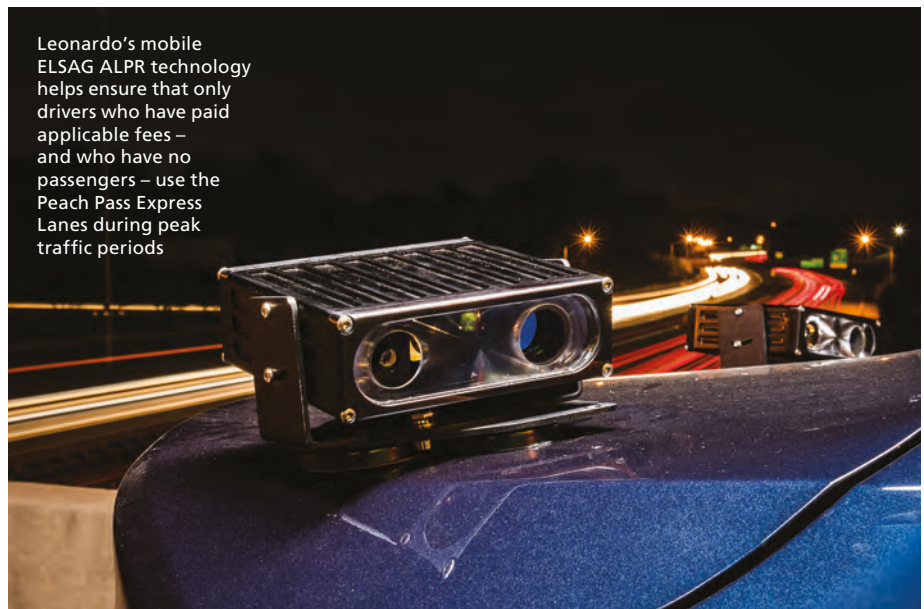
use. High-resolution digital cameras mounted on the trunks of patrolling police vehicles read license plates of commuters in the express lanes, instantaneously and automatically comparing each to a white-list database that contains each Peach Pass account holder's license plate details.

If the system reads a license plate that is not included on the white list, the police vehicle driver receives real-time alarms through his/her in-car computer. Alarm information contains the license plate number, along with a photo of it, to provide the patrolling police with identifying vehicle characteristics such as color and body style. This information enables the police to quickly identify the suspected vehicle and stop it for ticketing or trigger an automatic ticketing process.

GROWING THE PROGRAM

Following the success of the metro Atlanta Peach Pass Express Lanes program, the state of Georgia is expanding the initiative northeastward into neighboring Gwinnett County – an area that has outpaced the growth of Atlanta, having welcomed some 16,900 new residents from 2016-2017.[3] The express lane program aims to keep traffic hot-spots from occurring by reducing congestion.

A private contractor has been hired to maintain the ELSAG ALPR systems, including wirelessly pushing out updated white lists every seven to eight minutes to all ELSAG ALPR devices in the field. Peach Pass Express Lanes is expected to be open to Gwinnett County drivers in spring 2019.

Nate Maloney is VP of marketing and communications at Leonardo

[1] http://inrix.com/press-releases/scorecard-2017/
[2] https://www.lung.org/our-initiatives/healthy-air/sota/city-rankings/most-polluted-cities.html
[3] https://33n.atlantaregional.com/regional-snapshot/regional-snapshot-2017-population-estimates

FREE READER INQUIRY SERVICE

Leonardo   inquiry no. **505**
To learn more about this advertiser, visit: www.ukimediaevents.com/info/tol

comtrans

Your essential guide to the future of transportation communications

Tests conducted by the 5G Automotive Association (5GAA) have shown that cellular vehicle-to-everything (C-V2X) consistently outperforms dedicated short-range communication (DSRC) technologies.

In many instances, when comparing 802.11p/DSRC (known as ITS-G5 in Europe) with C-V2X PC5 radio systems in delivering vehicle-to-vehicle (V2V) safety messages, the performance of the latter technology was found to be overwhelmingly superior.

With a natural evolution path toward the low-latency and high-bandwidth benefits of 5G NR, the 5GAA noted C-V2X was better especially in regard to reliability over an extended communications range, non-line-of-sight performance, and resiliency to interference from other devices.

"These test results demonstrate that C-V2X direct communication is today's most cutting-edge technology for connected and automated driving, and the best way to finally deliver upon safety and traffic efficiency," said Maxime Flament, the 5GAA's chief technology officer.

"Hence why C-V2X ecosystem is growing so rapidly – the 5GAA now has more than 100 members, all of whom believe in C-V2X as the future of mobility."

The V2V radio performance tests were conducted over a period spanning six months, with the design and execution of each test set up to ensure conditions that were consistent for both communication technologies.

Featuring both laboratory and proving ground trials, the testing program relied on a Ford Fusion equipped with Savari MobiWave MW1000 DSRC and Qualcomm Roadrunner C-V2X onboard units.
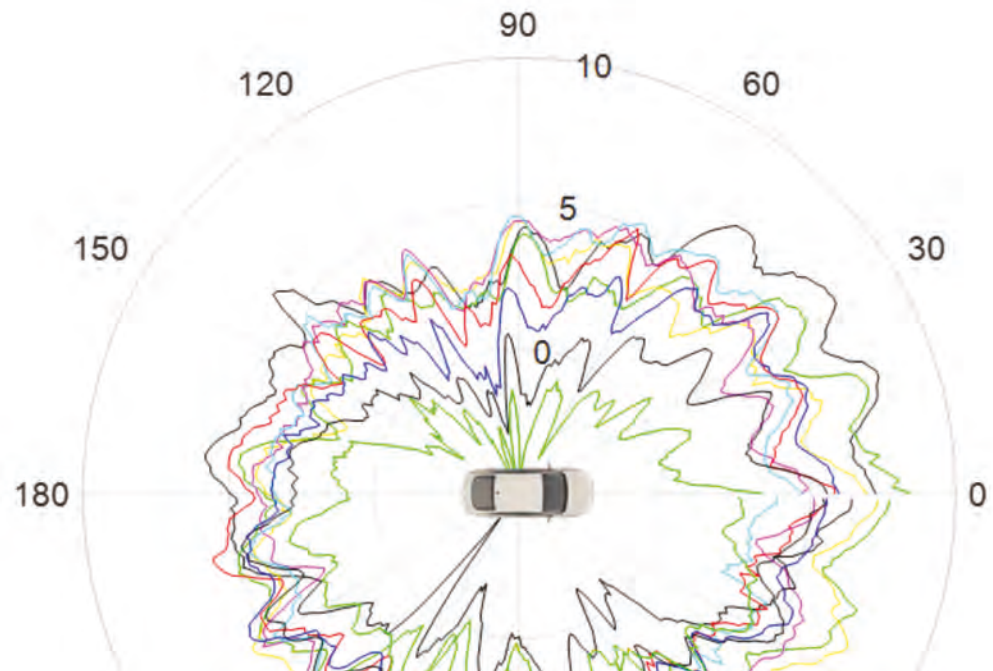
Cellular beats DSRC in new tests

Independent testing of the two communication systems indicates a clear winner in terms of which should be recommended for future V2V technologies
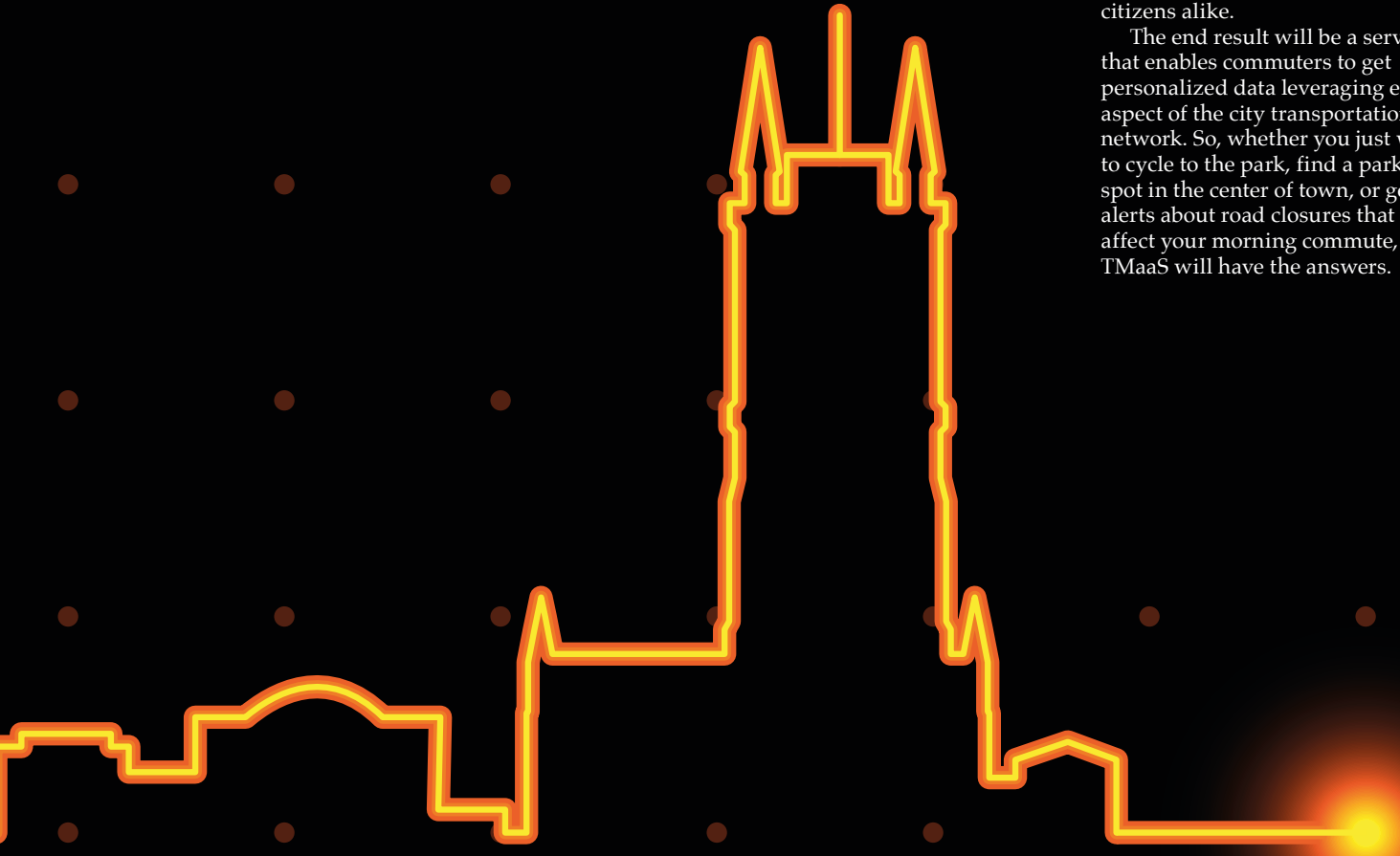
106: Joining the dots

A single, customizable traffic management platform for everyone that can also serve as a communications and control hub is not a pipe dream
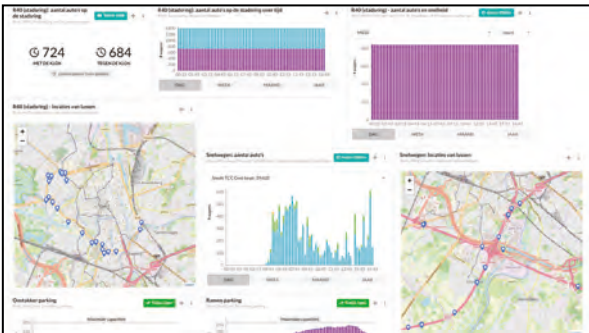
Joining
the dots

What if all traffic management information was stored on a single, customizable platform, accessible to transportation professionals and members of the public alike? And what if that platform also functioned as a communications and control hub? **Paul Willis** reports on the birth of Traffic Management as a Service

T he city of Ghent is home to a highly ambitious urban transportation project that has the potential to put the historic Belgian city at the cutting edge of traffic management. Called Traffic Management as a Service (TMaaS), the project intends to collate real-time data from multiple transit forms within the city to create a multipurpose platform that can be used by city operators and citizens alike.

The end result will be a service that enables commuters to get personalized data leveraging every aspect of the city transportation network. So, whether you just want to cycle to the park, find a parking spot in the center of town, or get alerts about road closures that will affect your morning commute, TMaaS will have the answers.

The city of Ghent in Belgium is set to be the first to be overseen using a new, smart traffic management system

Above: **The RSUs will manage more datapoints than Twitter does globally**

Right: **The TMaaS project in Ghent, Belgium, involves sharing transit data to create a multipurpose platform for use by citizens and city authorities**

The idea is so simple that the only surprising thing about it is that no one has tried it before, says project manager Ivana Semanjski.

"It surprised us somewhat that no one else is trying to do this because it seemed like a natural way to go," says Semanjski, an ITS expert at Ghent University, one of the project partners alongside the city municipality and a group of tech firms including the SatNav provider TomTom, Belgium smart mobility company BE-Mobile, and Ghent-based software company Waylay.

The three-year EU-funded project will not be confined to Ghent. While the TMaaS platform is expected to be operational in Ghent by the end of 2019, Semanjski and her team are also looking to identify three 'replicator' cities around the world where the framework can be rolled out the following year.

"It will be worldwide," she says. "We would like to have cities from different contexts. Different in size, demographics and their stage of readiness."

Information gathering

Right now, Semanjski's team is hard at work "mapping all the data sources for the city of Ghent".

These include commercial, globally available datasets such as probe data from smartphones and from satnav devices, as well as local datasets specific to Ghent, including counts on cyclists and data on public transport, taxis and ridesharing.

For cyclist data, bike counters are currently being installed on all the main cycle routes into and out of the city, says Sophie Gillaerts, project

> ❝ It surprised us somewhat that no one else is trying to do this, because it seemed like a natural way to go
>
> **Ivana Semanjski, TMaaS project manager, Ghent University**

leader for the City of Ghent. "They are very advanced," says Gillaerts. "They can measure the different types of cyclists – whether it's a child or an adult – and the direction they are traveling."

There's also a bike-counting week in Belgium where the public helps out in a national count of bikes. For public transportation, meanwhile, the TMaaS team has already reached out

to the city tram and bus companies for data on passenger counts and GPS location data, says Semanjski. "We also have a member of the advisory board who is in charge of the data handling for Belgium's national rail operator."

They are also working with taxi firms, who retain data on car counts at taxi stands throughout the city, and with a regional organization that collates data from carsharing companies in Flanders, producing publicly available real-time maps of car locations. "It's stakeholders like this we're trying to work with to leverage this data," says Semanjski.

Meanwhile, data from the city's road-traffic network will also be

This is where Waylay comes in. The company specializes in linking together IoT systems via cloud-to-cloud integrations. It has a patented Rule Engine that is already being used to carry out multi-integration of devices in smart homes.

"Through our platform, the devices can talk to each other and to other devices like smartphones, then take action," says Chambaere. "A simple use case would be if you're at work and your door at home opens. Through our platform, you'll be sent an SMS notification."

Waylay's technology is already being applied to traffic management via a pilot project it is running with the City of Ghent. For the pilot, Waylay created a dashboard in the form of widgets showing a limited number of transportation data sources. "TMaaS can be viewed as an extension of this earlier project," he says.

For TMaaS, the volume of data sources will increase and so will the options of how the end user can view the data. The platform is being designed with two broad categories of end user in mind: citizens and city operators. The last group includes traffic management teams, but also waste handling companies, and firefighting and police departments.

In the digital architecture of the project there will be two separate interfaces for the two user groups. But all users of the platform will be able to personalize their dashboard

processed into the platform. In the case of variable message signs (VMS) and traffic signals, data will also flow the other way, with the TMaaS team planning to build integrators that will enable operators to input TMaaS updates directly into their VMS and traffic light systems. Depending on how digitally advanced the signaling is, these updates could be integrated directly with TMaaS or pass through a controller first, says Semanjski.

Data access
Gaining access to existing data sources can be tricky, says David Chambaere, TMaaS project manager at software partner Waylay.

"The application programming interface [API] world is pretty chaotic," says Chambaere. "There's not really a standard, every provider has their own model. Some of the API is open data and for others you have to pay. This lack of standardization is a challenge. So it's not a problem of technology, but more of organization."

Not that the project is without its technical challenges, not least of which is the logistical difficulty of integrating all these different strands of data together.

> We can measure the different types of cyclists – whether it's a child or an adult – and the direction they are traveling

Sophie Gillaerts, TMaaS project manager, City of Ghent

Right: **Bike counters are being installed on cycle routes into and out of Ghent, Belgium**

feedback on the quality of the data they are receiving."

This crowdsourcing of data will be enhanced by the integration into the platform of the community-based driving app Waze. The Waze data will be filtered for quality, firstly on the app itself (Waze already marks data as more or less reliable based on the source) and then via a second quality gate within TMaaS.

Ensuring data quality will be paramount, given the large volume of data sources that the platform will be ingesting, says Semanjski. To do this, there will be "several levels of data quality checking", she says.

"The first will ensure the data fits the quality standard that we are

according to their unique preferences, says Chambaere.

"For example, the traffic manager who needs to know the bigger picture will be able to access things like induction loops and cameras, whereas a member of the public who just needs to know where they can park their car will be shown availability at different car lots."

Chambaere says the platform will be able to facilitate personalization to a high degree of detail. "For example, you could say, I'm interested in car lots A, B and C, and want to be notified when they are 90% full."

Personalizing interfaces
In terms of the operator-facing interface, there will be two levels of data: real-time data that will be directly available to the traffic management teams; and historical data, which will enable operators to make more strategic long-term decisions.

For the public-facing interface, the expectation is that most citizens will interact with the platform through social media updates, says Semanjski. "We would like to communicate with people the way that they communicate with each other," she says. Communicating via social media will also allow commuters to give real-time feedback, she adds. "So they could inform the system either about new incidents, or give

> ❝ TMaaS is not really a product, but a framework. We want to build a framework that is as flexible as possible, so that it can be applied to other cities
>
> **David Chambaere, TMaaS project manager, Waylay**

Top: **The city of Ghent has an area of 156km² (60 square miles)**

Right: **The Waylay platform, used in Ghent's TMaaS project, merges IoT systems via cloud-to-cloud integrations**
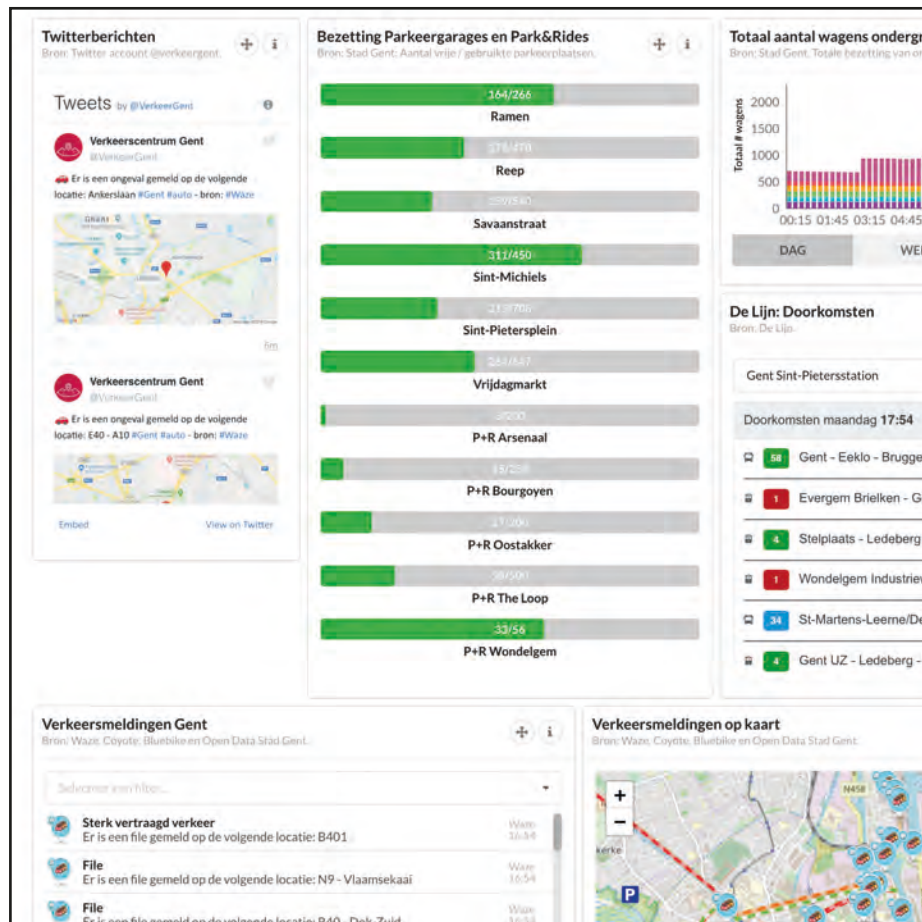
⤵ | Taking over the world?

The ambitions for the TMaaS system go way beyond Belgium. The idea is that it could be used almost anywhere around the globe

The project developers of Traffic Management-as-a-Service (TMaaS) have high hopes for their creation. They plan to expand it to three other 'replicator' cities after its roll-out in Ghent in 2019. But that is only the beginning of the story.

TMaaS is being designed in such a way that it could be implemented anywhere, says David Chambaere of Waylay, a software partner on the project. "We want to build a framework that is as flexible as possible so that it can be applied to other cities," says Chambaere.

To make the process of replicating TMaaS easier, it will have a base level of datasets that are available globally. These will include data from driving apps like Waze and TomTom.

"Part of the challenge will be trying to replicate it in cities that have different levels of readiness," says project leader Ivana Semanjski, of Ghent University. "In places where they have no traffic management solutions in place at the base level, datasets will be available as a basic solution."

In more advanced cities, more specific local datasets will be added. While these datasets will improve the capabilities of the platform, integrating them could prove challenging, says Semanjski, especially if they involve transportation solutions not already available in the TMaaS eco-system – a subway system or a light railway network, for example, neither of which currently exist in Ghent.

In spite of the obstacles, the TMaaS creators are hopeful. Sophie Gillaerts, of the City of Ghent, thinks it has the potential to transform traffic management in the cities that choose to take up the gauntlet. "The platform will create a lot of added value and will have a big impact," says Gillaerts. "It could revolutionize how people travel."

defining for input data," says Semanjski. "Then there's the question of tracking and comparing data. For example, there might be two separate datasets for the same piece of traffic information, where one dataset is higher quality than the other. We have to be able to input both datasets without risking the higher quality data being given less prominence."

Besides quality control, another aspect of data processing will be GIS technology. "The final dashboard will have various views, depending on user preferences, but one will be a map containing a GIS overview of all the data they are interested in," she says.

There is also the question of how the data is actually collected. There are two main methods of data collection known as 'pushing' and 'pulling' that the TMaaS system will rely on, says Chambaere.

With pulling, the API that is the data source is contacted using a fixed
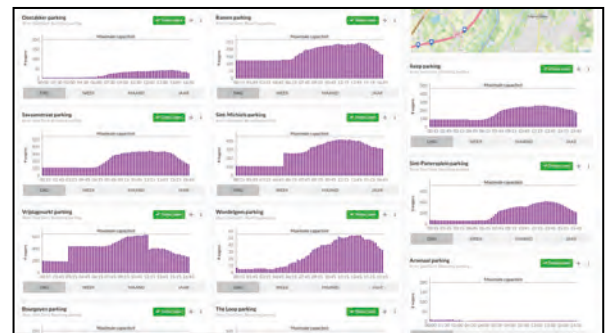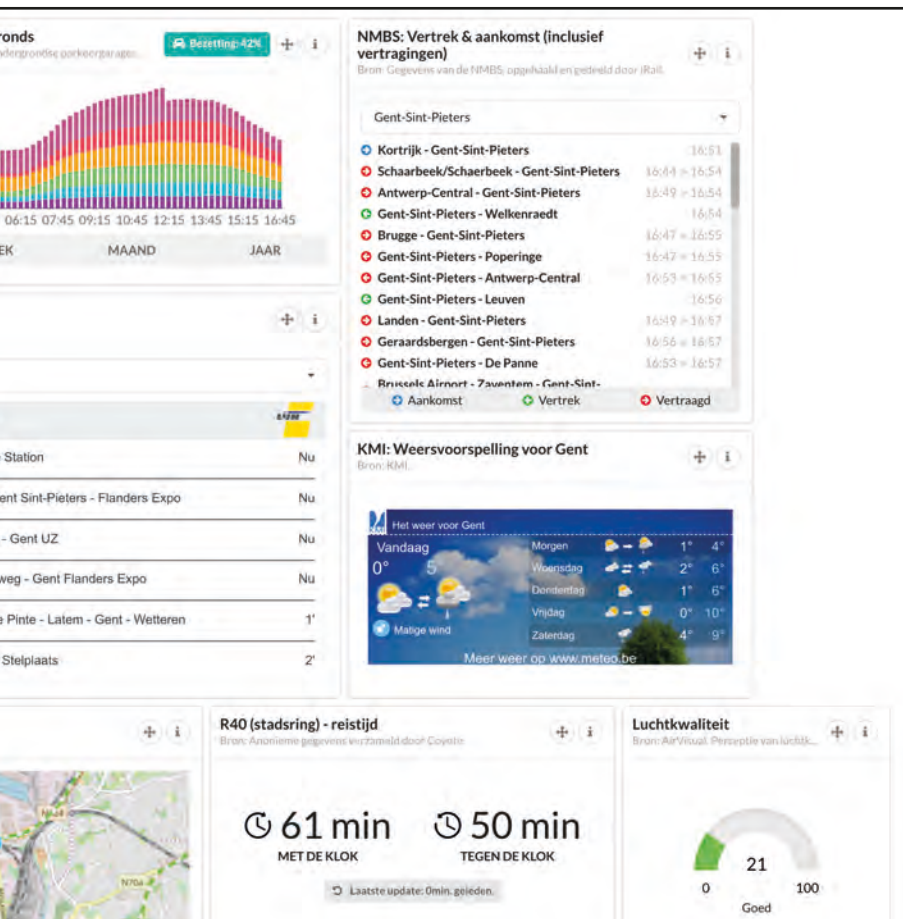
Above: The TMaaS project will enable members of the public to check parking availability at numerous parking lots

frequency. The data is grabbed at regular intervals – every 15 minutes, say. Pushing data is when the API provider actually sends the data to the platform rather than collecting it. The data is pushed out based on predetermined triggers.

"For example, if you have a smart door lock and it opens when you're not there, you don't want to wait 15 minutes to find this out," says Chambaere. "So for events like this, a push notification is sent out straight away to our platform.

"In the case of TMaaS, car parking occupancy would be an example of pulling information (you don't need to be notified every time a parking place is filled), while a road accident would be a push event." ○

AI-based object classification

Smartmicro, based in Germany, has been designing, developing and manufacturing high-performance radar sensors for the traffic and automotive industries for more than 20 years. Key motivations for the company's technology developments are safer roads, optimized traffic flow, autonomous driving and transforming urban areas into smart cities.

Forward-firing, multilane, multi-object traffic radar sensors are used for a variety of applications. Since 2009, when the first traffic sensors were manufactured by smartmicro, more than 50,000 have been installed worldwide. Key application uses for the sensors are intersections (multilane stop bar and advance detection, and queue length measurement); arterials (counting, classification and statistics); and enforcement (speed and red light).
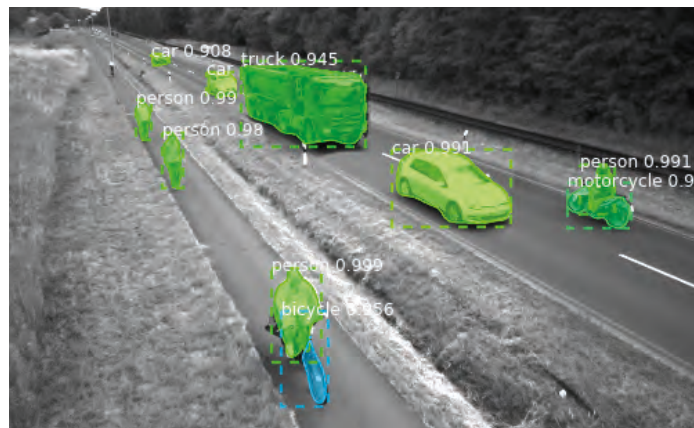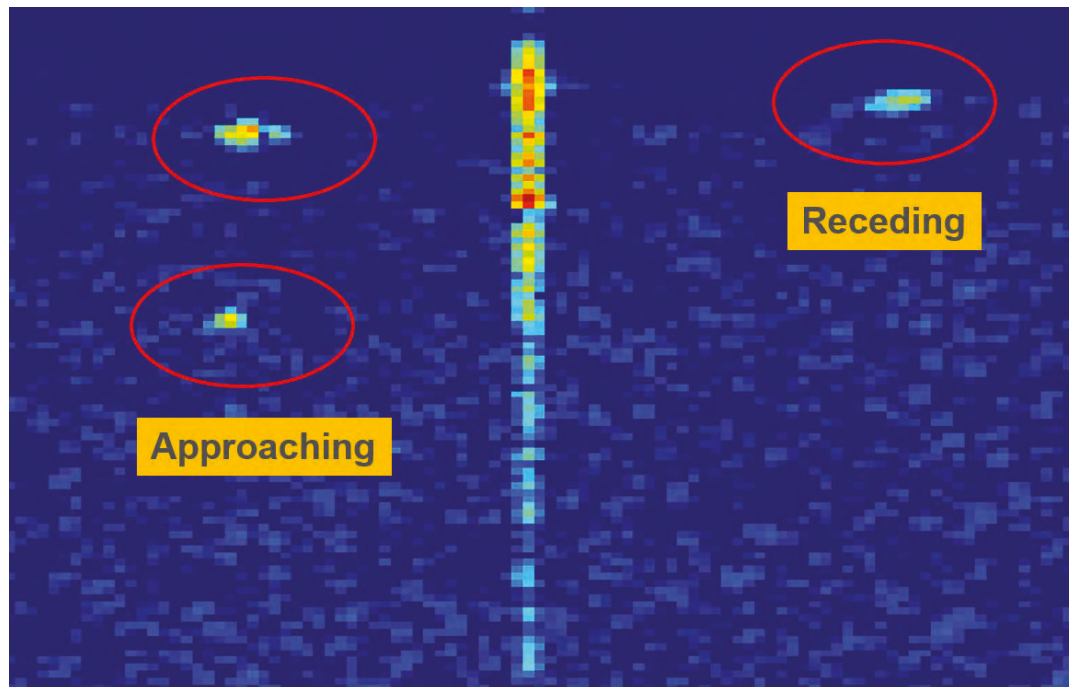
Radar traffic sensors

The sensors can detect vehicles in up to eight lanes, as well as objects that have stopped. They can also track up to 256 objects simultaneously at a range of up to 450m (1,476 ft). Other key features are 4D measurement (range, speed, horizontal angle and elevation angle), and ultra-high-definition object separation for objects' ranges, speeds and angles.

smartmicro's high-performance traffic detector is robust and reliable. With an operating temperature range of -40°C to 85°C (-40°F to 185°F), the company's sensors also set the benchmark.

Quality object classification

Currently the classification of objects, along with sensor fusion, are hot topics for most

Approaching

Receding

Above: **Radar tracks approaching and receding traffic in a range-Doppler matrix**

Above: **smartmicro combines radar and video data to train its AI-based classification**

automotive sensor suppliers, whose goal is to make fully automated driving a reality. Performance levels of object classification can be achieved with the help of artificial intelligence (AI) implemented in deep neural networks (DNN). smartmicro stands in the front line of such classification algorithm developments and

has now added this technology to its line of traffic sensors.

Together with customers, an approach was specified to identify seven classes of objects: pedestrians, bicycles, motorcycles, passenger cars, vans, trucks and large trucks.

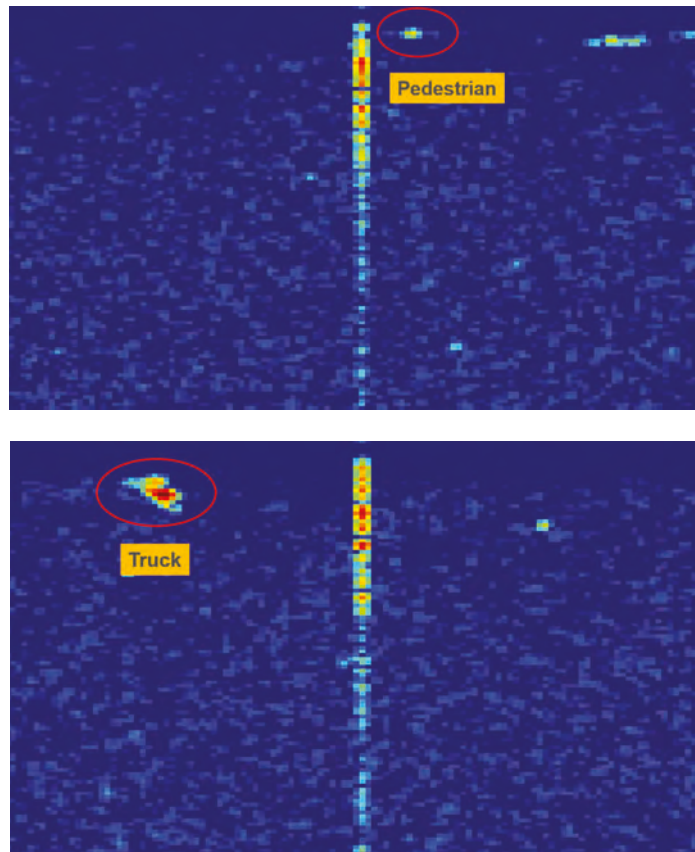Radar modules feature state-of-the-art antenna technology based on the multiple input,

multiple output (MIMO) principle. Using principles including (transmit) beam shaping, digital beam forming on receive and 2D fast Fourier transform (FFT), a multitude of so-called range-Doppler matrices are calculated from the radar signal. Within each of these matrices, peaks and adjacent zones of energy that contain reflected energy are detected. Using image-processing-like technology, the distribution of the energy in these zones in range or Doppler dimension is algorithmically evaluated and delivers classification feature information. In addition range, speed, angular information and amplitude values are measured. At a data rate of approximately 25Hz, all the data is used as input data for classification algorithms for the seven object classes.

When classifying vehicles, forward-firing radar sensors have the advantage of being able to observe objects over a longer time – usually multiple seconds. The closer the vehicle is to the radar, the more reflection property details can be seen in the range-Doppler matrix.

"The high level of detail of our radar enables us to determine the reflection characteristics of the different vehicle classes over the tracking range," says Dr Ralph Mende, CEO of smartmicro. "These properties and their change over time are used to extract features that can be used to separate vehicle classes with in different installation situations at high reliability."

Classification training
A large number of objects are used for the learning process of the classification algorithms. smartmicro uses a deep learning

Pedestrian

Truck

Left and below left:
Shapes of a pedestrian and a truck shown on smartmicro's range-Doppler matrix

to determine and decipher samples fed into the decision trees, as well as the corresponding decision. As a result, the classification algorithm is perfectly adapted.

smartmicro's traffic radar technology is an enabler for smart cities, providing precise real-time data for traffic flow on arterials. The traffic data is transmitted to a traffic operation center (TOC) and allows an optimum traffic flow in a certain region or on a longer arterial, where the traffic flow is remotely but automatically controlled from that TOC.

Real-time object data can also be wirelessly transmitted over a vehicle-to-everything (V2X) network to connected vehicles. This can help to prevent accidents and protect vulnerable road users (VRUs) such as pedestrians and cyclists. As V2X communication is rated as one of the key drivers for connected and autonomous vehicles, this system supports all V2X equipped vehicles where even vehicles with non-connective capabilities are covered. The key for the protection of VRUs is classifying them correctly. ○

ⓘ | Need to know

smartmicro develops and manufactures traffic management radar sensors:

> With AI-based classification
> For the improved safety of vulnerable road users (VRUs)
> For enhancing smart cities

neural network (DNN) where, with the help of a reference system, automated learning is possible. Thousands of objects physically pass a reference sensor system. The reference data and the radar data are then used to train the classifier. Automated training is very beneficial if, for example, country-specific classifying is required.

"We're now in a position where we can train our classification with country-specific data of vehicle distributions," says Mende.

In the future, smartmicro is aiming to equip more of its products with artificial intelligence. With the current AI solution, the developer has

@ | Free reader inquiry service

smartmicro inquiry no. **506**
To learn more about this advertiser, please visit: www.ukimediaevents.com/info/tfm

More than a road stud

The SR-i40 is not just a regular solar-powered road stud; it is an active road safety ITS device that uses in-built wireless technology to enable several beneficial features and control options even after installation. Features include a wake up and sleep function, automatic brightness control and night (darkness) detection. The SR-i40 was designed after extensive research and development and could contribute to the development of smart cities.

The stud's stainless steel, aluminum and polycarbonate body houses two unidirectional and four bidirectional LEDs. If for any reason a feature/option needs to be changed, it can be programmed in, whereas traditional studs would need to be replaced.

Thanks to its high-performing photovoltaic solar module, the SR-i40 ITS device is ideal for use in countries with low sun exposure. The SR-i40 effectively uses solar energy to operate LEDs that flash at night (or when programmed) to provide guidance, long-range visibility and advance warnings to road users. The stud gives drivers a longer time to respond to changes on the road ahead. Enabling drivers to see further in the dark reduces the chance of accidents and improves road safety.

The SR-i40's wireless and solar features make it easy to install and maintain. The studs also have high mechanical resistance. Recent independent tests showed that they can withstand up to 80 metric tons.

The road studs' robust construction makes them suitable for harsh conditions, such as on cold roads with snow plows and heavy machinery operating over them.
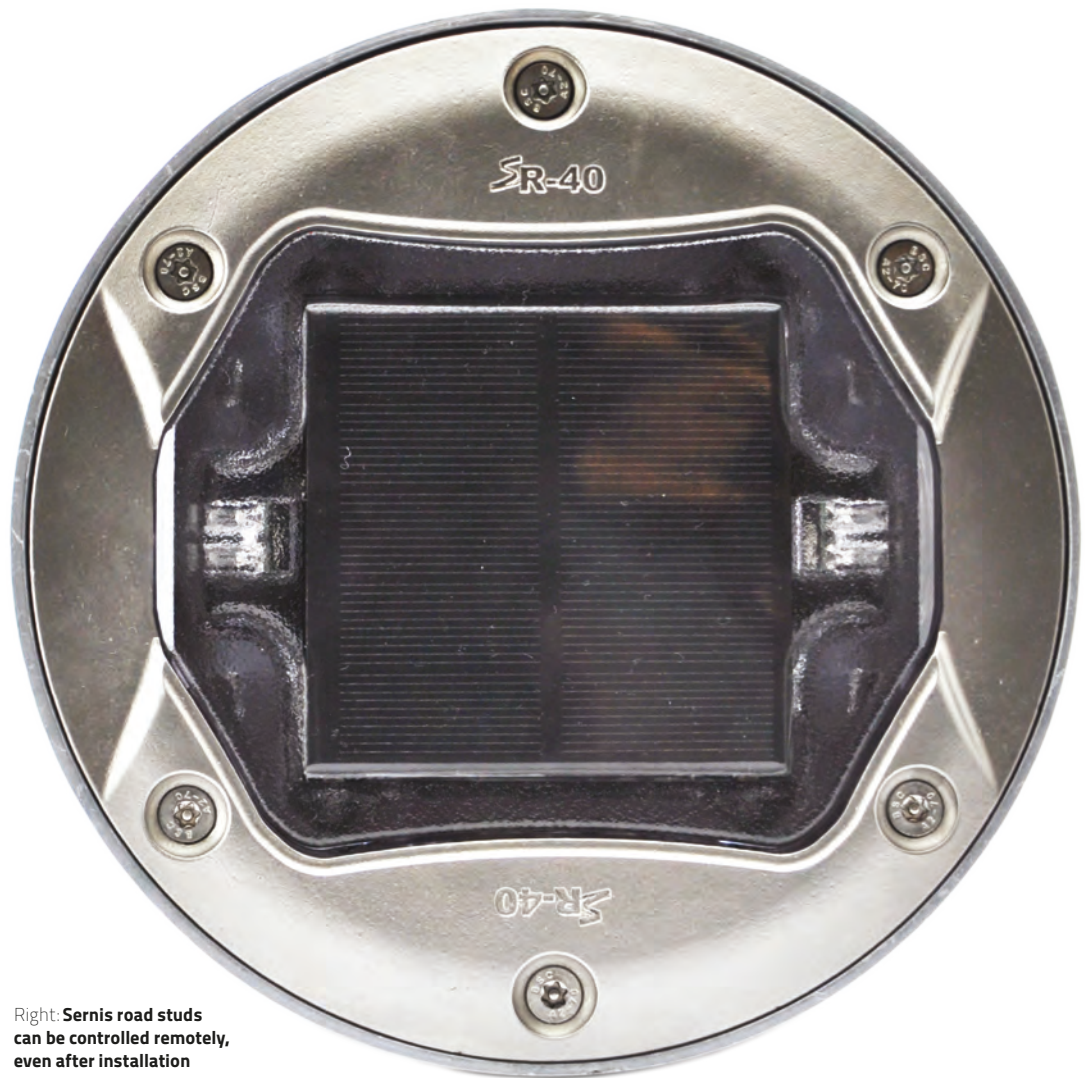
Right: **Sernis road studs can be controlled remotely, even after installation**

Each has low-power radio communication at 868MHz.

Taking (remote) control

A key advantage of the SR-i40's i-stud technology is the use of wireless communication inside each stud that allows it to be controlled even after it has been installed. If a problem with the stud is detected, the unit is able to make an internal log so that the cause of the problem can be discovered. The SR-i40 has rechargeable solar batteries that allow it to operate automatically without any external power source.

This means there is no requirement for huge expenditures for the setup of the electrical infrastructure or external wiring. The studs can therefore be deployed easily in remote areas where electricity supply is not available.

Automatic brightness control is an important feature of the stud that allows it to adapt to ambient brightness and regulate its light level accordingly throughout the day.

Appropriate modes

The wake up/sleep function sets the stud in dormant mode to prevent the battery charge from being wasted when the stud is not in use, thereby extending

Left: **The SR-i40 is a solar-powered, self-lighting road stud**

the life of the battery. Sleep mode allows the stud to stay dormant before and during installation.

The stud is then activated through the PC500 controller. Remote activation is especially helpful in countries that have severe winters or where sun exposure is low, making it harder for the stud's battery to be charged.

As soon as the road stud detects darkness, it will adjust its light output accordingly. This is useful for installations where the studs do not need to be operational throughout the whole night, as it means they can save energy for when they do need to be active.

With the operation mode function, a user can remotely switch the studs' mode between 'flashing', 'always on' and 'sequential'.

The remote control capability means that if the studs' operation mode needs to be changed, it can simply be programmed in, whereas

(i) | Need to know

Key benefits of the SR-i40 intelligent road stud include:

> Robust construction, suitable for harsh conditions
> Visible up to 0.6 miles (1km) away, due to the high intensity of the LEDs
> Maintenance mode to adjust studs, read logs and perform tests
> Wireless capabilities to enable remote control
> Low-power radio communication at 868MHz

conventional studs would all need to be replaced. This advanced technology ensures the development of highly intelligent and eco-friendly traffic solutions.

Safety benefits
The road studs' high-intensity LEDs allow up to 0.6 miles (1km) of visibility. The microcontroller technology inside the studs allows the user to modify the lighting direction to unidirectional or bidirectional, and control the LEDs both independently and on each separate side of the stud.

Another important feature of the SR-i40 is its ability to detect low temperatures on roads and to change the behavior of the LEDs accordingly in order to warn drivers about dangerous road conditions as a result of the low temperatures. The SR-i40's maintenance mode is especially useful for finding the source of problems that may have occurred during installation, adjusting the studs'

light level detection capabilities, obtaining internal logs and enabling or disabling one or all of the road studs at once.

The SR-i40 is environmentally friendly, easy to install, and requires little maintenance. It provides great visibility for drivers at night and during bad weather. It works efficiently and can operate reliably for years after installation. ○

@ | Free reader inquiry service

Smart Slovenian highway

Slovenia has its first test site for vehicle-to-infrastructure (V2I) technology, which informs drivers about road conditions in real time, by means of road information spread across the network, between vehicles and infrastructure.

Asist has just completed the V2I Smart Highway project – the first V2I ITS-G5 system in Slovenia. The aim was to develop individual components and a functioning V2I smart system that was capable of providing participating drivers on the highway with information about road conditions and related events.

The system, tested in a real environment, enabled the two-way exchange of relevant traffic information between road equipment and vehicles, in real time.

Key elements of the project were: the development of the V2I control system; the design and implementation of an ITS-G5 RSU (roadside unit) and ITS-G5 OBU (onboard unit); and the integration of communication and power systems.

The test site was established in the capital city, Ljubljana, close to the entrance of the Šentvid Tunnel – one of the most complex and best equipped tunnels in Slovenia.

Project goals
The project was able to distinguish that the reach of V2I communication is excellent on open roads, where an uninterrupted open space between the RSU and OBU was possible. The RSU and OBU also operated steadily along the entire length of the tunnel.

In addition, communication between the RSU and two OBUs effectively doubled the range of the communication network.

The test site for the Slovenian Smart Highway project was at the south entrance of the Šentvid Tunnel, in Ljubljana

ℹ | Need to know

The Slovenian V2I Smart Highway project tested the following elements:

> Traffic jam ahead warning
> Hazardous location notification
> Road works warning
> Weather conditions
> In-vehicle signage
> In-vehicle speed limits
> Probe vehicle data

Time synchronization, which is crucial in V2I networks, was achieved by a GPS or a network time protocol (NTP) server. Without the correct time stamp, no messages could be transmitted. It is expected that for GPS blind environments, other technologies will be needed, such as dead reckoning.

Findings in CAM testing
Cooperative awareness messages (CAM) serve as beacons, sending out vehicles' positions, direction of travel and speed. In real applications, CAMs could be used as an emergency call tool to accurately identify a vehicle's situation in the event of an incident. Special CAMs could also be used to achieve priority of traffic lights for emergency vehicles.

During the project, the frequency of transmitted CAM messages, ranging from 1-10Hz, depended on the speed of the vehicles. The content of CAM messages changed along with vehicles' speed to achieve the fastest delivery time and lowest network congestion.

Findings from DENMs
Decentralized environmental notification messages (DENMs) serve as road or weather condition incident messages and are designed to notify drivers of road hazards and conditions.

All tested V2X units supported the transmission and reception of DENM messages, but the graphical display on different OBUs did vary.

A valid speed limit was sent simultaneously with DENMs. Different OBU units correctly recognized the restriction. At present there is no means of sending a speed limit without an additional warning.

Certain messages were linked to the coverage area of the RSU. These are mainly weather-related messages, which can often be similar across a project's test site. For some common types of incident there is no defined V2I message type. The standardization of final messages is still in progress.

Conclusion
Despite the relative novelty and complexity of the technologies used in the V2I Smart Highway, the prototype system is fully functional and can already be used as a standalone V2I system.

The V2I Smart Highway was co-funded by the ministry of Economic Development and Technology in Slovenia and the European Union's European Regional Development Fund. ○

@ | Free reader inquiry service

The importance of timing in ITS lighting

Machine vision technology is increasingly being used to enhance in intelligent transportation systems (ITS).

The use of machine vision extends beyond traditional applications such as enforcement and tolling, into general surveillance applications such as parking lot monitoring, where adapting to varying light conditions is of critical importance. In these latter applications, both quality of lighting and the system topology are crucial to achieving the necessary high-intensity, short-duration bursts of light and precisely controlled camera triggering.

Camera trigger topologies

The choice of camera triggering topologies for machine vision are illustrated in Figure 1 (above right). Working from left to right, topology 1 shows the traditional triggering arrangement, where the camera is triggered by a vehicle sensor, followed by the camera triggering the light and starting its exposure.

Topology 2 shows the light being triggered by the sensor, with the light triggering the camera. This arrangement has the advantage that the light can filter the trigger signal, which is beneficial in situations where, for example, one vehicle can cause multiple triggers or false triggers can be caused by short noise spikes.

Topology 3 is an increasingly popular arrangement, where the camera continuously captures images and the camera's on-board software looks for vehicles in view. There is no external trigger and the light provides the regular trigger for the camera. Alternatively, the camera could continually trigger the light.

① **②** **③**
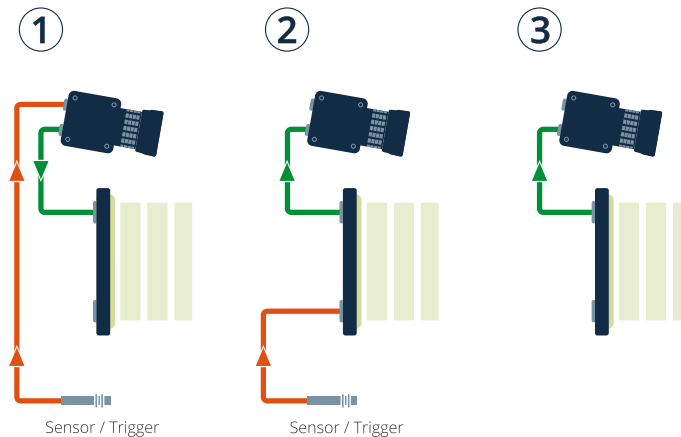
Sensor / Trigger   Sensor / Trigger

Above: **Figure 1 shows topologies of triggering arrangements**

Left: **The VTR6 is a high-power LED strobe light for use in ITS**

ⓘ | Need to know

The VCT6 high intensity OEM LED strobe light is suitable for most traffic applications including:

> Automatic license plate recognition (ALPR)
> Red light enforcement
> Speed enforcement
> Weigh-in-motion
> Toll management

The most important requirement for ITS applications is ensuring that the actual illumination area on the road has adequate light intensity.

Defining the illumination

The illumination area can include several tens of meters of distance across several road lanes. When determining the geometry of a lighting system, the critical parameter is how much light intensity arrives at the target area. For a given light, as the beam angle increases, the intensity at the target decreases. It is therefore very important to optimize the beam angle, which is a product of optics design and plays an important role in lighting system performance. A well-defined beam reduces both wasted light and light pollution, as well as minimizing energy consumption. Using an optimized beam angle can prolong component life and reduce costs.

The characteristics of the light pulse are another crucial element of ITS lighting, and fundamentally determine the effectiveness of the synchronization between camera and light – as well as defining the intensity of light available at the point where images are taken. The use of a dedicated lighting controller allows the LED to be overdriven for short, well-defined pulses to produce output light intensities well in excess of the standard LED rating. The controller also provides flexibility in system design for taking multi-images from one scene (with multiple pulse imaging).

Triggering in action

Multilane capability is becoming increasingly necessary for some ITS applications and very fast pulsing of LEDs can provide a solution.

In a recently completed project, a single LED light from Gardasoft was used to cover three lanes, each with a dedicated camera. The light had to accept a trigger from one or more cameras. The working distance of the lights was 20m (65ft) and Gardasoft offered the option for custom beam arrangements. In this instance, the beam geometry was arranged to give a 32° beam in the horizontal axis and 12° in the vertical axis.

To enable synchronization with the cameras, three transistor-transistor logic (TTL) trigger inputs were configured on the LED light such that any of the cameras could provide a trigger. ○

@ | Free reader inquiry service

Gardasoft   inquiry no. **509**
To learn more about this advertiser, please visit: www.ukimediaevents.com/info/tfm

Making roads safer with mobile enforcement vehicles

A new generation of multipurpose vehicles – both cars and bikes – is hitting the roads equipped with a complete suite of software applications to enable authorities to cost-effectively extend the reach of installed digital video platforms. These vehicles can be used tactically for a wide range of traffic and parking management applications, where safety or compliance issues have been identified.

Redcar and Cleveland

The UK's Redcar and Cleveland Borough Council is one of the latest local authorities to use mobile enforcement vehicles (MEV) to patrol school locations where illegal parking on marked yellow 'keep clear' areas has been shown to put children's lives in danger. The vehicles will also be used to deter drivers from parking at bus stops or blocking sidewalks.

A white Renault Kadjar, supplied by Videalert, is equipped with two roof-mounted automatic license plate recognition (ALPR) cameras. Used in conjunction

Need to know

Applications for Videalert mobile enforcement vehicles

> Keep-clear zones outside schools
> Bus stops, bus lanes, red routes and box junctions
> Residential permit zones
> Restricted areas for vehicles, such as waste depots

Above: **The mobile enforcement vehicle in use by Redcar and Cleveland Borough Council, UK**

Left: **A new generation of ALPR camera for mobile enforcement**

with the latest video analytics, the system delivers high productivity at a low operating cost, even in high-density traffic environments. Onboard systems are controlled by the operator manning the vehicle via a dashboard-mounted touchscreen.

All contravention evidence data is transferred to Videalert's digital video platform in the parking office at the end of each shift. Video evidence packs are automatically constructed for review by trained council operatives prior to sending confirmed offenses to the back office processing system for the issuance of parking charge notices.

New ALPR cameras

The functionality of these MEVs has been further enhanced with the latest ONVIF-compliant ALPR cameras with Sony DSP technology for noise reduction and infrared sensitivity. These HD cameras accurately capture crisp images of reflective license plates at distances of up to 40m (130ft), delivering license plate read rates in excess of 98%. The cameras have full-color overview modules to capture contextual vehicle images in daylight and in challenging light conditions.

Clean air zones

The Videalert MEVs can also play a significant role in the management of clean air zones. They can be deployed to capture images of vehicles that have not already been picked up by zone perimeter cameras while providing the same functionality as pole-mounted static cameras. This includes the real-time identification of vehicles by classification, make, model, color, gross weight, engine type, Euro rating and CO_2 emission band, to determine whether the vehicle is permitted in the zone without charge. For vehicles that have to pay a charge, vehicle registration data is sent to the payment system to determine whether the correct tariff has been paid for entry into the zone. MEVs can also be used to determine the extent of contraventions by highly polluting vehicles in any target location to determine potential charging schemes prior to clean air zones being established.

Data sharing

Data captured by MEVs and transmitted to Videalert's Digital Video Platform can be shared with other traffic management, crime prevention and community safety applications. For example, the platform integrates with urban traffic management control systems to assist with activities such as journey time reporting, to enable motorists to better plan their journeys. It also provides valuable data input for traffic modeling systems that are used to improve traffic flows, and reduce congestion and pollution.

To meet the growing demand for multipurpose MEVs, Videalert has recently opened an engineering hub in Trowbridge, Wiltshire, UK. The hub acts as a dedicated vehicle design, manufacturing, refurbishment and testing facility. Videalert is now the UK's only supplier with the ability to provide a full suite of CCTV traffic and parking enforcement solutions comprising attended, unattended and mobile, using the same intelligent platform.

A standalone ALPR system

CARRIDA's mission is to read cars and license plates, as is reflected in its name: 'Car' stands for the vehicles that it loves, while 'Rida' (pronounced "reader") indicates the company's passion to read and recognize different kinds of license plates. Its software module for automatic license plate recognition (ALPR) is designed for all kinds of applications.

A powerful OEM library
The CARRIDA software engine is easy to integrate into existing security and surveillance ITS applications. It is independent of hardware and runs on Windows and Linux on PC and advanced RISC machine (ARM) architectures. A very fast processing speed of typically 15-20ms per frame enables the reading of license plates on vehicles traveling at up to 240km/h (150mph).

The software can read license plates even when they are partially damaged, or if there is low noise, low contrast or low resolution in the image. Readings can therefore be achieved with an accuracy of 98%. The software can be used with any C and C++ projects via an application program interface (API). This means that the user can program a broad range of applications.

A single-unit solution
A small standalone, intelligent ALPR camera from CARRIDA can be combined with the software. The camera has an IP67 protective housing with M12 cable connectors. It is able to process data collected without additional hardware, thereby saving space and money.

Obtain key vehicle data
Adding vehicle 'make and model recognition' to an ALPR
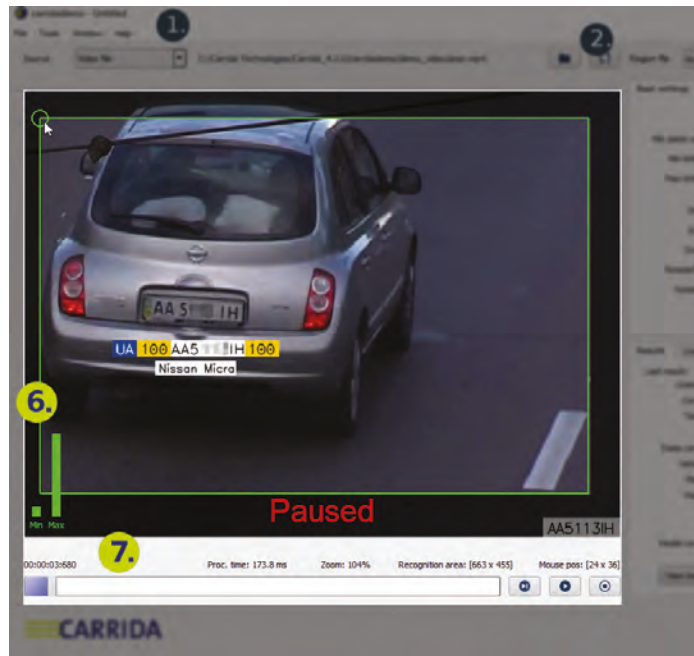
Left: **ALPR systems are used to obtain vehicles' license plate numbers in traffic management and enforcement applications**

ℹ | Need to know

Features of CARRIDA's ALPR system include:

> 98% accuracy for license plate readings
> Readings of license plates for vehicles traveling at up to 240km/h
> The use of AI to learn and manage areas with restricted access
> Fast processing speeds of typically 15-20ms per frame

solution results in more accurate readings. Readings with a positive match between the car and its license plate can be archived in the camera.

The software module is based on the latest artificial intelligence (AI) technology, ensuring high recognition rates of vehicle makes, as well as models, from all over the world.

Read cars with Android
The newest technological achievement from CARRIDA is an Android-operated software development kit (SDK). A reading time of approximately 300ms for full HD images can be reached, even on medium class Android devices. A sample application can be found on the company's website.

CARRIDA for Android is fully optimized for ARM/32bit architectures. Furthermore, the SDK includes color recognition for GCC, state recognition and

stacked characters for different countries.

A versatile solution
CARRIDA's software can be used in a broad field of different applications. The system is automatically able to manage access to restricted areas, such as smart parking lots. It can also help in law enforcement in the areas of like tolling, speed enforcement and license plate searches.

When it comes to ITS, the company's products support traffic analyses and statics.
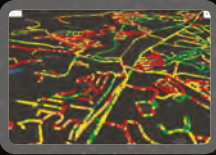
CARRIDA is developing, and is looking forward to releasing, innovative new features and novel modules. ○

@ | Free reader inquiry service

CARRIDA   inquiry no. **511**
To learn more about this advertiser, please visit: www.ukimediaevents.com/info/tfm

Express lanes

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

**"The whole idea
behind infrastructure
is that it is best when
nobody even notices
it's there"**

Dr Ben Schmidt, RoadBotics co-founder and chief
technology officer

The city of Savannah has hired a firm to collect detailed
assessments of the condition of its roads. See how artificial
intelligent machine-learning technology is simplifying this
mammoth task. **traffictechnologytoday.com/roadbotics**

"In the 1970s in
Victoria the road
death toll was
over 1,000 per
year, now it's
down to 200 per year, and the
size of the population has
doubled in that time. There are
also more cars per head and
speeds are higher. But the death
toll is lower"

Page 22

Dean Zabrieszach, ITS Australia's president, on the road
safety success story in his home state of Victoria

"It's important to
clarify that our
research does not
suggest that London
Bridge or any others are
actually falling down"

Page 74

Steve Gooding, director of the RAC Foundation, on the
organization's findings regarding the state of UK bridges

**"The good news is,
express lanes work
for everyone, even
those who choose
not to pay a toll"**

David Spector, director of high performance
transportation enterprise at Colorado Department
of Transportation (CDOT)

Watch this short Q&A from CDOT, which explains why, and by
how much, express lanes are improving traffic times for
travelers in the state. **traffictechnologytoday.com/CDOT**

Index to **Advertisers** | ⓘ

ADVANCED
TOLL COLLECTION SYSTEMS

A-to-Be LinkBeyond™

or

Advanced-connector-that-ensures-every-operator-joins-the-mobility-party.

A-to-Be LinkBeyond™ is our Advanced Mobility Connector on the road side that makes sure all transport operators and mobility players connect, making things happen on the field: access gantries are activated, fares enforced, barriers opened, customers pleased. **This is urban mobility, moving beyond.**

Mobility-Beyond™

A-to-Be

Powered by Brisa