January 2018

traffic
TECHNOLOGY INTERNATIONAL

Winter hazard removal
ITS is cutting down on crashes in the snow and ice

Toll bridge technology
The UK's newest crossing is designed for the future

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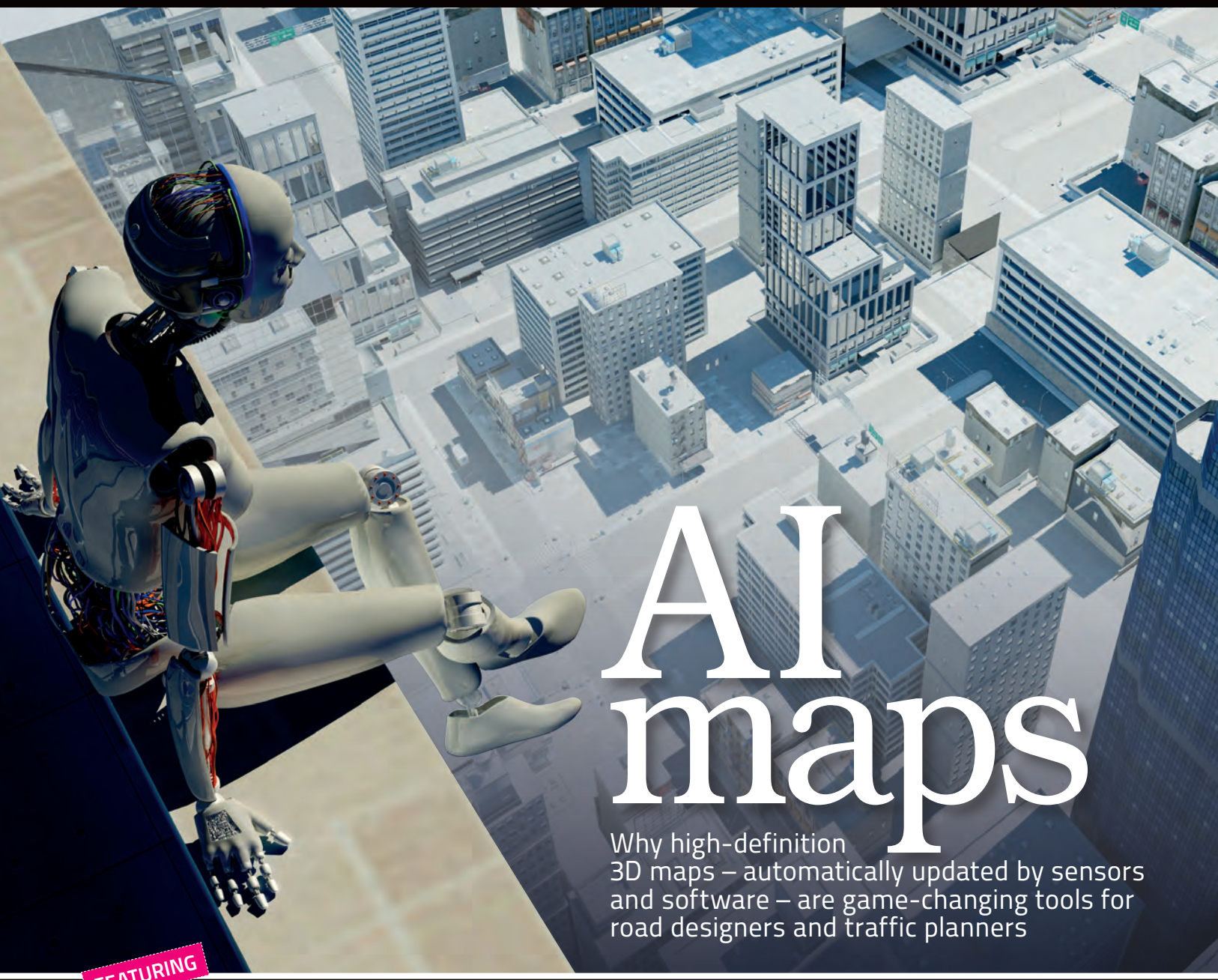

AI maps

Why high-definition 3D maps – automatically updated by sensors and software – are game-changing tools for road designers and traffic planners

FEATURING

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Your essential guide to the future of transportation communications

Connected streetlights
How one Washington city is leading the way in a streetlight-based Internet of Things revolution

Communication blackspots
In Wyoming, the USDOT's Connected Vehicle Pilot is confronting challenges of rural coverage and DSRC shadows

Flow experience

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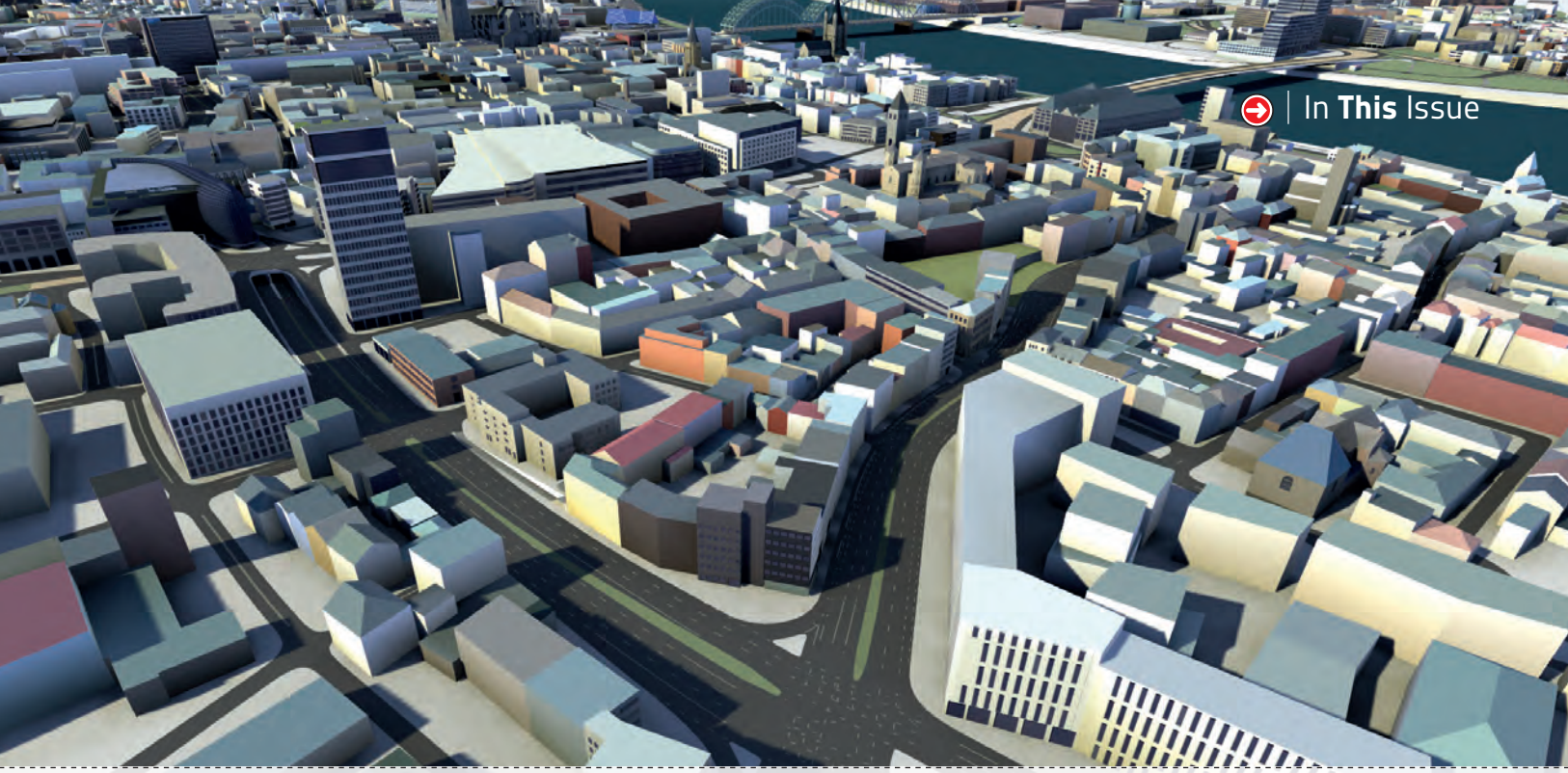
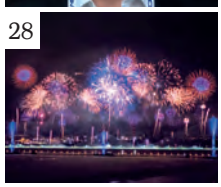


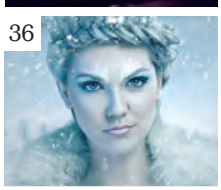
Cover story

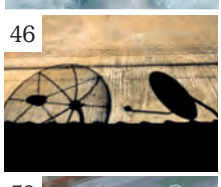
22 AI maps

Real-time updates mean 3D maps are almost organic in the way they are built

David Smith looks at how such technology, developed for autonomous vehicles, has useful applications for road authorities







Technology Profiles

Editor's letter

Last summer I drove from the southeast of England to Wigan, in the northwest, for my brother's wedding. A journey of some 270 miles which, most online trip planners agreed, would be a minimum four-and-a-half hours' driving time. With two small children there was no way we were going to attempt such a journey without breaks. Accordingly, an entire day was blocked out the trip.

Lucky we did. During our lunch stop in Banbury (there's an impressive statue of the nursery rhyme's legendary 'fine lady' at The Cross) we checked Google maps... An accident on the M42 round Birmingham, just 40 miles on from where we had stopped, had reduced the key stretch of motorway to a standstill (despite its 'smart' credentials). The delay looked like being at least an hour. We checked alternative routes… That artery turns out to be so key to England's Strategic Road Network that any detour added even more than an hour to our overall journey time. Our decision? Sit tight, relax over coffee and waffles at the Little Amsterdam café, go to the playground… and seek out that statue ("Don't sing, Daddy!").

Okay, so our overall journey still took another hour. But that hour wasn't driving. It was filled with some happy family time, rather than trapped in the angst of a jam. It was a victory for real-time maps. Probe data informing us that, for now, driving was not going to get us anywhere fast. Such advanced maps were unheard of 20 years ago. Now you can get them on your phone.

But maps aren't done evolving yet. The next generation, being put together by the likes of Here, are now fully high-definition and 3D. They are updated so regularly, and are so detailed, that autonomous vehicles will be able to use them to avoid fallen trees and potholes – and road authorities will be able to use them to address these same types of issues. The data is so rich that they're not so much maps as virtual reality mirrors of the world – read more on page 22.

Back in the car, and having navigated the M42 with minimal delay, one of my favorite bits of road lay ahead – the M6toll. The 27-mile stretch is a unique piece of infrastructure in England, being the only section of tolled motorway that does not form part of a major river crossing. It's fast, clear… and just a touch expensive. But, being a one-off trip, the £5.90 (US$7.90) price tag seemed worthwhile. Commuters in the area no doubt feel very differently. England's relationship with tolling has been a cool one over the years, but perhaps that relationship is warming, as a new facility has just been built. The Mersey Gateway Bridge (just 20 miles from Wigan) opened for business in late 2017; find out more on page 28.

The journey nearly done, there was just time to experience one more piece of traffic technology in action. Beyond Birmingham, the M6 has yet to be fully converted to smart motorway (there's more on smart motorways on page 41). And, where the overhead gantries ended, so the traffic queues began. The reason seemed to be nothing to do with all-lane running – at this point the number of lanes was unchanged – but simply that drivers paid more attention to variable speed limits when there were more signs to inform them, thus calming and smoothing traffic flows and reducing the dreaded stop-start of phantom jams. Which is a reassuring observation for all of us in the industry: drivers are paying attention to ITS and we are making a difference – even if journeys sometimes do take a little longer than expected!

Tom Stone,
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NYC gets connected

As the USDOT's Connected Vehicle Pilot in New York City nears the end of its design phase, **James Gordon** gets an update on the challenges being overcome in what looks to be the largest deployment of connected vehicles in the USA

New York City Department of Transportation (NYCDOT) is approaching the end of the design stage of its groundbreaking Connected Vehicle Pilot project, which will become the largest deployment of connected vehicles (CV) in the USA once it is underway.

The NYC Connected Vehicle Pilot Program will support six specially designed V2V safety applications including forward collision alerts, blindspot warnings, intersection cross-traffic warnings, and emergency brake light alerts, and seven V2I audio warnings, which will be relayed to around 8,000 test vehicles in total.

According to Dr Mohamad Talas, NYCDOT's Intelligent Transportation System program manager, the equipment roll-out, which is to be utilized in two specific locations – Brooklyn (Flatbush Avenue) and Midtown Manhattan (between 14th and 67th Streets) – has reached a critical juncture.

Take the Aftermarket Safety Device (ASD), which will be installed in 5,850 taxis, 1,250 Metropolitan Transport Authority buses, 250 sanitation trucks, 250 NYCDOT fleet vehicles and around 400 United Parcel Service (UPS) vans, for example.

"The ASD procurement tender is at a mature stage in development," says Talas. "However, we are in contractual process with two selected vendors – Savari and Danlaw. In terms of RSU deployment, we are in

Left: **Intersections in Midtown Manhattan are being outfitted with connected RSUs**

Right: **Urban canyons create challenges with obtaining accurate GPS data in NYC**

5,850
Number of NYC cabs that will be connected as part of the pilot

the process of procurement and are planning the installation of the 353 units, and hope to complete the process by mid-2018."

But with several thousand ASDs needing to be fitted to over 8,000 vehicles in the next six months, how exactly is the installation process being managed?

Talas explains, "Our in-house crews will be fitting many of the units. However, in the case of taxis, we are currently working with the Taxi and Limousine Commission to select authorized contractors who will be certified to install the equipment in the vehicles and working on agreements with taxi fleet owners."

Talas continues, "In the case of UPS, we will supply the ASDs and their installation kits. The UPS team will embed the technology into vehicles participating in the pilot."

Privacy issues

In addition to ASD procurement, there have been several obstacles that the NYC pilot team has negotiated and resolved. Take data collection and data analysis, for example, which are fundamental building blocks of the project. For Transcore NYC's site deployment lead, Bob Rausch, taking a privacy-first approach has been "a critical element for all stakeholders".

Says Rausch, "It turns out that the privacy issues were far more complicated than we first envisaged and more complicated than even USDOT had expected. Therefore, it took us considerable time to work with the stakeholders, the evaluators, the various lawyers from the different groups to develop, and to agree an approach that would be acceptable to everyone. And every step of the way, we focused on privacy by design. We realized that it was not sufficient to provide assurances to the stakeholder community that we wouldn't be collecting data. Instead, we had to demonstrate by design that it was physically impossible for us to collect personal information."

Rausch also says that in the pilot areas, where high-rise buildings, bridges and underpasses create urban canyons, "achieving GPS location accuracy in the urban canyon has been challenging".

Rausch says, "In New York City where we have very little open sky, we have been delighted by the creativity displayed by our vendors in the demonstrations. Together we are leveraging a raft of techniques to improve accuracy including RSU triangulation, Dead Reckoning and Inertial Management Unit (IMU) integration. Triangulation, in particular, has shown itself to be effective in dramatically improving location accuracy."

> "Our in-house crews will be fitting many of the units. However, in the case of taxis, we are currently working with the Taxi and Limousine Commission to select authorized contractors
>
> *Dr Mohamad Talas, ITS program manager, NYCDOT*

Another challenge centers on the equipment itself. Explains Rausch, "We have spent a lot of time in this phase on connected vehicle application tuning. In the absence of a standard application performance requirement, each vendor has had their own interpretation on how apps should be set up and have carried out their own adjustments and refinements to the applications. However, most importantly, in the real world where the apps have to function in dense urban areas, we needed each application, regardless of vendor, to deliver consistent expectations to the driver. Finally, as we are faced with open sky challenges, we have had to set up two separate testing environments to ensure consistency – one for open sky and another for the urban canyon."

400
Number of UPS delivery trucks that will be connected as part of the pilot

For an update on the USDOT's Connected Vehicle Pilot in Wyoming, turn to page 46

Autonomy ahead

As autonomous vehicle development continues **James Allen** rounds up the latest news in the field, looking at the funding, testing and new technology that is shaping the future of transportation

Extra UK funding

Two of the organizations leading UK research into connected and autonomous vehicles (CAVs), TRL Academy and Transport Systems Catapult, have welcomed the investment in the emerging technology announced by UK Chancellor of the Exchequer Philip Hammond in the autumn budget. The UK government has committed to £500m (US$665m) in funding for artificial intelligence and 5G, and an additional £2.3bn (US$3bn) for research and development was confirmed.

Find out more at:
trafficTechnologytoday.com/budget

Demo failure

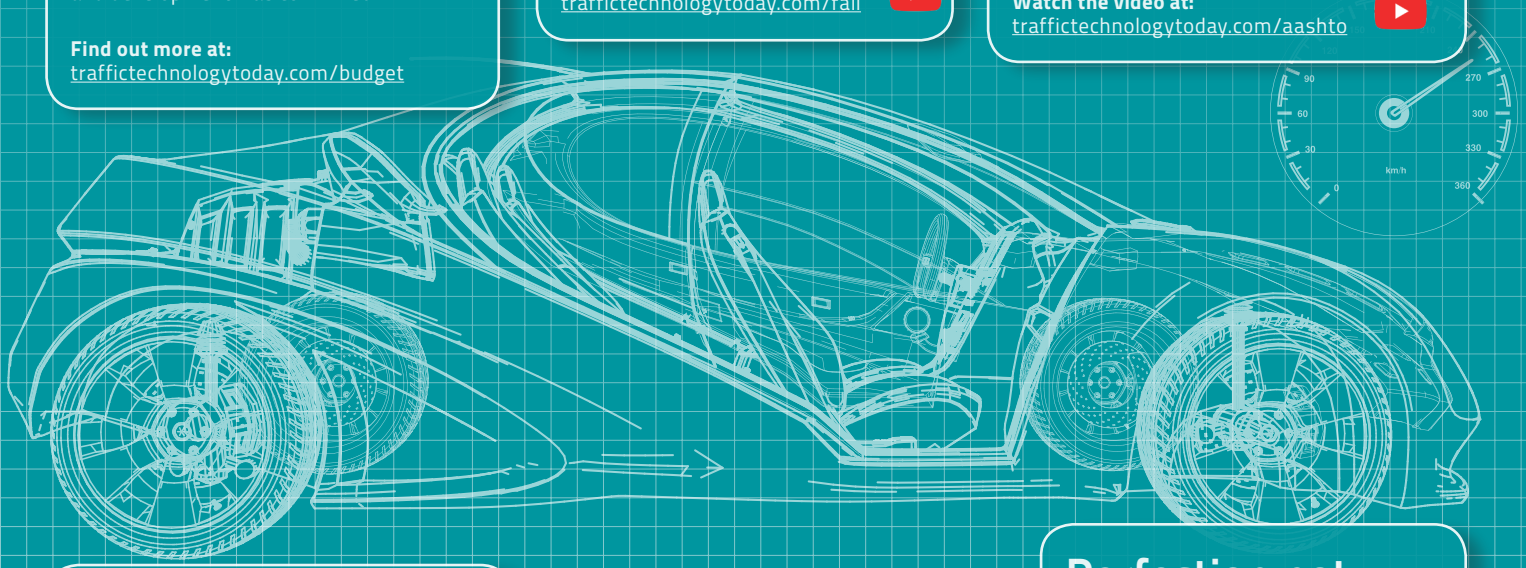
An autonomous vehicle being demonstrated at the ITS World Congress in November malfunctioned with delegates inside. The electric vehicle, developed by Navya, stopped midway on the test route, while the doors repeatedly opened and closed and an alarm sounded. The fault on the demo vehicle was resolved.

Watch a video of the trial at:
trafficTechnologytoday.com/fail

AASHTO report

The American Association of State Highway and Transportation Officials (AASHTO) has released a new video report exploring how the risks and rewards of connected and autonomous vehicles can be managed on US roads in the near future. The report features opinions from key transportation industry experts, as well as an overview of the new briefing document, titled *Strategies to Advance Automated and Connected Vehicles*.

Watch the video at:
trafficTechnologytoday.com/aashto



Test track expansion

The Virginia Tech Transportation Institute (VTTI), in partnership with the Virginia Department of Transportation (VDOT), has unveiled four expansions to the Virginia Smart Road, the state's full-scale, closed testbed research facility. The expansions offer an unprecedented opportunity to explore how autonomous vehicles will function on all US roadways, including edge-and-corner and rural environments.

Find out more at:
trafficTechnologytoday.com/four

World-first taxi

French self-driving vehicle manufacturer Navya has unveiled Autonom Cab, which it claims is the first fully autonomous 'robotized' production taxi cab on the market. The cab was designed from the outset to be autonomous, just like all the vehicles in Navya's Autonom range, meaning that there is no cockpit, steering wheel or pedals.

Find out more at:
trafficTechnologytoday.com/taxi

Perfection not required

Autonomous vehicles should only have to be moderately better than human drivers before being widely used in the USA, according to a new report from the RAND Corporation. The public policy research organization's claim that allowing widespread use of AVs when they are just 10% better than current US drivers could save thousands of lives annually, even before the technology is perfected.

Find out more at:
trafficTechnologytoday.com/moderate

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All ready in Rotterdam

As part of our Dutch focus, which begins this issue with the build-up to Intertraffic Amsterdam 2018, we take a closer look at Rotterdam, the port that lies 43 miles (70km) south of the exhibition host city

Rotterdam is the largest port in the EU, with

424 million

metric tons of maritime freight

29,022 seagoing vessels

105,000 inland vessels

Diesel cars built before 2001 and petrol cars built before July 1992 have been banned in the low-emission zone in Rotterdam since January

60%

fall in the number of registered old diesel cars in Rotterdam between 2013 and 2016

234km (145 miles) highway

6,746km (4,192 miles) non-highway

6,980km (4,337 miles) total road network

NOV 24

Most congested day of travel: November 24

50

water taxi berths

400,000 passengers per year

44,636

flights

1,626,573 passengers (Jan – Oct 2017) from Rotterdam The Hague Airport

600km

of separated cycle paths

5.9km (3.7 miles)

The length of Rotterdam's Metro system – one of the shortest in the world

160,000

people cycle daily (80% own a bicycle)

743

cycle routes

Heat sensors detect cyclists waiting and speed up traffic lights to green

Rain sensors at some traffic lights mean cyclists wait for less time in the rain

€40m

spent on improving cycle paths in past 10 years (US$47m)

Sources:
www.rotterdamfietst2016.nl
www.portofrotterdam.com
www.tomtom.com
www.rotterdamthehagueairport.nl
ec.europa.eu
www.watertaxirotterdam.nl

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Stay secure

James Allen looks at the progress being made by transportation authorities around the world in tackling the cybersecurity threats to modern vehicles

Cybersecurity playground planned

Multiple partners unite to launch a testing center for smart mobility security technologies

US firm Harman International has teamed up with Ben-Gurion University of the Negev, Cymotive Technologies, Deutsche Telekom Innovation Laboratories and JVP (Jerusalem Venture Partners) to launch the international cybersecurity Smart Mobility Analysis and Research Test (SMART) Range in Israel.

The SMART Range will act as an innovation hub for auto makers, Tier 1 suppliers and research institutions, for the testing and certification of automotive cybersecurity, autonomous driving and smart mobility technologies. Functioning as a living lab, it will encompass all aspects of future mobility systems.

The range will simulate a complex reality, enabling effective testing of advanced technologies, assessment of human-machine-environment interfaces, the evaluation of transport solutions in a future networked reality, and operability and robustness testing of software and hardware systems against cyber threats.

Future proofing

Praetorian to research cybersecurity threats in ITS and CV systems

Cybersecurity services provider Praetorian is working with the San Antonio, Texas-based Southwest Research Institute (SwRI) to help state and local agencies address cyberattack risks to current transportation systems and to future connected vehicles.

Praetorian and SwRI will work on the two-year US$750,000 government-funded project to develop guidance for transportation agencies on mitigating the risks from cyberattacks on the field-side of traffic management systems, including traffic signal systems, ITS, V2I and CCTV; and informing the agency's response to an attack on its equipment, systems or network.

Pushed to the limit

Consortium to test connected and autonomous vehicles to limit of operability

The Trusted Intelligent Connected Autonomous Vehicle consortium (TIC-IT), along with the cybersecurity, engineering and automotive design departments of the UK's Coventry University, will receive £13m (US$17m) of funding from Innovate UK to establish a piece of testing infrastructure that will be part of the world's most effective CAV testing ecosystem.

The TIC-IT facility will be built on Horiba MIRA's 750-acre Proving Ground at Nuneaton, and will create a purpose-built realistic, safe environment for testing CAVs up to the limit of their operability, which is critical to ensuring consumer confidence in the technologies.

Puzzle piece in place

Highways England commissions WSP to support four-year connected vehicle project

WSP (formerly WSP – Parsons Brinckerhoff) has been commissioned by Highways England to drive forward its connected and autonomous vehicles (CAV) program over the next four years in a contract worth £1.5m (US$1.9m).

WSP specialists, backed by supply chain partners, will provide services such as program management, design of CAV technology solutions, V2V and V2I communications, system architecture design, data security and cybersecurity systems, business case development, trials evaluation, road safety case development, and data analysis and modeling.

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ITS Norway's managing director Trond Hovland is one of those fortunate men who loves his work and is often disposed to smiling. Yet the revelation that first gave Hovland his infectious energy and sense of purpose took many years to arrive.

A chemist by education, in 1990 Hovland was hired for three months by the Norwegian Public Roads Administration (NPRA) to work on data systems. "After three months I was stuck," he recalls, "so I stayed for 18 years! I worked on buying intelligent transportation systems, installing them and getting them running. I worked with development teams making the specs for new systems. I worked on many large road and traffic data systems. Everything was data and models." And so it might have continued, had it not been for a moment of awakening in 1997.

Light bulb moment

As the Vision Zero agenda emerged from Sweden, Norway undertook a comprehensive review of its own traffic safety systems. "By digging through data, it was easy to find both existing blackspots and developing blackspots likely to become severe," Hovland explains. "We worked with insurance companies to find all the small pressures that eventually led to a fatality. We matched our curve with the death toll on the road. There was a kind of shrinking, pointing toward zero in the future. Then someone said, 'We can't bend this curve down without more data.'" That was his light bulb moment.

Trond Hovland, ITS Norway's managing director, explains why he loves his job and why cooperation will be vital in delivering future mobility solutions

Interviewed by Tom Stone

Written with Jack Roper

> In an instant, I realized that the data I provided and the quality of that data actually saved lives on the road

"In that instant I realized that the data I provided and the quality of that data actually saved lives on the road. It just clicked: I had to do this properly because it would save lives. That became my guiding star. From then on, I really fell in love with my job."

We are seated on a vast mezzanine beneath a glass ceiling at the Palais des congrès de Montréal, by the top of a long escalator. As Hovland recounts his epiphany, I notice little knots of people ascending the electric stairway, carried upward into the natural brightness of the circling sky.

"It's always about traffic safety. Technology will further prevent fatalities. Since ITS became mainstream – between 2005 and 2010 – the death toll has declined. We now have only around 100 deaths a year on Norway's roads, compared with 250 in 2005. The public sector is driven by safety, and the car industry and the roads are contributing, but rolling analysis out from the data has contributed a lot."

Nowadays Hovland is much engaged with standardization, seeing it as a prerequisite to combining data from multiple sources without loss of detail. "I go to meetings and I'm pretty good at seeing connections between committees. I've done that to build information models and geographic information systems and we now have an international group building those two families of standards together."

117
The number of road deaths in Norway in 2015 (2.2 per 100,000 population)

At present, he argues, much of the data from the design and building phase of road projects is lost in transition to the maintenance phase. "Road builders have a 3D model with every detail of interest. To keep this alive through the process, you must combine two families of standards."

Standardized data will be a key enabler for autonomous vehicles. "People think that cars can make increasingly detailed maps, but positioning the car on the true map still depends on beacon or satellite data," he says. "If we can put the millimeter-precision data from buildings and roads into a car, it will have a true picture of the road network. The car's perception of its surroundings can be matched to the true map."

A shared future

Hovland sees autonomous vehicles as promising to improve traffic safety while relieving (though not necessarily replacing) human drivers. He also hopes their mass production will come hand-in-hand with a utilitarian ethic of collective ownership. "You shouldn't own an autonomous vehicle – it should be shared," he insists. "Then you will see a decrease in the number of cars and a challenge for car makers: how can they make money?" Connected cars will be able to travel closer together, using less space and making more road surface available to bikes and buses. Mobility as a Service (MaaS) will encourage people to lift-share or use public transport so that acres of urban car parking space can be reclaimed, Hovland suggests.

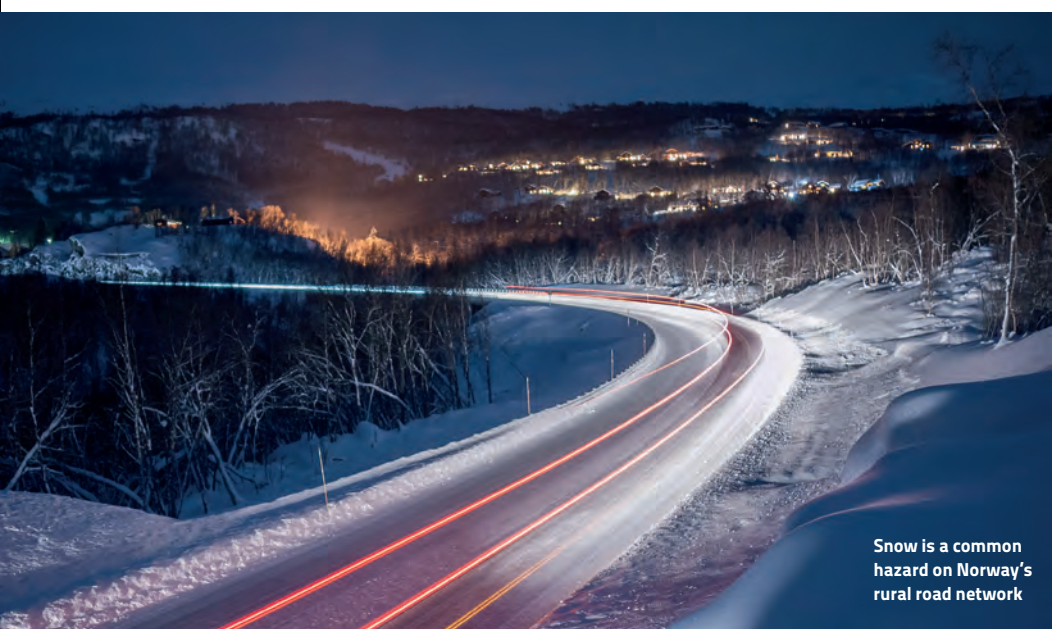
He hopes that MaaS will advance quickly, led by public transport administrations (PTAs) integrating their systems to provide a more seamless personal transport experience. Nonetheless, experience of testing car pool systems and working with taxi companies in Bergen and Trondheim make him doubt the willingness of smaller transport providers to share their data via a common platform. He understands their reluctance, though it saddens him: "I think cooperation is the only way to the future," he says. "You need to open up and share your data. In that way you increase the transportation market for each additional actor, but on a higher level."

Working together

The cooperative theme persists in respect of the next ITS World Congress in Copenhagen, where Norway is planning a joint stand with Nordic neighbors Denmark, Finland and Sweden. With a combined population of only 26.4 million, it is essential for these nations to pool their thinking – while seeking closer ties with the Baltic states. "We have worked especially with Estonia," Hovland says. "It may pass under the radar, but Estonia is a modern country with young people running it – and actually laughing at systems we are quite proud of in Norway!"

One fruit of such collaboration is the NPRA's partnership with the Finnish Transport Authority (FTA) in developing intelligent road features on the E8 Aurora Borealis Corridor linking Tromsø in Norway with Kolari in Finland, a key route for Norwegian fish exports. ITS stations are being set up along the route, which is used to test automated vehicle technologies in challenging weather conditions. "We are developing systems to hold long-haul vehicles at the bottom of the mountain in snow and icy conditions so that others can come over without being afraid of a head-on situation on a narrow road."

Cooperation is seen as key to securing Norway's future. "We have to find out what we can contribute and our position in future European markets. Bad weather and tunnels are our specialty – so we can make connected cars work in those conditions. But my dream is the state of convergence to come," Hovland concludes. "The point in time and space when that happens will be beautiful."



Snow is a common hazard on Norway's rural road network

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AMSTERDAM

Ahead of the highly anticipated Intertraffic Amsterdam 2018 exhibition, which will take place from March 20-23, 2018, **Rachelle Harry** finds out about the new ITSUP mobility event for startups, as well as key show highlights

Illustration: Magic Torch

It has been almost two years since the last Intertraffic Amsterdam – the Intertraffic flagship event. Taking place from March 20-23, 2018, and with more than 30,000 delegates expected to attend, the upcoming Intertraffic Amsterdam offers industry professionals the chance to add to their knowledge of the sector, keep up with the latest industry trends and expand their business networks. As with all Intertraffic events, there will be an exhibition showcasing the latest products in the fields of infrastructure, safety, parking and smart mobility. Conferences and the prestigious Intertraffic Innovation Awards ceremony will also feature.

This year, for the first time, ITSUP – the event for smart mobility startups – will be part of Intertraffic. "At ITSUP, startups can connect to established businesses to work together on the newest traffic and automotive innovations," says Jacques Goddijn, CEO of HR Groep, the 2018 sponsor for ITSUP. "During this three-day event, startups can pitch their innovative solutions to different audiences and professionals in the mobility and traffic industries, such as stakeholders, investors and key experts.

"Its international audience and the presence of many traffic technology professionals makes ITSUP the perfect location to pitch ideas and boost smart mobility startups."

HR Groep, which is an exhibitor at Intertraffic Amsterdam, is made up of several companies that specialize in traffic management, street care and wayfinding.

"At this year's ITSUP event, imagineers Mona Weischnur, Miarka Webb and Rosalie Verloop from HR Groep are launching a startup that can apply smart solutions in a co-creative way."

ITSUP will bring benefits to both startups and established businesses. The larger companies will gain innovative ideas while the startups will be able to pitch their ideas in front of partners and interested companies.

> Startups can pitch their innovative solutions to different audiences and professionals in the mobility and traffic industries, such as stakeholders, investors and key experts
>
> **Jacques Goddijn, CEO, HR Groep**

"In order to be eligible to pitch innovative start-up solutions, it is important that you have a solid business plan in place and that this solution is innovative, intelligent and globally applicable," says Goddijn. "It is also important that the proposed solution is feasible and can grow rapidly. Lastly, the solution should be oriented toward the industries that Intertraffic serves – traffic technology, automotive, telecoms and service providers."

Startups wishing to participate should apply online at www.intertraffic.com/ITSUP

Over the next two pages, we showcase key not-to-be-missed highlights of Intertraffic Amsterdam...

Intelligent sensors

Sensor devices for road weather information systems (RWIS) and traffic monitoring

Lufft is a developer and supplier of a wide variety of digital weather information sensors that are integrated into traffic control and weather alert systems on highways, country roads, urban streets, runways and along rails. Lufft sensors deliver information about safety-relevant traffic weather parameters, including friction, water, snow or ice depths, visibility, precipitation and temperatures.

In 2017, Lufft launched four new products for road, rail and runway weather information systems. These include a 20km (12.4-mile) range visibility sensor, a spectroscopic pavement sensor, a laser-based snow depth sensor and a maintenance-free radar disdrometer.

Visit
Lufft
STAND 12.532

Certified scales

Visit Haenni Instruments' stand for proven, robust equipment used for vehicle weight enforcement

Visit
Haenni Instruments
STAND 10.516

Leading mobile wheel load scales supplier Haenni Instruments aims to provide the best possible solution for mobile weight enforcement. Unique and patented measurement systems give Haenni's wheel load scales unmatched accuracy, making them popular all over the world. OIML certified and known as the thinnest on the market, Haenni scales are light, robust and durable. The variety of types, sizes and ranges enables their use in different applications. Besides weight enforcement, they can also be found in private industry, universities, test laboratories and departments of transportation.

Distortion-proof camera

Tamron Europe presents its industry-first block camera for capturing moving vehicles

At Intertraffic Amsterdam, Tamron will celebrate the debut of a brand-new block camera module. Its image sensor has been specifically designed for traffic applications. Unlike the rolling shutter CMOS imagers used in most block cameras, the global shutter technology in this module ensures that images taken of fast-moving vehicles are not distorted – essential for automated imaging tasks such as license plate recognition. Furthermore, this sensor brings out details in the images, regardless of lighting levels. With its full-HD resolution, 30x zoom and rich configurable auto-control features, this camera module delivers unseen image quality for all kinds of intelligent transportation systems.

Visit
Tamron Europe
STAND 12.916

Energizing mobility

Visit the Dynniq stand to hear about the very latest in intelligent infrastructure and traffic systems

Dynniq is a dynamic, high-tech and innovative company offering integrated mobility, parking and energy solutions and services. Its mission is to enable people, data and goods to reach their destinations efficiently, sustainably and safely through advanced technology solutions. Dynniq provides technology solutions under its own name, but also uses the name Peek by Dynniq and its subsidiaries YSP and WPS. At Intertraffic Amsterdam, members of the Dynniq team will be showcasing the very latest in intelligent infrastructure and traffic systems, reliable and future-proof parking solutions, smart grids and smart metering technology.

Visit
Dynniq
STAND 08.524

Versatile technology

Infrared specialist Komoto delivers a variety of traffic management solutions

Komoto has been a provider of infrared (IR)-based traffic technology solutions for over 20 years. With domestic and foreign patents for many products including a high-speed IR strobe, ALPR cameras, digital video recorders and image processing equipment, its specialists are confident in regard to the quality, technological advancement and customer service they provide. Taiwan, Europe and North America, Japan and Southeast Asia are all areas where Komoto's technology has been deployed. While pursuing the continued growth of the business, Komoto has remained dedicated to the development of technology that limits its impact on the surrounding environment. Use of natural radiation and low-power consumption technology for its products and careful selection of materials has helped to establish the environmentally friendly credentials of the business.

Visit
Komoto
STAND 12.409

Stable, reliable signals

Independent manufacturer Spinnea aims to support society's growing mobility

Spinnea is an independent manufacturer of traffic lights. Its mission is to support the growing mobility of society and increase road users' safety with high-quality and eco-friendly products. Founded in Slovakia in 1994, Spinnea offers stable and reliable products for the lighting industry, as well as cooperating with individual clients in order to meet their specific needs.

Visit
Spinnea Traffic Lights
STAND 07.408

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AI maps

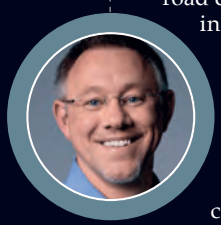
Maps are evolving from static, occasionally updated flat representations of the world, into depictions that are automatically built and updated in real time by sensors and software, to create rich, 3D worlds. **David Smith** takes a look at some of the new uses for such maps

Without innovative HD 3D maps, such as the ones recently introduced by Here Technologies, the autonomous car revolution would grind to a halt. Artificial intelligence needs the data from the maps to orient vehicles precisely enough to guarantee safety in complex, changing environments. Transport planners, too, could use the 3D maps to help design roads, update traffic infrastructure and improve the performance of roadside cameras. Meanwhile the greater detail in the 3D maps is improving the performance of ADAS functions.

Designing 3D maps is a radical departure for Here, which has been producing 2D standard definition (SD) digital maps for 30 years. SD maps were designed for human drivers to go from A to B and were simple to read. But in 2013 Here began to wrestle with the problem of how best to create accurate 3D representations for autonomous cars, in partnership with Mercedes, one of three members of the consortium that owns Here, along with Audi and BMW. The challenge was to produce a vastly more precise and detailed map using live data.

"The HD map and its derivative products can be used for road planning and traffic design," says Brian Lent, Here's CTO. "The precise detail and the real-time nature of the data will help planners. We are also providing consumers with a mobile app enabling them to report real-time road conditions with two taps. That information goes to our cloud and then gets sent back to drivers to give them a warning. We call it our Hyper Local Awareness Platform, an example of the use of real-time data that consumers can choose to

> The HD map, and its derivative products, can be used for road design and traffic planning. The precise detail and the real-time nature of the data will help planners
>
> **Brian Lent, chief technical officer, Here**



Detailed data enables a vehicle to precisely locate itself on the map

participate in. The data can also be sent back at the same time to the local transport authorities."

Lent also explains that the data they are collecting is relevant to connected vehicle services: "We get more efficient data for parking and traffic. We can do things at a higher definition than we have traditionally done with GPS probe data, because the data we are collecting from our automobile customers comes from a much richer sensor package array, which means it's generally more accurate. So we can improve the accuracy of a lot of the existing packages we have as part of the same update."

Triple layered

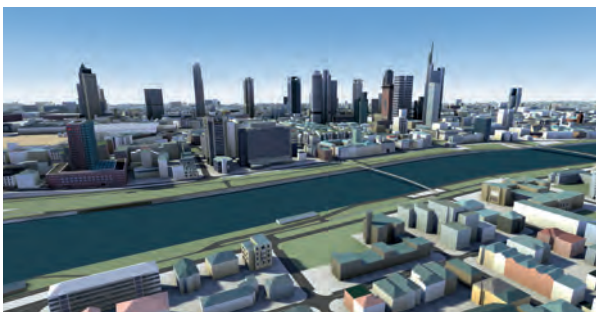
To achieve superior performance, HD Live Map is composed of three layers. The first is similar to an SD map. It provides a road map based on curves, elevation and coordinates. This layer allows the AI system to understand the topology of intersections and the basic attributes of the roads, including speeds. But it remains a generalized view, with nowhere near enough information for an autonomous vehicle.

With the addition of the second layer, Here was already getting much closer to its goal. The HD Lane Model provides live information that differentiates between lane types, such as shoulder, passing and express lanes, as well as lanes reserved for certain vehicles, such as HOVs and bikes. It sends data about the width and speeds of each lane, whether markers are striped or solid, and even their color. All the data is continually updated.

The final layer is the HD Localization Model, which allows the car to locate itself precisely on the map. "This layer provides information about traffic signs and infrastructure at the sides of the road. It also gets data about walls and guardrails, as well as polls and barriers, none of which exist in an SD map. With this added layer, a vehicle continually checks its orientation, which enables it to stay in its lane, stop in the right place at intersections, and make turns accurate to within 20cm [7.9in]," says Dietmar Rabel, Here's director of product management for autonomous driving.

Making the map

The data to build the HD Live Map is captured from two main sources. The first is the fleet of Here's True Cars, which drive around gathering 28TB of data every day. Each True Car features a 360° lidar system with rotating lasers that measure the world in 3D. There are six cameras beneath the lasers and a panoramic



camera above them. Additional sensors measure speed and orientation, as well as the incline of a street and the degree of a turn. This information is accurate down to centimeters.

The second source consists of crowd-sourced vehicle sensor data about paths, lanes and pavement marking. To date, 20 OEMs are helping Here gather the information. "As the saying goes, 'A rising tide floats all boats'," says Lent. "The more data we get from manufacturers, the better the quality of information. Our customers are finding ways in which more advanced vehicles, with more advanced sensors, can update the map as they go. Having up-to-date maps will become even more important as we move from level 2 to level 5 automation."

The HD 3D maps have broad applications beyond autonomous driving, including some for road transport agencies, which can receive precise data about traffic flows and accidents, or be alerted about sudden changes on the roads. "There are lots of scenarios a modern car can detect with its sensors. It could be useful for a DOT to know that a section of guardrail has been knocked down, a tree has fallen on a road, a dead animal is on the highway, or a fresh pothole has appeared," says Bernd Fastenrath, senior product manager at Here. "The cars can inform us and we can deliver that information, including the precise location, to highway maintenance companies."

Fastenrath says because the maps are so detailed, a city DOT could use them to spot bits of road infrastructure that require updating. "For example, a city that wants to make its environment more inclusive could use the highly precise map to know where it has pavements that are not wheelchair-friendly," he says.

Increasingly, camera-based sensors are also becoming adept at observing their environment. With roadside cameras, image-processing technology can be paired with HD mapping to help with lane-level vehicle counts. "You can get a more detailed understanding of traffic flow, or precise figures for people movements, such as pavement use by pedestrians, numbers using public

> The HD layer provides information about traffic signs and infrastructure at the sides of the road. It also gets data about walls and guardrails, as well as polls and barriers, none of which exist in an SD map
>
> **Dietmar Rabel, director of product management for autonomous driving, Here**

Left: **HD 3D mapping techniques create realistic models of cities from the ground up. Crowdsourcing and vehicle sensors are two important sources for the data needed to make these maps, which have to be updated as frequently as possible in order to remain useful**

HD maps without lidar #1

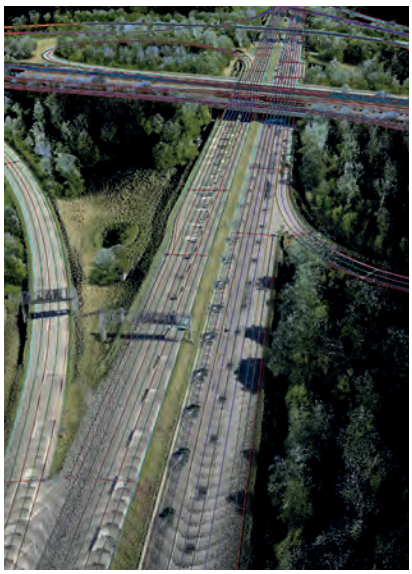
It's been almost impossible to think of live HD 3D maps without also thinking about lidar. A new startup is changing that

In July 2017 three former Tesla and iRobot engineers launched lvl5, a developer of crowdsourced HD 3D maps and computer vision software for self-driving vehicles. It has already secured US$2m in seed funding from investors.

The founders of lvl5 argue that lidar, while enabling cars to understand the world around them, has limitations, including an average price tag of US$80,000 and sub-par performance in inclement weather. With lvl5, there's no need for lidar. The system uses a combination of crowdsourced HD 3D maps and sub-US$15 consumer-grade cameras.

The company has been crowdsourcing mapping data using a dashcam app, Payver, allowing anyone to earn US$0.01-US$0.05 per mile driven. lvl5 is already working with Uber and Lyft drivers across the USA who run the dashcam app throughout the day. As cars drive around, they are vacuuming up data, such as 'a stop sign was just added to this intersection', which is then sent to a central hub.

lvl5 has also developed a computer-vision algorithm that translates the footage into HD maps that are accurate down to a 10cm threshold. In the three months leading up to its launch in July 2017, lvl5 claimed to have mapped 90% of all US highways using this crowdsourcing strategy, and will later build Payver's dashcam into vehicles. The company has existing pilots with major OEMs who will pay an initial fee to install the system into vehicles. Because HD maps must be continuously maintained, lvl5 will also charge a monthly subscription fee per vehicle.



HD maps without lidar #2

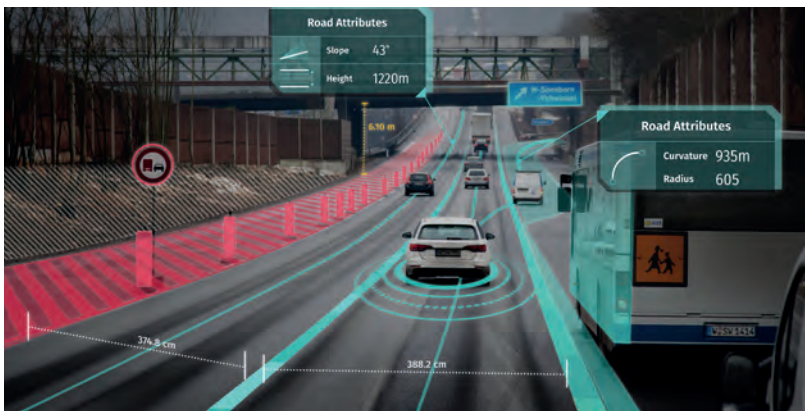
An alternative way to build HD maps without the need for lidar cameras is being developed by a startup from California

San Francisco-based startup Mapper emerged out of stealth mode on October 11, 2017, after a year spent developing 3D maps for autonomous cars and other applications. Mapper takes a different approach to Uber, General Motors and Google's Waymo, which all make their own detailed maps using vans equipped with expensive lidar technology. But Mapper doesn't believe lidar is essential.

Instead, it has created a small army of part-time workers to gather the data required to create a base map.

The company's engineers have designed a small plastic device called an S1 that contains high-definition cameras and sensors. It fits on a car's dashboard and gets power from the lighter socket. The S1 syncs to the driver's smartphone wirelessly. The Mapper app on the phone directs the driver to take a particular route. Data about the route is sent back to the company's server.

Mapper expects to need about 10,000 mappers to maintain its base map, which could then be licensed to auto makers and technology companies. Other customers might include DOTs looking for detailed coverage of their roadways, insurance companies looking for hazards, and augmented reality ventures.



transit stations, or cyclists using bike lanes," Fastenrath says.

Even with consumer-grade lidar, he adds, there are interesting potential applications. Some cars are equipped with lidar that could generate mini-maps for places such as indoor parking garages, where Here does not drive its capture vehicles. Another use for the data is to update Here's existing ADAS packages, such as cruise control, with more accurate information.

3D Slam

Here is not alone in innovating with 3D map technology for autonomous vehicles. Kudan, the UK-Japanese developer of computer vision, recently announced that its 3D SLAM (simultaneous localization and mapping) technology was ready for market. Kudan's real-time 3D tracking and mapping system provides computers with a form of vision. Unlike Here, Kudan does not provide AI computing, but teams up with hardware manufacturers.

"We offer tracking technology to generate 3D maps that help cars understand their position," says Daiu Ko, Kudan's COO of strategy and business development. "But to understand the meaning of the data, we team up with machine-learning companies. Kudan SLAM is the 'eye' and machine learning is the 'brain' and they need to be closely integrated."

Ko says that Kudan's SLAM is a highly versatile algorithm that is suitable for all hardware, including drones and robots. "Previous SLAM technologies have been mainly in-house products, such as Microsoft's HoloLens wearables. But we see the versatility of our product as crucial in selling the software. We're already working with a major Japanese automotive OEM that wants to develop its own camera and sensing system."

> We offer tracking technology to generate 3D maps that help cars understand their position. But to understand the meaning of the data, we team up with machine-learning companies
>
> **Daiu Ko, COO of strategy and business development, Kudan**

Top: **Here's lidar point cloud capture with HD Live Map overlay**

Above left: **The HD Live Map boasts lane-level accuracy**

Open for business

The brand-new Mersey Gateway Bridge, in northwest England, is the first crossing in the UK to be conceived and built as a free-flow tolling facility. **Jack Roper** meets some of the experts involved in its successful beginnings

Fireworks on opening night

One minute after midnight on October 14, 2017, the first vehicles rolled over the Mersey Gateway Bridge, a 1.3-mile (2.2km) cable-stayed structure, the centerpiece of an £1.86bn (US$2.46bn) infrastructure project undertaken by Halton Borough Council. The Mersey Gateway offers 5.9 miles (9.5km) of new road network, with interchanges, linking the towns of Runcorn and Widnes to form a new six-lane arterial route into Liverpool, some 11 miles (18km) distant. Lit in red and electric blue, its titanic, triple-masted 0.6-mile (1km) curve of riverspan is a breathtaking sight, and made possible through an innovation rare on UK roads: all-electronic, free-flow tolling.

> We're close to Liverpool Airport and people were leaving huge amounts of time in case of problems; either you'd get there very early or be stuck in traffic
>
> **Matthew Fearnhead, commercial and contracts manager, Mersey Gateway Crossings Board**

The Mersey Gateway's story begins some 56 years earlier and half a mile to the west, with the opening of another bridge. "The only way to cross the Mersey without a long detour – either to the Mersey Tunnels or the M6 Thelwell Viaduct – was over the Silver Jubilee Bridge, which was built in 1961," explains Matthew Fearnhead,

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Left: **The Mersey Gateway Bridge joins Runcorn and Widnes to form a new six-lane arterial route into Liverpool**

commercial and contracts manager at Mersey Gateway Crossings Board. "Built to serve 9,000 vehicles per day with one lane in each direction, it was reconfigured in 1977 with two lanes each way, but substandard-width lanes with vehicles in close proximity. If there's an incident, it quickly jams up."

This bridge has latterly carried up to 85,000 vehicles daily. "This caused a lot of congestion," says Fearnhead, "further exacerbated by incidents or accidents; sometimes you'd be stuck there for hours. We're close to Liverpool Airport and people were leaving huge amounts of time in case of problems; you'd get there very early or be stuck in traffic. We didn't have the network reliability or resilience to deal with it."

> "Everything in our systems from end to end is redundant. We allow for overlap so we can actually lose a lane-side camera and still have full coverage"
>
> **James Lee, UK support services and delivery manager, Merseyflow**

Thirteen years in the making

In 2004 Halton Borough Council approached the UK government for funding for a new bridge. "It said it wouldn't fund a completely new crossing," Fearnhead recalls, "and that the council should look to a tolled crossing for financing. The issues on the Silver Jubilee Bridge were getting worse. So it was a tolled bridge or no new bridge." Under a design-build-finance-operate (DBFO) contract, the consortium chosen by the council, operating as Merseylink, was responsible for sourcing finance, designing and constructing the bridge, and operating and maintaining it over a 30-year concession. For the 26.5-year remainder of that period, the council will repay £1.86bn (US$2.46bn) through a unitary charge, 80% of it from toll revenues collected for the council by a second contractual entity: Merseyflow.

Via a single pair of gantries on the bridge, Merseyflow operates state-of-the-art tolling with multiple technologies ensuring failsafe reliability. Registered customers display an RFID transponder. "They're sticker-type tags, which are less intrusive than DSRC for the end user," explains James Lee, UK support services and delivery manager for Merseyflow contractor Emovis. "This is one of the first times these have been used in Europe." Meanwhile, cameras linked to optical character recognition (OCR) software read the license plate (or VRM, vehicle registration mark), which can be cross-referenced with Driver and Vehicle Licensing Agency (DVLA) records to enable billing of unregistered vehicles. These license plate records are also tagged into RFID transactions, for dual-layer validation.

"Everything in our systems from end to end is redundant," Lee continues. "We allow for overlap so we can lose a lane-side camera and still have full coverage. It goes through the IT systems as well: we have multiple versions of the database running the system. If we have issues, we can migrate over and there's never any end-user impact. Everything – web servers, gantry controllers, tag reading, classification lasers – is redundant.

Photo: John O'Connell

6 critical road crossings

1 George Washington Bridge
New York City, USA

The GWB faces higher traffic volumes than any bridge on the planet...

First opened: 1931
Length: 4,760ft (1,450m)
Deck height: 212ft (65m)
Annual crossings: 103 million

6 critical road crossings

2 Golden Gate Bridge
San Francisco, USA

Arguably the most iconic bridge in America...

First opened: 1937
Length: 8,981ft (2,737m)
Deck height: 220ft (67m)
Annual crossings: 39 million

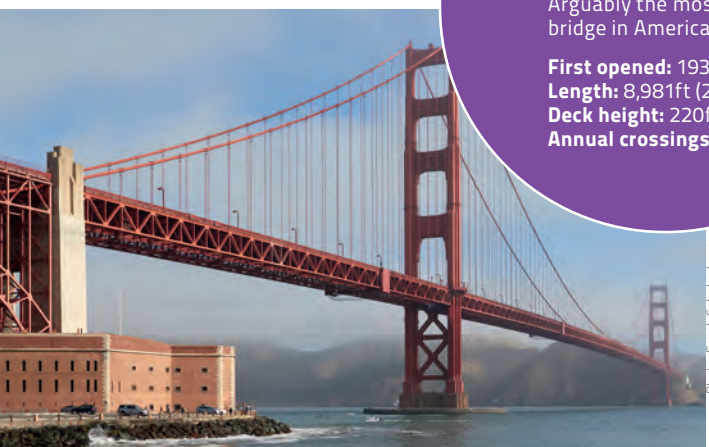
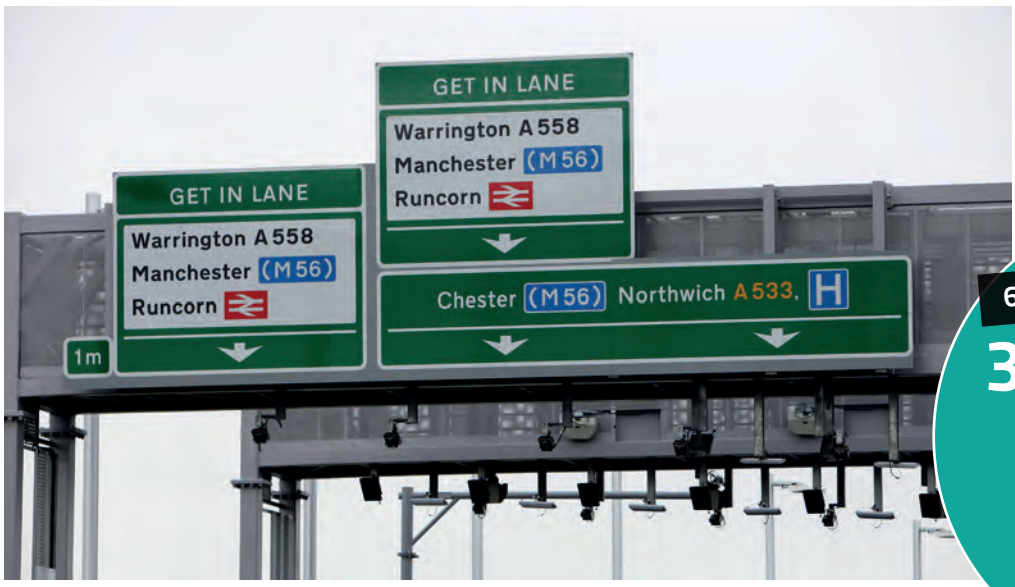


Photo: Frank Schulenburg



All-electronic, free-flow tolling is rare in the UK

With multiple redundancies, we can never have a single point of failure."

Besides the combination of RFID and OCR technologies, gantries have thermal imaging for external auditing. "We use thermal imaging to do what we call system ground-truthing," says Lee. "That's how we validate what's coming in from the roadside. If our normal processing says there are 100,000 vehicles in one day, we use our thermal imaging component to validate that, looking at the actual heat signatures from vehicles."

Flat-rate tolls are based on vehicle type, from £2 (US$2.60) per crossing for cars, up to £8 (US$10.60) for HGVs. But what would happen if an HGV driver tried to use an account linked to a lighter vehicle, evading the full toll? "We use classification lasers to detect the type of vehicle: its height, width, length and number of axles," says Lee. "If it says Class 2 on the tag register but roadside lasers identify an HGV, the system creates a class mismatch. There's also validation against the VRM and system account data. If there's a class mismatch, it goes through a manual image review to see if we're classing the vehicle correctly."

Charm offensive

The Mersey Gateway Project has enjoyed early success, with more than a million crossings made in the first two weeks of opening and traffic exceeding Halton Borough Council's conservative base-case estimates of traffic flow needed to cover costs. Yet toll facilities are uncommon in the UK and, with some daily commuters facing a new £1,000 (US$1,325) annual expense, public acceptance may not be universal. As an estimated 80% of traffic switches to the Mersey Gateway, the Silver Jubilee Bridge undergoes refurbishment and will reopen as a local crossing with pedestrian and cycle access – and will also be tolled. "We set tolls on the level needed to repay the council's debt over 26.5 years," says Matt Fearnhead. "Obviously people are used to not having to pay to cross the estuary, so it's a contentious issue."

> Halton residents can pay a 10-year subscription and get unlimited trips. This has been massively helpful from a project point of view
>
> **Matthew Fearnhead, commercial and contracts manager, Mersey Gateway Crossings Board**

Consequently, one dimension of Merseyflow's role is securing the trust of a potentially doubtful public. "We have a walk-in center in Runcorn; if end users are not technologically savvy, we can walk them through registration from start to finish," explains James Lee. "We have a heavy social media presence and place a lot of emphasis on acceptance. We started telephone registration early, helping people to register at their own pace and not face a big queue the week before the bridge opened." Because Council procurement came in under budget, the government has allowed savings to be plowed into a local-user discount scheme, securing crucial local support. "Halton residents can pay a 10-year subscription and get unlimited trips," says Fearnhead. "This has been massively helpful from a project point of view."

Mindful of public perceptions, Merseyflow subjected the system to

6 critical road crossings

3 Millau Viaduct
Tarn Valley, France

This marvel of engineering is the world's tallest bridge, based on structural height...

First opened: 2004
Length: 2,460ft (750m)
Deck height: 270ft (82m)
Annual crossings: 6.4 million

Photo: Stefan Krause, Germany

6 critical road crossings

4 Øresund Bridge
Copenhagen, Denmark – Malmö, Sweden

This sea bridge plunges into the Drogden Tunnel midway across the Øresund Strait...

First opened: 1999
Length: 7,845ft (2,392m)
Deck height: 57ft (187m)
Annual crossings: 35.6 million

Photo: Nick-D

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6 critical road crossings

5 Hangzhou Bay Bridge
Jiaxing-Zhejiang, China

This is the longest road sea bridge on Earth...

First opened: 2007
Length: 35,673ft (11,7037m)
Deck height: 203ft (62m)
Annual crossings: 18 million

Photo: Glabb

rigorous manual checks in the first days of operation. "When we initially went live at midnight, the system was prepared right up to that point," Lee explains. "From there, everything queues in the system. We'd feed in 100 queued transactions and follow each one manually through the whole system, making sure everything was correct and got posted to the right account."

"We were very conscious that we could start on the wrong foot and set that tone for the whole project," says Fearnhead of Mersey Gateway Crossings Board. "When some journeys didn't appear on accounts, there was a bit of publicity. But we were saying, 'We're checking the system. As it comes into effect and learns, it will become much quicker and more automated.' It was a decision to process things in a careful way over the first couple of weeks."

Future ready

Interoperability with other toll facilities is not an objective at present. Nonetheless, Merseyflow will be ready for a possible future when such toll-funded schemes in the UK proliferate and begin to interlink. "We've already installed the appropriate antennas to pick up, for example, the tags used in the Mersey Tunnels. We have that technical ability. If we ever wanted to go down the road of interoperability, the equipment is already there."

The Mersey's name means 'boundary river' and it once formed an estuarial border dividing the ancient kingdoms of Mercia and Northumberland. The first ferry was established by monks in medieval times, when perhaps a dawn crossing was bought through exchange of coin. Now it will be so again, although in different form, until the council's debt is fully repaid in 2044. And who knows how the UK may change before then? For now, commuters are feeling the benefits of improved journey times.

"Personally, it's saving me 15 minutes in the morning and 15 minutes on my commute home," says Fearnhead. "I'm getting half an hour a day back, basically." So far, Halton Borough Council and commuters would seem to broadly agree: it's money well spent.

Incentivizing incident management

Merseylink partners will be penalized if bridge journey times are not reliable – enter a dual-redundant journey time measurement system

The network reliability of the six-lane, 60mph (96km/h) Mersey Gateway is underwritten by a contract incentivizing its operator to clear incidents and keep lanes open. The operator, Merseylink, faces deductions from the charge paid by Halton Borough Council, based on journey times.

"Traffic-flow effectiveness and maintenance is monitored by a dual-redundant journey time measurement system [JTMS]," says Roger Higginson, senior manager, major projects, Dynniq UK and Ireland. "This consists of two independent measurement systems utilizing ALPR cameras at specified measurement points throughout the project."

As well as scheduling maintenance work in off-peak hours, Merseylink prevents stoppages by swiftly identifying and responding to incidents. "An above-ground remote traffic microwave sensor [RTMS] G4 system is used for detection of incidents and traffic speeds," he says. "When an incident is detected, the CCTV system is instructed to move the relevant cameras, highlighting the incident to the operator."

"All information from traffic control and information systems is connected back to servers in the Mersey Gateway Control Room," adds Hugh O'Connor, general manager and company representative at Merseylink. "Measurement systems include the RTMS-G4 detection system, pan-tilt-zoom CCTV coverage, JTMS and meteorological data. These are linked via a master control system, helping network managers ensure safe operation of the bridge and project road."

In emergencies, managers can implement pre-agreed signing plans on variable signage and fixed-text message signs, to communicate with drivers.

Bridge crossings can feel daunting to road users, but a combination of bridge design and continuous monitoring minimizes potential weather impacts on traffic. "Given that the Mersey Gateway Bridge runs for 1.3 miles (2.2km) at 82ft (25m) above the River Mersey, protecting vehicles from high winds is a key factor," says O'Connor. "The bridge design includes wind deflectors, so it can remain open in much higher winds than the existing Silver Jubilee Bridge. Meteorological stations measure the wind speed inside and outside the deflectors, highlighting their effectiveness and enabling operators to make informed decisions.

"The Mersey Gateway Bridge has been designed to the highest standards, with state-of-the-art technologies ensuring safe and efficient functioning of the structure," concludes O'Connor.

> All the information from various traffic control and information systems is connected back to servers in the Mersey Gateway Control Room
>
> **Hugh O'Connor, general manager, Merseylink**

6 critical road crossings

6 Mersey Gateway Bridge
Runcorn Gap, UK

This stunning new six-lane toll bridge spans the River Mersey...

First opened: 2017
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Deck height: 25m (82ft)
Predicted annual crossings: 26 million

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Remove winter hazards

Surface treatment and snowplows are the two traditional low-tech methods of improving safety on snow- and ice-bound highways, but in Colorado the integration of weather monitoring and variable speed limits is playing an increasingly important role, as **Saul Wordsworth** discovers

Glenwood Canyon occupies a 13.5-mile (22km) stretch of Colorado's I-70 just east of Glenwood Springs. Situated in a mountainous belt 6,000ft (1,830m) above sea level, the road and canyon corridor wend their way parallel to the Colorado river, making the road perilously prone to ice during the region's bitterly cold winters.

"Snow removal is extremely difficult along the canyon," says Mike Curtis, project engineer for Colorado Department of Transportation (CDOT) Region 3. "There are two lanes in each direction, but one section is elevated along a hillside and the other is close to the river. The only place snow can go is over the barriers, so we have to use high-speed plows with plow blades that will shoot the snow up over the edge. It tends to build up across both lanes in both directions, but the plows can only work a lane at a time. The surface regularly freezes over and is a serious hazard."

All this renders this particular stretch of asphalt one of the most treacherous in the state. In 2014 CDOT performed a safety assessment along the problematic 15-mile (24km) corridor. Using the previous five years' crash statistics it discovered that there were 744 reported accidents, 18% of which resulted in injuries and two of which were fatal.

21

The number of variable speed limit cameras to be installed along the 22-mile stretch of Glenwood Canyon, Colorado, classified as mountainous

Above: **A maintenance crew at an RWIS (road weather information system)**

Sixty five percent of these incidents occurred when a vehicle hit a fixed object, which in this case meant a concrete barrier or median guardrail. Seventy percent of all such incidents occurred during adverse weather. Accidents clearly peaked in the winter months. If the canyon has to close, alternate routes are four to five hours extra for anyone wishing to travel from Denver to Grand Junction.

"When we analyzed the results we realized that we needed the ability to vary the speed limit based on road conditions, accidents and any slowing traffic," says Curtis. "If drivers could be made aware of specific dangers associated with a combination of poor weather, tight bends and heavy traffic, we saw that a reduction in incidents could be possible. That's when the Glenwood Canyon project was born."

Bid for safety

Fast-forward to today and the construction bidding process is underway. The project will involve the installation of interconnected weather and road sensors by Vaisala, CCTV cameras by Apex and 21 variable speed limit (VSL) signs – 10 in one direction, 11 in the other – manufactured by Daktronic and Skyline. While there are similar projects in Wyoming and Utah featuring variable message signs (VMS) and VSLs, what makes Glenwood Canyon unique is the sheer density and depth of the technology. Having a variable speed limit sign every 1.3 miles (2km) is unheard of in this context, as are three weather stations for live condition monitoring, 73 new static signs and nine cameras, all contained within a 15-mile stretch.

> We realized that we needed the ability to vary the speed limit based on road conditions, accidents and any slowing traffic
>
> **Mike Curtis, project engineer, Colorado Department of Transportation**

Left: **A RWIS with Vaisala sensors installed in Snowmass Canyon on SH82 between Aspen and Glenwood Springs**

"Such a solution will lower the speed limit during inclement weather and help with incident management," says Curtis. "Ultimately the integrated weather monitoring with variable speed limits will provide drivers with warnings and generate a safer traffic flow to reduce accidents along the canyon."

The sensors

CDOT employs two kinds of sensors, both of which are manufactured by Vaisala. The first is a remote temperature sensor that works by measuring the infrared radiation emitted from the surface. This is particularly useful during the night when conventional, non-remote sensors can misread the temperature. Its ability to record air temperature and humidity with stable results even during busy periods makes it an important tool. The second – a surface state sensor – concentrates on the surface of the road, relaying the presence of water, spray, slush and – in particular – early signs of ice crystals in the form of snow or ice.

"The surface state sensor is able to measure the level of grip on the road's surface," says Curtis. "This helps determine what speed a vehicle may slide out at, and therefore what speed is safe. The maintenance people rely on the sensors, along with the weather forecast, to determine when to put magnesium chloride down."

Automation ahead?

Midway along Glenwood Canyon is the Hanging Lake Tunnel, an area that is especially susceptible to the impact of extreme weather. In the tunnel is a four-story building where many of the canyon traffic operatives work. They play a key part in an existing system where variable speed limits remain reliant on human input.

"Variable speed limits are still adjusted manually, albeit remotely, by an operator in the traffic control room," says Curtis. "CDOT uses software called the Colorado Transportation Management System (CTMS). It can talk to weather stations, VMS and ITS, but even with CTMS software, operators still receive a message and act on it. From a sensor detecting a change in the weather to an alteration in the VSL is only a matter of seconds."

Glenwood by numbers

Colorado's Glenwood Canyon on I-70 is an accident black spot – and bad weather is a major contributing factor

744
Number of accidents annually on Glenwood Canyon

18
Percentage of accidents that result in injuries

12
Percentage of accidents due to rear-end shunts

122
Average number of accidents that occur in December

71
Percentage of accidents due to fixed-object collisions

1
Percentage of accidents due to wild animals on the road

10
Average number of accidents that occur in May

Left: **VMS on the UK's smart motorways help to enforce variable speed limits and reduce jams**

14,000

Annual average daily traffic along Glenwood Canyon, Colorado

The English way

Use of VMS and variable speed limits on the UK's smart motorways reduces congestion by calming traffic and enabling all-lane running

Extreme weather may be less of an issue in the UK, but Highways England uses VMS to communicate variable speed limits and other traffic alerts, including advising drivers of conditions that they cannot see, both on the approach to and through poor weather. They also set speed limits for weather conditions that are visible to drivers except for known localized conditions, though they do set targeted messages in some conditions, for example fog.

VMS and variable speed limits are used mainly in the UK on 'smart motorways', which increase capacity, reduce congestion and improve journey time reliability by making the hard shoulder available as a traffic lane and using variable limits to smooth traffic flow. Large parts of the M1, M25 and M6 have this technology, with other motorways being upgraded.

"Technology is installed to monitor and manage traffic flow as well as enabling use of the hard shoulder, either permanently or at peak times," says Max Brown, Highways England's head of smart roads. "Smart motorways produce an optimized approach to upgrading our busiest sections of the network, provide 33% extra capacity on the strategic road network for 60% less cost than traditional road widening, and have proved to be as safe as conventional motorways."

The monitoring of routine traffic conditions is largely automated, with technology (either loops in the road or radars) determining whether it is busy or not and setting signs and signals accordingly. Where human intervention is required, staff override the system to set signs manually, for instance when an incident occurs. The teams keep a close eye on traffic conditions through a network of CCTV cameras, so can respond quickly to changing conditions.

"Highways England has recently updated the messages we display when we receive unconfirmed information about obstructions on our motorways," says Brown. "You will now see the text, 'Report of obstruction' or 'Report of pedestrian' and drivers should slow down and take extra care. We can also use the overhead VMS to close any lane by displaying a red X symbol."

> "Smart motorways produce an optimized approach to upgrading our busiest sections of the network"
>
> **Max Brown, head of smart roads, Highways England**

The issue of whether the Glenwood Canyon project can be automated is complex. Curtis believes it may prove difficult in the short term, primarily because of all the variables. He anticipates that for the most part Glenwood will be operator controlled. Operatives will monitor the CTMS alarm tab for alerts related to friction, traffic speeds, pavement conditions, visibility and precipitation for conditions that require a reduction in the speed limit. When an alert is received, they will visually confirm the conditions through CCTV where possible. Other sources of information include weather reports, radio reports, CSP dispatch or calls from CDOT maintenance personnel. The conditions will then be reported to a supervisor. The data will be reviewed and a change will be made to specific variable speed limits accordingly. However, Curtis states that the ultimate goal is automation.

"CDOT will run the Glenwood variable speed limits manually to begin with, using the existing CTMS corridor software," he says. "Doing so does have its own risks, of course, where personnel can make mistakes. Automation may be preferable but does come with a higher price tag and this may be too much for one region to handle. Therefore Colorado has two other ITS projects where these expenses could be shared. There is the Integrated Data Acquisition System (IDAS) project, where machine-learning and device health

Danger: falling rocks!

Steep slopes alongside roads bring with them the risk of rockfalls, but new technology is mitigating the risks

The western states of the USA are particularly prone to rockfalls. Along Glenwood Canyon in Colorado, the tops of the canyon walls are 2,000ft (600m) above the roadway. Protective fences purpose-built from submarine netting pepper the mountainside below, and new ones are erected each year, but it's not always enough.

When plummeting down the mountain, rocks the size of houses are capable of flattening almost anything in their path. Fatalities are rare, but they do occur.

In an attempt to mitigate such outcomes, CDOT came up with a solution. In Hanging Lake it installed a long-range radar unit to scan the north cliff face of Glenwood Canyon, and placed a series of sensitive movement sensors from Silent Solutions on rocks of concern. The sensors are monitored and data is recorded from a location three-quarters of a mile (1.2km) away, on the opposing face of the canyon. Data delivered from each of the devices, including live video from a long-range pan/tilt/zoom camera, is sent to a server in Denver.

If rock movement becomes significant, rockfall mitigation teams can be sent in to reduce the danger with controlled explosions. Less significant rockfall caught by the fences can trigger sensors tied to VMS to alert drivers on the road.

6

The percentage of accidents on the Glenwood Canyon stretch of I-70 that are due to collisions with large boulders

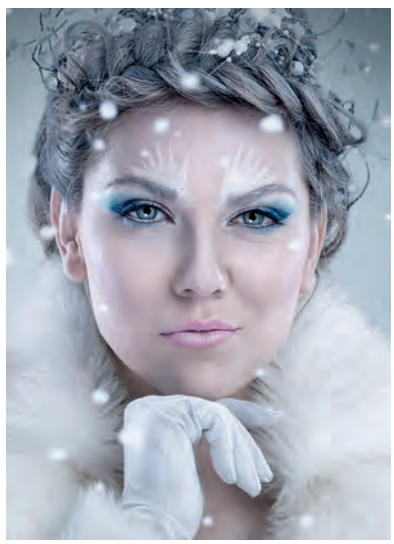
Above: **The western states of the USA are especially prone to rockfalls**

monitoring will occur, and which will lead to an integrated automated system with data gathering from all ITS devices. There is also the Colorado Region 1 smart workzone initiative, which will replace static signs with variable speed limits in workzone areas. There are many similarities between the projects, so as the projects mature, automation efforts could be teamed up."

Prevention

Rather than alerting drivers to problems or dealing with the fallout, is there not scope for addressing the issue at its origin? One of the original recommendations from CDOT's 2014 safety assessment was to install automated anti-icing systems. CDOT did just this with its roadside spray system known as FAST (fixed automated spray technology). But maintenance has been problematic.

"At the west exit of Hanging Lake Tunnel in Glenwood Canyon a de-icing system was installed, but is no longer in service," says Curtis. "Instead employees apply magnesium chloride using snowplow trucks."



It is not uncommon for mountain communities to boast heated driveways or even roadways. Notable examples include the Schweitzer mountain roads in the northwestern US state of Idaho, streets and sidewalks in Holland, Michigan, and even Microsoft co-founder Bill Gates's driveway. Could a similar technology prevent Glenwood Canyon's roads from freezing in the first place?

"The big issue would be the amount of energy that was required, the volume of water it would create and where it would all go," says Curtis. "For now at least salts and plowing are what we have to help improve safety, but in time variable speed limits should make a huge difference."

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Toyota to investigate how humans respond to connected and autonomous vehicle technologies

Toyota's Collaborative Safety Research Center (CSRC) has announced five research projects focused on better understanding how drivers use and respond to advanced vehicle technologies.

In partnership with five US research institutions, the projects will launch as part of CSRC Next, the Center's five-year program designed to facilitate a transition to future mobility concepts.

Emerging technologies, such as connected and autonomous vehicles (CAV), offer tremendous promise to help improve road safety, but important questions remain about the most beneficial interaction with drivers, and how they can be educated about safe CAV operation. Four of the five research projects will focus on societal acceptance and generate data-driven insights into the use of these technologies. The collected data can support their effective integration, foster safer driving behaviors, and offer potential countermeasures to risky driving behavior.

"The development of advanced vehicle technologies may be progressing faster than the ability of some people to appreciate their capabilities, and it's important to identify how drivers actually understand and use these emerging systems," said Chuck Gulash, CSRC's director. "Working with our partner institutions, and openly sharing our insights with the broader community, we believe that we can help to progress society's acceptance of these new and promising technologies."

46: Beat black spots
We visit Wyoming for an update on its Connected Vehicle Pilot, and discover how engineers are using satellites to solve problems with rural coverage and repositioning antenna to beat DSRC 'shadows'.

52: Smart lighting
In addition to illuminating the road for drivers and pedestrians, smart streetlights are increasingly being used to form the structural basis of traffic and infrastructure communication networks.

Communication black spots

As the USDOT Connected Vehicle Pilots near the end of their initial deployment stages, **James Gordon** gets an update from Wyoming, and discovers how experts there are attempting to solve problems around rural coverage and DSRC 'shadows'

With the second phase of the USDOT's Connected Vehicle Pilots in Wyoming, Tampa and New York at an advanced stage, it is a busy time for program managers and their teams. The deployment phase is due to end in April 2018.

In Wyoming, winter is when the effects of the new pilot are most keenly monitored. This location was chosen by the USDOT to particularly test the effectiveness of connected vehicle technology in reducing the impacts of inclement weather. Traffic, a high percentage of which is made up of trucks, often has to battle severe snow and ice on the state's I-80 corridor. It is hoped that, with V2X technology, such risks can be mitigated.

> Over the last year, we've successfully formalized all agreements and have finalized the system architecture
>
> **Vince Garcia, ITS program manager, WYDOT**

Vince Garcia is Wyoming Department of Transportation's (WYDOT) GIS/ITS program manager, and he is happy with the progress that his team is making. "Over the last year, we've successfully formalized all agreements and have finalized the system architecture," he says. "We have installed 10% of

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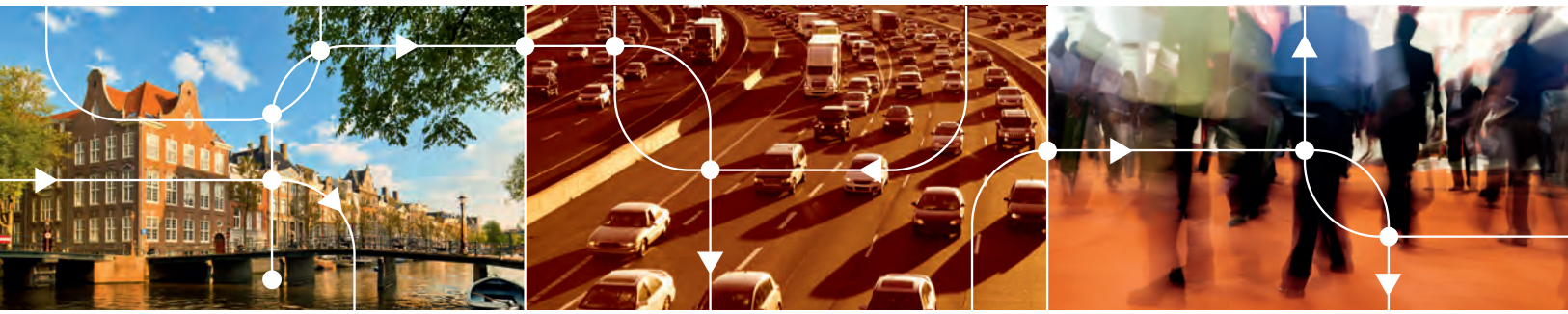

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the 75 roadside units, which can now broadcast and receive messages via dedicated short-range communication (DSRC) channels. We hope to install the remaining 65 units by spring 2018. As for onboard units, we have equipped 10 of 400 vehicles with onboard units, and plan to complete the deployment by August 2018."

With the technical infrastructure in place by spring 2018, Garcia confirmed that his 20-strong team will be carrying out "a rigorous and significant program of operational readiness testing through August 2018", which he says is necessary to show to the pilot's project partners that the CV program is "ready to seamlessly transition to the operational readiness demonstration phase".

"Our operational readiness testing will last until October 2019 and during this important phase we'll be carrying out acceptance tests weekly on the key applications, including – but not limited to – forward collision warning, distress notification, and V2I situational awareness, which will not only demonstrate the efficacy of the technology design, but also that the SAE and IEEE standards that we have embedded are robust and resilient enough to be fully rolled out on the I-80 corridor."

But the path to the third and final demonstration phase has not been easy. Garcia says that while his team has successfully negotiated many system architecture hurdles, some design challenges remain.

Rural coverage

Shedding further light on the technological barriers faced, and those that the team is still wrestling with, are Tony English, the WYDOT project's systems development lead, and Shane Zumpf, who oversees software development for the pilot.

Says English, "Our project differs from the other two in that it covers a 402-mile [650km] stretch of road. As we are deploying 75 roadside units (RSU), we realized that as each RSU has a range of approximately 300m [985ft], even if we placed them in the most strategic areas, the RSUs would only cover around 35% of I-80 in Wyoming. Therefore, we are using a satellite interface that enables us to relay traveler information messages (TIM) from our traffic management center in Cheyenne to connected trucks traveling on the I-80 corridor connected vehicles that are outside of the range of our RSUs."

And with bouts of inclement weather often creating treacherous

V2X cybersecurity

For all three Connected Vehicle Pilots, the security of the comms is of utmost importance

With the world near a connected vehicle revolution, the risk of cyberattacks grows. To reduce the probability of vehicles and their owners falling victim to cyberterrorism, all three pilots are integrating with the Proof of Concept Security Certificate Management Systems (SCMS), which use digital certification to ensure drivers receive valid BSMs and TIMs that have not been intercepted or manipulated by fraudulent actors.

HNTB's senior project manager, Steve Novosad, who works closely with the Tampa, Florida pilot, provides the following update: "The THEA [Tampa Hillsborough Expressway Authority] CV Pilot team is working toward obtaining the device certifications necessary to access the SCMS, in cooperation with the OmniAir Consortium. After receiving the certifications, the devices will be registered with the SMCS to obtain its root certificate and have the ability to receive certificates, which allows the vehicles to access the Tampa CV Pilot applications.

"That way, all connected vehicles and roadside equipment can trust others that have trusted certificates. Unlike the internet, the connected vehicle system included cybersecurity measures as one of its fundamental elements."

But what are the future challenges surrounding this security mechanism?

"We have made great progress with the SCMS integration, but there is a long way to go before it can be fully integrated into the system architecture," says Tony English, WYDOT's systems development lead. "For the WYDOT CV Pilot we plan to begin enrollment into the QA SCMS system in late December 2017 and into the proof of concept system at the end of Q1 2018 with certified devices. For overall security, we have found we need to use the SCMS for CV certificates and other certificate management systems for all other aspects of security."

> "We are using a satellite interface that enables us to relay traveler information messages to connected trucks outside of the range of our roadside units
>
> **Tony English, systems development lead, WYDOT Connected Vehicle Pilot**

Right: **Installing an OBU into a snowplow cab. It is planned that a total of 400 vehicles will be involved in the Wyoming pilot**

driving conditions, the team has been carrying out continuous system checks on the RSUs and antennas to ensure they can function in all weathers.

Says Zumpf, "All of our RSU devices are working through certification to 4.1 final specification, which means they will remain fully operable in temperatures from -30°C to 40°C [-22°F to 104°F]. We will carry out testing this winter to check that this is the case. We are also monitoring the effect that high winds, very common on vast tracts of the I-80 corridor in January and February, will have on the brackets and antennas."

Beating DSRC shadows

With 70% of the 400 vehicles involved in the pilot weighing over 38 tons, and some cabs pulling two trailers, one issue the team has worked hard on is to ensure that the technology is compatible with articulated goods vehicles, some of which can be up to 100ft (30m) long.

English explains, "At the beginning of the current phase, we discovered that large vehicles with tall and long trailers can create DSRC shadows, which if not tackled could mean that a trucker does not get a basic safety message [BSM], which is used by the onboard unit to create alerts for forward collision warning and other applications."

So how did WYDOT's engineers eliminate this problem?

Says English, "We are conducting a battery of real-world tests to determine the optimum position to install the antenna system so that long vehicles could receive full line-of-sight coverage for the majority of journeys. We feel we have a good solution for the snowplows with a high-mounted center antenna on the vehicle. We will begin testing with full-sized tractor trailers in the spring. We realize we will not solve this problem, but feel that by testing some combinations of a center high-mounted antennas and mirror-mounted antennas, we will find an acceptable solution."

> Tall and long trailers can create DSRC shadows, which if not tackled, could mean that a motorist does not get a basic safety message
>
> **Tony English, systems development lead, WYDOT Connected Vehicle Pilot**

Below right: **Road sensors have been fitted to snowplows in Wyoming. Data from these can be accessed by all connected vehicles using in-cab display units** (left and below)

Testing in NYC

There is potential for the NYCDOT Connected Vehicle Pilot to act as a proving ground for OEM technology

While the National Highway Traffic Safety Administration (NHTSA) and the Department of Transport have not made any final decision on the proposed rule-making concerning a V2V mandate, such a ruling could be a tipping point for the connected vehicle revolution, and, crucially, a landmark moment in framing a universal global Vision Zero strategy.

But, ahead of any such decision, the New York City Connected Vehicle Pilot Program could theoretically provide a key testing ground for V2V and V2I technologies. Will OEMs be able to make use of this real-world proving ground to test cutting-edge connected vehicle technology in the near future?

Dr Mohamad Talas, the NYCDOT project management lead says, "The RSUs will be able to receive any DSRC message from any standard in-vehicle device. If OEMs wish to test a vehicle, or their own RSU in the catchment area, they will be able to receive our information on their unit. The messages are standard, and so if they bring a vehicle into the testing grounds, they should be able to receive and interpret standard messages, too."

lighting the way

A new machine vision traffic monitoring system uses existing smart streetlight infrastructure to create an advanced, streamlined data network. **Michael Donlevy** finds out more

Smart streetlights are evolving rapidly. They're diversifying, too, in that they can be used for more than simply illuminating dark city thoroughfares. The concept of using smart lights to monitor traffic, track congestion and influence town planning has been in development for some time, but now it's starting to become a reality.

One high-profile example is the city of Spokane in Washington, which recently completed a Phase 1 pilot scheme using Echelon's InSight Cognitive Vision System to monitor its traffic levels.

The proof-of-concept deployment tested the ability of intelligent cameras fitted to streetlights to accurately count traffic on the city's streets, and the data was impressive.

"The pilot ran from April to June 2017 and covered one intersection – Regal Street and 44th Avenue – using two cameras and a SmartServer," says Adam Miles, associate traffic engineer at the City of Spokane Street Department. "Data was compared against conventional tube counts and stop-bar inductance loop counts to determine accuracy. Preliminary results showed Insight counts were consistent with the tube counts and significantly better than stop-bar counts during the daytime."

> "Insight's Power Line Carrier allows for monitoring along unsignalized corridors without the installation of a wireless mesh network
>
> **Adam Miles, associate traffic engineer, City of Spokane Street Department**

The streetlight-based system is easier to deploy and more versatile than conventional counters, and as

the system communicates over the lighting network, it can be deployed on any lamppost, not just those at junctions with traffic control boxes.

These things interest Spokane as the pilot broadens its reach. "We were encouraged by the results and we're installing a larger Phase 2 pilot along the Division Street corridor in our University District," Miles confirms. The plan, if Phase 2 is successful, will then be to roll out the system over a much wider area.

Seeing the light

Spokane is the first city to trial InSight, which is being marketed as an Industrial Internet of Things (IIoT) technology to support smart city applications. In technological terms, traffic data is collected and processed at the 'edge' of the network, instead of on a central server, to minimize bandwidth requirements. Echelon combines smart cameras with its own central management system – known as LumInsight.

This is more than simply about number crunching, too, because each unit analyzes video streams locally and makes decisions about how bright each individual light should be – so they can be brighter during peak hours and dimmer during off-peak hours. Intelligent control systems can therefore save energy by cutting CO_2 emissions, and in Spokane, Miles was impressed. "Energy-saving results were in line with the 30-35% savings projected prior to the pilot," he says.

The system can also send data to a central location for use by other city departments.

Echelon plans to eventually add more features to InSight, including vehicle classification, vehicle speed maps, traffic signal timing and parking intelligence. These systems can also potentially monitor road conditions, measure pollution and manage pedestrians – especially at stadia, parks and busy junctions – although these functions are still some way off.

"Interfacing with traffic signals has the potential for improved traffic flow, but it has a number of challenges including consideration of liability, compliance with existing products and standards, an entrenched intelligent transportation systems industry, and limitations imposed by jurisdictional boundaries," says Apurba Pradhan, senior director of product management at Echelon. "There's an entire industry dedicated to ITS and we're exploring ways in which we can work together. The base technology will ultimately be made available as a standard platform for integrators to create their own applications through a set of published APIs."

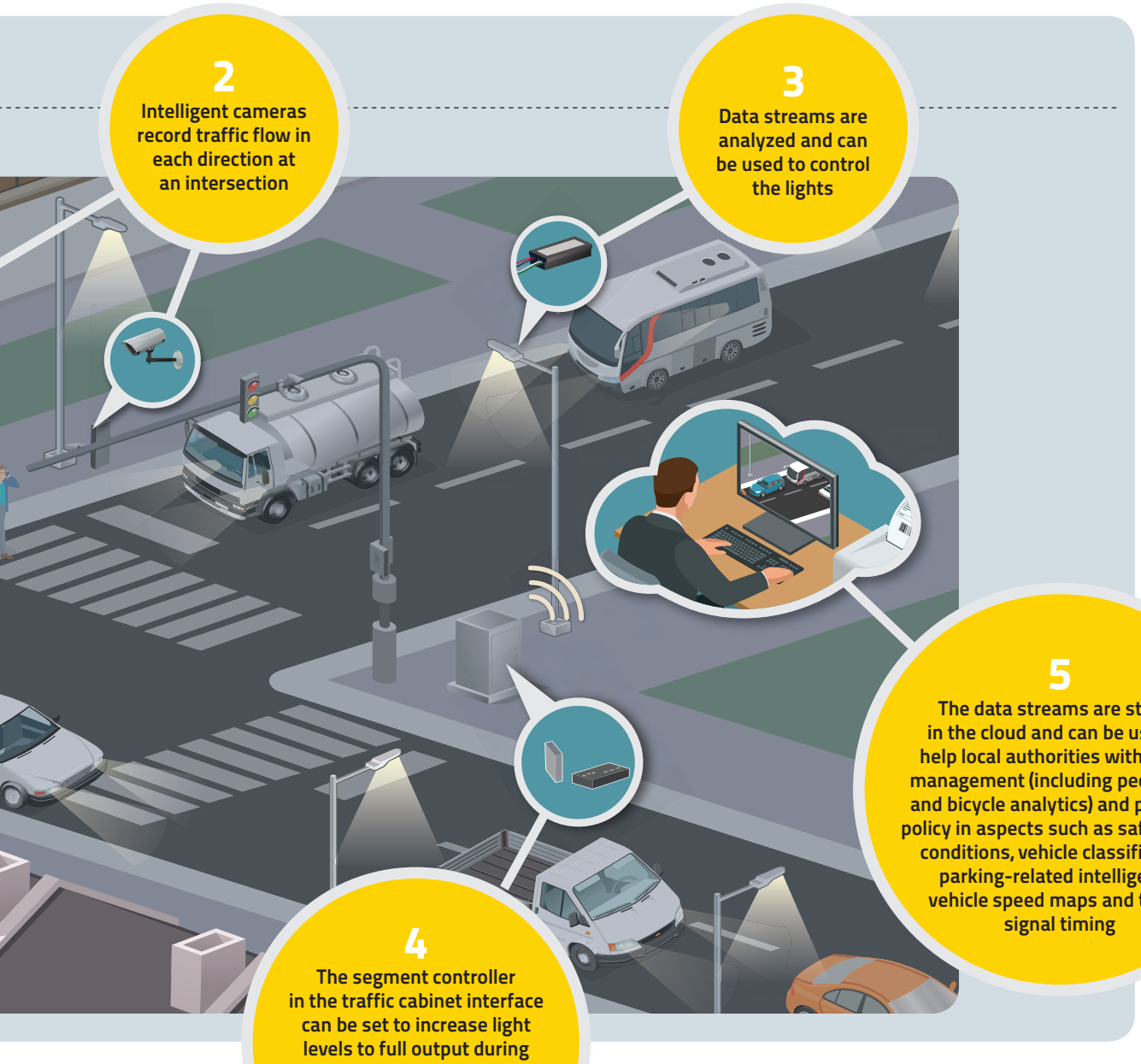
> We employ sophisticated learning algorithms that increase counting accuracy over time with more data
>
> **Apurba Pradhan, senior director of product management, Echelon**

"Live traffic information is a starting point," Miles agrees. "Eventually 24/7/365 traffic data by lane can lead to more detailed traffic analysis and planning. And Insight's Power Line Carrier enables monitoring along unsignalized corridors without installing a wireless mesh network."

It won't happen overnight, though. "As a pilot project, the city is still

Bright ideas

How the cognitive lighting system works



a long way from implementing any new plans," he adds. "Right now, we're more concerned with proving the concept and determining how this new technology and its capabilities may be integrated into a long-term approach to data gathering."

The road ahead

There will be challenges with any pilot project, and Spokane raised one issue that Echelon has had to address: "The prototype camera used for Insight failed after a few months because it still needed to undergo a 'ruggedization' process," says Miles. "Echelon has completed that process and a new camera will be tested in Phase 2."

"From a product perspective, the biggest challenge is convincing users that it's secure, reliable and accurate," says Pradhan. "We had to design the system to be redundant and failsafe. We had to ensure performance over a range of conditions, including rain and snow vibration. We employ sophisticated learning algorithms that increase counting accuracy over time with more data. Having a customer like Spokane, with clear goals, which is willing to test and provide feedback in a real-world setting, has been invaluable."

There are costs, however, says Dr Theo Tryfonas, reader in smart cities at the University of Bristol in the UK: "This technology does involve some significant computational overheads that require either more power at the edge or improved communications between the light and a collecting computer.

It all adds to the cost of the infrastructure eventually."

The next issue is the installation itself, in terms of supporting the traffic cameras and monitoring workflow through the provider's management software. In the future, the systems will be installed by traffic and lighting maintenance crews rather than the provider's own engineers, so it's vital the system is straightforward to install, operate and maintain.

It's also the product's unique properties that make establishing it a challenge. "This is innovative technology," says Pradhan. "We know of no city-wide deployment of traffic-counting systems using the lighting network for data backhaul or adaptive lighting. There have been some pilots using various technologies, but the challenge has been achieving a cost-effective and reliable network with peer-to-peer communication capability to pull this off on a large scale."

"Resilient hardware is a challenge, given that operational conditions may feature the likes of dust, rain and wind," says Tryfonas. "Maintaining sensors is another issue, as they degrade over time."

And that is another factor – time. "Public procurement is usually a slow process, for good reasons," Tryfonas adds. "The capital costs of smart systems are potentially higher up-front and the value of what a smart light adds to a city's operations is still under discussion, as there are more testbeds than real deployments. Using infrastructure that goes hand-in-hand with potentially opening up data to the public is always challenging politically as well – even for 'benign' environmental data. For example, the levels of traffic or air pollution may indicate the failure of measures put in place by local or national governments, so some authorities may be cautious not to open such cans of worms."

Matters of security

As with so much new technology, another challenge is security, which is particularly prescient in this case because so many cities now store vast amounts of data in the cloud. As an example, last year security expert Denis Legezo, from Russian anti-virus developer Kaspersky, successfully manipulated traffic lights in Moscow simply by finding their instruction manuals online and following their directions.

"If you succeed in identifying the model of a road sensor, you can find various documentation on the vendor's site (or that of their integrator), and, if you are lucky enough, you will also find the software used for working with the devices," he wrote in his report.

> Our focus now is on how we can leverage technology to add use cases to existing infrastructure – in this case, vehicle detection systems throughout the traffic signal network
>
> **Adam Miles, associate traffic engineer, City of Spokane Street Department**

"Spokane prefers hardline networks due to security risks," says Miles. "Our focus now is on how we can leverage technology to add use cases to existing infrastructure – in this case, vehicle detection systems throughout the traffic signal network and the hardline wire network to each streetlight."

"Cybersecurity is becoming more and more of a focus for IoT systems," Pradhan adds. "We have to manage security at multiple levels, starting from device to gateway to cloud software security. We use proven standards for encryption and authentication to ensure a secure network."

"Given the adoption rate, a serious incident isn't a remote possibility, but it is still unlikely," says Tryfonas. "Cybersecurity will – or should – become a key concern in the mid-term. It's difficult to imagine a direct threat to life from such systems, as opposed to future electrical distribution systems or smart traffic lights, but the compromise of personal data could be an issue. That will depend on the capabilities of each streetlight, which could vary from being recorded on camera, to wi-fi connectivity to the lamppost, to more advanced functionalities yet to be imagined…"

Lights, cameras, inaction?

Why it may be some time before European streetlights are gathering traffic data

Smart LED streetlighting projects are gaining popularity around Europe where the vast majority of lighting infrastructure is aging. New lights save authorities large amounts of money, thanks to the lower overall energy consumption of LEDs and the fact that they can be easily dimmed. A few percentage points less light can be unnoticeable to the human eye – but very noticeable when the lower bill comes in.

So, how about now harnessing these systems for wider traffic monitoring in Europe? Dr Theo Tryfonas at the University of Bristol, sounds a note of caution: "In terms of collating traffic data, smart lights aren't being trialled to the extent they could be," he says. "But this isn't necessarily a bad thing as a lot of regulation and compliance issues have to be resolved before widespread deployment can happen. Including those surrounding personal data, if faces are visible in the video. And as there are no real standards set yet, it's early days in that sense."

Using deep learning to 3D map Japan

Like anywhere else, autonomous driving is one of the fastest growing areas of technology in Japan. This is especially true now, so that self-driving vehicles will be ready for the Tokyo Olympic Games in 2020. The implementation is to start in metropolitan areas, with high-precision maps of city highways. Then high-precision maps of streets outside metropolitan areas will follow, to provide supporting transportation for Japan's growing senior population.

However, expanding coverage of high-precision 3D maps is not a simple task. The enormous amount of data gathered by specialized survey vehicles is one of the reasons. One survey vehicle can easily accumulate a few TBs of data in one day and it's not getting any smaller due to the improvements of the sensors the vehicles carry.

Image: Zenrin Co., Ltd

High road density

Japan is densely covered with roads and features that need to be included in high-precision maps. According to a 2017 white paper on traffic safety published by the Japanese government's Cabinet Office, the total length of roads in Japan is 1,220,724km (758,523 miles), with 208,000 traffic signals and 9,790,000 signposts. In an ideal world, all of it could be mapped automatically, but actual roads are highly complex and have many exceptions that cannot be processed accurately by a simple algorithm. We still encounter many instances that have to be manually processed off-line.

On the other hand, deep learning, a new area of machine learning, has helped image recognition performance tremendously in recent years. Many autonomous vehicles already use deep learning to detect road objects from camera images. This technology is also expected to improve efficiency when applied to production of high-precision 3D maps.

Need to know

The challenges of 3D mapping in Japan

- One survey vehicle can easily collect a few TBs of data in a single day
- The total length of roads in Japan is 758,523 miles
- There are 208,000 traffic signals and 9,790,000 signposts in the country
- Due to road variations, fully automating the production of maps is challenging

Loaded with data

In general, high-precision 3D maps are loaded with data such as the geometry and location of road signs, traffic signals, lane markings and road edges, along with 3D dimensions. All must have sub-meter precision. The data is usually extracted from 2D camera images and fused with 3D point cloud data. Road element extraction from 2D camera images is the key to accelerating the mapping process, and using computer vision for this task has always been on the mind of map makers. However, one of the issues Japanese map makers need to solve is that general algorithms, such as pattern matching, need to be highly customized to process Japanese road information. For example, road signs in the USA are rectangular with text information, while those in Japan are round with graphical information, and there are many variations.

Deep learning may produce a major change because the deep neural network architecture that mimics the human brain can learn the best feature values for extracting the road elements from data. This means road signs of different countries, including Japan, could be detected with high accuracy just by feeding the neural network with road sign images from each country. To achieve high

Left: **A survey vehicle collecting data for mapping in Japan**

precision, the deep neural network will require enormous amounts of data to learn, but thankfully we, the mapmakers, already have a huge database of road images.

Japanese mapmakers have great expectations for the future of deep learning. Seeing the rapid advances in the research and development of deep learning gives us hope for the full automation of complex road scenes in the future. ○

Richard Butter

Inventing new technology is sometimes easier than getting people to use it

"We will never solve the issue of congestion if we don't change our mindset first"

It is wintertime. You open the curtains and see rain pouring down. As a commuter you know what this means: congestion, big time. Nevertheless you jump into your car and do what most commuters do in this situation: you drive a little and then end up staring at the back of a long line of traffic.

Why, when we know there is congestion on our roads, do we feel pressure to get into our cars instead of staying at home? Especially in this age where we are connected everywhere – and certainly at home. Why don't we start our working day at home, make a few calls, do our email and reschedule a meeting? The answer, I think, is our old-fashioned office mentality. We feel that we should be at the office to avoid having our colleagues think that we aren't working. But in this era of connectivity, it is complete nonsense to feel that way. We must trust each other – but that is another discussion in itself.

We will never solve the issue of traffic congestion if we don't change our mindsets first. So are there any other parts of our current thinking that could be holding us back from realizing the true potential of our roads?

I believe another potential barrier is our generation's inability to completely adopt new technologies. For example, I drive a Mitsubishi Outlander that has several autonomous features, such as adaptive cruise control and lane departure assistance. However, the first thing I do each morning is disconnect the lane departure assistance because of the annoying sound it makes when the vehicle crosses road markings. It feels more like an obstacle than a supportive feature and that has something to do with my generation – we were not raised on connectivity and iPads.

In that respect, I heard an interesting story from a friend who did a nice experiment. He is responsible for a startup that deals with multimodality service cards and he drives the latest 'autonomous' Audi with more than 100 driver assistance features. He took his son, who just got his driving license, on a 200km (125-mile) roundtrip to see his grandmother in the northern part of the Netherlands. On the way there they drove with all features on, and on the way back drove with them all off – the 'old fashioned way', so to say. Interestingly, his son didn't feel comfortable driving with all the features off.

It is safe to say that the new generation Z, born between 1995 and 2012, is ready for autonomous driving and their mindset is different from ours. This generation is growing up in a highly sophisticated media and computer environment. They are more internet savvy and expert than we (generations X and Y) will ever be.

The new generation will be completely ready for autonomous driving, even if our generation won't. And in the years to come, congestion will disappear 'as snow for the sun' (a Dutch saying).

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

Implementing a new weigh-in-motion standard

Road authorities, toll road concessionaires and enforcement agencies keep control on overloaded trucks by using different static and dynamic weighing systems. What systems and technologies are used for enforcement depend on the national legislation, requirements, road and environmental conditions.

For example, the Netherlands uses high-speed weigh-in-motion (WIM) pre-selection systems in combination with static weighing systems, Brazil uses high-speed pre-selection with low-speed WIM at weigh stations, and Australia employs onboard weighing systems in its Intelligent Access Program.

For several years there have been three international standards on WIM: COST-323 European WIM Specification; ASTM-E1318: the American Specification for Highway WIM Systems; and OIML-R134 recommendation for automatic instruments for weighing road vehicles in motion. All three specifications have been used over the past years to determine the performance of WIM systems globally. Each document has its specific advantages and applications. However, none of the three specifications apply to the use of WIM systems for direct enforcement under regular (high-speed) highway conditions. For years, there has been a need from the WIM industry for a full international standard for WIM systems.

Manufacturers and governments have expressed the need for a simple standard, covering systems for WIM enforcement

A purpose-built system

NMi is a designated authority for the certification of police measuring instruments, such as speed meters, evidential breath analyzers and dynamic weighing systems. In 2016, NMi took the initiative to bring together a selected group of experts to develop a practical WIM standard, independent of technologies and road conditions. This new NMi WIM standard contains system performance specifications, test procedures and recommendations on site selection, calibration and example test plans. Any buyer or vendor of WIM systems, road authority, national metrology institute, or bureau for weights and measures, may use the standard as a basis for national approval.

The standard applies to fixed and portable WIM systems installed on, in or under the road infrastructure, including both roads and bridges, independent of which type of measuring technology is used. It applies to high-speed WIM systems operated under free-flow traffic conditions and may also be used for low-speed WIM systems since they operate in a more controlled measurement environment. Further vehicle dynamics are more restricted.

The standard is developed in a way that manufacturers and involved authorities have guidance and requirements to test, verify and certify the WIM systems. The standard distinguishes three levels of tests that are generally used for measuring instruments for legal purposes: type approval, initial verification and in-service verification. This one-time testing approach provides maximum confidence to the buyer/user on the performance of the WIM system, yet results in minimum costs for the vendor for the test procedures. The new standard combines both laboratory testing and road testing. An approved metrology institute performs laboratory testing. Road testing (i.e. verification) is to be performed by a local metrology service where the system is installed.

The implementation of WIM systems for direct enforcement consists of three elements: legal acceptance, system certification and data quality control. All three elements are essential to certify the system for legal purposes and to remain valid during its verification period.

The legal acceptance involves the adaptation of national legislation in order to use the WIM measurements as legal evidence for overloading and acceptance by a national court. An end user or national metrology authority generally initiates this phase.

Need to know

The UNI 10772 key facts

- The Italian standard for video image processing of all ALPR identification systems
- Unique in European requirements, it has been in place since 1998, with an updated edition introduced in 2016
- The standard now requires specified tests to be performed at a range of speed and lighting conditions

The system certification involves the testing and approval based on an (inter-) national standard. System certificates are issued by NMi or the national metrology authority in the country where the system is installed. This phase is typically initiated by the manufacturer of WIM systems or by the end user.

Data quality control involves maintenance, calibration and data quality checks to assure the systems continue to operate within specifications. This phase is generally developed by the manufacturer and independent experts, in cooperation with the end user, under a quality system approved in the country where the system is installed.

The standard has already been translated into Spanish for Argentinian legislation. More countries are translating their legislation, which has a positive impact on the global acceptance of NMi certificates. The manufacturer, together with local authorities, can arrange this system validation.

First year report on an ALPR standard

April 2016 saw Italy introduce a new edition of UNI 10772, the ALPR standard. A year after its implementation, here are some reflections on its impact.

The first impression is that quality requirements for the equipment are stricter, because these requirements force manufacturers to use advanced technical solutions. Since the standard is relatively new, some interpretations are under discussion and a couple of issues have been raised. One of these is the distinction of the ALPR homologation with the motion detection (or free run) technique used by the cameras. The target for the UNI 10772 is to certify the capability of character recognition. An EUT (Equipment Under Test) that works using motion detection will need to be verified and NMi has completed the setup of an appropriate location for this.

The other topic is testing at high speed. In the standard, there are three base speeds (26, 50 and 70km/h) that have to be tested in the laboratory. If the EUT is tested at higher speeds, the test could also be executed outside the laboratory using, for example, an automotive circuit. NMi laboratory is ready to test up to 230km/h. This has been chosen because it is the top speed requirement for homologation of speed meters under Italy's new decree.

Further development of UNI 10772 standard is foreseen since it is considered more and more as a base or part of other European ALPR legislations. The aim of the process is to create a European ALPR standard, utilizing the experience and knowledge of the UNI 10772 application.

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Reducing emissions in the city

Air quality is a growing source of concern for both the general public and those tasked with tackling it. Vehicle emissions are a major contributor to this problem, particularly in city centers.

"In the pursuit of improved air quality, structurally banning polluting traffic from the city center and positioning expensive measuring instruments to continuously measure the air quality are unnecessary measures," says Cees de Wijs, CEO of Dynniq. "Governments should make more use of available data to decrease emissions from traffic to supply cleaner air."

Dynniq has developed the Virtual Emissions Monitor (VEM), to help reduce these vehicle emissions and their environmental impact.

Need to know

Key elements of Dynniq's Virtual Emissions Monitor (VEM) technology

- The VEM can calculate localized emissions in real time without the need for extra on-street hardware
- It instantaneously combines data on speed, flow and vehicle mix
- Adaptors allow the taking in of data from SCOOT, Google and Bluetooth/ALPR systems
- A project in Manchester, UK, reduced NO_x emissions by 9-13%

Data-driven approach

The VEM provides an effective, data-driven approach to calculating localized emissions from road transport in real time, without the need for additional on-street equipment.

Traditionally, air quality is measured using expensive on street equipment, supplemented by highly aggregated models that simulate the dispersion and breakdown of pollutants from sources including traffic and industrial sites. While ideal for understanding long-term trends across an area, this approach cannot use the detailed real-time traffic data that is increasingly available, and therefore cannot reflect changes in traffic speed or volume due to changes in signal timings, variable speed limits and so on.

The VEM instantaneously combines data on speed, flow and vehicle mix, to estimate emissions in real time. The resulting emissions data can be as spatially and temporally detailed as the traffic data itself. This approach is not intended to replace traditional air quality modeling but to provide a complementary tool that allows air quality to be targeted by authorities as part of their day-to-day operations. The outputs can be integrated into other platforms or used as a standalone system with the web-based interactive dashboard.

Dynniq has recently undertaken a development program to prove its Virtual Emissions technology in Europe. The technology, which is establishing itself in various UK cities, is also gaining traction as an innovative approach to the emissions problem across Europe.

Live demonstrations

Dynniq has live demonstration systems using the Highways England MIDAS (Motorway Incident Detection and Automatic Signalling) network in the UK and the 16,000 traffic detection points in the Dutch National Data Warehouse. It also has adaptors allowing data to be taken in from SCOOT (Split Cycle Offset Optimisation Technique), Google and Bluetooth/ALPR journey time systems, making the system equally suited to urban and inter-urban networks.

Improving air quality

Dynniq is actively exploring how the VEM can be used to drive decision making and improve air quality. The UK's Department for Transport funded the AQUARIA (Air Quality Urban Analysis of Real-time Information and Actuation) project that took place on a traffic corridor in Manchester in early 2016. Transport for Greater Manchester used the VEM to identify modifications to traffic signal timings to produce a targeted traffic control plan that aimed to avoid or shorten NO_x concentration exceedance, by delivering term-time NO_x levels similar to those recorded during school holiday periods. As a result, emissions fell by between 9% and 13%.

Proof of concept trial

The VEM, which gives operators real-time, spatial detailed insight into emissions on their network, has already been trialled as a proof of concept and is a key component in a number of ongoing projects. Keen to work with clients to explore the new operational possibilities that this enables, Dynniq wants to expand air quality management from something that happens offline, through planning and strategy to something that is part of everyday business as usual – just like dealing with incidents and congestion.

In addition, the company is working behind the scenes to make the system more scalable, to support multiple users and higher volume big data. This is

Dynniq develops advanced technology solutions that can make transportation safer and more efficient

something Dynniq would like to trial with a customer responsible for a large, highly instrumented network. It is looking to develop and trial integration of the VEM with its existing ImCity platform and with its cooperative and connected technologies.

Further enhancements

Dynniq is also making the VEM available as a web service through the UK government G-Cloud framework. The aim is to incorporate more established emissions predicting technologies, including PHEM (Passenger Car and Heavy Duty Emission Model) to improve the accuracy in a wider range of environments.

by **J J Eden**

Electric vehicles are better than ever – and are here to stay

Autonomous vehicles (AVs) will certainly be a disruptive technology and they may have significant influences on today's transportation systems. But experts wonder: will the current rapid pace of AV development and deployment continue? Will government set standards, and impose restrictions, and will any new government interaction with the technology slow its deployment? Will this impact other related technological advances?

Those related technological advances include 'clean vehicles', or alternatively-fueled vehicles. These electric, hydrogen and hybrid propulsion technologies have not only caught the eye of the consumer, but also continue to crush opponents' objections through innovation and implementation.

Only a few years ago, it was feared that in-vehicle battery technology would only last five years, battery replacements would cost tens of thousands of dollars, and electric vehicles (EVs) could not meet public demands for performance, safety or range.

Wrong. The hybrid Prius was the first to disprove the battery lifespan and replacement cost theory. Performance? The *Motor Trend* annual World's Greatest Drag Race left the other concerns in the dust: it was amazing to even see an all-electric four-door sedan entered in a race against some of the top muscle cars in the world! Low centers of gravity, thanks to all those batteries located under the vehicle floor, also help some aspects of vehicle handling and safety. The effectiveness of impact crush zones are enhanced without a large internal combustion engine in the way. At the same time, ranges have increased for daily commuters to over 300 miles (482km) between charges.

As the public invests more in clean vehicles, the demand for vehicle charging stations will increase. Several private companies and many municipalities have installed both paid and free chargers for EVs. Tesla alone has installed thousands of superchargers that enable full charging of a battery, from empty, in around 45 minutes. This opens longer-range trips for drivers willing to take an occasional break while their vehicle charges – if they are Tesla drivers. Current chargers aren't universally compatible, though: a Nissan Leaf cannot charge at a Tesla supercharger.

Are EVs part of the transportation technology revolution? Will there be a common charging platform? Can the current electric grid support the installation of multi-bay EV charging stations?

"Almost all vehicle manufacturers will be delivering electric vehicles by 2020"

Do we care, or do we as infrastructure managers just need to make sure the market – and highway real estate – is open to multiple standards and entrants? Almost all vehicle manufacturers will be delivering EVs by 2020, fueled either from plug-in sources or by hydrogen generators. How will this mix of vehicles be incorporated into our existing infrastructure? Will EVs be discounted in high-occupancy tolling (HOT) lanes? Will the public demand chargers along our highways? There are many adjustments that will need to be made for both AVs and EVs.

Five years ago, few people saw EVs as even a small part of our mobility infrastructure. Yes there are operational and technical problems to work out, but public demand is only going to expand this market. For readers that doubt the readiness of this technology, I recommend that you take a test drive. These vehicles are here to stay.

J J Eden is director of tolling at Aecom
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Safely guiding drivers along roads at night

The risk of an accident on an unlit road at night is much higher than during the day. Since at night the number and quality of visual cues accessible to a driver are limited, the guiding role is taken by horizontal road markings, which must be retroreflective to be visible. Retroreflectivity (R_L) of horizontal road markings is crucial to improving road safety, which was recently proved by statistical analysis. An up to 23% drop in night-time accidents between intersections was correlated with increasing R_L of horizontal markings by 100 mcd/m²/lx.

Increasing retroreflectivity of road markings has cut night-time accidents by 23%

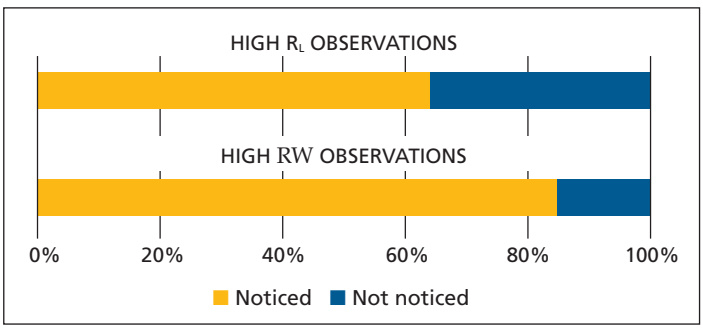
Glass beads performance

Typically, R_L is achieved with drop-on glass beads embedded in the paint layer. Standard glass beads provide markings with R_L of approximately 350 mcd/m²/lx but only marginal retroreflectivity (RW) under wet conditions. A modern advanced solution is the use of SolidPlus high-performance glass beads from Swarco. SolidPlus is a specially developed glass composition that provides extraordinary robustness, R_L up to 1,000 mcd/m²/lx, as well as high RW. These glass beads are suitable as drop-on material in any road marking system and also provide quite high R_L when used in yellow paint.

Instrumental measurements confirm high R_L and RW with SolidPlus. For a field test, a premium thin-layer road marking system comprising the high-performance waterborne paint Limboroute W15 (Swarco Limburger Lackfabrik, Diez, Germany), reflectorized with drop-on glass beads SolidPlus (M. Swarovski; Amstetten, Austria) was applied on a 2km test stretch of National Road 28 in Poland. Results demonstrated that with the premium system R_L and RW were significantly higher than the standard system.

In addition to these measurements, drivers' experience was studied via questionnaires. Among 156 valid responses, 64% of drivers reported noticing increased R_L of the horizontal markings with the premium system. R_L was most frequently observed by people who traveled there often. Such observations confirms research that people who know a road and drive on it regularly are more likely to drive without much awareness, but are likely to notice new safety features.

Right: **Retroreflection is more obvious in wet conditions for 85% of drivers**



Under wet conditions

High retroreflection in wet conditions was more prominent and was observed by 85% of drivers. This large number of positive observations of RW can be explained by a greater relative difference in visibility. Studies have shown that the minimum acceptable R_L is 70-100 mcd/m²/lx and under wet conditions only SolidPlus provided it. The results are shown in the chart (above).

Above: **SolidPlus beads pump up retroreflectivity for increased road safety**

The drivers not only noticed high R_L and RW but also 85% of them considered high retroreflectivity of horizontal road markings as a meaningful feature in improving road safety. Such a high level of positive response is likely caused by subconscious perception of safety on roads that are well marked.

Lack of research

While there are scientific reports increased R_L with reduced night-time accidents, peer-reviewed publications that would correlate high R_L with road safety are absent, which is most likely caused by the low market penetration of such modern solutions. Interpolating the existing reports, positive safety effects should be expected from increasing R_L, because it would lead to increased preview time for drivers.

Similarly, no scientific statistical proof has so far been given that would demonstrate the advantage of furnishing high RW, even though this is a broadly studied topic and RW is demanded by various road authorities. The effect might be large, similar to that measured for the introduction of road marking lines, because of such a huge difference between visibility (RW >100 mcd/m²/lx) and its effective perceived absence. Since the overall benefit of introducing road markings was calculated to exceed costs by 60 times, one might expect relatively similar effects related to providing RW.

Road trial demonstrations

It was demonstrated by road trials that very high R_L and RW could be obtained in thin-layer horizontal road marking by using SolidPlus glass beads and that such a system could be more durable than the standard system.

A questionnaire showed that the majority of drivers noticed increased R_L and RW. It is expected that the installation of road markings with very high R_L and RW would lead to a significant decrease in the number of accidents.

Road administrators should therefore demand such road marking systems to increase road safety. It must be remembered that additional expenditures could become insignificant if accidents could be prevented. In addition, mobility and quality of life of the drivers would increase, which is an important social factor. Furthermore, increased durability of road marking systems would lower the environmental impact.

Need to know

Key points of retroreflective technology

- Retroreflective horizontal road markings have been statistically proved to reduce night-time accidents by up to 23%
- High-performance SolidPlus glass beads are more robust than typical solutions
- SolidPlus provides retroreflectivity up to 1,000 mcd/m²/lx

Managing traffic with a single data platform

With the increasing pressure on budgets, local authorities must find ways to reduce overhead costs and increase efficiency without impacting on the delivery of public services. CCTV enforcement is not exempt from this challenge. In order to achieve this, local authorities can take some practical steps toward extracting greater value from their limited resources by employing existing assets more effectively.

Cutting costs

Using a single, multitasking digital video platform, such as that developed by Videalert, will reduce costs compared with legacy, single-point product solutions. It also delivers higher levels of future proofing as it supports multiple civil traffic enforcement, traffic management, parking, crime prevention and improved community safety applications simultaneously using the same infrastructure.

Videalert's DfT manufacturer-certified and hosted solution is easy to install and enables additional enforcement activities to be procured on demand, with installations taking place in weeks rather than months. It can be delivered through a variety of flexible commercial models to improve efficiency, increase income and enable greater control over costs.

This approach will be of particular interest to local authorities investigating how to cost-effectively enforce clean air zones (CAZ) and low emission zones (LEZ) to reduce pollution in city centers and encourage the take-up of modern, cleaner vehicles.

Videalert's hosted platform automates the management and enforcement of these zones with real-time identification of vehicles, including make, model, color, gross weight, engine type, Euro rating and CO_2 emission band. This enables the system to determine whether an offense has been committed and/or whether the correct tariff has been paid for entry into the restricted zone.

It can also provide real-time intelligence to determine the extent of contraventions in any target location.

Proven technologies

The challenge of encouraging behavioral change to clean up the air in our cities highlights the importance of using proven technologies in a more connected way. This is the rationale behind a new partnership between Videalert and Imperial Civil Enforcement Solutions, one of the largest and most experienced providers of parking, environmental and traffic management services.

This collaboration has resulted in an end-to-end solution that includes a virtual emission-based permit system that can use differential pricing structures to reflect the specific characteristics of different vehicle types. Being self-serve, it automatically calculates the specific vehicle pricing band during the online application process and provides a wealth

Need to know

The benefits of Videalert's video platform include...

- Reduced costs compared with legacy, single-point product solutions
- Supports identification of traffic violators
- Installation of the system is simple, taking weeks rather than months
- Sharing of data to multiple stakeholders is possible, increasing the value of information captured

Left: **Videalert's platform can carry out real-time identification of offending and non-offending vehicles in LEZs**

of back-office data and real-time information to ensure effective permit enforcement, which is carried out using Videalert's technology. Imperial also provides a proven back-office permit management system.

No risks or unknowns

What is particularly significant is that this new approach is founded on well proven, approved and fully integrated technologies, so there are no risks or unknowns. This type of collaboration is made possible through the use of open architecture platforms, enabling easy integration with third-party applications. Videalert expects to announce further partnerships in the future. ○

by **Larry Yermack**

Authorities at the top must actively plan to ensure that we can adapt to industry and technology developments

By the time this is published, the ITS World Congress will have passed, ITS America will have a new president, and the US Department of Transportation (USDOT) will still be in its anti-regulation mode. How are these connected? Let's look at their individual challenges and, then, a suggestion.

First, the ITS World Congress has been a valuable gathering place for the industry's community for more than 25 years, but it has not lived up to its potential for international cooperation. It has a board of directors and I am a long-standing member, but its sole focus has been on each individual World Congress that takes place in a different part of the world each year.

It has always seemed to me that the lost opportunity was for a group – the board – to work together to develop joint ITS policy recommendations that could be offered to, and could influence, national and local governments. I still believe that potential exists. Years ago, when I was ITS America (ITSA) chairman, I had ITSA work with Ertico to create a joint policy position on a long-forgotten topic, but that effort ran out of steam before we could present anything to our respective governments.

Second, ITSA will have a new president and a lot of work to do in order to reclaim its domestic leadership role. The historic core of the membership has been the departments of transportation and their role in the deployment of ITS is increasingly being challenged by the direct provision of technology to customers. There was a time when DOTs purchased all the ITS technology that was to be deployed. Today we can access a world of technology via our phones and the DOTs have no role in it. Their responsibility for network performance as well as health and safety won't go away, but the ability to do that will be limited because so much of the information that travelers receive is not from the government.

Third, USDOT has failed to create a national transportation policy for the 21st century and this failure stretches back through several prior administrations. It is only exacerbated by this administration's disinclination toward regulation. While Congress has addressed automated vehicles, the regulation to create connected vehicles languishes in DOTs. There is some hope that the automotive companies will deploy a common connected device, but there is little hope that the departments of transportation will take on the big policy issues.

> "Today we can access a world of technology via our phones and DOTs have no role in it"

Thus, the two organizations with the greatest potential influence on US transportation technology deployment are in transition and the potential international partner is just focused on meetings. So here is my plea to all three.

We are in the most challenging time for transportation in our lifetimes. We are faced with connected, automated, electric and shared vehicles. High-speed, wireless communication is getting more ubiquitous. Somebody with a megaphone needs to articulate how they work together and come up with a policy framework for the future. Any volunteers?

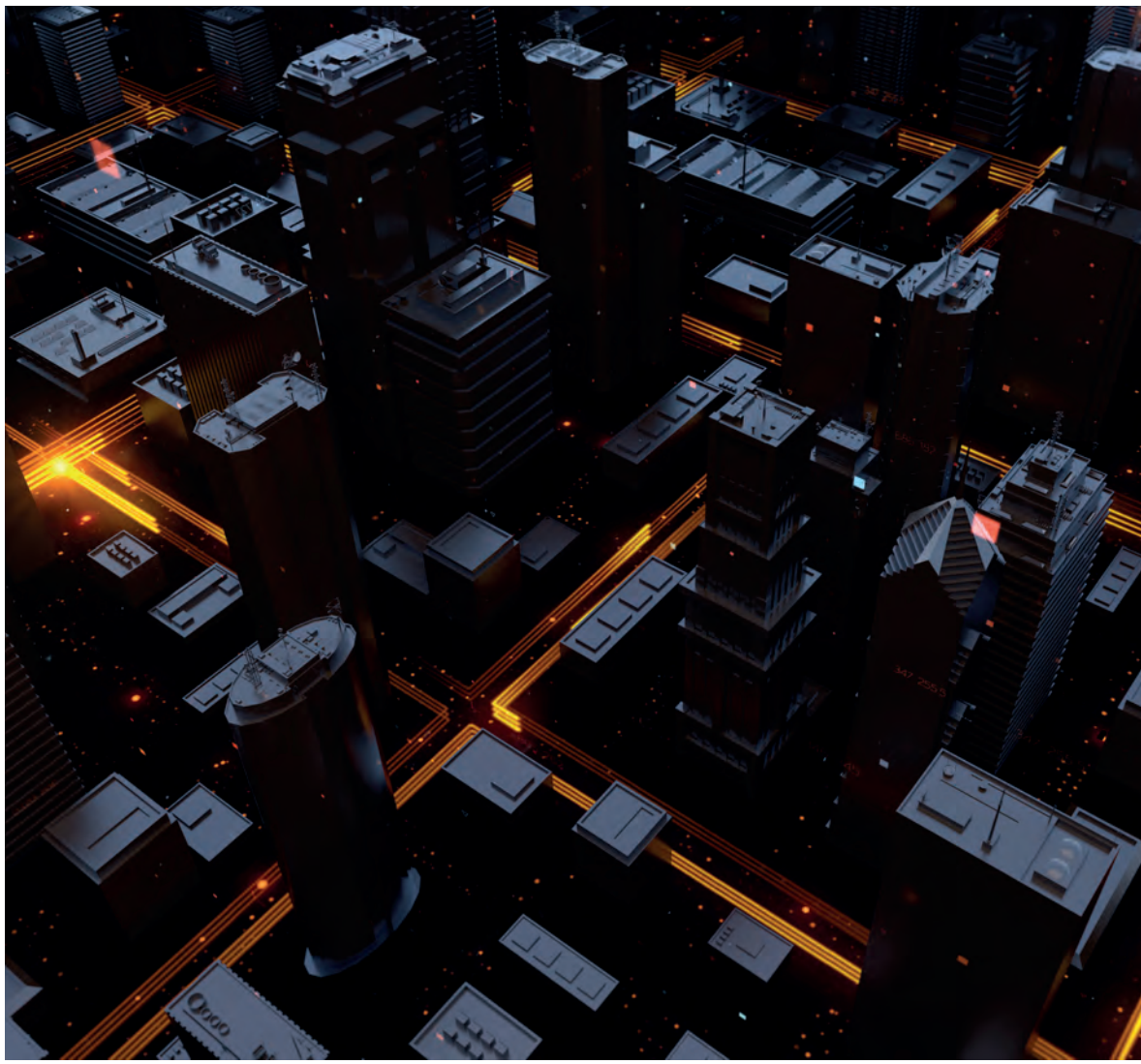
Larry Yermack is strategic advisor to Cubic Transportation Systems, USA. ***lyermack@gmail.com***

The binary dilemma

Most people think of the smartphone as precisely that: 'just' a phone. They hardly think about the complex bundle of technology it represents, but the reality is that it uses a host of different communications media to fulfill its many functions. These can include cellular, wi-fi, Bluetooth, near-field communication (NFC) and frequency modulation (FM) receivers. However, the buyer/user tends not to differentiate between the capabilities of these media – he or she will just get on and 'do', and assume that the smartphone will perform.

This is the mass-market approach to communications technology. It is both agnostic and opportunistic, and it works very well. It provides an unfortunate contrast with some current proposals for the Cooperative ITS (C-ITS) sector, where certain major players are looking to be more prescriptive about communications media. They are in fact promoting the use of a single medium – cellular telephony.

The main driver in this is a desire by some to increase market share, but this brings with it risks in terms of delayed deployments and, therefore, nearer-term improvements to both road safety and environmental performance.



Above: **The proposed move to 5G cellular technology for C-ITS applications would severely delay deployments**

The road to C-ITS

Many years of effort have gone into developing low-latency C-ITS communications based on 5.9GHz dedicated short-range communication (DSRC). The result, also known as ITS G5, 802.11p or WAVE (Wireless Access in Vehicular Environments), is matured and ready to deploy now. Yet a powerful lobby, consisting primarily of telephony companies, chip-makers and some of the automotive manufacturers, is advocating that we abandon DSRC/G5 and instead move to 5G, the coming generation of cellular.

The chief concern is advocacy of a binary decision – that the solution is either DSRC/G5 or 5G cellular. This is a nonsensical standpoint, but opinions within ITS are becoming increasingly polarized.

Advocates of 5G cellular use the slow progression of DSRC/G5 deployment as a reason to wait even longer, in order to move straight to a cellular solution that offers DSRC/G5's low-latency characteristics – characteristics that are essential for C-ITS applications such as intersection safety.

Relative maturity

It is worth considering where we now are in terms of both DSRC/G5 and 5G.

DSRC/G5 is evolved and matured. The technology is ready, proven and secure. Validation in large volumes and by a large number of

vehicle manufacturers has already taken place.

To repeat that process with any other technology would take at least five years and the point remains that no-one has truly yet defined what 5G cellular might be. It's currently at the 'headline' stage and there is a battle going on between factions within the 3GPP, the organization responsible for 5G definition, over which technology will ultimately prevail and give us 5G.

Definitions vary widely in capability from a simple desire for 1/2G-level performance, but with unbroken call connections, up to streaming video and zero latency. The two incremental technical proposals that have been produced in the past three years do not come close to the basic performance of 5.9GHz-based DSRC. A new proposal has been promised by the 3GPP, but none has been forthcoming as yet. Even so, it will be difficult to see how it will match, let alone better, DSRC/G5 – and we can expect to see no more revolutions in radio technology that will support a 'quantum leap'.

Also, 5.9GHz-based DSRC is mature technology that is basically royalty-free; this contrasts with the rather more commercial/IPR-driven environment in which the 3GPP has to work, and in which the benefits to all are therefore less clear.

Hybrid solutions

There is an element of lock-down associated with use in the immediate future of DSRC/G5. This is due to its broadcast-type nature – vehicles and roadside units will continuously broadcast messages without receiving responses and, so long as there remain vehicles out there that rely on DSRC/G5, that broadcast technology will be needed. However, that does not mean that deployment of DSRC/G5 precludes use of all else; Q-Free's experience with C-ITS pilots in Australia, for instance, is that DSRC and cellular can readily complement each other.

These hybrid solutions work perfectly well, supported by the Communications Access for Land Mobiles (CALM) stack of standards from ISO TC204. A 10-year development effort that is now in its second release, the CALM stack establishes a full C-ITS architecture, terminology, interfaces and protocols.

In the form of DSRC/G5, the technology need evolve no further. DSRC/G5's broadcast nature is a very efficient way of achieving time-critical C-ITS applications. CALM enables a top-down application of apps and anything else would seem to be a retrograde step, with certain players looking to 'bend' an open architecture to suit their own products and siloed approaches.

The current jockeying for market position/share has reached a stage where it risks compromising the more altruistic ambitions of ITS: safety, emissions mitigation and congestion reduction. Instead, vehicle manufacturers are refusing to use DSRC/G5 unless it is mandated and there is factionalism within some public authorities.

Need to know

Hybrid connectivity solutions are supported by Communications Access for Land Mobiles (CALM)

- CALM tells exactly how an application can use a wide range of protocols, including 5.9GHz DSRC, cellular, Bluetooth, 60GHz and wi-fi
- Its facilities layer sets up communications via whichever is the best means
- Thanks to CALM, interfaces are not vertical or siloed per application

Immediate benefits

There are numerous motivations for the current situation and trends. These include individual stubbornness, technologically siloed thinking, commercial issues, desire for new spectrum, and concerns over the relative maturity of relevant technologies.

Very few people at present seem to be saying 'Let's do it all'. It may well be that cellular will mature to a point where it can offer the necessary zero-latency performance. In time, we may enjoy the benefits of using mass-market communications rather than a discrete, ITS-related solution. But 5G is not yet ready to provide what is needed. DRSC/G5 is, and CALM hybrid standards give us a migration path, should we need one. To put it another way, the use of DSRC/G5 now does not preclude the use of 5G technologies at a later date. However, to prescribe the use of cellular adds quite some years to the roll-out of C-ITS applications that are ready and can have an immediate and positive effect on our road networks' performance.

And what if 5G fails to deliver? Do we wait instead for 6G? To save lives and improve mobility's environmental performance now, we need to deploy a solution that is already proven. We can realize the benefits of C-ITS right now. More to the point, we should.

Features to improve road weather maintenance

Different types of systems for monitoring and predicting road weather are used in many countries around the world. Metis is a web-based system developed by Cross Zlín that can be used to present road weather data and information focusing on current and future road situations. It provides a comprehensive overview of the weather in real time.

Core of the system

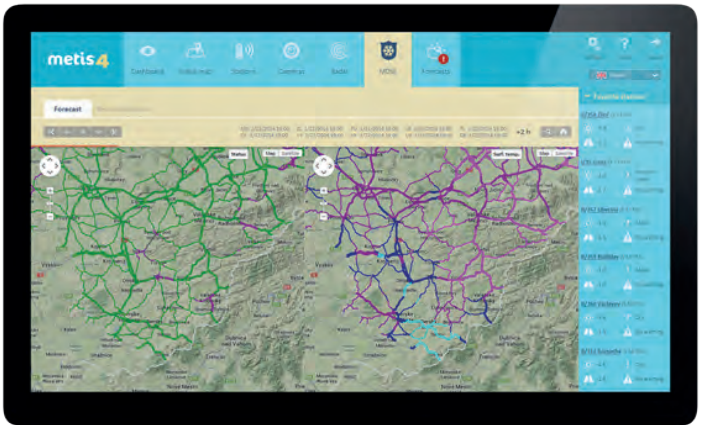
The dashboard forms the core of the system. It has online access for data presentation and visualization using maps, images, animations, tables, graphs and text. A status map gives weather station networks the ability to switch views based on measured parameters such as surface temperature, surface condition and warnings. A list of weather stations makes it is possible for the user to explore details of measured data including past data.

An overview function allows the user to compare data measurements from different stations. A key feature of the system is the capturing of images from the cameras, which offer a live view of the situation in each selected location. Other important aspects are the images taken by meteorological radars and satellites, and forecasts – used by authorities to decide if, and what, road weather maintenance needs to be carried out.

Need to know

Features of the Metis road weather maintenance system include...

- A dashboard system with web-based access
- Interactive data presentation tools
- Images collected from cameras in real time
- Forecasts based on past data
- Compatibility with smartphones and tablets



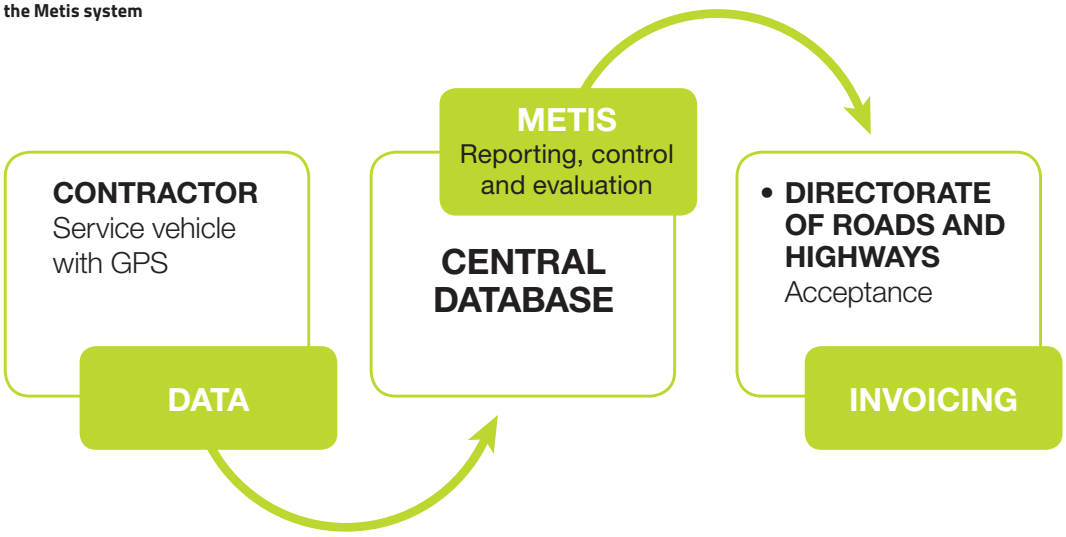
Above: **Status map of weather stations**

The Maintenance Information System (MIS) is improved with an interface that uses maintenance reporting using GPS-based vehicle monitoring. All vehicle types, such as the dispatcher's car, service companies' small vans and spreaders, are equipped with a GPS module for online monitoring of the actual position, distance traveled and spreading activity. The vehicle tracking system integrated in Metis uses a Protank Dynamics engine that features a standardized XML protocol for receiving data from connected vehicles. Based on GPS data, Metis can provide visualization of vehicles' movements and activity, as well as effectively reporting maintenance performance – such as the daily consumption of salt and the distance covered during salt spreading. This system is used by most winter maintenance contractors in the Czech Republic.

Winter road maintenance

The maintenance performance and cost-analysis features improve winter road maintenance. These tools are used to analyze and control the maintenance performed. The features are designed to support sustainability, detect over-reactions – and thereby excessive cost – and unify the standard of maintenance throughout the country by using an innovative comparison of regional standards for winter maintenance, so all contractors can reach the same level of safety, mobility and efficiency.

Below: **Flow chart of the Metis system**



The data goes automatically from the contractor to a central database, where it is available in the form of reports and statistics for specialist control, appraisal and final acceptance by a local authority. At the end of each month, Metis performs automatic invoicing, which is a cost-saving solution.

Metis has a built-in alert service automatically informing the user, by SMS or email, about critical road weather conditions or occurrences of dangerous forecast phenomena. It can react quickly, anywhere, at all times.

Weather station-friendly

Metis is a technologically independent and open visualization platform supporting all types of road weather stations on the market. It is also able to integrate data. As well as being a system for road weather monitoring, a significant part of it is applicable to the management and control of road maintenance. The system has proven its qualities and is being continuously improved with new functions. The benefit of using this kind of sophisticated information system is effective road maintenance. Meanwhile, the result for drivers is safer roads. Advantages for the road authority include cost control and cost savings, because maintenance is done only in the right place at the right time, ultimately saving public funds and the environment.

by **Don Hunt**

Paving the way for highly automated vehicles – with legislation

Looking back on 2017, some of the interesting activity related to highly automated vehicles (HAV) in the USA took place at the federal government level. Both the executive and legislative branches were active in creating HAV policy that supports vehicle deployment.

First, the USDOT issued *Automated Driving Systems 2.0, A Vision for Safety* (ADS 2.0). Published on September 12, 2017, ADS 2.0 replaces in its entirety the 2016 Obama Administration's *Federal Automated Vehicles Policy* (FAVP). ADS 2.0 leans toward a more industry-friendly, voluntary environment for the deployment of HAVs. Gone is the idea that the federal government could pre-certify automated driving systems. The new policy also puts voluntary back into the meaning of voluntary, scrapping the confusing manufacturer Safety Assessment Letter (voluntary yet required) in favor of a Voluntary Safety Self-Assessment. ADS 2.0 takes an even dimmer view of state and local regulation of automated driving systems in conflict with federal policy. But it does recognize that states have the right to regulate testing, so long as regulations don't impede technological progress.

Coincidentally, the National Transportation Safety Board (NTSB) issued a finding on the Tesla-truck accident on the same day that ADS 2.0 was issued. In 2016 a Tesla crashed with a tractor trailer crossing an uncontrolled intersection in Florida. The Tesla was in Autopilot mode, the cruise control was set at 74mph (119km/h), and neither the automated braking system nor the driver took action to avoid the collision. The NTSB findings are too extensive to discuss here, but important NTSB recommendations include the need to: 1) establish data parameters to be preserved post-crash; 2) implement systems that limit the use of Level 2 vehicles to those conditions for which they were designed; 3) develop applications to more effectively sense the driver's level of engagement; and 4) develop minimum performance standards for connected vehicle technology for all highway vehicles. The Tesla Level 2 system was not held at fault.

At the time of writing, the US Congress is finalizing legislation to provide a clearer, pro-industry framework for the introduction of HAVs. The legislation is aimed at encouraging and speeding the implementation of HAVs in the USA, and limiting the regulatory power of states and cities over automated driving systems. Auto makers will be able to obtain exemptions from NHTSA rules that require human controls and will have to provide safety reports to the USDOT before commercial introduction of a model. There will be no government pre-certification of HAVs. States can set rules on registration, licensing, liability, insurance and safety inspections, but not vehicle performance standards.

"The US Congress is finalizing legislation to provide a clearer, pro-industry framework for the introduction of HAVs"

All in all, the US government has given a green light to the testing and deployment of HAVs over the next few years. Opponents concerned about HAV safety achieved little change from the government's pro-technology, pro-industry view. And perhaps that's just the right path when our current environment of human drivers produces more than 40,000 highway deaths per year.

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

Express lanes

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

"Everything in our systems is redundant. We allow for overlap so that we can lose a lane-side camera and still have full coverage"

James Lee, UK support services and delivery manager, Merseyflow, ***on the UK's new free-flow tolling bridge, the Mersey Gateway***

Page 28

"There are four benefits to the deployment of average speed cameras on roads: they're safer, reduce congestion, are more environmentally friendly and fairer"

Geoff Collins, sales and marketing director, Jenoptik

For an insight into how the average speed camera technology works, watch the video at trafficTechnologytoday.com/average

"We need to utilize all modes of transport much more efficiently and I think new digital technologies and services can help us tremendously on that front"

Caspar de Jonge, program manager at the Dutch Ministry of Infrastructure and Water Management

The Netherlands recently launched its connected urban transport solution. Watch the video at trafficTechnologytoday.com/dutch

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"We realized that we needed the ability to vary the speed limit based on road conditions, accidents and any slowing traffic"

Mike Curtis, project engineer, Colorado Department of Transportation, ***on tackling treacherous weather conditions on the state's stretch of I-80***

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