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Probe-data revolution
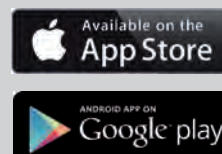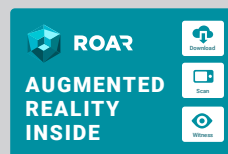Will vehicle-generated data one day do away with the need for traditional roadside cameras?

Two-way data exchange
How crowdsourcing navigation apps are being used by traffic managers to feed information back to drivers

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Cover story

36 Signs of confusion

The plus points and pitfalls of all-lane-running freeways

James Gordon finds out how Highways England maintains real-time information on the advanced VMS that control its smart motorways

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Editor's letter

My drive to work – which is primarily on a two-lane freeway – has been plagued in recent months by various workzones. The latest is typical – lane widening work that requires two lanes to go down to one on the approach. It's a classic bottleneck that creates long tailbacks. In the first few weeks the jams were particularly bad. A set of static signs at the roadside helpfully inform drivers that one lane will finish in 800 yards, then 400, then 200. However, instead of taking this as a useful warning, on seeing the first sign most drivers (presumably feeling they were doing the right thing, or possibly terrified at the prospect of the lane they were driving in ending abruptly) pulled over immediately into the lane that was signposted to continue. This created a long queue in one lane while the other was left completely empty, which risked stacking the line of cars right back to the previous junction.

It's a strange, but somewhat predictable phenomenon. The interesting thing happened when, after a few days of chaos, Highways England erected four large red signs with bold white lettering: "Use both lanes when queuing." And then another closer to the point where the two lanes converge: "Merge in turn."

Given the dramatic effectiveness of the previous set of signs, one might have assumed this new set would deliver similar instant results. Not so. For weeks after they went up, motorists on this stretch still seemed extra keen to get over into the lane that continued, leaving the other one

free. I even witnessed some aggressive vigilante commuters who actually half pulled out from their queue into the free lane, not to make use of the space, but to stop other drivers getting past: they must have somehow felt that it was their civic duty to maintain the orderly queue, ignoring the 15ft-high red signs they had just passed.

Now, three months into the works and with the end in sight, the traffic situation seems to have finally calmed. Drivers do now use both lanes when queuing (albeit with a slight preference for the continuing lane) and the majority merge as the road narrows. This has not only resulted in queues that take up fewer road feet, but also faster moving traffic – the 'zipper' effect of the merge seems to create a smoother, less stop-start flow.

Apart from the fact that the British love a queue, what lessons can be learned? An important one for traffic managers is that drivers don't always do what signs tell them. For signs to be effective, drivers need to understand what they are for and why they work. Nowhere is this more important than on all-lane-running freeways (or smart motorways as they are called in the UK). It's a subject we investigate more fully from page 36.

There are further learnings elsewhere in this issue, where we find out more about the latest advances in weigh-in-motion (p16), probe data (p46) and tunnel management (p30) among much else. Other people want to read *Traffic* after you? Ask them to form an orderly queue.

Tom Stone
Editor

Testing the
eyes
in the skies

The USDOT has launched a new test program to help move drones from the experimental phase to becoming a normal part of traffic management equipment, with an extended list of use cases. **Rachelle Harry** finds out more

The USDOT has launched its Unmanned Aircraft Systems (UAS) Integration Pilot Program, aimed at accelerating the approval process for drone operations.

The new round of testing, which is being done in conjunction with North Carolina, North Dakota and Kansas Departments of Transportation (alongside seven other academic and public bodies), aims to do away with the current need for special authorizations and enable rules that allow more complex low-altitude operations.

The testing, which is expected to last 2.5 years, will look at, among other tasks, the potential for night flights, beyond-line-of-sight operations and package deliveries.

Announcing the program in May 2018, US Secretary of Transportation Elaine Chao said, "Data gathered from this pilot project will form the basis of a new regulatory framework to safely integrate drones into our national airspace. The enthusiastic response to our request for applications demonstrated the

66 This is a terrific opportunity to explore new ways to use this technology to reduce the risks to our workers during infrastructure inspections, search and rescue, and remote area assessments

Richard Carlson, Kansas Secretary of Transportation
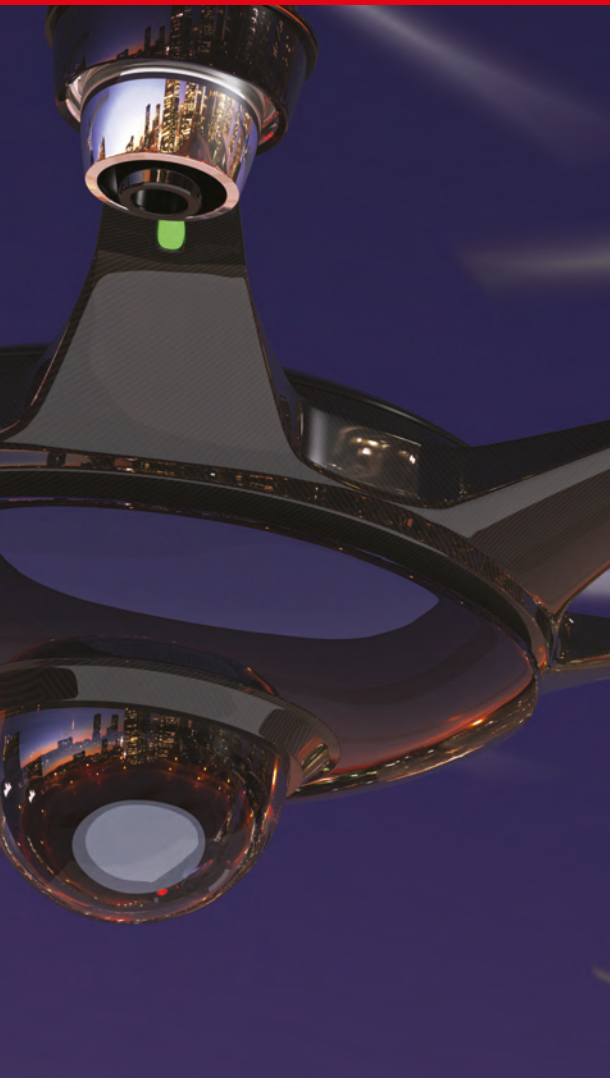
> ❝ Data gathered from this pilot project will form the basis of a new regulatory framework to safely integrate drones into our national airspace
>
> *Elaine Chao, US Secretary of State for Transportation*

↘ | A step forward for UK surveys

For the first time, the UK is welcoming the use of drones in surveys of transportation infrastructure

The UK's Transport for London (TfL) has given its approval for drones to carry out infrastructural and asset surveys. It is hoped that their use will improve data gathering, speed up the surveying process, improve safety, reduce the risk of operational disruption, and lower costs. Initially drones will carry out surveys only on TfL's rail assets. However, in the future TfL may award similar licenses for road inspections and other transportation infrastructure surveys within its network.

For the technology to be formally approved by TfL, the company involved – Lanes Rail – had to show that it met all TfL's stringent safety, security and operational quality standards.

"Using drones, combined with advanced imaging and analytical technology, will deliver significant service and sustainability benefits for us, for TfL, and for the traveling public in London," said Matthew Todd, Lanes Rail director.

many innovative technological and operational solutions already on the horizon."

Kansas DOT (KDOT) is the only agency that will be focused on using drones in highway and infrastructure management. It is an ideal state for testing this aspect of drone technology because it contains 140,000 miles (225,000km) of public roads, many of which are rural.

KDOT and its partners will study several potential drone applications, including assessing weather-affected roads, conducting bridge and infrastructure inspections, highway planning and survey work, emergency management, and even locating and assisting stranded motorists more quickly. Ultimately the program will help state and local transportation departments to operate more safely and efficiently.

The data collected from these operations will help the USDOT and the Federal Aviation Administration (FAA) to create new enabling rules that allow more complex low-altitude operations, address security and privacy risks, and accelerate the approval of operations that currently require special authorizations.

Kansas Secretary of Transportation Richard Carlson commented, "This is a terrific

Left: **The Centennial Bridge on Highway 73 in Leavenworth, Kansas. Drones have already proved particularly useful in conducting bridge surveys**

opportunity to explore new ways to use this technology to reduce the risks to our workers during infrastructure inspections, search and rescue, and remote area assessments. This agency strives to be on the cutting edge of transportation technology. We are always looking for better, more efficient ways to help make travel safer for Kansans, visitors and the commercial industries that depend on our roads." ○

One million
The total number of drones registered in the USA at the start of 2018; 122,000+ are for commercial or public use
Source: USDOT

Moscow
movements

This summer, all eyes have been on Russia for the FIFA World Cup. The nation's capital is infamous for traffic congestion, but just how bad has it been? And what are the alternatives?

The average Muscovite spends over

12 days

stuck in traffic every year (49 minutes a day)

4

ring roads circle the city

44%

The potential increase in travel times in Moscow city center when roads are congested, as compared with free-flow conditions

65%

Reduction in the search time for parking spaces due to implementation of a new ITS program

22,480 miles (36,179km) of roadway
232 miles (374km) of major highway

DECEMBER 5

Most congested day of travel in 2017: December 5

5,000
taxis in Moscow

3
major airports serve Moscow

12.9 million total population in a **969 square mile** total area (2,511km²)

It takes **six** days to get to Beijing on the Trans-Siberian Express

90 seconds
The intervals between trains at rush hour on Moscow's metro system

4,300
rental bikes in 430 docking stations

260 electrobikes

Moscow has the largest trolleybus network in the world

18
bus fleets operate over 1,000 different routes

Saving
the world

Low emission zones are gaining in popularity. But what other traffic technology is helping authorities around the world reduce levels of toxic fumes? **James Allen** investigates

ITS to the rescue

Roll-out of ITS across Mississippi will reduce congestion and cut emissions in the state

The Mississippi Department of Transportation (MDOT) is close to completing an ITS project that will ease congestion and reduce emissions on some of the busiest highways in DeSoto County.

Installation of 148 CCTV cameras, nine dynamic messaging signs, 44 Bluetooth monitoring devices, 41 radar detection systems, three travel time information signs and two traveler information video kiosks is almost finished.

Supported by the federal Congestion Mitigation and Air Quality Improvement (CMAQ) program, traffic backups are expected to fall by 20% as a result of the efficiency improvements being introduced.

Reducing congestion and tailbacks is also expected to improve air quality in the area as journey times are shortened and the number of stationary vehicles is cut.

148
The number of CCTV cameras installed by Mississippi DOT as part of new ITS predicted to help reduce congestion by up to 20%, thereby lowering emissions

Taxing times

Change in UK road tax law sees discount for Euro VI truck drivers

Drivers of cleaner trucks will pay less to use UK roads, the government has announced.

From February next year, heavy goods vehicles (HGVs) that meet the latest Euro VI emission standards will be eligible for a 10% reduction in the cost of the HGV road user levy.

Introduced in 2014, the levy applies to all vehicles weighing 12 metric tons or more to cover the greater wear and tear they cause to road surfaces.

Compared with non-compliant trucks, the cleanest HGVs generate 80% less NO_x.

The current HGV levy is £1,000 (US$1,310) per annum. The new rate for Euro VI-compliant vehicles will be £900 (US$1,180), while those not meeting the standard will pay an increased fee of £1,200 (US$1,570). When the change comes into effect, more than half of UK vehicles will pay less.

Money, money, money

SPC approves 16 air quality improvement projects in southwest Pennsylvania

Funding of US$34.25m for air quality projects in southwest Pennsylvania has been approved.

The Southwestern Pennsylvania Commission (SPC) is backing 16 proposals aimed at reducing emissions levels in the region.

Federally funded through the Congestion Mitigation and Air Quality Improvement (CMAQ) program, projects include seven adaptive traffic signal systems, establishing a last-mile transit service and a congestion-relieving scheme along the Parkway West (I-376) corridor, in addition to traffic demand management strategies in Pittsburgh.

The projects approved for funding advance the region's long-range plan, 'Mapping the Future: The Southwestern PA Plan', and its policy of designing the region's infrastructure system to protect and enhance public health and the environment.

Cleaner when it matters

Successful early-stage trial uses pollution sensors to switch hybrid vehicles to electric mode

An air quality monitoring system that can automatically swap passing hybrid vehicles into zero-emission mode has proved successful in early testing in the UK.

In the year-long trial undertaken by aerial mapping company Bluesky and the University of Leicester, EarthSense sensors were used to provide real-time data on pollution levels in city centers. When they detected high levels they automatically triggered emission-free, electric power in test hybrid vehicles equipped with plug-in devices that passed close by.

"This is a first – using real-time data from static and mobile sensors to create a dynamic air-quality model. It's then used to define a control zone, which can be adjusted in location, size and time duration," says Tom Hall, EarthSense's managing director.

Emissions shown the red light

Smart traffic light control is helping helping to reduce emissions in Strasbourg, France

The French city of Strasbourg is optimizing traffic signal control to reduce vehicle emissions and improve air quality.

A study of the city's traffic network carried out by PTV Group found an increasing volume of vehicles, in conjunction with the number of intersections controlled by lights or stop signs, was exacerbating the problem of stationary vehicles, thereby increasing pollution.

Software tools illustrated the potential benefits of adaptive traffic control systems to reduce stop-and-go traffic and the high emissions from stationary vehicles.

The results revealed that vehicle stops could be reduced by 9%, while NO_x and particulate matter emissions could drop by 8% and 9% respectively. Field tests are now being conducted on key Strasbourg roads.

80%

The reduction in overall energy consumption in Volvo's new 7900 autonomous electric bus – now being tested in Singapore – when compared to an equivalent diesel model

No driver, no emissions

Autonomous, emission-free buses to be tested in Singapore next year

Singapore is to introduce the world's first autonomous emission-free public transportation in 2019.

Developed by Volvo, in partnership with the city-state's Nanyang Technological University (NTU), testing of the electric buses will begin early next year.

The 40ft (12m) Volvo 7900-series electric bus is already in service around the world, providing a quiet and emission-free operation, and requiring around 80% less energy than an equivalent sized diesel bus.

"We are seeing fast-growing interest in autonomous and electric vehicles in cities all over the world," says Håkan Agnevall, president of Volvo Buses. "Together with NTU, we now have the possibility of testing various solutions under realistic conditions in a major city that has high ambitions for its public transport."

8%

The reduction in NO_x in Strasbourg, France, that is predicted now a new signal control system has been installed that aims to reduce stop-start traffic in the heart of the city

New locations for
PrePass

Truck weigh station bypass service announces new operation locations and weigh-in-motion upgrades

Help Inc., the public-private partnership that serves the US trucking industry to promote safety and efficiency, has announced its PrePass weigh station bypass system will soon be available in eight new locations – listed in *Non-stop service*, right.

PrePass, which operates at no cost to taxpayers, uses a vehicle-specific transponders (RFID or cellular) to identify trusted haulers and allow them to bypass weigh stations. Weigh-in-motion (WIM) is often used to verify the truck's configuration and ensure vehicle weights are within acceptable limits.

Help also announced upgrades to WIM scales in Missouri (Bloomsdale, southbound 1-55) and New Mexico (Gallup, eastbound I-40) as well as all-new WIM technology for Montana (Broadus, US 212) and the integration of PrePass with existing WIMs in Arkansas (Riverside, westbound I-40; Bridgeport, northbound I-55).

A further Help service is electronic toll payment options through its PrePass Plus. Also, both PrePass and PrePass Plus use Inform, a data management suite that helps fleets to understand and improve their safety scores, as well as reducing tolling impacts.

"Nationwide, the cost of diesel fuel is over US$3 a gallon for the first time in several years. Safe weigh station bypassing means significant fuel savings that flow directly to a carrier's bottom line," says Help's CEO, Karen Rasmussen. "Meanwhile, states have a primary responsibility to ensure those operating on their roads are safe. We are proud to partner with states on new opportunities for safe drivers to continue moving freight at highway speeds, while allowing officials to focus on other commercial vehicles that need the most attention." ⊙

PREPASS
FOLLOW
IN - CAB SIGNALS

570,000
The approximate number of trucks that use the PrePass service in the USA

Carlos Braceras, executive director at Utah DOT and chair of the ITS America board, reveals how a decision to install fiber optics on all road projects since the early 1990s is now paying back in a big way

Interviewed by Rachelle Harry

Carlos Braceras has been on an evolutionary career journey. Speaking to *Traffic* in the busy entrance hall of the ITS Annual Meeting (which took place in Detroit, Michigan, from June 4-7), he proudly states that he has worked at UDOT for 32 years. His first position in the organization was as a field engineer in what he first thought would be a temporary summer job after having obtained his second university degree.

"We were rebuilding the main street of a small town in Utah," he recalls. "It was so much fun."

He says that he is grateful to have been given chances throughout his career, as well as having been able to work in different areas of the organization. "One of the things I've realized – although I didn't realize it at the time – is that during my career at UDOT nobody put a roadblock in front of me. I was always able to say, 'What about this? Can we try this?' Thankfully at UDOT we have a culture that says, 'Sure let's try something new.'

"UDOT was very much – and still is – a civil engineering company, because typically it plans, designs and constructs," says Braceras. "But we're now moving into a world where we need more data analysts, scientists and engineers looking at the processes involved in operating transportation systems. So, a big challenge

We've been able to extend our fiber-optic system to connect over 90% of the traffic signals in Utah

Left: Road building in Utah today invariably includes the installation of communications networks

for us at the moment is attracting and retaining our workforce. Required skills are changing, partly because of the new technologies that are available to us and the ones to come."

Future-thinking technology

One such technology is fiber optics, which UDOT has installed on every single project since the early 1990s – albeit acting on a hunch at the time. "Even if we didn't have something to connect it to, we capped the ends," says Braceras. "That was when the Motorola brick cell phone had just come out. There was a huge buzz around cellular."

While installing large amounts of fiber optics may have seemed like a gamble, almost 20 years later – as transportation enters a new era automated and connected technologies – the investment has turned out to be an extremely wise one.

"We've been able to extend our fiber-optic system to connect over 90% of the traffic signals in Utah," says Braceras. "Now we have this infrastructure in place that allows us to exchange data with private telecoms. Incredibly, all those traffic signals are connected using the same hardware and software systems – and I think we are the only state that has been able to do that."

Thanks to the fiber optics, UDOT is in a position where it can push toward compatible

> "I like the idea of staff continuously learning at UDOT, so they can understand exactly what they want to do in their career and how to achieve it

and connected vehicle-to-everything (V2X) systems, using DSRC units. But is 5G next? "Personally I believe in this idea of 'safety sooner'," says Braceras. "DSRC is here today and it works. But when 5G becomes available it should be backward compatible with DSRC – and they should operate together, rather than separately, in order for us to serve one of our main purposes: saving lives. We always have to be thinking one step ahead."

"Everyone is waiting to see how it goes with connected vehicles," he continues. "Nobody wants to go first. DOTs are asking, 'Shall we install units if there are no connected cars to receive signals from them?' Something we're trying at UDOT is adding DSRC units to several large snowplows. We think that traffic signal preemption for the plows will make the snow removal process more efficient."

Right: **Signals in Utah are being connected to snowplows using DSRC technology, to improve efficiency**

Above: **The accelerating pace of change in traffic technology prompted UDOT to set up a new learning center, to keep employees up to speed**

He continues, "We've also got 20 DSRC units in place on the Redwood Road improvement project, communicating with our transit buses, and this has helped us to increase the reliability of service by 6-8%."

Money matters

Braceras always keeps budgets at the forefront of his work. "Making investments in new technologies is risky," he says. "As a public sector employee, my biggest responsibility is to make sure that we get the best bang for the public's investment."

Thinking back to the laying of fiber-optic cables, Braceras says a third party helped them make the huge decision. "We brought in a thought leader, because at the time we could only look forward to a limited extent," he says. "They believed fiber would be in operation for the long haul, so we went with it."

Braceras is extremely excited by what the connected future of transportation holds – and the power of data.

"We don't even understand the potential of the data that is being, and will be, generated," he says. "The other day I saw a man in a T-shirt that said 'Data is the new bacon'. I love that!

"We've got all this data coming in from sources like Bluetooth, wi-fi, sensors… The thing is, how do we figure out what the data answers are without even knowing the questions? Data – and the way we manage the questions about it – is going to take us on an evolutionary journey."

A learning culture

Braceras, reflecting on his own career experiences and success, is now is hoping for each UDOT member of staff will expand their knowledge and self-growth. In a supportive initiative, two years ago UDOT converted an old cafeteria space into a learning center led by a director of learning. "I like the idea of staff being continuous learners at UDOT – where every employee has a learning plan that helps them to understand exactly what they want to do in their career and how they achieve it."

He uses an example of a maintenance worker wishing to steer their career toward incident management. "What skills would they need? UDOT gives employees the ability to realize opportunities – and this positively changes the way they feel about their job."

Importantly, Braceras leads by example and hopes the entire industry will share his honest approach to maintain and strengthen public trust. "If you make a mistake, don't hide it," he says. "Share it, own it and learn from it. On too many occasions, government agencies have tried to hide mistakes. That damages trust – and trust is the number-one currency that we at UDOT have as a government organization. If the public trust us, they'll give us the latitude to try new things and the resources to do it."

So what is the key element to running a forward-thinking, risk-taking, honestly led and empowering department of transportation? "Be a fun place to work," Braceras says. "I don't want to get to work and not have fun – nobody does." ○

Scales
of justice

Using dynamic weigh-in-motion for direct enforcement and toll-by-weight is technically possible, and now more accurate than ever, but legal frameworks stand in the way in many jurisdictions. **Saul Wordsworth** finds out why, and asks if the situation is likely to change in the near future

Weigh-in-motion (WIM) is a means of capturing the weight of passing vehicles. A WIM site usually calculates gross vehicle weight (GVW) and axle load, and generates other traffic data. Its primary purpose is to reduce the number of overweight vehicles. Toll-by-weight (TBW), on the other hand, measures vehicles according to the loaded weight, and features a payment module.

"Toll-by-weight is when you want the user to pay for his road usage according to the wear or amount of road he uses," says Christoph Klauser, product manager road and traffic for Kistler, a measurement technology vendor. "The concept in many European countries is to charge vehicles based on specification, for instance over 3.5 or 7.5 metric tons, independent of their actual weight. TBW measures the exact weight, then bills the driver or

Are trucks across the world heading towards a future where the law requires tolling according to weight?

company. Assumptions based on vehicle size, number of axles and distance traveled lead to situations where heavy goods vehicles (HGVs) pay a fixed fee for their road usage regardless of how much wear they are causing to the road. With TBW, you know if someone's empty and causing less wear, or full and causing more. TBW brings fair pricing to the market. Unfortunately, no European country has so far adopted the TBW principle. To my knowledge China is the only country to do so." (See sidebar, *China stands alone*).

"Most countries are using classes of truck for tolls, and the tax per kilometer applies above a given threshold," says Bernard Jacob, deputy scientific director at IFSTTAR, the French Institute of Science and Technology for Transport, and deputy vice president of science for ISWIM, the International Society for Weigh-in-Motion. "However, this refers to the maximum permitted weight, not current weight. In the shadow toll system, which is likely implemented in some countries, the share of the revenue between the road concessionary company and the infrastructure owner is based on the traffic volume and loads. The higher

the volume and loads, the more revenue for the concessionary."

For the enforcement of TBW, three components must be in place: a weighing system, a camera-based automatic recognition solution for means of identifying the vehicle, and

> "It can be difficult to guarantee the accuracy of each high-speed WIM measurement. You need the combination of legal acceptance, system certification and data quality control

Chris Koniditsiotis, president, International Society for Weigh-in-Motion

behind all this, a charging module likely incorporating some kind of onboard unit designed and supplied by a tolling specialist. As things stand, no one company provides a turnkey solution for TBW. Instead the different components are linked together by an overarching architecture at the behest of the road owner. The technology is feasible and already in use, but has not to date spread beyond the People's Republic of China.

What, no toll?

Why TBW remains limited in application is up for debate. Some believe it's due to tradition. When the

demand for TBW first arose, the technology was not in place. Now that it is, the transportation world has been slow to adjust. For Chris Koniditsiotis, president of ISWIM and chief executive officer of Transport Certification Australia, there are two principal reasons for TBW not being more widely adopted: "Firstly it can be difficult to guarantee the accuracy of each high-speed WIM measurement. You need the combination of legal acceptance, system certification and data quality control. The second issue is that many toll road operators are quite happy with fees based on the vehicle class or the number of axles because it is much easier to detect and there are not so many issues with the measurement accuracy."

Accurate enough?

"There are inaccuracies inherent in WIM," says John de Pont, director of engineering research at TERNZ, a New Zealand-based independent research body specializing in transportation. "A good WIM system is accurate to about 5%. Depending on the charging schedule, this could result in some vehicles being substantially over-charged, others under-charged. This could then be challenged in the courts. For enforcement, WIM is usually used as a filter to determine whether or not a static weighing is needed. It is not used as the primary measurement."

The accuracy debate is one that rages, although some WIM companies would dispute this. With the advancement of piezo and sensor technology, weigh-in-motion is now said to be accurate to 2.5%. Indeed, direct weight enforcement via dynamic WIM is already in operation in the Czech Republic, Hungary and Russia.

"From the technical point of view, there are WIM systems on the market that enable accurate weighing of GVW and axle loads without slowing down or stopping," says Klauser. "We have a

China stands alone

While toll-by-weight has yet to catch on in the West, China began its enforcement regime at the turn of the millennium

Back in 2001, China introduced toll-by-weight (TBW) into a number of its provinces including Jiangsu, Qinghai and Henan. By 2005, the Chinese government had issued a formal roll-out of TBW across the entire nation. Today 90% of highways in China have TBW for HGVs. The TBW infrastructure is often located on specified lanes at toll plazas. HGVs drive through the toll plaza at low speed – less than 20km/h (12mph). When the HGV passes by the weighing system, the system collects data about vehicle classification, license plate, axle load, gross vehicle weight, and other information.

"The system calculates the charge according to the charge rule and limitation of weight of different types of HGVs," says Eric Qian, business development in Asia-Pacific for Kistler. "The vehicle then displays the related information in front of the driver, and the driver pays. Currently most payment is operated manually, and

trucks stop and go. There are some pilots in a few provinces to operate by electronic toll collection (ETC) along with a complimentary trend toward the implementation of high-speed or free-flow toll-by-weight in China. As of April 2018, 4.3 million truck drivers are using ETC in the country, including 839 toll plazas across 103 highways in Guangzhou Province."

A 2013 paper on the practice of TBW in China concluded that

while its fee structure is more complicated than a vehicle-class-based strategy, it is fairer and more flexible, and its performance may be further improved with more accurate WIM systems. However, the paper also suggested that TBW can increase freight transportation costs, cause some local truck drivers to switch to local non-toll roads, and increase traffic delay and highway operating costs.

solution that is capable of certified low- to high-speed dynamic weighing. In other words, technology for TBW is ready. What is missing is the legal background. This is as much a question for the political representative of particular countries as it is for solutions providers."

"Many countries do not accept the TBW concept because it is against the

> " Many countries do not accept the TBW concept because it is against the environmental efficiency and the productivity of road transport

Bernard Jacob, deputy scientific director, IFSTTAR

environmental efficiency and productivity of road transport," says Jacob. "It would penalize, or reduce the benefit of, fully loaded trucks compared with half-loaded or empty trucks, which are not the most efficient. There was even a debate

Weigh back when…

WIM technologies have come a long way since their 'birth' in the 1950s

Weigh-in-motion (WIM) systems were first created in the 1950s by engineers at the United States Bureau of Public Roads (now the Federal Highway Administration (FHWA)). They were initially used to help engineers with the design and development of pavements in accordance with the American Association of State Highway and Transportation Officials' (AASHTO) design code.

Following the creation of basic prototypes, made of sensors attached to concrete platforms, bending plates were used to collect information about vehicles' axle weights and vehicle loads.

From the 1970s, European countries began developing more types of scales, including wire, strip and bar sensors, capacitive, piezoelectric (ceramic, polymer and quartz), and finally fiber optics.

The first standard for WIM systems – the ASTM-1318 – was created in the USA in 1994 and a few years later, in 1997, the COST323 initiative created specifications for European WIM systems, as well as pan-European tests of WIM systems. From 1994 to 1996, the European WAVE (Weighing-in-motion Axles and Vehicles for Europe) project explored new and improved WIM technologies to better the accuracy of systems.

Since the 1990s, far greater accuracy of WIM systems has been achieved and they are now commonly used for screening overloaded trucks and preselecting them for legally enforceable static weighing.

WIM system technologies are continuously being enhanced to increase their accuracy – particularly when being used with vehicles traveling at high speeds. There is now the possibility for WIM to be used for direct enforcement, doing away with the need for static scales completely.

Left: **A truck weigh station in Pennsylvania in the 1980s**

> A number of countries are about to start pilot projects on the use of WIM for tolling by weight, or for direct enforcement
>
> **Hans van Loo, transportation consultant, Corner Stone**

about taxing empty vehicles to incentivize loading them optimally. The main idea is that the higher the load, the better the productivity. Many countries use WIM for overload enforcement, mainly for preselection. A few are using it for direct enforcement. France is about to join this list."

Approval for new measures requires endorsement from legal metrology institutes such as the International Bureau of Weights and Measures (BIPM), a notoriously conservative organization. According to one interviewee who wished to remain nameless, the BIPM "generally does not understand dynamic weighing, hence will not approve it".

"Education is the key," remarks Koniditsiotis. "That means education of the end users on the possibilities of the use of WIM for tolling by weight, as well as the legal metrology on how to test and certify the systems."

Rolling out around the world

"I see a trend where a number of countries have put in place, or are about to start, pilot projects on the use of WIM for tolling by weight, or for direct enforcement," says Hans van Loo, founder of Corner Stone, a Swiss-based consultancy specializing in WIM. The countries include Japan, India, Russia and Brazil. "I know other countries who are thinking about it, while some have rejected the idea outright as they have a different tolling philosophy, for instance Germany," says van Loo.

"Basically, the requirements for both TBW and direct enforcement are very similar – a fine or fee is directly based on a WIM data without any secondary control measurement. With the current generation of WIM technology, the new Netherland Metrology Institute WIM standard and the development of advanced WIM data quality control, I think WIM can be used for these applications. I am not saying it will be easy to implement it, or that it will happen overnight, but I think we will see the first implementations in Europe in the coming five years. The political challenge is always with the government to get the system accepted. The technological challenge meanwhile is to guarantee accuracy and reliability with each measurement, not just on average."

"We are constantly raising the topic, either with customers or at conferences," concludes Kistler's Klauser. "There is a huge potential out there for TBW. In due course, we hope it will become an area of great development." ○

WIM PRO 2.0

WEIGHT IN MOTION SYSTEMS

The WIM PRO 2.0 system is the newest solution that allows to weigh in motion vehicles at high speeds. The basic configuration allows to preselect vehicles exceeding the allowable values, especially vehicle weight and axle weight.

In connection with the VMS signs, the system may semi-automatically or automatically re-route vehicles exceeding the permissible standards, e.g. overloaded vehicles, to the car park. Such solution allows a selective control of particular vehicle type. The most advanced solution, when combined with a database, allows an automatic ticketing.

The WIM PRO 2.0 system was developed focusing on the highest reliability and measurement accuracy even for a large number of lanes. System can be integrated with other ITS systems.

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* Tested at - 37°C in Lapland.

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Bridge WIM

Game
plans

Preparations for the FIFA World Cup in Russia this summer weren't confined to stadia and training grounds; traffic management was a primary consideration for the nation's host cities, as **Eugene Gerden** discovers
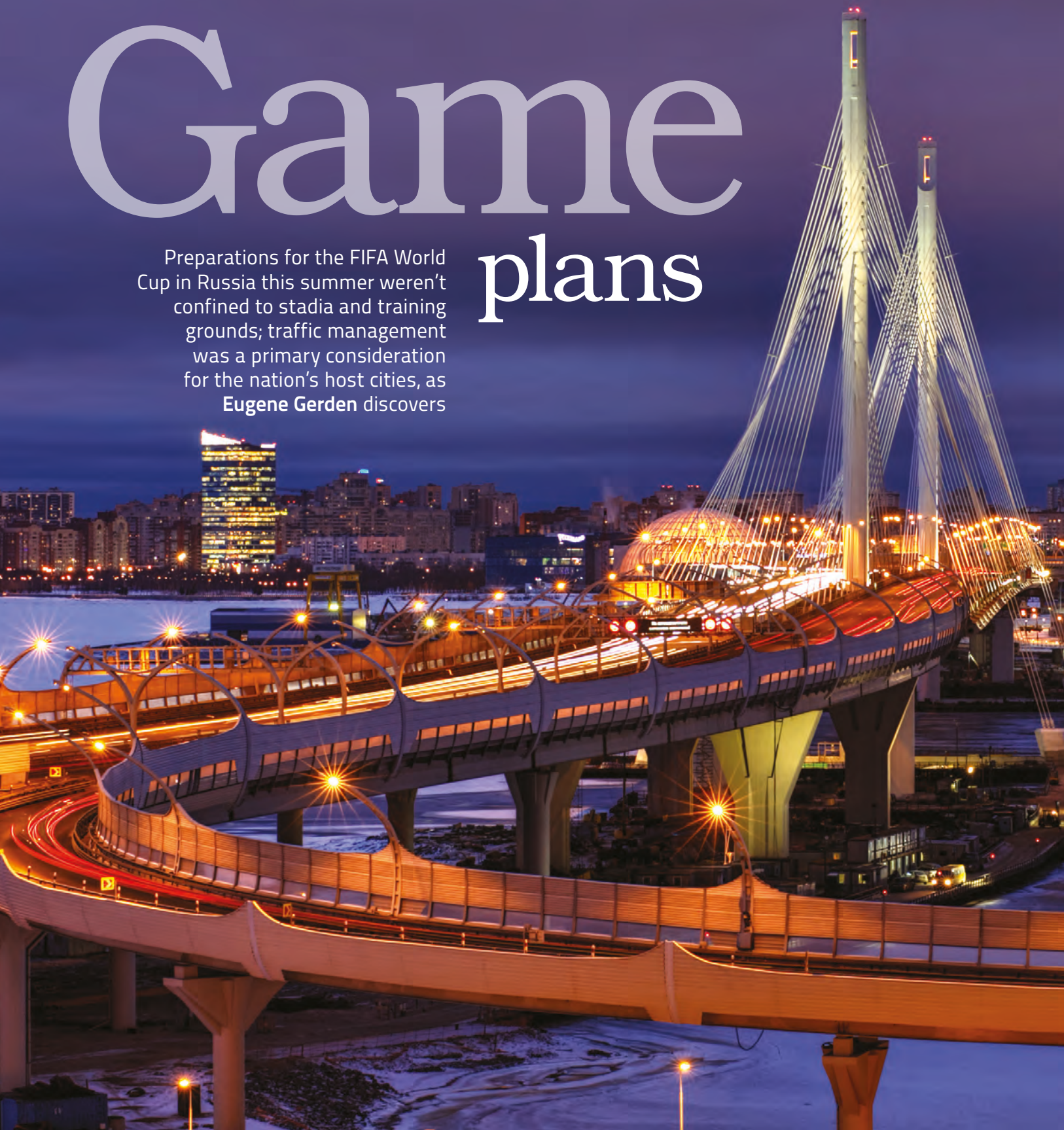
This summer, for the first time, Russia adds 'FIFA World Cup host' to its list of achievements. Such international sports events inevitably mean moving large numbers of people from place to place – a significant logistical challenge that means preparations must be taken very seriously.

In advance, the Russian Ministry of Transport predicted that around 2.5 million Russian and international soccer fans would be attending matches at the event this summer, many of them visiting at least two games. Therefore, it was necessary to plan for movement both within already traffic-congested city centers and across the country, between host cities, which lie an average distance of 300 miles (482km) apart.

In the weeks leading up to the first match between Russia and Saudi Arabia, experts at the Russian Ministry of Transport issued a statement saying that the country's transportation system was ready, thanks to huge efforts by the federal government and regional authorities

Saint Petersburg Stadium, also called the Zenit Arena: location of a 2018 FIFA World Cup semi-final and the third-place playoff match

Right and below: **This summer, Russian soccer fans put extra pressure on the country's road network, particularly in Moscow** (below right)

40,000

Approximate number of traffic signals in Moscow. Around 2,600 of these are now connected and adaptive

in improving the country's traffic management system. The event fully tests the new intelligent transportation systems that have been introduced in host cities, which includes some completely new traffic management centers.

City focus

No city has been under greater scrutiny than Moscow, capital and the location of the 81,000 capacity Luzhniki Stadium – the venue for the World Cup Final. Moscow's intelligent transportation system was fully upgraded ahead of the event and now includes around 2,600 traffic signals, 2,000 CCTV cameras and 3,700 vehicle detectors of various types.

The ongoing roll-out of ITS in the capital has helped to reduce the problem of congestion in recent years, and certain technologies have been key in easing flows of traffic around the key venues.

One of them is the Russian-Japanese traffic light regulation project, which is based on advanced traffic control system Artemis (also operational on key roads in Saint Petersburg). Vadim Yuryev, head of the Center for

> The new system allows us to analyze traffic and adjust signal settings accordingly

Vadim Yuryev, head, Center for Road Traffic Management, Moscow

Road Traffic Management of Moscow, explains that the new system has the ability to predict traffic flows and regulate congestion.

"The new system allows us to analyze traffic and adjust signal settings accordingly," says Yuryev. "It includes roadside signal controllers, vehicle detectors and a data network that connects all of these devices together. The overall aim of the
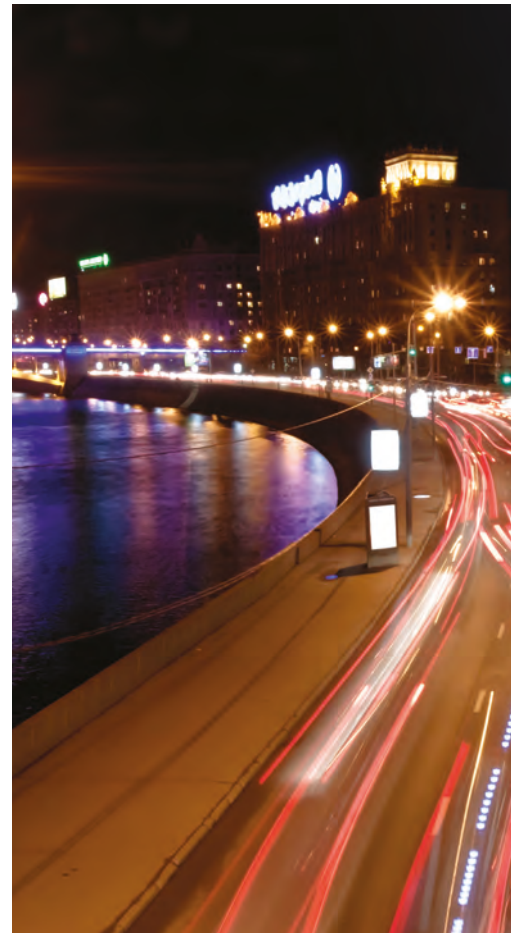
Pay-by-plate

An innovative system currently being rolled out in Russia enables automatic fine payments via license plate-embedded RFID chips

Rented cars, combined with some smart new tech, are offering a unique traffic management opportunity during the FIFA World Cup.

Some will be equipped with a new identification technology known as ElecTraCop, designed by a company called Vzglyad. The new system involves implanting an RFID tag into a car's license plate. The signals from these can be received by electronic readers that are installed under or next to the road, and collect unique data from the car.

The system can be used not only to monitor traffic flows, but also to automatically charge money to the personal account of the car owner, for everything from traffic violations to on-street parking.

"So far, no country in the world has tied license plates to the bank cards and e-wallets of car owners," says Igor Matsur, general director of Vzglyad. "The new system also has the ability to monitor traffic flows in real time, in order to help reduce or avoid traffic jams."

If anyone tries to remove the license plate, Matsur says that it is possible to set up the car so that it will be immobilized, and it is even feasible that police could remotely stop the engine should the car be stolen.

"The new system will not violate any civil liberties of Russian drivers, as they will have the right to file a protest if they are fined, and if they are successful the funds will be returned to their account," says Matsur. "In addition, funds can only be taken if a bank card is linked to an automatic program of payment traffic fines, which is offered on a voluntary basis by the majority of Russian banks."
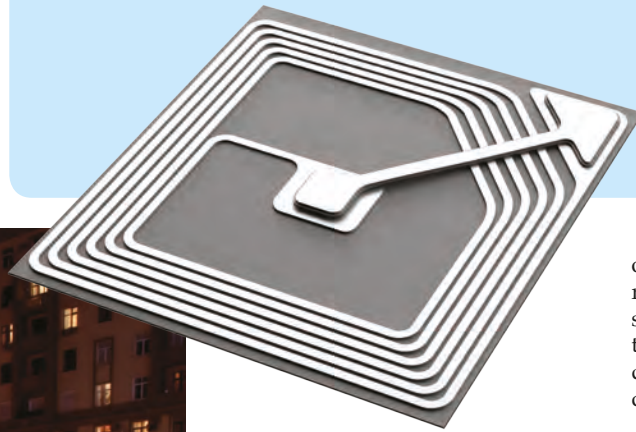
3,700
The approximate number of vehicle detectors in operation in Moscow

system is to minimize the waiting times at traffic signals."

Highway solutions
While city centers are equipped with increasing amounts of vehicle detection and traffic regulation hardware, out on major arterials the deployment of such systems is not so dense. This is where smart devices in cars can step in to inform drivers of potential problems ahead, in real time, so long as they are running the right software.

Starting back in April 2018, ahead of the World Cup, Russia began rolling out Atlas, an advanced software solution for managing traffic on freeways, which was designed by the Russian engineering company Kursus.

Artem Khozyainov, general director of Kursus, explains, "Our task was to design a new technology, which is able to supply accurate, up-to-date information on the state of the road traffic and events. For example, the start time and duration of planned road works, or the timings of World Cup matches. By transmitting such information to the navigation services, we allow drivers to pre-plan their route in such a way as to avoid unnecessary delays to their journey."

Cybersecurity
High-profile international events are potential targets for terrorist attacks. Protecting against these isn't simply a matter for security services. Key systems, including traffic management ones, must be protected from cyberattacks. This is why the Russian government invested US$250m to ensure of protection of the country's national road system and traffic management, ahead of the FIFA World Cup. As part of these

Above: **Moscow's Luzhniki Stadium, the national stadium of Russia**

plans, particular attention was paid to the protection of ITS in host cities.

According to data of the Russian Ministry of Internal Affairs, in recent years, the number of cyberattacks on the Russian traffic systems has increased, and, according to data that was recently collected by the Russian special services (in particular the Federal Security Service), hackers are still preparing new attacks.

Head of the Moscow Department of Transport Maxim Lixutov says the Center for Road Traffic Management of Moscow has installed a new software system, supplied by Kaspersky Lab, which is designed to protect the Moscow ITS against hacker attacks and leaks.

Lixutov says the new software minimizes the risk of penetration of malicious programs into the database of transportation infrastructure. "This is part of the latest software security tools that will ensure the safety of the Moscow ITS, which in recent years has been considerably modernized," he says. "The introduction of new ITS is usually connected with serious risks, as it can be vulnerable to cyberattacks, but we now have the most reliable protection available."

However, the introduction of the Kaspersky system in the Moscow ITS has already been criticized by some leading Russian experts in the field of ITS and experts of the Russian Ministry of

⟱ | Future solutions

Could the long-term solution to traffic congestion in Russia's major cities lie in an update to historical monorail concepts?

Germany, France, Italy and Brazil have all hosted the FIFA World Cup twice. If the event were to return to Russia in 20 years, what transportation solutions might be available then that aren't around today? The answer could lie in a solution designed by a Belarusian startup. SkyWay is an electric 'string rail' system, which runs pods above or below a thin double rail.

Benefiting from low-cost infrastructure with a small physical footprint and low running costs, prototypes of the concept have already been built and received approval from the Russian government, which has expressed interest in building working tracks.

Head of the department of targeted projects of SkyWay Technologies Co., Kirill Badulin, says the new technology involves the transfer of cargo-passenger flows from roads, rail and air into a new, separate space – the 'second level'.

"SkyWay vehicles are moving over land on a special rail-string trestle," he says. "This ensures unprecedented safety, the rational use of land and resources, increases the speed of movement of people and cargo, and minimizes the transport damage to the environment. The continuous pre-stressed rail-stringed pier, as well as track-mounted cars on steel wheels are the main elements of the SkyWay transportation solution."

> ❝ The introduction of new ITS is usually connected with serious risks, as it can be vulnerable to cyberattacks, but we now have the most reliable protection available
>
> **Maxim Lixutov, head of the Moscow Department of Transport**

12%

The average increase in traffic speed in Moscow in the past five years, since new ITS has come online

Transport. They say that, due to a reported affiliation of Kaspersky with Russian special services, there is a threat that Moscow ITS is being used by the city's authorities and special services to monitor the movements of foreign tourists and football fans.

These statements, however, have been denied by the Moscow Department of Transport, which says ITS is only being only used for the prevention of accidents and reduction of traffic jams, and that it helps to ensure the security of the public. ○

15%

The average decrease in incidents of speeding in Moscow in the past five years, since new ITS has come online

Safe
passage

Earthquakes and general wear and tear have taken their toll on Seattle's aging cross-city double-decked highway. **James Allen** reports on a major construction project to replace it that will instead redirect traffic underground through a newly bored tunnel

Main image:
Construction of the SR 99 tunnel nearing completion

Inset: **An aerial view of the Alaskan Way Viaduct, which the tunnel will replace**

State Route 99 (SR 99) is a 49-mile (79km) stretch of state highway maintained by the Washington State Department of Transport (WSDOT).

In 2013 WSDOT, in conjunction with the Seattle city government and the self-governing authorities of the city's port area, embarked on a major construction project on a section of the route running through Seattle. Five years on, there is light at the end of the tunnel.

For the past 60 years, the Alaskan Way Viaduct has served drivers in and around the city. Being one of two north-south corridors crossing Seattle, as many as 110,000 drivers make use of it every day.

Under, not over

Once the construction project is completed, however, drivers will no longer have the elevated position afforded to them by the viaduct and will instead be routed underground through a 1.7-mile (2.8km) tunnel.

Positioned in an area prone to tectonic activity, the 1950s-built viaduct was not only in need of repair but, following the tremors of the 2001 Nisqually earthquake, was becoming a safety hazard due to

Right and below:
Traffic will travel through the SR 99 tunnel on two levels – one for each direction

persistent settlement damage. The US$3.3bn Alaskan Way Viaduct Replacement Program (AWVRP) is a direct response to this concern.

In addition to the tunnel, a one-mile (1.6km) stretch of highway leading up to the tunnel, an overpass and a surface street to connect SR 99 to Seattle's downtown area are all included in the project, as is the demolition of the viaduct along the city's waterfront.

It is, though, the tunnel that is by far the dominant element of the project. Providing drivers with two lanes in both directions, the SR 99 tunnel will be the only one in the USA to be double-decked.

Associated risks

The risks associated with traveling through tunnels are many and varied, but Susan Everett, Alaskan Way Viaduct design manager at

> ❝ A robust deluge system can be deployed in the unlikely event of a fire. The entire tunnel is zoned to allow us to provide a targeted response only to the area where it is needed
>
> **Susan Everett, Alaskan Way Viaduct design manager, WSDOT**

WSDOT, is confident that the SR 99 tunnel will set a benchmark in safety.

"WSDOT's goal was a state-of-the-art tunnel to keep people and goods moving, as well as keep everyone safe in the event of an incident, large or small," she says.

A smorgasbord of design features and technologies back up this claim. They include an active traffic and demand management (ATDM) system to close lanes, adjust speed limits and notify drivers of congestion ahead; a public address system enabling traffic managers to speak direct to drivers

or broadcast AM/FM traffic updates; emergency exits with separate ventilation systems every 600ft (182m); an 8ft (2.4m) shoulder on one side of the two-lane road to provide space for broken-down vehicles to stop out of the way of moving traffic; and a 2ft (0.6m) shoulder on the opposite side to give adequate space for a pedestrian to move safely down the tunnel if required.

"In addition," says Everett, "power supply for the tunnel comes from two separate substations. If one source is lost, the second automatically kicks in. If both are lost, an emergency generator provides power, giving operators more than enough time to close the tunnel.

"We also have a robust deluge system that can be deployed in the unlikely event of a tunnel fire," she explains. "The entire tunnel is zoned to allow us to provide a targeted response only to the area where it is needed."

Above: **In the event of an emergency, a state-of-the-art ventilation system will assist response teams in fighting against fumes**

Above: **Bertha, the largest tunneling machine in the world at the time, bored the ground to create the foundation for the new SR 99 tunnel**

↘ A machine called Bertha

The Alaskan Way Viaduct Replacement Program heavily relied on a huge tunneling machine

The 57ft-diameter (17.5m), 300ft-long (91m) tunneling machine nicknamed Bertha – after Seattle's first female mayor – played an instrumental part in the Alaskan Way Viaduct Replacement Program.

Shipped to the city from its manufacturing facility in Japan, the Hitachi Zozen machine was assembled in an 80ft-deep (24m) launch pit underground.

Traveling at 35ft (10.6m) a day, Bertha began tunnelling underneath Seattle in July 2013 and broke through the other end nearly four years later in April 2017.

The largest tunneling machine in the world at the time, Bertha was able to bore through the ground while inserting the 1,426 2ft-thick (0.6m) concrete slabs that form the outer foundational ring of the tunnel's entire 1.7-mile (2.8km) length.

Bertha became a minor celebrity in the city, with its own social media

accounts and drawing crowds of several thousand at the start and end of its journey.

Once it had completed the boring of the tunnel, due to it being too large to be removed in one piece, crews spent four months dismantling the machine. The heaviest lift was 70 tons. In total, 580 truckloads hauled away 8,300 tons of equipment and metal, with over 75% of the metal being recycled.

A 10ft-long (3m) replica of the machine is now on display at the project's information center in Seattle.

"The system analyzes the video stream generated by the cameras and detects low visibility, stopped vehicles, slow vehicles, wrong way vehicles, pedestrians and debris in the roadway.

"When a slowdown is detected, our incident detection cameras search for a cause. If they detect something out of the ordinary, tunnel operators will be notified with an alarm and a live picture that pops up on computer screens inside WSDOT's Traffic Management Center.

"Operators can further use point-tilt-zoom cameras if they wish to get a better look. They can also activate signs informing drivers of a slowdown or accident, advise them what they should do and even close the tunnel if needed. Traffic ahead of an accident will continue leaving the tunnel."

Cell phone reception throughout the tunnel means drivers can also call 911 themselves in an emergency not detected by the system.

Reducing false alarms

Everett also points out that safeguards are in place to ensure that the ATDM system doesn't read too much into what it detects.

"To reduce false alarms, the system uses vehicle tracking to

To be able to do all this, the tunnel is fitted with 95 miles (153km) of electrical wiring, 21 miles (34km) of sprinkler pipes, 15 miles (24km) of lighting, 13 miles (21km) of fiber-optic cables and 8 miles (13km) of linear heat detectors.

The ATDM system alone consists of 35 color-matrix tunnel-control and 66 lane-control signs, as well as 300 roadway and security

cameras, while 98 emergency phones, 32 lane traffic data stations and 34 speakers for the PA system are spaced evenly along the interior of the tunnel.

"For traffic monitoring, the SR 99 tunnel relies on the intelligent ATDM system," says Everett. "We have taken the proven technology of traffic loops and ramp meters and added additional technology.

TEST 15 VMS

Left: **More than eight miles of fiber-optic heat sensors will line the tunnels' ceilings. When heat is detected, the sensors will activate ventilation fans and notify tunnel staff**

95 miles
of electrical wiring
in the tunnel

Below: **How the entrance to London's Silvertown Tunnel will look when it is completed in 2023**

analyze movement patterns," she says. "It can also identify permanent conditions such as shadows and signs. It has built-in learning mechanisms, enabling incident detection to become more accurate over time.

"Also," adds Everett, "there is the human part of the system – the tunnel operators – who receive the alarms, can activate, delay or deactivate the deluge sprinkler systems, and take other action as needed."

Should the tunnel need to be shut down, WSDOT, in conjunction with Seattle's DOT, can provide digital message signs covering the five-mile (8km) stretch approaching the tunnel.

Central management center
For the vast majority of the time, tunnel management will operate out of WSDOT's Traffic Management Center in the city of Shoreline, nine miles (14km) north of downtown Seattle. For additional monitoring, another operational building at the tunnel's north entrance also has control room capabilities.

Despite the scale of the project, replacing the viaduct with the tunnel has created only minimal disruption for travelers, as SR 99 has remained open for the vast majority of the construction period.

Under water

London to add extra road tunnel beneath the River Thames by 2023

Transport for London (TfL) has recently been given permission to build a road tunnel to relieve congestion in the east of the city. Set to open in 2023, the Silvertown Tunnel will relieve the bottleneck of traffic around the existing Blackwall Tunnel, which serves as the main route for crossing the River Thames in East London.

It is expected that as many as 37 electric or Euro VI buses an hour will be using the twin-bore road tunnel when its service commences in five years' time.

> **It has built-in learning mechanisms, enabling incident detection to become more accurate over time**
> Susan Everett, Alaskan Way Viaduct design manager, WSDOT

With the tunnel dug out and finishing touches on the new roads being made, attention is starting to turn to the challenging final task of the project. Three weeks have been set aside for closing the viaduct for the last time and rerouting traffic through the tunnel. WSDOT is preparing for the congestion challenges expected during the crossover. A rough date of sometime in the fall this year has been tentatively scheduled for an official opening.

"WSDOT, Seattle's DOT, King County Metro and other agencies are working together to ease the heavy traffic that always occurs when the viaduct shuts down for an extended period," explains Everett. "Drivers, bike riders, bus riders and others are already being informed of the changes ahead, and when the tunnel is closer to opening, we are planning a multifaceted campaign to inform the public."

It will be a challenging three-week period, but once over, drivers in and around Seattle will be able to reap the benefits of the city's new state-of-the-art tunnel. ○

SIGNS OF CONFUSION

1,500m

The maximum allowable distance between VMS gantries on a smart motorway (0.9 miles)

All-lane-running smart motorways – controlled by advanced VMS – are one of the flagship success stories of Highways England. Now, as the idea is taken up by other authorities around the world, **James Gordon** takes a look at the real-time traffic management practices necessary to ensure they work, and asks if a lack of public understanding could be hindering safety and reducing their effectiveness

On the surface, the West Berkshire village of Theale is like any other English hamlet. Small businesses, a school, a railway station and a golf course are its beating heart, while its proximity to the River Kennet puts it in an area of outstanding beauty. Yet, scratch a little deeper and not everything is quite as it seems. The village is also home to large businesses, which lie to the east on its outskirts. Many have located here due to the Berkshire suburb's easy access to the M4. And now with a 32-mile (52km) stretch of the M4 linking Theale to London – set to become a smart motorway – it's likely that many more companies will follow.

But this relatively short stretch of asphalt, which when it is finished in 2021/2022, could cost the UK taxpayer as much as £27m (US36m) per mile, has its detractors. Many wonder if smart motorways, which come in three forms – dynamic shoulder running, all-lane-running, and controlled motorways – are safe.

However, Nick Lloyd, the Royal Society for the Prevention of Accidents' (RoSPA) road safety manager, thinks such fears are unfounded. "Until we see evidence that shows there are safety issues arising from all-lane-running and dynamic-running motorways, RoSPA is not opposed to them. However, that said, we would advocate that further research is carried out as soon as possible, so we can statistically determine whether

> 66 Until we see evidence that shows there are safety issues arising from all-lane-running and the dynamic-running motorways, RoSPA is not opposed to them

Nick Lloyd, road safety manager, RoSPA
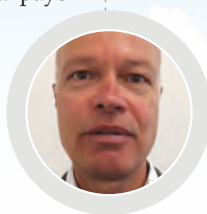
or not there has been an increase in accidents since they have been rolled out."

The primary aim of smart motorways is to improve traffic flows and boost capacity without the need to build extra lanes. This is achieved using a mixture of dynamic speed

250 miles
The length of the smart motorway stretches already in use in England, across **11** different M routes (402km)

limits and all-lane running. Highways England has already turned 250 miles of its highways into smart motorway, and plans to create a 700-mile stretch of smart motorway from London in the South, to Leeds in the North by 2030, some of which is expected to utilize 5G broadband technology to directly route traffic warnings and diversion information to connected vehicles.

Knowledge is power
But how do road operators win over the doubters, and ensure these super-intelligent stretches of highway work safety and efficiently?

One way of doing so is by educating the driving public. Joshua Harris, the director of campaigns for road safety charity Brake, thinks that opening the shoulder to drivers, a feature of smart motorways, "has

> 66 What the sign does not tell the driver is where the congestion is and what has caused it. Instead, it simply states, 'Congestion Ahead, Slow Down'
>
> **Jack Cousens, head of roads policy, AA**

raised safety concerns and it is clear that members of the public are not yet comfortable on such roads".

Harris adds, "It is vitally important that drivers are confident of their road environment and understand the correct procedures to follow – particularly on roads with high speed limits. The roll-out of smart motorways must be accompanied by an increased awareness and communications campaign to ensure drivers know the right road behaviors. A lack of clarity

can only lead to dangerous situations and this must be avoided at all costs."

But with Highways England's own research pointing to the fact that smart motorways are "actually safer than other motorways" while they improve traffic capacity "by up to a quarter", is the perceived lack of clarity really an issue?

On message
Jack Cousens, head of roads policy at British motoring association the AA, believes that one of the major issues is not so much around technology, but centers on how vital messaging is communicated by the road operators to motorists. Cousens, who has worked for the AA for eight years in a variety of roles including the AA driving school and manufacturer relations, says, "On smart motorways, the road operator has access to real-time CCTV cameras and radar to monitor the network and identify

Above: **Effective communication with motorists is key to good road management**

Smart workzone VMS

Using Google probe data, a UK-based VMS provider is able to display up-to-the-second diversion route travel times at the roadside

Another challenge that road operators must meet is accurately communicating the impact of freeway workzones on journey times. Too often, data that is relayed to the drivers is inaccurate or incorrect. So how do road operators solve this? Many think the answer lies in big data, and Highways England and its technology partners are already leveraging data to deliver shorter roadwork cycles.

To better manage traffic during recent construction work on the M60/M62 Smart Motorway Upgrade scheme in Manchester, for instance, Highways England reached out to Rennicks UK, a road signage technology provider, for help.

Managing director Ross Bullerwell takes up the story: "We use Google data to provide journey-time information for motorists on our portable VMS. It tells them exactly how long it will take to get through strategic diversion routes. We believe that our system is fairly unique because it takes into account the many nuanced and varying peaks and troughs of rush-hour traffic: information that the current one-dimensional systems employed today cannot process or communicate."

And so what is the science behind the technology? Bullerwell explains, "We begin by collecting live travel information from the Google Application Programming Interface. This anonymized crowdsourced information is drawn from cell phones, floating data from connected vehicles and roadside infrastructure. It is then further refined by algorithms processing millions of units of data, which then generate and update the journey time every 20ms."
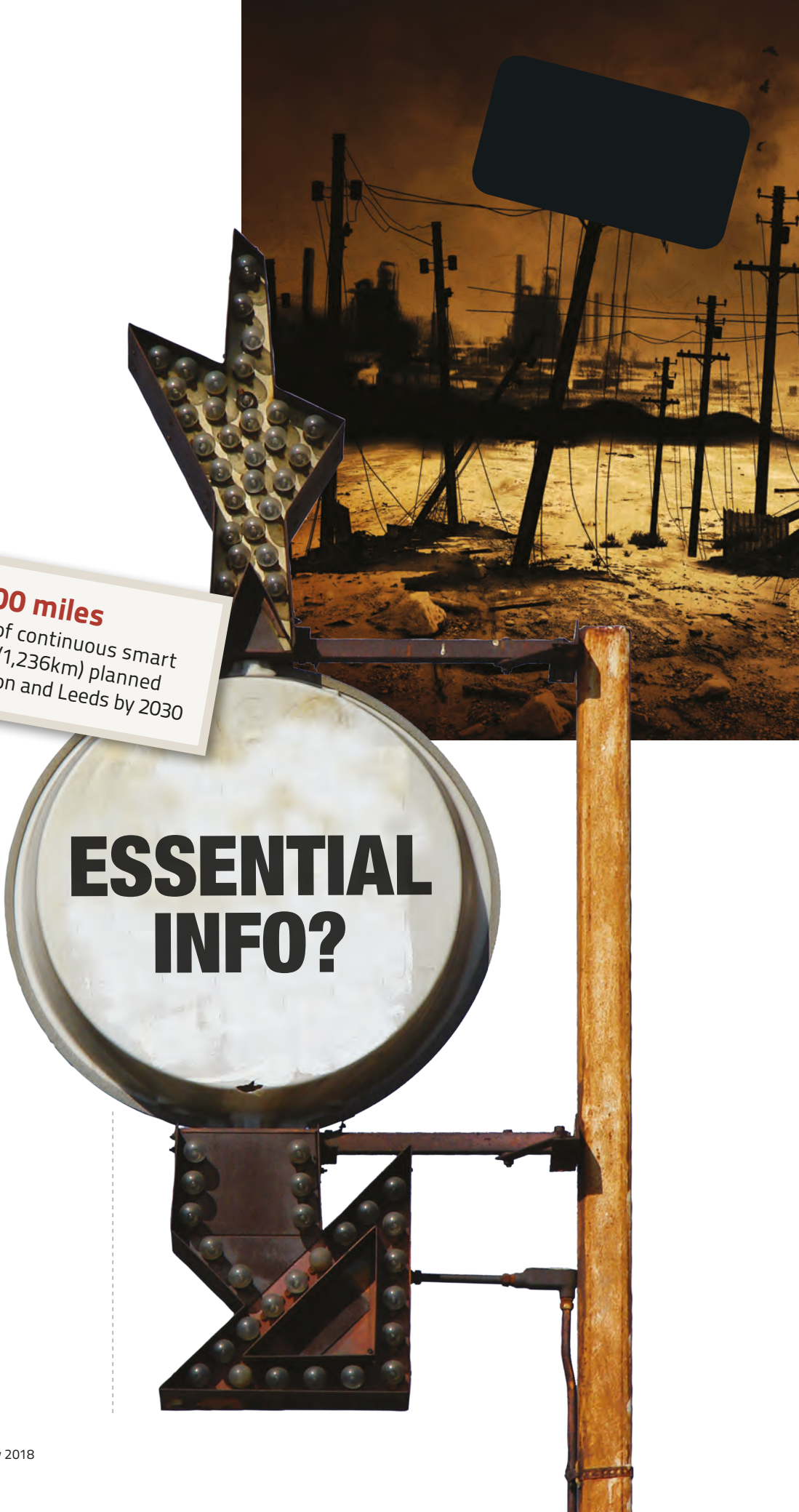
Bullerwell, who has worked in highways for the past 20 years in both the private and public sectors, thinks that real-time journey technology will be used much more extensively in years to come.

"Not only does it provide the driver with the most up-to-date information available, but it has the potential to save road authorities millions of pounds each year because one of the chief benefits of the technology is that it breaks the constant, iterative cycle of deploying and decommissioning standard time technology, which requires skilled engineers to attend the site every day."

So does Bullerwell think that a national roll-out of the technology could revolutionize how construction site information data is gathered and communicated to drivers?

"No system is infallible, and the success of our technology is reliant on other platforms for accurate data," he says. "But, yes, I believe it will significantly improve communication between road operator and driver."

congestion the second it happens. This technology enables Highways England to gradually reduce the speed of vehicles several junctions away from a tailback, so that when the vehicle reaches the jam – at least in theory – it will have cleared.

"But, what the sign does not tell the driver is where the congestion is and what has caused it. Instead, it simply states, 'Congestion Ahead, Slow Down'."

Cousens believes the system would benefit from greater clarity in terms of what messages are telling drivers. "If one says 'Congestion at Junction 1, Slow Down', then the driver will instantly know that if he continues to travel at 70mph (113km/h), then he'll hit the area of congestion, and in doing so, add more time to his journey," he says.

Steve Gooding, director of the RAC Foundation, a transportation policy and research organization,

700 miles
The length of continuous smart motorway (1,236km) planned between London and Leeds by 2030

ESSENTIAL INFO?

agrees that more coherent and intelligible messaging is required, and says that, "Information conveyed by VMS, which will display a red X when a lane is about to close, must always be accurate and timely."

He explains, "The very term smart motorways sets certain expectations. It conjures up ideas of fast-paced, adaptive, reliable traffic management. So if the reality, or even just the perception, is that the technology is not up to the job, because VMS are inconsistent from one sign to the next, or out of kilter with what people are seeing on the road, then the risk is that confidence in the whole system is undermined with potential serious results if the sign they doubt is the red X.

"Data disdain is a real danger. If warning signs and information signs aren't trusted by some drivers, it puts everyone at risk… Invalid information is, largely, an irritant at the time, but the cumulative effect on motorists' confidence, and ultimately their compliance, is a serious worry."

Timely reminders
Despite advances in technology, there are still concerns around the speed and accuracy with which key

Left: **There may come a time when traditional signage is no longer needed**

⬇ | The death of VMS?

Connected and autonomous vehicles make it possible to imagine a time when road signs are no longer needed. But how close is such a revolution?

With road operators moving more toward smart motorways and a connected vehicle revolution underway, could VMS boards, and the gantries they sit on, be consigned to history?

Jack Cousens at the AA believes that signage will be a necessary part of the road landscape as long as drivers have the capacity to control their vehicles, arguing that when we reach Level 5 autonomy, signage will no longer be required.

He says, "If and when fully autonomous driving technology emerges where there is no way that the vehicle can hand responsibility back to the driver, logically speaking, there would be no reason to know why the vehicle is doing what it is doing, other than the fact that it is taking you to your destination."

But Steve Gooding from the RAC, thinks that "this Holy Grail of traffic management", where cars will talk to each other and the surrounding infrastructure to communicate road conditions and traffic information, and make a better decision than a human being, "is some way off".

"It is sobering to remember that there are still thousands of miles of roads in Britain where a driver who breaks down can't even get a cell phone signal to call for help, let alone use the existing apps that might make travel easier," he says. "But even with the connected revolution coming, there is likely to be a place for traditional systems as part of an overall information networks – go to any railway station and you'll see people with all the latest travel information on their phones diligently studying the train departure board."

messaging is communicated via variable messaging signs.

"There are two types of issue," says Steve Gooding. "One arises where, for example, a sequence of VMS shows different messages because they are set by different systems, or where the reaction time built into the system means that the suspected debris in the carriageway is nowhere to be seen. The other, perhaps most difficult issue is where drivers are required to slow down because of queues or congestion ahead, only to find nothing but free-flowing traffic – precisely because they all slow down – a much trickier communications challenge, but surely not impossible to overcome."

Education and conflict with other information systems aside, Highways England is confident that its smart motorway network backbone is up to the job. Mark Pellowe, group leader for Highways England Operational Technology Architecture and Infrastructure, says network latency on Highways England's transmission network, which is one

> **"Data disdain is a real danger. If warning signs and information signs aren't trusted by some drivers, it puts everyone at risk**
>
> Steve Gooding, director, RAC Foundation

of the largest single networks in the country, does not present an issue to the operational environment.

"Latency is tightly specified and controlled so that the time between any two points on our network, for IP-related services, is no more than 20ms," he says. "Latency is not an issue, specifically because Highways England appreciates the risks that uncontrolled latency may present and therefore we must ensure that it is consistent.

"For message signs that display information to the traveling public, a 20ms latency between the central system requesting the message, and the sign receiving and displaying it, is tiny in comparison to the time it may have taken for the control center to become aware, and the information about the incident is simply that – information – and not an instruction [e.g. a speed limit change] to the traveling public."

Chasing away phantoms

If latency is not a concern, why do some motorists complain about VMS information that is no longer relevant, or signage warning drivers of congestion that isn't actually there? The answer is often that it is precisely because a smart motorway is working well that congestion appears to vanish. One of the primary aims of smart motorways is to reduce the instance of phantom jams, which occur when traffic is too dense and fast, and the sharp braking of one vehicle causes other vehicles behind to

Smart motorways improve journey time reliability by **22%**, according to Highways England

Left: **Smart motorway algorithms use input from radar or buried magnetic induction loops to recommend variable speed limits**

slow. In dense traffic, this can create a domino effect that eventually results in all the traffic coming to a standstill. If variable speed limits successfully slow traffic, then this domino effect can be avoided, or reduced, so that serious congestion never occurs.

Pellowe explains, "The MIDAS [Motorway Incident Detection and Automated Signalling] algorithms use input from buried magnetic induction loops or radar to determine traffic flow levels, and in some situations will request the central system to set advisory speed limits automatically [in line with safety-focused system rules], or inform road users of the potential queue ahead.

" Latency is tightly specified and controlled so that the time between any two points on our network is no more than 20 milliseconds

Mark Pellowe, group leader, Highways England Operational Technology Architecture and Infrastructure

"These algorithms have been developed over the years by the traffic engineering industry in cooperation with Highways England, and seek to encourage traffic to slow down to, for example, stop a queue forming, or protect the back of a queue – among other traffic flow and information purposes."

So, in fact, the main problem is with education. Motorists complaining about non-existent congestion need a deeper knowledge of the workings of smart motorways.

Meanwhile, for their part, traffic engineers are constantly monitoring the control systems to attempt to ensure they work as effectively as possible. "The algorithms are under constant review," says Pellowe. "Specific, site-based values can be individually configured, as can wider global variables such as the minimum setting time being reviewed. Updates can then be made to the traffic engineering algorithms. There are specific teams working continuously in this arena to monitor and improve on-road performance."

The only problem is, the more effective these systems become, the more pressing will be the need for public education. ○

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Your essential guide to the future of transportation communications

4G safety

A trial in Israel is proving the viability of a cellular-only, smartphone collision-avoidance system

Smartphone-based V2X safety enhancing technology has been successfully trialled in Israel.

The Eye-Net accident prevention system, from Foresight Autonomous Holdings, provides pre-collision alerts in real time to any smartphone user, be they a pedestrian or driver, via existing cellular networks.

The controlled trial was carried out at a central intersection in Ashdod, Israel's largest port, in collaboration with NoTraffic.

In the virtual scenarios tested, Foresight met all predefined objectives and indicators for the use of the Eye-Net system in a manner that enabled all drivers to brake safely and avoid a crash.

During the trial, information was streamed in real time to the control center on-site, displaying on a map the location and time of occurrence of the simulated collisions, as well as the classification of the road users involved.

Haim Siboni, CEO of Foresight, said, "This project enabled us to test our ability to integrate with smart infrastructure to reduce the number of accidents in an urban environment. Integration with the NoTraffic system helped us examine a variety of realistic scenarios, all of which presented impressive results. We intend to continue the development process."
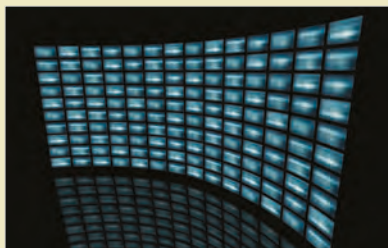
f camera

With probe data providing everything from weather and accident reports to speed enforcement and mapping, could traditional ITS be on its way out? **Paul Willis** assesses the current state of play, as the EU's recent eCall mandate looks set to send the connected vehicle revolution into overdrive

Using technologies like satnav and smartphones in cars is often blamed for jeopardizing road safety. A recent University of Utah study found that completing tasks with these technologies led drivers to take their eyes off the road for an average of 24 seconds at a time. To put this in perspective: the risk of a car crash doubles when a driver is distracted for just two seconds, according to research conducted by the US government.

But while these technologies are the cause of more accidents, they also offer a potential solution for cutting road deaths. This is because data from smartphones and

onboard vehicle systems like satnav is increasingly being put to use to detect, notify and even prevent road accidents.

This March the EU made it mandatory for all new cars to be fitted with an emergency call feature known as eCall. The system is connected to the car's airbags and in the event of an accident triggers an automatic call to the emergency services. Millions of US cars are already fitted with a similar system – General Motors' OnStar feature.

Because the technologies that enable OnStar and eCall are standard features in smartphones, a number of crash detection apps now exist for phones. In 2010 software designer Chris Thompson developed WreckWatch, one of the earliest of these apps, as part of a research project at Vanderbilt University in Nashville, Tennessee.

"It works like the airbag system," says Thompson. "It has a single tri-axis accelerometer that's looking for a big change in velocity. It works in conjunction with a GPS to plot your location."

> 66 **For slippery road conditions you need data from a combination of sensors, including the anti-lock braking system and the electronic stability control**
>
> Monali Shah, director of intelligent transportation, Here

Owing to limitations in cell phone technology at the time, when it finally made it to market, WreckWatch had evolved from an app into a standalone device known as SplitSecnd, which plugs directly into a car's power supply.

Probing for more

Data extracted from vehicle movements by the likes of eCall and SplitSecnd is known as probe data and its use in road management extends well beyond accident detection. Digital mapping company Here Technologies, which created the first digital maps for vehicle navigation 30 years ago, uses probe data extensively across its ecosystem of services.

"When we started collecting this traffic data we did it by putting out

road sensors," says Monali Shah, Here's director of intelligent transportation. "But over the past few years, the amount of probe data we've been collecting has exploded and now it's the primary source of traffic information for us."

In the past two years alone the company has gone from processing about 30 billion probe points a month to 100 billion, says Shah. Included in these figures is a growing amount of onboard vehicle data. Because Here is owned by a consortium of German automotive companies – Audi, BMW and Daimler – it has begun aggregating data from their fleets of vehicles.

"It's a really exciting development for us because it gives us access to a much broader range of more accurate data," she says.

For example, data from the car's hard-braking sensors can help signal sudden congestion. Other road safety alerts require a broader range of sensors.

"For slippery road conditions you need data from a combination of sensors, including the ABS and ESC. We use machine learning and algorithms to detect from this sensor

Right: **Probe data is already widely used in monitoring and predicting traffic flows**

APPROACHING SPLIT LANE MERGE

GPS 41.8781° N 87.698° W **20** mph

TRAFFIC FLOW
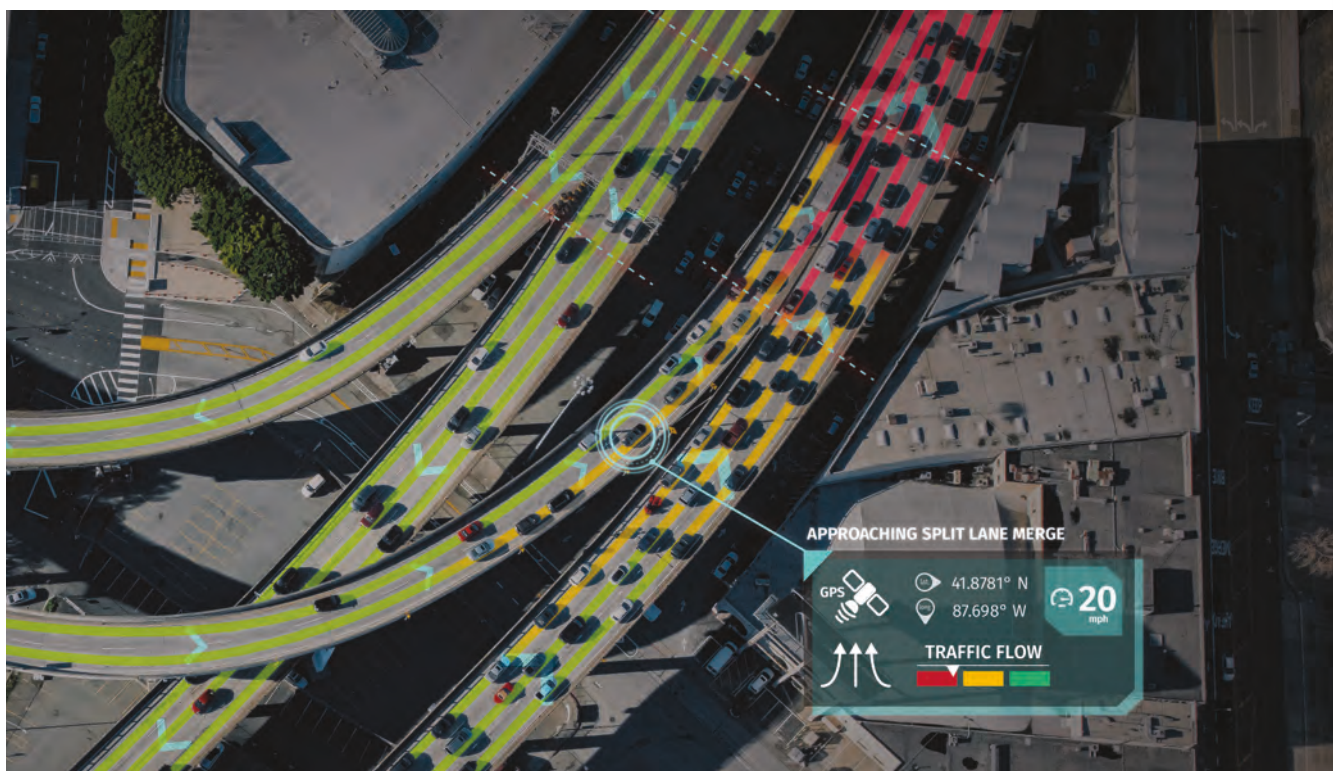
Left: **eCall could reduce emergency service response times by up to 40% in urban areas and up to 50% in rural areas**

◉ | Accelerating change

A new project in York, UK, will provide authorities with an exciting glimpse into how they can get the best out of fresh data

This March it became mandatory for all new cars produced in the EU to be fitted with the eCall emergency response system. There is nothing especially groundbreaking about eCall itself – a similar system, OnStar, has been popular in North America (and available in other territories) since the mid-1990s. However, OnStar has never been mandated by any government.

This fact, coupled with the timing of its introduction, means that eCall is expected to usher in a new generation of so-called connected cars as auto makers take advantage of the telematics technology eCall relies on to install a range of other telematics services, such as advanced navigation tools, smart parking and wi-fi.

"We're going to get a lot more connected cars," says Andy Graham, of the UK's ITS Connected and Autonomous Vehicle Interest Group. "And it won't just be top-of-the-range models. When I was young they used

to sell cars on sex and performance. But going forward it's going to be about how good your wi-fi connectivity is."

But while the extra connectivity may be its most attractive feature, the primary reason for eCall's introduction is to cut motoring deaths. Pilots of the service suggest that eCall could reduce emergency service response times by up to 40% in urban areas and 50% in rural areas. This is important because research shows that crash victims who get treatment within the first 60 minutes after a major incident have up to a 50% higher survival rate.

Even so, not all countries have welcomed the eCall rollout. The UK, for example, has questioned the business case for eCall on British roads. Graham understands their skepticism.

He says: "The UK is compact, with cameras all over the road network. If you have an accident someone is likely to come across you quickly. But in places where there's less traffic but more accidents, it's a better business case."

combination when these road conditions occur."

While a road accident can be detected using a single vehicle, other conditions like heavy rain must be corroborated by multiple vehicles because "there are reasons other than rain that might explain why a single vehicle might have its wipers on high."

The data that Here collects is used to create real-time traffic data feeds that are used to power apps such as Microsoft's Bing Maps, as well as by government and state transportation agencies to help manage the road network.

François Fischer, a senior manager in the connected and automated driving department at ERTICO-ITS Europe, says that the efficacy of systems like these relies on the volume of vehicles providing probe data.

"Data servers are hyper-connected platforms, in the sense that they have a 'southbound' connection to the sensors providing the data to be analyzed and a 'northbound' connection allowing customer-oriented applications," he says. "The more vehicles providing probe data,
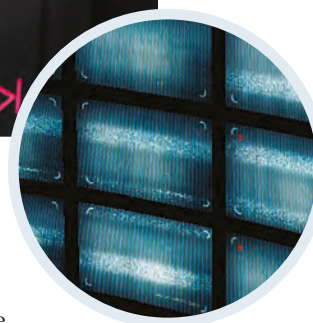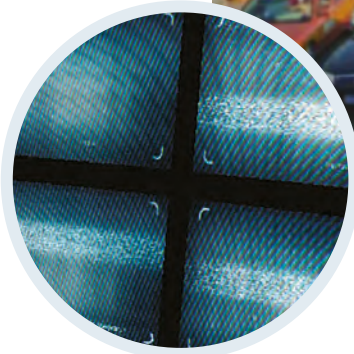
Roadworks ahead!
1km left lane closure

Roadworks Ahead

Traffic Incident

120 Meters

Warning!

Route updated, changing
lanes to avoid congestion

20 Meters

Speed safely adjusted, vehicle sensors
detect immediate obstruction ahead

3 Meters

Above: **Detailed
real-time probe
data can now be
sent back to drivers**

the more accurate and predictive the data servers can be in generating alerts or traffic information."

Analyzing driver behavior

More data also means greater granularity. This is certainly true with vehicle data, where the complex array of sensors on modern cars is giving rise to some potentially very interesting use cases. For example, researchers at Japan's Shibaura Institute of Technology have developed a method to predict traffic jams based on driver behavior. Prof. Toshio Ito used onboard

❝ The more vehicles that are providing probe data, the more accurate and predictive the data servers can be in generating alerts or traffic information

François Fischer, senior CAV manager, ERTICO-ITS Europe

sensors measuring speed, steering angle and pressure on the accelerator to detect a driver's unconscious responses to a rise in traffic volume.

According to Fischer, the additional data provided by onboard sensors could also give rise to more dedicated services: "For

example, you could provide insurance or car rental rates based on how a vehicle is driven." In these circumstances, two people could generate different rates based on the risks they take behind the wheel, and the wear and tear their driving style inflicts on the vehicle.

But while car data may offer greater potential than phone data, it is also less widely available as it is mostly the proprietary information of car makers. Phone data, by contrast, can be used for free. Consequently, companies such as Here still take the majority of their probe data from mobile devices.

"Car data is higher quality, but it's commercial data so you have to pay for it," says Andy Graham, chair of the ITS Connected and Autonomous Vehicle Interest Group in the UK. "Phone data is more about sharing."

Connected future

The comparison between the two data types is similar in some ways to the early days of the internet and the difference between proprietary search engines like Explorer and open-source systems like Mozilla. In the same way, Graham thinks the future will involve a mixture of the two data types.

Left: **Once considered distractions to drivers, smartphones are now being used to gather data that can help prevent accidents**

⬎ | Cars with eyes

When every car has a built-in or onboard camera, will there still be a need for cameras on the roadside? Toyota is looking to the future

Roadside cameras, either to catch speeding drivers or to monitor traffic flows, have been part of traffic management for some time. However, in the future, the cameras that make the biggest contribution to this area may not be on the roadside, but in cars themselves.

In-vehicle cameras are already being leveraged for this purpose. This spring, for example, Toyota began a trial aimed at using onboard camera data from 500 Tokyo taxis to help provide real-time traffic updates for the car maker's TC smartphone app. The camera data will be run an artificial intelligence-facilitated analysis to provide lane-specific traffic congestion information.

Meanwhile, Here Technologies has also begun aggregating vehicle camera data to make speed limit updates to its digital maps. "If we have a speed limit recorded for a section of road and then the camera detects a sign that shows a different speed limit, it can initiate an update process in the cloud. It's a new way of updating," says Monali Shah, Here's director of intelligent transportation.

Graham also thinks that the uptake of safety systems like eCall may ultimately hinge less on their ability to save lives than the extra features that the underpinning technology enables. Under the eCall mandate, cars must be equipped with a GNSS receiver to provide the vehicle location and a 2G modem for voice communication. Car makers are taking advantage of this new layer of connectivity to equip the eCall generation of cars with a range of new telematics systems.

Graham says, "The thinking is, if you're going to all that expense and trouble, why not install something that people would actually want to spend a bit more money on? When you're young, you don't necessarily care about having a vehicle that will notify the emergency services when you have an accident. But you do care about having a vehicle that has a wi-fi hotspot in it so that all your friends can Instagram each other while they're driving around. That's a much bigger draw."

In the end, the biggest consumers of connected vehicle data for road safety are more likely to be state and

> ❝ Countries like Bulgaria, where they don't have the roadside infrastructure, are going straight to connected vehicles
>
> **Andy Graham, chairman, ITS Connected and Autonomous Vehicle Interest Group, UK**
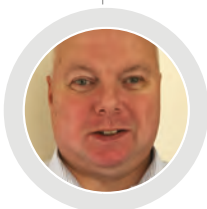
government transportation agencies than private motorists. And the level of interest will vary from country to country, as some public bodies are still wedded to the old ways of doing things. This is particularly true in countries like the UK and Australia that have invested heavily in traffic monitoring infrastructure.

"Richer countries have been slow to make use of connected vehicle data," says Graham. "But countries like Bulgaria, which lack the roadside infrastructure, are going straight to connected vehicles. It's like what happened with cell phones in Africa – people who had never had a phone before went straight to cell phones without ever having a landline." ○

Left: **When an incident occurs out of the view of a traffic camera, probe data provides the best way to report it to traffic managers**

With its new project, traffic app developer Waze will enable cities and public agencies to not only harness real-time probe data for advanced traffic management operations, but also communicate directly with drivers on the road.

Data collected from the company's real-time, crowdsourced, traffic and navigation app will be fed into a cloud-based traffic management platform, developed by Israeli firm Waycare.

After being processed and aggregated on the platform, the anonymized information from the app's users will be shared, allowing traffic managers to benefit from it as well as giving them the option to communicate back to drivers with the Waze app and warn them about dangerous roads, hazards and other incidents in the local area. The platform also enables municipalities to capitalize on the enormous amount of data coming from connected and autonomous vehicles (CAVs), to improve traffic safety and proactively manage the city's roads.

The Regional Transportation Commission of Southern Nevada (RTC), Nevada Department of Transportation (NDOT) and the Nevada Highway Patrol (NHP) were

Two-way street

Waze is sharing probe data with road authorities via a cloud-based system that will also enable traffic managers to communicate directly back to drivers on the road, in real time
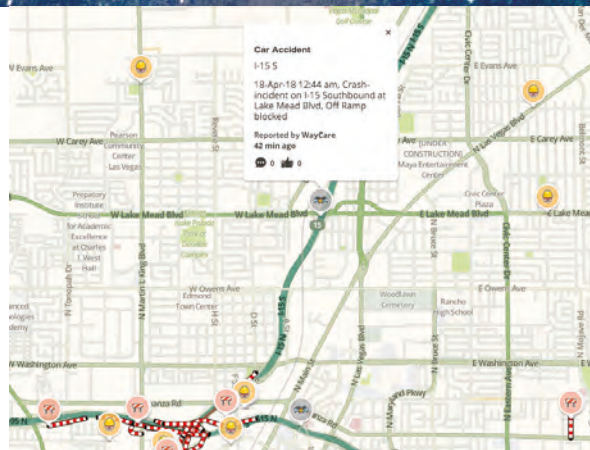
Left: **Waze incident detection at work**

Below: **Waycare's user interface for traffic managers**

Left: **Waze is connecting drivers and traffic managers via a smartphone app**

Below left: **Drivers in Las Vegas are set to benefit, as Nevada DOT is a Waycare user**
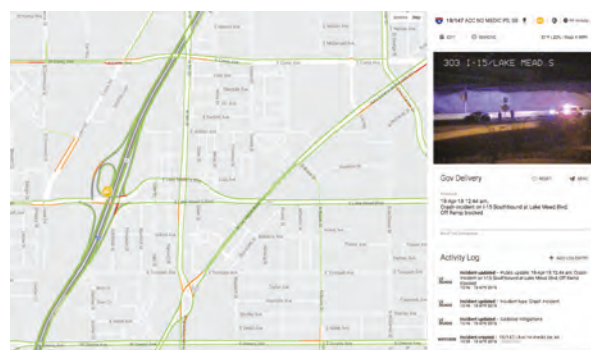
some of the first users of Waycare's system in October 2017, but other projects have since commenced in Florida, Delaware and California.

The new data-sharing partnership is part of Waze's Connected Citizens Program (CCP), which has grown rapidly over the course of a few years and now includes 600 partners

> **This partnership showcases how driver communities can benefit from interacting with municipal traffic organizations that hold vital traffic information**
>
> Noam Maital, CEO, Waycare

globally. The program helps cities unlock anonymized crowdsourced driver data, helping municipalities to act on that data in conjunction with their existing traffic management infrastructure to improve traffic safety and enable traffic to flow more freely.

"Cities everywhere are undergoing a massive transportation revolution, and we are thrilled to be at the forefront of this movement

with our Connected Citizens Program," says Adam Fried, Waze's global partnerships manager. "Our partnership with Waycare will empower even more municipalities with valuable data insights that will help them make informed decisions and improve city infrastructure."

The system analyzes and synthesizes the data with proprietary deep learning technologies to enable predictive insights and proactive traffic management optimization. This layer of artificial intelligence (AI) provides the city with the tools to conduct data-driven traffic management decisions. The cloud-based system is intended for use by various public agencies to manage local traffic operations, law enforcement, emergency services and freeway service patrol, enabling seamless cross-agency communication, efficient incident mitigation and resource allocation.

"This partnership showcases how driver communities can benefit from interacting with municipal traffic organizations that hold vital traffic information," says Noam Maital, CEO of Waycare. ○

Improving WIM accuracy by considering measurement conditions

High-speed weigh-in-motion (WIM) is an important tool for protecting road infrastructure and collecting information on traffic patterns. Today, the ITS market provides a range of measurement devices and technologies that are used directly to determine basic parameters such as wheel and axle loads, total mass, and vehicle height and length. APM Pro has extensive experience in producing high-precision weighing systems, as well as WIM systems for statistical purposes. The range of systems offered includes solutions ensuring accuracy according to the COST 323 specification in classes A(5), B+(7) and B(10).

Other ITS technology plays an important role in increasing the efficiency and benefits of weighing systems – an example being driver information systems in the form of VMS. APM Pro has positive experience in integrating VMS into its WIM systems to enable redirection of vehicles to designated administrative control stations.

The need for accuracy
European markets are now witnessing extensive growth in the use of automatic enforcement systems. Precision and reliability play a key role in these solutions. WIM demands a high level of reliability and long-term operational stability in order to ensure that vehicles exceeding a certain weight threshold are effectively detected and penalized. It is therefore important that factors related to traffic dynamics and the surrounding environment, that could affect the measurement, are taken into account in the automatic

enforcement process. APM Pro conducts research with scientific bodies to assess the impact of measurement conditions on WIM results, in order to ensure the highest possible precision and reliability. The key issue in this context is the quality of the road surface, which should conform to the highest COST 323 standards. Studies also show that the trajectory of the vehicle, and the acceleration or deceleration, can also have a significant effect on the measurement results.

Data collected so far shows that the influence of atmospheric conditions in most cases does not introduce measurement errors, except for in extreme situations. However, research in this area is still ongoing. Knowing the degree of

Right and below: **Dedicated software with smart-device interfaces enables simple, efficient control and monitoring of APM's WIM PRO**

influence of certain important external factors on the measurement of the vehicle weight, we can determine the error of the results. It is therefore possible for each measurement to be assessed, taking into account the most important interfering signals. To a certain extent, errors can be corrected using intelligent algorithms on the basis of data obtained from

additional sensors that measure external conditions.

In this context, the long-term stability of the system is particularly important when considering automated systems. Large changes in temperature between winter and summer, and changes in the characteristics of the road surface, mean that the parameters of the whole system can drift and, consequently,

MaaS is the disruptor – the Netflix – of the transportation industry

the accuracy of the measurements can exceed the permissible tolerance.

Linear gauges win

Experience gained over the past eight years with more than 30 WIM stations, which use different pressure sensor technologies, has shown the advantages of using linear strain gauges, which are highly stable over the long term. Linear strain gauges offer the typical advantages of strain gauges, while showing only a slight drift of measurement errors over a long period of time, even when there are obvious changes in road surface characteristics. In the near future, APM Pro expects high-speed vehicle weighing technology, based on linear strain gauges, to be ready for use in automatic enforcement systems. ○

❝ When you work at Amsterdam RAI (as I do), you can quickly and easily get to the center of the city simply by using one of the company's 10 bicycles. Compared with other big cities where Intertraffic holds events, such as Mexico City, Jakarta and Shanghai, Amsterdam feels like a small village.

So how difficult is it to manage traffic in a big city nowadays? We know that cities are growing. On one hand, that means higher demands for food, energy and housing. On the other, there is pressure to comply with the Paris Climate Agreement, in which 195 countries have agreed to reduce their carbon footprint. Ideally a city needs to be green, sustainable, affordable, accessible and attractive to business. But where do you start and how can you make it happen? The second-largest single producer of fossil-fuel-related CO_2 emissions (after creating energy for heat and light) is transportation – responsible for around 22% of emissions worldwide. But, as populations grow and people travel more, not less, can we turn this juggernaut around and begin reducing CO_2 emissions in the transportation sector?

I have a strong feeling that we are on a path to a sustainable world and that there is light at the end of the tunnel. For example, during the Mobile World Congress, which took place in Barcelona earlier this year, Mercedes confirmed it will be focusing on developing carsharing and electric-powered transportation solutions. The company predicted that, in the long term, carsharing could lead to an 80% overall reduction in cars on the road – which in turn could help our future megacities overcome the challenge of protecting the environment.

Carsharing is a key component of Mobility as a Service (MaaS) – a wider disruption that will help cities develop more efficient transportation systems in next 10 years. MaaS allows users to access different transportation modes via a single, smart-device platform, getting exactly the service they need, when and where they need it – on demand – a bit like Netflix for mobility. Add to this

> "MaaS could lead to private cars being prohibited from city centers by 2025"

the growing availability of real-time traffic information and ultimately people in cities will be able to travel much more easily and efficiently, despite population densities being much greater.

The ambitious outcome of MaaS is that it could lead to private cars being prohibited from city centers as soon as 2025 – although in order for this to happen, those living in, or visiting, cities must be getting a better, more usable transportation service, not an inferior one. One that enables them to choose exactly what they want, when they want it. In just the same way that, as terrestrial TV viewing figures decline, so our favorite shows are available on-demand – which reminds me, I'm overdue an appointment with my current Netflix favorite, *Designated Survivor*. I think I might cycle home today…

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

Creating smart, sustainable cities with modeling
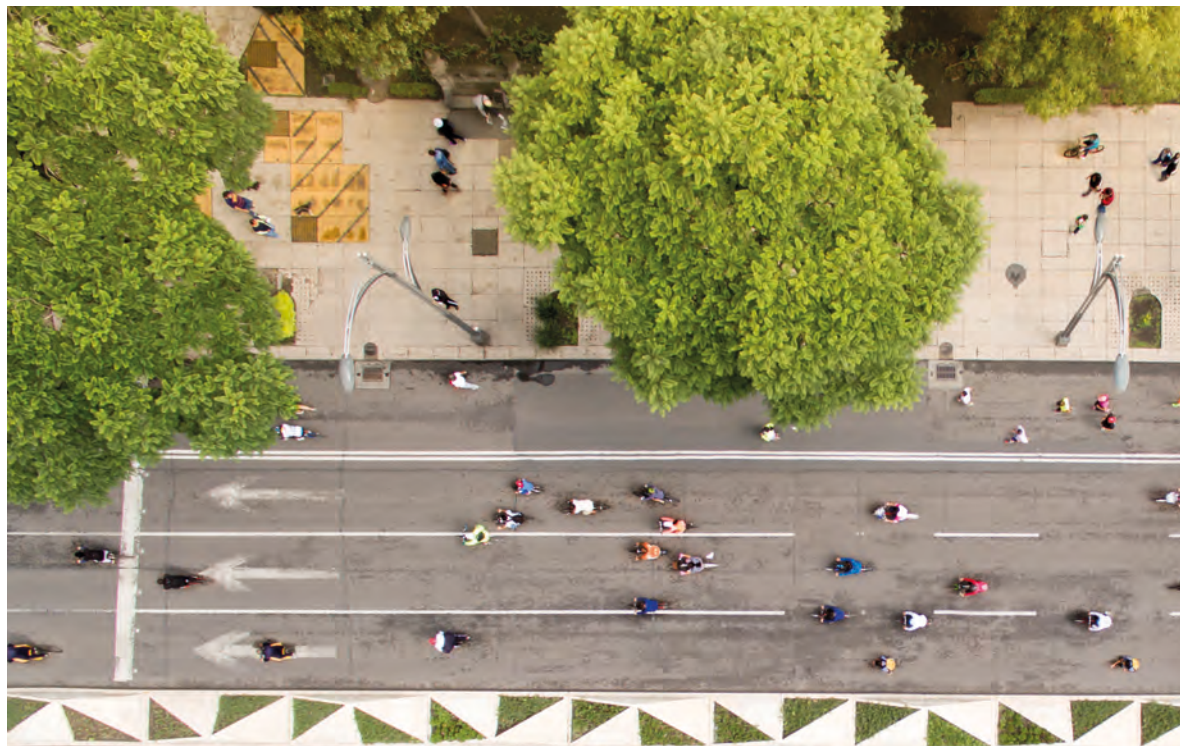
How do city planners achieve faster and more accurate results for urban planning? By taking a thorough approach, comprehensive solutions can turn metropolitan areas into livable urban centers. As many cities and municipalities continue to struggle with increases in congestion, traffic noise and air pollution, they need tools to assess the effectiveness of potential countermeasures.

Integrated urban planning

As more and more people move to cities, metropolitan areas are increasing their efforts to reinforce their attractiveness. They strive to offer their citizens a quality of life that balances accessibility and sustainability, as well as safety and environmental issues.

Building more roads or widening lane capacities for an ever-increasing traffic volume may not necessarily relieve congestion. In fact, sometimes these measures can lead to more traffic jams, noise pollution and higher emission rates of hazardous particulate matters. By identifying people as the central element of any city, conventional city-planning methods, as well as architecture and engineering, need to recognize the influences of social issues, economic development and technology in order to provide an all-encompassing smart-city dashboard.

To develop and redevelop cities for people, rather than for vehicles, it is essential that city planners understand how citizens use the transportation networks available. This understanding will form the basis for better alternative solutions. Taking land use or multimodal planning as an example, the number of planners involved in this process increases quickly, along with the level of complexity.

In a newly developed neighborhood, the demand for transportation links will probably increase, thereby putting a strain on current systems. One solution is new connections between transportation networks and, depending on exactly how the land is being used, this could also have a direct impact on air quality, noise and safety as well as the local and national economy.

Many spatial planning methods used today are unable to calculate different requirements interactively, because they work in silos and are time-consuming. Every aspect is calculated individually, which causes inaccuracies and inefficiencies. The different parties and departments involved are not interlinked and the processes can become so cumbersome that only a limited number of alternative strategies are tested. This leads to unguided urban expansion that perpetuates non-inclusive and unsustainable growth.

Modeling in real time

An alternative is to develop a 3D database of the city to which each of the models is connected and which is updated in real time. The modules calculate effects such as traffic, noise, air pollution and energy. Even external interfaces, including sensor feeds and external models, can be linked to the database. The communications framework constantly monitors the state

ⓘ | Need to know

Functions of PTV Visum traffic modeling software include...

> Configuring green times for traffic signals
> Reporting tools, such as matrix histogram and environmental analyses
> The operation of transportation systems designed to take user-defined object types into consideration

of the database and updates all calculations as soon as anything changes. This makes it possible for different scenarios to be modeled and evaluated with reliability and accuracy, as well as enabling urban planners to test strategies prior to implementation. Taking on this interactive approach to urban planning, the tool enables different stakeholders to weigh up environmental and economic effects carefully, while also considering how certain mitigation strategies will affect journey times, vehicle flows and speeds.

A benefit of the automated interaction between several models depicting, for example, air pollution, transportation noise, traffic, safety hazards and energy consumption, is that people are brought together from different departments to discuss the impact of the merged scenarios. Those using the Urban Strategy interactive decision support system can gain instant insights into their planning, as well as reliable decision support. Urban Strategy displays the effects of urban designs and planning measures, along with key performance indicators. The tool shows a scan of area scores and the status of the various indicators. This facilitates the decision-making processes and how stakeholders balance various interests concerning mobility, environment and health.

Optimizing workflows

The Netherlands Organisation for Applied Scientific Research (TNO) uses the powerful Urban Strategy tool to challenge traditional methods of city planning. It is a complete package that balances the urban sustainable trio comprised of urban planning, environmental quality and transportation. Together with PTV Visum, it enables multimodal modeling of transportation systems with instantaneous calculations of the models' impacts on various environmental aspects. For more than three decades, PTV Visum and its supporting microsimulation software packages, PTV Vissim and PTV Viswalk, have provided cities and governments around the world with the means to support strategic and operational decision making for their transportation systems.

From a holistic to a detailed view, Urban Strategy with PTV Visum enables policymakers to look at the bigger picture at a city level, as well as zooming into the details of specific neighborhoods. It calculates the impact of current and planned measures and it takes into account the effects on all adjacent areas.

According to estimations by TNO, by avoiding sequential processing, the city planning process can be made 25-50% quicker. Finding comprehensive solutions for complex challenges can benefit everyone involved and the interactive approach allows for cross-domain expertise to work in sync and deliver sustainable results. ○

A new generation of dynamic weigh-in-motion

OptiWIM is a free-flow dynamic high-speed weighing system that can accurately measure the weight of passing vehicles, regardless of the wheels' position and direction, which eliminates the possibility of violations being made. It makes the device the first one of its kind, as not being able to take measurements across the entire width of a road is a crucial weakness for many other WIM technologies.

OptiWIM won an award in the infrastructure category at Intertraffic's Amsterdam's 2018 Innovation Awards.

High-precision free flow

OptiWIM is a completely new sensor that takes weight measurements according to changes in a tightened optical fiber. It is also the world's first weigh-in-free-flow system that allows accurate vehicle weight measurements across the full width of a road and independently of the instantaneous wheels' position when the vehicle is crossing.

OptiWIM provides weight assessments with an accuracy of 3% in the whole length of the sensor, which means that the recorded value is the same in any part of the road, no matter where exactly the vehicle passes.

This free-flow approach is a revolutionary breakthrough in weigh-in-motion solutions. Most current WIM sensors suffer from inaccuracies on certain stretches of road, and in some instances, are not able to take weight measurements at all. The weight assessment accuracy of OptiWIM is also considerably higher than current solutions; it is able to overcome these challenges and to bring new unique features unambiguously. It offers the highest possible accuracy of vehicle weight measurements thanks to the newly used fiber-optic technology.

The sensor has a unique distortion-free temperature change compensation that allows for accurate weight assessments, regardless of weather conditions. OptiWIM remains absolutely passive with the maximum radio frequency immunity, i.e. resistance to a magnetic field.

Fiber-optic technology

The OptiWIM sensor operates solely on the optical principle, and without electronic components. The electronics are located in the control unit, not in the sensor, which enabled Cross Zlín to get a disproportionately large amount of data from the sensor during each measurement in comparison with the conventional technology. From the data, the operator can accurately detect, for example, a double-tire or twin-tire use and underinflated tires in a dual-tire assembly separately.

Low maintenance

Another advantage of the sensor is that it is easy to install and maintain. The system only requires a U-bend shape in order for it to be assembled in the correct place in the road's surface. When the U-bend shape is installed, maintenance and possible replacement (after its 10-year lifespan) simply involves changing the insides without the need to remove them from the road's surface.

Development and features

The OptiWIM testbed was developed and patented by Cross Zlín. The sensors and accessories are produced in the Czech Republic.

Thanks to its design and technology, the new OptiWIM sensor offers new and useful features. For example, it can measure vehicles' width directly. It can also detect double-wheel assemblies and underinflated tires, even

Side holders

OptiWIM sensor

U-Bed

ⓘ | Need to know

OptiWIM is the world's first free-flow dynamic scale for weigh-in-motion. Features include…

> Fiber-optic technology
> Direct vehicle width measurement
> Double-tire detection
> Direct detection of under-inflated tires
> 10-year lifespan sensors
> Toll-per-ton-ready
> Simple and quick installation
> 24-hour detection, even in the dark at night-time and in the most difficult weather conditions

We need to spread the word about road pricing revolution perks

❝ I have written several times about the good old days of toll collection. The days when we stopped at the toll booth to get directions or just have a discussion with the friendly toll collector. We have forgotten that even in those days, building a new toll road was difficult and very unpopular. I remember on one project a group of people had chained themselves to one of the bulldozers to stop us from initiating construction. Toll roads were not very popular – until they opened to traffic and opened new opportunities for transportation and commerce.

I think toll roads in general are more accepted today as long as the people initiating the project explain the need and benefits correctly, to politicians and more importantly to the public. Over the past two years, I have seen our industry expand quickly in a good way. We are now building projects with road-user fees in states and areas that we thought would never in our lifetime have tolling facilities or that are considering tolls as a transportation financing option. The public understands that infrastructure is aging, roadways and bridges have deteriorated, and traffic congestion has dramatically increased. Customers who use the infrastructure that we build want a road that they can rely on, a road to move traffic, and one which is well maintained. Today, time is a major commodity for the driving public. We are all in a hurry to get somewhere, whether it's to pick up the children in day care, or get home for dinner, or maybe get to our favorite vacation spot. We don't like traffic and are willing to pay for the convenience of avoiding it.

In recent years, we have seen proof of that in major metropolitan areas, where managed lanes have proven successful not only financially, but by relieving or significantly reducing traffic congestion. Most importantly, public satisfaction with these projects has been positive.

I believe that there's a secret to selling a road pricing project. You can't just say that this is better or will provide needed revenue. You must provide examples and show our politicians and constituents what they are getting for the extra payment. We as an industry have always prided ourselves in the extra service level that we provide. Whether it's faster roadside assistance if you break down, more efficient

> "We must remind people that they are paying for a premium service and that they may be getting a few perks along the way"

clean-up after an accident, or a better-maintained roadway, we always strived to be better. Today, we must remind people that they are paying for a premium service and that they may be getting a few perks along the way – important rewards like a faster commute, less traffic congestion, the funds to give us the ability to not only maintain this road, but the ability to support other mobility projects around the state or region. I think we have recently been taking for granted what people understand.

When selling these projects, we need to put a program together to remind them of the benefits and sell the advantages. We must explain it in examples that people relate to in everyday life, and give specifics of things that make a difference in people's everyday lives – that's what sells a toll road. This may all seem like a no-brainer, but all the time I see major public marketing mistakes killing or delaying needed road pricing projects.

J J Eden is director of tolling at Aecom
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for individual tires in dual-assemblies.

With such high precision in measuring vehicle weights, the sensor is suitable for use in applications including toll-per-ton and direct enforcement. ○

Safety and compliance in traffic control with WIM technology

In recent years, weigh-in-motion (WIM) technology has proven to be an ideal solution for direct enforcement in road traffic control. In the past, high-speed WIM systems simply helped to identify vehicles that violated weight limits, but now, they are being used more and more to directly penalize overloaded vehicles.

Overloading – be it accidentally due to negligent vehicle loading, or intentional as a cost-saving measure – affects road traffic in a number of ways. It damages infrastructure, reduces road safety, and increases unfair competition between transportation modes and operators. Overloading also violates taxation rules, such as vehicle registration fees, axle taxes and toll infrastructure fees. As a result, addressing the issue of overloaded trucks by enforcing vehicle weight and dimension regulations is essential.

The integration of advanced truck load monitoring systems into intelligent transportation systems (ITS) marks an important step forward compared with compliance officers' long-established roadside enforcement methods. Traditional enforcement is complex and time-consuming, with only five to six large vehicles being handled per day on average.

WIM systems can measure vehicle loads at high speeds. They collect traffic data continuously, producing data sets that can help identify operators who are transporting goods without the correct permit. While the results vary from country to country, up to 100 violations can be identified per day. The procedure is similar to automatic speed enforcement: WIM systems can

be operated 24/7, do not require enforcement personnel and are suitable for highways with a high volume of vehicles. The most important benefit of WIM systems is automatic direct enforcement, which means that traffic is measured constantly and consistently.

In 2015, Kistler was the first WIM manufacturer to receive the OIML (Organisation Internationale de Métrologie Légale) R-134 certificate for vehicle weighing using strip sensors at 3-65km/h (1.8-40mph). This certificate

Need to know

Kistler's WIM solutions include…

> The weighing of industrial trucks
> Weight-based tolling (toll by weight)
> Weight enforcement
> Traffic data collection

recognizes that Kistler's WIM systems, comprising the maintenance-free Lineas quartz WIM sensors and the Kistler WIM datalogger, can be used for legal weighing applications. The systems provide reliable data on traffic volume, axle loads and gross vehicle weight.

Legislation paves the way

A number of Eastern European countries have put legislation in place that permits the application of WIM technology in traffic enforcement. Most of these systems, which are

provided by different system integrators, use Kistler quartz sensors for data acquisition. The Lineas Quartz WIM sensor measures wheel and axle loads extremely accurately in order to determine gross vehicle weight under rolling traffic conditions. Kistler's WIM equipment offers a number of flexible and maintenance-free traffic monitoring options.

"In Eastern Europe, we are witnessing a rapidly rising demand for WIM technology for direct enforcement applications from all sectors – federal, regional and private," says Tomas Pospisek, EMEA sales manager for road and traffic at Kistler. "In Russia, we have observed a trend toward direct enforcement. In 2017, we gained market shares in the highly competitive market by installing WIM technology in various direct enforcement projects. Customers especially value our numerous regional sales and support centers," adds Pospisek.

New WIM projects with Kistler equipment are also being implemented in Hungary. One of the largest WIM projects in Europe – with 89 sites nationwide – includes the installation of a large quantity of WIM sensors on a weekly basis. Each site has two to four lanes and is connected to a tolling system. "Since 2016, we have experienced an increased demand for extended warranty," says Pospisek.

"Our customers see their WIM system installations as valuable investments that need regular care. We therefore offer the typical one-year warranty plus an optional extended warranty of up to 60 months." The longevity of Kistler sensors allows for a trouble-free lifespan.

Left and right:
Kistler WIM solutions help authorities to identify overloaded trucks

Industrial truck weighing also has a huge potential for highly accurate, certified WIM systems. When weighing vehicles leaving or entering industrial plants, mining facilities or ports and terminals, measurement speed and overall efficiency play an important role. This is particularly true for sites with a high density of traffic, where weighing is time-consuming and expensive.

Future WIM applications

Considerable progress has been made in recent years to improve and implement WIM systems that contribute to safer and more efficient vehicle operations. Manufacturers are continuously developing new WIM features in order to keep up with the wide range of applications that go beyond enforcement. For example, WIM systems are also being used for toll collection based on actual vehicle weight in China and Southeast Asia. The technology facilitates tolling and weighing vehicles at the same time without interrupting traffic flow. "We see a similar trend in Europe," says Pospisek. "Kistler plans to expand its sensor and system portfolio to cover even more WIM applications. From this year onward, we also want to provide more services to meet the needs of WIM users. Our weather-proof technology provides reliable and accurate data, which is backed up by a proven track record of successful projects." ○

Truck weight enforcement – with education

Nowadays weight enforcement can be carried out during mobile patrols or with stationary systems such as weighbridges. In some countries there are automatic weigh-in-motion (WIM) systems in place that are able to detect overloaded vehicles. Some trucks have independent onboard weighing systems (OBWS) that enable the vehicle to check its own weight.

Although WIM systems with international certifications are rarely implemented for direct enforcement, due to not always complying with international regulations and validations, some countries in Europe and South America already have certified WIM systems in place. Even if the reliability and accuracy of these systems is enough for direct enforcement, will they really make a difference to truck weights?

An automatic system would not be able to keep an overweight truck from moving, to prevent it further damaging a road's surface. Further, OBWS can be manipulated and must be officially checked periodically.

Ultimate solutions

While technology is an important factor in monitoring the weight of trucks and preventing overloaded trucks, it is not the only one. Education is arguably the most efficient way to prevent trucks from being overloaded, thereby protecting roads. The goal of weight enforcement should be to discourage drivers from overloading in the first place, rather than simply collecting fines, which will never cover the cost of all road repairs anyway.

According to a study by the University of Manitoba, Canada, mobile weight enforcement is 30 times more effective than permanent weighstations at detecting violating vehicles. The reason is simple: a mobile patrol team using mobile scales is the most efficient way to conduct official weighing control, because unlike WIM systems they allow drivers and enforcement officers to interact. This enables officers to instruct drivers on the matter.

"On a number of occasions when we participated in official weight checks, we realized that some inexperienced drivers are not aware that the axle overload is more important than the total load, or that an incorrectly distributed load can lead to accidents," says Márcia Otter, a business developer at Haenni Instruments. Another reason is that drivers can bypass permanent stations, whereas mobile spot checks at random locations take drivers by surprise.

Proven products

For the past four decades, Haenni Instruments has provided mobile wheel load scales for police checks around the globe. The company has become the reference point for mobile weight enforcement worldwide.

The wheel load scale type WL 108, launched last year, has a wireless option that helps reduce installation times. In harsh environments it is ideal because it eliminates the need for cables. The unit features a graphic display with a backlight that enables drivers to read the weight easily.

Left: **Interaction between a police officer and a driver during a mobile weight enforcement check with Haenni Instruments scales**

by **Don Hunt**

Regulated regimes are required for automated driving systems

On March 18, 2018, the first pedestrian was killed by a vehicle operating under the control of an automated driving system (ADS). The pedestrian was walking in the road, rather than on the sidewalk, in darkness across an arterial with a speed limit of 35mph (56km/h) in Tempe, Arizona. The vehicle was being tested by Uber and monitored by a safety driver. While it's difficult to say whether a human driver could have avoided the accident by swerving away from the pedestrian, this type of accident is what an ADS is designed to avoid. It's now up to NHTSA to investigate the accident and determine what went wrong.

The Uber vehicle was testing in Arizona without any government oversight. Like so many states, Arizona is welcoming ADS testing on public streets with open arms and a promise of no regulatory barriers. The accident put the state governor in the responsive position of acting as the sole government regulator, and he suspended further testing by Uber. The investigation by NHTSA will likely take 6-8 months, and the ultimate NHTSA action is unclear. While NHTSA could 'recall' the Uber ADS, the ADS software could continue to evolve in the investigatory time period. NHTSA could be recalling a system that no longer exists.

Think about the difficult position the Arizona government has created for itself. After the accident, should the governor have suspended public ADS testing by all companies? If Uber at some point states that it understands the reason for the accident and has upgraded its ADS, should the governor reinstate Uber ADS public testing? Should there be some type of company certification or reporting? What are the criteria for making any of these determinations?

There are two schools of thought about public ADS testing. The dominant approach by the US government and states is that ADS technology is a boon to the economy and that public testing brings us closer to effective automation that will improve highway safety. After all, in 2017 there were 40,000 highway fatalities in the USA, 6,000 of which were pedestrians. That means that on the same day as the fatal accident in Tempe, 15 other pedestrians, on average, were struck and killed by vehicles in the USA.

> "Companies will continue to resist any pre-deployment evaluation of automated driving systems"

The opposite school of thought is that the government needs to intervene in the testing and deployment of ADS vehicles and establish some type of regulatory regime. The challenge with ADS and all emerging technologies is that the government does not possess the knowledge or resources to directly assess the complex design of hardware and software systems. And the rapid learning and evolution of software makes the regulatory challenge even greater.

Given the rush by industry to be part of a driverless vehicle and services market estimated to be worth US$7tn by 2050, companies will continue to resist any pre-deployment evaluation of ADS. But a lack of oversight, accompanied by unnecessary accidents, will also have a chilling effect on ADS deployment. The time has come for a regulatory regime that requires a reasonable level of ADS testing in controlled environments before ADS vehicles move to testing on public streets.

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A bridge weigh-in-motion system

BWIM is a measuring system for bridge and structure surveillance. It is manufactured in Austria and it holds a patent in Europe and the USA. It measures bridges' surface expansions while heavy goods vehicles are crossing. A key advantage of the system is that it does not require sensors to be installed on a road's surface. Measurement data is collected and sent online to a central server and the operator is able to monitor the data of the bridge via web-browser in real time and with simulation functions for past data.

The system's hardware consists of a data collector and measurement amplifier called iBWIM Spider. The Spider is an electronic unit that collects data from different types of sensors and transmits it via LAN to the computer.

Uniting components

The iBWIM system enables the integration of third-party sensors – such as acceleration and inclination sensors – and lasers or IP cameras from various suppliers.

When the operator has chosen a suitable bridge, the system prepares a diagram to define sensor layout. Subsequently, it is necessary for the operator to accurately measure the road width in order to determine where the sensors have to be installed underneath the bridge. When the system has been installed and the parameters appropriately set, data collection can commence.

For the calibration process, trucks, with weight previously determined, can cross the bridge several times and their weight measurement results are accurately recorded. The calibration process complies with COST 323, a European specification for WIM systems.

Left: **The iBWIM device can collect vehicle load data from a particular bridge over timespans of days or years**

Need to know

PSP manufactures the iBWIM system. Its features include...

> Data collection from axle loads of heavy goods vehicles while the vehicles are crossing the bridge structure
> Configurable results to determine truck statistics, pre-selection of overloaded vehicles, or bridges' lifetimes
> Compliance with the COST 323 standard

The calibration phase is particularly important because it plays a key role in defining the quality of subsequent measurement results. Generally, the measurement accuracy ranges from 5-10%.

Measurements can be taken over the course of a single day, or up to several years.

The power consumption of the iBWIM unit is 230V and a battery buffers the voltage to ensure continual operation in the event of a power shortage. When a measurement phase is completed, the iBWIM processes the data and prepares a report.

When HGVs are crossing the bridge, iBWIM measures the load weights throughout the entire crossing period. This data is important because it can be used as a decision-making criterion for further tests, to determine whether the bridge needs to be repaired or renewed.

Processing data

The sensors installed underneath the bridge produce data that must be immediately compressed and sent to the local database. In this context, a compression algorithm is crucial because it substantially influences the work process. Other factors that directly influence this process are waiting periods for the data, memory space and quick filtering of noises. The content of the database is analyzed by an iBWIM algorithm that uses raw signal parameters, such as speed, axle spacing and axle weight. Analyzed data, in combination with other sensor information, makes it possible for operators to obtain a good understanding of the HGVs crossing the bridge.

iBWIM's goal is to define minimal information without impacting quality. iBWIM software includes a data compression function that minimizes the size of captured data. Such data is nevertheless still difficult to handle.

iBWIM is successfully being used in some countries in both Europe and Asia. The system can be rented in units, or sold as a complete system, with both hardware and software.

All parts of iBWIM are being continuously developed to increase the accuracy of the entire system, and to enable new hardware and software components to be used. ○

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Real-time information and incident management – a seamless solution

With the world growing more connected each day, it only makes sense that the areas of real-time traffic information (RTTI) and road incident management (RIM) are converging. When something happens on a roadway, RTTI needs to be created, but in most cases one or more responses are also required, and everyone must be kept informed of what is happening on the road.

Real-world example

Consider a common traffic incident: a vehicle crashes into a guardrail, fuel is spilled onto the roadway and there is traffic congestion as a result. Multiple projects need to be created to clear the vehicle, clean the fuel spill, and create a workzone to repair the guardrail damage. All the while, every organization, agency and motorist must be kept informed about the status of the congestion, response progress and associated impact. Ideally the system should also include an asset management component so that repair crews will know, in advance, exactly what parts need to be ordered to complete the guardrail repair.

All-in-one system

Over the past 20 years Gewi's TIC (Traffic Information Center) software has evolved from a system for creating real-time traffic information for RDS-TMC (radio data system-traffic message channel) broadcasts, to today also providing solutions for a whole host of other traffic management requirements including workzones, road incident management, ITS asset management, radio traffic news and more, all in a single, off-the-shelf solution. All the features described in the real-world example above, and more, are available and already in

Need to know

The main traffic management functions of Gewi's TIC software

> Congestion monitoring and reporting
> Incident management
> Travel time information for managers and motorists
> Emergency response support
> ITS asset management
> Radio traffic news support
> Data for connected and automated driving
> Alternative routing advice support

Above: **Gewi's TIC3 can provide real-time information for motorists**

Left: **Roadside data collection device**

productive use today in Gewi's TIC software.

Enabling CAVs

The ability to collect, harmonize and distribute emerging data types is essential for connected vehicles and Gewi has already been involved in several advanced demonstration projects. Automated driving will require extremely precise traffic data including location and routing advice, all of which is within the capabilities of Gewi's TIC software.

Flexible deployment

When TIC3, the latest version of the TIC product, was released in 2008, a flexible architecture was created based on lessons learned over the previous 11

years of customer requirements. Whether the TIC software is used as a multinational traffic information system, or for a small project to connect disparate systems, flexibility is present throughout. This off-the-shelf solution can be customized through flexible configuration and pricing using core product features. With little software development required in most projects, TIC can be deployed more quickly, and at a lower cost, than bespoke solutions. ○

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Does your highway have a weight problem?

Overloaded commercial vehicles are taking their toll on the world's highways, with much of the cost being passed on to taxpayers.

In most US states, weight enforcement is carried out by personnel at fixed locations. These are costly, repairs and rising traffic levels and can cause congestion, which leads drivers to use alternative routes with no enforcement presence.

There is an increasing demand for personnel, and yet the number of commercial vehicle safety inspectors has been declining annually since 2012. In 2016, there were just over 13,000 inspectors to enforce over 4,000,000 miles of US roadways. As a result, agencies are having to identify new solutions to manage the same workload with fewer staff.

Imaging improvements

Over the past 10 years, imaging capabilities have expanded considerably to allow weight measurements and license plate data to be extracted while trucks are in motion. Transponder bypass systems, such as Help Inc.'s PrePass and DriveWyze's Smart Roadside, have also improved efficiency by allowing enrolled carriers to bypass the scale facility if their load meets weight requirements, does not require special permits, and the carrier and vehicle have been recently inspected.

Truck data is processed and compared against state and federal databases, such as Iteris's CVIEWplus, to identify potential areas of non-compliance. A pass/fail indicator is then displayed to scale facility personnel. This data integration has increased enforcement capabilities, but not enough to satisfy demand. The huge amounts of data that agencies

ⓘ | ### Need to know

Key new technologies for improving weigh-in-motion systems

> Data management systems such as Iteris CVIEWplus
> Mainline (dynamic) weigh-in-motion sensors
> Bypass permit systems – still great potential for automation of verification of these permits
> Camera-based enforcement, such as Kapsch's Commercial Vehicle System

must process means there is now a pressing need to standardize and aggregate data streams so they are accessible to neighboring agencies. It is critical that screening solutions have access not just to data applicable to a state, but also to regional and federal systems.

Screening bypass issues

Weigh station pre-screening is the most common weight-enforcement activity. This does little to capture trucks that may be unwilling or unable to exit (due to traffic) or avoid weigh stations and use alternative routes. In his presentation, *Weigh station of the future*, from the FMCSA ITD-PRISM workshop in April 2018, Paul Clark, statewide scale operations manager at the Florida Department of Transportation (FDOT) indicated that more than seven million commercial vehicles are estimated to bypass weigh station screening annually, with no size or weight enforcement, in Florida alone. Agencies such as FDOT are pushing to add mainline

screening that can leverage smart data services to further automate size and weight enforcement.

One potential solution to the need for automated e-screening is the use of virtual weigh stations. Mainline weigh-in-motion sensor technology has advanced to be able to detect the gross weight of a vehicle at ±5%. This is comparable to static scale accuracy.

Furthermore, camera-based technology can positively identify the offending carrier and truck to ensure compliance. Kapsch's Commercial Vehicle Enforcement System combines these with a user interface to view real-time and historical data for enforcement and traffic management.

Permits are another system that can reduce the need to weigh every vehicle. Many states are currently issuing permits electronically, which require verification at the roadside. When a permit needs to be verified, the measurements from the hardware and the credential screening are

physically verified by port staff. Permit verification at ports is a greenfield area for technology providers to add immediate value through automation and integration.

The bottom line

Technological solutions are starting to drive weight and size enforcement activities across the US, with trends leading toward moving screening equipment to the mainline (highway space). With a hardware-agnostic platform, such as the Iteris CVIEWplus, data capture and aggregation applications can be easily interfaced to push citable information, enforceable immediately or after the fact, from anywhere in the country. Mainline screening reduces delays for compliant carriers and enables law enforcement agencies to use resources for enforcement activities rather than monitoring.

These solutions need to be expanded to fully address the gap in weight enforcement, and move toward safer, smarter goods movement. The automation will level the playing field for compliant carriers by keeping traffic moving and ensuring violators who have not paid their share in taxes, registration and permit fees are fined. This automation would provide funding through the capture of lost revenue. State laws also need to be updated to enable mainline weight enforcement using proven methods and technology. ○

As the ITS World Congress approaches its 25th anniversary, there's much to be proud of

❝ I've written critically in the recent past about how the ITS World Congress could achieve more. It is my nature to always prod and probe and try to make things better, but sometimes it's okay to praise. I've just finished a two-day meeting of the ITS World Congress Board in Singapore. I have been privileged to serve as a Board member for many years. My impression, which I will share here, is that the World Congress has been an ongoing and enormous success of our industry, so much so that others are trying to copy our approach. It is especially timely to focus on this now as the World Congress is 25 years old.

I was fortunate to attend the first World Congress, in Paris. I had just left government and was starting at Parsons Brinckerhoff. Since I'd been responsible for NYC traffic control centers in the 1980s and had recently created E-ZPass, I was curious to meet the international branch of this nascent community. It was quite exciting and at that time, really no more than a small circle of friends. At a reception at the magnificent Hôtel de Ville, I doubt that we numbered 1,000. In the intervening 25 years, we've grown to nearly 10,000 attendees at recent Congresses.

At the beginning we were largely populated by the infrastructure planners of DOTs and their suppliers, but we had the car companies from the start, as well as the infant consumer products side. Infrastructure has stayed at the heart of our industry ever since. Car companies came, left and returned. They are for ITS Japan the very heart of the association. But the biggest change was with consumer products. Remember Garmin? That was it for a while. But, starting in 2007 with the introduction of the iPhone, that market has experienced explosive growth.

Today, we are nearly overwhelmed by connected, automated, shared and electric vehicles supported by private communications networks and a

> "I've just finished a two-day meeting of the ITS World Congress Board in Singapore"

worldwide army of customers. One could argue that the World Congress has not grown enough. Maybe we should be as big as CES. The emerging products and their associations have borrowed much from the World Congress to aid in their own growth – and more power to them. However, there is a fundamental organizing principal of the ITS associations that we can't forget.

They were all built on a tripartite platform of the public sector, corporations and academia. We never intended to be merely a publicly driven group like AASHTO or IBTTA, or a trade association, or a research sharing think-tank. No, we wanted to bring everyone together to learn from each other. The model has been phenomenally successful, so here's wishing the ITS World Congress another successful 25 years.

*Larry Yermack is strategic advisor to Cubic Transportation Systems, California, USA. He can be reached at **lyermack@gmail.com***

Illuminated safety solutions for tunnels

The main purpose of safety signs in tunnels is to communicate to road users about the different safety devices available in the tunnel. Examples of such signs include emergency telephones, extinguishers and emergency exits. Other safety signs warn and guide drivers while they are in the tunnel. These include directional, danger, speed limit and destination signs.

One of the best ways to increase the visibility of safety signs in tunnels is to internally illuminate them. These signs must be reliable during normal operation times, because unplanned tunnel maintenance is costly. More importantly, signs in tunnels also have to function properly, even in the event of an accident or fire.

Producing solutions

Kig's mission as a designer and manufacturer of internally illuminated safety signs is to provide information according to each tunnel project's requirements, thereby adding safety value for tunnel operators, as well as increasing safety for users.

In order to be safe and durable, tunnel signs should have certain features. For internally illuminated signs, housing must be made of corrosion-resistant material – stainless steel or aluminum

ⓘ | Need to know

Kig manufactures illuminated signs for tunnels. Among the advantages are...

> Flexibility: based on project requests, custom-made signs can be produced
> Compliance with standards, including EN12899-1
> Durability: stainless steel AISI 316 or aluminum ALMG3 with powder coating protection and sheeting manufactured by 3M
> Low power-consuming LED lighting

are ideal. Powder-coating can be used to give sign housing additional protection.

Supports that affix signs to walls must provide a solid connection to the tunnel wall. Adjustable mounting is sometimes necessary to adjust to the wall inclination. A new feature on Kig's internally illuminated signs is a swing mount that enables them to rotate if they are hit by a vehicle.

Sign faces provide the user with information, so the durability of the face material is very important. Sign face bases are often made with polycarbonate or tempered glass. Symbols are then applied with printed foil and in some cases with retroreflective sheeting too. This option creates reflection even if its internal illumination is turned off.

Sign specifics

The LED technology for a sign's internal illumination, and quality sheeting for its face, provide a combination of luminance and chromatic properties that guarantee its visibility in any lighting condition in a tunnel. Luminance and chromatic properties should meet EN12899-1:2008 standards.

Depending on a tunnel's power supply, a 230V or 24V power supply should be used to illuminate safety signs – a double insulation class is recommended.

Water and dust are also important factors for tunnel planners and safety sign manufacturers to consider. IP66 protection against water and dust is recommended.

Proven success

Kig has experience working with different tunnel designs in many countries, including Norway, Italy, Greece, Slovenia, Serbia, and Bosnia and Herzegovina. It has produced applications and optional upgrades for tunnel safety signs, including: on/off sign faces and internal illumination that means no sign symbol is visible when it is in 'off' mode, while all symbols are visible while it is in 'on' mode; additional battery with a charging minimum of three hours autonomous power supply; guidance illuminated signs and additional path walk lights for tunnel evacuations; integrated flashing lights for additional warning; reports for signs' statuses; supervisory control and data acquisition (SCADA) communication; and vehicle-to-everything (V2X) capabilities. ○

Left: **An internally illuminated exit sign can guide tunnel users to safety in the event of an emergency**

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Smart WIM

For more than 20 years, Sterela has been recognized for providing medium- (15-40km/h (9-25mph)) to high-speed (90km/h (56mph)) weigh-in-motion (WIM) systems, including electronic cards that are compliant with multiple sensor technologies and IT infrastructures. With a wealth of experience worldwide, Sterela has been able to develop complex algorithms and improve the overall efficiency and precision of its WIM stations. Indeed, the best sensors cannot operate without additional inside intelligence.

By initially using electromagnetic loops and piezoelectric sensors embedded in a road's surface, a basic WIM station is capable of measuring the weight of a vehicle without slowing it down or diverting it from its traffic lane. Thanks to the data collected, including vehicle classification and axle loads, the system provides detailed traffic statistics that offer infrastructure managers a better understanding of traffic flows. It is also able to monitor wear and tear on the road's surface – and this information can be used to optimize road maintenance in terms of scheduling and budget allocation.

Multiple sensors

The Global-WIM system's benefits include multiple sensor technologies to provide much more complete data. It interfaces additional piezoelectric sensors to determine the lateral position of the vehicle on the lane and detect twin wheels on the axles. It uses contextual cameras to provide a three-quarter profile picture of vehicles, and automatic license plate recognition (ALPR) cameras and dangerous goods recognition (DGR) cameras to identify vehicles and transported goods. It can also be fitted with different dimension sensors according to the needs of the application. Sensor types include: infrared optical barriers to detect vehicles' heights; and laser scanners to measure the height and width of vehicles – as well as determining their 3D profile. In Europe, for example, to monitor a three-lane highway and its emergency lane with all previously mentioned sensors installed, the Global-WIM station would manage more than 40 sensors.

Inside intelligence

Each piece of the WIM system is used to take final weight measurements, but the overall environment and the vehicle dynamic behavior itself also impact strongly on the signal quality and could therefore reduce the system's accuracy. By collecting a large quantity of data in real time, and processing it to compensate the sensors' non-linearity and to make sure that dynamic behavior disturbances are avoided, the Global-WIM is able to transmit added-value information to operators. This requires not only the development of a cutting-edge electronic controller unit, but also work on specific and powerful algorithms to characterize and process signals in order to reach the best precision level. This is typically better than class A5, according to COST323 and class 5 according to OIML-R134.

Application range

Fundamentally, WIM systems are used by authorities in their fight to improve overall traffic conditions and road safety, but they can be also a very efficient tool to guarantee fair competition within transportation logistics activities. If WIM technology can be easily used as a statistic tool by road operators, a usual function of the Global-WIM system is to pre-select offending vehicles. It can also be used to intercept trucks more safely by controlling dynamic display panels that ask vehicles to exit the highway and enter the inspection area. Based on recent improvements

The Global-WIM system measures vehicle characteristics including the license plate number, gross weight and axle load, speed and length

to algorithms and accuracy rates, Global-WIM is now ready for direct enforcement and toll-by-weight.

Public roads authorities are not the only ones integrating WIM as a part of their long-term productivity strategies. In today's climate, where there is a continuous quest to save costs and where regulation constraints are increasingly demanding (like SOLAS, the logistic regulation from the International Maritime Organization), WIM is becoming ever more popular among private operators of transportation and logistics hubs, because it is a very efficient tool that can easily be merged with their IT systems, as well as offering them digital continuity directly from the moment the vehicle is identified, through to reporting and billing. ○

Proving a bridge WIM system in an arctic climate

Road pavements are structures with limited lifetimes. If a road section was not designed to withstand heavy vehicle axle loads – as is the case with many rural roads – then heavy traffic can significantly shorten its life.

In Finland a project called Aurora is aiming to find out more about the impact of traffic and future vehicles on road surfaces. The project was commissioned by the Finnish Transport Agency, and it involved Roadscanners and Tampere University of Technology (TUT) building extensive structural monitoring systems at two sites on the E8 highway in the municipality of Muonio in Lapland, Finland.

Proving grounds

Aurora is a public testing ecosystem that has been created to ensure that automated and intelligent transportation systems, as well as solutions for road maintenance and asset management, meet standardized requirements. The public testing area is open to all organizations interested in using it. It allows information to be gathered first-hand about how physical and digital infrastructure should be developed to serve the needs of future transportation vehicles. Aurora is enabling the manufacturers of intelligent transportation systems to operate safely in all conditions.

On the E8 highway, Roadscanners and Cestel have installed equipment that enables structural responses below the road's surface to be monitored – during normal traffic flow and when vehicles are being loaded. Using truck weight information obtained from a SiWIM weigh-in-motion (WIM) system installed at a nearby bridge,

the equipment will be primarily used to investigate the effect of seasonal variations on the mechanical behavior of road structures. The effect of heavy-loaded trucks in different seasons – for example when road structures are thawing during spring, dry during summer months, wet in autumn and freezing in winter – will also be investigated.

Bridge technology

SiWIM, a bridge WIM system manufactured by Cestel, is a monitoring and information system that uses a bridge as a weighing platform to collect the data. Various useful analyses can be carried out on the collected data, including the calculation of nominal axle loads, overloading analyses, life expectancies of road pavements, calculations of road layer thicknesses and road damage calculations.

SiWIM is one of the systems being tested in Lapland's snowy conditions, where it is typical for temperatures to reach as low

ⓘ | **Need to know**

Features of Cestel's SiWIM bridge WIM system include:

> Swift installation without disruption to traffic
> Remote access and online monitoring via the internet
> High accuracy
> Damage-free installation
> It is an entirely portable system

as -20°C (-4°F). This year the lowest measured temperature was -37°C (-35°F), but the SiWIM continued to operate without any complications. The system is also able to operate in hot conditions – up to 50°C (122°F).

The bridge WIM system uses existing bridges and culverts that run under road networks. Being entirely portable, the system can be installed and configured in just a few hours

The Aurora testing site in Finland for connected and automated vehicles, as well as SiWIM systems

without any disruptions to road traffic. Most bridge structures can be used for measurements from a bridge WIM system, provided that certain limitations of the geometry, pavement conditions and user requirements are taken into consideration.

How can better road infrastructure be achieved? Cost-saving proactive (preventive) asset management can be carried out by equipment such as ground penetrating radar and bridge WIM systems. ○

Express lanes

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

"When I was young they used to sell cars on sex and performance. But going forward it's going to be about how good your wi-fi connectivity is"

Andy Graham, chairman of ITS Connected and Autonomous Vehicle Interest Group, UK **considers a future where all vehicles will be connected**

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"We hope this trial will show us the best way to identify real-time bus usage, which in turn could help us plan our network better"

Simon Reed, head of surface technology and data at TfL, **explains why Transport for London is introducing automatic real-time passenger counting on London buses. Read more at TrafficTechnologyToday.com/buses**

"On smart motorways, the road operator has access to real-time CCTV cameras and radar to monitor the network and identify congestion the second it happens"

Jack Cousens, head of roads policy, AA, **on the workings of all-lane-running smart motorways**

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"The main objective is to find out how people react to sitting in an autonomous vehicle and watching it interact with road users"

Prof. Tony Pipe, deputy director at Bristol Robotics Laboratory, **explaining the research project testing driverless vehicles on public roads. To find out more, watch the full video at TrafficTechnologyToday.com/Venturer3**

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