traffic
TECHNOLOGY INTERNATIONAL

June/July 2012

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Features inside focusing on real-time traffic, Intellistreets, combating GNSS spoofing, and much more!

Jam busters?
The brains behind Honda's congestion-avoidance vision

Heavyweight champions
Our search for the ultimate weigh-in-motion system

Smooth operators

Expert advice to ensure your mega event runs according to plan

PLUS

Emergency services
Putting theory into practice to maximize the fire performance of road tunnels

On the right path?
Bern Grush questions if we have lost our way in the quest for a mileage-based user fee

Professor Phil Blythe
"The fact that a lot of ITS work has been hived out to consultants has been a real inhibitor at times"

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Managing mega events

Ensuring your road networks run smoothly during special occasions

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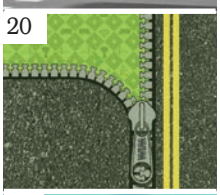

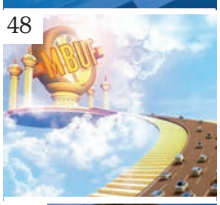

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Foreword

Being more of a fan of the Sex Pistols' *God Save the Queen* than our official equivalent, it's been hard to summon up the seemingly mandatory enthusiasm for the Diamond Jubilee celebrations that were taking place as we were putting this June/July issue to bed.

From a traffic-geekery perspective, however, the huge outpouring of patriotism (I do suspect the Queen saw a sudden boost in popularity after granting a couple of extra days of national holiday) was genuinely interesting. Road closures for street parties are not an everyday event over here. Nor for that matter is a 1,000-vessel floating parade down the River Thames. Yet despite London witnessing a surge in traffic across all modes of transport, everything went swimmingly – aside from the traditional British weather, obviously.

This is a year of quite a few 'mega events' – huge occasions attracting visitors from many different countries. Whether it's a soccer tournament, the Olympics, or indeed a royal celebration, the traffic management issues faced by those in charge are the same. Security is clearly paramount: how do you ensure the safety of all participants and spectators? Another pressing issue is how to ensure transport networks run smoothly in the face of far higher demand than usual – much of it from people unfamiliar with the roads and transport systems. After all, Usain Bolt missing the 100m final because he's stuck in a jam wouldn't go down particularly well.

As our cover story (*p40*) reveals, the issue of mega events is one area of traffic management where it's not all about the technology. Many of the countries featured reaped more value from simply learning from the experience of others than they did from investing in costly ITS kit. The importance of shared experience and communication cannot be underestimated.

On a similar note, communication via social media is becoming an increasingly prevalent part of our sector. As Phil Blythe observes in our interview with him on page 60, when an incident occurs on a transport network, platforms such as Twitter and Facebook are often quicker to report and disseminate the information than the official traffic channels. Blythe ponders whether there's a way to harness the untapped potential of these 'weak signals' and turn them into valuable data sources. I predict we'll see growing numbers of projects focusing on social media in ITS, so watch this space for the latest developments.

At the time of writing, the trigger on the London Olympics starting pistol is about to be pulled and there's much debate about how well the transport network will cope. Whether the Games go as smoothly as the Jubilee or we'll witness *Anarchy in the UK* remains to be seen…

Louise Smyth
Deputy editor

Who's **Who**

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S E E I N G I S B E L I E V I N G

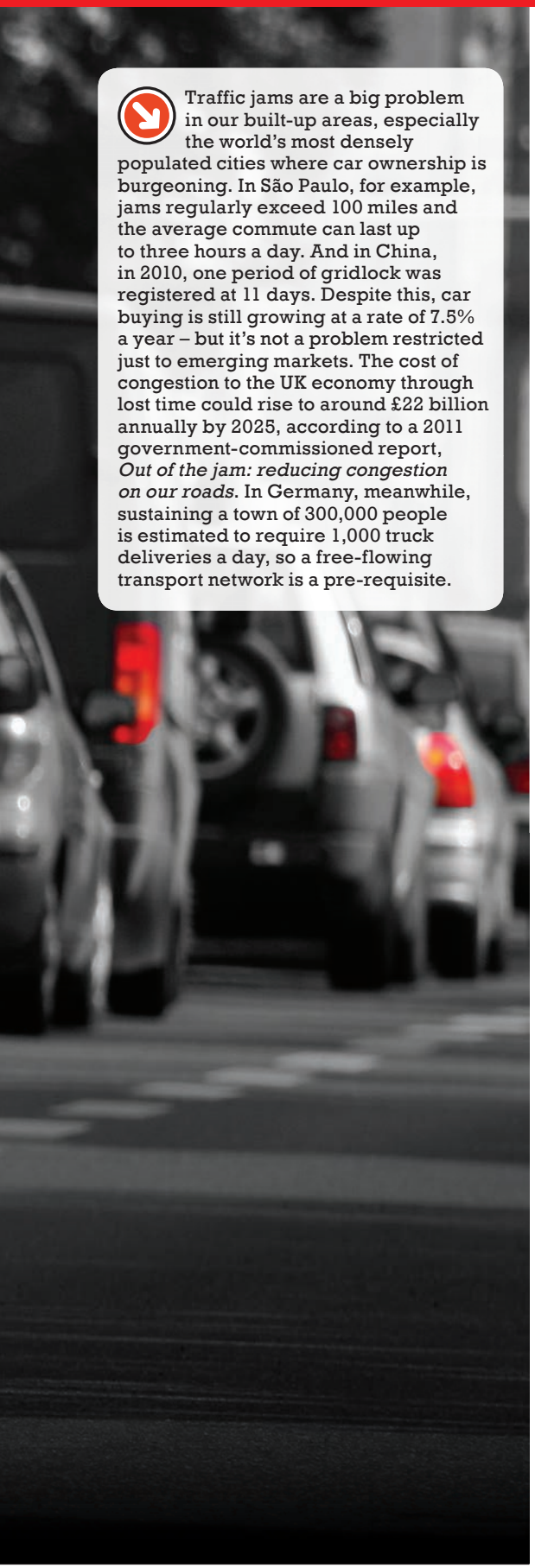
As the number of cars in the world is forecast to increase from around one billion currently to maybe four billion by 2050, a much-touted solution to manage the extra traffic could see transport networks and vehicles becoming integrated using V2X technologies such as those demonstrated by Honda, and others, to avoid the doomsday scenario of 'global gridlock'.

Smarter cars could help reduce the billions of gallons of gas wasted in traffic jams every year. Vehicles stuck in congestion could, for instance, be traffic probes and issue a warning to approaching vehicles about any problems, in essence signaling their status to a roadside communication unit. These would then send the data to a TMC, which would subsequently report the delay via DSRC or cellular or satellite radio signals to other vehicles. They could even use the information to suggest a new route to drivers.

Jam busters?

A new system from Honda aims to flag up congestion-causing driving behavior and even prevent it, using cloud servers and adaptive cruise control. **Izzy Kington** investigates how the testing stage is progressing

Images courtesy of Honda



Traffic jams are a big problem in our built-up areas, especially the world's most densely populated cities where car ownership is burgeoning. In São Paulo, for example, jams regularly exceed 100 miles and the average commute can last up to three hours a day. And in China, in 2010, one period of gridlock was registered at 11 days. Despite this, car buying is still growing at a rate of 7.5% a year – but it's not a problem restricted just to emerging markets. The cost of congestion to the UK economy through lost time could rise to around £22 billion annually by 2025, according to a 2011 government-commissioned report, *Out of the jam: reducing congestion on our roads*. In Germany, meanwhile, sustaining a town of 300,000 people is estimated to require 1,000 truck deliveries a day, so a free-flowing transport network is a pre-requisite.

For around two years, Honda and the University of Tokyo have been quietly working on a system that they hope will slash vehicle congestion. In contrast to the more passive systems used in the past – congestion prediction systems, for example, where drivers are alerted to existing traffic jams and encouraged to change their route – the 'Traffic Congestion Minimizer System' is designed to take a much more proactive role, actually preventing the congestion in the first place.

Based on the theory that drivers who constantly accelerate then decelerate have a knock-on effect to trailing vehicles that results in unnecessary traffic jams, Honda's solution revolves around sensors that monitor the driver's acceleration and deceleration patterns. Mathematical modeling is then used to determine whether this behavior is likely to contribute to congestion. An onboard terminal (a smartphone, navigation system or another metering device linked to a smartphone) relays this information to the driver. The prototype uses green to signify good driving behavior, and blue to indicate bad. "In the future, in addition to changing colors, we are envisioning the use of voice guidance and/or warning sounds to communicate appropriate braking or acceleration partners to the driver," a Honda source told *Traffic Technology International*.

> "In the future, in addition to changing colors, we are envisioning the use of voice guidance and/or warning sounds to communicate appropriate braking or acceleration partners to the driver

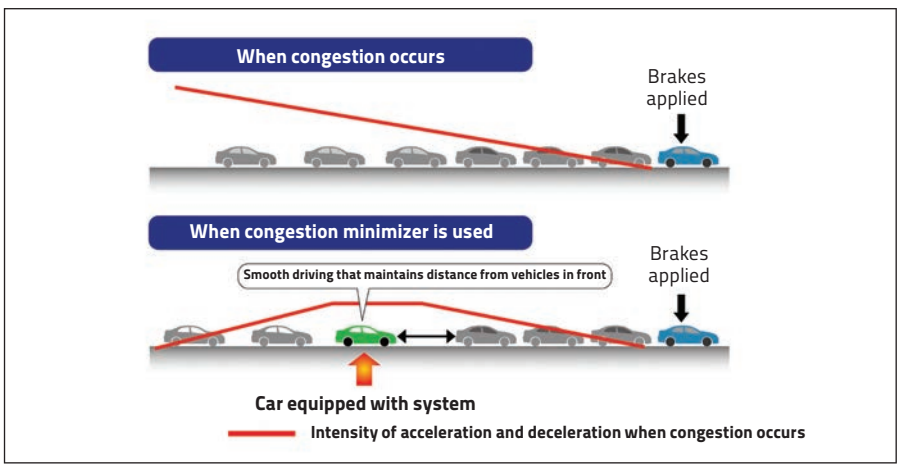
In 2010 one of the world's worst-ever jams occurred on the Beijing-Tibet Expressway, with drivers stuck for days in 100km of tailbacks

Behavioral therapy

The technology breaks new ground with its focus on the behavior of single vehicles. In a further departure, Honda also believes the system can be combined with cloud computing (where data is accessed over the internet) and the adaptive cruise control (AAC) system for greater benefits.

A typical ACC employs a millimeter-wave radar at the front of a car to monitor its speed and the distance to the vehicle in front, using this data to keep the car traveling at a speed and distance defined by the driver. Honda proposes to use the ACC (any standard system, not just Honda variants – indeed, past experiments have

Image of congestion prevention effect with the system



Keep your distance

Professor Katsuhiro Nishinari from the University of Tokyo's Research Center for Advanced Science and Technology began testing the theory that maintaining an adequate distance between cars can help to prevent traffic congestion on the Central Expressway in Tokyo and Kanagawa Prefecture back in 2008.

At the time, he and his researchers took six vehicles on the road and always maintained a 40m distance between each vehicle.

Because drivers tend to over react when traveling too close to the vehicle in front, maintaining a safe distance can reduce traffic congestion. If the car in front brakes a little, drivers in the following vehicles are likely to hit the brakes with increasing force, until the traffic stops, hence gridlock. Uphill starting points and tunnel entrances are especially vulnerable to traffic jams created in this way.

In July 2011, President Obama announced an agreement with 13 automakers to increase fuel economy to 54.5 mpg for cars by model year 2025

(Below) **The current ADAS system display in the Honda Accord** (shown right)

used non-Honda systems) to keep the driver in sync with the driving patterns of vehicles ahead, maintaining a constant distance between vehicles at the most appropriate interval, using data stored on Microsoft cloud servers.

University challenge

Although Honda has developed the system independently (approximately 90% of 25 related patents are currently being processed), it requested the help of The University of Tokyo's Research Center for Advanced Science and Technology – and in particular Professor Katsuhiro Nishinari – to collaborate in the verification process.

"Honda and I have been collaborating for more than three years, and the idea for this technology comes partly from my study," says Professor Nishinari. "I have been studying the jamming phenomena of vehicles and pedestrians for more than 15 years (see *Keep your distance* sidebar). I have focused on the phase transition from free-flow to congested flow in my research. I realized that it is very important to take a longer headway and keep non-fluctuating velocity near the transition in order to avoid the growth of a jam. Thus we have incorporated this idea into the technology, and it tells the drivers how to drive in order to avoid jams."

Nishinari's key hope is that the technology will reduce CO_2 emissions. "We check the fuel consumption of cars with and without our technology," he notes with satisfaction. "In almost all the cases we have obtained better results if we use the technology."

Testing times

Four demonstration tests have taken place so far at the Japan Automobile Research Institute (JARI) in Shirosato-cho, Ibaraki Prefecture, Japan. Results have shown a 23% increase in average speed (calculated based on the last vehicle in an experiment where equipped vehicles were driven in a circular pattern) and 8% greater fuel efficiency for trailing vehicles. Using the cloud and ACC, the average speed increase is 39% (16% more than without the cloud and ACC), and fuel efficiency is 13% better (up by 5%). Obviously not all vehicles are going to have this technology, although it is Honda's belief the results can be obtained as long as 30% of the vehicles are equipped with the system.

The car-maker is now verifying the results through two lots of public road testing, although not in Japan. "The road traffic law in Japan imposes a number of restrictions on the use of public roads for testing," Honda admits. "After conducting public road testing in Italy and Indonesia, consideration will be given to extending the testing program to Japan."

The Italian round was carried out on May 8-11, 2012 and aimed to assess fuel efficiency, travel time and traffic flow improvements. The University of Milano-Bicocca helped by obtaining testing permits and arranging personnel and rental vehicles. The tests were held on the Autostrada A4 Expressway, Tangenziale Expressway and Fulvio Testi Boulevard, chosen "because they already have installed equipment that measures traffic volume". Seven cars were used: a Honda Accord equipped with ACC and six other vehicles (including a Peugeot, Citroën and Fiat) each equipped with an onboard terminal (a smartphone). The ACC-equipped Accord didn't need a terminal because "the function of the ACC to control vehicle speed and inter-vehicle distance will have the same effect as showing a green display on the onboard terminal," according to our Honda source. A specially tailored cloud server was also used.

Testing involved using fixed-point observation and data from a camera in the passenger seat to measure the traffic flow (the number of vehicles per unit of time) and traffic density (the number of vehicles per unit of distance). It assessed the correlation between the duration that the prediction device showed green and the traffic congestion recorded.

The next round of road testing is to be held in Indonesia on July 14-16, 2012, without ACC. It aims to verify the system's durability on public roads, traffic flow measurements for durability assessments, and establish methods for measuring traffic volume. Indonesia was selected because "it will become a business center in the future, and it has traffic flows with unique characteristics not seen in advanced countries," *Traffic Technology International* was told. Indeed the roads chosen are the arterial road from Jakarta Sukarno Airport to Jakarta city, and a road in Semarang in central Java that "is typical of a local road in an emerging nation."

Honda aims to commercialize the technology in the next three years, probably in the form of a smartphone application costing a few hundred yen per month. It says the idea is to "work toward the establishment of a congestion-free mobility society all around the world", part of its vision to realize "the joy and freedom of mobility". Indeed it looks like the system is set to create happier drivers (fewer frustrating jams), happier environmentalists (fewer CO_2 emissions) and happier insurance companies (fewer rear-end collisions).

The Must-Know about automatic de-icing systems using Lufft NIRS31

Most important

Lufft NIRS31 utilizes algorithms for real-time actions with automatic de-icing systems making the systems more reliable. No matter where the installation is and what the environmental conditions are. Non invasive.

For high-speed readers

Today: embedded sensors deliver the measurement inputs into the control-software to “fire” the de-icing system. Very often, only passive sensors are installed. In other cases, passive and active embedded sensors are used together (redundancy and better reliability); the embedded sensors typically measure a small spot of approx. 12 cm diameter.
Tomorrow: Lufft NIRS31 makes your system “weather-ready” and allows proactive algorithms to prevent ice formation. The sensor is easily accessible and securely mounted and represents approx. 1 sqm of surface conditions.

For technical experts

Whereas winter-related services with snow plows are based on RWIS data and user experiences, an automatic de-icing system is a fully automated solution.
As far as the sensors are concerned, these are the inputs to the controller to “fire” the system, activating the nozzles. A 100% automated system needs maximum of sensor reliability.
The combination of different sensor technologies (embedded/non-invasive) and a smart correlation of all measurements makes the system operate very reliable. It is important to open the “black box” and to use the sensor values as parameters to operate the system. This allows optimization over time by adapting the thresholds.

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Pole position

Louise Smyth speaks with the inventor of a smart all-in-one solution to a number of traffic management, security – and even entertainment – issues

When a relatively small Detroit-based lighting design and multimedia firm decided to take a bite out of the ITS market, nobody could have predicted how fast this initial foray would snowball. Not even company president Ron Harwood. He recalls what prompted the move from multimedia solutions to those with life-saving potential: "In our endeavors to create unique environments, our company, Illuminating Concepts, has developed many strategies for providing media in outdoor environments, generally based on sound, video and sensor technologies – things such as sensing someone walking by," he says. "When 9-11 occurred, we began research into using the technology we already had to generate mass notifications through systems we had previously been playing music on. We began to focus on taking our existing techniques – such as including cameras, which we had used to monitor our sound and light shows and water features – and began to apply that idea to a simple streetlight."

This gave birth to the Intellistreets solution, a wireless network of urban light poles that provides everything from safety services and entertainment through to traffic data collection and, of course, lighting. "It's a bi-directional mesh network," Harwood explains. "What's unique is that we embed essentially real computers, although microprocessors – each the size of an iPhone – in each streetlight. Because we've got sensor technology embedded, we are able to have many inputs into one small system that can sense and analyze right on the spot. First they do their own analytics at each location, then based on the embedded software, they begin to share that information with their neighbors."

Incident detection abilities

So what type of applications could this be used for? "A good example might be if we saw traffic stopped in the middle of the road," Harwood suggests. "A lot of intelligence can be gathered. Based on our recognition software, we can tell where an incident has occuured or congestion is forming by sharing intelligence. In many cases, people monitoring traffic are looking only at the intersections – that's all the equipment they can afford and they don't have PTZ cameras everywhere. Whereas with a simple streetlight

In case of emergency

The Intellistreets team is working on a 'disaster relief' version of the system, prompted in part by Hurricane Katrina. "When New Orleans flooded in 2005, the only things left standing in most of the wards were streetlights, and the water level never rose to the top of any of them," Harwood says. "As our processors actually rest within the light (above any recorded water level) we started to look at ways we could help.

"The system is set up to be battery operated (for at least a night) under an emergency and we're now developing a system that regenerates itself for long-term disasters, via photoelectric or wind power."

In event of an emergency, people seeking aid can push an emergency button that triggers a flashing light that can be seen both laterally and from above (i.e. from helicopters). "It also records the fact that someone has hit the emergency button and logs it and puts the location on a map to assist first responders," he adds.

So far this version has been beta tested and Harwood hopes to see a commercially available version by the end of the year.

New Orleans lost 4,200 streetlights, 458 traffic signals, approximately 20,000 street signs and 3,700 parking meters in Hurricane Katrina

The first Intellistreets deployment at its test site in Farmington Hills, Michigan

Balancing security and privacy

Government-level officials have responded enthusiastically to the Intellistreets concept, according to Harwood. "They are keen on the fact they can have more features than they've ever been able to integrate before in one common operating platform," he says. But he also recognizes the privacy issues associated with any sort of surveillance. "I recognize the individual right to privacy, and we do not take pictures of people or invade their privacy until there's probable cause. A black and white image-sensing system like ours is not actually taking your picture to begin with. A good example is if we are using vehicle-recognition software and see two vehicles – if you were to see pictures of this you'd see they don't even look like vehicles, but we're performing data analytics on the speed of the vehicles and what type they are. If, via that data, I see those two vehicles touch each other then I know there's been an incident and can start recording images. Our system does the best it can not to be required to take any images. But once an incident is detected, if officials decide they want to record the aftermath, they can set the software up to do so."

Across

Hampshire in the UK, thousands of streetlights will be dimmed by up to 50% at night in a bid to save money and conserve energy

The concept is available in a number of different designs

covering 100m or so at a wide angle – and these streetlight locations being on average 30m apart – you essentially have a very granular opportunity to look at a traffic situation and make sense out of it, not just on one block but across a number of blocks."

All-in-one appeal

The solution can also be used for less complex applications, such as traffic or pedestrian counting. It could even be used as an electric vehicle charging point – and discussions are very much ongoing on this side. In times of austerity, this idea of doing so much more with just one piece of infrastructure has an obvious appeal to DOTs and road managers.

With regard to the lighting side of things, Intellistreets is an attractive option for cash-strapped agencies as it allows them to save energy. "Because we have a microcomputer in every location and we have this shared intelligence, we can look at ambient light in an entire area and adjust the streetlighting automatically," Harwood says, detailing his 'intelligent dimmable lighting technology'. "Unlike anyone else's dimming systems – which usually deal in 1-100 increments – ours deals in thousands, and every 1% or 0.5% of energy that's saved is dramatic across an entire community.

"So why would we dim? Well, let's say a High Street has three or flour blocks that stay open to midnight and the light spills out of the windows of the shops and bars, thereby contributing to the usable light, our sensors will be aware of this and adjust the lighting to a preset amount that the DOT wants to provide. So if the DOT wants 10 lux on the street and we get two, three or four lux from the shops, why waste energy?"

Harwood is also keen to grab a chunk of the VMS/parking guidance market by attaching his firm's digital signage to the Intellistreets light pole, too. "Our digital signage could replace parking guidance systems as it's so much smarter!" he boasts. "It needs virtually no manual intervention. Once it's set up, if you feed the car park counting system into our system, and it says '10 spaces available: next car park one block to your left', that stops the people from crushing into a space for which they've had no previous notification of. Unlike others, we go beyond just making a message board: we feed ours with real-time, analytical data."

Debuting the technology

In October 2011, the city of Farmington Hills in Michigan became the first location to deploy the Intellistreets system. Federal grant money was used to install eight poles and Harwood reports an enthusiastic response since this first deployment.

"The launch in Farmington Hills has since taken us to the highest levels of the US government," he reports. "We have continuing negotiations and collaborations on the deployment side. One of the most interesting ones is in New Orleans and we are also in discussions with Chicago about a test site."

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Traffic jamming

A UK test facility has just launched a service targeted at preventing the security issue of GNSS spoofing within ITS applications. **David West** gets the inside story

The UK's new InnovITS ADVANCE test facility recently announced a testing capability to help combat GNSS 'spoofing'. This is a particularly hot topic today as a wave of GNSS-based ITS technologies are being developed. Such systems are at risk from the malicious jamming of GNSS – from a variety of sources with differing motivations – including their substitution with fraudulent data. InnovITS ADVANCE is offering ITS developers the opportunity to submit their products to simulated attacks, which will enable them to create in-built system robustness.

"GPS signals are now very much a part of almost every aspect of day-to-day life," says Steven Warner, InnovITS ADVANCE business development manager. "In addition to their use in automotive navigation through the ubiquitous satnav, its timing signals are used extensively for everything from telecommunications to financial transactions – all of which makes it vulnerable to malicious attack from an extremely wide range of sources. The communications industry is rapidly developing countermeasures to combat current and potential threats but until now it has lacked the capability to physically test the robustness of new products subjected to denial or malicious corruption of signals."

The test facility is equipped with the NSL Skyclone system, which enables users to precisely replicate the effects of GNSS degradation and denial of service – urban canyons, for example. Although the test facility itself has the visible appearance of a network of urban roads surrounded by grassed level ground, for the vehicles under test, the conditions of GNSS denial can be made to replicate anything from a high-rise environment – similar to Lower Manhattan or London's Docklands – to a low-rise industrial estate or suburban sprawl punctuated by the occasional open space.

Via the Skyclone system, users can simulate almost any form of GNSS corruption. In addition, they can assess the combination of these scenarios with parallel interruption and corruption of GSM and WiFi signals using the center's private telecoms networks, which can be controlled at an individual mast and beacon level.

GNSS in ITS

InnovITS CEO, Phil Pettitt, explains the sort of applications this service could be used for: "It can help with any system intended for deployment in vehicles or on our roads that uses

Built to last

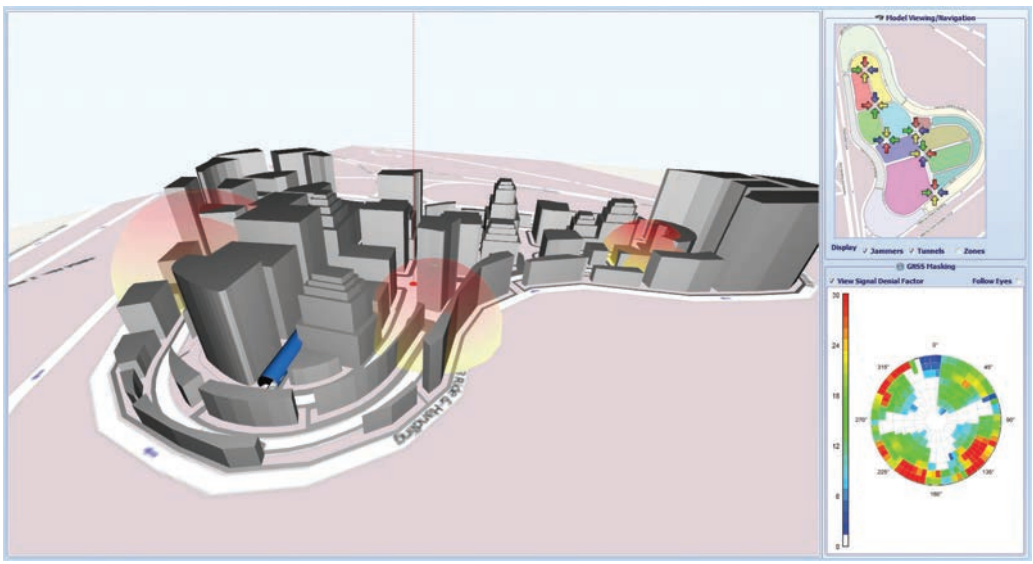
The overall goal of this new service is to allow people to 'build in robustness' to their systems. So how this might be done? "Our role is to provide an environment where that robustness can be tested," says Phil Pettitt. "Nobody wants a system that works only under ideal conditions and so can never be relied upon fully. Thus, we have private communications networks so the RF signal can be weakened or switched off. This can be set up so that it happens at predefined points to test systems in the extreme. For example, we have discussed with one supplier how we can reduce the GSM signal to a threshold at a critical point just before a junction, to exercise a specific application on the vehicle; in this case to do with collision avoidance at intersections.

"Similarly, we have GNSS denial so that systems that depend upon satellite navigation can be developed in an open-field environment without signal hindrance but when required, the signal can be attenuated to test performance in an urban landscape, tunnels or even in the presence of jammers. So many applications depend upon such positioning, whether for safety, navigation, tolling or pay-as-you-drive insurance. It also helps that this is a realistic setting with standard roadways as one would find on the public highway; that has already enabled one organization to refine its testing with scenarios it had never encountered in its previous testing of active safety systems."

Civil
GPS spoofing is an intentional interference technique by which a GPS receiver is fooled into tracking counterfeit GPS signals

What is InnovITS ADVANCE?

InnovITS ADVANCE provides a safe, comprehensive and fully controllable, purpose-built 'cityscape' test track environment that enables clients to test, validate and demonstrate new innovations through 'plug and play' simplicity. The track enables the precise specification of road conditions and communications access and denial for the development of ITS innovations without the constraints of excessive set-up costs and development time. The facility is Europe's first purpose-built single site ITS and telematics test track. It connects vehicles, highways, and telecommunications through two private standalone fully integrated and independent communication systems (GSM and WiFi).



The Skyclone system allows users to replicate denial of service of satellite signals across the InnovITS ADVANCE test site

wireless communications or satellite positioning to deliver its functions. People have already been considering it for a wide range of applications – for instance, automated emergency call systems such as eCall that require an accurate position and reliable communications just in case they are required in an emergency situation. Similarly, active safety systems to prevent collisions increasingly benefit from communications between vehicles and the roadside. There are also congestion-beating and environmental benefits with others considering how to carefully measure mechanisms for traffic management that reduce emissions and their environmental impact."

Antenna
diversity – employing either multiple separate receivers or a multi-antenna single-oscillator receiver – can be used to defend against GPS spoofing

Industry response

Pettitt reveals that there has already been great interest in the new service. "Those who used the facility so far have included vehicle manufacturers and those supplying systems to them," he says. "We have also had universities and research organizations engaged in a variety of applications. Finally, there is interest from IT and telecommunications firms. Essentially, it's for anyone considering new telematics products and services, but especially those who need to be assured of reliability or exactly how well their systems perform in the real world."

From an outsider's perspective, one could imagine that this service is something the ITS industry has been crying out for. And Pettitt does report strong interest from key players in the sector. "Ever since we announced our plans – and thus got early contributions as to what was really required – we have seen growing interest in what we have to offer," he comments. "Now it is in place and people can see what we can do for them, the enthusiasm is growing stronger. The challenge is that it is new and unique, so it implies new ways to test and develop products and services. But it is timely with the rising debate about liabilities."

> "Nobody wants a system that works only under ideal conditions and thus can never be relied upon fully

Risk and responsibility

This latter point touches on an interesting aspect that affects the GNSS technologies marketplace – the issue of responsibility. If a technology vendor creates a product that uses satellite signals (say for a V2I application) then is it their responsibility to ensure that their product is not vulnerable to denial of service attacks? Or is their responsibility simply to make a product that works when satellite signals are available? At the moment, this is something of a gray area. Pettitt offers a pretty comprehensive overview of this issue. "We have increasingly complex telematics offerings," he explains. "Furthermore, those products and services being developed and introduced are increasingly safety-critical, or indeed transaction-critical, in that reliability is required because money or legal liability is at stake. As a growing issue, there is less room for mistakes in the marketplace; a product needs to operate as advertised – what I refer to as 'brand criticality'. There is therefore a need to test thoroughly to ensure a product or service works as claimed and in every circumstance it should, irrespective of how well the infrastructure upon which it depends is operating. That is a driving motivation for InnovITS ADVANCE – an effective resource to help get products right."

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Intelligence quota

The latest findings from UK experts suggest that much more needs to be done when it comes to creating safer, more efficient roads and a coherent vision for ITS. **David West** spoke with a key author of the new study

A new report from the UK's Institution of Mechanical Engineers (IMECHE) has caused a flurry of interest, both in the media and on a wider level. *Intelligent Transport Intelligent Society* was published in April and one of its key findings was that the installation of collision-avoidance technologies should be made mandatory for all UK buses and lorries by 2015.

Phillipa Oldham is one of the report's authors and head of transport and manufacturing at the IMECHE. She believes that legislating such technologies is the way forward. "The installation of collision avoidance technology could have huge benefits in reducing the number of cyclist, pedestrian, and vehicle occupant deaths," she says. "By helping to prevent accidents these technologies could also help reduce congestion on UK roads. A lack of cohesion, with many individual groups and companies trying to address these problems in isolation, is hampering progress. Legislation is useful in that it provides clear guidance." The technology created in the Lateral Safe project, which is a tool that alerts drivers to obstacles and potential collisions, is listed in the report as having particular merit in this area.

As well as installing collision-avoidance technologies, the report also calls for automated emergency response systems to be integrated into all new road vehicles within the next two years. Similar to the European eCall system, such systems alert emergency services to an accident and provide the exact location of it via GPS. "New intelligent transport technologies have the potential to save thousands of lives," Oldham comments. "Cyclists, pedestrians, and other road users could all benefit but – just as with seatbelts 30 years ago – we need policymakers to work with the automotive industry to make them mandatory."

ITS and the economy

It's not only safety that the report focused on. A significant part of it relates to the economical aspect of road transport and making the UK a more attractive market. The report states that "if the UK is to remain a competitive economy, it is critical that mobility of people, their goods, and what they consume is efficient, quick and economical". Oldham concedes that the financial side does play an important role in future progress. "Industry, government, and society as a whole all want safer transport," she says. "It is necessary to consider the financial implications to developing any type of technology."

Other technologies assessed in the report include: a lane-guidance system to alert drivers if they drift from their lane; autonomous vehicles (such as the Google driverless car); pedestrian protection through sensors in the

As recommended

The report offers a number of recommendations:
A detailed vision for the ITS industry needs to be agreed. This should be led by government in close collaboration with industry.
The Institution of Mechanical Engineers advises that:
1. The Catapult for Transport Systems works with industry to develop an agreed unified vision for ITS across the UK's entire transport network within three years, focusing on increased capacity, congestion reduction, improved efficiency in movement, improved safety and reduction in environmental impact.
2. Industry and government collaborate to make the installation of collision avoidance technologies, such as Lateral Safe, on buses, lorries, heavy goods vehicles (HGVs) and large goods vehicles (LGVs) mandatory by 2015, in order to improve UK road safety.
3. Government introduces a nationwide coordinated charging and information system for all public transport within the next five years.
4. Industry and government collaborate to enforce the installation of automated emergency response technologies in all new surface transport within the next two years.

Although heavy goods vehicles represent just 5% of the traffic on the UK's roads, figures show they they cause 20% of all fatal accidents involving cyclists

> The London Congestion Charge model should be adopted by other cities across the country

front bumper area; speed-proportional steering; and a vibrating steering wheel that notifies drivers of possible collisions, lane departures or drowsiness.

The report also calls for the government to roll out a national coordinates charging and information system for all public transport.

Much is made of the need for all players – automotive manufacturers, ITS practitioners, and policymakers – to work together in the coming years. But in practical terms, what actually needs to happen next? And how can we encourage the systems integration and cooperation that is required to make some of the report's ideas a reality? Oldham says: "The Catapult for Transport Systems has just been formed by government. This Catapult should work, together with industry, to develop and encourage a unified vision for ITS across the UK's entire transport network within the next three years."

It is also worth noting how the IMECHE actually classifies 'ITS'. The report includes three 'types' of ITS:

In-vehicle: Technologies within the vehicle such as sensors, information processors, onboard units or displays that can provide additional information to the user. They may also automate or intervene with some part of the driving task.

Infrastructure-based: These offer two general functions. First, to provide drivers with additional information via roadside messages, and second to better manage and control traffic flow. Sensors gather information from the environment, other vehicles, and infrastructure and then apply this information to influence driver behavior. This may be referred to as infrastructure to infrastructure communication (I2I).

Cooperative: This involves communication between infrastructure and vehicles or between different types of transport, which may either be one-way or two-way communication. This is known as vehicle to infrastructure (V2I) or vehicle to vehicle (V2V).

The report holds up the London Congestion Charge as a positive example of ITS in action on UK roads. And with lorry user charging also back on the agenda, we asked Oldham for a comment on road pricing in general. "The London Congestion charge that was introduced in 2003 has seen a 6% increase in bus passengers during the charging hours," she explains. "London adopted a bylaw that ensured that the net revenue raised by the charge (£148 million in financial year 2009/10) has been reinvested in improving the transport infrastructure in London. This model should be adopted by other cities across the country. If road charging is to be introduced, it needs to reflect the true cost of travel, taking into account both the financial costs associated with the road use as well as the environmental factors."

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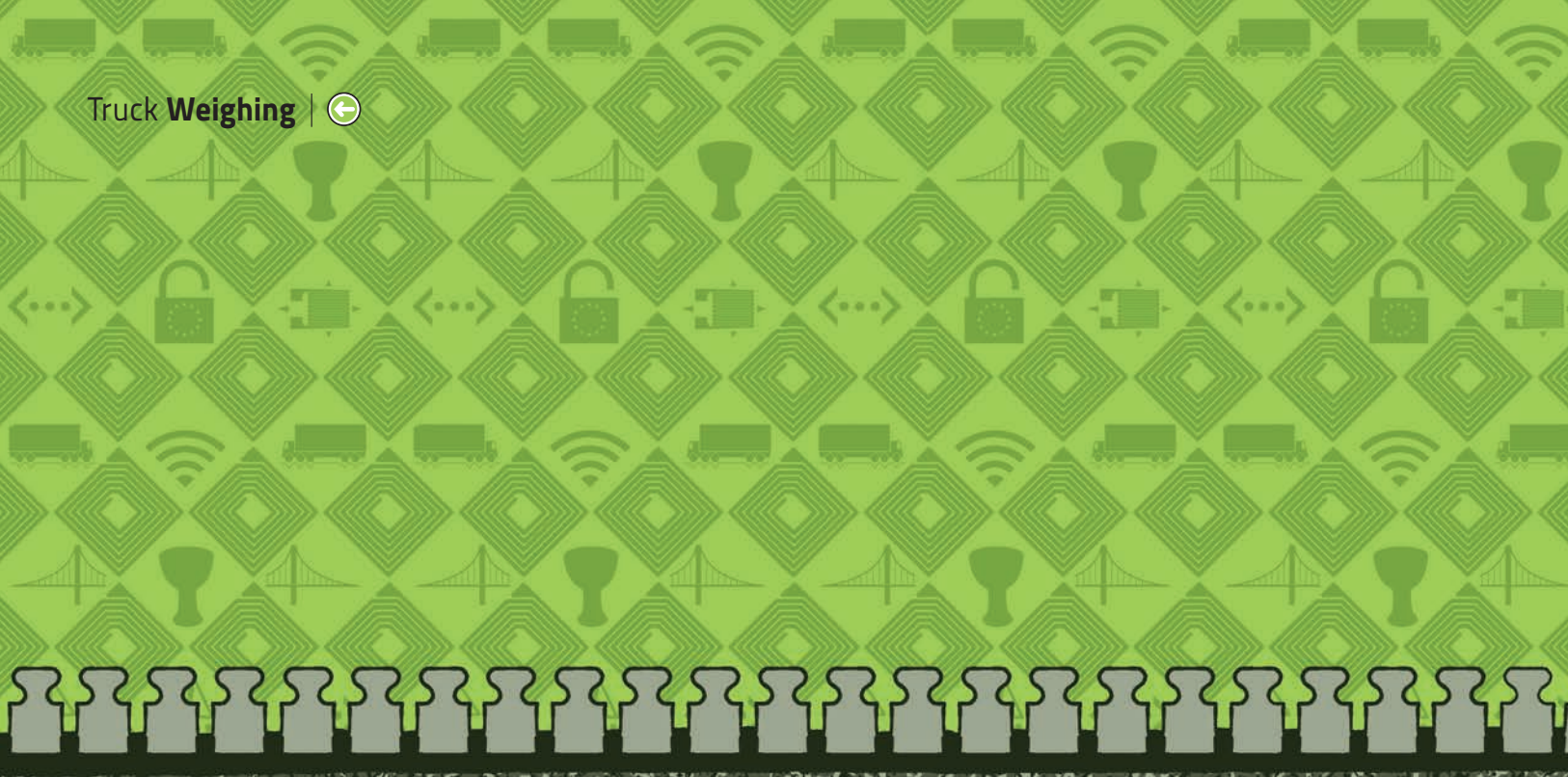
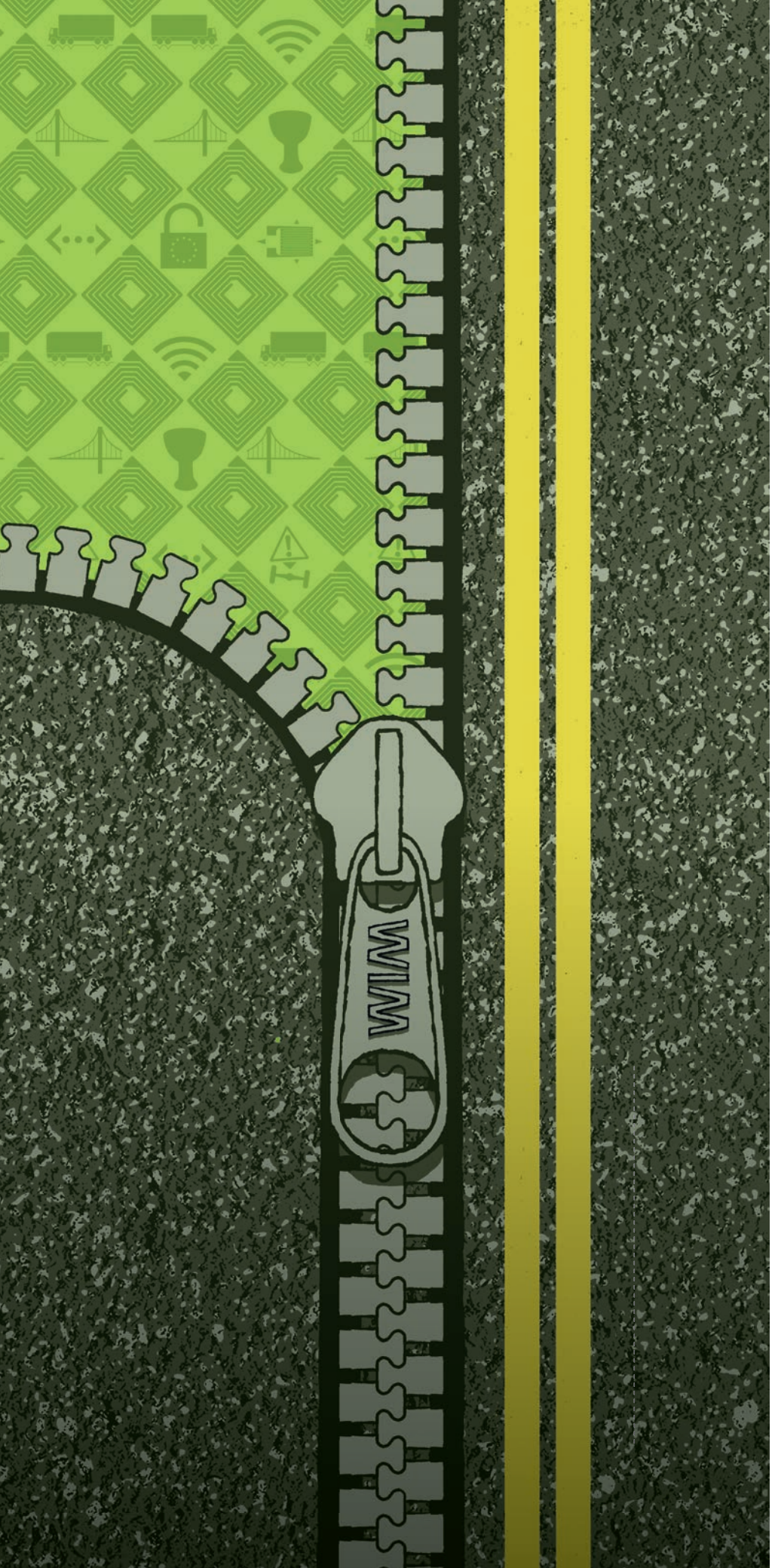


Preservation society

Ahead of the International Conference on Weigh in Motion, **Nick Bradley** speaks with some of the academics and specialists working on the next-generation WIM systems to protect our pavement assets and rid our roads of the scourge of overloading

Illustration courtesy of Tim Ellis



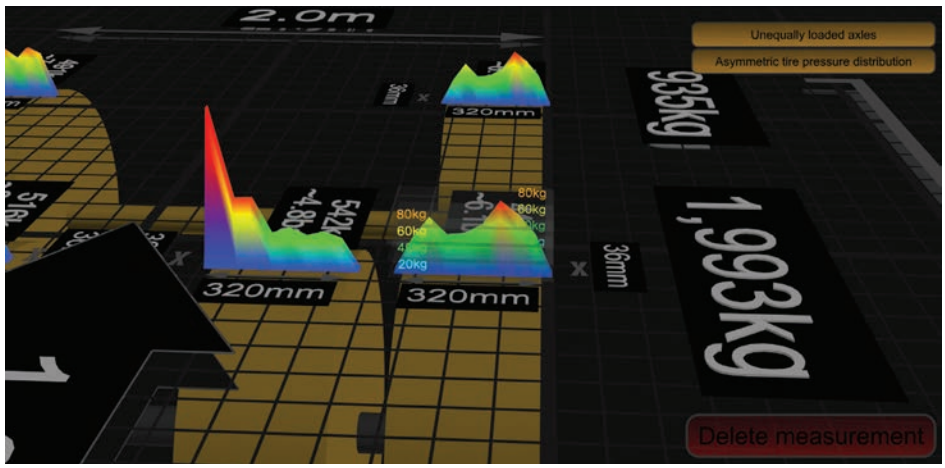
Anyone who thinks weigh-in-motion is a branch of ITS that sees little in the way of progress clearly needs to have a conversation with Professor Eugene O'Brien at University College Dublin's School of Civil, Structural & Environmental Engineering. "It's one of those technologies that people don't see so they end up taking it for granted," the Irish bridge engineer concedes. "But there are loads of interesting things happening out there beneath the road."

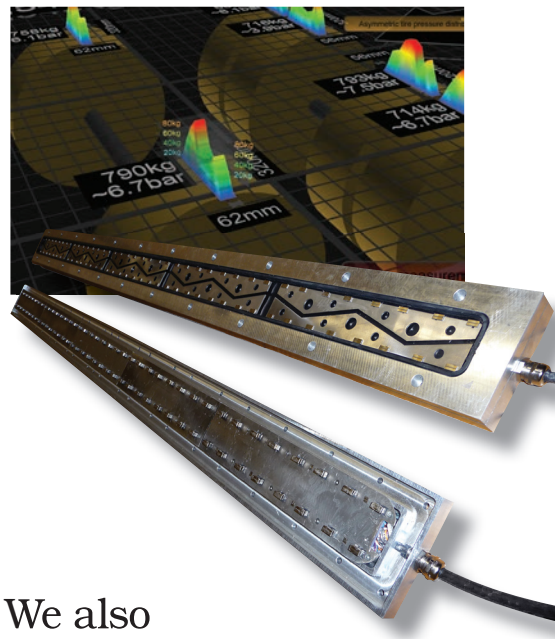
To establish exactly what those things are, O'Brien is busy packing his bags for a trip to Dallas, Texas, for the sixth installment of the International Society on Weigh in Motion Conference (ICWIM6), at which the elite in the WIM sector come together every three to four years to dissect the latest trends and research. "I'm often surprised by the progress between one conference and another," says O'Brien, who will be presenting several papers himself.

Direct approach

One of the hot topics in Dallas is likely to be a potentially groundbreaking WIM sensor under development at the Austrian engineering firm ROC Systemtechnik. "Our primary goal has been to create a technology that enables fully automatic and direct WIM enforcement," reveals Rigobert Opitz, a 20-year WIM veteran and senior manager at ROC. Such a system is the Holy Grail for those involved in overload enforcement. And although two technologies have been announced in the past 18 months from Czech companies Camea and Cross, they are currently only certified for legal enforcement in the Czech Republic. The system that gains certification under the new OIML R134 standard for Europe and beyond – and is sufficiently accurate enough for prosecution purposes – could change the face of WIM forever.

Opitz has been at the forefront of numerous WIM research projects over the years, from the 2002 Top Trial initiative to the €8 million EU-funded ASSET project, which concluded in December 2011. He knows the technology options inside out. Unlike the Cross and Camea systems that integrate piezo ceramic sensors, ROC's combines strain gauge technology with





embedded microelectronics for signal processing and Ethernet interfacing. Opitz admits he is some way off having the product in production – it will move to independent testing in three to six months, production facilities and tooling will take a year to build, so it might be up to 18 months before it hits the roads – but if this high-tech sensor does what he says it will do, it will be "a very exciting prospect" in the words of Eugene O'Brien.

"At ROC we have many years' experience with WIM, we have investigated all existing sensor types for their pros and cons, and we have consulted with customers," Opitz continues. "Ultimately we've designed a solution that is optimized on all counts. If you're developing a direct, fully automatic overload enforcement system, it needs to work in all traffic conditions, from stop-and-go to multi-lane free-flow. It also needs to be easy to install and exchange because you don't want roads closed for longer than necessary, hence why ours is designed to be fixed into a framework in the road surface – it takes just 15 minutes to swap over. And importantly, it has to allow for dynamic and precise measurement."

So why did Opitz select strain gauge rather than piezo ceramic or bending plate? "It's a proven and reliable technology and it's my belief that other sensors suffer from durability and calibration stability problems," he says. "We have designed ours to have a guarantee of more than a year with built-in redundancy – and strain gauges are used in load and calibration cells so are precise and reliable, which is a prerequisite if you're considering prosecutions. We also measure footprints, pressure distribution, double tires and missing wheels, which allows for other novel safety solutions to be incorporated other than WIM."

Not only, but also

And that's where Opitz's WIM solution really starts to tick the innovative box. In the future, the system could analyze tire pressure and wheel alignment, incorporate an RFID reader (for dangerous goods tracking, etc), work in tandem with thermal imaging (security and vehicle dimensioning), accelerometers (for wrong-way or ghost vehicle detection), tailgating and vehicle-specific speed enforcement, general truck monitoring of unbalanced axles, and much more. Such claims will undoubtedly raise an eyebrow or two among the WIM fraternity. "In the next 12 months we will have something more tangible than a prototype," Opitz confirms. "But we are an engineering company – not a manufacturer – so we will need partners to take this into full-scale production. But there's no reason why it couldn't be on the market in the second half of 2013."

Such a multi-sensor setup with embedded microelectronics, Ethernet communications, built-in redundancy, etc, does sound as if it might be accompanied by an equally impressive price tag, though, when compared to the existing WIM sensor stalwarts? "If you are comparing sensor to sensor, maybe. But if you are looking at this in terms of a complete WIM system and lifecycle, with ours you do not need any expensive roadside cabinets for computers, communications, processing, interface

> We also measure footprints, pressure distribution, double tires and missing wheels, which allows for other novel safety solutions
>
> **Rigobert Opitz, senior manager, ROC Systemtechnik, Austria**

(Top) **ROC's new strain-gauge-based microelectronic sensor is WIM and more rolled into one**
(Left) **The scene after the I-35W bridge collapse in 2007**

A supervisory role to play

ASFINAG's **Reinhard Wendler** reveals how Bridge WIM employing the cloud paradigm has been found to be an efficient and valuable monitoring system on the Austrian motorway operator's road network

Bridges have to be refurbished every 40 years to control the static rated value, which can change because of bending and dynamic loading

Senior executives at Austrian motorway operator ASFINAG say the excessive weight and improper and/or uneven weight distribution of vehicles using its road network are the source of substantial damage to its infrastructure. Consequently, the additional repair work required not only has a cost factor but also has a negative impact on network availability. Checks and inspections are therefore indispensable in ensuring that vehicle loads don't exceed maximum permissible weight limits and are properly and evenly distributed.

According to Karl Wolfgang Gragger, a technical coordinator at ASFINAG, a vital goal for the operator is for these truck examinations to be organized and carried out as efficiently as possible for all involved. Gragger first started investigating Bridge Weigh In Motion (B-WIM) five years ago, with a view to gaining experience of the technology before introducing the technique more widely on the motorway network.

The 'iBWIM' system incorporated is developed by Austrian company PSP. Using bridges on the ASFINAG network as a weighing platform, three main areas are targeted: statistical data collection of heavy trucks; bridge re-assessment; and pre-selection for traffic control. According to PSP's founder, Markus Petschacher, iBWIM is installed easily without damaging either the pavement or bridge because it is fixed underneath the structure, while a simple webcam is deployed beside the road.

> "An important aim when developing iBWIM was to generate better-quality data than other systems were able to deliver

When a truck passes over the bridge, it is weighed immediately, analyzed and filtered according to specific legal requirements. Overloaded vehicles are defined if axle weights or GVW (gross vehicle weight) are exceeded by distinguishing gear and axle weight. The recorded results are then sent to a smartphone or other device, which holds the basic information as well as the expected timespan until the vehicle's arrival. The results are accurate and vary between ±5%.

The strains and vibrations from trucks are measured on all lanes in each direction using up to 32 sensors installed beneath the bridge. These sensors are connected in groups of eight with the computer-based 'spider' (data collector), and synchronized within a bandwidth of 5ms. In Austria's case, four such 'spiders' are needed for one motorway bridge, connected to one another via a local network that supplies them with energy. A computer installed in the router pre-analyzes the data and then sends it via a mobile GSM connection to a local database. The whole process takes between one and three seconds depending on traffic volumes and connection quality. Measurements can be performed at various locations along the road network and data is then forwarded to the database for post-processing. The final data is available immediately and sent to mobile phones or desktop computers upon request.

The sensors installed underneath the bridge produce data that must be compressed immediately and sent to the local database. A compression algorithm

was therefore developed during a research project and is key in that it substantially improves the overall process. Other factors that have a direct influence on this process include waiting period, memory space, and quick filtering of noises.

The data within the database is analyzed by the iBWIM algorithm from raw signal parameters such as speed, axle spacing and axle weight. In combination with other sensors – high-speed cameras and laser detectors – it is possible to obtain a complete picture of the truck crossing the bridge.

The volume of data collected is huge, so defining the minimum amount of information required without impacting data quality was crucial. For iBWIM, this meant reducing volumes of data in gigabytes from a single measurement down to kilobytes. Even so, such amounts are still difficult to handle so to facilitate data processing, traffic-flow and axle-load models were developed to enable a reduction in the entire volume.

iBWIM is the first commercial WIM system for installation on bridges to have been successfully established in Austria. As a result of its novel electronics, the system records high-quality measurement results providing accuracy levels of 5% compared with a static weighing process. It is easy to install and can be used under the toughest of environmental conditions.

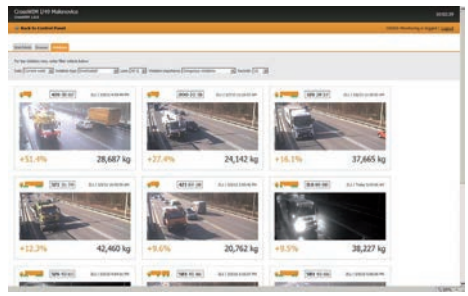
By enabling the measurement of real traffic loads and particularly axle loads, iBWIM becomes a tool that may be used as an additional traffic monitoring system. Reliable information on axle loads and load patterns, road surfaces and bridges are key elements when it comes to strategic maintenance decision-making.

But iBWIM data can also be used in computer programs to simulate a structure's entire lifecycle, by enabling calculation of aging processes or provision of statements on a structure's load-bearing capacities. The monitoring system may also be used in real-time operation for traffic-monitoring purposes. Immediately after recording and post-processing, iBWIM measurement data plus images can be sent to mobile devices.

Previously, police would only be able to capture a certain number of offenders through the use of random checks – iBWIM, though, allows many more overloaded vehicles to be detected, and an app is now being developed for smart devices so relevant enforcement information can be used by responsible parties. Overall, ASFINAG thinks iBWIM is unprecedented for optimizing its maintenance efforts as well as for saving money in the long term.

iBWIM sensors are connected in groups of eight with the computer-based 'spider' (data collector)

Showing the vehicle pre-selection and enforcement process of Cross's WIM system in more detail



electronics, and so on," the Austrian engineer explains. "The installation and ongoing maintenance will be much quicker and thus cheaper, too – you don't lose the sensor in the case of resurfacing, for instance – so I think the cost will be comparable. But you must remember that by using our new dimension sensor with 80 measurement points each and 8kHz sample rate, you will be able to do so much more than just the direct enforcement. It's a total integrated safety solution."

"It would need to be independently tested, of course, but I can see the advantages," suggests Eugene O'Brien, who as an academic has no commercial bias. "It's shear rather than a bending distortion so the results are much more linear throughout a wide range of weights. And as it's based on strain gauges it can be checked statically, so for enforcement

> BWIM is attracting increasing interest everywhere and is a vital tool for our decision-making
>
> **Karl Wolfgang Gragger, technical coordinator, ASFINAG, Austria**

validation a meteorologist can go out there, place a weight on it and get a result, which you can't do with piezo as the vehicle has to be in motion. It has great potential and I'm excited to see how it progresses.

A bridge for the gap

"Maybe I'm biased because of my background, but for me the exciting future developments are going to be in Bridge WIM (B-WIM)," O'Brien continues. Using a bridge structure as a weighing scale to weigh vehicles as they pass over the top is of course nothing new, having surfaced in the late 1970s as a result of work by, among others, Professor Fred Moses, who is now with the University of Pittsburgh's Swanson School of Engineering. B-WIM never really captured the imagination in the USA, however, and didn't re-emerge in Europe and the Far East until the 1990s, due in no

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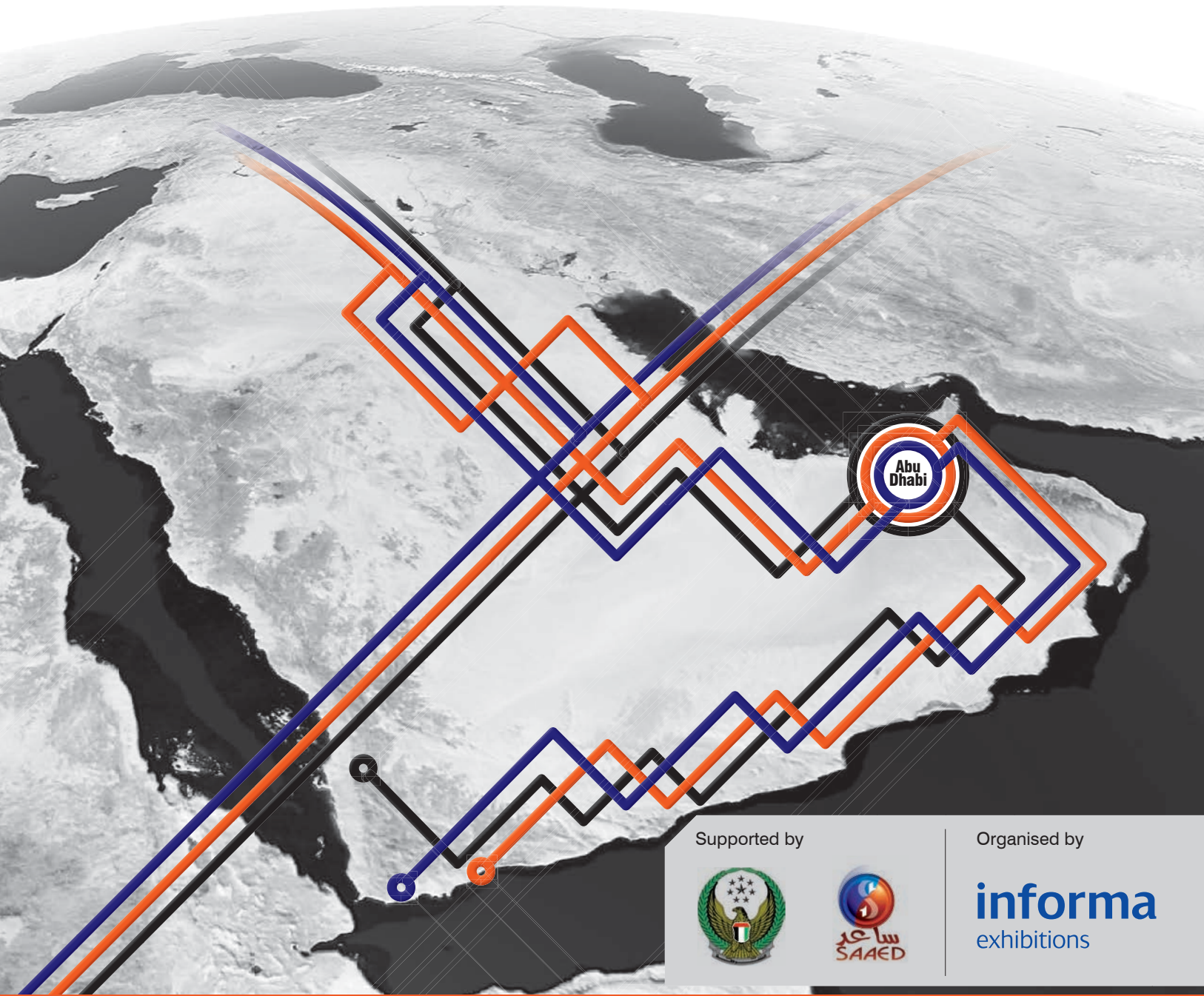

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When speed and overload enforcement converge

Australia has one of the most transport-dependant economies of all OECD countries, with the vast distances between major cities placing a heavy strain on all modes of freight transportation. One of the busiest stretches of road for both freight and passenger vehicles is the 880km Hume Highway, linking Melbourne and Sydney.

To prevent damage to this important route resulting from heavy vehicles, trucks have traditionally been required to stop at a manned weighstation. With the recent installation of a WIM system from Redflex, though, what was once done manually is now completed automatically without the heavy-vehicle driver having to stop at all.

Redflex's WIM system on the Hume Highway between Melbourne and Sydney

Along with Redflex Weigh-In-Motion (WIM) instrumentation to detect weights, the system uses piezo electric sensors and inductive loops placed in the road to accurately detect vehicle presence, the length of the vehicle and vehicle speed. The enclosure houses a two megapixel camera (10fps) that produces the high-resolution images required for prosecutions. A high-repetition infrared flash is used for illumination yet isn't noticeable or distracting to drivers. Video cameras also provide continuous footage for storage; the camera control unit and dual-core server PC are all included in the system's compact enclosure. This downloads all of the incidents for processing and also processes the optical character recognition for ALPR.

The statistical aspect of the WIM system allows for the recording of vehicle classification information such as gross vehicle weight, individual axle weights, number of axles, wheel base and vehicle length. Authorities are able to compile data reports that map trends and allow for transport planning. With ALPR added, records can be correlated with hotlists and vehicle registration offenses also detected.

With the Hume Highway carrying both high volumes of truck and passenger vehicles, there are also safety concerns surrounding overloaded trucks being involved in speed-related incidents. To ensure compliance with the posted speed limits and to improve road safety, the technology installed for the WIM system also allows for the detection and capture of speeding violations. The multipurpose system is all encapsulated into the one installation, allowing for minimal roadside furnishings and disturbance.

small part to advances born from COST 323 and the WAVE research project. But with the price of sensors, data acquisition, software and electronics dropping significantly, B-WIM can now stand shoulder to shoulder with traditional sensor WIM, so O'Brien is hoping that delegates at ICWIM6 – particularly those from the USA – take a fresh look at the approach. "Being non-intrusive, B-WIM also doesn't come into contact with the road so you don't have to close lanes for installation," he adds. "The vehicle traffic doesn't directly impact the sensor, so very little maintenance is required and as it's mobile, it can easily be relocated from one site to another."

Moving Force Identification

Durability assured, then, what of accuracy – the other critical criterion for any WIM system? Can B-WIM based on strain gauges live up to bending plate and piezo quartz? According to O'Brien, the game-changer could be Moving Force Identification (MFI), which calculates the complete time history of a truck's axle or wheel forces applied to the bridge. The UCD man has even been involved in recent trials with the University of Alabama and Alabama DOT.

In actual fact, O'Brien envisages MFI could improve accuracy of the WIM data by a whole class, accelerating Class C up to Class B and Class B+ to Class A. "It's based on static equations that relate the strain on the bridge to the weight of the truck – essentially moving more in the direction of dynamic equations – so the mathematics are a lot more complicated," he says. "It's a real challenge to perform the calculations in real-time but we're addressing these issues and believe that ultimately MFI could render B-WIM more accurate than most other technologies." In the Alabama trials, the SiWIM B-WIM system from Slovenia's Cestel is being used (developed with ZAG) and if the marriage with MFI proves fruitful, B-WIM could enjoy something of a renaissance in the USA, where bridges particularly are in need of some attention.

O'Brien is keen to quash the misconception that B-WIM can only be used for bridge applications however. "The data in general can be used for pavement observation to protect your pavement assets or to find out information about the loading on the pavement," he stresses.

Due to the greater levels of kinetic energy dispersed by heavier vehicles in the event of a collision, the likelihood of a fatality from impact when these heavy vehicles are involved in a crash is increased greatly

Clearly, though, the appeal of B-WIM in general bridge condition monitoring is obvious. Around half of the USA's 600,000 highway bridges were built prior to 1940 and some 220,000 of these are considered to be defective and therefore ripe for replacement or refurbishment. So why haven't DOTs in the USA embraced B-WIM more warmly, particularly in light of the 2007 I-35W bridge collapse in Minnesota?

"We're delving into why B-WIM hasn't really worked as successfully in the USA as it has in Europe," the bridge expert responds. "We think that it comes down to construction – US bridges differ to those in

(Far left) **Freight is predicted to double on Europe's roads every 25 years** (Left) **TCA's IAP provides road agencies with confidence that heavy vehicles are complying with the agreed road access conditions**

A fully loaded B-double truck causes as much damage to Australian roads as 20,000 cars

Europe in that they're deeper and feature a lot of heavy girders – and maybe a few of the US experiments thus far haven't been conducted knowing some of the tricks of the trade we've learned over time in Europe."

Intrigue in the USA is clearly picking up though. Connecticut DOT (ConnDOT) and the University of Connecticut conducted their own evaluations of B-WIM a few years ago and made direct comparisons of the data against static measurements. Anne-Marie McDonnell, a transportation engineer from ConnDOT (and chair of the TRB's WIM subcommittee) was involved in the research and thinks it shows "great promise" to achieve the tolerance of 95% probability of conformity for Type II ASTM Standard Specifications for Highway Weigh-In-Motion Systems.

With some 3,700 bridges in the Constitution State – and memories of the Mianus River Bridge collapse in Greenwich nearly three decades ago still fresh – it's easy to see why ConnDOT is taking a closer look at B-WIM. "You can't fix all the bridges in an instant, so DOTs will need an enhanced understanding about the true safety of their bridge assets, and for that they need data," says O'Brien. "That's why I think B-WIM will make a comeback."

The European community

"B-WIM is attracting increasing attention everywhere," believes Karl Wolfgang Gragger, a technical coordinator from ASFINAG, who has been managing a B-WIM project for the Austrian motorway operator for the past several years (see *A supervisory role to play* sidebar). "It's an absolutely vital tool for our decision-making."

The vast majority of Austrian road bridges were built between 1960 and 1980, although some are much older yet are still in daily use. Furthermore, the weight of cargo shifted on Austrian roads is also increasing and trucks now commonly transport heavy and/or abnormal loads up to 150 tons. "From a vehicle technology standpoint, there seems to be no limit regarding axle loads and total weight, which as a result of economic constraints in the freight-forwarding industry fosters the trend toward deliberately overloading vehicles," suggests Andreas Kammersberger from the road infrastructure – construction department of the Office of the Styrian Province Government.

This is especially a concern for Eugene O'Brien, who points to EC data stretching back 10 years focusing on the volume of freight in ton-kilometers in the EU27 countries. "It's growing at about 3% a year, which is a lot more significant than it sounds, so it's more or less doubling every 25 years, which means we've got a huge problem on our hands. So what are we going to do about it? Twice as many roads? Twice as many trucks on each road? More lanes? And can we continue to grow indefinitely? Clearly that's not sustainable."

> If we have good control, we can allow bigger trucks; if we have poor control, we tax-payers are really going to pay for it
>
> **Professor Eugene O'Brien, University College Dublin, Ireland**

Freight expectations

Many experts predict the medium-term solution will be larger trucks. The general workhorse of the current fleet – the five- or six-axle tractor-semi-trailer – will be replaced by an eight-axle truck with two trailers. Such vehicles are already commonplace in Finland and Sweden. There are ongoing trials in the Netherlands, and Germany is also considering their implementation. But won't larger vehicles simply do proportionally more damage to the roads? O'Brien thinks not. "They'll actually spread what is currently a 40-ton truck on five axles to a 60-ton truck on eight axles, so it might actually be less damaging to the road surface," he explains.

There will also undoubtedly be a certain degree of optimization in terms of vehicle design and distribution of weight between axles, which may also alleviate the situation. "The two big issues we are

> Australia's freight task is growing so it's vital we look for new ways to drive improved productivity, efficiency and safety
>
> **Chris Koniditsiotis, CEO, TCA, Australia**

going to have to confront are general growth of truck traffic and control of that traffic," O'Brien says. "If we have good control, we can allow bigger trucks; if we have poor control, we tax-payers are really going to pay for it due to infrastructure damage and the heightened risk of bridge collapse."

Monitoring on board

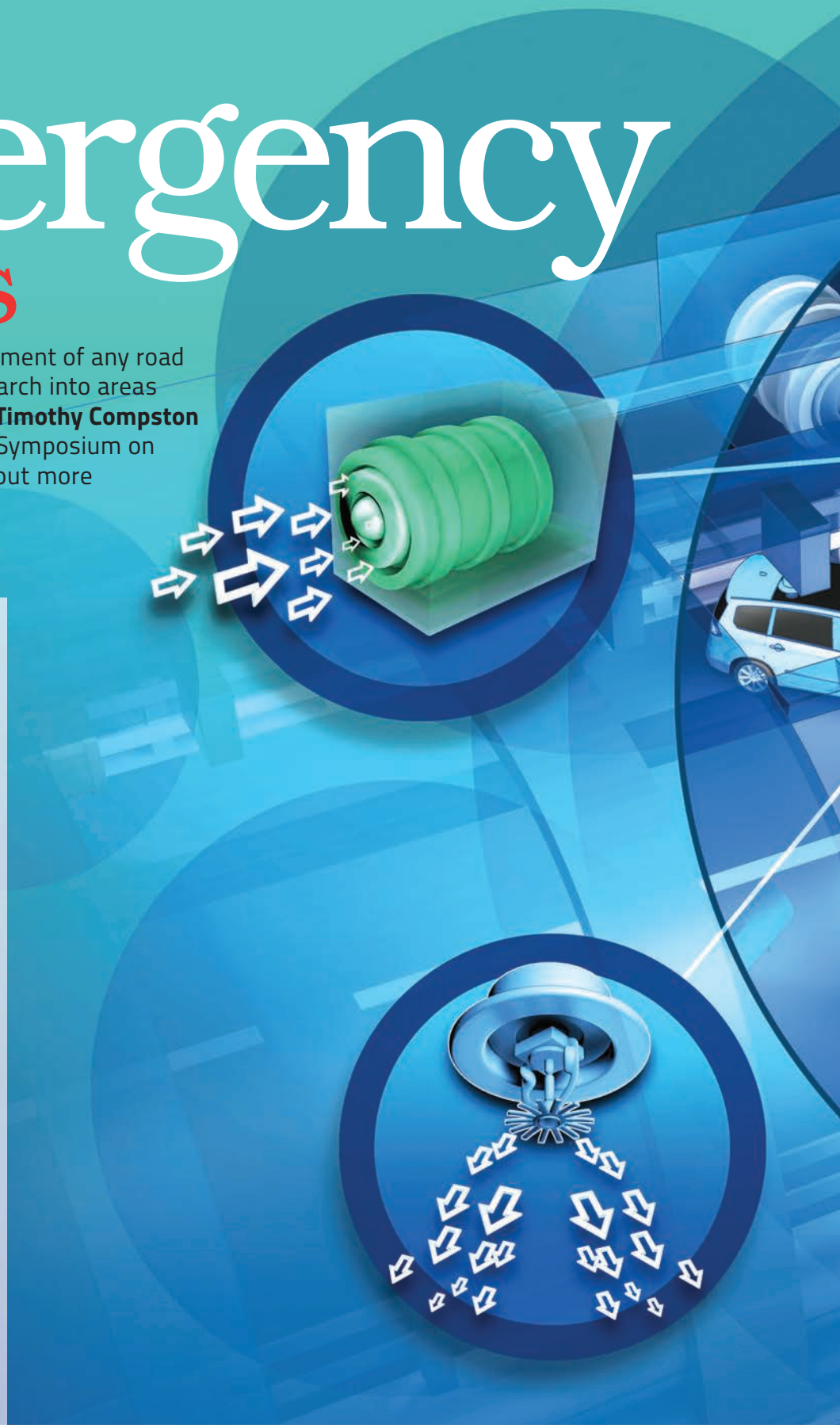
Better control is in fact exactly the approach adopted in Australia under what's known as the Intelligent Access Program (IAP) with the use of both onroad (i.e. WIM) and on-vehicle (mass monitoring) extensions. "Similar to Europe, Australia's freight task is growing so it's vital we look for new ways to drive improved productivity, efficiency and safety," states Chris Koniditsiotis, CEO of Transport Certification Australia (TCA) and an ISWIM board member. "In Australia, we have risen to the challenge of bigger trucks by monitoring their route compliance with GNSS. The IAP-monitored vehicles are also checked for mass compliance through a number of strategically located WIM screening systems. This is conducted at high speed with the mass of the individual axle groups and gross combination mass (GCM) compared to what's stated on the permits; if the vehicle exceeds the limits, it is then statically weighed for formal compliance purposes."

The very latest approach Down Under is to use IAP with onboard mass-monitoring scales. "This interfaces with IAP to provide for both static and dynamic individual axle group mass as a function of vehicle location and time," Koniditsiotis explains. "Ultimately, this has offered a level of confidence to regulators to provide better access to the road network and at the same time better manage the vulnerable infrastructure," the TCA man concludes. "The benefit of onboard mass-monitoring scales is all mass changes (increases and decreases) are recorded irrespective of the location of the vehicle. You therefore aren't restricted by site-specific WIM systems." ○

Emergency services

The successful design and management of any road tunnel owes much to ongoing research into areas such as fire and smoke dynamics. **Timothy Compston** takes his seat at the International Symposium on Tunnel Safety and Security to find out more

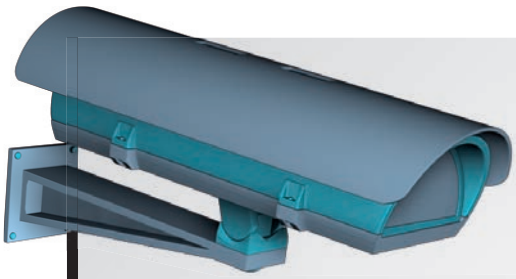
Illustration courtesy of Jason Cook



Should the worst happen in a road tunnel – whether it be a traffic accident or fire – it's imperative that the right measures are in place to keep drivers as safe and secure as possible and, crucially, to protect the integrity of the infrastructure itself. Thankfully, a huge amount of theoretical and practical work is being done where these critical arterial routes are concerned, touching on areas from ventilation and fire dynamics to the positioning of exit routes. In fact, these were the hottest topics at the recent 5th International Symposium on Tunnel Safety and Security (ISTSS) event, held in New York City in March.

A question of exit spacing

Paul Williams, fire engineering manager (New Zealand) for engineering consultancy Norman Disney & Young (NDY), has been investigating the relationship between exit spacing and the choice of tunnel ventilation systems for a number of years. His research into this often neglected area stems in part from his involvement in a major tunnel project where the initial feasibility design had a large transverse ventilation duct. Williams was tasked specifically with considering the options to remove the transverse duct and replace it with longitudinal ventilation, the goal being to reduce the cross-sectional area and, vitally, the cost. "Our analysis showed that by bringing the exit spacing down significantly it would essentially be possible to balance



Keep your distance

Navtech Radar's **Steve Clark** reveals how the company's trial of its millimetric radar technology is providing an effective counter to illegal tailgating and unsafe lane-change maneuvers in a tunnel in Taiwan

In addressing a longstanding and unfulfilled requirement of a police authority in Taiwan, in December 2011 Navtech Radar successfully carried out trials to test the suitability of its millimetric radar for enforcement against tailgating and lane-changing in tunnel environments.

> "Tailgating is something that is difficult to measure accurately with video analytics

The new application – tested in conjunction with a Far Eastern transport consultancy – takes advantage of how Navtech's systems work. The TS 200-X radar, which provided the front end of the solution used during the trials, scans through 360° eight times a second and has a resolution of 25cm. This was allied to the company's 'Witness' back-office processing and control solution, which allows operators to define areas of interest within the radar system's detection area. For enforcement against tailgating, two areas of interest are defined – one in which vehicles are initially detected and then accurately sized by the radar, and the area within which enforcement is to actually take place.

When a vehicle enters a facility, it is therefore provided with a unique identification tag that it carries with it throughout the enforcement zone. It is also sized to a very high level of accuracy. This combination of accurate tagging and sizing is used to identify bumper-to-bumper merging and trigger a camera that takes an enforcement-quality image of the offense.

For lane-change detection, carriageways and lanes are also drawn in Witness. Vehicles are continually tracked as they travel within a lane. As the location, heading, and speed of each vehicle is known, the software can judge when a vehicle will pass over lane markings and therefore when to take an enforcement image. This predictive capability counters any system latency through to the enforcement camera.

"To improve safety in tunnels, drivers are often encouraged to leave sufficient headway to the vehicle in front and to not change lane," says Navtech Radar's director, Steve Clark. "However, enforcement of such driving behavior has proven difficult. Any enforcement system must accurately detect offending vehicles. It should also maintain a high level of coverage of the area around the installed equipment in order to maximize detector coverage per sensor.

"Tailgating is difficult to measure accurately with video analytics, and in any case the quality of the images provided would be unusable in a legally enforceable sense," Clark explains.

out the risk between the two designs so that the outcome was comparable," he explains. "The original transverse design had longer exit spacing so drivers would have been in the tunnel for longer during an incident."

Tunnel ventilation systems are rarely designed in a consistent manner, according to Williams, so there's certainly a need for more quantitative risk analysis and putting it into a wider context: "You find dissimilar guidance and experience for different jurisdictions," the fire safety expert adds. "In general, mechanical ventilation for a short, low traffic tunnel may not be deemed necessary, however in most instances some form of mechanical system is generally suggested, comprising longitudinal impulse fans and/or transverse ventilation ducts."

In Williams' view, the approach to ventilation that provides the lowest risk to life safety in any individual tunnel depends, essentially, on the inter-relationship between four key factors:

> With this risk-analysis model, the consequence of each event is separately determined and the risk of a single event or combined event can then be calculated
>
> **Paul Williams, fire engineering manager, NDY, New Zealand**

"What stands out is the type of ventilation system, its reliability, the frequency of congestion in the tunnel and – importantly – the travel distance between emergency exits."

To help make the correct choice, Williams feels that something beyond a simple flow chart is required and so, necessarily, he created a risk analysis model where event trees are constructed to determine the frequency of specific events that can be applied to any tunnel. "With this risk-analysis model, the consequence of each

If you were looking to carry out wide-area enforcement of this sort without radar, you might, Clarks highlights as an example, start at the tunnel entrance with a laser sensor over each lane and then complement these throughout your tunnel scheme with a series of cameras equipped with video analytics. "The number of individual systems needed to carry out the same task starts to ramp up quite quickly," he says. "By contrast, a single TS 200-X radar system can provide detection for both lane changes and tailgating out to a 400m diameter, depending on tunnel geometry. That's 200m in all directions from a single system, which – at the same time – can also be fulfilling a range of other tasks. These can include automated incident detection as well as vehicle count and classification."

The tailgating and illegal lane-changing application is already available on Navtech Radar products, however the company has recently engaged with a UK testing house to carry out third-party verification testing. This has proven the 'trigger/no trigger' efficacy for the tailgating function, Clark reveals, and is a step toward Type Approval.

Navtech Radar's tailgating and lane-changing technology was trialed in Taiwan

Stockholm's Klara Tunnel was subject to a great deal of systems testing

Emergency exits are a critical – if little used – component of tunnels

event is separately determined and the risk of a single event or combined event can then be calculated through the product of the frequency and consequence," he suggests.

As an example, the NDY man highlights the 2.5km Waterview Connection in New Zealand – which is being designed for 90,000 vehicles a day and is due to start construction soon – to help illustrate the approach. Provided that there's an appropriate choice of exit spacing, a longitudinal ventilation system can be shown to present an equal or lower risk to life safety than a local smoke extraction system, even, Williams notes, when the assumption is that there is a reasonable level of congestion. This is an important finding, as he explains further: "The use of local smoke extraction tends to increase the cross-sectional area of a tunnel that has a direct bearing on the cost of construction."

Learning lessons

There are many older road tunnels still in operation worldwide so, although new-build projects tend to grab all of the headlines, it is interesting to take a closer look at the results of a series of full-scale fire and ventilation tests and the implications that these might have for other similar structures. Jonas Andersson, the safety officer for the municipal road tunnels in the city of Stockholm, Sweden, also attended the New York ISTSS event to unveil the findings of tests he conducted on the city's Klara Tunnel. Dating back to the 1970s, this important artery in the center of Sweden's capital city had started to come under scrutiny in relation to its fire and life safety: "It was important we took a new look at Klara because we hadn't conducted any tests on the tunnel before, and although there was a vehicle fire in there 20 years ago, the analysis from that event probably wasn't detailed enough," Andersson reveals. "I had

Decisions in the mist

Tunnel safety consultant Ricky Carvel used his keynote address at the ISTSS to ring the alarm regarding the pressing need for a system of testing and classification of mitigation systems. Take water mist technology. Just how well does it actually work? And how can it be accurately assessed in real-world conditions?

Carvel's technical investigations into vehicle fire suppression go back five or six years to work undertaken at the Dartford Tunnel in England: "They were in the process of upgrading and putting in a water mist system, which was a major move as there were no similar systems in operation in UK tunnels," he explains. At the time, Carvel insisted a number of key questions had to be addressed. "What sort of suppression system should be used? Will it be safe and, fundamentally, will it actually work and improve life safety?"

The tunnel safety expert says a similar set of questions are just as relevant today and many of which remain unanswered.

Focusing on solutions on the market, Carvel singles out water mist as an option that is being heavily promoted as a fire suppression system – as opposed to old-fashioned sprinklers – but one which has not as yet been tested for real: "Where you don't want large pipework and there isn't access to a large water reservoir, there is a trend toward water mist. This is despite the fact that, as far as I know, it hasn't actually been used in practice."

Carvel has his doubts about whether a water mist system would actually work to suppress a fire: "Thinking about what happened in the Mont Blanc Tunnel, for example – where there was a refrigerated trailer carrying margarine and flour – would a water mist system really have been able to influence this type of fire?" In contrast, Carvel cites the Australian experience where their road tunnels pretty much all have sprinkler systems that are able to pour large quantities of water over the road: "We saw how sprinklers worked in the 2007 Burnley tunnel incident in Melbourne to control the fire, protect the tunnel, and save lives."

Tunnel ventilation systems require regular testing

also been looking closely at ventilation cases and fire ventilation strategies as well as what could cause problems. To do this, I needed a better handle on the actual facts."

In terms of structure, the urban tunnel – one of seven in Stockholm – is made up of two sections that are connected, a 500m section with two lanes and a 350m section with one lane, through which average daily traffic is 35,000 vehicles. With regards to ventilation, the system is transverse with 15 fans – eight exhaust and seven inlet. The inlet openings are located near the pavement and run almost along the entire tunnel on one side with the exhaust fans ventilating through a gap between the wall and ceiling on the opposite side.

Four full-scale fire and smoke tests were devised and implemented with the assistance of Anders Lönnermark, senior research scientist from the SP Technical Research Institute of Sweden, and carried out at two different locations in the tunnel, the aim being to generate heat and smoke equivalent to that of a small car. Methanol was used as the fuel and smoke was produced through the use of smoke machines. Ventilation conditions were set to simulate low and high traffic conditions and fire ventilation was activated 10 minutes after ignition.

Lönnermark is a strong advocate of the importance of full-scale testing for this kind of ventilation system: "They really need to be tested regularly because conditions may change due to alterations in the tunnel or other factors," he explains. "We learned a lot from implementing the tests that we would otherwise not have known."

What these examinations underscored was the huge impact that external conditions can have on a tunnel containing a transverse ventilation system. For instance, it was found that conditions outside and general tunnel design determined the direction of airflow regardless of the preset ventilation settings. So, when high traffic conditions were simulated, the ventilation destroyed stratification (the layers within the tunnel), causing visibility to markedly deteriorate. In fact, the actual air speed measured in the real-world tests turned out to be the opposite to the simulated traffic direction in all of the tests, while it was also found that for three of the tests smoke tended to accumulate in a specific spot.

> "It demonstrates the importance of not basing everything on calculations but actually seeing what happens with your own eyes"
>
> **Anders Lönnermark, SP Technical Research Institute, Sweden**

A key point, Lönnermark stresses, was how the smoke in the Klara Tunnel behaved when different settings were applied and the role that the external conditions played: "This demonstrates the importance of not basing everything on calculations but actually seeing what happens with your own eyes," the Swedish scientist

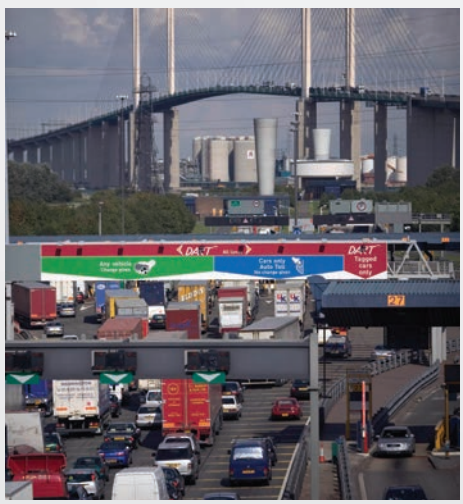
VIP treatment

The quick detection of incidents is vital for any tunnel, but especially so when it's the Dartford-Thurrock River Crossing – one of the busiest tunnel-bridge crossings in Europe

The Dartford-Thurrock River Crossing in England is one of Europe's most heavily used and complex crossings in terms of traffic management. Spanning the River Thames between Dartford and Thurrock, it forms a vital link in the M25, one of Europe's busiest motorways.

An average of 140,000 vehicles a day use the crossing, which comprises two dual-lane tunnels carrying traffic to the north and a four-lane cable-stayed bridge carrying traffic to the south.

As part of the European Union Directive 2004/54/EC concerning minimum safety requirements for tunnels in the Trans-European Road Network, England's Highways Agency is installing a CCTV-based automatic incident detection (AID) system. The technology comes courtesy of Belgium's video detection specialist Traficon via UK-based company Vital Technology, the main contractor. "By detecting incidents fast, secondary accidents can be avoided and traffic congestion reduced dramatically," explains Sukhdev Bhogal, business development director at Traficon. In all, 70 of Traficon's VIP-IP Video Image Processing boards are being installed in both bores. The Traficon technology will provide extensive AID capabilities, including the detection of stopped vehicles and smoke detection. The project is due for completion in September 2013.



The Dartford Tunnel will use Traficon incident detection technology to ensure a safe passage for all vehicles

The Traficon VIP-IP is a multifunctional Video Image Processor for traffic control using network cameras. It integrates AID, data collection, vehicle-presence detection, digital recording of pre- and post-incident video sequences, and streaming video in one board for a variety of traffic management applications such as tunnels, highways and bridges. It makes use of field-proven Traficon algorithms that were implemented in other boards such as the VIP-T video detection board for analog

> "By detecting incidents fast, secondary accidents can be avoided and traffic congestion reduced dramatically

cautions. "Here we found that the smoke actually went in a completely different direction to what we expected; the ventilation was pushed at an angle one way but was still turned around due to the external conditions."

Jonas Andersson from the City of Stockholm Traffic Administration makes the point that when you have transverse ventilation, you do not want to have longitudinal airflow: "You need the ventilation to stay where it is in case of a fire," he says. "What we found was that the external conditions and environmental ventilation in our tunnel were having a very big impact on the direction of airflow and stratification."

Mobile fans were used as part of real-world tests in Stockholm

In terms of the lessons from the tests, Andersson thinks that for new tunnels they will be looking to put fans higher up as fire and thermal expansion naturally goes up and not down. For the Klara Tunnel, they are increasing the automation of the ventilation system and the walls have been lengthened between the parallel ducts because there was an issue with smoke leaking over to the other tube. The sprinkler system has also been reinstalled: "This is important because, as the tunnel is only 3m high, thermal expansion moves faster than in larger tunnels," Andersson stresses.

Fire mitigation

For Ricky Carvel, assistant director at BRE Centre for Fire Safety Engineering, University of Edinburgh, the New York Symposium offered an ideal platform to present or collaborate on a number of thought-provoking papers, perhaps the most significant of which was his keynote presentation focusing on the mitigation of tunnel fires (see *Decisions in the Mist* sidebar). Alongside this was a joint paper he contributed to on the multiscale modeling of fire emergencies in the context of a transverse ventilated tunnel.

cameras. This ensures high reliability and a low false alarm rate of this new IP version right from the start.

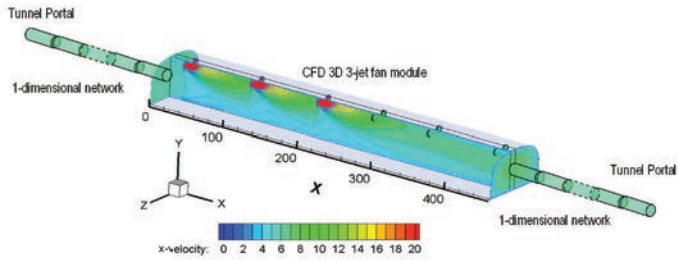
Data, events, and alarms generated by the VIP-IP detector boards are handled by the Traficon Management System, known as Flux. The main goal of this innovation is to manage and control all traffic information generated by these various detectors and to make it useful, meaningful, and relevant to the user.

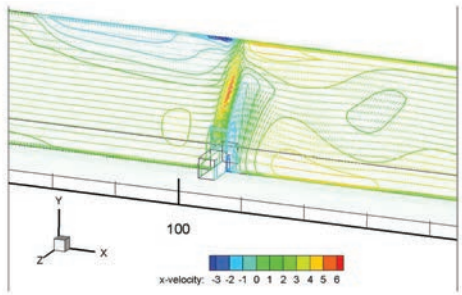
Traficon has been awarded a fair number of a AID tunnel projects in the UK over the past few years, with the Tyne, Hatfield, and Medway Tunnels the most notable. Last year, however, the company also successfully commissioned 40 VIP-T AID detector boards in the northbound Blackwall Tunnel, which is set to be a crucial traffic gateway toward the Olympic Stadium in East London during the upcoming 2012 Summer Olympic Games.

(Below) **70 VIP-IP boards are being installed in the Dartford Tunnel**

This multiscale work was a collaborative effort between DENERG-Politecnico di Torino in Italy and the BRE Centre for Fire Safety Engineering. The rationale behind the multiscale modeling was proposed by Carvel to make better use of available computing power when looking at tunnel ventilation. The major consideration for adopting the new technology was to ensure that detail only appears where it is actually needed, so offering an alternative to the very fast but basic or accurate but very computationally intensive model types that had previously been available. "Essentially this form of modeling brings together a Computational Fluid Dynamics (CFD) solver with a simple 1D model so 1D can be utilized where ventilation flows are more developed and 3D for a closer look at key areas such as the ventilation fans," Carvel explains. The upshot of the team's work is that modeling can now be undertaken in a much faster timescale – for example over two days rather than three weeks – and more efficiently when it comes to the demand on computing power. Significantly, Carvel says it's possible to achieve these practical benefits while maintaining a good degree of accuracy.

The flexibility of the technique, meanwhile, is underlined by the fact that it allows interesting parts of the tunnel to be characterized – such as individual fan types – and then these can be tried out in multiple variations: "We are able to put this together rapidly – it is almost like building something from blocks of Lego," Carvel says.





Schematics showing how multiscale modeling is used for tunnel projects

The challenges of adopting such an approach for transverse ventilation are much greater than longitudinal by virtue of the higher number of 1D-3D interfaces, such as gallery sections and extraction dampers. The methodology highlighted in Carvel's work has already been applied to a project, looking at the potential interaction between a growing fire and a ramping-up ventilation system in the Grand-Saint-Bernard Tunnel between Italy and Switzerland.

Going underground

When it comes to a fire in a road tunnel, unsurprisingly a factor that needs to be taken into account is the role that vehicles can play in the instigation and development of any blaze. One of the ISTSS presentations that stood out in this regard was given by

> 1D can be utilized where ventilation flows are more developed and 3D for a closer look at key areas such as the ventilation fans
>
> **Ricky Carvel, assistant director at BRE Centre for Fire Safety Engineering, University of Edinburgh**

Rickard Hansen, a PhD student from the School of Sustainable Development of Society and Technology at Mälardalen University, Sweden. With previous experience as both a fire protection engineer as well as a fire chief, the focus of Hansen's paper was on the methodologies that can be applied to calculate the overall Heat Release Rate (HRR) of a vehicle in tunnels and other underground structures.

Research and rescue

The Save Me project (funded by the EU and coordinated by Newcastle University) has developed an intelligent sensor-based system that detects both natural and man-made disaster events in public transport terminals, vehicles, and critical infrastructures. The aim is to provide support in emergency situations to help save the lives of the general public and the rescuers, giving particular emphasis to the most vulnerable travelers (i.e. children, older people, and the mobility impaired).

The two trial sites are at Monument Metro Station, Newcastle, UK and the Colle Capretto road tunnel in Italy. The latter is a dual-bore structure, 1,171m in length and located near San Gemini, forming part of the SS3bis Autostrada. It is monitored from a control room located in Perugia (about 70km to the north), not at the site itself. A successful demonstration of the Save Me system occurred at the end of May and included the evacuation of 60 people using the Save ME guidance system developed at Newcastle University under the guidance of the Italian Fire Service.

Although, as he points out, his decision to look at HRR curves was sparked initially by a focus on vehicles in underground hardrock mines, he feels that the work he has undertaken is equally valid for road tunnels, too: "Vehicle fires are the most common types of fires in both underground mines and tunnels, and the types of vehicles found in each type are comparable, for instance even a drilling rig can be found in a tunnel during the construction phase."

As to why a better understanding of HRR is such a critical element, Hansen thinks it's important in the wider context: "It provides information that can help when decisions are being made on the level of ventilation that is required, such as providing a better understanding of smoke production, and other critical requirements such as fire barriers."

Hansen is pleased with how the methodologies he applied worked out, and confirms that they came very close to the corresponding results from full-scale fire tests.

Something that really stood out was the impact that a few vehicle components can have on a fire: "They can very much dictate the fire's behavior," he reveals. "In the case of the bus we looked at, the passenger compartment played a key role, whereas in the fire experiments for the drilling rig it was the hydraulic hose and oil."

What surprised Hansen was how relatively simple methodologies could mirror the true test results: "It became apparent that what is most important is ensuring that the component that is decisive for fire behavior is correctly accounted for."

> "It became apparent that what is most important is ensuring that the component that is decisive for fire behavior is correctly accounted for"
>
> **Rickard Hansen, Mälardalen University, Sweden**

Moving forward, he believes that operators need to focus on the kind of vehicles and cargos that are likely to pass through their tunnel. This will allow them to then calculate the HRR of the vehicles and analyze the risk of fire spreading to adjacent vehicles, which could increase the overall HRR. He also feels that vehicle manufacturers need to make a greater effort with regard to adopting more fire-resistant and non-combustible materials.

Best practice

The factors involved in keeping tunnels safe and secure are many and varied. What's clear is that the wealth of new techniques – such as more efficient computer modeling alongside real-world testing and the sharing of experience and lessons learned through forums such as the ISTSS – all serve to ensure that these vital connections can be designed and managed in the most effective way possible.

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Beat the traffic

Mega events such as the FIFA World Cup and Olympic Games place huge added pressure on transport networks. But **Joshua Gans** finds that with meticulous planning, sharing of best practice – and a bit of luck – traffic nightmares can be avoided

Illustration courtesy of Ian Dodds

Revelers were euphoric in Trafalgar Square on July 6, 2005 when Jacques Rogge, president of the International Olympic Committee (IOC), announced from Singapore that London had been selected as the host city of the 2012 Olympic Games. Fewer than 24 hours later, with the morning rush-hour drawing to a close, there was pain, confusion and condemnation as four suicide bombers wreaked havoc on the English capital's transportation system, killing 52 and injuring 770. Then London mayor Ken Livingstone later suggested the terrorists ultimately failed as London bounced back and is a lot more resilient as a result. Security, though, will be just one of the many challenges facing transport managers when the 2012 Olympics gets under way in a matter of weeks.

Fail to prepare, prepare to fail

Something in the region of 4.5 billion people will be watching sport's greatest tournament when it kicks off on July 27. London 2012 will in fact be the UK's largest-ever peacetime logistical exercise, with 11 million spectators, almost 300,000 athletes, officials and media plus other members of the 'Games family' and staff converging on one of the most complex and congested cities on the planet. This was not lost on the IOC, which – during the bid stages in 2004 – was "terrified at the prospect of the world's most famous athletes being stuck in hot cars on gridlocked roads on what will likely be the most important day of their lives".

All through preparations, though, Transport for London's commissioner Peter Hendy has remained confident that there won't be a repeat of the 1996 transportation mess experienced in Atlanta, with London 2012 hopefully mirroring the success of Sydney 2000. "Atlanta was such a spectacular disaster in terms of getting athletes to events that we clearly cannot have that happening here," he says. "Our two clear objectives are to support the delivery of a great 2012 Games and ensure we keep the city moving."

Actions speak louder than words, of course, but there has been a monumental investment to ensure everything runs smoothly, even in the face of mischievous scare-mongering in the mainstream press and predictions of a 'transportation doomsday'. "The bottom line is that 1.2 to 1.8 million Games-related journeys per day are by far not totally additional traffic," suggests Philippe Bovy, professor emeritus of transport at the Swiss Federal Institute of Technology in Lausanne. "For the large part they 'replace' normal traffic, which in big cities such as London is usually 18-25% lower – due to the vacations in the summer season when the Olympics take place – than in average conditions."

Nevertheless, Bovy, a longstanding transport consultant to the IOC, admits the scale of the biggest and most diverse sports event around is indeed gargantuan. "The traffic loads generated by a Summer Olympics are quite extraordinary and can only be tackled by cities with high-performance public transport systems," he advises. "Experience has shown that around half of the success of transport at an Olympic Games depends on an accelerated expansion of public transport infrastructure to be operational for the Games, while a quarter is down to integrated multimodal transport management and centralized traffic command, control and communication systems. The last quarter depends on the authorities inducing changes in traffic modal split to better master car traffic, as in Beijing in 2008 and in Vancouver for the Winter Olympics in 2010."

Invest to impress

London has certainly splashed the cash. Around £6.5 billion has been spent on upgrading and extending transport links, with some £40 million alone on intelligent signal control (see *Down to the timing* sidebar), which has been installed at 500 extra intersections for the Games, bringing the total to around 2,500. A recently maligned aspect of London's 2012 traffic management strategy, though, has been the Olympic Route Network (ORN), successfully introduced in 2000 in Sydney and implemented at every Olympics since.

"The insights gained at Sydney have had a tremendous influence on the transport and traffic management measures introduced for all subsequent Games as well as for other mega events such as the FIFA World Cup in Germany (2006) and the European Championships in Austria/Switzerland (2008)," explains Bovy, who has been advising mega events for more than 30 years. "Sydney used all available techniques to cut Games-time traffic demand: holiday periods were extended; some central business activities were shifted to outlying areas; freight deliveries were pre-empted on a large scale; and curb-parking restrictions were applied to most of the downtown Sydney area. All measures combined resulted in a background traffic reduction of about 20%."

Keeping Sydney moving is one thing, but Beijing eight years later proved an altogether different challenge. At the time, the Chinese capital was in the middle of one of the fastest motorization rate increases ever seen, with 500,000 cars being added to its jammed roads every year, resulting in alarming levels of congestion and pollution. Following the Sydney formula, a network of more than 200km of Olympic lanes were reserved for Olympics-accredited vehicles. They worked in Beijing largely because the city is full of six-lane highways, something that London certainly cannot contend with.

The London 2012 Olympic Games has been the catalyst for transforming 2.5 square kilometers of land in East London, with brand-new transport links to ensure timely travel to and from events

Olympic Network Route

The implementation of an ORN has been met with criticism from some quarters, which is something of a mystery to TfL's Peter Hendy. "There are a lot of myths out there: that the ORN will be full of VIPs traveling in limousines; that the ORN and restrictions will result in 100 days of disruption," he states. "The fact is, any vehicle can use the vast majority of the ORN and in London it covers just 1% of the entire road network – and only one third of that are 'Games lanes' for official Games use only." Despite the headlines, the truth is that the Games lanes are only being implemented where more than one lane is available, are in the offside lane, and some replace bus lanes. Most users, Hendy has acknowledged, will be media, athletes, officials and workers, and only after that sponsors and IOC members. If demand from official Games traffic is low and capacity is

> "The insights gained at Sydney have had an influence on the transport and traffic management measures introduced for all subsequent Games"
>
> **Prof. Philippe Bovy, Swiss Federal Institute of Technology, Lausanne**

(Left) **Olympic traffic lanes, as seen in Beijing and prior to that Athens and Sydney are being adopted this year** (above) **in London, too**

spare, they will be reopened to general traffic using variable message signs. And when demand from Games traffic is too high, empty low priority vehicles will be taken off the ORN.

In terms of how the Olympics may affect day-to-day business in London, in 2011 TfL distributed to the freight and logistics industry and other interested parties maps showing the areas by day that will be affected by the ORN throughout the Olympics. "We have now extended that on the *Get Ahead of the Games* website to public information about those areas that will be affected," Hendy adds. "There will be similar messaging to the sort you get on the State Opening of Parliament day or if there's a Royal Wedding, for instance – 'Please avoid these areas', etc – because clearly capacity will be affected. Ultimately, the Olympic Games will be like a Royal Wedding or a State Opening of Parliament or, for that matter, the recent Diamond Jubilee. It's just that the Olympics goes on for longer."

(Left) **Around 6,500 roads were closed for street parties for the Queen's Diamond Jubilee celebrations, although the jams in London were largely localized** (Right) **TfL's campaign to highlight the ORN**

Critical parameters

Even though there are similar requirements for mega events such as the Summer or Winter Olympics, the FIFA World Cup and even Queen Elizabeth II's Diamond Jubilee, the mobility issues are quite different for each. The Olympics are multisports events generally in one host city, while soccer championships are 'one-sport' events in multiple cities, so the critical organization parameters

Winter wonderland

The awarding to Russia's Sochi of the 2014 Winter Olympics also signaled the 'green' light to propel its transportation infrastructure into a new era, according to organizing committee president and CEO **Dmitry Chernyshenko**

One of the major priorities for organizers of the Sochi 2014 Winter Olympic Games has been the transport infrastructure. The huge investment in terms of the reconstruction and rebuilding of streets, the construction of junctions, roads and bridges will contribute to social and economic vitality in the resort city. "Barcelona grew from an industrial center to a global tourist resort and Beijing became a great exhibition of modern Chinese achievements, but I think Sochi 2014 will catalyze an even more remarkable transformation," says Dmitry Chernyshenko.

The president and CEO of the Sochi 2014 organizing committee believes that by the start of the Games in February 2014, the Black Sea coastal city will be one of the most free-flowing in Russia, boasting new roads, traffic management systems, and the very latest in ITS.

> "The new transport system will have IT-based control and management systems, making it possible to manage traffic in real-time

Poor transport accessibility and road capacity has long been one of Sochi's main infrastructural problems, preventing the resort from reaching its full potential. Now, though, the Krasnaya Polyana region will also have 36km of new access roads to the skiing areas, while a 50km auto-rail road is being built, with its 12 tunnels cutting through the nearby North Caucasus mountains, linking the Olympic Park in the Imeretinskaya Valley with the ski slopes in Krasnaya Polyana. Once built, the journey will take no more than 30 minutes.

The road infrastructure of the coastal territories will also be transformed. New highways are being built to make it possible for transit vehicles to circumvent Sochi's currently congested urban area. A 19.2km road bypassing Sochi was commissioned in 2009, for instance, while a 16.2km support road for Kurortny Avenue and an 8km highway from Adler to Veseloye are under construction.

such as transport, accommodation, etc, bear little operational resemblance. The Olympics may feature more than 300 competition events in 16 days, for example, and the program is known well in advance. Knockout phases in soccer tournaments, though, unfold rather more unpredictably once the group games have taken place.

So just as best practice in transport strategy filtered from Sydney via Athens and Beijing to London, traffic management experts in Stuttgart – who kept local roads moving throughout the 2006 FIFA World Cup in Germany – have been advising their counterparts in Rio about the upcoming 2014 competition in Brazil. While Germany's 2006 tournament was ongoing, a delegation from the South American country visited Stuttgart's integrated traffic management center (IVLZ). By observing traffic from the IVLZ control room as well as on the scene, valuable insights were gained in terms of traffic management strategies for such special events. Visits were also arranged to IVLZ partner organizations, such as the operation control center of the public transport company SSB, Stuttgart's police situation and control center, and so on. The delegation even called on soccer club VfB Stuttgart, where advice was given on the organizing of the 2006 FIFA World Cup in and around the stadium. Much of their time was taken up by introductions to the city's traffic control facilities, including the operation of traffic light controls and the use of alternative-route management techniques.

Paulistos in São Paulo, a 2014 FIFA World Cup host city, currently spend a significant part of their lives inching their way through gridlock

Brazil, though, has not one but two mega events on the horizon, with the 2016 Olympic Games following two years after Ronaldo, Rooney and Robben fly home. The country's problems are considerably more complex than Germany however, with organized crime, extortion, drug trafficking and gang violence commonplace, so security for tourists, fans, VIPs and even competitors is going to be a concern for organizers.

> Atlanta was such a spectacular disaster in terms of getting athletes to events that we clearly cannot have that happening
>
> **Peter Hendy, transport commissioner, TfL, UK**

Transportation also remains a significant challenge. In 2009, Brazil's Federal Government committed US$6.6 billion to improve urban mobility, with a priority on bus rapid transit (BRT) – about 500km of systems are being implemented in eight World Cup host cities.

As with any city hosting a mega event, the emphasis on public transport is key, particularly if you're São Paulo. A recent NAVTEQ study conducted in the city showed that Brazilians are now spending more time stuck in traffic jams than ever before – a problem likely to worsen over the next few years. Half of the drivers surveyed said that they tend to get stuck in traffic at least once a day, and are concerned that the 2014 FIFA World Cup is only going to make the situation worse. Clearly the survey is

During the preparations for the Sochi 2014 Olympic and Paralympic Winter Games, 47 transport infrastructure installations will be built and enhanced in Sochi and the surrounding area

A number of large transport hubs and junctions will spring up at the crossroads of the busiest roads, too. The 'Adler Ring' is being built, as well as junctions at the crossroads of Donskaya Street and Gagarina Street and near the Central Stadium. This will not only help solve the city's existing transport problems but also remove traffic jams, which are the main cause of excessive emissions and increased air pollution.

The entire new transport system in Sochi will have modern IT-based control and management systems, making it possible to manage traffic on a real-time basis. Such measures and initiatives may, over time, be adopted by other Russian cities as well, hence why Sochi is being described as Russia's largest experimental platform. It's much than that for Chernyshenko though. "We've been planning and working for seven years already just for these two weeks (in 2014) to be perfect."

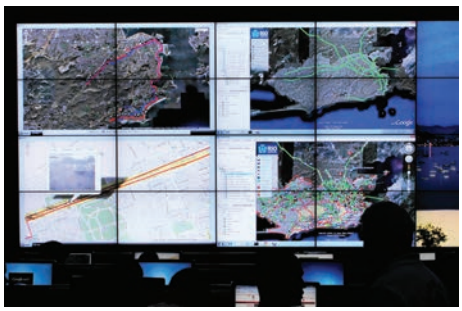
intended to drive sales of GPS devices for the delivery of NAVTEQ's real-time traffic information, but Brazil's efforts to regulate its traffic problems are increasing in urgency. Wasted time and fuel consumed in traffic congestion cost the economy of São Paulo nearly US$20 billion in 2008, for instance, which is roughly 10% of its GDP.

And São Paulo is not the only Brazilian city with its traffic problems. According to Vinodh Swaminathan, IBM's global director for ITS, much focus has been on another World Cup host city (and stage for the 2016 Olympics) Rio de Janeiro, with scrutiny from FIFA, the IOC, the World Bank, and several other agencies, to ensure the right infrastructure is in place to deliver sporting events to remember. "In 2010, Rio was devastated by severe floods and mudslides, which took hundreds of lives and left thousands homeless," Swaminathan says. "Out of the need for improved emergency management and better weather prediction, we helped the city integrate predictive analytics, real-time data, and weather modeling technology and establish a state-of-the-art operations center, all of which will pay dividends when the World Cup and Olympics eventually touch down."

At the heart of the Cidade Nova facility is PMAR, a high-resolution weather prediction system powered by IBM's 'Deep Thunder' supercomputer. "It lets the city predict rain and floods 48 hours in advance, allowing for better management of emergency services with the potential to save lives," IBM's ITS lead reveals. The Rio Operations Center now acts as a nervous system for the entire city: managing traffic congestion, keeping a close eye on crime response and prevention, predicting brownouts in the power grid, and coordinating large-scale events to ensure public safety. In actual fact, it's one of the first public facilities to be concluded ahead of time in the run up 2014 and 2016.

Leave behind a traffic legacy

What the experiences of Atlanta, Sydney, Athens, Germany and more recently Poland and the Ukraine show is that transport operations and mobility are vital for any mega-event to be a success. The million dollar question, however, is how to keep the long-term development vision and legacy in mind while meeting the shorter-term mobility needs of the occasion event. The experience in this regard is decidedly mixed. For the Olympic Games in particular, many cities invest heavily in stadia and other facilities that later go under-utilized. Beijing, though, implemented travel restrictions for virtually all private vehicles during the 2008 Olympics and then kept a reduced version of the policy in force once the Games roadshow left – a so-called 20% restriction regime, in other words, a private vehicle is able to circulate only four out of five weekdays per week. Such concepts are no doubt already on the minds of transport planners and decision-makers in Russia as it maps out plans to host the World Cup in 2018, as well as those in Qatar for the World Cup in 2022.



(Left) **Rio's Operations Center integrates information and processes from 30 different agencies into one center**

Down to the timing

Over the past two years, Transport for London has begun to increase the number of signals using the Split Cycle Offset Optimization Technique (SCOOT) system from 2,000 to 3,000. Work has already started at 861 sites and been fully completed at 514 locations. So far, SCOOT has helped deliver an average 12.7% reduction in delays for vehicles traveling across the network, with the increase being almost 20% at some locations. Around 40% of London's 6,000 traffic signals now use SCOOT and work is continuing to have half of the city's traffic signals running with the system by spring 2014. TfL is also reviewing the operation of 1,000 traffic signals every year to ensure that they continue to operate as efficiently as possible. Since April 2009, London's transport authority has carried out around 2,650 traffic signal reviews and has been able to reduce delays for traffic at these locations by almost 8% and by around 1% for pedestrians, achieved without compromising pedestrian safety.

As well as the introduction of 'pedestrian countdown' technology to around 200 locations across London from summer 2012, TfL will begin trialing of a pedestrian version of the SCOOT technology after the 2012 Olympics. The work will allow TfL to better detect large groups of people at pedestrian crossings and amend traffic signal timings to allow them to quickly move through areas of London. TfL will also begin work to see whether SCOOT could also be adapted to better detect cyclists and other vulnerable road users on the network to further improve and adapt the system to deliver benefits for the city. Although still an aspiration at the moment, TfL is hoping to have developed a prototype for the new systems by the end of 2013.

> It lets the city predict rain and floods 48 hours in advance, allowing for better management of emergency services and potentially saving lives
>
> **Vinodh Swaminathan, global ITS director, IBM, USA**

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Pervasive and persuasive

Developments in Oregon and on the I-95 corridor appear to suggest that the USA's uphill quest for a mileage-based user fee could soon reach a peak. But, asks **Bern Grush**, could the political argument be strengthened by focusing more on value-added services rather than the MBUF component?

Illustration courtesy of Magictorch

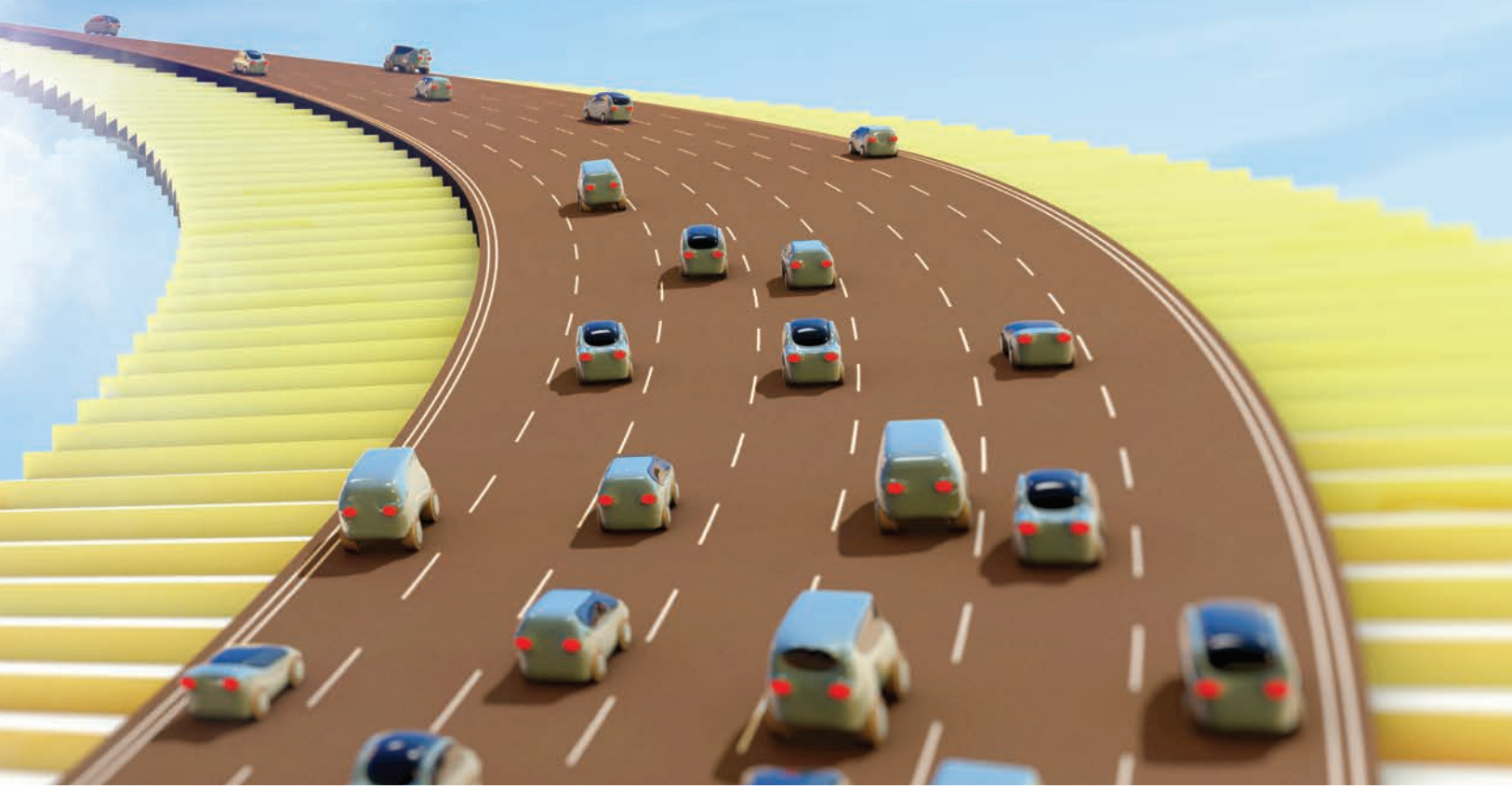
The USA continues to study mileage-based user fees (MBUF), as proposed in the 2009 National Surface Transportation Infrastructure Financing Commission (NSTIFC) report *Paying Our Way: A New Framework for Transportation Finance*. Although many have taken the Commissioners' advice seriously – evidenced by the mounting output of studies, reports and conference papers – we are likely behind their intended schedule "that will accommodate the desired 2020 comprehensive implementation".[1]

Standing on four legs

Four major components are needed for a comprehensive implementation – in order of critical value, they consist of social acceptance, political support, workable operations, and road-use measurement/charging technology. The money and weight each of these is allotted in the studies and papers produced to date are negatively correlated to their importance and difficulty. Technology is easy and fun. Social acceptance is daunting. To the degree we do not focus on social acceptance, the NSTIFC target will remain 12 years away.

Two key 2012 studies include Oregon DOT's RFP for Road Usage Charge Pilot Project Equipment and Systems and the I-95 Corridor Coalition's Concept of Operations for the Administration of Mileage-Based User Fees in a Multistate Environment. Both recognize the importance of user acceptance, but their titles betray a different primary focus. The work of ODOT and the Coalition, while necessary, seems insufficient for the suggested NSTIFC schedule.

ODOT's proposal to have electric vehicles pay MBUF is intended to initiate Oregon's shift away from the gas tax. Motivated by a need for sustainable road finance and fairness (EVs pay no fuel tax), the 2012 project is designed to educate around "40 to 50 people [such as] ODOT managers, Oregon transportation commissioners and state legislators sitting on transportation revenue committees". The assumption is that if 'VIPs' can observe such a system working with a range of motorist choices, easy operation and privacy management, then they will be more amenable to passing further legislation. If we still seek ways to educate transportation managers and legislators while over a quarter of the way through the recommended NSTIFC schedule, how close are we to public acceptance for a "2020 comprehensive implementation"?



In information available to a skeptical Joe Public, much is expressed about miles driven and too little about variable fees related to time and place. Most transportation professionals understand that sustainability is not only about funding but also about maximizing the utility of the built infrastructure and the footprint we have already taken. Variable fees would result in many drivers finding ways to take some trips at different times or different ways. MBUF that only addresses miles driven becomes a very expensive replacement for fuel taxes and leaves the core matter of system viability unaddressed. The fact that we discuss this hairy problem so little in wider public forums indicates how difficult the education problem that Oregon has taken on really is. Every state DOT is aware of the worsening road-funding crisis – and many are watching ODOT – but rare is the legislator or opinion-leader that champions (or even understands) a sustainable solution. ODOT deserves kudos for the foresight to have legislators focus on ways to make this transition doable.

The Coalition's report compounds the sense that MBUF is far more complex and costly than a simple gas tax. With its focus on multi-state issues, transition concerns include "distribution of revenues among states, the exchange of vehicle ownership and use information, enforcement, rate structures, etc". It also questions other operational considerations such as which roads and vehicles to start with, collection handling, equipment certification, standards, accuracy, voluntary enrollment, customer service, data storage, privacy, tampering, and clearinghouses.

The Coalition's work is focused on administration, data access and exchange

Americans could one day replace their fuel taxes with road use fees

1 Incentive-based approach

Consider that incentive-based approaches are more effective. They increase freedom of choice. If the problems of congestion, making our vehicles more eco-sensitive, and paying for our road system are to be addressed effectively, the ultimate best strategies will be based on incentives and not command-and-control. We need to study voluntary, sustainable switchover incentives, regardless of vehicle classes or the type of energy used in a vehicle. Government can later mandate that all vehicles pay usage-based fees while providing appropriate choices between mileage fees, gas-tax surcharges or annual odometer fees.

2 The value of acceptance

Given current technology, the problem of reliably metering a vehicle's road use is minor compared with gaining acceptance of that technology – and the shift to MBUF – by a majority of drivers. New York City's deputy commissioner for Traffic and Planning, Bruce Schaller, illustrated a value-first approach with his 2011 *NYCDOT DriveSmart Technology RFEI: Safety, money- and time-saving technology for drivers*. He invited commercial vendors to consider equipping cars for several applications simultaneously: usage-based insurance, fuel efficiency and route advisories, crowd-sourcing and social media programming, HOT lanes and parking payments – and eventually road-use fees "should their time come". He cared little about technology specifics as long as it would be

acceptable to drivers and achieve his goals. He also asked vendors to propose a way to self-fund such systems. His approach models the option described in a 2010 study, *System Trials to Demonstrate Mileage-Based Road Use Charges*, spearheaded by Paul Sorensen et al of RAND Corporation, which studied whether federal or state governments, or even industry should lead the way.

3 The power of choice

Richard Thaler and Cass Sunstein (*Nudge*) argue that using behavioral economics to provide (and encourage) better choices changes behavior more reliably and sustainably than mandates. We can use human nature to encourage the switch we seek. Imagine a payment service suite that replaced your US$83 a month insurance premium with a US$75 usage-based premium and US$150 a month in parking fees with US$135 after incentive discounts for vehicle size or loyalty to a parking operator. Imagine guaranteeing no parking citations for time-limited, on-street meter violations and receiving several other location-based consumer perks, such as just-in-time, opt-in discount coupons to the driver's smartphone. And that it could provide eco-driving or safe-driving discounts for the first two years of use from governments seeking to lower emissions or improve road safety. Imagine such discounts and services pervasive throughout the region where you do 98% of your driving. Then, in a few years, imagine switching from US$25 a month in fuel taxes to US$25 a month in road use fees – or even paying a mandated road-use fee for your electric vehicle while enjoying several counterbalancing benefits (such as discount parking as offered for EVs in Copenhagen in 2009). Resistance and cost would melt away. With enough value add, we could approach the low cost of collecting fuel tax.

and managing the long period of transition and states moving toward implementation with varying temporal and rate schedules. Naturally, what we expect to learn from ODOT will interact with what we have learned from the Coalition.

Social acceptance

Of the four critical components, ODOT focuses on measurement/charging technology, and the Coalition focuses on workable operations. Both contribute somewhat to garnering political support. Where we still need more work, however, is in the area of social acceptance.

Consider that drivers and journalists will continue to fixate on anti-MBUF interpretations of privacy, equitability, government trust, and entitlement (note the failure of the South African tolling program, *p77*). Politicians will also continue to take positions against these proposals to garner votes, exploiting the public's (or their own) lack of understanding of road funding and transport economics. Even drivers who understand funding issues are not eager to pay MBUFs; few understand that paying by time and place of use rather than via fuel or property taxes can reduce congestion. Even fewer understand that most drivers – and indeed non-drivers – would be advantaged by the shift. A background issue is that all of us experience tolling as an additional cost. No government has yet dropped the fuel tax in exchange, although both ODOT and the Coalition assume that. A significant number of drivers need to understand that with a variable MBUF, people who stay out of congestion can save money. Unfortunately, low fuel taxation in the USA makes that a significant hurdle.

4 Value-add services

Significant value-add services would motivate drivers to ensure in-car devices are connected, working, paid up, and untampered, which can reduce the enforcement costs that the Coalition report identified as a key consideration. Leading with desired services also pre-sets some familiarity with road-use metering when MBUF finally arrives.

> A significant number of drivers need to understand that with a variable MBUF, people who stay out of congestion can save money

What's in it for me?

Rather than government top-down approaches, can we develop user-oriented market approaches that would be accepted and even welcomed rather than being seen as suspicious and intrusive? Could industry provide multiple and flexible programs to which motorists would voluntarily subscribe in significant numbers as a result of convenience, savings, and rewards? Such programs could include premium-lowering usage-based insurance, self-monitoring and ticket-free parking metering, automated parking payment, parking finders, parking fee (and later road-use) discounts for a safe or eco-friendly driving style (as measured

by onboard sensors), intelligent safety aids such as private monitors for distracted driving, navigation, and other location-based traveler services.

Such programs could acclimatize drivers to in-vehicle devices and pay-by-use concepts. Participants could overcome fears and see that privacy is indeed protected. It has already been demonstrated that many of these programs have an attraction for a majority of drivers in many jurisdictions provided they are able to control their privacy exposure. These are systems on which road use fees can depend later, just as we depend on the fuel distribution system today to host the fuel tax.

There is merit in fostering industry innovation for social acceptance. Industry fixates on acceptance, choice, flexibility, profit, desire, incentives and – most of all – rapid, competitive innovation. Industry is able to adapt more quickly as technology evolves, and is in a better position to offer bundling and cross-channel business models that will help cover the cost of these innovations.

Add value up front

Although providing some value for heavy trucks and a few urban cordons, single-purpose, autonomous road-use metering and detection systems deployed in Europe are expensive and make no business sense for statewide or nationwide fuel-tax replacement – especially as we enjoy fuel taxes that are among the lowest in the world. The solution to this is to include significant value-added services to make the expense and intrusion of an in-car metering system far more acceptable to users. ODOT recognizes this… but only as a secondary goal. Making acceptance secondary will retard implementation. Compared with the European Union a decade ago, Oregon is on the better path but we need to go further. We need industry to shrink the MBUF component of road-use telemetrics to a relatively minor consideration with pervasive and persuasive technologies – as described in the six sidebars.

The Coalition report correctly asserts governments should focus on developing policy, technology standards and communication protocols. One technology standard to be adapted to MBUF is the ISO/CEN draft for Charging Performance for Road Use Metering. Now is also the time for matters of privacy to be legislated and audit methods set up. Equity must be understood, anticipated and managed by policies and perhaps contingent programs for disadvantaged or rural commuters that must rely on automotive travel given insufficient alternate choices.

What is demanded is not so much methods to collect and manage MBUFs as ways to make acceptable the switch from paying by fuel use to paying by road use. It is much less the technologies and much more the policy, business and social models for acceptance, fairness, access to mobility, privacy, equity that matter. Fifty years from now, we will be stuck with the social effects of the policy innovations we devise over the next decade or two while the technology we trial in 2012 or the back-offices we repurpose from our heritage tolling programs will seem quaint, if we are even able to remember them.

Tolling is already an additional cost – this needs to be factored in to future plans

5 Exploration and innovation

According to both ODOT and the Coalition we are far from agreeing on deployment details for MBUF. This gives us what Tim Harford (*Adapt, Why Success Always Starts With Failure*) prescribes for tough problems: an opportunity for trial and error. Although I may be convinced of the sanity of the value-first approach, I cannot know which – if any – of these proposals is a 'killer app'. And there may be other programs that none of us has yet imagined.

6 Another channel

A critical purpose of profitable, industry-led, telematics-based services is that we need another channel to replace the fuel-distribution channel as the aggregator and collector of road-use fees. A telco-operated telematics platform could assess and forward billing feeds for parking, insurance, emissions, as well as any form of road tolling currently practiced. To achieve a 2-3% MBUF expense, we need to establish a new payment channel, and not at taxpayer expense. We need to reduce the billing cost for MBUF to the marginal cost of adding a smart-app. Only industry can do that.

> Although I may be convinced of the sanity of the value-first approach, I cannot know which – if any – of these proposals is a 'killer app'

References

[1] *http://FinanceCommission.dot.gov/Documents/NSTIF_Commission_Final_Report_Mar09FNL.pdf, p203*

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Just in time...

From tweets to Bluetooth, **David West** reports on the latest methods DOTs are utilizing to gather and disseminate real-time traffic information to road users

Illustration courtesy of Ben White

Aside from the ongoing challenge of actually gathering accurate data on what's happening on our roads, another of the other longstanding issues is how best to disseminate that information. Are roadside VMS the best way to inform drivers of current conditions? How about good, old-fashioned traffic radio? TV news, perhaps? Although all of the above have their place, there's a growing trend that also has great potential – the use of social media.

Social standing

Whatever your thoughts on social networking – whether you're a prolific Tweeter, avid Facebooker or you shun the entire concept – it's becoming an increasingly prevalent form of communication. And a fast one at that. You only have to look at how quickly events 'trend' on Twitter to realize that the internet is the go-to source for information when something major occurs. The sticking point, though, is just how accurate that information is – consider the numerous celebrity 'deaths' that get reported before turning out to be hoaxes.

Accuracy aside, then, how can social media benefit the real-time traffic information sector? The number one selling point is how cheap it is. It costs nothing to tweet. The second is the instantaneous response and dissemination of information. Twitter, Facebook and the like have access to a switched-on and captive audience; one message can be enough for people to alter their travel plans on the spot. It's no wonder, then, that agencies are embracing the use of social media.

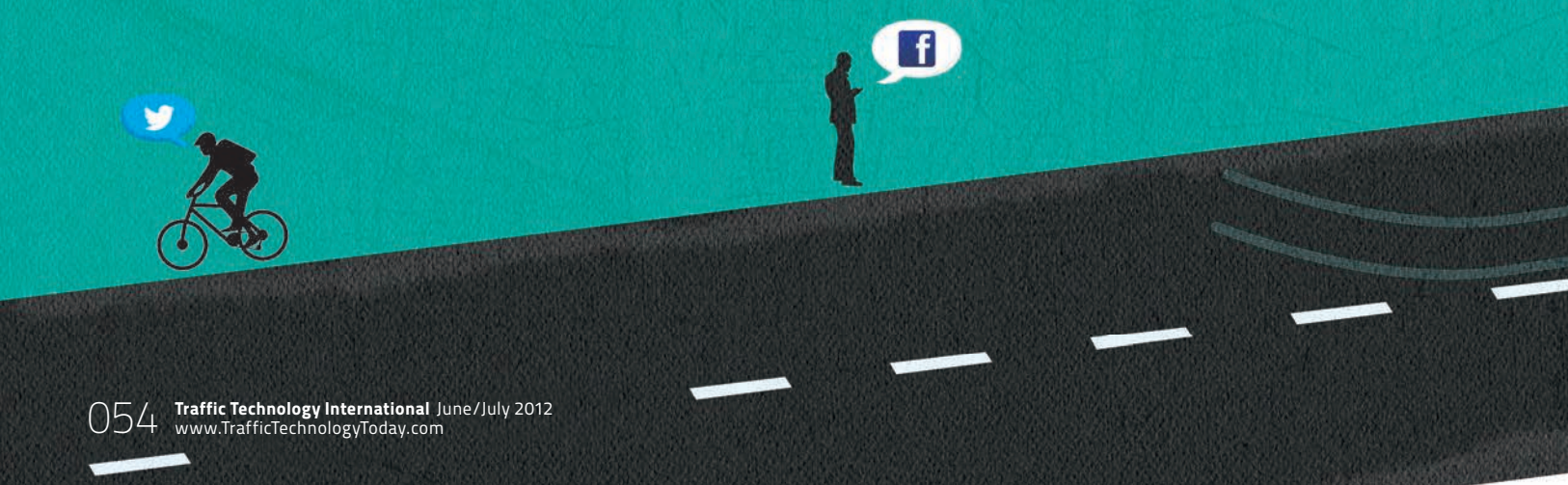
The biggest adopters so far have been in the public transit sphere, with operators around the world choosing to communicate the details of incidents, delays, schedule alterations and more, directly to their users' smartphones, tablets, laptops or PCs.

Incident management

Road managers and DOTs are also starting to adopt social media as part of their everyday operations however. Nowhere is this tool more valuable than in the case of incidents. If something out of the ordinary occurs, once it has been verified, it can be communicated in real-time to people using – or intending to use – that particular stretch of road. This enables traffic managers to encourage the traveling behavior that best fits their plan for managing specific incidents – which could be anything from diverting to an alternate route to warning people not to access certain roads.

The other noteworthy point about using social media is that it's an interactive, two-way form of communication. Drivers themselves can share information, experiences and their 'eyes on the road' view of what is happening around them – it's a simple form of crowd sourcing that is unbelievably effective.

Ultimately, though, its value comes back again to how accurate the information is that's being tweeted, posted and shared. Over the course of the coming pages, we've highlighted some of the innovative methods to actually collect real-time traffic data.



Into the blue

The acquisition of traffic data without fixed infrastructure sensor technology

> These unique Bluetooth IDs are anonymized directly on the sensor and are given a highly accurate and synchronized timestamp before transmitted to the BLIDS server

Besides increased public transport, congestion charging and the promotion of electric vehicles, dynamic traffic control can also contribute to helping avoid congestion and its associated emissions. Dynamic message signs (DMS) play a vital role in traveler information and event notification by displaying messages to motorists. But to gather all of the required real-time traffic information in the first place, it's necessary to use a wide range of sensors.

One of the most compelling classes today could be a system based on Bluetooth, which is a non-intrusive and inexpensive alternative to ALPR. In fact, the latest tests conducted on behalf of the Bavarian government in southern Germany in 2011 have demonstrated that a Bluetooth-based traffic sensor from c.c.com was assessed to be equally or more suitable than a system based on ALPR.

The BLIDS system combines Bluetooth-based sensors and algorithms (such as for adaptive smoothing), which integrate seamlessly into existing ITS.

Installation engineers will typically prefer a detection platform that is easy to install and requires no calibration. The BLIDS solution has been created with this in mind and offers user-friendly software tools for set-up. Reliability and robustness is key, and the most common data transmission is through cellular data networks.

BLIDS sensors mounted next to the driving lane acquire unique Bluetooth IDs from devices such as cell phones and navigation systems that come within the each sensor's reception range. These IDs are anonymized and are given a highly accurate and synchronized timestamp before being transmitted to the BLIDS server. Based on the information gathered from at least two sensors, real-time information on travel times, traffic interruptions (incidents) and traffic flows can be calculated. The sensor consists of specially developed hardware and software based on embedded Linux. Services that run on the system use Bluetooth sensors, GPS, GSM, RS232, WLAN and USB interfaces to create the scanning and communication components. An external power supply (in/out), a radar sensor for cross-section count, optional battery buffering or solar panels complete the overall package. There is also a built-in monitoring agent to handle possible network problems, low battery, etc, and start the self-healing process to remain online and functional. Firmware over the air (FOTA) is also supported, which allows the sensors to be maintained and updated remotely. With the Bluetooth module, all visible Bluetooth devices are acquired in a single scan cycle. Here, the 'discovery' mode is used and only the Bluetooth addresses, time, class of device, and received signal strength indication (RSSI) value are read out.

The BLIDS solution has already been deployed by customers across Europe, notably the local Austrian radio station, OE3, which relies on the online traffic information generated by BLIDS.

A further installation in the municipality of the city of Rostock, Germany, is also using BLIDS sensors for traffic flow analysis, travel-time measurement and recognition of retention time within crossroad areas, as well as visualization of travel time via a web interface.

In high definition

TomTom's new web-based service for mobile devices should give drivers ample opportunity to plot new routes if there is evidence of long delays

One of the recent technological trends in real-time traffic information is to use connected devices – whether that be cell phones, satnavs or other sources – to provide the type of information that would traditionally have come from ITS equipment such as cameras, loops, etc.

TomTom has invested heavily in the sector and its HD Traffic system is becoming increasingly popular among those looking for accurate real-time data.

HD Traffic fuses information from a number of freely available sources to create an accurate picture of what's happening on the road network. These include government traffic data, some historic data, data from fleet management systems, some cellular data (accrued by monitoring the movement of cell phones) and of course data gathered from TomTom satnav units. The advantages of all these sources being combined to provide accurate, real-time information are obvious.

HD Traffic is already used by a million people across Europe and is present in 23 countries around the world. Among a flurry of recent contract wins (including the UK's Automobile Association) one of the latest announcements is that Research In Motion (RIM) is using HD Traffic for BlackBerry applications.

Winning with wireless

A Barcelona-based company has created a new vehicle detection solution for gathering real-time traffic information

Based on a wireless traffic monitoring station, the SenseFields solution consists of several magnetic sensors (depending on the width of the road section to be covered) and a data processing system (DPS) that receives their signal and outputs vehicle-counting and -classifying data.

Core to the platform is the strong and reliable vehicle-detection capability, which is based on advanced wireless sensor networking technologies, paired with a scalable sensor DPS. This allows a cost-effective and versatile solution for the management of traffic in cities and on interurban roads.

The wireless sensors are finely tuned magnetic sensors with highly robust algorithms able to reliably detect vehicles – even in the presence of strong magnetic interference (such as metal pipes, power lines, underground, bypassing cars, etc). There is no need for extra sensory information, such as sound or light. Sensors send the data collected to the DPSs using IEEE 802.15.4 PHY, compliant with a greatly enhanced MAC, which allows for aggressive duty cycling. Meanwhile, the configurable radio frequency below 1GHz allows sufficient communication range, even in radio-saturated environments such as urban areas.

The wireless sensors are physically accessible by unscrewing the top case, so their battery can be replaced. This accessibility means the system can be implemented in temporary situations for periodical traffic monitoring in different sites with just one wireless traffic monitoring station. They can even be uninstalled while pavement works takes place and then redeployed afterwards.

The system can be installed very quickly with little need for civil works; a 125mm drill crown and polyester resin provides hardly any traffic disturbance during installation.

Offering a scalable and secure platform for traffic management, this wireless monitoring station processes large volumes of data from sensors in real-time and displays relevant information in a customizable view. It also offers advanced analytical tools for historical data.

> The wireless sensors are finely tuned magnetic sensors with highly robust algorithms able to reliably detect vehicles

Probing report

Better traffic monitoring can be achieved at a fraction of the cost using probe technologies

> The VPP not only helps target investment in roads and transit in the most critical areas but delivers improved traffic operations at reduced cost

In the USA, the I-95 Corridor Coalition's Vehicle Probe Project (VPP) has offered strong evidence relating to the merits of probe technology. The VPP uses crowdsourced traffic data and advanced analytics techniques to turn billions of data points into insights that are transforming how member states build, manage and measure their road networks. During the project, which kicked off in 2008, 19 agencies were given access to vehicle probe data, with several using the data to support their 511 web and phone services. Some use the data to calculate travel times and post them on VMS. Performance measures and travel-time reliability – particularly in congestion-prone areas – are calculated using real-time and archived VPP data.

Part of the appeal of probe vehicle data is that it can help agencies to save money, as illustrated by a case study from New Jersey. During a surprise snowstorm in October 2008, the NJDOT Traffic Operations Center was reviewing an accident on I-80 via a CCTV camera. The vehicle probe data-monitoring site identified a second incident involving multiple jack-knifed tractor-trailers along I-80 where no CCTV coverage was available.

Without the VPP monitoring site, response to this second incident would have been delayed by as much as an hour as operators were busy responding to the first. The expedited response to the second incident translated into a US$100,000 saving in user-delay costs.

Last October, the Coalition, the University of Maryland and INRIX announced a thee-year extension and program expansion. It now provides INRIX real-time and historical traffic information for more than 20,000 road-miles across 10 states along the I-95 corridor.

Through a complete, precise view of traffic conditions across their network, the VPP not only helps target investment in roads and transit in the most critical areas but delivers improved traffic operations at reduced cost. According to North Carolina DOT, in fact, where previous approaches to gathering traffic data had a lifecycle cost of nearly US$50,000 per mile, the probe data has been proven to deliver more coverage at 25% of the cost.

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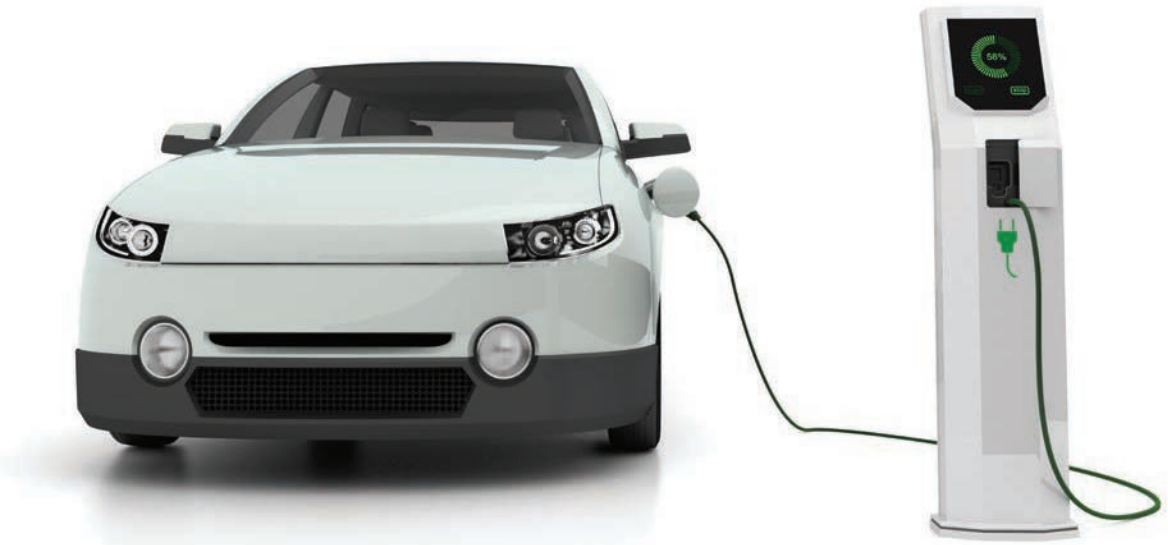

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Professor Phil Blythe explains the need for ITS champions to put the UK back on the intelligent transport map

Interviewed by Louise Smyth
Photography courtesy of Lex Kembery

Academic, innovator, policy advisor, and a member of numerous industry boards. There are many strings to Phil Blythe's bow, so much so he's become one of the most recognized faces within the UK ITS sector. His expertise is sought after far beyond these shores however. Before joining the academic staff at Newcastle University in 1999 (home to other early advocates of ITS such as Margaret Bell), though, the professor of ITS and director of the university's Transport Operations Research Group (TORG) was also heavily involved in research at a European level. "People will possibly associate me most with some of the earliest electronic tolling and road pricing projects," he reveals. "If I had to define what I do now, I'd say it's working on the interface between technology and policy. It's about looking at how technology can deliver current policy better and more efficiently. It's also about horizon-scanning – looking into the research labs to pinpoint the technologies that might be viable in a few years' time to enable you to have new sorts of policies and to do things completely differently."

Ahead of the game

It's a useful set of skills for Blythe to have because he suspects that a lot of people just "chase their tails" and do the same old research, while he and his colleagues always try to look at what's around the corner. "I suppose the classic example of this was when I was a young researcher and working with automatic tolling," Blythe continues. "Back then, the best you could hope for was a tag stuck onto a windscreen, and the driver driving through a toll plaza at perhaps 10mph or stopping and waiting for a barrier to open. Through European projects and UK government-funded projects (PAMELA, ADEPT and ADEPT II, etc), we set out to change that and developed the first demonstration of multi-lane high-speed tolling anywhere in the world. In parallel with that, we showed that you could build systems that could perform quite complex road user charging. So back in 1993/94, we established the Cambridge congestion metering trial, which showed that although people didn't like the whole idea – it was maybe 10 years ahead of its

People power

One of the overall messages you sense when speaking to Phil Blythe is that ITS is about people as much as it is technology. We need 'champions' of ITS, to drive forth its evolution and spread the word as to how it can help manage traffic, reduce congestion, and improve safety. So then, who does he particularly admire on this front?

"Going back a long way I think the people who really raised the whole European game with the DRIVE 1 programs back in the late 1980s were people like Fotis Karamitsos, who is now back in transport at the European Commission. He has a passion for ITS and a long-term vision."

He's also keen to praise another Brit, Professor Eric Sampson. "I think that ITS would be 20 years behind if we hadn't had Eric at the helm of the DfT at the time that we did," he says. "He kicked off things like Transport Direct, ITSO, most research on road pricing – a lot of the standardization and specification detail that sits behind successful interoperable ITS. When we lost Eric, we really lost a champion in the DfT, and that slowed down deployment and policy thinking on technologies for the UK for a good four or five years."

time – it was possible to look at how technology could help facilitate road pricing. That led to the DfT's 1995 electronic tolling trials and London looking at the potential of road charging through its *Review of Charging Options for London*."

Slow out of the blocks

Yet aside from the London Congestion Charge and a handful of tolled roads, the UK has been a lethargic adopter of the types of technologies Blythe and his cohorts investigated. Look elsewhere in Europe – Stockholm, Slovakia, Poland, and Germany, for instance – as well as across the Atlantic to the USA and the technologies are being widely implemented and are totally mainstream. So despite the fact that the UK clearly has some incredible minds working in ITS and is undeniably strong on the research side, why does it appear to lag so far behind in terms of actual deployments? Blythe admits that this is a source of frustration. "Considering technology seems to evolve more quickly today, the speed at which we get it out on the street is not particularly dynamic," he observes. "I think the ITS industry has not been the best at extolling the benefits and impacts of ITS to the wider community. In conjunction with organizations such as ITS UK and the Institution of Engineering and Technology (IET), it's something we do quite a lot as a university, but at times that message doesn't get out quickly enough to the local authorities and the people who have to make the decisions on the ground."

A further problem Blythe identifies has two prongs. "There are probably too many third parties with both the DfT and local authorities advising and conducting the work, so local authorities don't have the indigenous skills and champions to drive things forward," he feels. "The fact that a lot of ITS work over the past 15-20 years has been hived out to consultants has been a real inhibitor at times. They do a great job but it means the knowledge isn't retained and local authorities are subsequently bereft of any in-house skills. It's a self-perpetuating cycle of them being unable to be intelligent clients for the consultants."

Blythe believes local authorities are at last wising up to this and trying to rectify

> "The fact that a lot of ITS work has been hived out to consultants over the past 20 years has been a real inhibitor at times

Tolling: a logical progression for the UK

Now that lorry RUC is seemingly back on the UK agenda, Phil Blythe predicts that RUC and tolling schemes in general will very much be part of the UK's future. "Tolling is very different to road pricing in the sense that it's recovering the capital operating and maintenance costs of a particular piece of infrastructure, but I can't see it being avoided," he explains. "As a country, we have no money, so we've got to look at new innovations concerning how we fund future infrastructure needs. In the long term, anyone who's realistic is going to have to accept that if we're going to manage congestion, try and decarbonize the roads by making people think more about a journey before they choose to go by road, and if hybrid and other alternative fuel vehicles become a large proportion of the fleet, there's going to be such a hole from money coming into Treasury that they're going to have to look at another way. And I can only see that some form of pay as you drive is the way to take that forward. There are no issues with technologies to do that. Whether a tag, a black box or a GPS-based system, the technologies have been proven and are improving by the day, so it's just a political issue to make that decision and have a champion to take it forward.

"I realize there are many steps we have to make toward that, but in the long term I can't think of any other logical way to manage the demand that will exist for the road infrastructure."

this situation by building up core teams – particularly now, when money is short. "We're seeing them banding together and trying to collaborate to reduce costs, attain a stronger purchasing power and to share expertise," he details. "The problem there, though, is that you secure a lot of capital funding to buy kit but you don't obtain a lot of revenue funding for the people who can run these projects, make them sustainable, and keep them going. That's where a lot of local authorities get hamstrung with ITS."

Across the spectrum

Stuttering, then, in the past few years at a street level, the UK remains dominant when it comes to research. Blythe's focus currently spans everything from 'green' ITS, road pricing, ITS for older and disabled drivers, electric vehicles, biometrics, and more. All the while, the northeast of England appears to be establishing itself as something of a hub for ITS research – in large part simply due to the likes Blythe and Bell being based there. In practical terms, this means a great deal of on-road research: "We put a lot of systems out on the street to sense, collect data, and so on, so we can build up huge databases to understand how traffic changes when you put interventions in. That includes environmental sensing, devices in cars for recording their movement, extracting data from pedestrians through their smartcards or cell phones, and generally bringing all manner of different datasets together. The One NorthEast regional development agency pushed a lot of this because as part of trying to persuade companies such as Nissan to invest in EVs in the region, they wanted to show that there's a real passion and infrastructure in place."

Blythe is also involved in a number of European projects, such as CVHS demonstrations – and he's lucky enough to have a testbed for such projects on his doorstep: "Our regional urban traffic management control center, run by Tyne and Wear, is sited at the university so in addition to being used as a commercial entity, we collaborate on research."

Blythe envisages a big future for CVHS. "A lot of the funding has been invested in deploying technology in-car, so we need to focus more on the infrastructure now," he believes. As the lead expert for the groundbreaking Foresight Intelligent Infrastructure study, he is well placed to comment on this issue. "Intelligent infrastructure is the key to creating the best possible travel options and delivering the safest, least-congested journey with the lowest CO_2 impacts. The technology and the intelligence to achieve that is available – it's just not yet joined together."

Clearly convinced of the merits of CVHS, Blythe is disappointed to report that it's another one of those areas where the UK has been left behind: "There are many UK companies and universities involved in CVHS but there's so little opportunity here to conduct meaningful work. Around six years ago, the consultants were asked to write a report for the DfT on the benefits of investing in CVHS but unfortunately they focused primarily on the safety benefits – and the quantification of these benefits wasn't very high – so the DfT withdrew from supporting a lot of work in that area."

On a more optimistic note, though, the chartered engineer predicts faster short-term progress in other, already existing technologies. "I think that putting together the embedded intelligence in the infrastructure, in cell phones and in cars will really deliver results," he says. "If you consider today's regional UTMC, the majority of information they get is from CCTV cameras and loops from their SCOOT systems, so there's whole swathes of the network where they haven't got a clue what's going on. If we have more embedded intelligence, we would see more about what's going on and that could make a real difference. That's one area we're pursuing."

Socially adept

As a father of both a pre-teen and a teenager, Blythe is also sourcing inspiration for research from the technologies they have embraced. "I think there's a real role for social media," he proffers. "Although I don't 'tweet', my kids do and they're very good at driving those sorts of technologies. When there is a transport incident, a lot of weak signals about things going wrong with transport systems come out via social networking before being officially announced by the airline, rail operator or road manager. So I think if there's a way of capturing those weak signals and validating them to decide which ones you can trust and then disseminating the information, that's a massive wealth of information available that hasn't as yet been tapped."

> When there is a transport incident, a lot of weak signals about things going wrong with transport systems come out via social networking

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FROM THE PUBLISHER OF
TRAFFIC TECHNOLOGY INTERNATIONAL

AET solutions for all road users

READER ENQUIRY NO. 501

With the continuing global expansion of electronic toll collection, the toll industry has an ongoing focus on looking for ways to bring the flexibility and efficiency of modern, electronic payment options to toll collection. Consumers are familiar with using the commercial Electronic Payments Network for small payments such as music and coffee – an approach that has only become cost-effective in recent years. The value of electronic payment systems (EPS) to the toll industry includes: lower cost, reduced infrastructure, lower risk, and consumer familiarity. Large economies of scale push operating costs down; and there is very little, if any, capital investment required to maintain the technology. The EPS narrative suggests that toll payment processing is not much different than processing the transaction for a drive-through cup of coffee: firstly, the customer/user drives through the point-of-sale (POS); secondly, the user is identified by the merchant/operator, and a payment transaction is built; next, the transaction is posted on an EPS network; and finally, funds are remitted to the merchant/operator.

The same desire for efficiency that pushes toll operators toward EPS has resulted in a growing number of them choosing to convert their roads to all electronic toll (AET) facilities. AET eliminates toll booths, collectors, coin machines and other technology that requires the consumer to slow down or stop. However, the inability to stop users leads to a larger problem. On every AET road, a significant segment of users will use the system without having a valid tag. For some systems, this number approaches 30% of users. AET operators are left with few options to collect from the untagged users. Most operators resort to license plate lookup and sending the user an invoice. Of the users invoiced, only a fraction pay; and those that do pay are generally charged about twice the toll for prompt payment, and up to 50 times the toll in fines and penalties if the payment is not made promptly.

Registering by cell phone is a convenient way for untagged users to pay their tolls

Need to know?

How the move to AET is prompting new innovations that include all road users

- Lessons learned from consumer electronic payment systems (EPS) and how we can apply these to all electronic tolling (AET)
- The pressing need not to penalise those least able to afford toll payments
- A new organization has been formed to bring EPS to AET in a way that benefits all users
- How a cell phone application can offer easy registration for untagged users to enable them to pay for their use of AET roads

The infrequent user

Sending an invoice in the mail is clearly not the most efficient way to collect a toll; however, the underlying economic injustice issue may be a larger problem. In many locations, a large percentage of the untagged users are un-banked or under banked. This group includes the users that are least able to afford to pay, yet they pay a premium over other users.

EPS coupled with advances in vehicle identification is well suited to begin solving these types of problems with AET. For this reason, BancPass was formed. The company's focus on future payment technologies is intended to create as many payment options for consumers to pay their tolls as there are ways to pay for a cup of coffee. BancPass has been working with AET operators to increase the consumer options for 'cash only' users to pay for tolls on AET roads. For example, frequent users should be able to easily and inexpensively buy a toll tag and replenish it through a number of convenient options. These options are familiar to consumers, and include checking accounts, credit cards, or cash replenishment through

a local retail outlet. For the 10-20% of drivers who use the system on average less than once per year, BancPass has developed a patent-pending approach to allow those with cell phones to register their license plate number to establish payment through a mobile application, which can be used for personal vehicles or rental cars. The PToll application has been piloted, and is easily adapted for any operator that has a license plate recognition system or violation system. It is an exciting time for the industry, with the potential for tremendous options for improvement in efficiency and convenience.

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If you have followed the New York media lately, you'll probably know what I've been up to. If not, here's the scoop…

For more than four decades, I have been a fixture in the New York City traffic scene, starting out as a cab driver, then junior engineer with the Traffic Department and ultimately traffic commissioner. I learned a few things along the way and on my own and at my expense, I've put together a kind of master plan for NYC transportation.[1] A major element is tolls at the now 'free' East River Bridges and along the avenue entry points to Manhattan's Central Business District at 60th Street. I would toll all motor vehicles and pedal-powered vehicles (bikes, unicycles, etc). This plan wouldn't go into effect until mid-decade at the earliest so I need your help on the right technology to use.

In the interim, the existing E-ZPass ETC system could be expanded to the East River crossings and along the 60th Street screen line. Those unregistered with E-ZPass can be accounted for by using an automatic vehicle identification system with ALPR technology. But I'm not yet sure how to toll bike riders this way so it may have to wait until sleeker, more adaptable devices can be in place.

There are also a few drawbacks with utilizing the existing E-ZPass technology currently in operation. For one, the transponder technology is fairly old and still requires batteries, which make the transponders liable to operational failure. They are also relatively expensive to manufacture and the changeout due to battery failure puts an added cost to the operator. From the user perspective, the transponders are a bit bulky, making the dashboard or windshield the only suitable place to put them. They are not practical for cyclists. So what's the next generation for transponders?

A new standard of RFID transponder has emerged in recent years, known as ISO-6C. With it come several advantages over traditional RFID tags, for both user and operator. The transponder circuitry is much thinner and requires no batteries, making them much more cost-effective to manufacture. The smaller dimensions also mean they can be integrated into various formats, including windshield stickers, license plate tags, and even ID cards. 6C is also helping to advance the growing trend of interoperability in the USA with multiprotocol readers being developed and deployed to allow an easier transition to the newer technology. With 6C RFID, the toll collection experience for motorists and cyclists can be greatly improved.

However, I would like to take ETC another step forward. Approximately 85% of adults in the USA own a cell phone, with a large and growing percentage being smartphones. Considering such a high level of market penetration, why not incorporate 6C RFID technology into every smartphone? In fact, many phones already have near-field communication (NFC) technology, which gives the phone contactless payment abilities. With RFID and NFC, a smartphone can be the perfect device for a universal multi-use payment system. Imagine being able to pay bridge tolls, taxi, subway and bus fares, and parking fees with a wave of your phone. Mobile phone applications can be developed to allow users to check their balances, usage statistics, and refill a prepaid account.

With the help of ETC, NYC could fix its current dysfunctional road pricing system and improve its transportation outlook in the coming years. Advances in ETC technology can enhance the toll collection experience for all system users, with fewer delays and ensuring better compliance. Only when the system is priced correctly and everyone pays their fair share can we begin to alleviate the considerable burden that vehicle traffic imposes on the city.

[1] *http://samschwartz.com/Portals/0/ETF041912.pdf*

> Imagine being able to pay bridge tolls, taxi, subway and bus fares, and parking fees with a wave of your phone
>
> **Sam Schwartz, Sam Schwartz Engineering, USA**

Mobile approach to road weather data

For more than 35 years, road authorities in charge of winter maintenance have relied on fixed road weather information stations (RWIS) to monitor current conditions and enable decision-makers to have the necessary information to make appropriate choices. However, on February 1, 2012, a new solution was unveiled to the ITS market. This innovation has the potential to change the way authorities collect, use, and view road weather information.

The new advance is a first-of-its-kind weather sensor kit that attaches to a vehicle. Called Condition Patrol, it is the only commercially available product that can monitor so many road weather conditions in one solution. To promote the concept and be able to show the solution first-hand to as many customers as possible, its creator, Vaisala, also began a driving tour of the USA on February 1, traveling from coast to coast over 16 weeks. The tour ended on May 21 at the ITS America Annual Meeting in National Harbor, Maryland.

Addition to the fleet

Vaisala outfitted a brand new 2012 Ford F150 pick-up truck with the Condition Patrol product. The truck was chosen because it would be added to the Vaisala field service fleet of vehicles once the tour had concluded. The truck was passed between territory managers across the country so that one person alone would not have to drive the nearly 20,000 miles. For the entire trip the truck collected air temperature, pavement temperature, dew point, relative humidity, surface condition, water or ice thickness, and surface friction. The data was transmitted every three seconds to Vaisala software and every 30 minutes to a public website for anyone to view. If the data signal was ever lost, the data was stored on the system until communication was restored. The latter half of the winter of 2011-12 was a pretty mild one for much of the USA, so the truck only saw limited amounts of snow or ice. In fact, it saw more ice at the agencies' offices when the system was demonstrated by using man-made ice.

The mild winter did provide one unexpected advantage. The tour and the truck were never late for a tour stop or meeting, and maintenance agencies were always able to see the technology, instead of being out fighting snow.

Even though the Condition Patrol is a new product, the backbone of the system is based on some very familiar sensors. There are three sensors that provide the road weather data to the Condition Patrol; Remote Surface State Sensor DSC111, Surface Patrol DSP101, and Humicap Humidity and Temperature Probe HMP155. All three sensors have been installed around the world and have been trusted by road authorities for many years.

The DSC111 has been used to provide non-intrusive road condition measurements at RWIS locations. The DSC111 used in the Condition Patrol has been modified for the mobile application so it can continue to provide quality readings more often and over changing pavement surfaces.

Need to know?

To showcase a new road weather information solution, one company opted to take its technology on a road trip

- Condition Patrol is a mobile weather sensor system
- Its creators decided to bring the new system to its users – road maintenance agencies – and so began a national tour of the USA
- Today, fixed RWIS sites still offer some advantages; the smart approach is to combine fixed and mobile systems as part of an overall strategy

READER ENQUIRY NO. 502

(Left) **The Condition Patrol product** (Above, right, below) **Shots taken during the Vaisala Across America tour**

The Surface Patrol probe provides the road surface temperature and has been around the longest within a mobile environment.

Finally, the HMP155 measures the moisture in the air, providing the dew point temperature and relative humidity. These values are crucial for the detection of frost, some types of black ice, and critical humidity levels – for operations such as weed control and chip sealing.

Future focused design

All the data is collected by an interface unit that resides inside the vehicle. The interface unit was designed with the future in mind, by allowing for additional sensors to be added later as new technology is developed. The interface unit creates a wireless network in the vehicle, so that no additional wires are needed to display the data on the Condition Patrol's smartphone application, which increases the ease of installation. A key feature is that the design allows for data viewing that meets individual user needs. Data can be used on the smartphone application, which allows for multiple configurations and some diagnosis of the sensors. Some users may decide that this is as far as the data needs to go; to the driver. However, if you are considering building a mobile weather network of vehicles, then bringing the data back to the Vaisala road weather software is an important step.

The launch of the Condition Patrol and the promotion of this tour does not mean that Vaisala is trying to move away from fixed RWIS technology. On the contrary, the company believes that this new mobile technology complements fixed technology and fits into a great road weather technology plan that all agencies should have. Mobile technology will fill in the holes that will always exist no matter how many fixed sites an agency has. Mobile technology allows you to get a greater picture of an entire route or region. Plus, at a lower total cost than fixed sites, mobile data allows for more decision points than a few fixed sites would provide.

Fixed sites still offer some key benefits that mobile cannot: 24/7 data collection; accuracy superior to mobile; collection of weather parameters not possible in a mobile environment; and proven reliability.

These are all benefits that mobile data will not be able to overcome any time soon, if ever. However, there is one point that Vaisala has learned along its tour. The volume of data is so vast (observation every three seconds) that accuracy is not as important because there is just too much to look at. This of course differs from fixed sites that typically transmit every 5-15 minutes. Once customers start deploying Condition Patrol on multiple vehicles at the same time, data frequency will again be so high that individual data points will be less significant.

Winning the battle

Whether an agency's road weather technology plan began with fixed sites or mobile, including both in the plan will improve its overall success with battling winter challenges.

The Vaisala Across America tour was a huge success in that the company was able to collect road weather information across the entire country all in one trip. In addition, the media was also following its efforts. The tour appeared in more than 45 local television spots, radio interviews and industry trade publications, allowing Vaisala to bring awareness of all types of road weather technology to the true end customers: the road users. Next stop… a possible repeat of the tour in Europe for the winter of 2012-13.

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Anomaly and change detection for intelligent traffic control

READER ENQUIRY NO. 503

The detection and prediction of incidents and anomalies is clearly a pertinent issue for any type of 'intelligent' traffic and environmental control and management system. On the one hand, it allows for a quick and early response when it comes to changing traffic control strategies accordingly, or triggering the right actions for managing an incident. On the other hand, though, anomaly or change detection can be used to identify situations where the control strategy of any given traffic control system exceeds its domain of validity or range of optimal performance. By adopting such a strategy, anomaly detection can be used to identify situations that have not yet been considered but should have been in the calibration of the traffic control algorithms and strategies. Incident detection systems can therefore be used to identify malfunctioning devices or systems components.

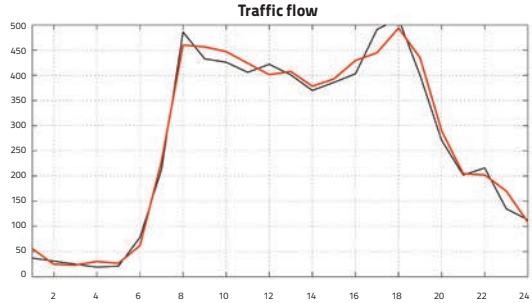
Although there are a lot of use-cases for incident and anomaly detection, there are also many sources of incidents and anomalies; there won't therefore be a single system or method to cover every single type. And due to the fact that not every incident can be predicted or detected per default, such systems must be expendable and highly adoptable, in an ideal world also being able to learn autonomously from new situations that arise – normal as well as abnormal circumstances.

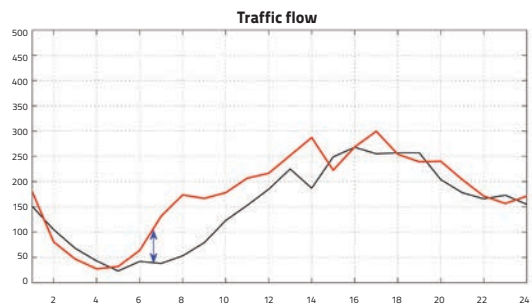
Intelligent incident detection helps prevent huge jams

Foundation for detection

Using this situation as a starting point, the engineering company, ANDATA – which specializes in the application of artificial intelligence (AI) and data mining solutions – has developed a new software environment for collecting a set of numerous anomaly and change detection methods and algorithms within a uniform framework.

The concept includes a broad range of different detection methods, from very simple ones to very sophisticated self-learning and self-adopting procedures from the field of AI. An incident, for example, can be detected simply by checking the certain threshold of a sensor. Traffic flow rates at certain times should be within specific parameters – e.g. the flow of a queue of traffic on a Friday afternoon might always be between 300 and 500 an hour for a certain lane of traffic. Hence, everything outside of this range can be treated as an incident. A second traffic flow sensor downward in the same flow direction should also measure similar traffic flows at a later time as well as inflow and outflow tolerances. This, of course, isn't rocket science. The initialization of the critical regions can be performed with very common and simple statistical measures – e.g. for outlier detection. These simple methods are already very





(Figure 1, top graph) **Illustrating the traffic flow on a normal working day**
(Figure 2, bottom graph) **Showing the traffic flow on a holiday**

Need to know?

As traffic behavior cannot always be predicted, systems must adapt quickly

- A new, comprehensive approach for an 'intelligent' traffic management with an appropriate intermodal control for each relevant situation
- System designed to be adaptive, including the possibility to be adjusted extremely quickly to a new traffic situation or even being self adaptive
- Open for any kind of data and information for identification and forecasting of traffic situations and conditions

efficient and may be enough for extreme events or for the detection of sensor failures. But for the selection of proper traffic control strategies – where even small perturbations can lead to jams – these may not be precise enough and might deliver detection rates that are too low.

For more precise detection, the use of machine learning-based times series-prediction models are the method of choice. Figure 1, for instance, shows a one-hour prediction of a time series-prediction model for traffic loads. In the regular case, the prediction model matches the real traffic flow very well. Figure 2, though, illustrates an example where the same prediction model failed, the reason in this case being that it was a holiday instead of a normal working day. If the system should treat that holiday in future as a normal case, the prediction model can be trained with the information relevant to such holidays and in the future it won't be treated as an incident anymore.

Combining a broad set of incident detection methods within a single framework and database for arbitrary sensor information – from simple to sophisticated – can increase the detection rate significantly. A huge advantage is that the mixture of the methods and their collocation into a single committee also allows a very quick and easy formulation and calibration of what is and what isn't expected, resulting in a steadily growing database to safeguard systems.

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Each year at its annual meeting, ITS America inducts several folks into the 'ITS Hall of Fame'. The inductees are usually national leaders who have advanced the cause of ITS over the course of their careers. In a spirit of full disclosure, I have been a part of the committee that selects candidates for this honor. Today, I want to suggest that there are other true heroes of ITS who have limited national recognition but without whom we would not have anything to celebrate. These are the local leaders who risked their reputations and even their careers to put systems in the ground and in use by transportation agencies. The national leaders could inspire and encourage but could not themselves make things happen on a local level.

My nominee for hero of ITS is Matt Edelman, executive director of Transcom in New Jersey. Matt is not alone in this regard. I could have easily picked Tom Werner from New York State DOT or Doug Wiersig from Houston, but I know Matt's story best because I was there at the birth of Transcom 20 some years ago. The New York region went into gridlock when one of its major bridges was shut down by a leaking LNG tanker truck. The main communication we then had between agencies was two-way landlines. The problem was that during these major incidents, there were more than a dozen affected agencies across three states and two-way communication just didn't cut it.

Transcom was created to coordinate the flow of information among agencies so that they could operate together better. After all, the impact of major incidents had no respect for political boundaries across a region of almost 20 million people. Transcom was never created to manage incidents on-site, provide police services or to substitute its judgment for that of operating agency managers.

The needs went beyond regional incident management. They included construction coordination so that agencies did not shut down capacity in the same direction at the same time and all of this preceded the creation of ITS. Transcom then created Transmit to use toll tags as anonymous traffic probes on 18 miles of roadway and is now deployed on more than 3,000 one-way miles of roadway and considered 'ground truth' to the industry. Through a long series of projects, they automated the information exchange and facilitated regional travel. I shudder to think what metro New York traffic would be like without it.

But in the early days, they sat across the table from powerful chief engineers and public safety officials who saw coordinating through Transcom as just one more complication to their already demanding responsibilities. Had they not been won over, they could have snuffed out Transcom's existence, but Transcom succeeded because they were solving real problems with technology and not just trying to apply technology to problems. That might just be the key to Transcom's long-term success. They were created to solve a transportation problem before ITS and were able to use the latest technology as it was developed to serve that need

For Transcom, ITS was the solution to their problem. And I think that's a good lesson for all of us…

> I want to suggest that there are other true heroes of ITS who have limited national recognition but without whom we would not have anything to celebrate
>
> **Larry Yermack, Wendover Consult, USA**

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High-speed WIM solutions

READER ENQUIRY NO. 504

High-speed in-ground weigh-in-motion (HSWIM) systems are used in two primary applications: gathering data to measure the effects of overweight vehicles on pavement and structures, and as a screening device to aid authorities in overweight enforcement.

The range of applications continues to increase as HSWIM is combined with other data-gathering equipment that can be used for real-time collection of information from a remote location. Often referred to as virtual weigh-in-motion (VWIM), these systems are seen as a cost-effective solution because they eliminate on-site manned operation and infrastructure and can be deployed in strategic locations. VWIM relies on HSWIM scale technology, but is also coupled with smart cameras that have OCR capabilities. The cameras are used to read the vehicle's license plate, DOT number (or unique vehicle ID), and capture general vehicle images. They play an essential role in VWIM, as the data collected not only allows the vehicle to be clearly identified, but also provides the information necessary to query central databases to gather more information about the vehicle and its carrier. In an Intercomp system, data captured by the smart cameras, along with all data collected by the HSWIM scale is transferred to a CPU located within close proximity and processed to accurately identify and classify the vehicle.

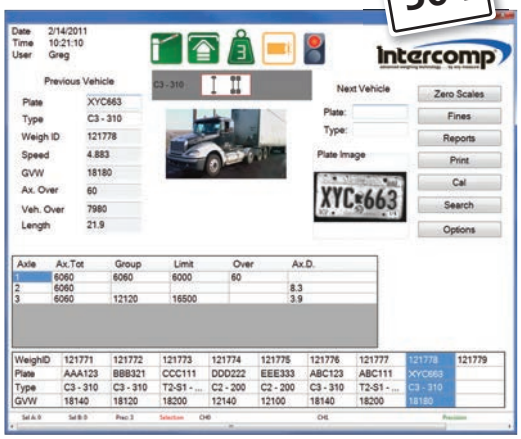
An unmanned VWIM system automatically monitors truck weights. It automatically captures the axle weights, axle spacings, images of the vehicle, and license plate and/or unique vehicle ID. Gross vehicle weight is computed and formulas for vehicle classification and equivalent single axle loads are applied.

Need to know?

The applications and merits of high-speed weigh-in-motion (HSWIM) systems

- Used for two main tasks – gathering data on the effect of overweight vehicles on roads, and to aid overweight vehicle enforcement – HSWIM systems have a great deal to offer road operators
- Virtual weigh-in-motion (VWIM) is an attractive and flexible option for law enforcement personnel
- How strain gauge technology helps to create highly accurate, durable WIM systems

All VWIM data is accessed by web-based software through an internet browser. The CPU hosts all data for a single site, while it is also capable of transferring all data to a central server (via Ethernet or cellular) where data from multiple sites can be hosted. Law enforcement is then able to log on to a secure website for a specific VWIM location, where vehicles passing through the VWIM station would appear in real time and be flagged if suspected of violations.



Intercomp's WIM solutions offer web-based software to assist agencies in their screening processes

Core weight data aids engineers and road designers in studying traffic characteristics as they relate to traffic flow, pavement design, and long-term impact. Existing standalone HSWIM systems can be upgraded to include vehicle recognition capabilities, which, when combined with access to the information via web-based software, is used to aid authorities in screening and properly identifying potential overweight vehicles.

As agencies improve means to access and share information about the vehicle and operator (associated with license plate or unique vehicle ID), VWIM software is capable of querying central databases to determine if there are outstanding and/or a history of violations.

Strain gauge technology

Intercomp's HSWIM solutions consist of electronic load-cell based strain gauge scale technology installed in the highway. Strain gauges provide the extremely fast reaction and sampling rates needed for accurate dynamic weighing, while temperature compensation ensures consistency in harsh environments.

Along with the use of VWIM, portable wheel load and portable WIM systems can be used for enforcement efforts positioned downstream of VWIM installations. Data and images can then be accessed in the officer's vehicle via the web from roadside locations for enforcement after violators bypass major weigh stations.

Portable scale technology also allows for enforcement and monitoring to screen for probable overweight or oversized vehicles. Both of these types of portable systems are used throughout the world for citation-based purposes in high traffic areas as well as secondary or rural roads.

There are many reasons to invest in overweight vehicle weight enforcement. Safety is of significant concern, but the investment in protecting the infrastructure can ultimately provide a net financial gain when the reduction in roadway maintenance is considered.

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The changing face of traffic safety camera design

READER ENQUIRY NO. 505

Protecting the sensitive measuring equipment inside, high-quality equipment housings are vital for traffic monitoring units, particularly given the need for continuous, uninterrupted and accurate measurement. Generally speaking, such housings must be solid and functional while also being weather-resistant and vandalism proof. Operation must be ensured in extremely demanding, disparate climatic conditions – and for any type of application. So from snow or sand storms to being drenched in rain or damp in fog, the seams, gaskets and locking systems must be up to the task.

Longstanding history

The design of these housings barely changed between the early 1970s up to around 2006. The windows for the camera and flash have always been small to prevent intrusion of heat or projectiles; and they've remained gray or green for camouflage purposes. The only significant alteration has been a larger housing to integrate air conditioning and a heat-protection shield. New expectations and demands have been materializing though.

(Above) **Jenoptik's new RoBox L housing and** (inset) **the RoBox M equivalent**

The aesthetic TraffiTower 2.0 housing

One of these is how roadside equipment can contribute to urban aesthetics. An increasing number of countries are requesting street furniture that blends into the cityscape; some cities have a very modern feel so are calling for a more contemporary look. Process optimizations through modular design in manufacturing mean more flamboyant ideas can be realized at a lower cost than in the past, while bullet-proof windows or vandalism-proof materials can now also be utilized to enhance durability.

In addition to its standard housing portfolio, Germany's Jenoptik has introduced a new look that not only gels with any environment but also has a positive impact on the Jenoptik brand and the Robot technology inside. TraffiTower was the first product launched as part of this range and quickly set new standards by scooping a red dot award for design. Other camera vendors followed Jenoptik's lead and started changing their designs, too. With TraffiTower, though, the external cladding is designed to perform a double function: an integrated 'crush zone' effectively offers extra passive safety in the event of a vehicle collision, while the heat-resisting deflector plates offer passive cooling. A variety of Robot systems and assemblies can also be fitted within the tall housing, which reduces costs as other individual housings and control cabinets are no longer required.

New to the Jenoptik housing series is 'RoBox'. Recent technological advances have paved the way for the introduction of additional case documentation with video or sequence cameras, meaning housings require wider windows to optimally position the additional equipment. RoBox M, for instance, has room for cameras and flash while RoBox L houses cameras, flash and sensor. Both host basic infrastructure (such as a computer for system management, LPR and data storage, and a communication platform) as standard. Across the entire RoBox family, a passive climate concept offers sun shielding while a passive cooling system consists of heat-resisting deflector plates. This delivers two benefits: it contributes to an attractive design and also keeps the inner housing cool. Air conditioning or heating systems are optional. Additionally, Robot's plug-and-play technology can be accommodated for easy installation or rotation of one camera at several different sites.

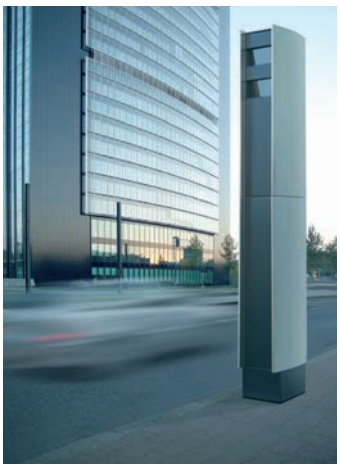
Latest addition

Jenoptik's design story has recently been updated with the TraffiTower 2.0 chapter, designed to support all non-invasive sensor systems. In line with the new and consistent modular design of the modern housings, the TraffiTower 2.0 comprises up to six identical sections placed on top of one another to essentially build a tower of ITS applications. These independently rotating segments can be aligned modularly, in doing so permitting traffic surveillance in flexible directions with

Need to know?

How housing demands are evolving in the design of modern-day roadside equipment

- Creating designs that blend into the modern urban environment
- Contributing both actively and passively to the safety of all road users
- Attractive housing can accommodate sub-assemblies that would normally require installation in separate housings



Form and function rolled into one

up to two measurement systems across six lanes. Air conditioning and/or heating are optional, while its modularity future-proofs the investment for highway authorities and DOTs. "Aesthetics, good design and economics are not contradictory factors – the opposite is in fact true," suggests Ralf Jakubowski, designer of the TraffiTower.

Form is clearly important to Jenoptik's Traffic Solutions division, but function, too, runs hand in hand. The company has vast experience in designing and manufacturing housings for speed and red-light enforcement equipment and can boast more than 20,000 installed units in 80 countries. Despite a very satisfying reaction to TraffiTower 2.0, the company is not stopping there and is busy working on integrating the latest materials and technologies to ensure this high level of excellence for many product generations to come.

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I was recently in Washington DC where the sunshine was intermittently interrupted by rain. I was indoors, away from the vagaries of slick roads, reduced visibility, veiling road glare and blinding snow storms. (Okay, there were no blinding snow storms; it was springtime after all.) I was instead soaking up not the sun but interesting and informative presentations from the National Oceanic and Atmospheric Administration (NOAA) and the National Center for Atmospheric Research (NCAR). These erstwhile institutions are turning their attention to drivers for the very good reason that in the USA weather figures as a factor in traffic crashes to the tune of approximately 7,000 lives a year. Let's be careful here: weather may not be the primary factor for 7,000 lives lost in traffic accidents per year in the USA; rather, weather is one factor in crashes that claim that number of lives. Yes, this is a large number and worthy of scientific investigation.

Weather may affect driving and drivers at virtually every stage of a journey – from pre-trip planning through tactical maneuvers to detailed throttle, brake and steering control. In my generation, a smarter car has emerged as the braking has been improved with ABS, then further down the line with brake and steering safety via electronic stability control (ESC). But researchers at NCAR believe there is much more than 'just' ABS and ESC, as smart connected cars can wirelessly transmit onboard data such as windshield wiper 'on' or headlight 'on' to roadside units either via short-range communication or to a more centralized or regional station. The aggregated data would provide location-based near-real-time information or in effect a dynamic map of imputed weather, available to road operators and drivers alike. From this, application algorithms and warnings would be developed and provided to the driver's and/or operator's benefit, either by allowing the operator to redress or reroute around weather-related hazards as they develop, or by allowing the driver to choose a different time or mode of travel if the weather is frightful. The applications may also provide near-field situational awareness for nearby safety threats.

The NOAA researchers firmly address atmospheric weather; however, in recognition of the road safety problem related to weather, the NOAA direction has been to provide even higher spatio-temporal weather models, nearer and nearer to the road surface. Validation and experience has engendered over time increased confidence of weather predictions to travelers and road operators. It is NOAA's goal to continue this accuracy to the point that reliable weather advisories would effect better pre-trip planning and allow trustworthy predictions.

In the future, what I dub the 'embedded meteorologist' may become part and parcel of a weather-smart transportation system. At the extreme, the national or regional government may foresee impending storms and provide warnings or even trigger evacuations. More normally, travelers would be able to plan the time and conveyance of their trips to avoid weather – or at least understand to drive carefully due to impending inclement weather. At the frontier of safety, very specific and local pockets of unfolding reduced visibility or slippery roads would be provided – a safe NCAR not unlike NOAA's Ark.

> In the future, what I dub the 'embedded meteorologist' may become part and parcel of a weather-smart transportation system
>
> **Jim Misener, executive advisor, Booz Allen Hamilton, USA**

Line management system

READER ENQUIRY NO. 506

Today, both new and existing motorways are being furnished with modern equipment designed to coordinate the flow of traffic, and to increase the roads' throughput capacity. This task is increasingly undertaken by using a Traffic Line Management System, which provides for the secure and reliable operation of high capacity roads.

This form of traffic control is on offer from AŽD Praha, a Czech company that specializes in transport technologies. AŽD supplies a fully automated Traffic Line Management System based on the dynamic control of traffic at a given point, using VMS to provide drivers with extra information. The system controls the speed of the flow of traffic in response to increased traffic density or poor weather conditions. A drop in speed automatically reduces the distances between vehicles, while increasing the traffic density and throughput capacity of the given road.

Gantry-based VMS are used to ensure safe driver behavior

Need to know?

To successfully manage motorways demands a smarter, more automated approach

- How traffic line management systems are helping to keep our motorways moving
- A Czech expert in the sector offers its own advanced system as part of a wider portfolio of products and services
- Control room operators can communicate with motorists in real time via VMS

Automated appeal

The system provides automated operation based on live traffic data collected from vehicle detectors installed throughout the entire managed motorway segment, as well as meteorological data provided by weather stations. The measured parameters are picked up by air temperature and humidity sensors, windspeed and direction sensors, rain gauges, and in-road sensors to measure the road temperature and warn of the potential formation of ice. The data received from the weather stations is transmitted for processing to individual gantry servers to ultimately be delivered to the control center.

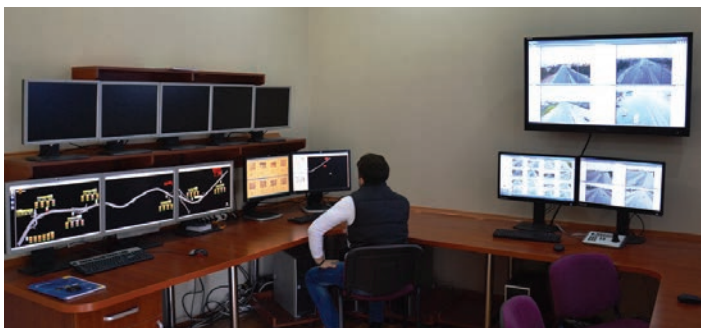
Operating as the brain of the individual gantries and their associated technologies, a gantry server uses embedded algorithms to assess the current situation, and displays situation-appropriate symbols on the full-matrix VMS installed over each traffic lane.

The VMS provide additional information for drivers. When in idle mode, only directional signs are displayed. However, the operator can respond to a change in weather or traffic by setting the display accordingly.

While being set up for standalone operation, the gantry server also communicates with the control center. Data from the detectors and cameras installed on each gantry is sent to the control center. The cameras AŽD supplies offer high-quality images and high photosensitivity. Their proportional rotation and tilt allow the visual monitoring of traffic throughout the area surrounding the gantry.

In the event of an emergency, the operator can manually step in and control system performance. The operator can send a command to the VMS in order to change the text or to modify the displayed speed limits. Every action taken by the operator is automatically stored in the system log.

An operator who has issued a non-standard command receives a system notification of such error, and is prevented from doing anything that might jeopardize the traffic. Only the servicing mode allows the manual control of the display on the respective VMS. Such actions are also monitored and stored by the system. This provides for high security in the road segment equipped with the Traffic Line Management technology.



Live data is fed back to the control room to enable operators to make real-time decisions on how best to manage traffic flows and deliver information to drivers

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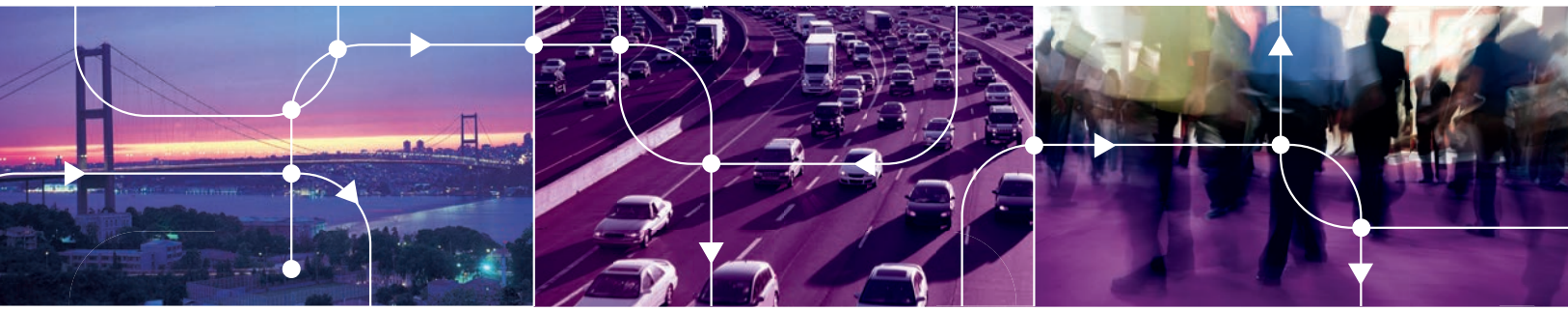

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Battling bottlenecks with sensor technology

READER ENQUIRY NO. 507

Every day, major roads around the world become parking lots when accidents, stalled vehicles, construction zones and other traffic disruptions block lanes and constrict the free movement of vehicles. A common cause of these bottlenecks is a phenomenon known in some regions as 'zip merging', in which a lane of traffic ends and vehicles in that lane are forced to merge into the remaining lanes. During peak commute times, these road configurations can become heavily congested. In an effort to mitigate backups and maintain efficient traffic flow, though, a new detection system in the Czech Republic is using the Wavetronix SmartSensor HD to monitor these zip merge locations.

The 'Congman' system is the result of a partnership between Far Data of Poland and the Transport Research Centre, a company that operates as part of the Czech Republic's Ministry of Transport. The companies joined forces a few years back to create a system that could influence driver navigation at locations where drivers are forced to merge because their lane ends using high-resolution radar to effectively manage traffic bottlenecks.

"The system uses real-time traffic flow and vehicle speed data to inform drivers," explains Hubert Nagorny, manager of Far Data's sales office in Wroclaw. "Drivers know if they should remain in the ending lane or if they should proceed to merge fluently without reducing speeds and interfering with drivers in the continuous lane."

The zip management system consists of two SmartSensor HDs on portable trailers. The first sensor is located at the merge point to measure flow rate and vehicle speeds; the second is installed along with an LED display sign at a spot approximately 1,000m ahead of the merge point. According to Nagorny, the system responds to a minimal speed of 50km/h (31.1 mph) and updates its data inputs every 30 seconds.

"Under optimal conditions, the system is able to control traffic flow without formation of queues longer than 1km, up to 2,000 vehicles per hour," Nagorny continues. "For full effectiveness, drivers must keep the capacity of both lanes up to the closure point."

Congman is designed for effective traffic flow management in bottlenecks on the roads and highways, and utilizes Wavetronix's SmartSensor HD technology

Need to know?

The vital role that non-intrusive sensors are playing in two ITS innovations from the Czech Republic

- System depends on real-time traffic flow monitoring and on speed and flow rate data interpretation
- Under optimal conditions, the system controls the traffic flow without formation of queues longer than 1km up to 2,000 vehicles/hour
- Includes trailer with up to 10m-high telescopic pole, LED VMS, surveillance camera, RWIS, radar detector and sonometer

Remote control

Controlled remotely, it will operate in either automatic or manual modes, depending on conditions. Communication between the devices is wireless, and IP cameras and weather stations provide additional information about conditions such as fog or snowfall. Based on the information provided by the sensors, LED signs display graphics that indicate to drivers the ideal place to merge. And as the stations are portable, they can respond quickly to almost any situation resulting in lane closures. "So far, we have been very pleased with the performance," Nagorny says.

In addition to Congman, Far Data has also created the award-winning Enviro 151 system, an environmental monitoring station that consists of a variety of sensors continuously collecting noise levels, traffic volumes and environmental conditions such as temperature, humidity, wind speed and air pollution levels. "Enviro 151 has been designed for constant and long-term registration of ongoing environmental conditions,"

Nagorny states. "It features a modular design that enables a free configuration that can be adjusted to the individual needs of a particular customer." To date, the Enviro 151 system has been successfully implemented at several locations throughout Poland, and in 2008 it received a gold medal for innovation at the Poleko International Trade Fair for Environmental Protection.

Similarly to Congman, the Enviro 151 system uses SmartSensor HD for traffic detection as it is non-intrusive, works in all weather conditions and is highly accurate. "We don't need to install any instruments within the road itself as a result, and the sensor's resistance to difficult weather conditions such as snow and fog gives it an advantage over video systems," Nagorny says. "It's also worth pointing out that the sensor can measure 10 lanes of traffic simultaneously and provides accurate traffic parameter measurements, including classification of vehicles and vehicle speeds."

Widespread interest

News of the Congman system's success is spreading beyond the Czech Republic and Poland. In fact, interest in the system is being generated in the USA. "We recently installed one Congman mobile station in the state of Rhode Island for testing," Nagorny reveals. "As a potential partner in researching bottleneck management using ITS, Rhode Island DOT is very interested in this project."

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In South Africa's Gauteng Province, an ambitious and expensive toll road scheme has now been put on indefinite hold – just two days before its launch – due to popular, trade union, business leader, and Automobile Association protest, according to *The Economist*.[1] This will have significant financial repercussions for the road authority and the government. In hindsight, there is little surprise this happened.

Road operators are in desperate need for funding the world over – and roads get more congested every day. But installing a one-size-fits-all tolling system on a pre-existing road network does not go down easily. However necessary for any number of reasons, this indeed "represents the state's bullying power" as *The Economist* bluntly put it.

Adding new lanes and tolling them as high-occupancy toll (HOT) lanes for discretionary use meets little resistance. But tolling major routes that have few or diminished alternatives would generally be received poorly. People who have had free access to roadways for as long as they remember expect free access to remain available as long as they live. In behavioral economics lingo, they are 'anchored' to a road-price of zero. You can't just start charging US¢12 per mile on a Monday at 12:01am, which is what was to happen in Gauteng.

To have acceptance, you have to make the individuals subject to tolling better off than they were without tolling. Voters don't buy into tedious economic arguments about highway funding and congestion and pricing and the tragedy of the commons. They ask, 'What's in it for me?'

Here is an alternative. Phase in gradual fuel duty increases over a few years expressly to pay for new or repaired roads. Pre-announce the full plan to give users time to adjust (move, renegotiate contracts, different vehicle, etc). This will be difficult enough.

Then provide a choice: pay the newly increased fuel tax or use an autonomous, in-vehicle, time-and-place-of-use meter to trade road tolls for a fuel tax rebate (calculated by the same meter). For those choosing a meter, arrange the road prices (stored in the meter's 'pricemap') to have drivers who avoid congestion save money with the meter and other drivers to pay about the same as the fuel tax. Then be sure that the smart in-vehicle meter offers several additional features that those self-selected drivers would like (reduced insurance premiums, parking conveniences and discounts, etc). The trick is (again according to behavioral economists) to provide at least twice the perceived value to the driver than the perceived cost (nuisance, money, trouble) of using the meter. This is technically easy to do (including privacy, security and reliability) but needs policy that encourages usage-based insurance and permits wireless parking management and perhaps behavioral rewards for safety, emissions and the like. Without associated value-added services and incentives with benefits that counterbalance this type of increasingly needed tolling, governments are not offering a voteworthy solution.

What we are missing are policies to encourage innovation and permit voluntary migration. We need a telemetrics payment ecosystem that allows driver services to move metering away from one-size-fits-all gantries for users with a variety of needs.

[1] *It doesn't toll for thee*, *The Economist* (May 12, 2012)

> "Voters don't buy into tedious economic arguments about highway funding and congestion and pricing and the tragedy of the commons. They ask, 'What's in it for me?'"
>
> **Bern Grush, principal, Bern Grush Associates, Canada**

THE ENDLESSLY VARIABLE MESSAGE SIGN

The PEGASUS Urban Variable Message Sign is a new kind of VMS, offering a range of flexible matrix displays with a choice of mounting configurations.

The power efficient and environmentally friendly Pegasus sign takes advantage of improvements in LED technology performance, reliability, and message setting capabilities flowing from the latest generation of high resolution motorway sign designs.

Three variants offer different matrix areas suitable for the display of four lines of text with character heights of 160mm, 100mm, and 50mm. The two larger format signs employ a dual-coloured, amber and red matrix; the 50mm version is a single-colour amber sign. All offer high resolution which can display simultaneous text and pictogram information.

The slim and attractive design is well suited to today's urban streetscape and the flexible mounting options, for either landscape or portrait fixing, ranged left, right or centred, can work around the most demanding space restrictions.

In fact, the installation options are almost as variable as the messaging capability.

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Portfolio of confined space solutions

READER ENQUIRY NO. 508

In the confined-space market – where every decision could be mission-critical – it pays to take expert advice. One pioneer in this sector is Intelligent Radio Solutions (IRIS), a UK-based company offering a catalog of bespoke tunnel and in-building solutions.

"IRIS has created and maintained a superior, long-lasting radio-based and public address communications service, which has been established through a work ethos that each member of the team – whatever their job role – has a key part to play in the implementation of each solution derived from individual client requirements," explains Daniel Lewing, managing director and principal technical consultant.

The company prides itself on liaising with clients on whatever technology needed – whether a standalone system in DMR, PMR, RF, GSMR, microwave, IP backhaul or TETRA and/or the integration of one of above (or another technology) into an existing or new in-house system, to provide the quality control and quality assurance that IRIS is known for.

Services on offer include: the design of radiating cable and antenna solutions to extend and tailor radio coverage into confined spaces, i.e. tunnels and buildings; the design of public address systems within any confined or specific area; predictive radio propagation calculations and surveys; contract and project management; installation and/or commissioning; system aftercare; and access to the purchasing of IRIS's dealership products (speakers, radios, etc).

One recent success story saw IRIS working on a project in Eastern Europe to provide an integrated radio rebroadcast system for a road tunnel.

The end solution was a radio rebroadcast system with radiating cable for emergency services, VHF for both half-duplex and simplex channels, and domestic radio (FM with audio break-in). The break-in system has a local and remote control facility.

As part of the final solution, IRIS engineered the communication racks, attended the site to oversee the installation of all the equipment in line with the previously accepted radio design, and thereafter commissioned the design to the customer's standard of requirement. This is just one example among a whole host of transportation tunnels that IRIS has and continues to work on.

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New online data collection system launched

READER ENQUIRY NO. 509

Miovision Technologies has launched Traffic Data On Demand – an online traffic data collection system for coordinating and managing the data required to measure and correct urban traffic problems. Based on a software-as-a-service (SaaS) model, it centralizes traffic data projects through an internet-based data management platform that features an intuitive map interface and file management tools. It is designed as a comprehensive end-to-end system that combines the ability for traffic engineering firms and government agencies to request, receive, and manage traffic data studies. The system allows traffic engineers to acquire traffic study reports about turning movement counts, average daily traffic (ADT) counts, roundabout counts, and gap studies, across the USA and Canada within two, three or four days – a marked improvement on normal industry turnaround times. Traffic data is collected using the company's automated Scout video collection unit (VCU), and is processed by Miovision's proprietary video analysis software to generate traffic study reports that have an extremely high data accuracy rate of more than 95%. Customer results from beta testing indicate that, on average, the system eliminates eight steps from the data collection coordination process, saving approximately seven hours of resource time, with similar time savings for finance-related tasks, such as project invoicing and accounts payable.

Miovision's new system relies on its Scout video collection unit

"We are excited to offer yet another innovative solution that helps traffic consultants at engineering firms and government agencies gain full access and control of their traffic data projects from coordination to completion, in order to optimize traffic management and improve the driving experience," comments Kurtis McBride, CEO of Miovision Technologies. "Traffic Data On Demand fills a need that has long been overdue in the traffic industry – the ability for any traffic engineer across North America to request, receive, and manage traffic study reports for when and where data is needed, with just a few clicks of a mouse."

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What still needs to be done – from both an enforcement and an ITS technology perspective – to make road tunnels safer?

"If you look at the risks associated with being in a tunnel, the likelihood of dying from a fire is very low. For most of the tunnels we do risk assessments on, 95% of the fatalities come from normal traffic accidents – and much of that relates to the physical design of the tunnel. In my experience, one of the major things that needs to be factored in is the distance drivers are away from the tunnel wall. The reality is that if you don't leave a large enough gap, drivers tend to move away from the wall and creep into the next lane. Similarly, there is the question of whether emergency lanes should be provided in a tunnel. A major contributor to tunnel accidents is a car breaking down and the vehicle behind not stopping quickly enough. Putting in laybys and emergency lanes is expensive, so good control systems can help to ensure people are actually aware that traffic is stationary or there are lane closures ahead of time. In the end, greater emphasis needs to be put on the day-to-day incidents rather than a fire or a petrol tanker turning over in the tunnel, which – thankfully – is a very rare occurrence."

Paul Williams
fire engineering manager, Norman Disney & Young, New Zealand

"In terms of ventilation and fire, having a point shaft or similar where you can provide an outflow on each side of a fire is a very good system. Of course this is not always possible to implement without a very large expenditure due to where, for example, a tunnel is situated – such as in a mountain. Where it is practical, what is so advantageous about this approach is the fact that the outflow, as mentioned, is situated on each side and fresh air then comes toward the fire but not up to the actual fire itself. Essentially you have a flow from the fire to your point source and, outside the point source, you have a flow with more fresh air. In some tunnels, there are even combined systems where the shafts can also be used for comfort ventilation and, if necessary, the flow reversed. Given that fires can start at any point in the tunnel, this means that operators are able to decide where to have their inflow and outflow depending on what is actually happening at the time."

Anders Lönnermark
senior research scientist, SP Technical Research Institute, Sweden

"I am interested in enforcement when it comes to fire safety in road tunnels. One of the conclusions I gave in a recent keynote address concerned suppression systems and the need for tests of these technologies against realistic vehicle cargos so we can actually categorize the products that go into our tunnels. One of the things that concerns me over the current state of the industry is that any sprinkler or deluge system installed in a tunnel is generally given one of two terms, being referred to either as a suppression system or a fixed firefighting system. The point here is that both of these imply things about the system that are not necessarily always true. In my view, a suppression system should only be called a suppression system if it has been demonstrated to suppress a fire, meaning to hold it in check or to reduce in severity, and a firefighting system should only be called this if it makes the fire smaller or extinguishes it completely."

Ricky Carvel
assistant director, BRE Centre for Fire Safety Engineering
University of Edinburgh, UK

"From my perspective, as a safety officer dealing with a variety of different road tunnels across Stockholm, the answer is fairly simple: it has to be all about information, information, information! You have to get the information out there to the people using these facilities through all types of media and various techniques so that they have a chance to know what is expected of them should something actually happen in the tunnel. It is about encouraging safer behavior from tunnel users. From a technology standpoint, you can enhance the visual information available to tunnel users, improve the emergency lighting and make the fire exits more visible, but this has to go alongside a process that educates and explains to drivers not just what a specific sign looks like but what it means in practice – and in the case that they go through the exit door, what happens on the other side."

Jonas Andersson
safety officer for the municipal road tunnels,
City of Stockholm, Traffic Administration, Sweden

Readers are invited to answer the Burning Question for the August/September 2012 issue:

With safety cameras seemingly deployed less and less, how will we deal with speed management on our roads in the future?

email answers to:
louise.smyth@ukipme.com

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