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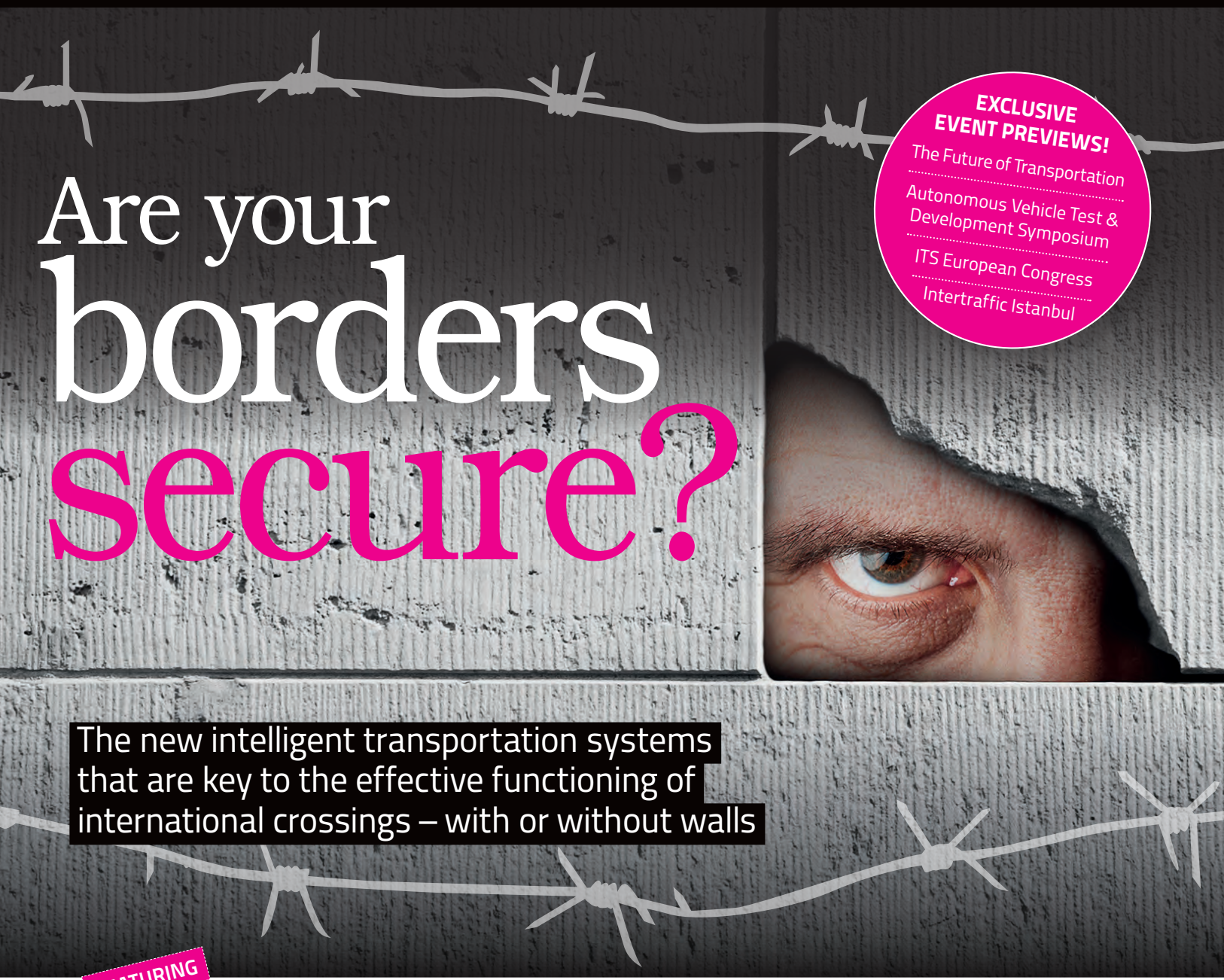

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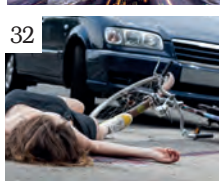

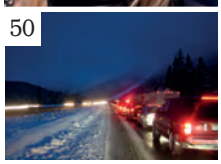

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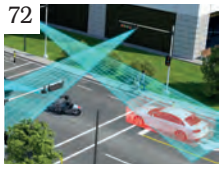
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Editor's letter

Six years ago the UN predicted there would be 33 megacities (urban centers surpassing 10 million inhabitants) in the world by 2025 – rising from 22 classified as such in 2011. Today we have already surpassed that prediction with 37 international cities laying claim to the dubious honor.

This rapid urbanization of our planet brings with it significant challenges, not least for those responsible for managing city traffic. Gridlock and declining levels of road safety are two obvious and upsetting side-effects of cramming more and more people into our cities – and road authorities have long focused on trying to improve both of these situations. However, today there is increasing awareness of a different, invisible scourge – pollution. The nitrogen dioxide and particulate matter emanating from the tailpipes of vehicles across London is estimated to be responsible for a staggering 9,500 deaths in the city each year. Compare this with the latest figures for people killed or seriously injured in road traffic accidents in London – 2,092 in 2015 – and it's clear why the UK government is now striving to reduce pollution in cities to safer levels.

One of the most important tools for achieving this aim is low emission zones. London already has one, with the introduction of a planned Ultra Low Emission Zone, the world's first, being brought forward to April 2019, and an additional Toxicity Charge to be levied on the most polluting vehicles in the city's central Congestion Zone as soon as October this year. Elsewhere in the UK, clean air zones are planned in Birmingham, Leeds, Derby, Nottingham and Southampton by 2020. Across Europe there are already over 200 such schemes, with many more planned. Now governments all around the world are beginning to wake up to the huge societal benefits of reducing traffic pollution.

New traffic regulations in cities mean big business for ITS. It was a fact that wasn't missed by the companies showcasing their latest innovations at Traffex – the UK's largest transportation expo – in Birmingham in April. As I walked the exhibition hall the buzz from all corners concerned how to tackle pollution from vehicles. Products ranged from those directly enforcing low emission zones to others that enable traffic managers to use signal timings to distribute polluting vehicles more evenly. It's an area that is set for rapid growth in the coming months and years, as ERTICO chairman Cees de Wijs points out as he looks forward to the ITS European Congress on page 4. We also look more deeply into the subject in *Breathe again,* on page 40.

If our current way of life is to remain sustainable, then smarter, greener ways to facilitate urban existence must be developed. Getting transportation right is at the very heart of this, which is why *Traffic Technology International* is excited to be a partner in the first ever Future of Transportation World Conference. We catch up with two of the key speakers on page 24, to find out how road authorities can prepare for the future, today.

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European focus

The 12th ITS European Congress will be hosted this June in the French city of Strasbourg – at the physical and administrative heart of Europe. **Tom Stone** gets the inside story on what delegates can look forward to, and asks what trends will impact on the industry as a whole

Right: **Strasbourg's historic, narrow streets demand smart solutions to tackle 21st century traffic problems**

Every year ERTICO–ITS Europe hosts either an ITS European Congress or the ITS World Congress (once every three years). This year it's a Europe-focused event and will take place in Strasbourg – the historic French city that sits on the banks of the Rhine, on the border with Germany – from June 19-22.

Ahead of this important industry gathering we caught up with ERTICO chairman Cees de Wijs, to discuss his hopes for the Congress and vision for the future of the industry as a whole.

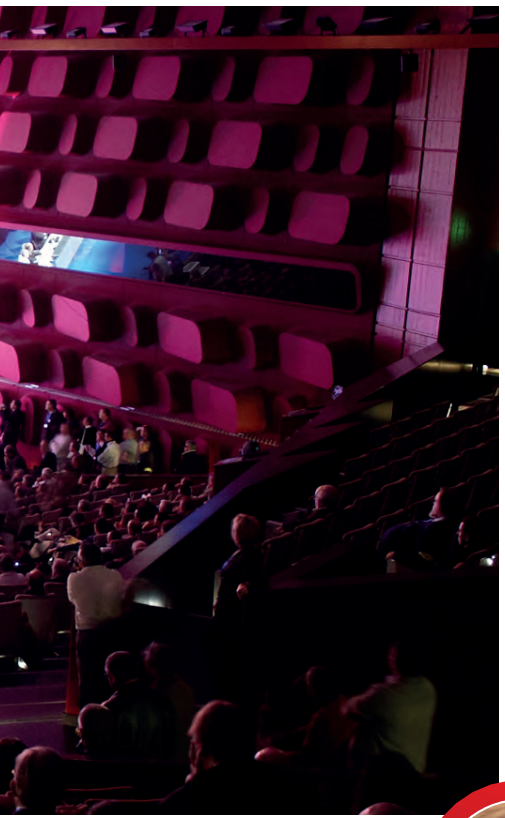
"We picked Strasbourg because we believe it is symbolically at the center of Europe," says de Wijs. (Indeed, it is the seat of the European Parliament.) "Also it is in a very advanced stage of multimodal transportation management. Hopefully it will be a place where we will be able to demonstrate that we are bringing smart mobility to life across Europe."

The theme of the congress is ITS Beyond Borders, with the stated aim of highlighting the importance of developing intelligent transportation solutions that are coherent and coordinated across the EU. With such a pro-EU focus, how should delegates from the UK feel, in light of the ongoing Brexit process? De Wijs is sanguine.

"From my experience over the past 20 years of working in the industry," he says, "it's clear that there has always been very good and intense collaboration between the British people and the people of mainland Europe, as there is with people in the USA, Japan and Asia. And I believe that, despite Brexit, that collaboration will stay intact. We cannot say yet what the impact of Brexit will be precisely, but I do believe that the collaboration that has always been there in our industry will stay."

Sustainable future

Another key theme at this year's congress will be helping to make transportation more eco-friendly. Ahead of the event the European Commission is running a competition – The European Transport Innovation Challenge – which is designed to help move the



Above and left: **Strasbourg's Palais de la Musique et des Congrès is the venue for this year's event**

> Sustainability and quality of life will be the driving factors of our industry in the future… They will drive our ITS markets for the next one or two decades
>
> *Cees de Wijs, chairman, ERTICO*

EU along the path of decarbonization and sustainable growth. Entrants are invited to submit an idea for a new product or service and 12 winners will get a free trip to Strasbourg for the congress. As we go to press, the May 2 deadline for applications is nearly upon us, so keep an eye on our daily news at TrafficTechnologyToday.com for the announcement of the winners.

Sustainability is an area of transportation that de Wijs believes is set for rapid growth in the coming years. "I think our industry, for good reasons, has been focused strongly on safety. And I think that focus needs to stay there," he says. "Then of course for a long time we have been discussing optimizing journey times. But I think that as a society we now realize that we have melting ice caps and there are obvious signs of climate change. So it's high time we started to do something real in the sustainability area. Sustainable mobility and eco-mobility will, I think, be higher on the agenda than we have seen over the past 20 years. Sustainability and quality of life will be the driving factors of our industry in the future. That's not hype. I think they will drive our ITS community and markets, for the next one or two decades."

Growth in ITS

De Wijs's vision is that this new focus for ITS will help to make the industry more profitable: "I expect to see rebalancing of price points on what the industry is delivering to society against the value that is brought to society," he says. "I see a strong imbalance at the moment. The prices are too low."

This rebalancing will be coupled with a move toward more software-driven solutions. "We are now starting to see software platforms driving mobility services," says de Wijs. "I think it's really just the beginning. We are just starting to realize what data fusion, data science and data analytics can mean for improvements in transportation. The whole movement around data science has just started. And that's good news for the whole industry."

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Strasbourg specials

1. Cross-Rhine Driverless Shuttle Challenge

Connected and Automated Driving (CAD) will be one of the major topics at the congress. There will be a range of demonstrations, and one of the major events will be the Cross-Rhine Driverless Shuttle Challenge. Driverless shuttles will navigate a 2km (1.2 mile) route around Strasbourg and the adjoining German city of Kehl. This involves crossing the Strasbourg-Kehl Tramway bridge. Louis Fernique, head of the ITS Task Force in ERTICO, says, "The idea of the challenge is to show the general public and the media the potential of the concept. Compared with autonomous cars, shuttles are much more mature and developed because the concept and technologies are more straightforward. Shuttles can learn the path they will follow."

2. World class exhibitors

The exhibition hall will feature over 80 companies, including TSS-Transport Simulation Systems (TSS), which has a singular focus on algorithms, software and operational know-how for mobility applications in strategic transport planning, traffic engineering and mobility management. TSS develops and supports the integrated Aimsun traffic modeling software environment and Aimsun Online, the simulation-based decision support system for real-time traffic management. TSS services thousands of licensed users in 75 countries. Aimsun licensees include government agencies such as Transport for London, NYCDOT, SANDAG, NPRA, MTO and Transport for New South Wales, while academic users and research partners include the University of Minnesota; University of California, Berkeley; and MIT.

3. Mobility as a Service

One of the key topics in this year's conference program will be Mobility as a Service (MaaS). ERTICO chairman Cees de Wijs explains why this is such an important subject right now: "MaaS is helping to connect different transportation modes in a more creative way, and perhaps even more importantly it is making them more consumer-centric. I have great expectations for MaaS in the next five years."

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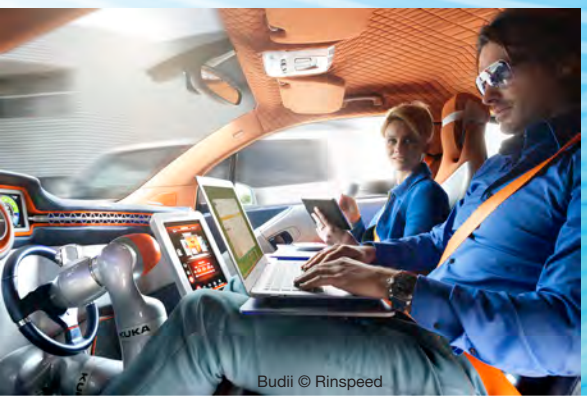

Topics under discussion:

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- Reliability testing of software and hardware systems

For more information about the Autonomous Vehicle Test & Development Symposium 2017,
please contact Andrew Boakes: andrew.boakes@ukipme.com
Tel: +44 1306 743744 | www.autonomousvehiclesymposium.com

Autonomous Vehicle TEST & DEVELOPMENT Symposium 2017

Learning from Tesla

Last year's fatal crash involving a semi-autonomous Tesla vehicle was widely reported. A keynote speaker in Stuttgart will be Dr Ensar Becic, human performance investigator at the US National Transportation Safety Board (NTSB), who will deliver the findings of the NTSB report on the accident

To attend, register at: **autonomousvehiclesymposium.com**

Join the AV experts in Stuttgart

On June 20-22, the German city of Stuttgart will once again be the focal point for experts to present papers on the latest developments in autonomous vehicles

Now in its third year, the Autonomous Vehicle Test & Development Symposium has gained a reputation as an important forum for the discussion of new technologies and regulations, and for predicting what a world with AVs will be like.

The potential benefits of autonomous vehicles are many and varied, but much will depend on individual priorities. For example, a reduction of labor costs for transportation companies is attractive to those running these companies, but not to those driving for a living. Meanwhile, a reduction in the need for parking spaces might benefit city planners, but not garage operators. One much-talked-about advantage should have a wide appeal, however: safer roads.

But, in keeping with the symposium's reputation for questioning and testing, one of this year's speakers, Truls Vaa, a senior research psychologist at the Institute of Transport Economics in Oslo, Norway, asks, with roads already becoming safer, is reducing accidents really the main driver of the emerging technology? He says, "I ask whether the development of self-driving vehicles is a measure that is aiming toward allowing more distractions: talking, reading, using your mobile, working on the PC or whatever, more than reducing the number of accidents."

Focusing on the benefits of AV introduction – and heading-off unintended consequences – is now becoming the responsibility of vehicle developers and road authorities alike. So, as the other speakers prepare their presentations, we asked the keynotes: What will be the main benefit of having fully autonomous vehicles on the road? Turn the page for their answers…

> Is the development of self-driving vehicles a measure that is aiming toward allowing more distractions… more than reducing the number of accidents?
>
> **Truls Vaa, a senior research psychologist at the Institute of Transport Economics in Oslo, Norway**
> **Presentation on June 21 at 5:00pm, Room A**

Below, left to right: **Tesla's Autopilot system has courted controversy; Google started self-driving car tests in Phoenix, Arizona in April 2017; The Symposium venue, Messe Stuttgart**

Autonomous Vehicle TEST & DEVELOPMENT Symposium 2017

We ask keynote speakers: **What will be the main benefit of having fully autonomous vehicles on the road?**

> The main benefits from my point of view will be the possibility to eliminate human errors as a source of accidents and the possibility to make traffic more efficient. Especially the latter is getting more important, because of the higher volume of vehicles – particularly in urban areas.

Andrea Leitner, project manager and research engineer, AVL
Keynote on June 20 at 11:40am, Room A

> The biggest benefit of fully autonomous vehicles will be safer roads as a result of fewer accidents. The realization of new mobility solutions that save time and money will be a close second.

Dr Houssem Abdellatif, head autonomous driving and ADAS, TÜV SÜD
Keynote on June 20 at 9:25am, Room A

> The benefits of fully autonomous vehicles are many. Improved safety is of course the obvious answer, but there are many other societal benefits, from reduced traffic congestion (due to better vehicle management), environmental benefits (as autonomy enables efficient car sharing), to increased productivity as autonomous vehicle passengers can use their time more efficiently during commutes. Harman is working closely with the world's auto makers to bring a vision for seamlessly simple in-vehicle technologies that harness the potential of the autonomous car.

Mike Tzamaloukas, autonomous drive and ADAS vice president, CoC navigation, Harman
Keynote on June 20 at 10:50am, Room A

A complete package

The Test & Development Symposium is just one part of a much bigger event

Running alongside this year's Test & Development Symposium are two other conferences: The Autonomous Vehicle Interior Design & Technology Symposium; and the Autonomous Vehicle Software Symposium. Both programs are packed with expert speakers, who will be presenting on the latest research in their fields.

Moreover, for the first time, the event will also include the Autonomous Vehicle Technology World Expo, where companies will be showcasing the latest products relevant to the rapidly expanding field of AV production. Entry to the exhibition is completely free and your pass will also gain you access to the concurrent Automotive Testing Expo, Automotive Interiors Expo, Engine Expo and Global Automotive Component and Suppliers Expo.

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PREVIEW

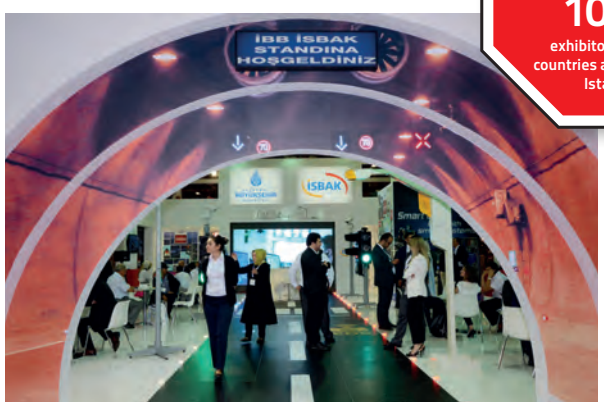
Intertraffic ISTANBUL

May 24-26, 2017

As traffic technology continues to develop at a rapid pace, we find out why Istanbul, Turkey, is an ideal host city for the next Intertraffic show

It is almost time for the next Intertraffic event, which will once again bring together experts, professionals and exhibitors from the traffic technology industry at a global scale. Hosted in Istanbul, Turkey, on May 24-26, 2017, Intertraffic Istanbul will take place six months after the previous event of its kind in Mexico in November 2016 and just weeks after Intertraffic China, taking place from May 4-6 – but with notable changes already seen by the industry, the timing is just right.

There will be **4,500+** visitors and **100+** exhibitors from 75 countries at Intertraffic Istanbul



Ahead of the game

"The traffic technology sector is developing rapidly," says Joyce de Winter, Intertraffic's exhibition manager for Amsterdam and Istanbul. "Big players in the market are redefining their strategies to coincide with the industry's transition toward a world of connected and automated vehicles, smart infrastructure and smart mobility. They have brought forward their expectations for 2025-2030, to 2020. So, the future is approaching faster than expected."

Delegates can look forward to these industry changes being reflected at Intertraffic Istanbul, with themes at the show set to include: how big data and data sharing will influence the automotive and traffic technology market; smart mobility, including smart cars and smart roads; innovative parking solutions; and new stakeholders entering the market.

"Developments in automation, telecommunications and the Internet of Things are happening very quickly," says de Winter. "People are constantly connected to the internet and they expect road authorities and transportation operators to be so too. Every player in the market now needs to adapt their products and solutions to this new era to stay relevant."

In-person productivity

Although technology enables us to connect with anyone at the touch of a button, it is still useful and valuable to meet with people in person, not only to discuss current trends, but to turn ideas and concepts into a reality. For the traffic technology industry, Istanbul, located in the MENA region, forms a hub between Europe, Asia, the Middle East and north Africa. "It's easily accessible and offers plenty of opportunities," says de Winter. And for those involved in the industry, Intertraffic acts as an international platform where they can get industry updates and share their knowledge.

Conferences and workshops

As well as the ever-popular exhibition, Intertraffic Istanbul will once again offer a conference and workshop program, with presentations from industry experts.

On day one, Carlo van de Weijer, director of strategic area smart mobility at the Eindhoven University of Technology will present a paper on the future of mobility.

Day two will be dominated by Turkey's association of ITS Ausder in conjunction with ITS Korea.

Across both days, the International Road Federation (IRF) will also run four workshops covering topics including the deployment of ITS.

Pre-registration is required for some of the program events, so check online to avoid disappointment on the day.

Intertraffic Istanbul is jointly organized by RAI Amsterdam and UBM/NTSR, Turkey

Register for FREE at **www.intertraffic.com/en/istanbul**

Jim O'Sullivan has enjoyed two successful years as CEO of Highways England. Now he's making plans for even greater achievements in the near future

Interviewed by Tom Stone

The phrase 'We're going to reorganize the department' is one that usually strikes fear into the hearts of those who hear it. It has become shorthand for layoffs, missteps, confusion, botched plans and failing computer systems – particularly in the public sector. However, when it comes to the transition from the UK's Highways Agency to it becoming Highways England things have been a bit different.

It's been just over two years since the change was made, creating a new 'government company' responsible for the Strategic Road Network (motorways and A-roads) in England. It has greater overall autonomy than the Highways Agency did, but nevertheless remains fully accountable to Westminster – and it has proven to be a great success. The credit for this smooth start can be claimed in no small part by the man at the helm for almost the entire duration of the new setup, Jim O'Sullivan, who took over from Graham Dalton in July 2015, when Highways England was just a few months old. Another major factor is, as O'Sullivan readily admits, well-planned, extensive funding.

"Infrastructure needs the certainty of long-term planning to be effective, and the government's £15bn (US$18.3bn) investment in roads, as set out in its Road Investment Strategy (RIS), gives us the ability to plan," says O'Sullivan. "In our first year we had completed five major schemes on time – that included adding more than 90 extra miles to some of our busiest sections of motorway, improving journeys for road users; construction progressed on 11 developments that had already been announced; and we started work on another eight."

> "We are consulting on the A303 Stonehenge proposals... a tunnel near the World Heritage Site has international significance"

Left: **Smart motorways are a success story for Highways England**

The network-improving projects O'Sullivan is overseeing range from local upgrades to projects that are capturing imaginations all around the world, such as building a tunnel under the site of Stonehenge. But O'Sullivan is always careful not to lose sight of his major aims: "We focus on journey time and reliability and road-user experience. We've started work on the A14 Cambridge to Huntingdon scheme, which will vastly improve connectivity between the east coast ports and the Midlands, and we are consulting on the A303 Stonehenge proposals to upgrade the corridor that links the M3 in the Southeast and the M5 in the Southwest. As the plans include a tunnel near the World Heritage Site, they have international significance."

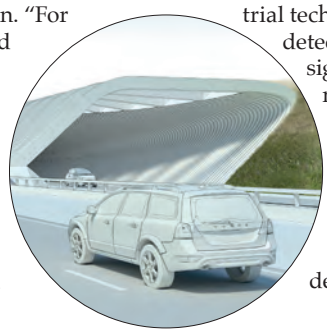
Currently, the A303 Stonehenge tunnel consultation is attracting some controversy, with disagreement over the correct length for this key piece of infrastructure. It's a process that O'Sullivan is monitoring closely, while being careful to remain impartial. "It would not be right to pre-empt the consultation results," he says. "We want to hear the view of stakeholders and we welcome all feedback.

Above: **The new landscape around Stonehenge as it is now and how it might look after the A303 tunnel is built**
Below: **One of several proposed designs for the tunnel entrances and exits**

Innovation now

Of course, creating 21st century infrastructure isn't just about building extra tunnels or roads. "We're also doing important work to support local economies in other ways," says O'Sullivan. "For example, with our Growth and Housing Fund awards, which are unlocking key areas of development."

And where roads are congested, but space doesn't allow for expansion, smarter solutions must be found. "Our Innovation Strategy builds on our successful track record of innovation, from developing and building the world's first smart motorways, to pioneering the use of more efficient and effective pavement materials," says O'Sullivan. "The strategy sets out our wide-ranging plan to ensure we keep pace with advances in technology. It commits us to autonomous vehicle trials by the end of 2017, as well as connected corridor and platooning trials over the next five years. We will also trial technology to improve breakdown detection, look at improving the signaling of junctions on motorways to increase traffic flows, and investigate the use of sensors that could provide better information about the condition of roads, bridges and tunnels on the network."



And O'Sullivan is determined to ensure that this drive toward embracing new technology continues to gather pace in the future. "Innovation will be critical in helping us meet the safety, economic, environmental and efficiency challenges we will face over the next 25 years," he says.

One useful tool for helping this to happen is the UK's Innovation Designated Fund, which provides £150m (US$183m) for innovation capital projects between now and 2021. "It will deliver a step change in how we demonstrate and implement emerging technologies, new materials, and ways of working," explains O'Sullivan. "We are pursuing a strategy of innovation, increasing our external focus to identify potential partners, opportunities, and promising new areas of research and technology."

A vision for the future

O'Sullivan's policy of openness and innovation was in evidence in April last year when he was keynote speaker at the UK's largest transportation expo, Traffex. It was a gathering he clearly enjoyed. "Events like Traffex provide an excellent opportunity to share ideas, to hear and see what others are saying and doing, to understand their vision, and to be part of the future, and that is where I want Highways England to be," he says.

Now O'Sullivan is keen to ensure that the long-term funding certainty he has enjoyed so far in his role continues, despite the potential for short-term political uncertainty in the UK. "The decision of the UK to leave the European Union puts an even greater emphasis on the need to support the UK economy, and the scale and stability of our plans puts us in a good position to play a strong role in this," he says. "The funding process is set out in the Road Investment Strategy and we are now collaborating with sub-national transport bodies and involving them in our planning for RIS2 (Road Investment Strategy 2) and beyond."

Ultimately, it all comes down to just one thing: better roads. "My vision is for Highways England (working with partners) to be a world-class roads operator, an exemplar of safety, customer service and delivery," says O'Sullivan. "All our projects are about improving the network."

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Watchers at the wall

What is the best way to protect your borders while processing vehicles at speed? **Saul Wordsworth** examines a case in point at a border crossing between the USA and Mexico, in Arizona

Border protection has rarely been a higher priority, or a more politicized subject, than today. Protecting nations from terrorism and illegal immigration, along with reducing the smuggling of weapons and drugs over country boundaries, are both controversial subjects and a source of business for ITS suppliers.

There are a number of points along the US-Mexico border where high volumes of goods are transported into the USA. None is in greater demand than Mariposa Port, close to the city of Nogales in Arizona. Ten years ago the site was rudimentary with little technology, and was mostly operated with manual stop-and-search of vehicles as they crossed the border. This all changed in 2008 when an application was developed and implemented to bring Mariposa up to the level of security and processing it warranted. The system has been regularly updated and enhanced since and is now regarded as the most high-tech crossing on the US-Mexico border.

> The Expedited Processing at International Crossings system integrates several border management and ITS technologies
>
> **Steve Kalina, strategy consultant, Arizona DOT**

Combining technologies

"The Expedited Processing at International Crossings system, or EPIC, is a modern port of entry enforcement system that was installed at the Mariposa Border Port of Entry," says Steve Kalina of Arizona's Department of Transportation (ADOT). "The software integrates several border

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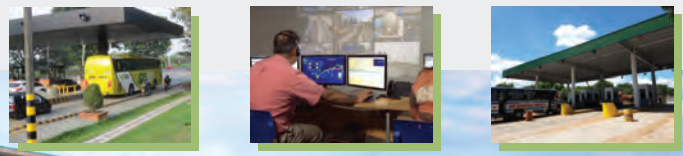

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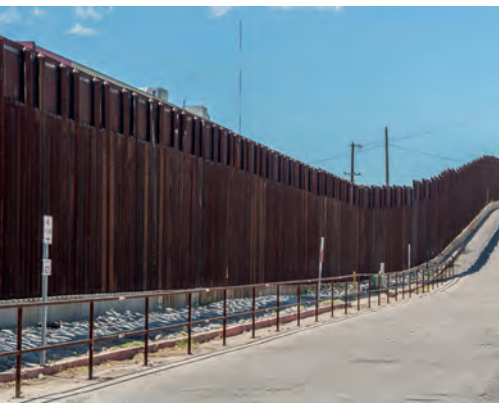

management and ITS technologies including license plate readers and USDOT number readers, radio frequency identification (RFID) antennas, weigh-in-motion (WIM) scales, dynamic message sign (DMS) traffic control, data entry and vehicle display workstation, and a central server system. As vehicles in the seven lanes approach the Nogales port of entry, cars are directed to the customs building and commercial vehicles proceed to the initial pre-screening area. At the pre-screening location, all commercial vehicles are weighed, photographed and checked for automated vehicle identification (AVI) transponders."

The system is designed to improve the efficiency and security of port operations in a number of ways. Arizona DOT enforcement and compliance officers can create vehicle screening rules that will generate an automated referral to an inspection station or the permitting office based on the driver, vehicle or commodity characteristics. Officers can track vehicles within the compound to determine where they have been and where they need to go before exiting the compound. From a safety perspective, checks are performed by comparing vehicle and carrier information obtained from the license plate, USDOT camera reads and weight, against pre-determined parameters.

Tracking time

Vital to Mariposa is the ability to track vehicles over time. This lets officers review information obtained during previous crossings to assist in processing procedures and determining patterns. A record of the time it takes a vehicle from its arrival at the first triage location to driving freely onto Arizona's interstate is now required by the federal government as part of its border wait time improvement program.

"The software has been enhanced to allow tracking of vehicle processing times," says Kalina. "The system tracks this based on comparisons of arrival times, referral clearing and vehicle exit times. It includes transponder antennas in each of the seven rapid enforcement lanes (REL). Readings detected at locations within the compound, as well as at the customs and border protection facility on the Mexican side of the border, are forwarded to the Texas A&M Transportation Institute, where overall border wait times for commercial vehicles are determined and made available on their website."

> The software has been enhanced to allow tracking of vehicle processing times… based on comparisons of arrival times, referral clearing and vehicle exit times
>
> **Steve Kalina, strategy consultant, Arizona DOT**

Of course, border crossing goes both ways, but the prime focus for Mariposa is the control of vehicles entering Arizona. On the Mexican side, corresponding upgrades have not taken place and the system there remains fairly basic. Interestingly, there are a number of distribution centers in Nogales where trucks heading north unload their goods before driving back into Mexico. The goods are then reloaded onto US carrier vehicles and driven onwards.

Continual modernization

"The last upgrades to the system were carried out in 2012," says Randy Hanson, chief operating officer at IRD, the supplier of the EPIC

Donald Trump and The Wall

Trump's proposed border wall aims to keep 'illegals' out, but it won't work without intelligent official crossings to ensure trade continues smoothly

The election of Donald Trump to the Presidency released shockwaves around the world, not least in Mexico, where his threat to build a wall in order to project the USA from illegal immigration was a popular cornerstone of his campaign.

"If there is any increased surveillance on the border I don't think that it is going to impact trade," says Randy Hanson, chief operating officer at IRD, the supplier of the EPIC solution. "The types of systems installed at Nogales are examples of how you can take advantage of technology to still allow trade to go across the border efficiently.

"President Trump's primary focus is on illegal immigrants crossing the border as opposed to trade. Our understanding is that he is very focused on the business side. He is after all a businessman at heart and he wants to ensure that jobs and employment are improved in the USA. I can't imagine that he's going to cut back on systems that actually help to facilitate trade."

As with all things Trump, we will have to wait and see...

Top: **An imposing border fence near Nogales, Arizona**

solution. "In those five years, camera technology in particular has advanced significantly, so it is certainly time for further upgrades."

Technology that can remotely detect whether any tires are underinflated or damaged and therefore pose a safety risk for vehicles may also be installed at the site. Other new technology that looks set to be introduced includes an improvement to vehicle measurement technology that analyzes the vehicle profile. This means ensuring all vehicles are not just height, but also length and width compliant, most likely with the introduction of laser scanners to support this functionality. There are also discussions regarding the transportation and identification of hazardous materials at the border crossing. The plan is to automatically capture the Hazmat placard on a vehicle, look up and assess the specifics of the material on board and then incorporate this information into the inspection process. Beyond that, it is mostly a case of upgrading existing overview and license plate camera technology and USDOT number readers;

Top and right: **The fully integrated EPIC border system features some of the latest intelligent transportation systems**

Below: **A border fence near Nogales, Arizona**

> The systems ensure you are spending resources and time on vehicles of primary interest, rather than on every vehicle passing through
>
> **Randy Hanson, chief operating officer, IRD**

every truck has an officially assigned DOT number on the side.

"There have been a number of locations, especially across this border, where new technology has been added, but this one is an all-encompassing system that I would say is probably the leading-edge crossing on the US-Mexico border," says Hanson. "It allows you to process vehicles much more expeditiously than ever before, and to ensure that you are actually spending your resources and time on the vehicles of primary interest rather than on every vehicle that passes through."

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Foundations for the future

The path that transportation may take in the future will be discussed at the first ever Future of Transportation World Conference, taking place on July 5-6, in Cologne, Germany. Ahead of the event, **Rachelle Harry** caught up with two of the conference speakers to find out why making infrastructure smarter is an essential, financially feasible step that city planners should be taking now

Visualize the future of transportation. It might one day consist of flying, car-like vehicles, super-high-speed pod trains, and pedestrian hoverboards or jetpacks.

Far-fetched as that image may seem, aspects of this future are already taking shape. For example, short-distance passenger drones were approved for testing in Nevada last year. Meanwhile, development of the high-speed 'pod train' Hyperloop concept continues, with an announcement in April 2017 that Elon Musk's SpaceX company will be organizing a 'drag race' of prototype pods in August.

Arguably more imminent advances in technology, set to considerably disrupt transportation as we currently know it, are connected (V2X) and automated vehicle technologies. Having reached a point where tests are being carried out in a number of cities across the globe (for example, the 'Towards 5G' connected car partnership between Ericsson, Orange and PSA Group, and various tests of semi- and fully-autonomous vehicles in the USA and Europe), the next question is how these technologies will transition from testing stages to full implementation and operation as the norm.

Possibilities and challenges

"We need to work together to find the best way to solve the transportation challenges that we're experiencing

today," says Hamid Zarghampour, chief strategist at Trafikverket, the Swedish Transport Administration. "We have to define the importance of what we want to test and we have to be very quick to implement these solutions, test them to validate them and verify that they really work."

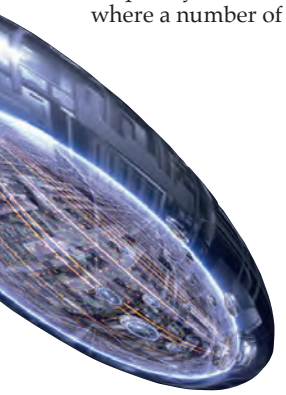
Zarghampour will be giving a presentation on the topic of 'Digitization and automation as the main components for creating the next-generation road transportation – possibilities and challenges'.

Challenges facing the industry, such as congestion and road safety, remain the same as they were a few decades ago, but thanks to continual developments in technology, solutions are becoming evermore advanced. Technology has developed so quickly that we are now at a point where a number of solutions are imminent: live, in-car traffic updates; 'green light' traffic signal-to-car communications; and vehicular (vehicle-to-vehicle) communication systems, to name a few. But many of these solutions won't work without the right infrastructure to support them. And this is what road authorities must now look to invest in.

"What can we do in the next two to three years, and what are our long-term aims? City planners must remember that the future of transportation doesn't just include personal means of transportation; the movement of goods is very important too," says Zarghampour. "Additionally, they need to make spaces more flexible, because during a 24-hour period, we need road space for different reasons.

"Transportation doesn't just need to be smarter," he continues. "It

> We have to be quick to implement solutions, test them to validate them and verify that they really work
>
> **Hamid Zarghampour, chief strategist, Trafikverket, the Swedish Transport Administration**



Paying for smart infrastructure

'Land value capture' can raise funds for transportation improvements by charging those who will benefit most

Even subtle changes to infrastructure – such as Colorado Department of Transportation's I-70 project, which will see data-sharing and data-receiving sensors added to roadside infrastructure (for more see page 50) – come at a cost.

"One option for financing transportation is land value capture," says Richard Blyth at the UK's Royal Town Planning Institute. "So, for example, if we were to expand cities in the UK outward along transport lines, the value of land in that corridor will go up enormously because it will become much more connected." Land value capture also acts as a solution to who pays for these expanded transportation links. "Across the world, I think the money for building transport links that will benefit the surrounding land owners should come partly from those land owners. There are some cities that are particularly good at this – Paris [the Grand Paris Express] and famously Hong Kong."

Hong Kong's use of land value capture is unique, yet financially sustainable enough for transportation authorities across the world to consider following its lead. Residents of the densely populated city rely on its transportation links, but it's the businesses that are such a valuable source of revenue, because they too rely on people using the transportation links to make money. This gives the Mass Transit Railway (MTR) Corporation, which manages Hong Kong's subway and bus systems, the power to take a cut of profits from shops and property development close to its transportation links.

And what's to say that this model can't be applied to other major cities, or that the implementation of smart infrastructure – such roadside units, smart highways and traffic signals with V2X capabilities – won't vastly improve road links and increase the value of surrounding land in a similar way to building new links? "Certainly in the UK, the government is looking carefully at ways in which taxpayers' investments in transport and infrastructure can be recouped from the increase in land value," says Blyth.

Before city planners rush to reap the benefits of land value capture, however, they should know that it can be more easily applied to new sites and urban areas than to existing ones. "The UK Treasury was very much opposed to the proposal that London home owners should pay for Crossrail 2," Blyth comments, using the proposed north-to-south London rail link to demonstrate his point. "The Treasury wanted taxpayers across the entire UK to pay for it, not London home owners, which I don't think is an equitable answer because taxpayers outside London won't benefit from something they have made a contribution to. It's a question of politics."

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needs to be a safe, clean and affordable for everybody, as well."

Digitizing infrastructure with connected technologies, such as data-collecting and data-sharing sensors, will enable city planners, as a starting point, to monitor and adapt their roads to suit needs according to the time of day. "Connectivity is the most important thing that we can do to accommodate the future of transportation – and data captured from connected infrastructure should be made available, free of charge, to everybody," says Zarghampour. "But of course we can only make use of this data when connectivity has been put into place."

Expressing concern over the speed – or lack of it – with which connective technology is being implemented, he adds, "The level at which connectivity is being spoken of and promoted is worrying, and although it is, and will be, beneficial, those in the industry should be wary of what they are promising to deliver."

The future: at what cost?

If connective technologies are in fact being implemented too slowly – all the while hindering the development of the future of transportation – is cost the reason?

Richard Blyth, head of policy practice and research at the UK's Royal Town Planning Institute, is giving a finance-led presentation at the conference on 'Transport – the wider benefits'. He says, "When you talk about changes within transportation, the way that infrastructure is managed and governed is not always directed at growth; it's quite often directed at maintaining a system. Quite often, for good reason, managers of transportation and infrastructure networks have to focus on the very near future, rather than a 20-year horizon. But unless someone faces up to long-term transportation planning, then we will struggle."

> "The future of transportation isn't necessarily only a question of throwing money at it. It's a question of 'can we use what we have more effectively?'"
>
> **Richard Blyth, head of policy practice and research, Royal Town Planning Institute, UK**

Blyth agrees that sustainably developing infrastructure is a step that needs to be taken before we can envision the long-term future of transportation. "We all know that private cars are not a very good use of infrastructure and space," he says. "The future of transportation isn't necessarily only a matter of throwing money at it. It's matter of using what we have more effectively."

Blyth's point is clear. As city populations, densities and congestion continue to increase, now is the time for all growing cities to make their infrastructure smarter, as a fundamental basis for the future of transportation.

Zarghampour concludes on an optimistic note. "Small changes to infrastructure can result in big changes to traffic flow and mobility. They are less costly to carry out than major city projects and they can facilitate movement of road traffic."

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Protecting cyclists

From huge countdown signs at traffic lights to tiny bike-mounted detection devices, technology is helping to make cycling safer, as **Max Glaskin** discovers

This year marks the 200th anniversary of the first true ancestor of the bicycle – the draisine. Invented in 1817, it was the first steerable two-wheel in-line vehicle. No pedals, no chain, it was a grown-up's version of a child's balance bike.

Some 60-odd years later, cyclists were the first to demand that highways should be better than cart tracks, yet today they are among the most vulnerable road users because traffic technology and road design has focused on motorized vehicles.

Now that cycling is recognized as one remedy for urban congestion and pollution, it is attracting a host of clever technical innovations to make it even more appealing.

Riding the green wave

Traffic lights are probably more disliked by cyclists than by drivers. They hate having to stop at red signals because they lose hard-won momentum and have to expend more energy to get moving again when the light shows green. It's one reason cyclists are tempted to jump red

lights. So there have been several schemes to mimic the green waves that some cities give motor traffic. However, cyclists are not as uniform as motor traffic.

"Realistically, cyclists travel at anything from 10-25km/h [6-15mph], so they spread out and arrive at the next signal over quite a wide period of time," says Robbin Blokpoel, technical research manager at mobility solutions company Dynniq. As part of the European Union's (EU) Horizon 2020 XCYCLE collaborative project, he is leading developments that will help the infrastructure be kinder to human-powered road users.

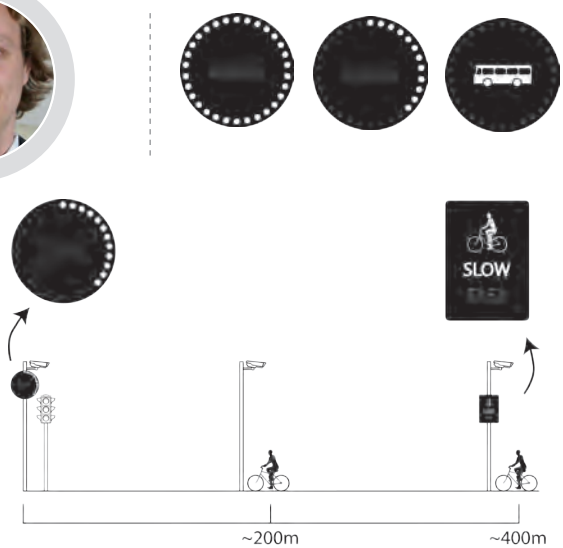
"We have a special algorithm that stabilizes the signal phases and, next to the traffic signal, a big clock that counts down the time remaining for the green light. It's a meter in diameter so that cyclists can see it from up to 300m [1,000ft] away. They will soon get a sense of whether they can get to the signal while the light is green, or whether they should slow down to arrive in time for the next green phase," says Blokpoel. "In that way, the cyclists create their own green wave."

Car conflicts

It's all very well helping cyclists, but won't the stabilized phases impact the flow of motor vehicles? "We have done simulations, including one of a specific intersection in Groningen, the Netherlands, and the motor traffic doesn't have to make a big sacrifice at all, losing only a few seconds, but still outperforming regular actuated control," says Blokpoel. Public transit will have priority over the green wave and cyclists will be alerted by an additional illuminated graphic on the clock when a bus is on its way.

The system will go live by September at the latest. Meanwhile, the movements and speeds of bicycles and vehicles are being monitored so they can be compared later with results once the green wave technology is in place. A team from Sweden's national research lab, VTI, and the University of Groningen will be using eye-tracking cameras, also, to assess the ways cyclists watch and respond to the clock and signals.

> A big clock counts down the time remaining for the green light. It's a meter in diameter so cyclists can see it from up to 300m away
>
> **Robbin Blokpoel, technical research manager, Dynniq**



Right: **XCYCLE features large countdown clocks at traffic signals to help cyclists ride green waves**

Roadside technology

Another strand of XCYCLE addresses the three persuasive reasons why ITS equipment for cycling will first be part of the infrastructure and roadside furniture rather than on the bike. Bicycles are a relatively cheap mode of transport, so any technology that adds to the rider's costs is less likely to be adopted voluntarily. Also, with only human energy available for propulsion, devices that require more than the lightest power supply will be resisted. Finally, anything added to a bike is exposed to accidental damage, the weather and theft.

So an experimental system for warning truck drivers that cyclists

V2X for bicycles

Making bikes part of the connected vehicle network has its own unique challenges, particularly as costs must be kept to a minimum

"We want something that can be useful to the cyclist very quickly, rather than waiting for all the motor vehicle fleet to be equipped with V2X," says Prof. Rajesh Rajamani at the University of Minnesota,

"And we wanted something to be inexpensive, US$200-US$500. So that ruled out things like lidar for our smart human-centered collision warning system for making cycling safer."

The Roadway Safety Institute at the University of Minnesota seed funded the project and it now has three-year funding from the National Science Foundation. In its current state, bike-mounted sensors detect vehicles approaching from the rear and overtaking.

"It tracks the position of all the cars nearby. If there's a danger of a collision, an audio warning is provided to the cars – it's an on-bike car horn. With NSF funding, we're looking at a combination of visual and audio," says Rajamani.

An US$89 laser is used for rear detection, mounted on a movable platform controlled by a stepper motor. It scans the lane and when the algorithm on a linked microprocessor identifies an approaching car, it locks on to track its position and speed. A US$20 sonar is used to sense vehicles on the left of the bicycle, in case they make a right hook on a collision course.

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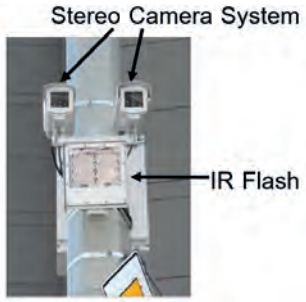
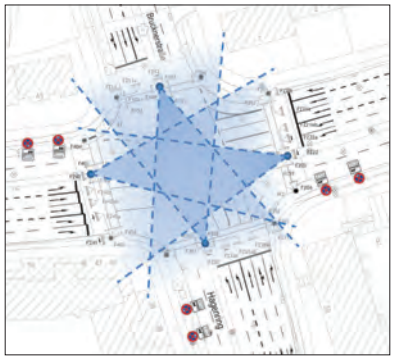


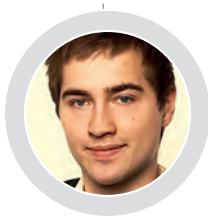


Above: **Testing a system that warns truck drivers of nearby cyclists, at an intersection in Braunschweig, Germany,**

are active at an intersection places nothing on the bike or rider, putting all the hardware, software and comms packages beside the road instead. It has been installed at an intersection in Braunschweig, Germany, that is one part of a testbed for intelligent mobility services.

The signal-controlled crossroads have had two pairs of digital traffic cameras added to a suite of existing sensors in order to track cyclists. The cameras work in tandem so that algorithms can create a stereo view. "Experience from a previous project shows that the data quality is best with stereo cameras. The tracking is much better than with mono camera and radar," says Kay Gimm, of Germany's Institute of Transportation Systems. "Infrared lighting enhances their performance in darkness and wet weather to give us 24/7 coverage."

> Data quality is best with stereo cameras… We get the position, speed and trajectory of any bicycle or vehicle, 25 times per second
>
> **Kay Gimm, Institute of Transportation Systems, Germany**



Multiple servers in a walk-in roadside cabinet analyze the sensor data. "We get the position, speed and trajectory of any bicycle or vehicle from this detection system. That's 25 measurements every second, in real time," says Gimm. "Using situation assessment, we can predict their paths and derive whether or not there will be a safety-critical event." A typical hazard is when a truck turns right, into the path of a bicycle approaching from behind, on its near side.

Warning truck drivers

"The idea is that we give out this risk-related warning, through a communication gateway to the truck where an HMI [human-machine interface] is triggered to alert the driver to the bicycle approaching from behind," says Gimm. "We also plan to have an individually triggered amber light at the intersection, visible to all vehicles, and it will adaptively flash when a safety-critical event for cyclists is predicted." The system should be functioning fully by next year and includes the possibility of communicating to an on-bike HMI to alert the cyclist, too.

Joining the dots

Making roads safer for cycling is difficult when the information about conflicts is incomplete. In many countries, only collisions with legal, medical or insurance consequences are recorded and even those files can't be compared because they are not standardized. One European project, called InDeV, may help remedy the problem with a set of technology tools to fill the data gaps consistently. Then road safety practitioners can act on the evidence and reduce the dangers for cyclists.

Platooning ahead

In the wake of real-world testing of truck platoons, the first technology for bike platoons has been demonstrated

One perceived benefit of bike platoons is that by 'herding' cyclists, they'll help drivers to accept and react to them more easily, safely and efficiently. It may also be simpler for traffic controllers to offer a green wave to a bunch than to a disparate number all moving at different speeds.

The technology for platooning is fixed to the bicycles in three modules and is completely independent of the infrastructure. A control module acquires sensor data, runs the cooperative adaptive cruise control, and operates the other two modules. The low-rate wireless communication module has a range of 10m (30ft), while location data captured through a smartphone's GPS is relayed via Bluetooth.

The grips of the handlebar vibrate to tell the cyclists about the platoon leader's speed, so they can slow down or accelerate appropriately, while keeping their eyes on the road. It has all been put together by engineers at the University of Chile and Icesi University in Colombia.

"We can have up to 10 bicycles in the platoon, each up to 2m (6ft) apart with multi-hop communications for bicycles that are more than 10m from the group leader. The spacing between them should remain roughly fixed during the journey, but the speed will depend highly on the behavior of the group leader," says Sandra Céspedes from the Department of Electrical Engineering at the University of Chile.

"We want to compare safety of different intersections, so we are enhancing traffic video data collection and the analysis of collisions and near misses," says Aliaksei Laureshyn, project coordinator at Lund University, Sweden. Thermal cameras seem to improve collection of traffic behavior at night, which is when more cyclists get injured. The researchers are also assessing the benefits of using two cameras at intersections, so that relatively small objects of interest, such as cyclists, aren't obscured by larger ones, such as trucks. To marry the images from the two cameras, mathematicians are working on algorithms that recognize the same moving objects from the different perspectives and track them.

Yet even a single camera will collect many more hours of incident-free video than moments of conflict, so InDeV is working to automatically reduce the data to a manageable size and make analysis easier. "We have a tool that automatically edits hundreds of hours of unremarkable traffic video and keeps just the few hours that may contain conflicts," says Laureshyn. They are also making it robust for long sequences and in all lighting conditions.

> We have a tool that automatically edits hundreds of hours of unremarkable traffic video and keeps the few hours that may contain conflicts
>
> **Aliaksei Laureshyn, project coordinator, Lund University, Sweden**

Top: **A stunt rider tests an app, which detects when a cyclist has fallen off**

App-based collision warning

Hundreds of regular cyclists in four European countries are already contributing data about their conflicts via a smartphone app distributed by InDeV. Put simply, it's a Q&A form they submit after each incident, but Laureshyn hopes one day it will be semi-automated, triggered by the app recognizing a collision from the data of its accelerometers.

"Stuntmen and dummies with phones in their pockets have been crashing deliberately, to see if there is rotation and acceleration data typical of a cyclist crash," says Laureshyn. It seems to work for impacts, but not for slow falls and sliding.

A prototype of the app is being used by a handful of volunteers who are able to keep their phone batteries well charged. It's not being distributed more widely yet because the app needs to monitor movement continuously and it drains the battery within three hours. When phone batteries can last longer, the crash-triggered reporting app will be ready. With luck, it will happen before another 200 years have passed.

Max Glaskin is the author of Cycling Science, published by Chicago University Press (USA), Frances Lincoln (UK), and in six other language editions

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ALPR

Breathe again

As low emission zones hit headlines across Europe, **Jack Roper** investigates the challenges involved in using ALPR cameras to enforce such schemes

With 467,000 deaths per annum in Europe attributed to air pollution, and urban areas choking on congestion and spluttering in a malign fog of particulate matter (PM), CO_2 and NO_x, authorities are queuing up to implement schemes addressing the twin challenges of congestion and pollution. From Athens to Aberdeen, and from London to Ljubljana, there is an eclectic smorgasbord of initiatives with over 200 low emission zones (LEZ) around Europe excluding more polluting vehicles and some cities employing road-user charging to deter vehicles from entering. Although differing widely in strategy and scope, all these schemes increasingly share one integral feature: the use of

automatic license plate recognition (ALPR) as a means of enforcement.

ALPR-enforced LEZs across Europe are shaped by national legislation and culture, with not all countries embracing the technology. Across Germany, a system of colored stickers is used to exclude vehicles not meeting various Euro emissions standards from around 80 environmental zones. Police and parking inspectors check vehicles manually, issuing fines for non-compliance. "We have strict regulations about personal data," explains Dr Annette Rauterberg-Wulff, Berlin's senior air quality management advisor. "ALPR is not in conformity with these regulations." However, although Germany eschews ALPR enforcement, it uses ALPR to monitor LEZ impact. "We do video recognition once a year," says Rauterberg-Wulff. "We can see how many vehicles meet the standards, but the data that we collect is completely anonymous."

> [The Stockholm congestion tax] paid for itself within four years. The money is going into a massive infrastructure investment
>
> **Daniel Firth, chief transportation strategy officer, Stockholm, Sweden**

Working in Sweden

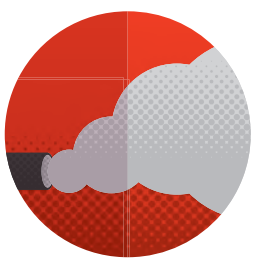
Stockholm introduced an ALPR-enforced congestion tax in 2007. A toll-ring of 25 electronic charge-points girdles the city and two gantry-mounted cameras per lane photograph vehicles both front and back to ensure an ALPR hit rate of over 99%. Data is transmitted via a roadside unit and processed by the Swedish vehicle registration authority, with monthly bills sent to registered vehicle owners. A sliding scale of charges is used to discourage peak-time journeys. All vehicles pay, irrespective of Euro emissions stage.

Despite costing an estimated SEK250m (US$28m) initially, an obvious benefit of this system is the revenue it generates. "It paid for itself within four years," says Daniel Firth, Stockholm's chief transportation strategy officer. "The money is going into a massive infrastructure investment." Moreover, a 20% decrease in congestion has been sustained despite rapid population growth. "Reduced traffic is having knock-on benefits for pollutants, PM10 [particulate matter less than 10μm in diameter], NO_x and CO_2 emissions," says Firth. "The reduction in PM10 within the inner city is 10-15%, which we attribute to the congestion tax." Air quality has therefore improved – albeit, perhaps, as a secondary outcome.

Left and above: **Stockholm's ALPR scheme has not only reduced traffic congestion, it has increased air quality too**

Focus on air quality

ALPR more commonly – although less profitably – enforces European LEZs that exclude more polluting



A 10-15% reduction in PM10 pollutants has been achieved in Stockholm, Sweden, thanks to the city's ALPR-enforced congestion tax

Standard slip-ups

Low emission zones in Europe rely on EU standards to exclude vehicles deemed more polluting – but has this always guaranteed better air quality?

Euro 3 diesel engines actually proved more harmful than previous classes, as Margaret Bell at Newcastle University, UK, explains: "On London buses with old diesel engines you saw black smoke coming out of the tailpipe. That wasn't as harmful as the next generation because those big particles were trapped in people's nasal hairs. When you burn fuel more efficiently, you get less CO_2 but produce finer particles." As a result, by 2005 initiatives to promote Euro 3 vehicles had served to create increased levels of harmful fine particles in London's air.

But the remedy had unforeseen side-effects. Euro 4 engines were fitted with particle traps, but their filters needed cleaning. Urea was used as a catalyst – producing NO_2 as a by-product. Consequently, most Air Quality Management Areas in the UK are due to NO_2 exceedances caused by newer diesel engines. "A scrappage policy is very difficult. We'd be scrapping the newer vehicles people bought because of government incentives to move to diesel, so we're in a politically sensitive situation."

And aside from the Volkswagen scandal, Professor Bell argues that Euro emissions testing results in vehicles are being tuned to test cycles rather than real-world cycles – where, she claims, their emissions are up to 40% higher.

An imperfect system? Probably. But emissions standards appear to be the best tool currently available to authorities seeking to phase out older vehicles.

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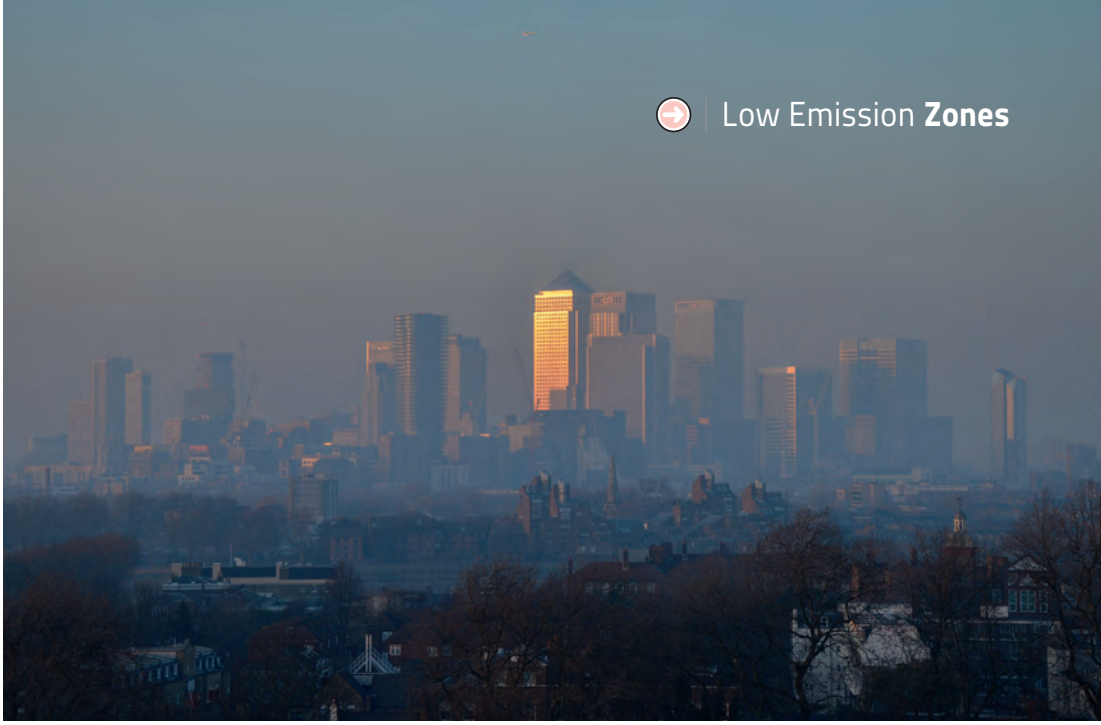
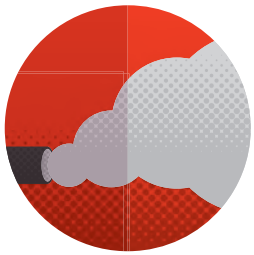




1,500 ALPR cameras enforce London's Congestion Zone. They will soon be used to charge polluting vehicles, too

vehicles with reference to Euro standards, checking ALPR records against databases to impose fines for violation. Trevor Ellis, former enforcement infrastructure project manager on the London LEZ, emphasizes the distinct objectives of congestion charges and LEZs. "With a low-emission scheme you try to get people to use the right vehicles rather than charging them. So you don't necessarily catch them every day as you may in a road-user charge situation. You try to bring about a behavioral shift rather than generating revenue."

The dual approach at Transport for London (TfL) illustrates the differing implications for ALPR deployment. During peak times all vehicles pay a congestion charge of £11.50 (US$15) to traverse a small central zone that is encircled by 1,500 cameras taking front and rear images of vehicles entering and exiting – which makes the chance of evading detection vanishingly small. However, the London LEZ is many times larger, covering nearly all of Greater London, and aims to catch large vehicles failing to meet Euro 4 emissions standards, and medium-size vehicles that fail to meet Euro 3 standards.

The near-watertight hit-rates possible in small congestion zones become proportionately less achievable over larger areas. Covering every route into Greater London with cameras is unfeasible, so ALPR is positioned at major LEZ entry-points, with mobile ALPR units collecting additional data. Some violations go undetected, but there is a likelihood of being caught before long, with fines set sufficiently high to be prohibitive (up to £1,000/US$1,280).

Above: **In January 2017 a 'red alert' for smog was issued in London for the first time ever, with residents advised to stay indoors**

Right: **ALPR cameras have enforced London's LEZ since 2008, but now restrictions are being tightened further**

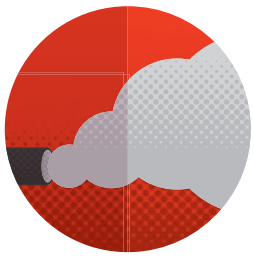
"The ideal situation is that you have no violations at all," explains Ellis. "You'll get no penalty income, but you'll have achieved your primary objective of improving air quality. Some LEZs in mainland Europe do not have automatic enforcement but just rely on manual checks. You've really got to think about getting compliance. If it's unenforced and people do violate it, you're still probably better off having it than not."

> With a low emission zone, you try to bring about a behavioral shift rather than generating revenue
>
> **Trevor Ellis, former enforcement infrastructure project manager, London Low Emission Zone**

In London, though, rather than attempting to encourage payment on an 'honesty' basis, authorities are looking to impose extra charges through the ALPR system already enforcing London's Congestion Zone. From October a new T-Charge will make the total cost of entering the Zone a startling £21.50 (US$27.50) for pre-Euro 4 vehicles. This is on top of the £100-£200 (US$128-US$256) charge many of these vehicles pay for entering the wider LEZ. And, whereas the LEZ only applies to larger vehicles, the smallest being pickups and 4x4s, the T-Charge will apply to nearly all vehicles, only excluding solo motorcycles. As motivation, London mayor Sadiq Khan has cited the 9,000 deaths annually linked to emissions exposure, and children in 438 schools currently breathing pollutants that exceed legal safeguards, along with the severe smog the capital endured in late January this year.

Light van ban

The Amsterdam Milieuzone links pre-existing speed enforcement cameras to ALPR software. Here, a light van exclusion has reportedly produced a 65% drop in targeted vehicle journeys – despite penalties not beginning until May. "They don't know they don't get fined yet," explains senior traffic advisor Anne Blankert. "At certain access points we have panels showing your license plate at the side of the road." Thus perception and strategic ITS deployment can have significant impacts within a wider emissions strategy. The Milieuzone is not a money-generator, but Amsterdam



ALPR cameras have led to a 65% drop in the use of light vans in the center of Amsterdam even before a penalty system for violators comes into force

Reading the signs

To the layman, ALPR sounds as simple as taking a holiday snap, but the challenges of getting it right involve a lot more than just point-and-shoot

The London Congestion Charge ALPR system was prone to generating false positives in its early days, serving penalty charges on vehicles that hadn't been in London. "The classic case was when they gave one out to a vehicle in Beaulieu Motor Museum," Trevor Ellis recalls. "The newspapers loved that."

Whereas older ALPR systems used analog cameras, much higher-resolution megapixel imaging is now available, while computer processing power has become both greater and more affordable. "I don't think there have been step-changes; there have been incremental changes over the years," says Ellis.

The syntax of Estonian and Latvian license plates is based on the Swedish model. Consequently the Stockholm Congestion Tax ALPR was at first susceptible to false positives whereby charges were issued to Swedish drivers if an Estonian or Latvian plate matching theirs entered Stockholm – but software refinements have eliminated this issue. "There are systems for flagging up plates that there are question marks around," Daniel Firth explains. "Almost all processing is done automatically, but there is the possibility to escalate certain images for humans to look at."

ALPR detection rates can still be affected by snow obscuring plates or other local factors. Whereas Stockholm positions its cameras on imposing road-straddling gantries for optimal effectiveness, London's cameras are less obtrusively sited on roadside poles to limit visual impact. But ALPR has become more sophisticated and less error-prone with time – and this seems sure to continue.

profits instead from parking fees on the outskirts. "The city is changing and trying to discourage car use by closing down streets to create a better environment for pedestrians and having high parking rates in the city," says Blankert. "ALPR is just one way to help with enforcement; there are a lot of other measures."

Data driven

In the past, UK data rules have constrained academics from accessing DVLA records and required local authorities – as distinct from charging regimes – to anonymize the ALPR journey-time data they use to model congestion. According to Margaret Bell, professor of transport and the environment at Newcastle University, UK, this has limited the usefulness of ALPR to air-quality managers.

Prof. Bell emphasizes the potential of ALPR in modeling pollution and promoting strategic responses – a potential under-exploited in the UK because of data constraints. Rather than collecting real-time emissions data by linking ALPR to specific vehicle type, authorities have historically modeled air pollution by assuming an average mix of vehicles on their roads. "However, in an affluent area of a city like London, your vehicle mix is much newer than in a less affluent area," says Prof. Bell.

Hence real-time concentrations of pollutants can vary widely, with problems exacerbated by local geography. "If you know where traffic is emitting more pollutants, you can predict pollution at a much finer resolution and get a better traffic management strategy using technologies that are already available. When you've got a pollution hotspot, you can use your traffic signals to ventilate it by displacing the queues to an open space, such as a park." Linking ALPR to real-time emissions data can thus enable optimal use of existing infrastructure to manipulate air quality and limit potential damage to health.

> "Amsterdam discourages car use by closing streets to cars and having high parking rates. ALPR is just one way to help with enforcement
>
> **Anne Blankert, senior traffic advisor, Amsterdam Milieuzone, The Netherlands**

With authorities like Transport Scotland providing consultancy on new LEZs, and existing schemes around Europe timetabled for major extension, ALPR's versatile potential for road charging, violation enforcement, real-world modeling and effectiveness feedback appear to guarantee it a large and adaptable role in air-quality management.

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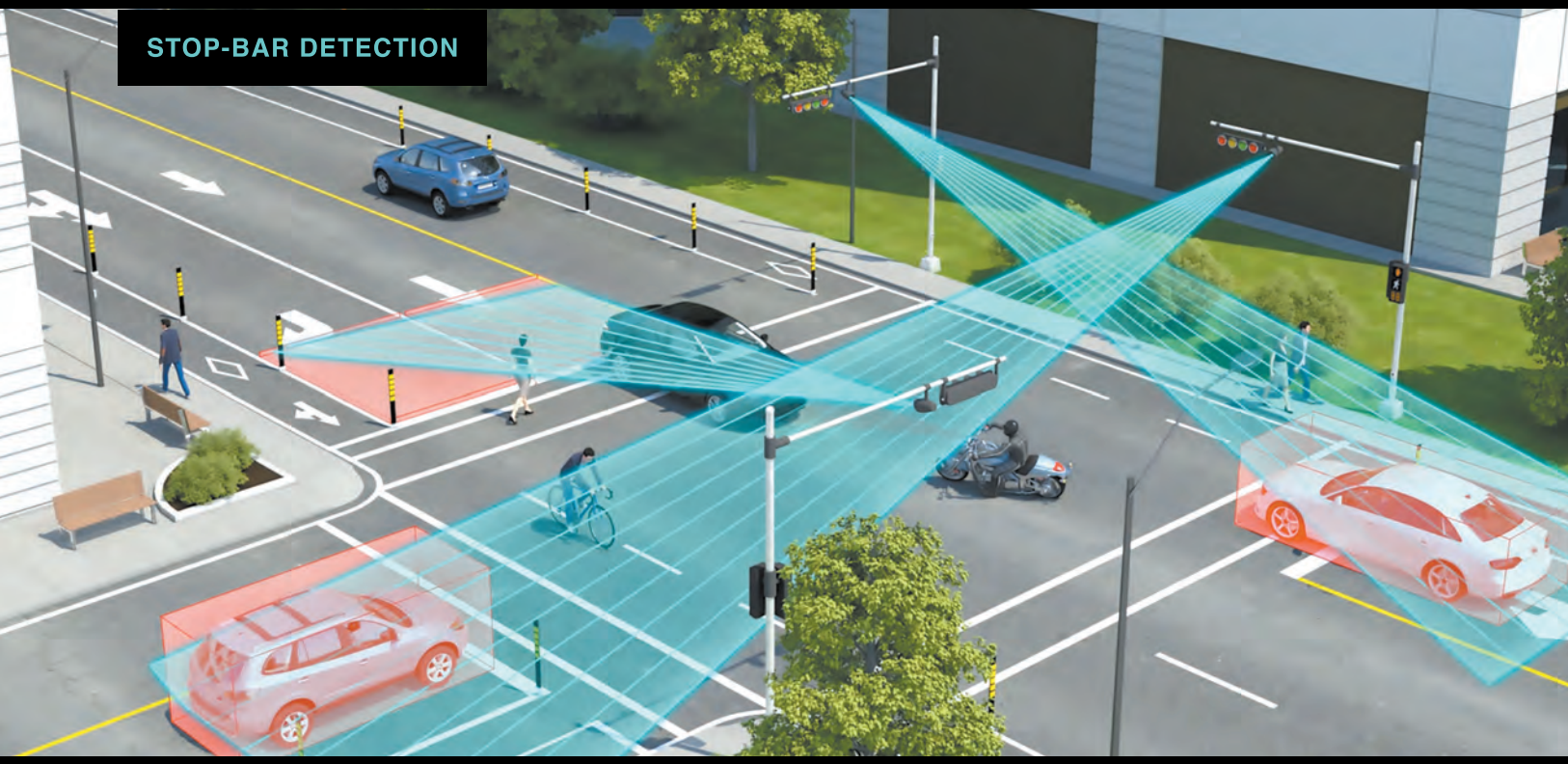

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Data warning

New vehicular network solutions are being developed to facilitate precise real-time reporting using 5G technology

A new project coordinated by VVT Technical Research Centre of Finland is pushing the boundaries of live reporting using 5G technology. The project, named 5G-Safe, involves the identification of weather and road conditions using data collected from, and the exchange of real-time video and radar data between, vehicles on the road. Warnings and real-time updates will also be automatically sent to drivers, road operators and vehicle control systems.

The project, which will finish in 2018, will also investigate how sharing data about road and weather conditions can improve situational awareness for autonomous vehicles operating in environments with poor visibility, such as in extreme weather.

"Contemporary driver support systems are mainly vision-based, relying on signals generated by the vehicle's sensors. 5G and short-range radios will also bring the power of speech and hearing to vehicles, taking their capabilities to a new level," states Tiia Ojanperä, a project manager from VTT.

The services being tested and developed require no action during driving from the vehicle drivers involved; data and warnings are shared automatically.

50: A mountain to climb
Traffic on Colorado's demanding I-70 corridor is to benefit from fast cellular hazard updates thanks to new mapping technology

56: Smart cities on a budget
A UK government scheme is funding innovative, low-cost projects aimed at reducing congestion on the country's roads

A mountain to climb

Traffic on Colorado's demanding I-70 corridor is to benefit from fast cellular hazard updates thanks to new mapping technology. As **Graham Heeps** discovers, it's one of several new initiatives under CDOT's RoadX program

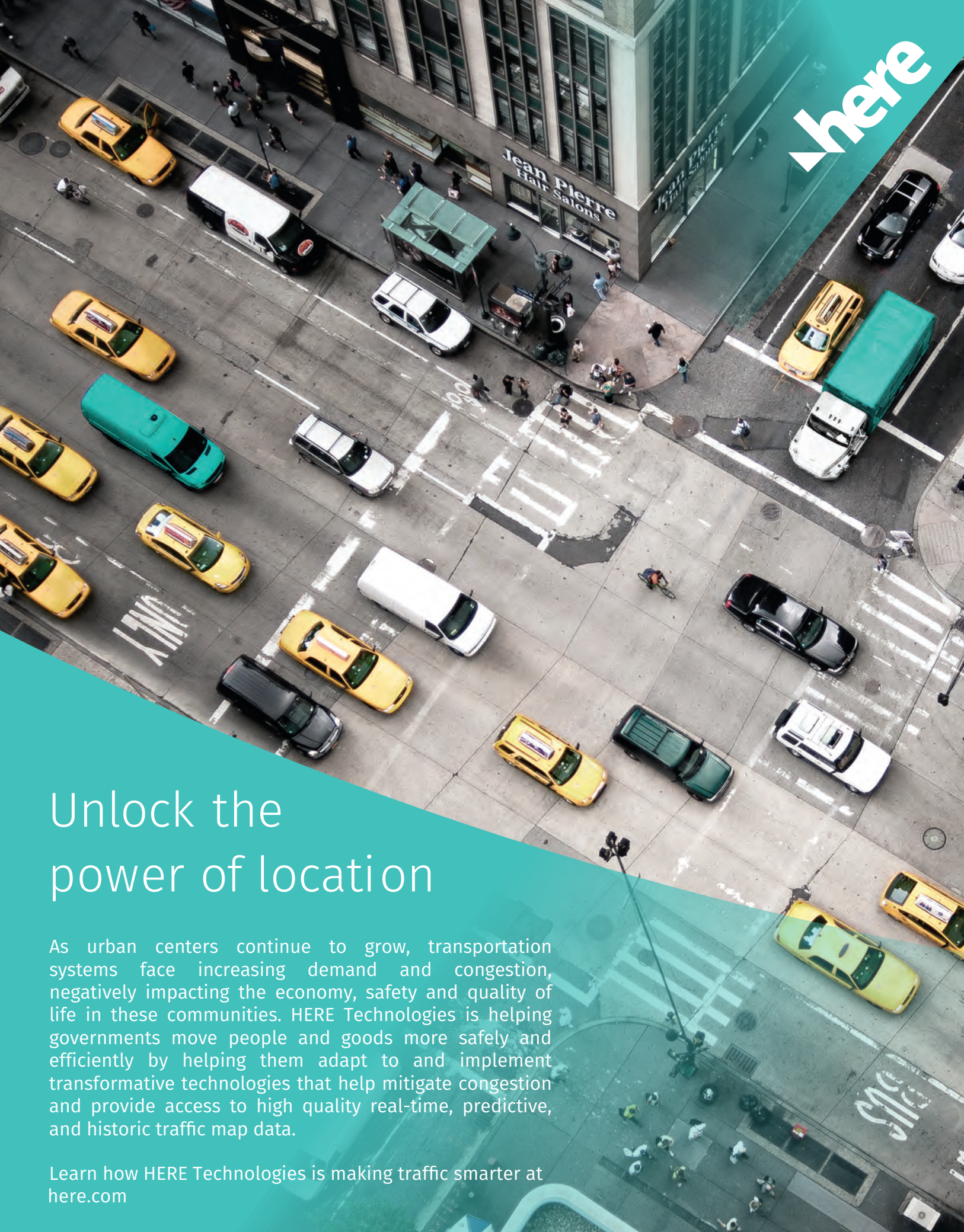
Interstate 70 is one of Colorado's most important arteries, running from the border with Kansas in the east, to Utah in the west, via the state capital, Denver. The 243-mile (391km) stretch between Denver and Grand Junction carves a spectacular route through the Rocky Mountains, passing through canyons and tunnels, ascending and descending with the terrain and servicing National Forests and ski resorts such as Aspen.

However, this key route's popularity and environment also mean that it's prone to some demanding road surface and traffic conditions, which can change quickly with weather and altitude. Colorado Department of Transportation (CDOT) has been looking at ways to make the traffic flow in this corridor safer and more efficient for the last 20 years (the award-winning final section, through Glenwood Canyon, only opened in 1993). Now, help is on the way at last from a program that's part of the state's RoadX initiative, which since October 2015 has been integrating technology into the transportation system in Colorado. It in turn fits with CDOT's philosophy of improving the road network through technological enhancements or system upgrades before resorting to a heavy capital construction project.

"About five years ago we signed a decision document suggesting we should add more capacity to the roadway in the form of traditional infrastructure and building an

The Eisenhower tunnel is the highest point of I-70, with an elevation of

11,158ft



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advanced roadway system along the corridor," explains Peter Kozinski, director of the RoadX program at CDOT. "The price tag for those proposed improvements is US$13bn. Colorado Department of Transportation doesn't have US$13bn so we have to find a stopgap measure using technologies such as cellular networks, until vehicles become smarter and can improve the overall efficiency of our roadways by their own embedded technologies."

A partnership between CDOT and Here, the digital mapping company that's developing location technologies for connected and autonomous vehicles, came about after the former took notice of the latter's cooperative intelligent transportation system (C-ITS) hazard notification pilot in Helsinki, Finland. The Colorado scheme calls for an app to be rolled out in phases, free of charge to I-70 users. It informs drivers with very rapid and precisely targeted alerts about hazards ahead. This might concern an accident, icy road surface, visibility issue, obstacle or unexpected traffic jam. The two partners hope that the result will be increased safety and mobility, without major investment in highway construction, roadside units (RSUs) or additional cellular infrastructure beyond the existing LTE (long-term evolution) network.

Right: **The Eisenhower tunnel directs I-70 under the Continental Divide in the Rocky Mountains**

Below: **The Colorado scheme will use a free app to notify drivers on I-70 of upcoming hazards**

> Agencies can receive data to help them operate more efficiently… from GPS probes and vehicle sensors
>
> **Monali Shah, director of global intelligent transportation solutions, Here**

"We know that everybody has cellular phones in their hands pretty much at all times; we felt we should capitalize on that to help improve the corridor," says Kozinski. Behind the app lies a major data integration and analysis operation that was assembled and tested through the winter of 2016/2017.

The data that detects the hazards themselves is collected from multiple sources, including I-70 users via GPS probe data, CDOT's own road monitoring infrastructure and Here's national traffic operations center in Chicago.

"The information in today's navigation devices is updated every minute or so, but as we move to the world of automated driving, we're going to need to deliver much faster and more highly targeted information to the vehicle," says

Two-way street

The huge benefits that Here's data can bring to road operators

Here's Monali Shah, director of global intelligent transportation solutions, notes that it's not just drivers who can benefit from cellular data, but the road operators, too.

"Agencies can also receive data that is going to help them operate more efficiently," she says. "We can send them data from GPS probes and vehicle sensors when, say, a slippery road is detected. That information can go to a traffic management center, which can send a snow plow or salt truck out to address the situation."

For Here, the I-70 trial also adds new use cases to the C-ITS program in Helsinki and another trial in Belgium that's part of the European Commission's C-ROADS Deployment Platform, as well as providing another step on the road to a future V2X environment in which automated vehicles might be dependent on up-to-date, external information about road and traffic conditions in order to operate safely.

"It's about setting up that two-way connectivity through our location cloud, and responding to things much faster," adds Shah. "Today the data being sent is more on an informational level; it's useful, but we need to upgrade those capabilities as we move to more connected and automated driving. On one side, we're seeing that government agencies and road operators like CDOT are looking at their role and what they should be generating in terms of data freshness, quality and accuracy to get it to the level required for it to be relevant and useful to a vehicle. On the automotive side we're working with Audi, BMW and Daimler, who are sharing vehicle sensor data so that we can detect hazardous road conditions or even hard braking [for a traffic jam]. That's exciting because now, for the first time, that type of information is being shared so that we can make that two-way communication happen."

Monali Shah, director of global intelligent transportation solutions at Here. "The lower latency is one of the big things we're trying to prove in these pilots, trying to get to much faster and more safety-focused messages."

Sharing the knowledge

The I-70 program began with 25 internal CDOT users and has since been expanded to 50, including first responders.

"We wanted them to see how it brings value to their particular needs," says Kozinski. "We got feedback on [the service] this winter ahead of further refinement and development. We want a very attractive, useable interface because there are a lot of choices out there – Waze, Google Maps, and others. We need to compete with those groups to ensure that our app is being used by [enough] folks so that we can get the needed information to and from them. We don't want something lackluster because we need critical mass.

"We expect that by next winter it will be open to the masses," he continues. "We will team with our partners in the mountain corridor – ski resorts, for example – so that as people start getting ready for ski season, they are made aware of the app and can download and start using it straightaway . We are planning to participate in trade shows and do a complete marketing campaign; when we start to talk about winter snow tires in the high country, we'll also try to tag this feature as a way to get hyper-accurate information in a cellular environment in the corridor."

For Colorado DOT, the I-70 scheme will not only complement a DSRC project with Panasonic, but also take advantage of additional information about the road network that it may be able to provide.

"Part of our relationship with both companies is that the two platforms need to share information with each other," says Kozinski. "Any cellular information that is collected via Here's cloud-based computing needs to be ingested by Panasonic; conversely, anything collected from DSRC must be fed into the Here cloud and shared out in a cellular environment. We want the efficiencies and improvements that either one can bring, sooner rather than later. Saving lives and making people's trips more reliable is ultimately our job. We need to use the tools that are out there as quickly as possible, not sit back and wait for them to fully mature. We have to embrace them in their early stages and help set the path for how they can be used in the future." ○

RSUs too

In a second element of the Smart 70 project, CDOT is placing roadside units (RSUs) along the I-70 Mountain Corridor

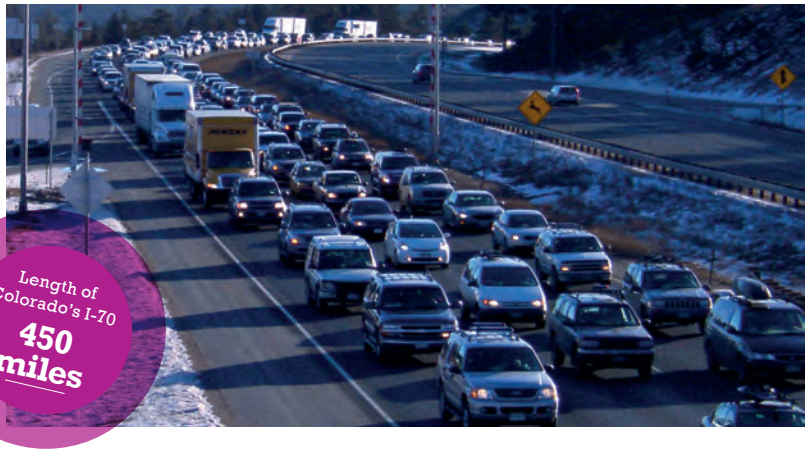
In the initial deployment, 25-40 RSUs will be installed by next winter, but not before the technology has been tested on a smaller scale in a controlled environment around Panasonic's campus at Denver International Airport.

"The true benefit will be in the ecosystem we're building behind the scenes," says CDOT RoadX program director, Peter Kozinski. "We will be able to seamlessly integrate all of our future RSUs into the system. We hope to have more than 100 units throughout the state of Colorado within a year."

Through dedicated short range communication (DSRC), the RSUs will collect all manner of vehicle diagnostic data that can act as indicators of environmental and road conditions: from the use of windshield wipers, to the engagement of electronic stability control or emergency braking systems. Kozinski acknowledges that the current number of vehicles able to connect with RSUs is low, but has no doubt as to the value of the enhanced information that even a small number of vehicles can provide, in combination with the information being shared through the cellular network.

"We know that the number of connected vehicles will increase over time, but it's also possible to connect an onboard device via the OBD-II port to send information to an RSU," he expands. "We haven't determined how extensively we want to get into that space, but most likely we will start to retrofit some vehicles, given that it's still difficult to buy a vehicle that has the technology already embedded."

Above and right: **The I-70 route is subject to snowy and icy weather, which leads to road incidents and traffic congestion**



Length of Colorado's I-70 **450 miles**

> Saving lives and making people's trips more reliable is ultimately our job. We need to use the tools that are out there as quickly as possible, not sit back and wait for them to fully mature
>
> **Peter Kozinski, director, RoadX program at Colorado DOT**

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Smart cities on a budget

Cloud-based traffic management technology has obvious benefits, but is it affordable? **James Allen** reports on a UK government scheme that is funding innovative but low-cost projects aimed at reducing congestion

The debate around cloud-based, vehicle-to-everything (V2X) technology has moved on. It is now beyond doubt that it is possible, but questions still linger concerning how effective it is in reducing traffic congestion and whether cities with restricted budgets will be able to roll out such systems.

In a bid to provide some answers, the UK government's Department for Transport (DfT) has set aside £4m (US$4.95m) in funding for 19 local authorities willing to explore the benefits of smarter traffic management technology.

Coastal calling

Portsmouth, a city on the south coast of England, has more than its fair share of traffic issues, and the plan put forward in its bid for funding is certainly ambitious.

"We are going to build a small section of central network sensors within the city as well as build a big data platform to receive information from those sensors, which we will use to do a short trial of V2X communication," says Pam Turton, assistant director for transport, environment and business support at Portsmouth City Council (PCC).

"We want to establish how feasible this is. If it is successful, then there are clear opportunities for us in terms of expansion, to give people more informed choices about the modes of travel they choose."

PCC is keen to use innovative technologies that can help it to solve

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some of the distinct challenges it faces. "There are only three road routes into and out of the city and we know that the network runs almost at capacity," says project manager and PCC's IT business partner Paul Darlow.

"At the moment, when there's an incident with congestion, all we can do is try to alleviate the problem. But by using prediction models we will be able to realize that traffic is slowing down. If we then issue information to the public we can potentially prevent a major traffic problem from happening at all."

Having only recently had confirmation from the DfT that its bid for £285,000 has been accepted, Portsmouth is now beginning the process of turning the proposal into a working reality. Darlow, however, is under no illusions as to the scale of the task it are embarking on.

He says, "One of the issues I see straight away is the whole V2X concept. In order to get messages to people in their vehicles, technology obviously has to be fitted into them.

"The best and cheapest way to do that is at the manufacturing stage, but although some new vehicles are being equipped with the technology, it's still too early to rely on that. Furthermore, not everyone is going to have the money to go and buy a V2X unit to put in their car.

"So this project is really about preparing the city for the emerging technology and its related standards. We can then say, 'We understand this. We're ready,' as opposed to getting vehicles coming in with all the technology and being unable to interface with it. It's about getting a head start."

A location has yet to be confirmed but the aim is to find a relatively small area of the city that offers a reasonably complex road network to reap the full benefit of the trial.

Once an area has been designated and prepared with the necessary sensors, the plan is to fit off-the-shelf, aftermarket V2X equipment to council-owned vehicles and drive them through the area.

"Most of what we learn will be about the setup and how to connect everything," says Darlow.

Currently the project is very much in its infancy and PCC's technology partners are yet to be announced.

Old York technology

The northeast English city of York also had its funding of £295,200 (US$369,500) confirmed and is now close to launching a physical trial. Unlike the Portsmouth project, however, the York project's success will very much be determined by its impact on traffic congestion in the city.

> The bigger the data sets you can amass, the more useful they are, and the more easily you can share it to enable creative things to be done with it
>
> **Darren Capes, York transport systems manager**

The aim is to explore what is possible regarding connected vehicles using the antiquated and low-latency detection systems currently deployed on the town's roads, without having to invest in new (and costly) hardware.

York transport systems manager Darren Capes explains: "When a new technology comes along, everyone doesn't immediately throw out their old kit and buy the latest equipment. Most people wait until it wears out or becomes too old to use.

"We want to work with the signal suppliers and other companies to see if we can enable existing traffic signal controllers to interface with whatever opportunities connected vehicle data presents.

"We want to enable gradual and relatively cheap migration to the new technology and then, maybe in five years' time when the industry is selling fully connected vehicle-compliant controllers, we can move forward with new technology and ditch the hardware we've been using with no great financial loss."

As well as heading up York's transport management team, Capes is the transport expert for the Institute of Engineering Technology (IET) and sits on the UK government's Transport Technology Forum. Involved in discussions at a national level on the development and deployment of innovative solutions for the UK's traffic problems, he is keenly aware of how cloud-based technologies could impact congestion.

"In the next five years we will see a huge shift in urban traffic management," he says. "Most local councils have their own network servers, and that's not particularly cost-effective, considering capital

Below: **Portsmouth is technically an island city, and only three roads enter it from the mainland**

US$4.95m

The amount the UK government is setting aside to divide between 19 local authorities for the purposes of experimenting with smart city, traffic-reducing technology

484
The number of million miles (779 million km) traveled by motor vehicles in York, UK, in 2015
Source: DfT

outlay, maintenance and renewal. Moving things into the cloud is the way to go.

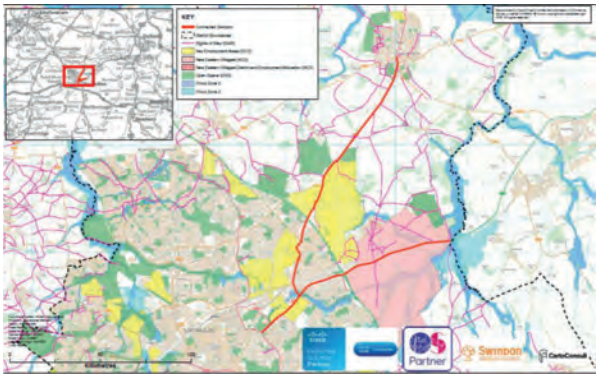
"For a smart city, the bigger the data sets you can amass, the more useful they are. And the more easily you can share data between users and enable them to do creative things with it, the better."

With very few connected cars on public roads, the trial in York will rely heavily on data supplied by software company Inrix, which provides cloud-hosted services and will act as a proxy. The floating vehicle data will be delivered as a feed to the traffic management center, with collection and analysis all done in the cloud.

Capes says, "People talk about using 5G or beacons for direct communication but those technologies aren't around yet. It's not easy to do connected vehicle research when there are no connected vehicles on roads.

"Inrix can produce a very rich, detailed data set of where vehicles are, how fast they are traveling, how congested roads are and that sort of thing. That will allow us to do clever things with SCOOT [split cycle offset optimization technique] and fixed-time signal operation in the future."

The A59 corridor coming into York from the nearby town of Harrogate will be the testbed for the trial, with high-capacity fiber-optic cables and a Dinex PTC1 controller ensuring consistent quality of traffic signal controls along the road. The success of the trial will be measured in terms of shortened journey times.



Top: **York is exploring the connectivity using existing systems**

Above: **The two roads at the center of the Swindon trial marked in orange**

People power

Swindon, in the southwest of England, is also seeking to improve travel times but aims to do so by improving the system that alerts drivers to traffic hot spots.

Real-time data for traffic on two arterial roads leading out of the town to the M4 will feed into an analytical software platform that compares the situation with expected journey times for the time of day. Any unexpected congestion will be flagged and communicated to affected road users and transport managers.

> We don't have real-time information across the network that would enable us to respond as quickly as we would like
>
> **John Sneddon, Swindon's strategic transport commissioner**

"At the moment there is relatively little monitoring taking place for traffic management," says Swindon Borough Council's strategic transport commissioner, John Sneddon.

"We use social media and our website to get information out about road closures, road works and incidents happening on the network. We don't, however, have real-time information across the network that enables us to respond as quickly as we would like."

Automatic traffic counters will deployed on the designated roads, as will cigarette box-sized Bluetooth detectors, which will pick up passing Bluetooth-enabled smart devices.

Once collected, the data will be processed by Cisco Systems software and will then be passed to fleet managers by text or email while local drivers could be informed through their satnav.

If the project is successful, Sneddon is hopeful that it will be rolled out across the whole town.

"The intention is that it will provide us with the evidence base for the technology, and the costs of running and operating the system. It can then inform a business case as to whether rolling it out across the Borough will be good value for money, or whether there are other solutions that would be better."

The technologies that Swindon, York and Portsmouth are experimenting with are relatively new, but the concerns of the teams involved revolve more around finance than capability.

While small in scale, the trials should be viewed through the tightly budgeted world the local authorities inhabit, and as a vote of confidence in innovative technology to reduce traffic congestion in urban areas.

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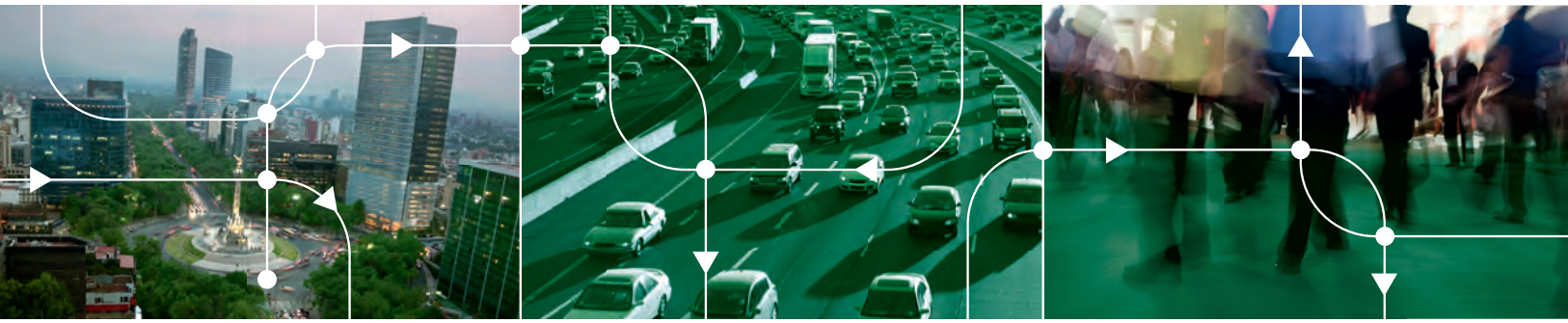

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Advanced enforcement for clean air zones... and more

Five new clean air zones are set to be implemented in the UK by 2020 and air quality looks certain to become an urgent priority for authorities and governments worldwide as the public health hazard caused by toxic vehicle emissions becomes fully understood. In response, UK-based ITS provider Videalert has developed an innovative clean air solution that is the latest addition to its fully hosted digital platform that can support multiple traffic enforcement applications using just one camera type.

With no need to install software or involve their internal IT departments, clients simply access evidence packs direct from the Videalert-hosted platform via a standard web browser. For a fixed rental, Videalert can also provide and maintain cameras, thus offering a fully managed service requiring no pre-existing infrastructure beyond camera-mounting poles with a connected power source. Implementation can therefore be swift, with a greatly reduced chance of any project delays.

Above: **Videalert's web-based user interface**

Left: **Clean air and low-emission zones are rapidly growing in number across Europe**

Right: **Tim Daniels, director of Videalert**

Need to know

Videalert's hosted platform is versatile and simple to use

- Supports analog and digital megapixel cameras
- Single redeployable server (RDS) unit supports up to five separate enforcement locations
- Redeployable as locations achieve compliance
- Communications through fiber, fixed or wi-fi LAN, and 3G/4G WAN data links
- Integration with all PCN processing systems

Versatile functionality

The Videalert platform provides additional value through its versatile functionality. "Our philosophy is to leverage the digital platform so that you can easily add enforcement scenarios," says Videalert director Tim Daniels. "The range of applications that can run simultaneously on the platform includes unattended parking, bus lane enforcement, moving traffic management, tolling and restricted zones. In addition, cameras could be used for police intelligence and crime prevention."

The system supports charging or exclusion of more polluting vehicles. Cameras capture license plate data, which is sent to the hosted platform. This information can then be linked to vehicle databases that identify engine type and emissions information. Vehicles of no interest to the emissions regime are added to a whitelist in the camera and thus not repeatedly captured.

"The whole system is self-learning," says Daniels, "so you have to store less data and running costs are minimized. Vehicles of interest are then filtered according to the tariff schedule to ensure correct payment. For vehicles that have not paid or are not permitted to enter, an exception list is created. At that point, evidence packs are produced, reviewed and sent to the back office for issuing tickets." Both prepayment and payment up to 48 hours subsequent to capture can be accommodated.

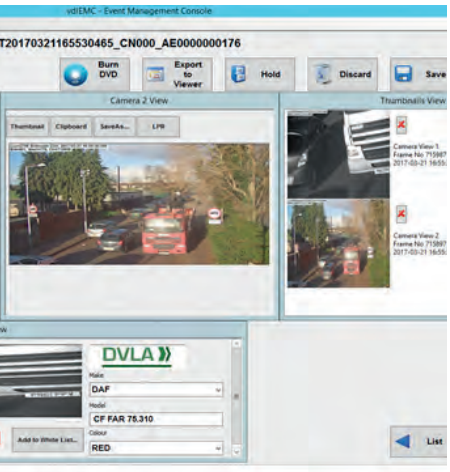
All Videalert cameras support the ONVIF (Open Network Video Interface Forum) digital standard for interoperability between IP devices. "Because they are high-definition cameras, it's high-quality video," Daniels says, "which equates to higher capture rates and less appeal success, because the video evidence is irrefutable."

Since 2008 Videalert has established a track record for technological innovation in unattended parking enforcement and moving traffic management, providing digital platform-based solutions to a number of UK authorities.

"It's an open platform for intelligently capturing license

by **J J Eden**

Toll agencies must act soon to prepare for in-car payment systems



plates, processing video, presenting the evidence and distributing data to third-party systems," says Daniels. "We're leveraging that backbone to deliver the required outcomes for clean air zones."

And with a number of procurement models available, from a capital expenditure-style purchase to the fully managed 'CCTV enforcement as a service' model, authorities contemplating emissions enforcement will be attracted by the return-on-investment case that Videalert can make.

I have previously written on the advancement of autonomous vehicles and their connection to mobile payment systems. When I speak to individuals and toll agencies about these pending deployments, they all say it is at least five or 10 years away, "so why worry about it now?" While it may seem like connected and autonomous (CAV) technology is way in the future, the reality is the future is now.

Jaguar and Shell recently collaborated to introduce a mobile payment system into new vehicles. Although it's being released in the UK, they plan to roll the system out worldwide. And according to reports, these systems will be linked to Apple Pay and eventually Google Wallet, providing customers with a seamless and coordinated mobile payment system.

Although no plans for expanding the system into tolling or other applications such as parking and fast food were announced, the evolution of in-car payment systems is not that far away. Remember, this is a potential US$50bn a year industry the public is clamoring for. In the past month, I have had several other car manufacturers approach me regarding in-car payment systems and tolling. We have all seen the shift in demographics toward convenient mobile applications and away from the privacy concerns of the past. To clarify, I feel systems run by government are far more distrusted by the public than those run by private entities, where security breaches are seemingly accepted as a daily occurrence. In contrast, a breach of any government-run system is in the headlines for days.

Although complex, deployment of these interrelated systems is the easier part. The hard part is the agreements and business rules between the individual business units. This deployment will be complicated as it will eventually cross into multiple industries such as parking, tolling, fast-food and fueling services. So where do we, as a tolling industry, stand in accepting private industry involvement or even takeover of tolling's payment systems?

IBTTA discussed this very topic in its last meeting and more sessions are scheduled this year. Some senior officials at US-based toll agencies have told me they welcome and accept this change as it could open their market, drive more traffic onto roads, and cut their costs. Another concern is how to enforce violations on a hybrid system combining commercial use with required government payments. Would license plate look-up still be allowed? Will agencies that suspend drivers' registrations or licenses for flagrant violations be able to continue to do so? Would companies providing the systems offer some type of toll guarantee? Would these guarantees only cover the drivers that opened an account?

"It may seem like CAV technology is in the future – the reality is the future is now"

The reality is that these systems are coming faster than we ever thought. It used to be that a government transportation entity would either issue a grant or provide funding for a study to develop futuristic transportation technology. Today, consumers are driving it. They want speed, convenience and the mobile applications they use in their daily lives. We, as an industry, will in the immediate future need to deal with the challenges of technologies deployed by a car manufacturer, cell phone operator, or yet another innovator.

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The new enforcement standards that will help vendors and users

UNI 10772 is the Italian standard for video image processing systems for automatic license plate recognition (ALPR), also known as automatic number plate recognition (ANPR). This standard has been in use in Italy since 1998. It is applicable to all ALPR identification systems. The related certification is required by the Ministry of Infrastructure and Transport.

NMi, having ISO 17025 accreditation, is able to perform tests in relation to ALPR and mobility applications. It is also accredited for UNI 10772 testing.

UNI 10772 is not only applicable for enforcement purposes, but also for accessing restricted or private areas. Furthermore, the standard can be applied to toll criteria. The need for verified characteristics therefore has a wider scope.

The standard describes the operation and features of telematics systems that remotely acquire and/or transmit digital images of vehicles based on the automatic recognition of license plates. Furthermore, it describes different license plate categories such as rear (Format A & B) and front plates for motor vehicles, plates for motorcycles and plates for mopeds.

Setting the standard

Despite UNI 10772 being a unique Italian ALPR standard it could form the template for other national or international standards in the future.

UNI 10772 details the functions and requirements of the video enforcement system (VES) as well as describing the requirements for the VES subsystems – including optical character recognition, lighting, and the capture and authentication of images and the man-machine interface. The standard also outlines the laboratory requirements, in addition to test procedures and reports.

The NMi lab is specifically designed for testing the standard and consists of a large room able to create an indoor lighting condition of 0 lux. It is also equipped with a speed simulator that moves the plates at the requested speed and position.

The NMi test system is designed to adapt to different characteristics expected from equipment under test (EUT) produced by different manufacturers. The tests to be performed are at specific illuminance conditions from 0 lux up to 10,000 lux; have EUT geometrical configurations; are at speeds of 26km/h, 50km/h, 70km/h and more at different illuminance conditions; and have different plate positioning, indicators and illumination.

The standard includes a mathematical algorithm describing the overall accuracy of the EUT. This algorithm considers and combines the result of each character and each test performed.

Group classification

Based on the results, the EUT is defined into class A, B or C. Class A requires an accuracy of over 98%, class B over 95% and

Need to know

The UNI 10772 key facts

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

Above: **UNI 10772 regulates all systems that read plates in Italy**

UNI 10772 is also applicable to cameras used for access control

class C over 90%. If test score accuracy is less than 90% it is not passed.

A supplier of ALPR systems entering the Italian market is entitled to provide its product for certification. Suppliers can apply to NMi and will then receive checklists and test suggestions.

After conducting the selected tests, NMi will issue the final outcome in a test report, which the applicant can send to the Ministry of Infrastructure and Transport. The Ministry will then issue the formal UNI 10772 certificate.

As an international test and certification institute, NMi will always issue the test reports it produces in both Italian and English.

The certification is for manufacturers that request official Italian testing and certification to enter this market; EU manufacturers that can request ALPR testing in accordance with UNI 10772 in order to use it as independent verification of their products; and manufacturers, end users, producers and governments in the enforcement field that can use the Italian tests/NMi accreditation as the basis for extra verification of ALPR specifications in relation to enforcement services.

Raising the bar for weigh-in-motion systems

Weigh-in-motion (WIM) systems for detecting overloaded trucks are increasingly being used in a wide variety of operational conditions. Following the demands of both manufacturers and governments, NMi has developed, together with a group of experts, a new international WIM standard that covers both legal and statistical applications for high- and low-speed WIM systems.

For many years, three documents (COST-323, ASTM-1318 and OIML R134) have been used as international specifications for certification of WIM systems. However, these documents are not suitable for all the applications and operational conditions for WIM systems required by end users. Both manufacturers and governments expressed a need for the standards to be updated to cover all new applications.

The document that NMi has produced gives specifications for automatic instruments for measuring the vehicle weight and axle loads of road vehicles when in motion. It specifies the performance requirements for these systems and the minimum testing procedures required in order to determine the actual performance of a type of WIM system.

The International NMi WIM standard is independent of technology and the type of system or sensors and it is applicable for scales, strips and bridge WIM systems. It is also independent of vendor or manufacturer, buyer or user, country or region. Further details about its background can be found in the guide that is included in the standard.

The NMi International WIM standard is open to be used by all buyers and vendors of WIM systems. It may also be used by any national metrology institute or bureau of weights and measures in any country as a basis for national legislation.

Author: Alessandra Bendistinto, sales & BD manager, Italy, NMi Certin B.V., anpr@nmi.it

Making the most of ALPR technology for intelligent transportation systems

Automatic license plate recognition (ALPR) cameras are powerful ITS tools widely used around the world, covering a huge variety of applications and purposes. In many cases, these cameras operate as standalone units, providing the operator with an immediate and unique identifier for the car, based on the vehicle registration mark (VRM).

Each camera can capture a vehicle's VRM, along with associated data such as the time, location, direction of travel and more, sometimes enriched with additional data captured by devices such as radar, laser or video analytics.

However, data alone is useless, unless it can be interpreted and presented in ways that allow its value to be accessed.

Using appropriate intelligent software to analyze the raw data material, data can be turned into knowledge. That knowledge enables intelligent decisions and interventions to be made.

Jenoptik is responsible for the provision and support of thousands of ALPR cameras internationally, involving police and security, average speed (or point to point) and spot speed enforcement, red light cameras, access control and many more.

Data transfer

The roadside systems capture data and typically send it to a back-office (BOF) system, which will use rules to determine if any action is necessary. Usually these systems are standalone, in many cases because local data protection laws or approvals prohibit the use of shared data.

However, using appropriate security protocols and access management, it is increasingly common for this valuable data to be used in a number ways that assist road users, highway operators and the police – delivering safer and more efficient journeys for all.

ALPR data management will become an increasingly used tool for the ITS and security sectors, delivering improvements in road safety, general policing and investigations, national security and border protection.

The merging of data and data types from multiple sources and locations provides greater scope and functions for data.

The future of traffic camera networks sees a convergence of enforcement, traffic control, law and order, and national security.

More devices in more locations will create data sets that are so large or complex that traditional data processing applications will be inadequate to deal with them.

This highlights the need for a 'big data' approach with faster and more sophisticated data analysis tools, while addressing the public concerns of personal liberties and information privacy.

Need to know

Key takeaways of ALPR technology

- ALPR is used increasingly for road safety, policing, national security and ITS
- Increased use will lead to large and complex data sets that traditional systems can't cope with
- Data captured on the road is typically sent to a back-office system
- Modern systems can intuitively analyze raw data and present it in a user-friendly way

Three stages

The value of 'big data' can be seen through the stages of ALPR capture and analysis – which are read, understand and act.

The process starts with capturing the roadside data, which will typically involve a network of ALPR cameras, taking images of the license plate, along with an overview

by Larry Yermack

How will President Trump fund his proposed infrastructure projects?

"Trumpfrastructure will likely be different from anything ever seen"

Yogi Berra once said, "It's hard to make predictions, especially about the future." It's even harder when the news cycle is 24 hours – and more than a month between magazine issues. But I'm going to take a chance as the biggest variable in the funding of transportation in decades is what Trump's infrastructure plan will look like and what will actually be adopted. I'm calling it Trumpfrastructure because it's likely to be different from anything we've ever seen before.

Let's start with the promises of candidate Trump and newly elected President Trump. He has made infrastructure a main pillar of his plans. It was not so long ago that we all sat with bated breath to hear it just mentioned in a presidential address. Then it became a tool of economic recovery. And now it's touted for what it truly is – rebuilding the core of our country.

As always, the key question is how to pay for it. Most road funding comes from state and federal gas taxes and we know that the federal one hasn't been raised in 20 years. We have seen a handful of states recently raise their gas taxes, which, while a good short-term solution, pays no heed to plug-in electrics and hybrids – but that's another discussion.

Most of the Trumpfrastructure funding ideas floated rely on public private partnerships (PPP). There has been some talk of repatriating corporate profits held overseas. There has been some talk of long-term infrastructure bonds and even some talk of additional federal funding from the General Fund.

All of these will be 'scored' by the Congressional Budget Office and Congress will be presented with the bill. Of these, the lowest cost will likely be tax credits for PPPs. In a world of 'pay fors', I think we can expect the lowest-cost idea to be the most palatable to the majority of congressional voters.

Here is where the problem arises for the folks that want funding for highways, bridges and ITS. They will not have a revenue stream to attract PPP investment. Toll roads that are financially viable have already been built. Unbuilt projects are unbuilt precisely because they are not financially viable.

There is another problem that's even more significant. Infrastructure – even Trumpfrastucture – will include dams, water supply, gas lines and the power grid. All are in serious need of investment and have one thing in common that highways lack. They all have an associated revenue stream. Investments in them can be recouped with permission to raise the rate base, but states that want the funding might just offer that permission to the public utilities.

It's very complicated and one short column does not begin to do the issues justice, but I do think that we in the surface transportation business have reason to be wary of the promises and focus on what is within our control to rebuild the infrastructure. If you've been reading this column, you know that means tolls and road user charging.

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

image showing the vehicle on the road. This data will then be encrypted and partially or completely transferred to a central data server, depending on the application.

Until the captured data has been analyzed, it is just raw information and its value is limited. However, sophisticated data mining tools can allow the power of the ALPR data to be accessed.

Data can be presented spatially, chronologically and statistically through intuitive use of maps, charts and graphs. This allows patterns of behavior to be identified, making connections between events, locations, vehicles and people, which would be virtually impossible to achieve by any other means.

Through the ALPR capture and BOF analysis, a detailed picture can be constructed of what is happening within the monitored zone. Depending on the specific application, intelligence-based decisions can now be made.

Local legislation and requirements will ultimately have an impact on what is permitted, but the capability exists to share data across applications, thus reducing the amount of equipment required while realizing the benefits of big data use.

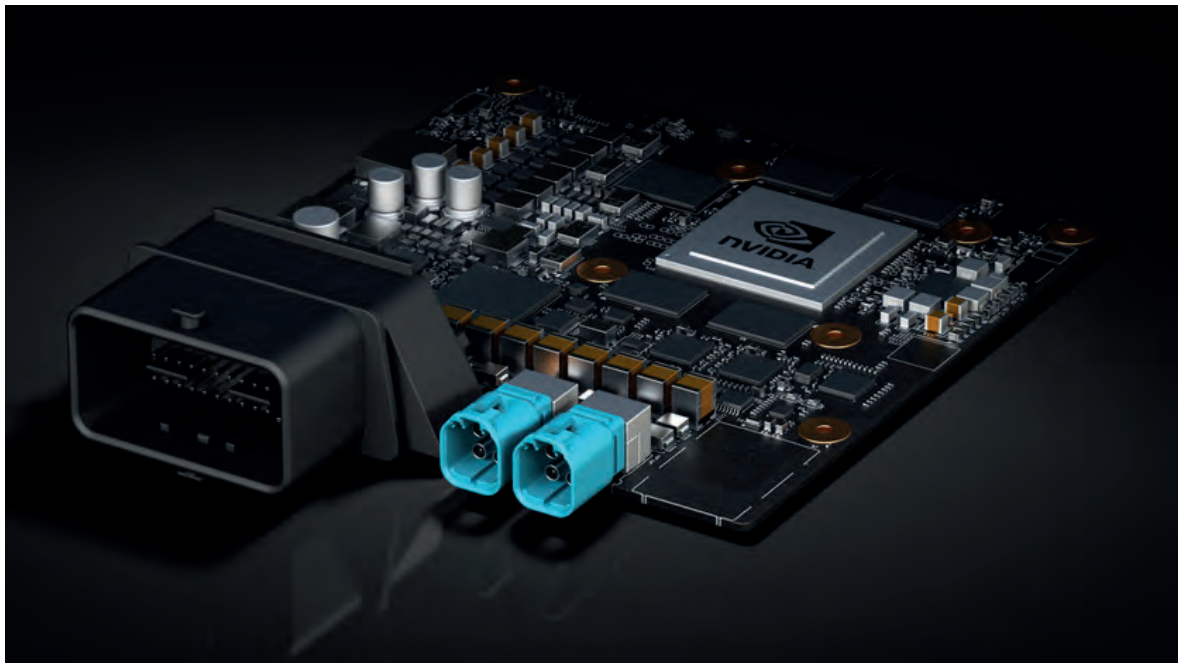
The data stored within the BOF can be accessed through different views, allowing operators to see only what is relevant and important to them.

How to take advantage of deep learning systems

Writing algorithms to automate complex decision making is difficult and time-consuming, but by leveraging deep learning with open-source libraries, Nvidia hardware and FLIR (forward-looking infared radar) cameras, it doesn't have to be.

But what is deep learning? It's machine learning using deep neural networks (DNN) with 'deep' layers between the input and output nodes. By training a network on a large data set, a model can be created to make accurate predictions based on input data. In DNNs, each layer's output is fed forward to the input of the next layer. The model is optimized iteratively by changing the weights of the connections between layers. On each cycle, the accuracy of the model's predictions is used to guide changes in the weighting.

Deep learning is improving traffic systems by automating processes too complex for traditional vision applications. Easy-to-use frameworks, affordable, accelerated graphics processing unit (GPU) hardware, and cloud computing platforms have made deep learning accessible to everyone.



GPU architecture

The architecture of GPUs, which use a large number of processors to perform a set of coordinated computations in parallel (known as a 'massively parallel' architecture), is ideal for deep learning systems.

Ongoing development from Nvidia has resulted in large increases in the power, efficiency and affordability of GPU-accelerated computing platforms. This technology is available in a range of form factors such as compact embedded systems based on the Jetson TX1 and TX2, PC GPUs such as the GTX 1080, and dedicated AI platforms like the DGX-1 and Drive PX 2.

In addition to the development of easy-to-use frameworks, the widespread availability of tutorials and online courses has contributed to deep learning accessibility. C++ wrappers, including Google's TensorFlow and the open source packages Caffe, Torch, and Theano, enable users to quickly build and train their own DNNs. The general-purpose TensorFlow is a great starting point, and Caffe's GPU optimization makes it an excellent choice for deployment on the TX1 and TX2. The Cuda Deep Neural Network (cuDNN) library provides developers with highly optimized implementations of common deep learning functions, further streamlining development for these platforms.

Although the development of autonomous vehicles attracts a lot of media attention, deep learning has many other traffic applications. Deep learning is used to solve problems on smaller-scale systems, like detecting pedestrians and emergency vehicles for traffic signal control, parking management, high-occupancy vehicle lane enforcement, and high-accuracy vehicle and license plate recognition. It is also applied on larger-scale systems to solve problems such as the optimization of traffic flow across cities.

Continuous training of deep learning systems enables them to respond to changing conditions. HERE is working to deploy its deep-learning-powered mapping system in autonomous vehicles. This technology will generate continuously updated maps with a resolution of 10-20cm. Using deep learning, the maps will include the precise locations of fixed objects like signage, and temporary driving hazards such as construction work.

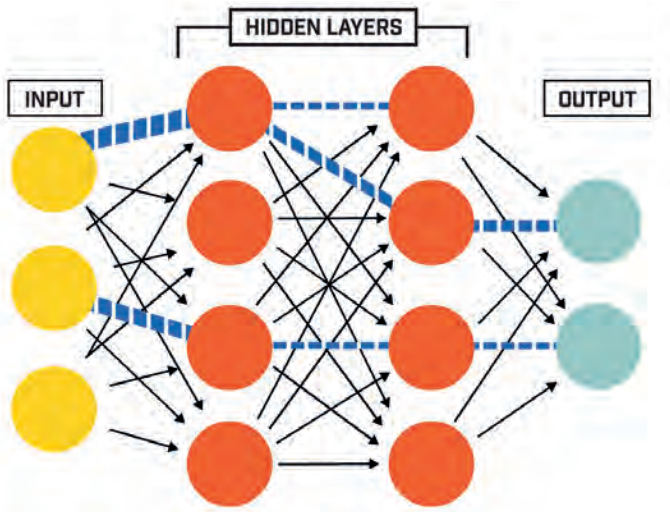
Shorter lead times

The availability of discrete, off-the-shelf cameras and embedded platforms gives traffic system designers the

Need to know

The power behind deep learning networks

- Nvidia's Drive PX2 has the equivalent computing power of 150 MacBook Pros and supports autonomous vehicle applications of deep learning
- Global shutter sensors on FLIR cameras can read all pixels of moving vehicles simultaneously in day or night-time lighting



Above: **Deep learning paths are based on how the human brain functions**
Left: **Nvidia's open AI platform Drive PX 2 is equipped with two GPUs**
Right: **FLIR cameras have 72dB of dynamic range**

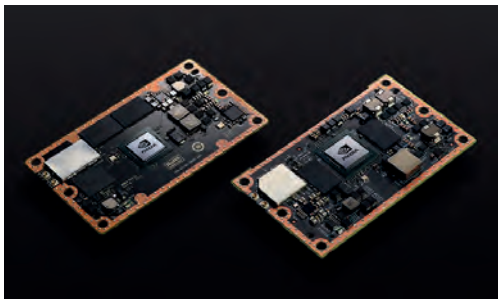
flexibility to tailor systems to fit their projects. Separate cameras and processing hardware enable a simple, independent upgrade path for each component. This ecosystem results in better prices and shorter lead times versus dedicated smart cameras.

Deep learning training

Designers must train a deep learning model before deploying it. High-quality training data is essential to achieving accurate results. High-performance cameras provide the best-possible training imagery for systems to make decisions based on visual input.

On-camera image processing simplifies the data normalization required prior to training. Camera features such as precise control over auto-algorithms, sharpening, pixel format conversion, lens shading correction, and FLIR cameras' advanced debayering and color correction matrix optimize images. FLIR has strict quality control during manufacturing which minimizes variation in performance, reducing the need for pre-training normalization.

For applications that image moving vehicles, global shutter sensors read all pixels simultaneously, eliminating distortion caused by the subject moving during the readout process. Many FLIR machine vision cameras use Sony Pregius global shutter CMOS sensors.



Left: **Nvidia's Jetson TX1 and TX2 provide significant amounts of processing power**

They have 72dB of dynamic range and less than 3e- read noise, enabling them to simultaneously capture details in brightly lit and shaded areas, and providing excellent low-light performance.

Low-light applications, such as indoor parking management, benefit from the pixel structure of back-side-illuminated Sony Exmor R and Starvis sensors. These devices trade readout speed for greater quantum efficiency, making them small, inexpensive sensors with great low-light performance.

Once enough training data has been collected, it's time to train your model. To expedite this process, it is possible to use a PC with one or more GPUs or AI training hardware like the DGX-1.

Deploying the system

Many traffic applications rely on systems with more than one camera. With FLIR machine vision cameras, system designers can accurately trigger multiple cameras over general purpose input/output (GPIO) or software.

The IEEE 1588 Precision Time Protocol enables camera clock synchronization to a common time base or a GPS time signal with no user oversight. The mean time between failures of multi-camera systems decreases with every additional camera, making highly reliable cameras critical to building robust systems.

Compact and powerful GPU-accelerated embedded platforms, like the Jetson TX1 and TX2, support USB 3.1 Gen 1 and GigE Vision cameras. Specialized Jetson carrier boards provide input/output connectivity and application-specific features.

The SmartCow TERA+ supports eight GigE cameras natively, and up to 16 with the use of a managed switch. SmartCow also provides a Caffe wrapper, which streamlines the design and deployment of deep learning-powered vision applications on the TERA+ hardware.

The Connect Tech Cogswell Carrier supports both USB 3.1 Gen 1 and Power over Ethernet GigE cameras. The Nvidia Drive PX 2 is an open automotive AI platform for autonomous vehicle guidance built around two Pascal GPU cores. Capable of eight TFLOPS, the Drive PX 2 has the equivalent computing power of 150 MacBook Pros. In addition to USB 3.1 Gen 1 and GigE vision cameras, it has inputs for cameras using the automotive GMSL camera interface.

The future of electronic toll collection systems

The latest deployments of MEP have been in Peru

The requirements of the collection systems in the tolling industry continue to evolve. While concessionaires demand transaction effectiveness, users look for convenience. Nevertheless, they have two goals in common: to avoid queues at toll stations and to manage electronic payments. Tecsidel has the most complete solution for both sides – MEP (Medio Electrónico de Pago)

This distinctive system allows management of all electronic payment devices, linked to users' accounts.

MEP is a 100% online, back-office platform solution, which acts as an intermediary between final customers (individuals or companies) and vehicular infrastructure operators such as highways, car lots, gas stations and municipalities for managing access control.

The payment is electronic, made by tag or other electronic standard payment method, which means time can be saved during the journey, as well as enabling a comfortable and secure transaction due to the user not needing to bring cash.

Three steps

The process has three simple steps. First, the operator creates an account in the database to register the user's data. Through this operation, the system links the customer data to the vehicle and the tag or other electronic device that will be used during journeys. The user then recharges the balance as necessary. The same electronic device and account can be used by all integrated concessionaires. Finally, the operator registers transactions, updates balances and generates all usage invoices.

The platform is very intuitive and allows the user to check the account and recharge by only entering the tag or registration number. Furthermore, the system is multi-vehicle; the user can register more than one vehicle, used for personal or business purposes.

MEP has access to multiple payment platforms and the user accounts can be prepaid, where the customer updates the balance and can recharge on the website, by automatic charge, or post-paid, where the system periodically generates all users invoices.

This comprehensive solution means a win-win for final users and the concessionaires, because as well as the advantages mentioned before, the system creates several reports that enable them to control the complete financial status.

In addition, the secure file transfer protocol is implemented between operators and MEP, and all transactions are sent in batches once they are validated.

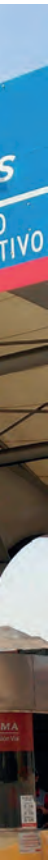
Real-world deployment

The latest implementations of MEP – Easyway and E-pass – are operating in Peru. In both

Need to know

The benefits of MEP

- The back office platform is 100% online
- It is compatible with all the main browsers
- Payment is electronic via an electronic standard payment system, so it is cashless
- Audit-friendly operations
- Prepaid payment is possible



cases, the system's functions are focused on account management, tags, transactions and transfers, financial and shift management, and operating over the country.

The most important technical features of MEP are: visual user interface, 100% online and intuitive; compatible with the main browsers; high standard of security; audit-friendly operations; and generation of low network traffic.

This solution also enables the operator to deliver important announcements and notifications to customers by conventional mail, email and SMS.

The MEP system architecture consists of the following functional modules:

- Back office, online module: this makes all the service configurations, billing, transactions revision, and other functions;
- Customer area: subset of customer relationship management (CRM) functions executed by the final customer;
- MEP manager service: this performs all periodic systematic tasks of the platform such as sending and receiving lists and batches, automatic billing and communication with CRM modules.

The integration with enterprise resource planning, credit operators and a range of back-office applications makes the MEP system a comprehensive and interoperable solution that can be employed throughout an entire country.

by **Neil Hoose**

V2X will never become an everyday reality without early customer benefits

"C-ITS cannot be achieved without a supply chain of data and communications"

Current EU guidelines on cooperative, connected and automated mobility (C-ITS) draw heavily on a broad-ranging study on the topic; available from tinyurl.com/euc-its. The strategy proposes a number of day-one services under the broad headings of hazardous location notifications and signage applications. The former offer more timely and reliable warnings direct to the driver in the vehicle, while the latter could greatly reduce the amount of physical signage and considerably improve data, leading to network and intersection efficiency.

Virtually all these services exist in some form at the moment without digital communication between the network and the vehicle. Automated, autonomous vehicles are reported to be capable of many of these functions, based on existing arrangements. C-ITS offers a different way of achieving these services that may be more effective, although the evidence is not without ambiguity, and from an engineering perspective is much more logical as it reduces the reliance on onboard sensors and their maintenance.

Cooperative systems are complex to implement. They are not technically that complex in relative terms as most of the elements are quite mature. However, organizationally they are a major challenge, not least because of a big difference in objectives and maturity between vehicle suppliers and network operators. Unless all parties in the supply chain are capable of the minimum level of service, then the outcome can't be assured. C-ITS can't be achieved without a supply chain of data and communications. Operating safety-related services from multiple parties requires continual testing and auditing of technology and processes.

Unless cooperative services are delivered in such a way as to enhance the service over and above existing services, why would anyone pay for the additional complexity? Replicating existing services in the vehicle won't be adequate but there is a temptation to do so on the grounds that it provides a baseline. In my view, to follow that course is a wasted opportunity. If we are to get traction with C-ITS there needs to be a customer-based service design that looks for simple enhancements to give the customer some added value. No one would be impressed by just getting a text message or graphic displayed on their dashboard, particularly in the early years when roadside and in-vehicle will have to coexist.

As I discussed in my article in the last issue, the difference between individual benefit and societal benefit is important. At a time when the political movement is toward decentralization and deregulation, how much of the deployment is dependent on political will rather than commercial opportunity? The EU work is important because it ranges across all the deployment issues, both soft and hard, but there is a risk that it is seen as too centralist in approach. Within its own pages it admits that there are still areas of disagreement between vehicle manufacturers, network operators and information service providers, notably in the area of data management. Demonstration projects will offer some insights but, as with many existing ITS that are part of business as usual, the gap to deployment is much bigger than we envisaged and we need to consider these problems now.

Neil Hoose is an independent ITS consultant and owner/director of Bittern Consulting Limited ***info@bittern-its.com***

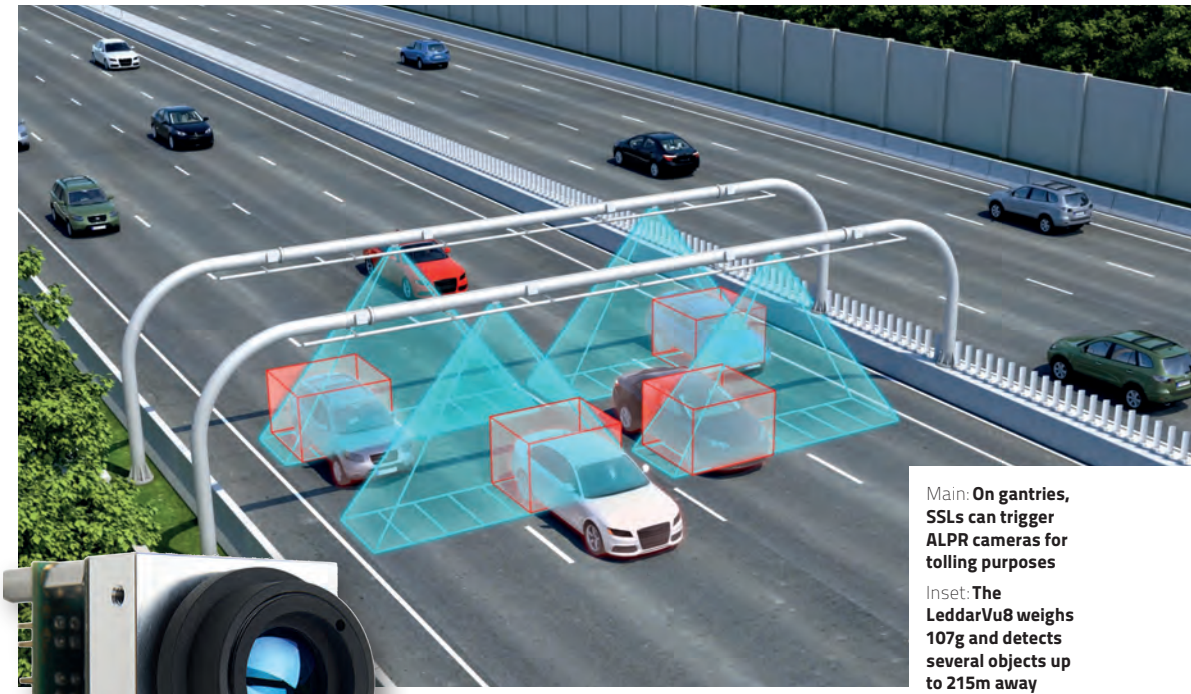
Deploying solid-state lidar technology in ITS applications

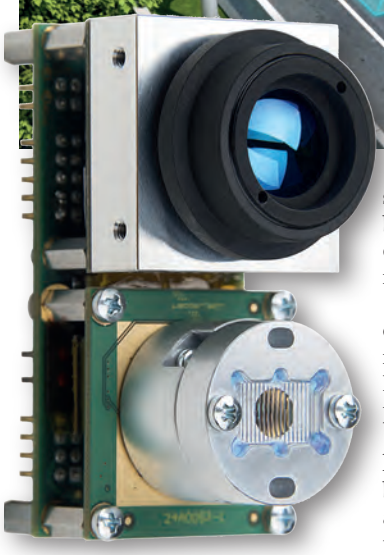
There is a new kid on the block in detection and ranging technologies, and it is coming to an ITS application near you.

Lidar (an acronym for light detection and ranging) sensing technologies are evolving rapidly, seeking to meet the requirements of various fast-growing markets, from traffic management to autonomous driving.

Lidar sensors use the time of flight of light pulses to precisely calculate the position of a remote object, enabling multi-object detection, measurement and profiling, plus speed and ranging information. While providing superior precision and reliability, deployments of the versatile lidar have typically been limited to very specific ITS applications due to their high cost, among other things.

But that is set to change, thanks to the availability of new solid-state lidar (SSL) solutions. Able to provide key lidar functionalities, SSLs open up new possibilities for the optimization and automation of traffic and tolling applications.





Main: **On gantries, SSLs can trigger ALPR cameras for tolling purposes**

Inset: **The LeddarVu8 weighs 107g and detects several objects up to 215m away**

Two approaches

There are two main approaches to lidar design that coexist on the market today: mechanical scanning and flash.

Mechanical scanning lidars use powerful optics and a mechanical system that swivels the light beam or spins the whole sensor to collect data over a wide area.

To deliver vertical resolution, these mechanical scanners stack multiple source/receiver combinations on top of one another. While mechanical scanning lidars deliver good performance, they also face many issues, including cost, size and reliability.

On the other hand, flash lidars project a fixed, diffuse light beam to illuminate a wide area (like a camera flash) and use a receiver array to separate the return signal into various segments to provide resolution and lateral discrimination of objects in the field-of-view. They are much simpler and cheaper to build, by leveraging affordable optical components and eliminating the mechanical elements.

However, the return signal of diffuse light sources is of much lower intensity, which limits their range and overall performance.

For this reason, using lidars has often implied a compromise between overall solution costs and performance. However, the new generation of high-performance SSLs is able to deliver increased performance and resolution at a much lower cost than scanning lidars, while providing more reliability due to a design with no moving parts.

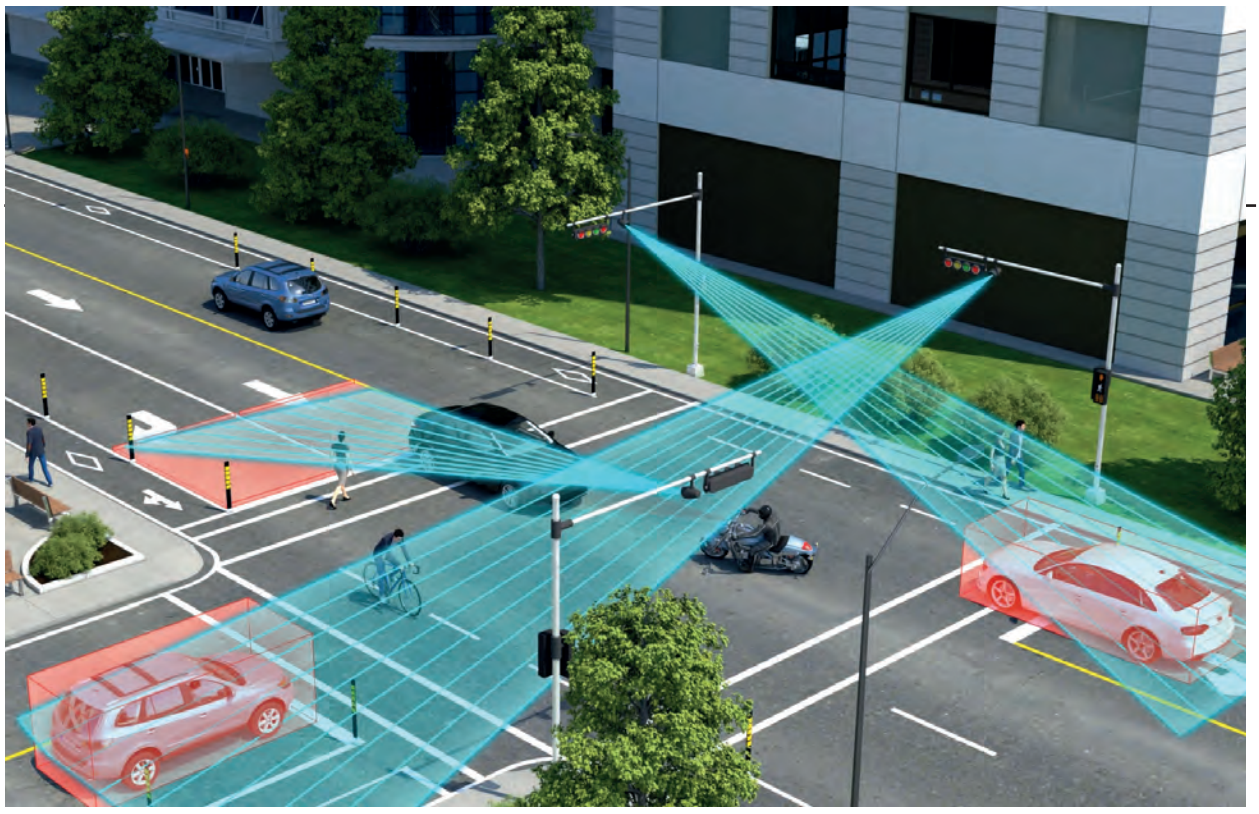
Affordable performance

The SSL technology, developed by LeddarTech, uses patented signal processing that is able to work well with lower signal intensities, delivering superior detection, target discrimination and range.

Leddar's technology enables the production of reliable, cost-effective SSLs that rival the performance of mechanical laser scanners and makes possible the deployment of optical sensors on a large scale in ITS applications.

Providing advanced detection and measurement capabilities, Leddar SSLs can be deployed as standalone units or in combination with cameras, radars, induction loops and other types of sensor to provide complementary information or redundancy.

Leddar SSLs are particularly adapted to long-range and large-area detection applications. Offering narrow and wide fields of view and independent detection segments, Leddar sensors are able to monitor specific areas such as sidewalks, cycle paths and specific traffic



Left: **Solid-state lidar can monitor and regulate traffic more efficiently than induction loop sensors**

lanes. Their measurement rates ensure accurate multi-vehicle tracking and measurement, even at high speeds.

All-weather performance

Leddar delivers consistent all-weather, 24/7 performance, thanks to a superior ability to filter out unwanted noise for efficient detection in challenging outdoor conditions including rain, snow and fog. These SSLs are also unaffected by lighting conditions, vibrations and temperature extremes, which are frequently encountered in ITS installations.

The deployment of lidars in strategic locations contributes to generating valuable real-time information and statistical data for traffic monitoring and management systems, such as vehicle count, speed and profiling. Leddar sensors are also able to detect vehicles entering a one-way street in the wrong direction.

The sensors can be mounted on existing road infrastructure with very few positioning constraints required.

Another benefit of using SSLs for monitoring purposes is that they capture data, not images, which eliminates potential privacy and legal concerns.

Leddar-based traffic management systems provide advanced vehicle detection. Installed above ground, such as on traffic light posts, they efficiently replace induction loop sensors and greatly reduce system maintenance complexity.

With excellent lateral positioning and object discrimination in its field-of-view, the sensor compiles measurements hundreds of times a second to accurately locate vehicles of all sizes, including bicycles and motorcycles, as well as pedestrians in the locality.

High sampling rates

Leddar SSLs can be used to profile vehicles of all shapes and forms, thanks to the sensors' ability to measure several segments with high sampling rates in a given field-of-view.

This provides the capability to estimate the dimensions and shape of moving vehicles for classification purposes.

These capabilities also make the technology attractive for applications such as gated access control systems; clearance warning solutions for overpasses, tunnels and parking barriers; or public transit priority systems.

As part of an automated tolling system, Leddar sensors positioned on gantries, above streets and highways, detect each incoming vehicle in every lane, triggering an automatic license plate recognition camera (ALPR). More sophisticated SSL-based all-electronic tolling systems can also provide vehicle profiling and measurement capabilities.

LeddarTech SSLs provide ranging capabilities for multiple targets, simultaneously measuring the speed of several vehicles within a wide detection area. They can be combined with ALPRs to be used in two-point average-speed measurement systems.

They can also be used in traffic calming systems by providing actual speed information to drivers.

Need to know

Solid-state lidar is ideal for ITS applications because...

- Performance is consistent in all weather and lighting conditions
- It captures data, not images – avoiding privacy concerns
- It can accurately locate and profile all shapes and types of vehicle, as well as detect pedestrians and bicycles

Regulating high-occupancy-vehicle lane tolling safely and effectively

High-occupancy vehicle (HOV) lanes have been deployed in countries around the world for the exclusive use of vehicles carrying more than one person. They can also be run as high-occupancy toll (HOT) lanes, where lower-occupancy vehicles pay a toll to use them. HOV enforcement is, traditionally, carried out visually by roadside police patrols. This is labor-intensive and expensive, and violation detection rates vary depending on the concentration levels of the officers involved.

With increasing numbers of HOV and HOT lanes being planned, and multiple entry and exit points, the need for reliable, cost-effective automated occupancy detection has never been greater.

High-quality images of the complete vehicle passenger compartment are required. Processing software must be able to accurately identify and report the number of human occupants. Linking in a license plate system allows automatic transmission of HOV violation details to enforcement officers.

Need to know

Issues to consider when regulating HOV lane tolling

- Vehicle glass absorbs infrared light heavily at 850nm wavelength
- Light at 730nm wavelength is visible but not blinding – and not absorbed by filters
- Gardasoft traffic-specific LEDs can be optimized for appropriate light intensity

Imaging the passenger compartment will in general require two camera and illumination systems, one through the windscreen and one from the side. This places huge demands on the illumination technology since the vehicle could be moving at speeds up to and in excess of 100mph.

Lighting challenges

Key factors that need to be considered are: exactly how much light is needed?; can the light be directed accurately to enable image capture?; and which wavelength is the most appropriate?

For occupancy detection, the choice of wavelength is very important. Many vehicles have dark-tinted glass in the rear passenger compartment, meaning that external illumination will be essential.

Projecting strobe lighting operating in the visible spectrum into a passenger compartment would be dangerous. Infrared light is used instead, but most vehicle glass, especially windscreens, contains filters to reduce solar heating in the vehicle and this absorbs heavily at the 850nm wavelength used in many ITS applications.

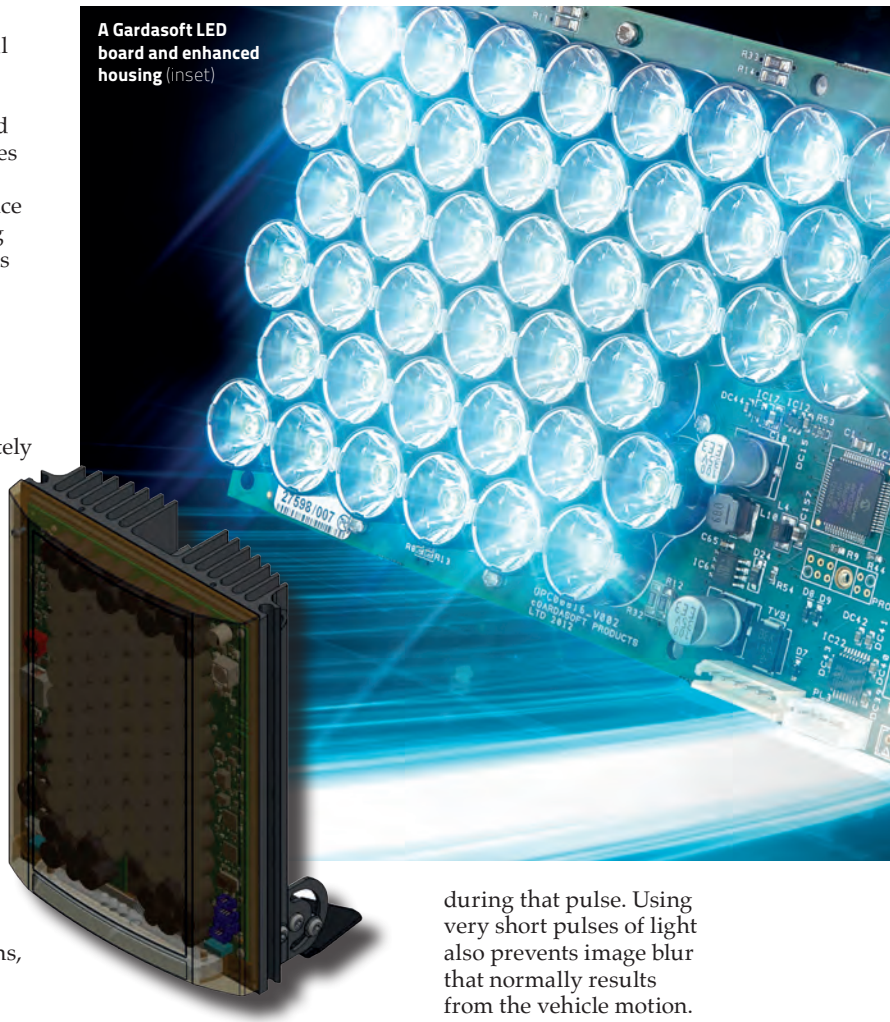
The solution is to use light at 730nm, which is visible but not blinding, and will not be absorbed by these filters.

Not blinded by the light

To ensure the light is directed into the passenger compartment, care must be taken to choose an LED system that optimizes light output across the imaging area of interest, taking into account whether it is mounted at the roadside or on an overhead gantry.

Pulsing or strobing the light using an LED controller brings considerable benefits for intelligent traffic systems. It means the camera exposure and light can be synchronized, and also allows for control of the light intensity to meet the application.

Driving an LED at greater than its maximum current (overdriving) during a short pulse allows very much higher brightness to be obtained during that pulse. Using very short pulses of light also prevents image blur that normally results from the vehicle motion.

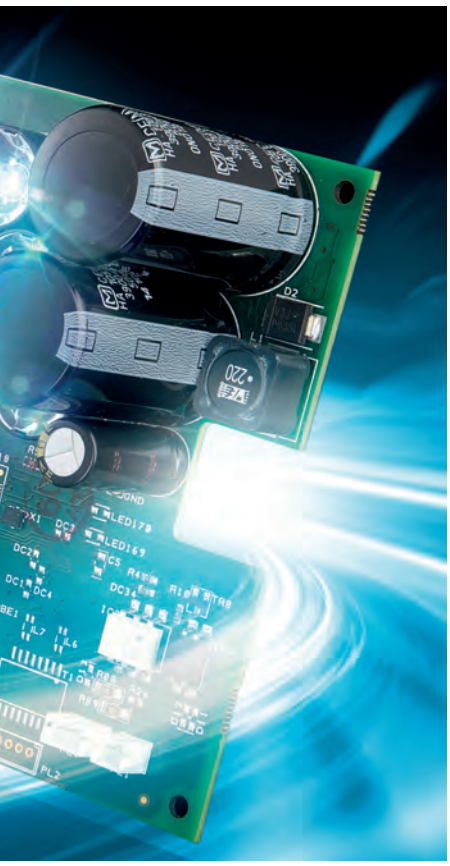


A Gardasoft LED board and enhanced housing (inset)

LED specialist

Gardasoft's range of traffic-specific strobe LED systems with built-in LED controllers are often used in higher-end ITS applications. The VTS series of lights, due for release in 2017, include versions with 730nm output and redesigned housings complete with heat sink.

With lens/diffusers precisely matching the chosen wavelength and various beam angles, light intensity can be optimized across the specific field of view.



Fully integrated internal timing, intensity control, trigger input and long-distance communications provide the flexibility for various trigger arrangements between the camera, light and any external sensors. In this way, the same timing, power and brightness can be obtained for every image, whatever the vehicle speed, which is critical for reliable occupancy measurement.

by **Don Hunt**

There are many benefits in incorporating Uber into public transit provision

Much is being discussed about the opportunities and challenges of connected and automated vehicles. The benefits in private vehicles and the even greater potential of automated on-demand ride sharing are increasingly recognized. However, the effect on public transit systems has been less investigated and could be one of the real mobility game-changers.

Despite some hype about growing transit ridership in the USA, the data is quite disappointing. Statistics show that 2016 transit ridership dropped in absolute terms in every metro area except six: Seattle, Houston, Milwaukee, Detroit, New York and San Francisco. Certainly, relatively low fuel prices are encouraging private driving. But public transit suffers from several limitations that will be even more problematic in the future.

Public transit runs on a fixed route and schedule system. Emerging tech-enabled ride sharing is on-demand, point-to-point. Although on-demand ride sharing is not best for every trip, it overcomes two of the big limitations of transit – fixed routes and fixed schedule. The limitations of fixed transit were highlighted in a recent study of travel times.

On average, US transit riders spend about twice as long getting to work as those who drive – about 22 minutes longer than private car commuters. These longer commute times are related to transit wait times, but also related to first- and last-mile access challenges. To encourage ridership, transit agencies need to get more serious about travel-time efficiency. And cooperating with ride sharing to overcome the first- and last-mile time penalty could be a large part of the fix.

Another challenge for transit riders is payment systems. Although many transit agencies are moving to smart card, electronic payment technologies, most agencies are behind the technology curve in providing mobile payment options. This becomes even more important when transit agencies recognize ride-sharing companies as a partner in overcoming first- and last-mile access challenges, helping to build transit efficiency and ridership.

A number of agencies are rolling out electronic payment options or partnering with ride-sharing companies for transit access. But no agency as yet has fully integrated mobile payments with both public transit and companies such as Uber and Lyft.

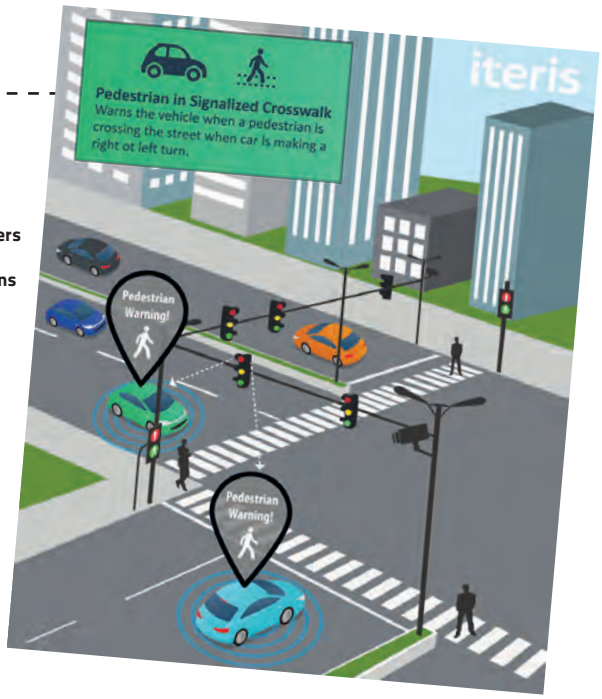
> "There's potential to cut demand-response service costs by 50%"

Finally, transit agencies have an obligation to provide demand response services for persons with limited mobility. The cost of providing these on-call services is significant. Brookings recently estimated that demand-response services make up 12% of the total cost for all transit services while carrying about 2% of all trips. This situation gives transit agencies ample incentive to look to ride-sharing companies as a new way to provide demand response services. The potential to reduce demand-response service costs by 50% or more through ride sharing services is within reach.

By embracing ride sharing options, transit agencies will begin to reinvent bus services. Ride sharing is at the base of the learning curve, as first ride sharing enhances transit, and then automation allows for complete reinvention of rubber-tire transit itself. As US transit agencies continue to be burdened by capital debt that strains the operating budget, agencies would do well to rapidly embrace new technologies to increase ridership and reduce trip costs.

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

Increasing protection for vulnerable road users



Iteris is working on smart signals to warn drivers of nearby pedestrians

Road fatalities among vulnerable road users (VRUs) – pedestrians, bicyclists and motorcyclists – are intolerably high. This is emphasized in the *Global status report on road safety 2015* by the World Health Organization (WHO), which reported that 49% of the 1.25 million people killed each year on the world's roads are VRUs and urged more of a focus on safety.

The Vision Zero Network, a collaborative campaign aimed at advancing a shift toward safety for all, released its *Moving from vision to action* document in February 2017. It calls for efforts to prioritize data collection and use, to manage speeds, and to maximize technology advances. Regarding that latter point, the document states, "Autonomous and connected vehicles offer promising tools to reduce the role of human error in crashes. However, many questions remain about how they will interact with people, walking and cycling."

Similar concerns are being raised across the globe. At the California Polytechnic State University in San Luis Obispo, a Bicyclists' Manifesto for an Autonomous Vehicle Future has been developed by Dr Michael Boswell and Dr Billy Riggs. It calls for autonomous vehicles to be able to detect cyclists and detect and understand their hand signals. From Melbourne, Australia, the Amy Gillett Foundation's *Driverless vehicles and road safety* document calls for a clear message to driverless vehicle technology proponents that the safety of people outside the equipped vehicle needs to be at a level of priority equivalent to that of the occupants, and that the onus should be on driverless vehicle proponents to identify features to avoid crashes with bicycles and other VRUs. The European Cyclists' Federation document, *Advanced vehicle technologies, autonomous vehicles and cycling*, looked at the status of connected and autonomous vehicle technologies and their possible effects on cycling. It calls for VRU detection to be programmed into the vehicles, and raises concerns with forcing VRUs to be equipped with detection devices.

For pedestrian detection by connected and autonomous vehicles, Iteris is working with the University of Michigan Mobility Transformation Center to test camera-based, smart sensor, pedestrian detection capabilities. Embedded within the Iteris video detection algorithms is a new feature, called PedTrax, that provides pedestrian tracking measurements that do not require any additional equipment for operation. PedTrax will interface with Cobalt advanced transportation controllers from Econolite, which will indicate the presence of a pedestrian at the intersection in the signal phasing and timing (SPaT) data sent to the local road-side unit, and then on to connected vehicles.

Iteris is also exploring alternative methods for setting speed limits that consider all known road users, consistent with Vision Zero efforts for prioritized data collection and use, speed management to address safety of all road users, and maximizing technology advances. The Vision Zero Network document observed that, "In a complicated, multimodal environment, the time is long overdue to change outdated and detrimental policies of some of the most established traffic engineering practices, such as setting speed limits at the 85th percentile of car movements." Any such change would need to be data driven. With all of the existing infrastructure in place today at signalized intersections, there is plenty of capability available from multiple vendors to provide data on roadway mode shares of vehicles, bicycles and pedestrians to inform the setting of speed limits that consider all users.

The WHO report on road safety concluded that changes are needed to account for the mix and safety of all road users. The Vision Zero Network details needed changes to prioritize data collection and use, to manage speeds to safe levels, and to maximize technology advances. The use of technology interventions to communicate the presence of vehicles and VRUs to each other, and to help manage speeds, will reduce both the likelihood and the severity of crashes. Making our roads safer will not be possible unless the needs of these road users are addressed, and there is technology available today that can offer an important approach to VRU road safety.

Need to know

The need to increase protection for VRUs

- 49% of the 1.25 million people killed on roads worldwide annually are VRUs
- Concerns have been raised about forcing pedestrians to be fitted with detection devices
- Embedded video detection algorithms are able to identify and track VRUs and relay the data to connected vehicles

Automated identification of anomalous tires

International Road Dynamics (IRD) has introduced a technology designed to carry out the automated screening of commercial vehicles with tire anomalies. IRD's tire anomaly and classification system (TACS), powered by the VectorSense Tire Sensor Suite, collects information about tire characteristics independent of the vehicle speed. The information collected by TACS is transformed into two useful data points: presence of a tire anomaly and the type of tire on each axle – single, dual or wide-base single.

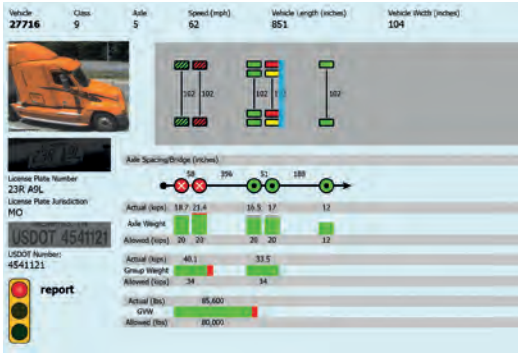
Risk factors

Enforcement agencies view tire violations as a considerable safety risk, and they play a role in many road accidents involving commercial vehicles. According to the most recent *Large truck and bus crash facts,* published by the Federal Motor Carrier Safety Administration, tires were a factor in 19% of fatal crashes where a vehicle-related factor was identified.

Identifying anomalous tires on vehicles that would otherwise not have been due for inspection could put vehicles that pose a safety risk out of service before they can cause an accident.

A tire on a vehicle could be identified as being anomalous for one or more reasons: being under-inflated, being over-inflated, being missing (for dual tire groups), or having a load imbalance.

If a vehicle has a tire that is identified as being anomalous, this information is passed to existing weigh station enforcement systems to flag and/or direct the vehicle for a detailed inspection. TACS provides enforcement personnel with a visual view of a vehicle's data in order for them to easily identify which tire is anomalous.



Above: **IRD's VectorSense sensor suite provides tire anomaly and classification data to TACS**

Left: **TACS identifies tire anomalies, axle configuration and tire configuration**

Information about the type of tire on an axle can be provided as part of the vehicle classification process, in order to refine compliance decisions that are made about each vehicle. This allows enforcement personnel to select vehicles that may be compliant with vehicle weight requirements, but are using unauthorized tire configurations.

In addition to augmenting commercial vehicle enforcement applications, a similar system to TACS can be used to identify any tire anomalies that exist on a vehicle entering a maintenance or loading center. This allows fleet operators/managers to schedule tire maintenance while a truck tractor or trailer is stopped at a depot. Scheduling tire maintenance for a vehicle when it is not otherwise in service on the highway can help fleet operators/managers improve fuel economy, extend tire life, and reduce the probability of a vehicle in transit being placed out of service for having non-compliant tires. Equally important, it reduces the time spent on checking tire status, increasing the efficiency of vehicle and tire safety checks.

Cloud-based intelligence

TACS fully integrates with IRD's 'Vehicle Information in Motion' (VI²M) service, a cloud-based traffic data repository and transportation intelligence analytic system. VI²M extends the usefulness of the tire characteristic information collected by TACS to support the analysis of all data being collected to determine trends in tire health and the effectiveness of targeted tire safety programs.

In addition, the availability of such data for statistical analysis is of great benefit to transportation agencies as yet another set of data points assisting them in their infrastructure asset management and roadway planning activities. Precise, long-term data on vehicle lane position and lane loading profiles, supplemented by individual tire anomaly information as presented through VI²M, may be used to predict pavement wear patterns and thus improve maintenance prediction to reduce roadway damage.

Need to know

IRD's tire anomaly and classification system serves a number of purposes...

- It provides an immediate safety benefit by providing real-time tire anomaly detection to enforcement personnel
- It improves freight logistics efficiency by reducing the risk of tire failure while expediting truck tire maintenance activities
- By integrating with VI²M, the system could be used to predict pavement wear patterns as well as reduce roadway damage

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Improving productivity in the control room

The control room plays a critical role in a number of industries, from power generation and air traffic control, to broadcast and transportation.

This is also true of the traffic management sector, where critical decisions are made that have tremendous effects on overall operations, as well as commuters and road users.

The basic premise of a control room remains the same regardless of industry – information from various sources comes into the control room and is then received and analyzed by the right people, at the right time, in order to make those mission-critical decisions.

While operators are the key to success in the control room, they are supported and enabled by a number of factors, including the technology, layout and design of the working space.

Multiple elements work together to create the optimum environment in terms of comfort and ergonomic operation, therefore assisting effectiveness and efficiency. It is this user-centric design that is vital in bringing together elements such as lighting, access, user interface and desk layout for the benefit of the operator and their role within the control room.

Adder's CCS-PRO8, IP-based KVM switching hardware

Knock-on effects

Looking at technology specifically, there is a range of equipment and devices that ensure the control room's success. IP-based, keyboard, video, mouse (KVM) technology, for example, enables other technologies in the room and improves user ergonomics, therefore driving productivity, efficiency and user experience.

So just what is KVM? And what role does it play within the control room?

KVM, particularly IP-based KVM, brings instant computer switching and pixel-perfect video and USB extension capabilities to the control room. The benefits include streamlined operations, a more comfortable working environment and operational flexibility. All of these are crucial in a high-pressure environment where space is at a premium and critical decisions need to be made, often under time constraints.

Using KVM, all computers can be removed from the control room, freeing up space in the user environment by locating them elsewhere.

Not only does this remove the heat and noise generated by these machines, it also heightens performance of the machines and can improve lifespans. Computers are typically rack mounted in a centralized server room that is access controlled for better security, and temperature controlled. As a result, users are more comfortable and still have an 'at the computer' experience with pixel-perfect resolutions, zero latency and absolute USB control.

Ease of operation

With KVM switching technology, any one operator can control any number of machines from a single workstation, using just a single keyboard or mouse.

This has benefits for supervisory functions, training, streamlining shift handovers and preparing presets to defined situations.

Downtime is also reduced as, if one machine fails, an operator can simply log into another machine without moving desks. Also, with trends like hot-desking, switching has particular advantages as operators can log in from any workstation and access their personalized user interface and perform as they need to.

Resilience is another key advantage with IP-based KVM because setups can mitigate against network, hardware and power failure, ensuring 24/7, 365-day operations.

One of the newest and brightest KVM switching technologies on the market is the Adder CCS-PRO8, which allows operators to control up to eight machines across eight displays by simply moving the mouse across screen borders.

It is ideal for improving user ergonomics in a control setting where physical space is limited or management of multiple computers from one station is needed. This drastically reduces the chances of operator error in a critical control room situation.

Efficient control rooms allow operators to analyze data from a number of sources quickly so that they can make accurate mission-critical decisions.

While all elements of the control room work together in creating the most productive space, it is supporting technologies such as IP-based KVM that are adding value and workflow management to control room applications, helping to improve the comfort of operators, user experience, and operational flexibility.

Need to know

The key points of KVM switching technology

- Enables other control room technologies and improves user ergonomics
- Streamlined operations, more comfortable working environment and operational flexibility are some of the main benefits
- All computers can be removed from the control room – freeing up space and reducing unwanted heat and noise

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ITS cameras: resolution versus sensitivity

When it comes to choosing digital cameras for intelligent transportation systems (ITS) and applications such as tolling and speed enforcement, resolution is an important factor. Thanks to increases in camera pixels, clearer, higher-resolution images can be produced. In ITS applications, more pixels enable more traffic lanes to be covered with a single camera, reducing overall system costs. However, more pixels do come at a cost of sensitivity.

When pixel density increases over the area of the sensor, the size of each pixel must be decreased. This in turn reduces the overall sensitivity of the camera and minimizes its performance in low levels of light, impacting the accuracy of images captured at night. However, by increasing the size of the sensor, pixel density can be increased without the camera losing its sensitivity.

Sensor formats

Two cameras with similar resolutions but with different sensor sizes can vary greatly in low light performance and sensitivity. An example of this is comparing a cell phone camera to a digital single-lens reflex (DSLR) camera. They both produce images of similar resolution, but the DSLR will perform better in low light conditions because of its larger sensor.

Camera comparison

The image above shows the results of an experiment illustrating the impacts of resolution and sensitivity. Cars traveling on a highway with a speed limit of 100km/h (62mph) were imaged using two of Lumenera's full frame cameras: the Lumenera Lt16059H and Lt29059 with 16 and 29 megapixels, respectively. The license plates are enlarged to show their resolution at various distances from the cameras.

Above: **The results of an experiment illustrating the impacts of resolution and sensitivity**

Throughout the experiment, the cameras were placed in the same location and used the same lens. (Note: the license plates are blurred for privacy purposes).

The dashed blue lines provide a reference point to demonstrate the distance of the cars to the camera. In the case of the Lt16059H, the license plate of the closest vehicle (a white car with the license plate number AL***10) measures 100 pixels across. At this resolution, a critical point for many automated license plate recognition (ALPR) systems, the Lt16059H captures five full lanes because of its large sensor width of nearly 4900 pixels across. The fourth license plate in the Lt16059H image (BC***69) is still readable by the human eye. At this point in the frame, there is an equivalent of nearly double the lanes of traffic visible from edge to edge of the image.

The Lt29059 increases the number of resolvable lanes of traffic with its sensor measuring 6576 pixels across. The license plate of the first car in the image (BP***66) measures 115 pixels across. At this point in the frame, the Lt29059 has been able to capture six lanes of traffic and can discern information at greater distances from the camera. For example, the license plate of the vehicle before the second dashed line (N3***HJ) is readable by the human eye. At this distance, there are roughly 1.5 times more lanes of traffic from each edge of the frame, compared with the car with the license plate number BC***69 from the Lt16059H.

Although the images appear similar in level of intensity, they were not recorded with the same settings. The gain settings were different and a digital gain was also applied to the Lt29059 in post-processing. This highlights the sensitivity difference between the cameras being used in similar lighting conditions, with identical exposure and iris settings.

These factors must be taken into consideration when selecting a suitable camera for ITS applications. For example, if an external flash is being used, in either the visible or NIR spectrum, a higher resolution will most likely become more important than sensitivity. However, if the light beam's width does not allow coverage for all the lanes of traffic, two lower resolution cameras would be a better solution.

Need to know

Sensor sizes in ITS cameras can vary...

- Common sensor formats can range from '1/3' to 'full frame' or '35mm', which have similar dimensions to that of traditional 35mm film
- When comparing both ends of this spectrum, the available area on a full frame format sensor is roughly 60 times that of a 1/3 format sensor

Express lanes

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

"We thought this would be a good opportunity to use drones to supplement terrestrial surveying. The mapping is going to be very important to IDOT"

Bill Viste, project coordinator, Illinois DOT Aeronautics

Watch a video report of IDOT's drone road-survey project on IL-251 at traffictechnologytoday.com/idotdrones

"I expect to see a rebalancing of price points on what the industry is delivering to society against the value that is brought to society. I see a strong imbalance at the moment. The prices are too low"

Cees de Wijs, chairman, ERTICO

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"RTOP [Regional Traffic Operations Program] is an active management program of all the major arterials within metro Atlanta. We make real-time adjustments to signal timings to maximize the efficiency of our network"

Andrew Heath, state traffic operations engineer, Georgia Department of Transportation

Find out how GDOT is coping with the closure of I-85 after a fire, at traffictechnologytoday.com/gdot-i85

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"Small changes to infrastructure can result in big changes to traffic flow and mobility, plus they are less costly to carry out than major projects"

Hamid Zarghampour, chief strategist, Swedish Transport Administration

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