April/May 2015

traffic
TECHNOLOGY INTERNATIONAL

Software failures...
...and how better automotive standards will eradicate them

10 driverless essentials
Autonomous safety laid bare by the world's top developers

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Safe from harm?

Using intelligent transport systems to protect pedestrians and cyclists

THE TRUTH ABOUT
ISTANBUL'S ROADS
Meet the woman battling 10,000 traffic fatalities a year

ITS

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ON ITS AMERICA
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Cut congestion by 20%
How the latest road-charging systems are using ALPR technology to keep urban centers moving

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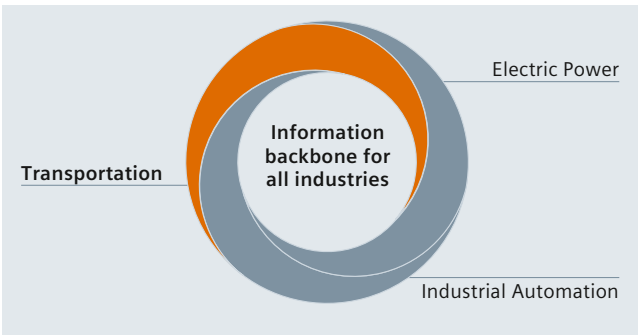

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E20001-F740-P820-X-7600

Cover story

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Extending safety systems to outside the vehicle

Max Glaskin finds out how intelligent technology can be used to protect vulnerable road users


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Technology Profiles

Editor's letter

This issue goes to press on the very same day that the UK goes to the polls to elect a new government. There has been much on the agenda over the past few weeks, from education and the health service, to taxation and the future of EU membership. But, perhaps the most talked about issue has been the economy – or more specifically, the UK's budget deficit and how we go about decreasing it. There have been many ideas and policies on the table; however, what all the political parties can be thankful for is that just last month Highways England officially came into being – a new government company that brings with it a threefold increase in capital expenditure on roads over the next five years: because without this investment, central economic planks of election manifestos would be decidedly shaky.

When I traveled to Birmingham last month to attend Traffex, the UK's largest traffic expo, Highways England CEO Graham Dalton reminded attendees that more than half of all traffic on our major roads is commercial. They are the arteries that carry the lifeblood of our economy. Without them, modern civilization as we know it would grind to a halt – literally. "We need to keep remembering that it's primarily an economic network and the country relies on it," he said. "It's a vital network and traffic on it is growing." We are fortunate indeed to have a well-laid plan for its future.

In the USA, it is earnestly hoped that a similar long-term funding plan, in the shape of the Grow America act, will be approved by Congress. No doubt it's a subject that will be on everyone's lips at this year's ITS America Annual Meeting, which falls at the end of May, just as transportation funding runs out. Don't forget to check trafficTechnologyToday.com for the latest on this story, and turn to page 56 for our interview with the USDOT's Gregory D Winfree, who talks candidly about why the funding dollars are so important.

One area that is attracting increasing levels of investment and interest all over the world is autonomous vehicle research. That's why this magazine is co-hosting the first-ever Autonomous Vehicle Test & Development Symposium in Stuttgart, Germany (June 16-18). To celebrate this, you'll find 19 pages of the latest cutting-edge research and opinion in this field, starting on page 13. Because no amount of funding can get around the fact that we're running out of space, and autonomous vehicles will clearly be a smart way to get more out of the roads we already have.

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Allied Vision

Open Roads

Lauren Dyson takes a look at recent proposals and initiatives – including a €50m investment announcement – that promise to make transportation within Europe easier, safer and more sustainable

Earlier this year, the European Commission (EC) published nine studies on the current state of play and development needs of the Trans-European Transport Network (TEN-T) core network corridors. The studies identified infrastructure development needs that represent approximately €700bn (US$813bn) of financial investment until 2030. They also highlight the importance of optimizing corridor infrastructure, notably through ITS, efficient management and clean transport systems.

"We have to step up our efforts to make sure the core network will be fully operational by 2030, to ensure smooth transport flows for passengers and goods throughout the EU," said EU transport commissioner Violeta Bulc, as the studies were released. "Now is the time to invest in TEN-T projects and to maximize the benefits of the Connecting Europe facility and the Commission's €315bn [US$366bn] Investment Plan. After all, the Trans-European Transport Network is crucial for a Union striving for more growth, jobs and competitiveness. As Europe is slowly stepping out of the economic crisis, we need a connected Union, without barriers, in order for our single market to thrive."

As a result of the studies, the EU's TEN-T Program will spend €50m (US$58.2m) in co-financing five projects that will use ITS to improve the safety, security and efficiency of European highways. The projects will also improve traffic management and cross-border communications throughout the EU, helping to reduce delays due to traffic congestion and increasing safety levels on the road network.

The five projects were selected for funding with the assistance of external experts under the TEN-T Multi-Annual Call 2013, priority 'Intelligent Transport Systems'. Implementation will be monitored by the EC's Innovation and Networks Executive Agency (INEA).

The missing link

Widening a major road in the Mediterranean corridor will improve traffic flow and driver safety

In addition to the five announced ITS projects, the EC has also agreed to contribute more than €1m (US$1.1m) to co-finance a project in the Scandinavian-Mediterranean corridor that will address a 'missing' section of motorway between Sweden and Denmark.

The 30km Ljungby-Toftanas section of the E4 is currently a bottleneck that impacts the flow of the entire road and is the site of a high number of accidents. The project will involve an environmental impact assessment, archaeological investigations, design of the road plan and preparation of parts of the tender documentation prior to starting the construction works. It will also involve completing the eastern section of the PP12 road in Sweden and the connection with continental Europe.

It is thought that widening the road to motorway standard will eliminate the current bottleneck, have a positive impact on the road safety, improve traffic services and reduce travel time for motorists using the E4. The project also includes ground-water protection and noise-reduction measures.

License to bill

Germany wants to fund improvements by charging foreigners to use its autobahns

In October 2014, the German government unveiled a controversial plan to introduce a road toll aimed specifically at foreign drivers. Under the new scheme, which is slated to begin in 2016, motorists with non-German license plates will be required to pay up to €130 (US$148) a year to use the country's autobahns. German drivers would also pay the toll, but would be compensated with a reduction in existing motor vehicle taxes. There is ongoing dispute about whether the plan complies with EU rules that prohibit discrimination against foreign motorists.

Each project will focus on a specific part of Europe: the Ursa Major project will cover roads linking the North Sea ports, the Ruhr and Rhine area, as well as metropolitan areas in southern Germany and northern Italy; the Crocodile project includes three main road corridors, Baltic-Adriatic, Rhine-Danube and Orient-East-Med; the Next-ITS project will deal with the Scandinavian-Mediterranean Corridor from Oslo and the Finnish-Russian border in the north via Copenhagen, to Bremen and Hanover in Germany; the MedTIS project will deploy ITS services in Italy, France, Spain and Portugal along the Mediterranean corridor, linking several major sea ports and connecting the Mediterranean with the Atlantic coast; and the Arc Atlantique project will link key economic nodes in the UK, Ireland, France, the Netherlands, Belgium, Spain and Portugal.

Common ground

Could a Europe-wide tolling system be in the pipeline?

EU transport commissioner Violeta Bulc believes that the numerous different tolling systems currently operating in Europe are a burden on car drivers and an obstacle to their mobility. As such, she has called for the introduction of a standardized European-wide road pricing system.

In a January 26 interview with German newspaper *Welt am Sonntag*, Bulc said that it would "make sense" to work on a European system that could regulate road charges in a uniform manner.

"The fee should be exclusively based on kilometers driven and should not be time-dependent," she said. "It doesn't matter where you come from – everyone will only pay for the distance they have driven and it will be billed on a device throughout Europe. We're currently investigating such an idea."

On January 27, Bulc tweeted, "My vision for EU tolling system would be optional for Member States. A uniform system would be fairer and more efficient for EU citizens."

Congestion costs Europe 1% of its GDP every year, or €143bn in 2014

> "The Trans-European Transport Network is crucial for a Union striving for more growth, jobs and competitiveness
>
> *Violeta Bulc, EU transport commissioner*

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- Autonomy software
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- V2V and V2X testing
- Robotics
- Testing legislation
- Safety standards and legislation
- Case studies
- Possibilities
- Best practices
- Reliability testing of software and hardware systems

For more information about the Autonomous Vehicle Test & Development Symposium 2015, **please contact Mike Robinson,** conference director: mike.robinson@ukipme.com
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Boom or burst?

The fast-growing city of **Istanbul** is the heart of culture and industry in Turkey, and with 30,000 new vehicles registered in the city each month, its roads are the second-most congested in Europe

Infographics: Ben White

The 11,231 miles of Istanbul's road network are governed by the national Ministry of Transport, Maritime Affairs and Communications

Traffic congestion in Istanbul costs the local economy

US$2.8bn

each year

The current population of Istanbul is estimated at approximately

14.3 million

(January 2015)

Istanbul's bus rapid transit (BRT) system was designed to transport

400,000

people per day, but it actually serves more than **715,000**

According to the *2014 TomTom Traffic Index*, congestion in Istanbul increased by

3%

between 2013 and 2014

Istanbul's roads are most congested on

MONDAY MORNINGS and FRIDAY EVENINGS

(2014 TomTom Travel Index)

DID YOU KNOW?

Situated on the Bosphorus waterway in northwest Turkey, Istanbul is a transcontinental city. The commercial center is in Europe, but the rest of the city is in Asia

The two bridges that cross the Bosphorus are designed to handle

210,000

vehicles per day but more than twice that number cross them

3,284,483

vehicles are currently registered in Istanbul (⅕ of all vehicles in Turkey)

During peak hours, a 30-minute free-flow trip through Istanbul will take

62 minutes

To ease traffic in the most congested areas of Istanbul, a nine-mile highway tunnel is currently being built underneath the city

250

streets in Istanbul's historic peninsula are pedestrian-only zones

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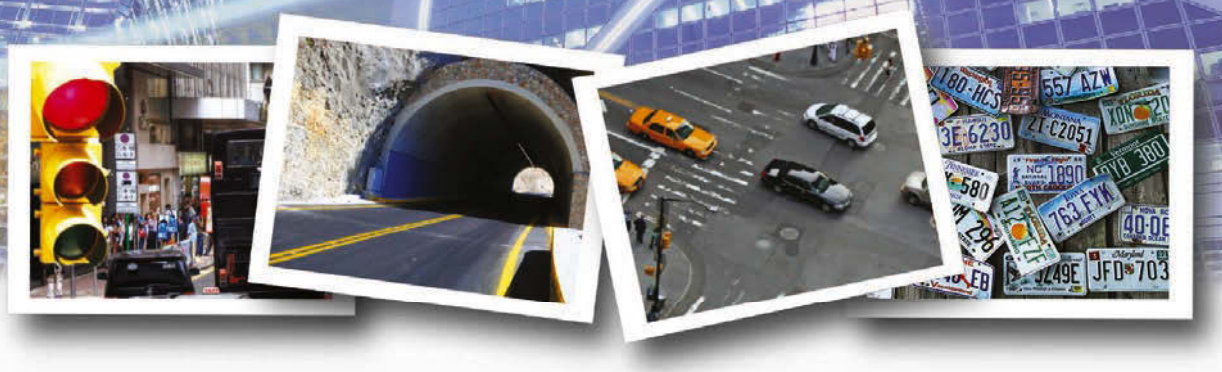

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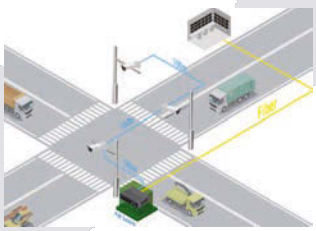
Powerful connections

Lloyd Fuller takes a look at recent developments in the field of industrial communications technology

Reliable network

Ethernet connection improves reliability

An innovative series of network cameras from Vivotek has been equipped with embedded Power over Ethernet (PoE) extenders, enabling them to be deployed in a 'chain', without having to be linked to external power supplies. The company's new IB8367-R, IB8367-RT and IB8338-HR models are ideal for diverse outdoor applications. The unique PoE extender embedded within the cameras allows for both PoE input and output and direct connection with other PoE network cameras, without an additional power source, thereby facilitating long-distance surveillance connectivity operations.



Ethernet efficiency

Optimized functionality for ITS networks

Actelis Networks has launched the first two products in its new Industrial Ethernet switching portfolio.

The Actelis ML684D can efficiently transport up to 30Mbps of reliable bandwidth over two bonded copper twisted pairs, and connects with devices such as HD cameras, sensors, and traffic, environmental, or other controllers. The bandwidth can be distributed to serve multiple locations using ERPS rings, or with a linear drop-and-continue topology. The ML684D offers multiple 10/100Mbps Ethernet interfaces, as well as two SFP ports at each node, and can also transport up to 60Mbps when deployed point-to-point using four bonded pairs. Traffic from

HD cameras, a variety of intelligent sensors, traffic controllers, wi-fi base stations, environmental control systems, and alarms can be reliably/effectively backhauled over either two or four pairs of bonded copper, or a 1G fiber uplink. The ML684D provides network connectivity over bonded copper or fiber, giving network operators flexibility in deployment today, as well as a smooth future migration path from copper to fiber.

The company's ML680DF model offers the same design, features and functionality as the ML684D, but provides a cost-optimized platform for which only fiber backhaul is needed.

Better connected

Sophisticated communications networks facilitate efficiency and safety on remote project sites

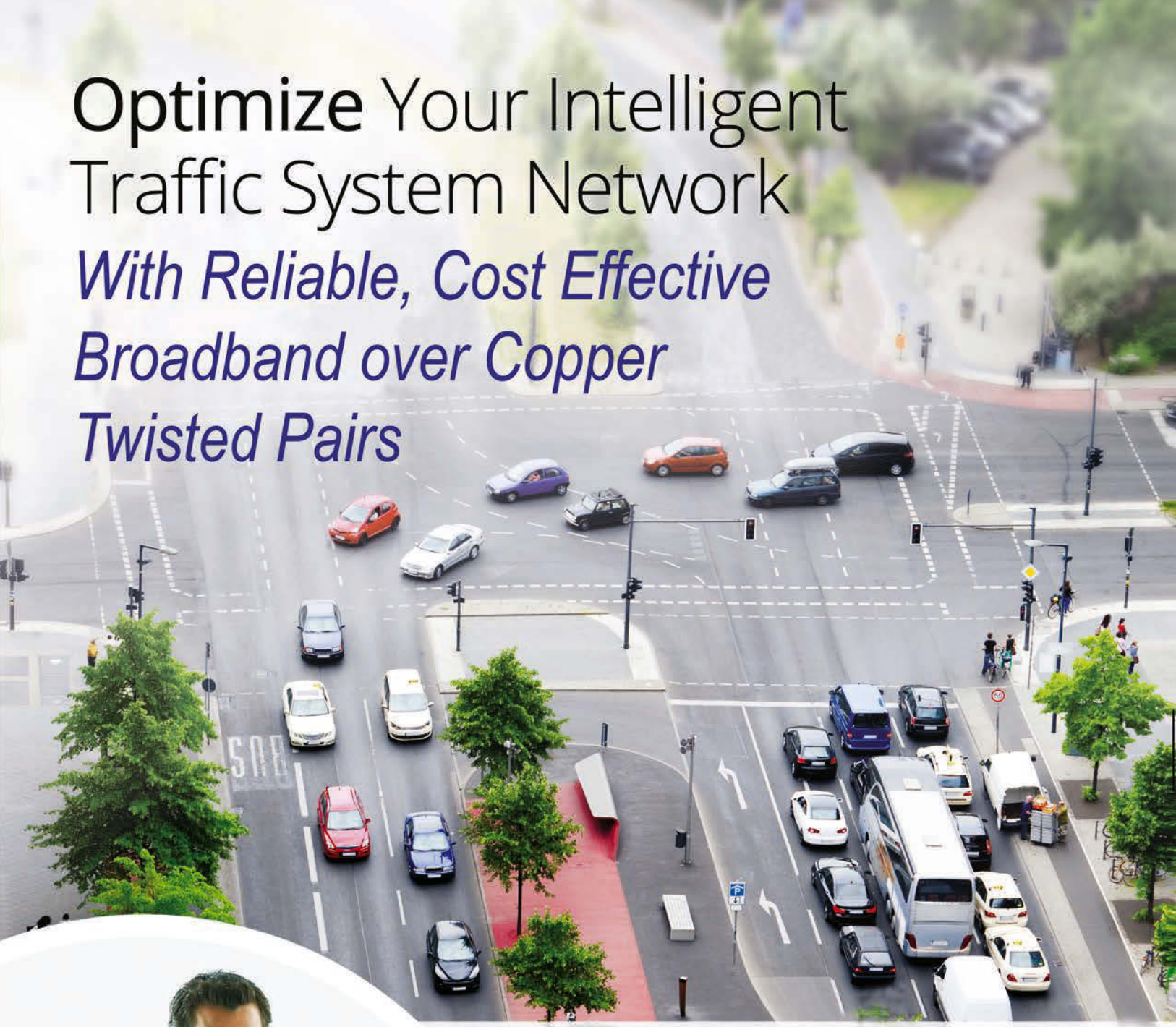
Obtaining a sufficient internet connection in remote locations is a concern for those involved in road construction and maintenance. A lack of on-site communications can cause projects to be delayed, create safety concerns, and impact project costs.

The new Site in a Box system from Datasat Communications has been designed to solve these problems. This simple, cost-effective solution can enable communications in remote working environments via satellite internet, wireless 3G and 4G, site wireless coverage, and HD camera surveillance with camera analytics and video storage.

The solution can be used to connect remote and temporary jobsites quickly, and prevent workers from being isolated while they await a terrestrial connection.

Optimize Your Intelligent Traffic System Network

With Reliable, Cost Effective Broadband over Copper Twisted Pairs



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AUTONOMOUS-VEHICLE SPECIAL TEST & DEVELOPMENT

Ready for the future?

As *Traffic Technology International* prepares to co-host the first-ever Autonomous Vehicle Test & Development Symposium in Stuttgart (June 16-18), this three-part special takes a comprehensive look at the many systems being developed to connect and ultimately drive the cars of tomorrow

Page 15 **Symposium preview**

Leading autonomous vehicle experts from around the world, who are taking part in the Symposium in Stuttgart, give their opinion on how we can guarantee the safety of driverless vehicles

Page 20 **Cloud formations**

Vehicles on the road today are already being connected via the cloud. We look at how these systems are rapidly developing and how they could one day be essential to autonomous vehicles

Page 26 **Critical software**

Automotive programming failures have already occurred. So far they have always been rectified before causing harm, but how do we ensure bugs never make it into vehicle systems in the first place?

Autonomous Vehicle TEST & DEVELOPMENT Symposium 2015

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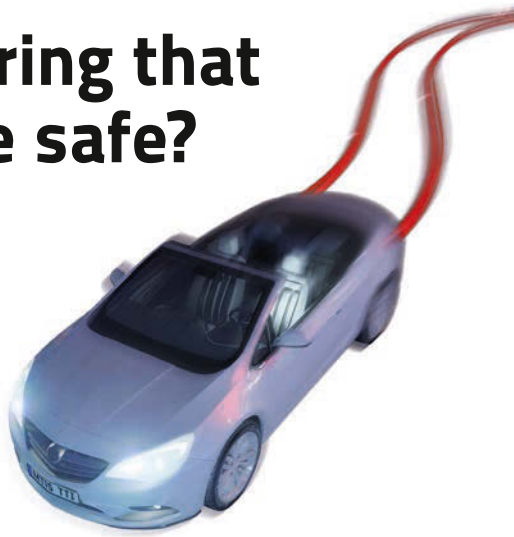
What is the single most important factor in ensuring that autonomous vehicles are safe?



Dr Brendan P Hafferty
regional general manager,
Forum8, UK

The problem is not whether the vehicles are safe, it's whether the general public perceives them as safe. I believe that the vehicle manufacturers must make a big deal of, first of all, testing the vehicle technology within the totally safe environment of virtual space, and then making sure the public is made aware of the same through a major advertising and marketing campaign.

This could involve the use of drive simulators in mobile trailers being taken to strategic locations during a national roadshow so that members of the public could experience for themselves how autonomous vehicles work, within the safe environment of 3D virtual space.

Symposium presentation

The use of interactive VR simulation in autonomous car R&D

Date: Thursday, June 18
Location: Room A **Time:** 9:00am

Florian Friederich
manager, eXept Software,
Germany

Make sure a human is not at the wheel!

Symposium presentation

Embedded systems testing and simulation with Expecco

Date: Wednesday, June 17
Location: Room A **Time:** 1:15pm

Steve Boyle
managing director
Moshon Data, UK

Knowing the vehicles are tested to a very high standard before they hit the road, unlike current vehicles, which are on the road for a few years before a standard test is developed. This would require a safety body with legislative powers to enforce these safety standards.

Symposium presentation

ADAS and its testing – the forerunner to autonomous cars?

Date: Wednesday, June 17
Location: Room A **Time:** 9:30am

A recent study suggests autonomous vehicles will boost the UK economy by **£51bn** (US$75bn) by 2030

Phil Morse
technical liaison, Commercial Group
Ansible Motion Ltd, USA

Implicit in the engineering pursuit of fully autonomous vehicles is the assumption that replacing a human being as the primary vehicle motion control system will reduce the number of path-following errors and object collisions that result in injury or damage.

However, in order for this assumption to be valid, two things must be in place:

1. Superior-to-human input/output (sensor/actuator) capabilities. This is technically achievable, but expensive.
2. Superior-to-human decision-making capabilities wedged between the inputs and outputs. This specialist artificial intelligence for vehicle control is not yet technically achievable at acceptable confidence levels.

Any autonomous vehicle safety assessments would, of course, be predicated on the existence of this AI in an acceptably capable form. And then, just as is the case with any other currently deployed automotive system, the most important factor in the safety assessments would be the quality of the interrogation protocols – the test and simulation procedures used to verify normal and fail-safe performance.

Symposium presentation

Driver-in-the-loop simulation for autonomous vehicles?

Date: Thursday, June 18
Location: Room A **Time:** 11:00am

Autonomous Vehicle TEST & DEVELOPMENT Symposium 2015

AUTONOMOUS-VEHICLE SPECIAL TEST & DEVELOPMENT

Stephen Hamilton
partner, Mills & Reeve LLP, UK
Stephen.Hamilton@mills-reeve.com

Every autonomous vehicle must have a critical-event control system that is designed to take appropriate action in an emergency situation. This system should be separate from any system that is networked to other vehicles or infrastructure, as it will be responsible for keeping the vehicle and its occupants and other road users safe. By separating the navigational control of the vehicle (i.e., the vehicle's systems that are connected) from the critical event control of the vehicle, the vehicle becomes far less vulnerable to cyber attack and also more self-aware – and therefore intrinsically safe as a result. Separating the systems in this way will also enable the creation of performance standards that will facilitate the development and widespread introduction of autonomous vehicles. It is worth noting that, to date, public testing of autonomous vehicles has focused on navigational control (not critical-event control), relying instead on a human driver being ready and able to take control should the need arise. Appropriate phased testing and approval of autonomous critical-event control systems will need to be introduced, not least because (just as we do not test seatbelts and airbags in public) it is inappropriate and unsafe to test autonomous critical-event control systems in a public environment.

Symposium presentation

Legalizing autonomous vehicles: facilitating technological development

Date: Thursday, June 18
Location: Room B **Time:** 10:30am

In April 2015, Delphi's autonomous vehicle traveled 3,400 miles on a coast-to-coast journey across the USA

Matthew Avery
head of research, Thatcham, UK

To ensure that systems can safely hand back control to the driver at the end of an autonomous drive and that the system will retain control and park if the driver fails to respond.

Symposium presentation

The development of EuroNCAP test procedures for autonomous emergency braking

Date: Thursday, June 18
Location: Room B **Time:** 9:00am

The impact of autonomous vehicles on future vehicle insurance

Date: Thursday, June 18
Location: Room B **Time:** 11:00am

David Bailey
group leader, embedded software, ETAS, Germany

Testing of the cognitive computing platform and its interfaces to the real-time control system is the most important factor in ensuring autonomous vehicle safety. The cognitive platform is a new part of the vehicle architecture and its hardware basis and software paradigms are largely new to automotive systems.

What has developed over the past 10 years is a high degree of maturity in control systems, but cognitive platforms are not rolled out widely and we should be wary as we're looking to apply these in a mass safety-critical market.

Symposium presentation

Challenges for software development and testing for autonomous automotive control

Date: Wednesday, June 17
Location: Room A **Time:** 12:45pm

Dr Michael Helmle
senior expert system development, Robert Bosch GmbH, Germany

In my opinion, safety is largely controlled by the design of the automated system, so this is the most important factor. This starts with the selection of the environment sensors; which and how many you pick. The automated system must be built n a sound electric/electronic architecture with the components data net and power net. Next, it needs powerful and safe computing units, and reliable actuators that are able to provide back-up capabilities in the event of failure. And, of course, everything has to work together smoothly.

Another topic connected to design, albeit from a different view, is the system's capability for self-diagnosis, which provides the ability to detect shortcomings and faults, and judge their implications. Validation and verification are assessments that try to argue that the design job was well done, but, in the end, can never strictly prove that the system is perfect. Rather they can point out the remaining flaws. So this may be not the most important part, but definitely the most difficult one.

Symposium presentation

Challenges and concepts for validation of highly automated driving

Date: Wednesday, June 17
Location: Room B **Time:** 1:15pm

Autonomous Vehicle TEST & DEVELOPMENT Symposium 2015

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The innovative view

Dr Graham Hellestrand
CEO, Embedded Systems Technology, USA

Autonomous-vehicle safety starts with top-down, model-driven engineering of the parameterized and fully distributed vehicle control. This must be followed by simulation using thousands of vehicle scenarios – ranging from the basic to the extreme, where death is inevitable. The partial and full results of these many simulations empirically drive the re-engineering of the failed models.

Finally, we should be able to run between 10 and 200 of these communicating models in the same simulation. These should involve other vehicles, pedestrians, animals and pieces of infrastructure. Once again, the empirical data from the simulations must be used to re-engineer not just the vehicles, but also the traffic-control systems and roadways. Since all models are parameterized, design of experiments and Monte Carlo optimization studies become a basic part of the vehicle and traffic engineering tool set.

Death from cardiopulmonary diseases due to exhaust fumes is estimated to be 10 times higher than death due to vehicle crashes. Modern modeling is able to compute vehicle emissions (gaseous and particulate) and combine them with geographic information to determine concentrations in local areas and rates of diffusion. Modeling and simulation studies that demonstrate acute and persistent exposure can and should be used to design and then engineer safe traffic systems.

There is no substitute for this level of modeling and simulation and no excuse for not adopting it as a primary vehicle and traffic engineering tool. Claims for safe autonomous vehicles that have not been developed using this empirical engineering process are likely bogus. Dead drivers tell no tales; dead driver models and the models they drive tell many tales.

Symposium presentation

Safe autonomous vehicles?

Date: Thursday, June 18
Location: Room B **Time:** 3:15pm

Volvo plans to test 100 self-driving vehicles on the streets of Gothenburg in **2017**

Frederik Diederichs
senior researcher
Fraunhofer, Germany

The most important factor is that humans and machines work cooperatively and that this teamwork is resilient to errors

Symposium presentation

Human factors of automated driving

Date: Thursday, June 18
Location: Room B **Time:** 1:15pm

Fátima Pereira da Silva
CEO, InOutCister, Lda;
professor, Polytechnic Institute of Coimbra, Portugal

To guarantee autonomous vehicles are safe, we need to take into account the operator's characteristics, as well as the vehicle's specifications. Studies must be based on the operator's ability to perform tasks adequately and the operator should know what is required of him or her.

Let's take an example from aerospace. Imagine you are getting on a plane and someone lets you know that it is equipped with the most modern technologies, you will be delighted. However, if someone tells you the pilot has had no specific training on that plane, with the rationale that any pilot can fly it without needing any training, then your confidence will surely be affected. The same will be true of driverless cars.

Symposium presentation

Mental workload, driving task and intelligent transport systems

Date: Thursday, June 18
Location: Room B **Time:** 3:00pm

Keynotes

Three leading research specialists will open the Symposium on **Tuesday, June 16**:

Prof. Frank Flemisch
head of system ergonomics, Fraunhofer, Germany

Symposium presentation

Testing of automated driving and cooperative interaction strategies

Location: Room A **Time:** 9:00am

Dr Jean-Baptiste Haué
autonomous driving HMI specialist, Renault, France

Symposium presentation

Autonomous driving from a user-experience perspective

Location: Room A **Time:** 9:30am

Stefan Wolter
vehicle interior technologies, Ford Research and Advanced Engineering Europe, Ford, Germany

Symposium presentation

HMI Testing Methods for ADAS

Location: Room A **Time:** 10:00am

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Cloud formations

David W Smith finds out how public-private collaborations are using cloud-based data sharing to improve road safety, optimize traffic management and accelerate progress in ITS, automation and sustainable transportation

Images: Solarseven

In order to create a future in which ITS and automated vehicles play a prominent role, public authorities and private sector companies are having to cooperate more closely than ever. Without the right public infrastructure, the most advanced private technology can't achieve its full potential. Conversely, road authorities are aware that new technologies can save money – and lives. Realizing the need to pool their expertise, the private and public sectors are increasingly working together to develop cloud-based safety solutions.

One of the biggest such projects is taking place in Scandinavia, where Volvo Cars has teamed up with the Swedish Transport Administration (Trafikverket) and the Norwegian Public Roads Administration (Statens vegvesen) to investigate how to use the cloud to help cars navigate slippery roads. Volvo has already run successful tests of the system on a small fleet of cars, but that fleet is now expanding twentyfold from 50 to 1,000 vehicles, and the test area has widened to include the cities of Gothenburg in Sweden, and Oslo, Norway.

"We're getting more ambitious," says Erik Israelsson, project leader for C-ITS at Volvo Cars. "We want to test the quantitative aspect, which means scaling up hugely. We need to know how many cars it takes to detect slippery roads accurately. The more information shared on the road, the fewer nasty surprises there will be."

The new cloud-based technology has two functions. The first is a slippery-road alert, which warns of icy patches ahead. The second alert notifies drivers when a nearby vehicle has its hazard lights on. The flexibility of the technology makes it easy to add functions later.

"We use the hardware already installed in the car and add some algorithms," Israelsson says. "When a driver accelerates, steers or brakes, we can measure the road friction, so we detect slips on ice. That information, along with the time stamp and the GPS location data, is sent to the cloud over our mobile network. The data from multiple skidding cars is aggregated."

Once the technology has determined that a road is slippery, a warning is automatically sent out to other vehicles approaching the risky area. "A car gets a warning in good time, so it can keep track of the remaining distance to the slippery slope," says

> The more information shared on the road, the fewer nasty surprises there will be
>
> **Erik Israelsson, project leader for C-ITS , Volvo Cars, Sweden**

Israelsson. "Fast-moving cars are informed further ahead so there's a large enough time gap."

The second cloud-based safety function, the hazard road light, warns drivers that a car ahead is parked on an unsuitable section of the road. "Normally, we're alerted by warning triangles behind the car, but our electronic version gives drivers much more time to prepare," says Israelsson. "It's especially useful during winter months."

Israelsson is keen to stress that because the data is aggregated, individual cars cannot be identified. "We use Volvo's own cloud so we maintain the integrity and anonymity of the data," he explains. "We don't share any details about the location of specific cars. Personal information is locked in the back end and not accessible to the wider public."

Expanding possibilities

To date, the slippery road and hazard warning lights are the only functions being assessed. But Israelsson says the Scalable Product Architecture (SPA) technology in Volvo's XC90 makes it easy to add other functions later. SPA, he says, will change the way Volvo cars are built in the future by enabling a wide range of technologies to be fitted on the same architecture.

"It's just a question of adding the software we're developing because we have everything we need in the platform and have developed the technical infrastructure," he says. "This is just the beginning. In the future, we will increase the exchange of vital information between vehicles, as well as between vehicles and infrastructure. Our plans are somewhat secret, but I can say there is considerable potential to enhance traffic safety, create a more comfortable drive, and improve traffic flow."

Looking further ahead, he says, Volvo would be open to collaborating with other manufacturers. For now, it is doing what it can in conjunction with the Swedish and Norwegian road authorities. They have agreed to help fund research because they believe the data will help administrators and subcontractors plan winter maintenance and react swiftly to changes in conditions.

Anders Lie, who is a specialist in traffic safety at Trafikverket, believes the Volvo project is a good opportunity for Trafikverket to assess just what infrastructure is required to facilitate V2V and V2I communications.

(Right and below right) **Each car equipped with Volvo's slippery road alert system has an icon on the dash panel close to the speedometer. This lights up after receiving a notification from the cloud that there are hazardous conditions ahead**

"We have a lot of practical questions for researchers," he says. "For example, would we need to set up sensors to support those vehicles in real time? Will cameras be an essential part of the situational awareness of the car? Our current infrastructure is not camera ready."

> The cloud has huge potential advantages for autonomous vehicles and the infrastructure needed to support them
>
> **Anders Lie, traffic safety specialist, Trafikverket, Sweden**

Trafikverket also has questions about the quality of lane markings and traffic signs. "Cars, whether automated or non-automated, will have to read road markings in snow," says Lie. "The right infrastructure will help them to send back the data to the cloud, which will feed back into our maintenance systems."

For Lie, much of the excitement of the Volvo project comes from being able to envisage the effects of cloud-based systems on the automated cars of the future. "They will need support from good infrastructure to be safe and efficient," he says. "Otherwise they could

More data, better decisions

A new cloud platform enables optimized traffic management through improved communications

Ericsson's Connected Traffic Cloud facilitates the sharing of real-time traffic and road condition data between connected vehicles and traffic authorities. Each element of the platform has already proved effective in other commercial applications, including managed cloud platforms such as Connected Vehicle Cloud and Maritime ICT Cloud.

"Demand for in-car connectivity is increasing, for infotainment purposes and for a range of regulatory initiatives that aim to increase road safety," says Orvar Hurtig, Ericsson Industry and Society head. "So vehicles are becoming a major source of data that could be used to improve road authorities' ability to manage traffic and prevent accidents."

The primary customers for Connected Traffic Cloud are road traffic authorities, who currently rely on a limited set of data provided by a relatively small number of road sensors and cameras. The authorities use the data to manage traffic flow with signal timings, and providing advisories to help drivers avoid dangerous conditions.

With the new system, drivers will get relevant communications from the Connected Traffic Cloud through connected devices. The program also has the potential to greatly increase the authorities' ability to aggregate and analyze real-time data from connected vehicles and devices when the owners of the data are willing to share it.

end up driving too slowly and actually become a nuisance on the roads."

But he is already looking beyond the ownership of individual cars to contemplate how automation will make a difference to society as a whole. "I always talk about how to link personal mobility with a more personal transportation system," he says. "For example, how could automated vehicles enable a more intelligent distribution of goods in congested cities? The learning curve is very steep right now and we're rapidly seeing exciting new possibilities. Therefore, as an infrastructure provider, we want to be at the heart of the debate. We're looking far into the future, but we feel the journey is starting now and that's why we need to be part of this project."

Lie says the cooperative is also looking at the possibility of forming a partnership with the Swedish communications technology provider Ericsson, whose new Connected Traffic Cloud platform will improve the ability of authorities to communicate with drivers (see sidebar, left). "We're trying to build a culture of openness and inclusivity around the project as the more experts that are combining resources, the better it will be," Lie says.

Open source advantage

Another major cloud-based collaboration between the public and private sectors is underway in continental Europe, where the German Federal Ministry of

(Above) **A specially equipped all-electric Fiat 500e, being used in Germany's OSCAR project (Open Service Cloud for the Smart Car)**

Economics and Technology is subsidizing Project OSCAR (Open Service Cloud for the Smart Car). The project integrates electric vehicles into the cloud by building modular information structure and communication technology (ICT). Government funding means the project has to have the potential to benefit all German car manufacturers, so the ICT architecture is open and manufacturer-independent. It has already been tested successfully on roads in the Aachen region.

The OSCAR Project is led by the German vehicle engineering company FEV, but it has taken a team of experts to develop the complex modular systems. In addition to the German government, FEV's partners include the automotive firms Fritz Dräxlmaier and Hans Hess Autoteile; university researchers from the Technical University of Aachen; telecommunications provider QSC; and StreetScooter, which has contributed the electric cars.

"Electric vehicles benefit enormously from cloud-based data," says FEV's Prof. Günter Feyerl. "They gain accurate information about battery capacity and how to use it more efficiently. Central IT services also suggests the best routes based on data about slow-downs, weather conditions and hill gradients."

Project OSCAR uses FEV's iCU (intelligent Connection Unit) platform, to gain access to data from the car's onboard network. The information collected through CANbus and a GPS system is sent to the cloud via a UMTS interface. To ensure that the right data is sent to the correct addresses in the cloud, an FEV-developed AES (automotive embedded service) server filters it for relevance. Data analysis is then done in the cloud and the results are sent back to the original vehicle, or other connected vehicles. Smartphones and tablets use Bluetooth, or WLAN, to access the data in the car.

As well as getting instant feedback, drivers can also carry out more detailed analysis of their driving patterns. The cloud data combines with apps in the vehicle display unit to analyze the individual driver's historical data. This can be compared with the profiles and fuel consumption of other drivers in similar vehicles. The apps give advice, such as how to optimize fuel consumption.

The cloud-based system also has major advantages for fleet operators, according to Feyerl. "They benefit from improved diagnostic capabilities on electric vehicles," he says. "Digital data provides information about position, operating state and battery state for fleet management. Even error codes can be read via the cloud. Safe and limited access to such sensitive data improves the coordination options for maintenance schedules and enables preliminary diagnosis by authorized parties."

Feyerl says the use of the cloud for electric vehicles is a growing area of research. The European Green Vehicle Initiative has stressed the need for greater innovation around ITS and V2V, and various manufacturers, including Bosch and Continental, are developing similar IT for engine and powertrain control in cars and trucks. But the potential inconveniences of electric cars may still put off buyers.

Ultimately, both the Volvo and the OSCAR projects reveal how important the cloud could be for the autonomous vehicles of the future. As Anders Lie says: "The cloud has huge potential advantages for autonomous vehicles and the infrastructure needed to support them. That's because it allows data to be gathered more efficiently by improving communications. Autonomous vehicles will place more demands on infrastructure providers and they will need to get a lot of valuable information.

"But it also works the other way around. Autonomous vehicles will also be information collectors. For example, they will gather data on where it's hard to read the traffic signs, or where the lane markings need to be repainted. That information will then be sent back to the cloud. So it's a two-way process."


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Software

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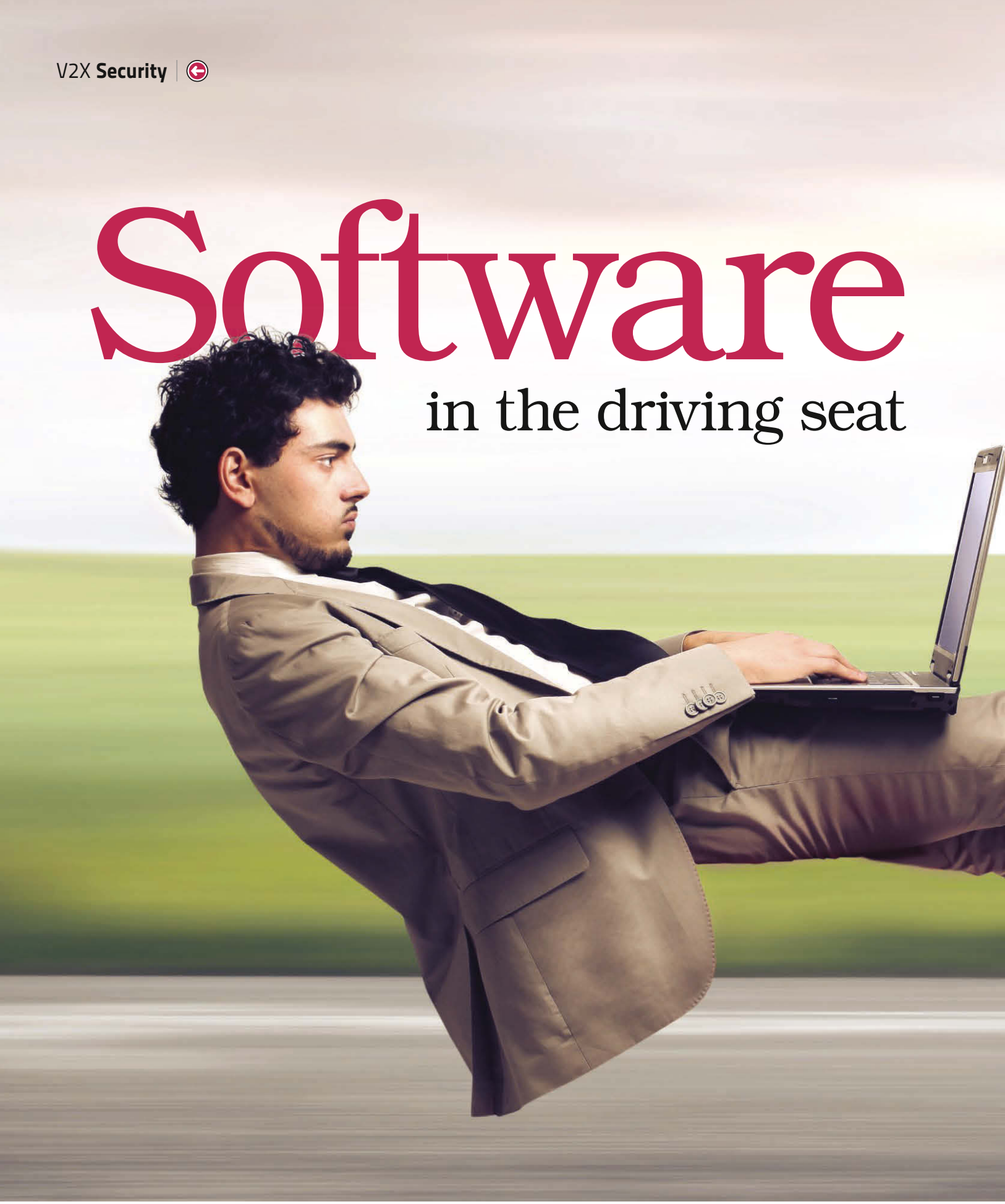

The autonomous vehicles of tomorrow will rely on technology being developed to control the intelligent vehicles of today. **Tony Dyhouse**, director of the UK government's new Trustworthy Software Initiative, explains why security and standards are so important and what is being done to ensure they are maintained and improved

Next time you slide behind the wheel of your car, consider that what you are driving could quite accurately be thought of as an extremely advanced computer on wheels. After all, it contains several hundred million lines of code and software to manage everything from airbag release to engine operation, and within a few years it could be capable of driving itself around with virtually no input from you.

The incorporation of software into automotive design has revolutionized the way our cars interact with each other and with the world around them, making them easier, safer and more comfortable to drive. With more than a billion cars currently on the world's roads, advances in software can also make a real difference in tackling global problems such as traffic control and fuel emissions, which would otherwise require mass concerted action to overcome.

For all the promise that connected software holds, and the excitement associated with the fast-approaching Internet of Things, we must not lose our grip on the brakes. Too much of the code currently produced for the automotive industry is insufficiently protected, leaving manufacturers and drivers vulnerable to potentially dangerous attacks.

In a report on transportation technology published in February, US senator Edward J Markey lamented the "alarmingly inconsistent and incomplete" state of security practices in software development (see *Vehicle data up for grabs?* overleaf). With a constant stream of security vulnerabilities by established firms including Toyota and BMW making headlines, such concerns appear entirely justified. If we are to entrust our safety on the road to software, much more needs to be done to guarantee its quality and ensure its adherence to best practice.

Behavioral drivers

Software manufacturers across all industries are under increasing pressure to sacrifice quality for quantity and push out continuous new functionality. As the demand for connected vehicles continues to grow, automotive manufacturers are incorporating connectivity into in-car systems faster than developers can test them.

Just as we take for granted the extensive testing undergone by a vehicle's physical components, we should raise the standard of testing on the equally important though intangible software elements. Most importantly, manufacturers need to have tiers of testing for different types of software depending on their relative importance. So-called mission-critical systems, such as the airbag deployment mechanism or the engine management system, need to undergo a higher level of security testing than, say, the software powering the car radio.

Vehicle data up for grabs?

A new US Senate report puts auto manufacturers in the security spotlight

An investigation carried out by US Senator Edward J Markey (D-Mass), which reported earlier this year, exposes a lack of preparation and understanding surrounding cyber security in the US auto industry. The situation was revealed when the senator wrote to 16 major vehicle manufacturers.

Their responses revealed that nearly all new cars have wireless technologies that could make them vulnerable to attack, however security measures are inconsistent and haphazard. Only two manufacturers were able to show the ability to diagnose and respond to infiltration in real time.

A further alarming finding of the report, entitled *Tracking & Hacking: Security & Privacy Gaps Put American Drivers at Risk*,[1] was that half of manufacturers admitted they routinely collect and store driving history and vehicle performance data off-board, without an effective means of securing such data. Furthermore customers are often not made explicitly aware of this and cannot opt out without disabling valuable features.

Although some manufacturers have responded to the concerns of Senator Markey and others by setting out privacy principles, there is still concern that such policies are somewhat 'hidden' from consumers, for example deep within user manuals. Also, although the new policies give consumers some choice in how data is used, there is nothing that controls the collection of data in the first place.

The report recommends that new standards be set out by the NHTSA, in consultation with the Federal Trade Commission:

- Validate security systems using penetration testing
- Include measures to respond to hacking events in real time
- Require that drivers are made explicitly aware of data collection, transmission and use
- Ensure that drivers are able to opt out of data collection.

As transportation systems become increasingly integrated, however, the ability to keep these functions isolated is disintegrating. We already have apps in place that enable your smartphone to control your car-locking mechanism, for instance, widening the scope for potentially damaging attacks. As the various networks in our lives start to connect via the Internet of Things, we will find ourselves in a position where the integrity of the entire system is reliant on the weakest link in the chain. The Internet of Things is carving a virtual path for criminals to access our private lives.

This troubling scenario may be a way off yet, but the attitude of automotive manufacturers to such concerns has been far from reassuring. The Markey report, which collected responses from 16 major US companies to questions about software security, revealed that measures to prevent remote access to vehicle electronics are inconsistent and haphazard (see *Vehicle data up for grabs?* above)

To those of us in the software community, this does not come as a surprise. In recent years, countless car companies have crashed into the headlines over basic software problems that have long since been resolved in other sectors. Concerted action is therefore needed to prioritize the development and use of trustworthy software from the earliest stages of manufacture.

Patching up the road?

BMW Group is the fifth largest car manufacturer in the world, with more than two million vehicles sold in 2014 alone. Earlier this year the company admitted it had recently encrypted its communications after discovering a vulnerability. It is a positive development, but makes us wonder why BMW had left its communications unencrypted to begin with.

When a company of this size is capable of leaving its customers vulnerable to attack, it is time to take a good hard look at what we expect from the industry.

The abuse of owner-to-vehicle communications, such as was unintentionally left possible by BMW, could lead to catastrophic results. Under such an attack, any feature that made it easier for a car owner to perform a function would also make it easier for a criminal to do the same. The very properties that make the Internet of Things a boon for drivers could therefore be used against it.

An attacker could exploit such vulnerabilities by pretending to be the manufacturer's network and spoof it, in what is known as a man-in-the-middle attack. As the systems are designed to gradually remove the need for human judgement, in such instances there would be nobody to identify that the system was under attack.

Under such circumstances it would even be possible for criminals to use one car as a gateway to hack into

a car made by a different manufacturer. Just as car companies use common components for mechanical parts, many also use common components in the manufacture of software. With the rise of non-proprietary software programs written by third-party developers, vulnerability-laden software could simultaneously affect several manufacturers.

Many of these problems ultimately come down to insufficiently robust testing of the underlying software. For example, the wealth of problems faced in recent years by Toyota – with regard to failures in the software governing stability control, antilock braking and engine management – is indicative of a widespread deficiency in the industry's testing protocols.

Poor software can also impact user safety in much more direct ways. For example, Jeep was recently forced to recall Cherokees from the 2014 and 2015 model years owing to faults in the software governing side-curtain and seat-mounted side airbags. Although no injuries had been reported, the company had received news of a small number of inadvertent deployments brought about by 'extreme' off-road driving.

Such risks are set to increase given the likely explosion in the quantity and diversity of software that will power the digital revolution and the Internet of Things. Initially at least, there is likely to be a large increase in software written by individuals with little or no formal training and who do not adequately consider the trustworthiness of the software they are producing. The availability of so much new and market-driven software, combined with the increase in connected vehicles, means that software will be at the heart of many 'decisions' made without human interference. Connected vehicle technology is one of many areas where software vulnerabilities could have a truly catastrophic effect.

Tony Dyhouse is director of the Trustworthy Software Initiative (www.uk-tsi.org). Prior to this he was director of the UK government's Cyber Security Knowledge Transfer Network programs (2009-2014)

Fuel change

In many instances where software vulnerabilities are mentioned, the focus tends to rest on security – or the ease with which a system can be compromised. These issues are important, but are only a single aspect of the more fundamental issue of trustworthiness.

Safety, reliability, resilience and availability, along with security, represent the five central tenets of trustworthy software, and for far too long, one or more have been ignored at the expense of the others. The vulnerabilities at the very bedrock of software in any sector can only be addressed holistically, which is to say by discussing and enforcing trustworthiness as a whole rather than any element in isolation.

It is in order to address these deep-seated issues that the UK government has set up the Trustworthy Software Initiative (TSI), a public-good activity working to improve the quality of software used and manufactured in the country.

Through collaboration with industry, government and academia, the organization has collected and collated a comprehensive body of existing guidance, relevant standards and best practice in the form of the Trustworthy Software Framework. As of June 2014, in collaboration with the British Standards Institution, the Framework's central concepts, principles and techniques have also been formalized into a publicly available standard known as PAS 754:2014, *Software trustworthiness. Governance and management. Specification*, which can be purchased via the BSI website at: tinyurl.com/trustsoftware.

PAS 754 is the first document of its kind to set out overall principles for effective software trustworthiness, and represents a major opportunity for UK industry to benefit from expert guidance in this field. The standard includes technical, physical, cultural and behavioral measures alongside effective leadership and governance techniques, and will be a critical tool in helping businesses and developers avert IT risks.

The implementation of trustworthy software can also have more practical benefits. Writing in 2013, Steve Lipner, partner director of program management for Microsoft Trustworthy Computing, stressed that the return on such investment includes a potential 20% improvement in programer productivity.

Following the TSI's recommendations can save manufacturers time and money, and notably improve the safety of road users. With an enhanced regulatory framework slowly coming into place, and the necessary technical guidance easier than ever to procure, the transportation sector's reliance on untrustworthy software may soon be a thing of the past. We should all do what we can to help the industry navigate the bumpy road ahead.

1. Read US Senator Edward J Markey's full automobile cyber security report at tinyurl.com/markeypdf

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Breaks for the border

Against a backdrop of heightened terrorist activity worldwide, **Timothy Compston** looks at some of the technologies that are geared up to mitigate risks to security, particularly at border crossings

Security on road bridges and in tunnels is paramount. Often they span borders between countries and so present the opportunity for illegal crossings. And, wherever these valuable pieces of infrastructure are built, increasingly DOTs and security agencies must be alive to the possibility of a terrorist attack. They are always pivotal links in road networks, and yet, by their very nature, are vulnerable to damage. Furthermore, the confined nature of these structures means that dealing with an emergency situation is far from straightforward, so anything that can provide an early warning has to be welcomed.

(Above) **The long-range, aircraft-style MQ-9 Predator B drone has been in use by US border patrols since 2005 – a far cry from the lightweight quadcopter drones that have become increasingly common in recent years**

Flying high

So what surveillance and wider security solutions can DOTs and other agencies turn to for their border defenses and post-incident management? One form of surveillance technology that has been hitting the headlines over the past few years is unmanned aerial systems (UAS), also known as drones.

For its part, the US Customs and Border Protection (CBP) and Office of Air and Marine (OAM) has embraced unmanned aerial systems as an added weapon in its law enforcement armory. The CBP first employed the MQ-9 Predator B, manufactured by General Atomics, in 2005, to support operations on the southwest border with Mexico and in 2009 on the northern border with Canada. Beyond this, Lothar Eckardt, executive director for National Air Security Operations, reflects on how the Predator B system has come into play where bridges require attention. There is the capability, he confirms, to provide high-quality streaming video to first responders and to assess critical infrastructure before and after large-scale incidents nationwide.

To date, the CBP has provided emergency support for multiple hurricanes and floods since 2008, and there is certainly the potential for unmanned aircraft systems to be employed in homeland security efforts in

the case of terrorist-related incidents. "One of the radars that we operate landside for highways and bridges during disasters unlocks 'change detection technology' where we can fly over a bridge and fly back a couple of hours later or a day later and fly the exact same profile and the computer measures what has altered," reveals Eckardt, "We can pick-up if a bridge, for example, has shifted, and make that part of our disaster response."

Controlling the skies

Of course, these days drones aren't the expensive military equipment they were 10 years ago. Lightweight quadcopters can be bought extremely cheaply and flown by pretty much anyone with a few hours' practice. But for DOTs that may want to deploy their own drones for an 'eye in the sky' capability, it is not just a question of buying a drone and taking to the air; there are still tight restrictions to contend with in the USA through the Federal Aviation Administration (FAA) and the Civil Aviation Authority (CAA) in the UK. Although in theory drones should help to ramp up security, the flying of unidentified drones over seven of France's nuclear plants last year served to raise concerns about this technology getting into the wrong hands. As a consequence, many governments are recognizing that some sort of regulatory control over where, and how, drones are operated is needed, although, as yet, the approach taken can vary markedly from country to country.

The FAA is set to introduce rules on small unmanned aerial systems (sUAS) later this year, which may help. According to Richard Taylor of the UK CAA, from a British perspective, distance separation rules are already in place for drones: "The first requirement is to keep the drone at least 50m away from any person, structure or vehicle that is not within the control of someone operating the unmanned aircraft," he says.

(Left) **The latest thermal imaging can distinguish vehicles from pedestrians – key at border crossings**

> [Cameras on drones] can generate information that is, in some cases, a higher resolution with regard to spatial density than a laser
>
> **Dave Kroetsch, CEO, Aeryon Labs, Canada**

Another main element, Taylor explains, is the need for sUAS to remain within line-of-sight at all times.

Early adopters

As CEO at Aeryon Labs, a Canada-based company that specializes in the development of sUAS, Dave Kroetsch is an expert in this field. He reveals that Aeryon Labs has just signed up a customer in Japan who is using a system to undertake bridge inspections, and says that beyond inspections, as part of a preventive maintenance program, the same sUAS could be

a fantastic tool should there be a major natural or man-made incident: "The prime case is where you can operate drones in dangerous situations where you don't want to send people in until you know that it is safe. You can do that inspection from the air and you are not putting anyone on the bridge in harm's way."

He confirms that the sensors typically carried on these systems are primarily optical: "We have actually found from a photogrammetry perspective [making measurements from images] we are able to generate information that is, in some cases, a higher resolution with regard to spatial density than a laser." Kroetsch also says visual images provide that added element of detail, a picture of the bridge – the structure, as opposed to merely an outline: "Sometimes it is more useful if you can visually see a crack that you might otherwise not be able to measure with a laser scanner." (Don't miss the next issue of *Traffic Technology International* for a more in-depth investigation of drone technology and how it could be used in traffic management in the future.)

Rapid deployment

Back on the ground, should the security threat level rise for a border crossing, there may be a pressing requirement to shore-up the video surveillance capability. There may not necessarily be the time to install conventional solutions and undertake all of the associated works. One way of moving things into the fast-lane for surveillance, in this respect, is to turn to a wide array of rapidly deployable CCTV systems. Some of these technologies are already a common sight on highway workzones, where they are more typically adopted to enhance safety.

From a security perspective, the beauty of the latest CCTV towers is that, with their demountable wheels, they can be towed quickly to site and, coupled with flexible power options such as wind and solar and fuel cell, do not necessarily need to be hooked up to the grid. The availability of 4G, 3G and wi-fi connectivity on the latest models that vendors are bringing to market means it is immediately possible to link in video from any new CCTV towers to a control room so operators can view it alongside footage from permanent cameras. Alongside CCTV towers, other rapidly deployable solutions that are now finding favor include dome cameras, suitable for fixing to lighting columns or street furniture. Some manufacturers offer these with an ALPR capability, which could help the authorities to identify suspicious vehicles.

> If the change in the picture is moving too slowly, or in the wrong direction, or is stopping, then we get a pop-up on one of our monitors
>
> **Jopas Wulff, traffic manager, Øresund Bridge**

Bridging the detection gap

So what is it like having responsibility for monitoring one of the world's largest bridge and tunnel cross-border combinations? Jopas Wulff, the traffic manager with the Øresund Bridge, is one man who has the answer. By any measure, the Øresund Bridge, which first opened in 2000, is an impressive structure carrying 18,000 to 19,000 vehicles per day, according to the latest figures. This vital link between Sweden and Denmark stretches for 16km and comprises a bridge, artificial island and tunnel, supporting a four-lane highway and railway line.

(Above) **Øresund bridge, which spans the border between Sweden and Denmark**

Given the need to ensure everything runs smoothly, any unusual activity needs to be picked up at the earliest stage. Wulff says that steps were taken two years ago to swap out the antiquated video-based detection system, which his team were struggling to keep operational: "Because the old one was 12 or 13 years old, the problem was getting parts to fix it when we had trouble. We almost reached the stage where we were going onto eBay to buy spare parts!"

Another catalyst for change, reflects Wulff, was the reality that the technology for detecting stopped cars, dropped loads, cars going in the wrong direction – which he refers to as 'ghost drivers' – slow vehicles and even pedestrians, has accelerated in its level of performance: "This makes the systems today much more sensitive and capable of detecting different sorts of obstacles and issues."

One particular aspect of the new detection system that stands out for Wulff, compared with what went before, is its higher sensitivity. "It doesn't miss as much as the older system and it adapts better to low light conditions," he says. "The image is constantly monitored by the detection card, which senses any change. If the change in the picture is moving too slowly, or in the wrong direction, or is stopping, then the detection system gives us a signal and we get a pop-up on one of our monitors that shows the camera that detected it."

Looking for the hot spots

Using thermal imaging can often be a more effective way of spotting incidents on a road than trying to observe them with conventional, visual camera equipment

Providing an important surveillance resource for bridges and tunnels, outside the spectrum of conventional visual cameras, is thermal technology. The thermal route has moved on in leaps and bounds in recent years thanks to improved in-use performance with a plethora of uncooled models being launched into the market by vendors offering capabilities that previously might only have been found in more specialized – and expensive – 'cooled' variants.

Stefaan Pinck, vice president of ITS worldwide sales at FLIR Systems, is keen to flag up the outcome of some comparative testing between a visual and thermal cameras in a tunnel.

Carried out at the beginning of 2013, this head-to-head applied standard detection algorithms to both forms of camera, which, given Pinck's previous background with detection and conventional visual cameras, really opened his eyes to benefits of thermal imaging.

(Above) **The thermal image on the right reveals a fallen object that the regular camera hardly sees**

"We had a truck that was starting to go through the test tunnel and a tire exploded," he says. "Looking at it with the visual image we could see a little bit of smoke, but the reason we knew about the tire was because we already had an alarm caused by a very bright object on the thermal camera. Playing it back, we saw it was a tire being torn apart."

Pinck says this outcome served to underscore the power of thermal: "With a visual camera and detection, it all depends on the color of the object compared with the background; here, the tire was gray/black and so too was the asphalt." On the thermal camera, the image stood out very clearly as a very white object because it was hot.

Having implemented a change of system, Wulff points out that there is also flexibility with the latest solution, that means they can change the sensitivity of detection alerts in order to increase the margin around false alarms. "You can tell the detection card that the vehicle has to stop for 15 seconds and then has to send an alarm," he says. "Or if you have the possibility that you might miss something, as some cars may stop and go after 10-12 seconds, then you can increase the sensitivity." Going down as low as three seconds, says Wulff, is probably too far as this is where problems with false alarms really emerge. The requirement to have detection in the tunnel, in particular, is fueled, explains Wulff, by the lack of an escape lane. "That is why we have complete coverage of the tunnel – every inch."

On the bridge part of the border crossing, the camera setup is different, as it isn't necessary to monitor the roadway so intensively. Whereas the 138 cameras in the tunnel at Øresund are fixed, on the bridge, every other camera is moveable. "We don't have a complete grid that covers the whole bridge," explains Wulff. "We have detection cameras covering about 150-200m, but we have 500m between each camera, so we don't have stop-and-go detection on the bridge. What we do have is ghost driver detection."

Of course, for a border crossing like Øresund, it is not just about keeping a close eye on the roadway. From a safety and security perspective, employing PTZ (pan, tilt and zoom) cameras allows for monitoring of the wider structure above and below the deck for people or objects that are not supposed to be there. Down at the water level, Wulff reveals the importance of being able to communicate and work closely with other entities, in this case the coast guard, which has access to technologies such as radar, which simply aren't a practical proposition for bridge operators to run themselves: "There is a function for the Swedish and Danish coast guard – VTS [vessel traffic surveillance] – that monitors every boat that passes through the Øresland."

Driving ahead

Ultimately, given the critical nature of border crossings – particularly at bridges and tunnels – to the transport network and the growing concerns from a homeland security perspective, it is comforting to know that the solutions available to operators wanting keep a watchful eye on these structures, and to physically deter attacks, has never been greater. Today, portable CCTV systems and the latest video analytics mitigate the threat from hostile vehicles, while solutions such as drones are coming to the fore – albeit with strict regulations governing their use. Only time will tell if unmanned aerial surveillance will be available for wider use by DOTs. Of course, it is more than just having the right technology in place – being able to coordinate successfully with law enforcement and other government agencies is also imperative when the unexpected occurs.

> "With a visual detection, it all depends on the color of the object compared with the background. Thermal detection isn't limited by this"
>
> **Stefaan Pinck, vice president ITS worldwide sales, FLIR Systems**

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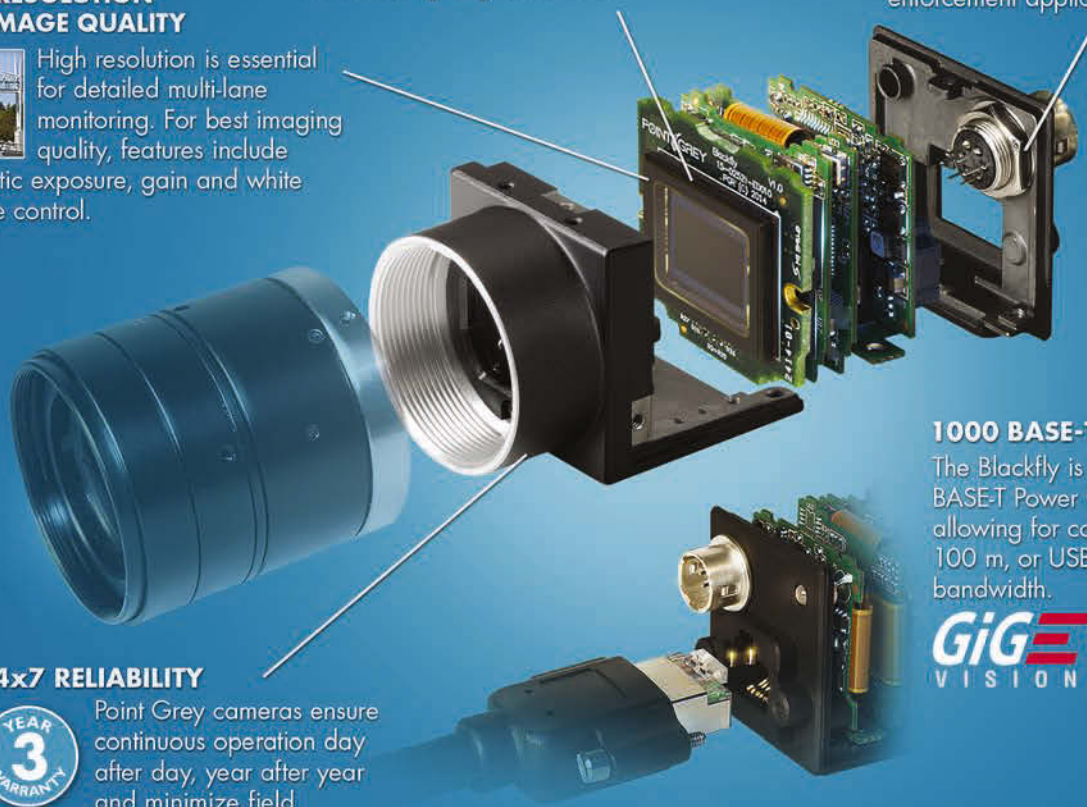

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As the ever-popular Intertraffic show returns to Istanbul, EMBARQ Turkey director **Arzu Tekir** reveals how technology is being used to help combat one of the country's most critical transportation issues: road safety

Interviewed by Max Glaskin

PHOTO: YUNUS DEMIRYUREK

> Our focus is on saving lives. The consequences of crashes are not without a cost to the community and cities. They can destroy family finances

Making transportation more sustainable is a challenge wherever you are, but it seems particularl y daunting in Turkey, where more than 10,000 people are killed and 200,000 are injured on the roads every year. The cost to the national economy of these traffic collisions has been estimated to be around US$7bn.

Fortunately, the World Resources Institute's initiative, EMBARQ Turkey, helps local and national authorities tackle this massive problem. Its director for the past four years has been Arzu Tekir and, whatever feelings she may have had when the non-governmental organization was set up, she's clearly not intimidated today.

"If you are working for a civil society organization, you have always got to be optimistic – and also realistic," she says from her office in Istanbul. Her hope is founded on the fact that EMBARQ Turkey has developed good relations at the highest levels, with the ministries of transportation, development and health. "Everybody can see that there is a need for more sustainable transport and we are the helpers, for cities and for some key government institutions," says Tekir.

Her organization's influence is impressive. It has contributed to Turkey's 10th national development plan as well as to its next five-year strategy for transportation. It's clear that the doors at government and in city halls are now open to Tekir's team. "We are invited and we want to be heard and we are in demand because everybody knows that, in economic, environmental, health and social terms, we need to change the way we develop mobility," she says.

A change population distribution is a major cause of the current situation, with people moving from rural areas into towns and cities. Now 73% of the Turkish population is urbanized. "Our cities will continue to get bigger, and road safety is one of the most important things we must address," says Tekir. Rather than lobbying to change laws and enforcement, EMBARQ Turkey has taken a more subtle, some might say more realistic, approach to making traffic safer, using the latest traffic analysis techniques.

Identifying the blackspots

EMBARQ Turkey has run a two-year project in five cities – Kocaeli, Konya, Eskisehir, Antalya and Kayseri – and has identified five crash blackspots in each. Using its access to the resources of the EMBARQ global network, a transport planning and traffic safety expert was brought in from Denmark to audit the 25 locations and then a report was published, containing recommendations about how each could be made safer. They include proposals to re-time signals to reduce waiting times for pedestrians and stop them being tempted to step out into danger, improve road markings and cycle path designations, and calm traffic by using center divides and sidewalk build-outs.

"If the recommendations are implemented, there will be 500 fewer accidents every year and 70 lives will be saved," says Tekir. However, paying for the improvements can be a barrier for some authorities. "In our recommendations, we do not say how much money it will cost," adds Tekir. "Our focus is on saving lives. The consequences of crashes are not without a cost to the community and the cities. They cost a lot of money and they can destroy the economies of entire families. So we should be prioritizing saving lives."

(Right) **The Bosphorus Bridge carries traffic from the European to the Asian side of Istanbul**
(Below right) **Istanbul has a thriving, modern center, which brings with it its own transportation problems**

What is EMBARQ?

EMBARQ is part of the World Resources Institute (WRI) – an independent, non-profit organization, established in 1982, which now employs over 450 staff. The aim of the WRI is to promote the efficient and sustainable use of the world's resources through the expertise of scientists, economists, statisticians and business analysts. EMBARQ is the transportation initiative from WRI and currently has five centers around the world employing 180 staff.

This doesn't mean that EMBARQ Turkey, having told an authority what steps will help, simply walks away. "We always follow up our reports and we are there to help cities if they need it," says Tekir. "We can introduce them to development agencies, bilateral funding organizations, and development banks."

The five-city project was completed at the end of 2014 and already one of them, Kocaeli, is adopting some of the report's recommendations and will work to make intersections safer. Also, a similar project is now being started in Istanbul itself, where blackspots will be identified and improvements suggested to make the roads safer. As EMBARQ Turkey always works with stakeholders, it will be hosting workshops and impact assessments to both gather and share knowledge.

Detailed knowledge makes the job of improving traffic safety and flow easier and EMBARQ Turkey has addressed this energetically. "Data is one of the most challenging areas for us," says Tekir. "The quality of the data available has not been so good, or it has been discontinuous, or it has not even been publicly available. Without good data it's simply not possible to identify the causes of problems, so it is harder to solve them."

By carefully building relationships at all levels of national and local government, data streams are improving. "By working with key institutions, some of whom are allocating budgets to data collection, the quantity and quality of traffic and incident data is getting better and easier to access," says Tekir.

Looking to a brighter future

One of Istanbul's transportation bright spots is the Metrobus rapid transit (BRT) system that runs on its own segregated lane along 32 miles of the city's main roads, serving 44 pick-up stations. It's a crucial network with hundreds of services, carrying up to 80,000 passengers per hour during peak periods. "The BRT is good for the city because it serves around 800,000 people, saves each passenger 28 days of travel time in a year on average, and removes 90,000 cars from the road," says Tekir. "The routes have got longer and its popularity continues to grow, so we want to help it remain a safe way to travel."

So EMBARQ Turkey, in cooperation with the BRT operators, conducted a safety study and made recommendations, which have now been implemented. They included refreshing road markings, closing the ends of platforms with wire fences, enlarging platforms to reduce crowding, placing secure guardrails along the entire corridor, and adding ramps and elevators to give safe access to all stations for elderly and disabled people. The impact of their work is eye-opening. In the year before the recommendations were applied, there had been six fatal accidents and 29 injury accidents. However, in the 12 months after the changes, fatalities fell significantly, to just one death. Admittedly injury accidents rose by a little under 10%, although it's possible that, without the new safety measures, they would have been fatalities.

The analysis of what accident rates may have been if no safety improvement steps at all had been taken as the BRT service grew gives another perspective on the impact of EMBARQ Turkey's work. Without the extra safety measures, there would have been a further five fatalities above and beyond the already unacceptably high number.

Coupled with pedestrianization, speed reduction and pro-cycling projects, Tekir and her team of seven core staff continue to make transportation in Turkey more sustainable – through a unique combination of optimism and realism.

Crash protection

Cars have never been safer – as long as you are inside one. **Max Glaskin** investigates ongoing efforts to use the latest technology to protect us on the roads – when not surrounded by a ton of steel

Photographs: Conrado

Vulnerable road users (VRUs) are people who are not in a vehicle, so don't benefit from the protection it offers. As everybody has to step out of their vehicle at some point, it's a problem that affects us all. Even die-hard motorists occasionally walk across the road, protected by nothing more than their clothes.

The latest annual figures show 4,735 pedestrians and 743 cyclists were killed in the USA, with 66,000 and 48,000 injured, respectively. Just 1% of all the reported motor vehicle collisions in the USA involve pedestrians, yet they make up 14% of fatalities. In Europe, 5,100 pedestrians and 1,870 cyclists were killed last year. On both sides of the Atlantic, two-thirds of pedestrian fatalities happen in urban areas.

Can advanced traffic management provide virtual body armor for pedestrians?

Auto companies have naturally focused on improving the safety of vehicle occupants. Admittedly, sophisticated braking technologies do benefit everyone and, more recently, real-time image and sensor analysis alerts drivers of some new vehicles to the proximity of pedestrians and cyclists.

Road authorities have struggled to accommodate motorized vehicles, pedestrians and cyclists on the same thoroughfares. In developed countries there is some limited separation, sidewalks and a small number of cycle lanes, but in most of the world, there's not even a white line to keep these various users apart, and soft human bodies take their chances next to cars, buses and trucks.

Making roads safer

There are three places to apply solutions and make roads safer for VRUs – vehicles, VRUs and infrastructure. Not all of it is complicated. Simple solutions can be the most cost-effective and recent experiments have shown that one that's taken for granted in Western Europe – yield signs for drivers at crosswalks – has great potential to make roads safer for pedestrians in the USA. By deploying movable yield signs and monitoring vehicles at crosswalks on the campus of the University of North Dakota and its home city of Grand Forks, engineers have shown that drivers give way to pedestrians more often when the signs are deployed. They also reduce the average speed of vehicles approaching crosswalks.

> We will determine whether there is a change in the number of drivers yielding to pedestrians when the rapid-flash beacons are located above, or within, the sign rather than below it
>
> **Kay Fitzpatrick, senior research engineer, Texas A&M Transportation Institute, USA**

There's also a perceived need to increase the vehicle yielding rate at crosswalks at T intersections. Not all such junctions are signalized, and pedestrians' view of oncoming vehicles can be blocked by those that have yielded. A simulator experiment by researchers at the University of Massachusetts Amherst has tracked the

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Georgia Tech's mobile machine-vision unit has high-definition cameras that are solar powered

Vision for the future

Georgia Tech Research Institute is developing a mobile machine-vision unit to analyze the behavior of pedestrians

Improving pedestrian safety might sound like a straightforward proposition, but to be effective it is important to have a complete understanding of pedestrian behavior. People may move more slowly than motor vehicles but they are free to make many more quick changes in speed and direction. Recording them is a task that, until now, has always been done by human observers.

Colin Usher and Wayne Daley of Georgia Tech Research Institute are developing and testing a mobile monitoring system that can be deployed quickly to gather and analyze video. It's a trailer with a telescopic mast up to 25ft (7.6m) high, with high-definition cameras and data storage powered by solar panels. Custom software using commercial algorithms identifies and characterizes pedestrians and their behavior. The setup is pictured above.

Preliminary trials counted pedestrians at an accuracy of 88% and the researchers believe that the algorithms can be made more accurate. "This is an ongoing research project due to finish this summer, and the results presented are initial results from field testing," says Usher. It's anticipated that when the system is fully fledged, it will be applicable not only to analyzing the behavior of pedestrians but also that of cyclists.

gaze patterns of drivers approaching such a crosswalk, where other vehicles have stopped in an adjacent lane, to see how to make them safer for pedestrians.

The study revealed that shark-tooth pavement markings 25-50ft in advance of the crosswalk seemed to do the trick. "Drivers scanned more for pedestrians," says post-doc research fellow Dr Siby Samuel. "These additional markings have the ability to draw drivers' attention and give them more time to stop. Also, drivers were more likely to scan for pedestrians at the far side of the crosswalk at intersections, as opposed to the near side."

Of course, the law of unintended consequences means that technology designed to improve safety might actually reduce it. This may be the case when flashing LED beacons are attached to pedestrian crossing signs. They're meant to draw drivers' attention to the sign and the adjacent road space, but the lights could dazzle drivers and obscure VRUs in their path.

This has prompted the Federal Highway Authority (FHWA) to fund a team at Texas A&M University's Transportation Institute (TTI). Its experiments show that the brightest lights at night slow drivers' perception of pedestrians by 8.5% compared with the time it takes when there are no beacons. Also, to minimize the effect of the glare, the lights ought to be placed on top of the signs, rather than at the bottom.

To make sure there are no other unintended consequences of repositioning them, the FHWA is funding a second phase of the study. "It will determine whether the number of drivers yielding to pedestrians attempting to cross within a marked crosswalk changes when the rapid-flash beacons are located above, or within, the sign rather than below it," says Kay Fitzpatrick, senior research engineer at TTI. "That effort should be completed toward the end of the summer or early fall this year."

Wheel safety

Unlike pedestrians, cyclists are never usually separated from motorized traffic. Protecting these road users is seen increasingly as one way to foster more livable cities because the more that people cycle, the fewer vehicles are needed, leading to lower infrastructure and environmental costs and a healthier population.

However, people will only cycle if they feel safe, so some choose to wear a helmet because it can reduce the severity of skull injuries in low-speed impacts. Yet there's no accurate analysis of the benefits because it is not known how helmets affect cycling collision

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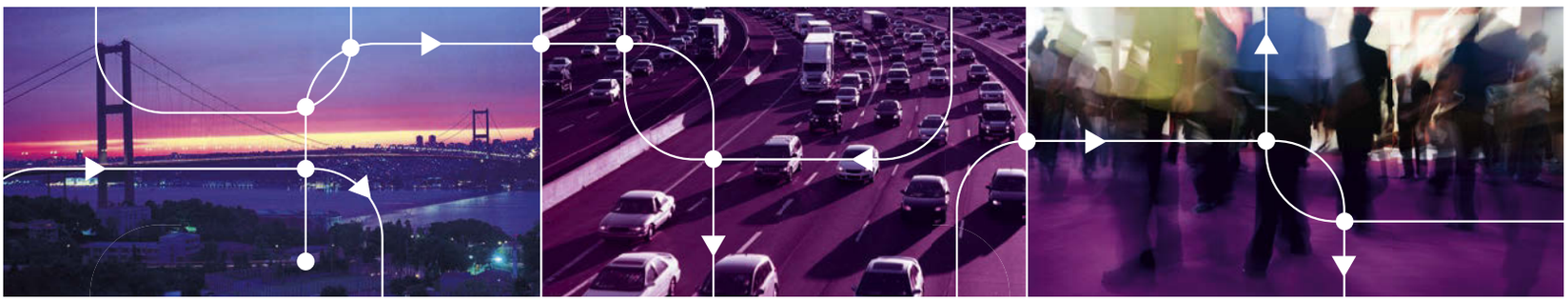

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rates. Some cyclists might take more risks when wearing a helmet – or perhaps only the most cautious wear them in the first place.

This conundrum may soon be solved thanks to efforts led by Dr Mohamed Zaki at the University of British Columbia. He showed that, by using video footage, a computer can automatically classify cyclist behavior in traffic, in terms of their tracks and speed, and was therefore encouraged to go one step further. "One reviewer of our paper asked if we could automatically detect helmet-wearing cyclists," says Zaki.

So they enhanced their analysis and now their software can also see which cyclists are wearing helmets and which are not. In trials, their algorithms have been 90% accurate. "The results were satisfactory for the given data set," says Zaki, "We did an evaluation of the classifiers and assessed the potential errors including the false positives."

Having developed the system using video from its home city of Vancouver, the team is looking further afield. "We are continuing this line of research. We are expanding our cyclists data sets to include data from China and Australia," says Zaki. They want their work to help improve the efficiency and safety of cycling for commuters. However, some legislatures mandate wearing of helmets despite the very limited protection they afford, and it's now credible that footage from existing traffic cameras could be harnessed to automatically identify when cyclists flout the law.

Image analysis of another kind is helping to reveal how cyclists decide which roads are more dangerous.

> The presence of six to nine vehicles on a street decreases the probability [of it being chosen as cycle-friendly] by 10.2 percentage points
>
> **Gulsah Akar, assistant professor of city and regional planning, Ohio State University**

By showing almost 60 images of streets to more than 200 people and asking if they would cycle down them, Jennifer S Evans-Cowley and Gulsah Akar of Ohio State University have discovered how cities could attract more cyclists on their networks.

"For instance, all else being equal, the presence of six to nine vehicles on the street decreases the probability of an image being chosen by 10.2 percentage points over an image with no vehicles on the street," says Akar. Streets with sidewalks, pedestrians, curves and more traffic lanes are perceived as safer for cycling, according to the survey. Those with parking lots are seen as more dangerous.

"We are continuing the research, looking at the perceived safety of intersections, from a pedestrian's perspective, for example," says Akar. "We have also shared the results with our university's transportation department, which is considering implementing our findings in the design of new transportation infrastructure."

Support for Scotland's Cycle Action Plan

Q-Free TDC Systems is helping local authorities in Scotland to monitor government efforts to increase numbers of cyclists and build more sustainability and fitness into personal mobility

Cycle Monitoring Units (CMUs) are currently being installed at 23 sites in Edinburgh by Q-Free TDC Systems. Installations are also presently underway at 21 sites across various towns and villages in Aberdeenshire, northern Scotland.

Edinburgh, in particular, is a very tricky environment in which to provide VRU monitoring, says Colin Reekie, TDC Systems regional account manager for Scotland. "It's a mixture of dedicated cycle lanes, combined cycle/pedestrian lanes, and cycle lanes in mixed traffic lanes," he explains. "In Edinburgh, the installations are on the City Council's Cycle Route Network as well as on sections of the National Cycle Network, so we're demonstrating an ability to accurately report in some very demanding conditions."

The national goal, as part of the Cycle Action Plan for Scotland (CAPS), is to have 10% of everyday journeys in Scotland cycle-based by 2020, so there is a real need to have specific data on how and where people are cycling.

"Local authorities are keen to have filtered data that shows whether they are succeeding," Reekie continues. "At the same time, we're offering integrated pedestrian detection, which is a major selling point for us."

The Q-Free TDC HI-TRAC CMU is a piezoelectric-based solution that features roadside solar power and GRPS (cellular) connectivity. As a result, it is a very self-sufficient system – and its accuracy in comparison to inductive loops has been verified by independent testing.

"We have the capability to detect clusters of cycles, and to differentiate cycles' unique signature from, for instance, strollers and wheelchairs," says Reekie. "We also offer a very good pedestrian detection capability, which can help local authorities to monitor cycle/pedestrian interactions and remove conflicts there."

Q-Free TDC Systems also offers data hosting and maintenance. In the case of Edinburgh, it is providing just such a service, including monthly reporting, for a period of five years. In Aberdeenshire, the company is contracted to provide hosting and maintenance services for three years from the point of installation.

Lobbying for change

Making roads safer isn't just about improving technology – changing government policy and laws plays an important role

The European Transport Safety Council (ETSC) lobbies to reduce death and serious injuries on Europe's roads. "We hope the next revision of regulations will mandate the introduction of key technologies to mitigate speeding, drunk driving and the non-use of seatbelts," says policy director Ellen Townsend.

Intelligent speed assistance will help protect VRUs. "At the moment, technology limits the speeds of some commercial vehicles – but only to the maximum speed limit," she explains. "We want ISA [intelligent speed adaptation] to be introduced so that it aids drivers to abide by the local speed limit, whatever it is, wherever they are. It should be fitted to commercial and passenger vehicles, with an overridable system for the drivers of passenger cars."

Autonomous emergency braking should be required on all new passenger cars, light trucks and vans, not just on trucks and buses,

and more work is needed to progress pedestrian-specific AEB. Improved 'under run' protection on the side of large trucks, which fills the open space between the front and rear wheels, would save the lives of VRUs, who can be caught and dragged by current designs, according to ETSC.

"European road safety requirements should not be watered down in future trade agreements such as TTIP [Transatlantic Trade and Investment Partnership]," says Townsend. "And we are lobbying for the road safety audits that are currently applied mainly to principal motorways to be extended to all roads."

European pilots

The EU-funded VRUITS project is looking at how ITS can improve the safety, mobility and comfort of VRUs. With just under a year left of the three-year project, the 12 partners from eight countries are taking a VRU-centric approach. "There are no automotive partners in the project, mainly because they were not eager to join our consortium," says Johan Scholliers, project coordinator. "It wasn't a deliberate decision to exclude them and we had discussions with the automotive sector, but they decided not to join. At that time, the EC would only support limited pilots."

So, in this instance, the automotive sector, whose products are central to road safety, is distanced from the issue of improving safety for VRUs. "We do request their feedback through the ERTICO and iMobility forums," says Scholliers.

Among the pilots being developed within VRUITS are signal-controlled pedestrian crossings in Spain, which connect wirelessly to an app on Android phones via Bluetooth beacons. As the person approaches the crossing, the app counts down to when the traffic will be stopped. It uses the phone's screen to deliver the information in real time. Also, the crossing has a camera that observes pedestrians as they cross, to extend the duration of the green light if they need the extra time.

> We want intelligent speed adaptation to be introduced so that it aids drivers to abide by the local speed limit, whatever it is, wherever they are
>
> **Ellen Townsend, policy director, European Transport Safety Council (ETSC)**

In March, the Dutch national research center, TNO, hosted the demonstration of another VRUITS pilot that showed how cyclists can be equipped to be part of a cooperative vehicle network. By sharing the cyclist's location, direction and speed information with cars that have cooperative autonomous emergency functions, the system prevents collisions with at least three seconds' notice. The VRUITS pilots will inform recommendations about the functionality of technologies that should be considered for use in future developments.

Compared with enhancing the safety of vehicle occupants, protecting vulnerable road users is clearly more complex. Pedestrians and cyclists behave less predictably than motorized vehicles, which are limited in their movements by the mechanics of steering. Their vulnerability, however, makes them less likely to be the cause of fatalities and more likely to be innocent victims. Responsible countries are beginning to recognize their needs.

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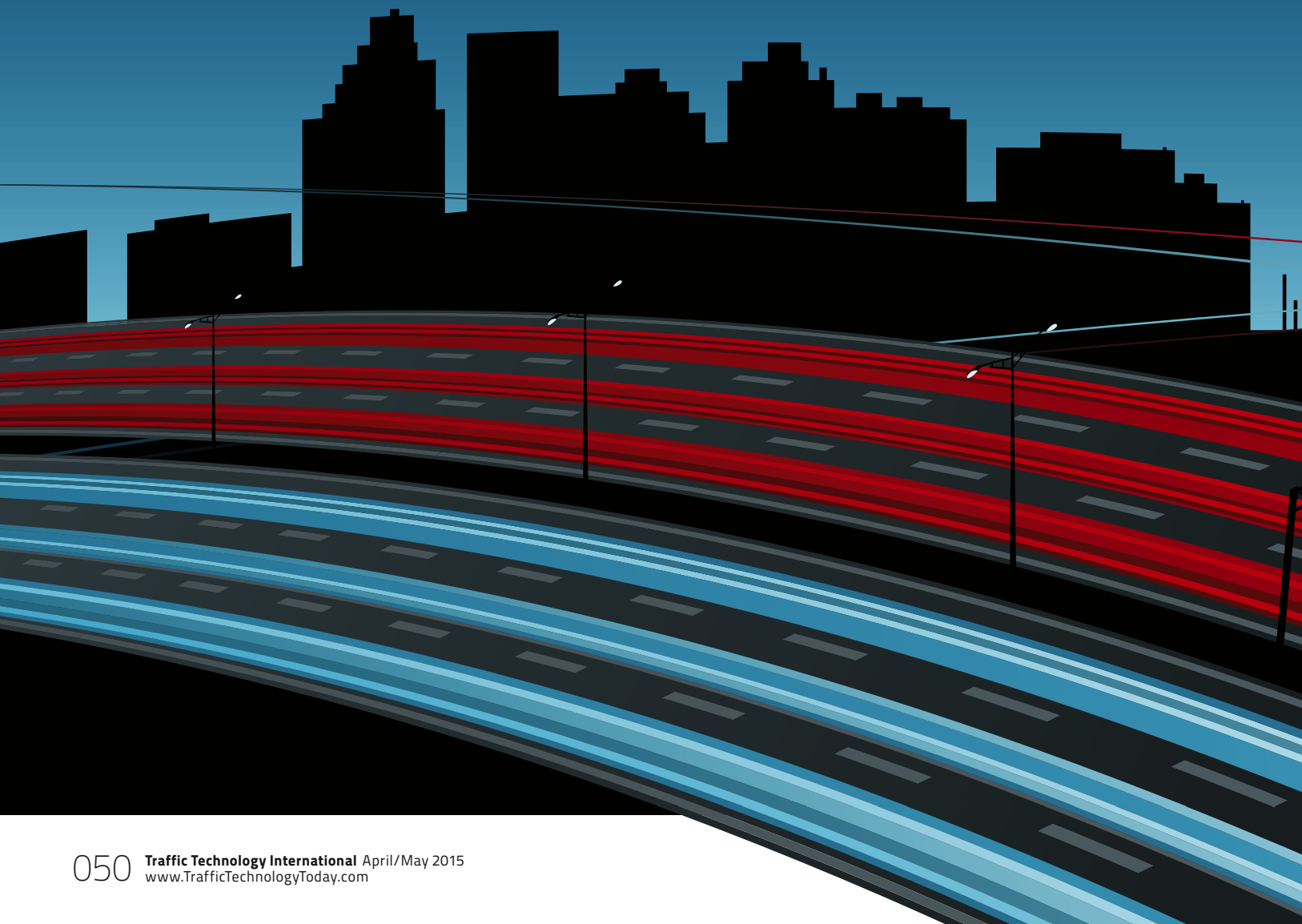
LEADING THE WAY

Leading the charge

Charging motorists to enter the heart of a city is a proven way to decrease congestion and reduce local pollution. However, implementing such schemes is often a bumpy ride. **Chloe Barrow** looks at some operational systems and the challenges facing those planned for the future



Congestion charging has come a long way: an idea that started in Singapore back in the 1970s, with police officers checking paper documents, has now been adopted in other countries and is enforced by high-tech automatic license plate recognition (ALPR) cameras and even global positioning satellites. But despite successfully reducing urban traffic levels, lowering pollution and raising public funds, road user charging has been embraced by only a major few cities – and not a single city-based road charge exists in the USA.

While cities such as London and Stockholm seek to improve their existing systems through technological innovations, other cities are fighting to win public approval so that they too can start charging vehicles to enter densely congested urban areas.

The London Congestion Charge, which began in 2003, is one of the largest road user charging schemes in the world. The £160m (US$258m) project resulted in better circulation in the inner city, boosted the economy and reduced pollution, according to Paul Cowperthwaite, general manager for congestion charge services at Transport for London (TfL). "The scheme has reduced levels of carbon dioxide and has generated more than £1.2bn (US$1.9bn), which has been invested back into London's transportation network," he says.

As one of the first cities to implement congestion charging, London faced numerous challenges. "When we started, nobody had really used ALPR technology on the scale we were using it, so we didn't know if the cameras would be able to cope," says Cowperthwaite.

TfL felt that an area-based scheme would be most effective in solving the capital's congestion problems. "We needed a robust solution and felt that ALPR technology was the best option," explains Cowperthwaite. "It supports the charging mechanisms as well as the enforcement process."

London's ALPR camera system has proved to be very reliable. Approximately 97% of all vehicles driving within the 8.1 square-mile zone are captured. "The accuracy of the ALPR interpretation is approximately 86%, i.e. only 14 out of every 100 vehicles captured are misread with the most common errors being the letter 'S' being interpreted as a '5'," says Cowperthwaite. "However, these errors are captured and rectified through manual checking."

Cowperthwaite would recommend an ALPR-based approach to other cities looking to implement similar programs. "The scheme has proved very successful, with a sustained reduction in traffic," he says. "We have also been able to deliver customer improvements. Through the use of technology and the internet, we were able to introduce an auto-payment system in 2011, meaning that more than 90% of our customers now self-serve."

TfL puts its 85% customer satisfaction rating down to listening to what people want and investing in desirable technology. "We are mindful of changes in technology and know it's important to keep reviewing the effectiveness of our solutions," says Cowperthwaite. "We will be making improvements to our system and cameras over the coming years, including improving our payment channels with the introduction of an app, introducing improved and new functionality for our customers with an enhanced website, and enabling customers to apply for discounts online. We will also eventually replace our current camera network with high-definition cameras."

Having previously worked with IBM, TfL signed a contract with Capita late last year, which it says makes good use of commercial off-the-shelf products to lower costs and help deliver a better customer experience.

In January 2015, TfL awarded a new contract to Siemens to upgrade and operate the city's detection and enforcement infrastructure (D&EI), including the supply of equipment, systems and services to monitor the capital's traffic as part of TfL's Low Emission Zone (LEZ) and Congestion Charging schemes. The five-year agreement includes the replacement, support, maintenance and operation of in-station systems and services, including the replacement of ALPR cameras and associated infrastructure for the purpose of enforcement and monitoring. The ALPR cameras will be located on streets across various sites, including transportable ALPR for the LEZ scheme.

Support network

Stockholm was the second European city to use ALPR to enforce a congestion charge. Beginning as a pilot scheme in 2006, it succeeded in winning public support for long-term implementation, despite controversially spanning the entire city and charging road users for entering and exiting the zone. "Public acceptance was a challenge before implementation, but public perception swung strongly in favor very quickly after the trial began and people saw the benefits," says Daniel Firth, chief transportation strategy officer at the City of Stockholm's traffic administration.

> When we started, nobody had really used ALPR technology on the scale we were using it, so we didn't know if the cameras would be able to cope
>
> **Paul Cowperthwaite, general manager for road-user charging at TfL, UK**

(Above) **Traffic in London is managed by one of the most successful schemes in the world** (Left) **Stockholm's congestion charging scheme has reduced the volume of traffic in the city center**

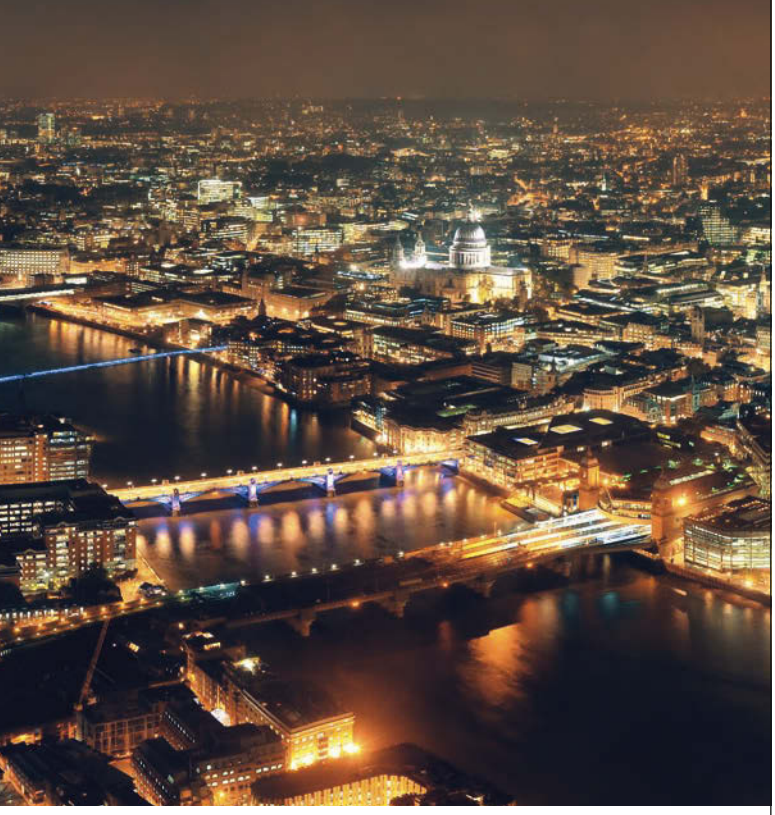
Firth, who worked on congestion charging at TfL at the time of the Stockholm trial, confides that the Swedish capital consulted London and cities in Norway when it implemented the system.

Stockholm's 18 control points at city entrances and exits were fitted with ALPR cameras to register vehicles automatically. Some vehicles could also be identified via electronic onboard units used for direct debit payment.

Like London, Stockholm has since been striving to reduce its administration costs by making technological adjustments to the system. "When it began operating, the system used cameras and DSRC [direct short-range communications] tag and beacon equipment," says Firth. "However, it quickly became apparent that the camera system was more than sufficient, and the tag and beacon equipment was really just an unnecessary cost."

Since the implementation of the program in 2006, traffic levels in Stockholm have fallen by 15-20% and average travel times have shortened by 50%. Local pollution levels have also decreased and the overall accuracy of the system has increased public support.

In January 2016, some major changes will be made to the city's congestion tax, including its first price hike since the system began – a 50% increase in peak-hour charges – and the introduction of a charge on the



Essingeleden [E4] motorway. "Revenues from the new charges will be used to extend the metro network with 10 new stations," says Firth.

A need for change

Following the success of the schemes in London and Stockholm, other congested cities around the world are now investigating how congestion charging could solve their traffic problems.

The San Francisco County Transportation Authority (SFCTA) has been mulling over plans to install a congestion charging system for years. If the proposals do go ahead, San Francisco would be the first city in the USA to introduce this kind of road charge, following New York's failed initiative in 2008.

"We did a study back in 2007 to look at whether congestion charging is something that could work in San Francisco," says Michael Schwartz, senior transportation planner at the SFCTA. "Then in 2010, the study was adapted and we found that it would work, so the next step was an environmental review followed by implementation."

The plan was to follow London's example – using ALPR cameras to photograph vehicles entering and exiting the city's most congested areas at the busiest times of day. But the proposed scheme, which was due to commence in 2015, was put on hold. "It was the middle of a recession and so traffic levels had gone down, and there wasn't the feeling that we needed to do this tomorrow," recalls Schwartz. "Since that time, our economy has come roaring back. The job market is back and there's a ton of residential building happening, particularly in the downtown core where there's the most congestion. So there's a growing acknowledgement that we need to figure something out and congestion pricing is part of the solution we're looking into."

As Schwartz points out, the decision making and politics behind such a scheme is usually much more time-consuming than the actual implementation. "Once we have approval, it should be quick as we're

not tearing up or closing down roads," he says. "But I can't see it getting off the ground any earlier than 2016, assuming that people continue to want to do it."

Conflict and interest

Belgium has also been investigating congestion charging. According to Inrix's latest traffic report, Brussels, the capital city and center of European politics, is the most congested city in the European Union, followed closely by the country's second-largest city, Antwerp.

In a bid to resolve Brussels' traffic woes, last year the government of the Brussels-Capital Region commissioned a study on congestion charging for passenger vehicles, as well as a trial GPS-based kilometer charge in the city.

"The technical studies highlighted the benefits of introducing a congestion charge in terms of reducing congestion and increased revenues," explains Pierre Courbe, mobility project manager at the Fédération Inter-Environnement Wallonie. The findings of the study showed that a €3 (US$3.3)-per-day road-user charge in the city would generate €458m (US$574m) a year, which is roughly equal to the yearly direct income from the Brussels Intercommunal Transport Company, STIB, according to Courbe.

However, public response to the scheme has been negative. In fact, an online petition opposing the scheme gained an impressive 170,000 signatories, according to Reuters. "Unfortunately politicians fear public opposition," says Courbe. "During a political debate in May 2014 [just before the regional elections in Belgium], all the parties except one declared they were opposed to a congestion charge."

Discussions on how to solve the traffic problems in Belgium's major cities continue.

Delhi also hit the headlines last summer when the city's transport department revealed plans to introduce a congestion tax in the hope of easing growing traffic and pollution problems. Similar to London, the proposed tax would involve charging private vehicles a fee to enter specific congestion charge zones.

"Congestion pricing is becoming a part of mobility planning in Indian cities," says Anumita Roychowdhury, executive director of the Centre for Science and Environment, New Delhi. "Currently, with the kind of taxation and pricing policy we have in the transportation sector, car owners do not pay adequately for using the road space and public spaces, and this is affecting the environment."

Indeed, a 2014 study by the World Health Organization ranked New Delhi as the world's most polluted city, although the findings were rejected by the Indian government.

Delhi is looking to cities such as London and Stockholm as examples where a road user fee has worked, but is mindful that there is no one-size-fits-all solution when it comes to conquering congestion. For a congestion charge to be an effective deterrent, its implementation would need to be combined with other investments. Driving is particularly popular in Indian cities because cars are relatively inexpensive to buy and there is also a lack of dependable public transportation. Even though Delhi has a modern underground railway system, other mass-transit systems need to be developed, and be made cheaper and more reliable, to encourage commuters to leave their cars at home.

Singapore joins the space race

The pioneer in road user charging is to develop an infrastructure-free system using GNSS and intelligent onboard units

Having introduced the world's first-ever congestion charge in 1975, Singapore was streets ahead of its time. Over the years, the city-state's approach has progressed from a low-tech manual operation, to a high-tech digital system.

The initial area license system, which charged drivers a flat rate for unlimited entries into the city center, resulted in a reduction in traffic and road accidents. However, the system was cumbersome, requiring police officers to carry out visual checks and record violations at the 34 overhead gantries along the boundaries of the restricted zone.

In 1998, a more user-friendly electronic road pricing (ERP) program was introduced. Eighty ERP gantries are positioned on all roads linking into Singapore's central business district. The system uses sensors placed on two gantries, one in front of the other.

There are also ALPR cameras attached to the gantries to capture the license plates of vehicles passing through.

The southern Asian superpower is now set to take another landmark step, as the city's Land Transport Authority announced plans in October to develop a next-generation electronic road pricing system based on GNSS technology. The new system, which is scheduled for deployment by 2020, will change the way motorists are charged, with them paying for the distance they travel on congested roads rather than a flat fee once they enter an ERP zone.

> Public acceptance was a challenge before implementation, but public perception swung strongly in favor very quickly after the trial began
>
> **Daniel Firth, chief transportation strategy officer at the City of Stockholm's Traffic Administration**

(Above left) **Road authorities are still looking for ways to reduce congestion in Brussels**

As ITS America convenes for its Annual Meeting, USDOT assistant secretary for research and technology **Greg Winfree** discusses what's next for the transportation industry in the USA – and the world

Interviewed by Tom Stone

> There will be a lot of fascinating developments from brilliant minds looking at this 'data tsunami' and trying to figure out how to surf it to shore

As this issue goes to press, the US Highway Trust Fund is nearing insolvency with federal funding for transportation projects set to expire at the end of May. It is fervently hoped that those reading this at the ITS America Annual Meeting in Pittsburgh, which begins on May 31, will have received good news about Congress approving the Grow America act, which will secure the fund for the next six years. But whether the news is good or bad, one thing is for certain: the days of short-term funding, if not over, must surely be numbered. It's a subject Greg Winfree, the assistant secretary for research and technology at the US Department of Transportation (USDOT), is passionate about.

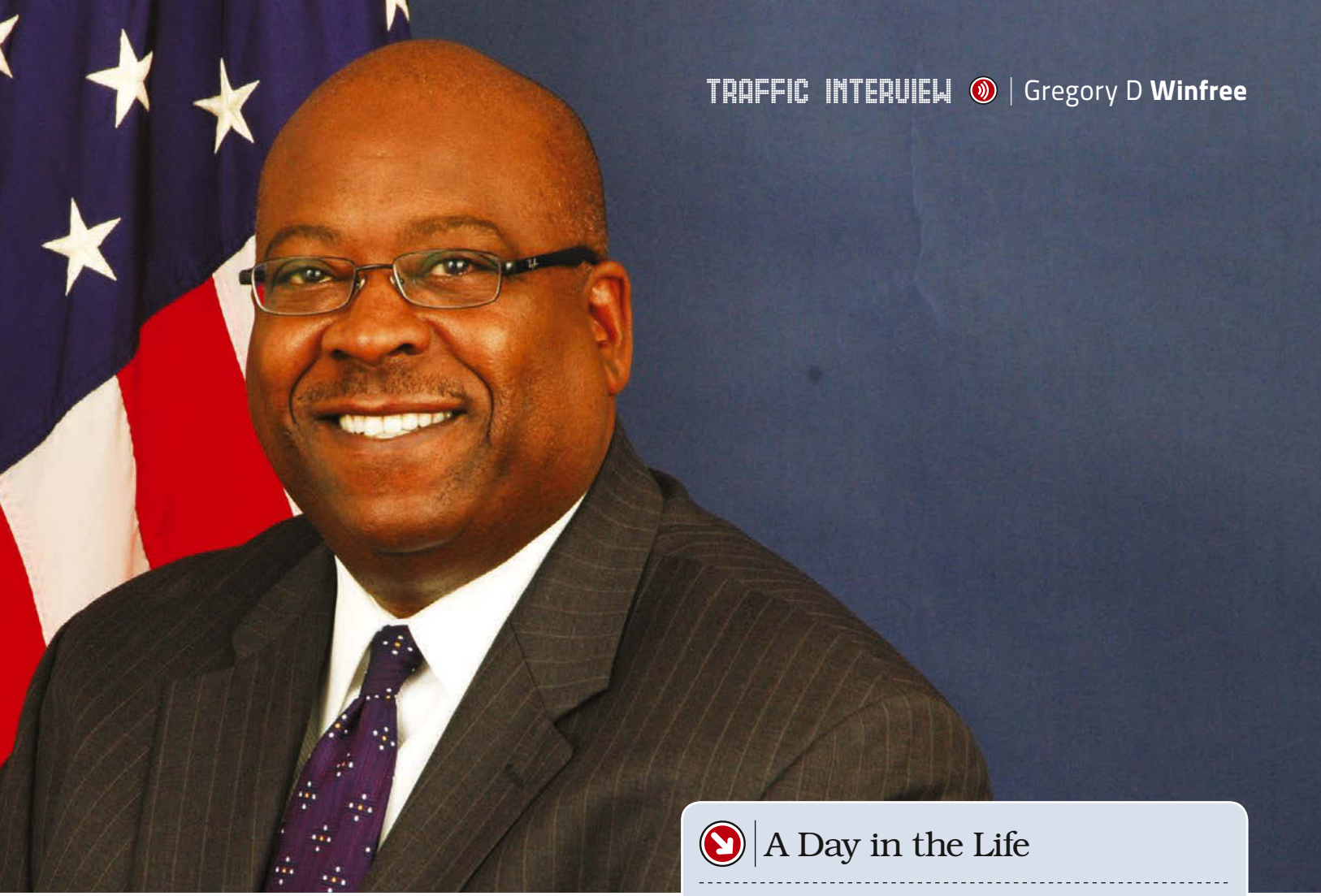
"We need to get out of short-term emergency funding," he says. "Two-year transportation bills do not work on a real-world timescale in the transportation sector. Major projects require careful planning – from environmental responsibility to contractor selection and all the attendant procurement requirements, as well as the engineering requirements. It's not a two-year proposition to fund and construct a bridge, highway paving or any other fundamental infrastructure project. Our state partners are getting squeezed because they can't engage in long-term planning with short-term funding.

"The Grow America act changes the discourse about funding for transportation," says Winfree. "It's a huge benefit to have a well-considered, well-crafted proposal that talks about six-year funding, because we've been stuck in continuing resolutions and two-year bills. Transportation is an issue that Congressional members' constituents care about, and are vocal about. This should not be a political issue. We can't continue to kick the can down the road."

Focus on improvements

Whatever happens with funding, Winfree is clear that his department will continue to work with the ITS community in efforts to make transportation smarter – and the ITS America Annual Meeting is a big part of that. "Our work with ITS America is paramount to maintaining continuity with the many private sector actors involved in ITS deployment – from OEMs, suppliers and technology firms to infrastructure and construction firms," says Winfree. "The high visibility of ITS America, and its Annual Meeting, provides an excellent forum for key decision makers to understand where Intelligent Transportation Systems are headed."

So, just what is the trajectory of advanced traffic management? From Winfree's point of view, improving road safety is one of the biggest priorities and connected vehicles offer one of the best opportunities in decades to do this. "The successes in the connected vehicle realm are based upon the uninterrupted availability of the 5.9GHz dedicated short-range communications (DSRC) spectrum. Our plan is to have all road users connected so that vehicles know what motorcyclists, pedestrians and



bicyclists are doing, and vice versa," he says. "Japanese researchers have developed a chipset that school children can put in their backpacks. When these children are in and around traffic, other road users are aware of what they are doing. We haven't taken that step yet, but that's the kind of research that is currently in existence."

New research is also looking at the potential of using smartphones to enhance safety in a connected-vehicle environment. "Maricopa County Department of Transportation has been working with the University of Arizona on a test platform called Smart Drive that is designed to test connected-vehicle prioritization technology for emergency vehicles and public transport," Winfree explains. "They have also developed a smartphone app that enables visually impaired pedestrians to communicate with intersections, influence when the lights change and have additional time to cross the street."

This year's Consumer Electronics Show (CES) in Las Vegas revealed to what extent smartphone manufacturers are planning for a connected environment. "Ultimately connected-vehicle technology will be within smartphones," Winfree confirms. "But we should keep in mind that chipsets might also have a place in a connected environment – perhaps for younger children whose parents don't want them to carry smart devices."

With international public and private sectors united in the venture toward vehicle autonomy and connectivity, Winfree notes that governments should play an active role in developments. "While the industry and academia have the flexibility to innovate, governments play an essential role in ensuring standards harmonization, international interoperability and overall policies for how this will work in different regions," he says.

Interoperability, for example, is an important part of standards harmonization. "It not only ensures that vehicles work border to border, but also gives manufacturers comfort in that they only have to build to one standard, i.e., they don't need different cars for different countries," says Winfree. "Having just one set playbook on how to develop these vehicles is attractive to manufacturers, and to governments, because it helps keep our roadways safe."

There was a lot of excitement in the industry after the National Highway Traffic Safety Administration (NHTSA) announced in August 2014 that it would be making rules with respect to V2V in the US car fleet. "The announcement said to the industry, 'This is real, this is moving forward and this

A Day in the Life

Winfree usually starts his working day by making a to-do list, but he admits that: "Within five minutes, the list is no longer relevant!"

"The interesting thing about being in this office is that we have connections and relationships with every other operating administration within the department," he says. "We cover everything; from the actual research and engineering technology work at our Volpe center; through training at our Transportation Safety Institute in Oklahoma City; our program offices with GPS civilian responsibility in our office of positioning, navigation and timing; the collection of world-class statistics through our Bureau of Transportation Statistics; as well as our UTC program and research."

As a result, there is no such thing as a typical day for Winfree. "No two days are ever the same, but every day is interesting and a lot of fun," he says. "Furthermore no issues outlast a day because we address them as they arise. We work collaboratively with our modal partners and cross-governmental partners."

(Left) **Responsibility for approving highway funding in the USA rests on Capitol Hill, close to Winfree's office**

is the future,'" says Winfree. "As a result of the announcement, GM felt emboldened to step up and say, 'We'll have a car on the road by 2017.' The governmental role in developments is to clear the way for innovation to grow. I think that's why you see a great marriage between government and industry in moving this forward."

Data dilemma

Of course, a world of connected vehicles will generate unprecedented amounts of data and new challenges in dealing with it. "Our CIO Richard McKinney calls it a 'data tsunami'," says Winfree. "I think that's a good way to look at it. We have requests for proposals and a request for information from the industry about a Security Certificate Management system. Essentially we'll need a system that allows connected vehicles to periodically change their security certificates. They need to be changed frequently enough for you to be able to quickly detect any nefarious activity or a vehicle that's malfunctioning."

This, however, presents some feasibility challenges. "Let's say a car needs to have six certificates a day, multiplied by however many million vehicles we have in the USA – that's a pretty big data lift," says Winfree. "Not so much from a data generation perspective, but from a data logistics and movement perspective. We'll need to figure out what we need to keep and what we don't, and that will be a challenge."

While there will certainly be a lot of information to handle, the anonymity of DSRC should, in theory, minimize privacy and security concerns. In a connected environment, information created by vehicles will be anonymous and short term with regard to relative positioning. It will, however, be accessible by the public.

"I don't see the need to store randomized data about what vehicles are doing, but there could well be innovators – software and app developers – out there that could find some value in this information," says Winfree. "So we intend to have data available that the people will be able to use as they see fit. It is a data democratization process. President Obama put forth an executive order that requires federal agencies, departments and offices to make data generally available. So what we're holding on to is actually now public information. There will be a lot of fascinating developments from those brilliant minds who are looking at this 'tsunami' and trying to figure out how to surf it to shore. It'll be an interesting time."

Gregory Winfree joined the USDOT's Research and Innovative Technology Administration (RITA) in March 2010 and was sworn in as its fourth administrator in October 2013. In January 2014, RITA was elevated to the newly-created Office of the Assistant Secretary for Research and Technology, and Winfree was sworn in as the assistant secretary. During his tenure, Winfree has also served as the agency's chief counsel, deputy administrator and acting administrator, and as chairman of the Innovation Council.

Prior to joining the USDOT, Winfree served in several corporate legal roles and was a trial attorney in the Housing and Civil Enforcement Section of the US Department of Justice, Civil Rights Division. He started his legal career as an associate at the Venable law firm in Washington DC.

The human element

In an increasingly technologically driven world, humans are still of prime importance. None of the new systems being developed can be properly deployed without the right experience. It's a problem that explains why there is another important part of Winfree's role within the USDOT. "This office is also responsible for workforce development for the DOT," he says. "So, we have mentoring programs for high school kids and we have other outreach specifically to girls in the STEM disciplines: science, technology, engineering and math. We're looking at it from elementary school, right through to university."

The education drive is all about heading off a future staffing crisis as current members of the transportation workforce move into retirement or other endeavors over the next 10 years. "One of the challenges for transportation is that on the surface it doesn't resonate like working for Google, Microsoft or Intel," he says. "It's unfortunate because just about every kid plays with some kind of Tonka truck, but when they get older they don't think of transportation as an industry. The truth is that no matter what profession or job experience you've developed, there's an application for it in transportation. I was a lawyer and found myself here with a role helping this organization move forward. We need to do a better job of marketing what transportation is and what it does.

"When I first came to transportation, I didn't really have a perspective of it as a system," continues Winfree. "When I was a kid there was a parkway in Long Island New York called the Southern State Parkway that had a 10 cent toll. And I always used to say to my mother, 'Mom, why are we paying this toll, if the road is already here?' I had no concept of what it costs to maintain and keep a roadway in a state of good repair – bridges and overpasses and that sort of thing. And that's what my 10 cents was going toward. But I had no reasoning to put it all together.

"Once you get involved you find out that the efficient movement of people and goods is a very complex undertaking. So marketing is what is needed. Because the better perspective folks have on what transportation is and what it needs – as the foundation for our country's prosperity – the better."

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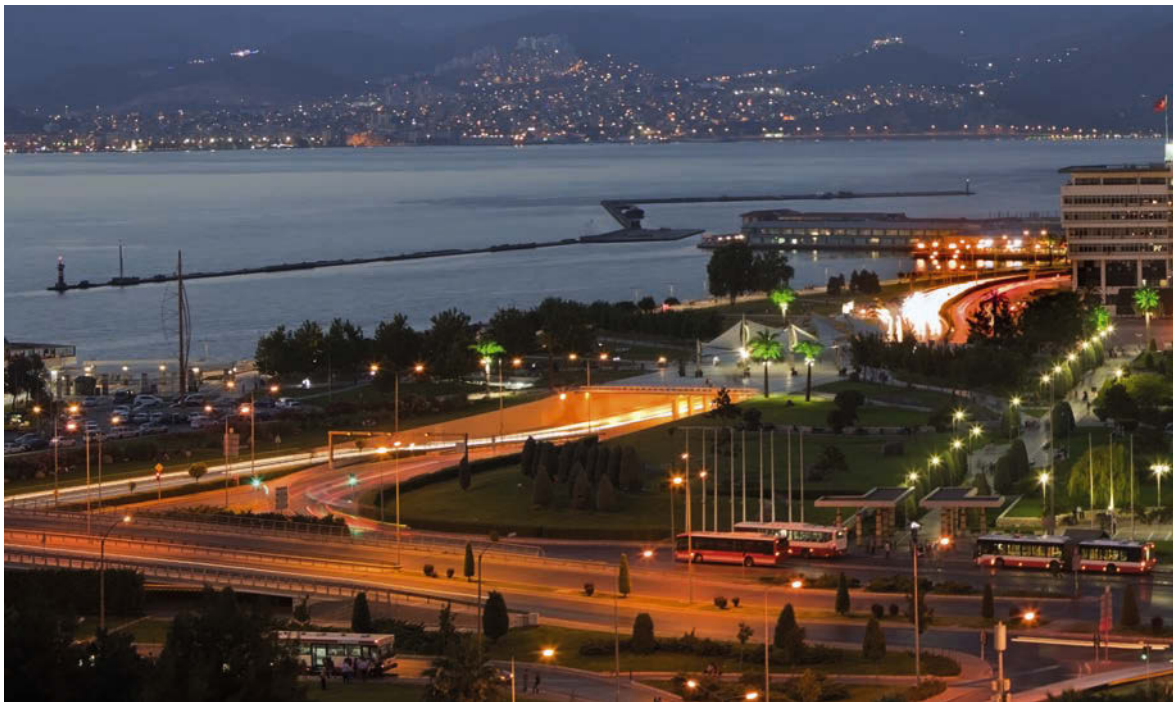
Izmir gets Turkey's first fully adaptive traffic management system

Earlier this year, the Greater Izmir Metropolitan Municipality began a new project, its Fully Adaptive Traffic Management, Control and Information System. It is based on similar projects being rolled out in cities around the world to enhance the safety of road users and reduce the environmental impact of traffic systems for years to come. This, however, is the first comprehensive metropolitan traffic management system to be implemented in Turkey. The project has been awarded to a AZD Praha SRO – Cross Zlin joint venture.



Once completed, the system will be capable of: automatically adjusting signal timings to the most appropriate plan, based on real-time information; managing parking across the city; detecting traffic violations; and automatically setting up diversions in the event of an incident. Information will constantly be relayed back to road users using a network of variable message signs (VMS).

In the period until the completion of the tender, full adaptive intersection control devices will be submitted to the management to be tested and set up in appropriate locations.

AZD Praha SRO – Cross Zlin has chosen the Turkish IT solution provider, Ortana AS, to supply 48 VMS and 60 parking VMS, including all steel structures/poles, roadside control cabinets and all site work and installations on a turnkey basis, in the city of Izmir. The contract also includes Ortana's GIS-based integrated service management control center software.

A complete picture

Ortana signs will display a wealth of information for drivers, from dynamic traffic information, road condition and weather forecasts, to general warnings to drivers and potential alternative routing. Parking variable message signs will inform road users about availability of spaces on the route.

Need to know

What makes Ortana VMS ideal for Izmir's new traffic management system?

- Full color and full matrix displays certified to EN12966 by SGS Intron
- Low power consumption – maximum: 196W/m² daytime: 75W/m² night-time: 10W/m²
- Patented front optical lenses have a 15-year life
- UV-protected paint gives a high level of visibility
- Control center software for detailed remote monitoring
- Steel structures comply with Eurocode-3 and EN 353-1 standard

The Metropolitan Municipality has already successfully completed factory acceptance tests on the VMS, and the project's pilot regional installations have already been completed.

Technical excellence

The VMS are all in full color and full matrix, and certificated according to the latest standards of EN12966 by SGS Intron's independent European Union laboratory. SGS Intron provided Ortana with the first EN12966 certificate in the world in 2006, making Ortana the first VMS supplier certified according to these standards.

Ortana's VMS were mainly chosen due to the efficiency of their power consumption. With the maximum power consumption of 196W/m², the nominal daytime power consumption of 75W/m² and 10W/m² consumption at night,

(Left) **Izmir is soon to have the most advanced traffic management system in Turkey** (Far left) **Ortana VMS are already providing motorists in the city with valuable information**

Ortana is setting the standard in the market.

The specially designed and patented front optical lenses have a 15-year life and the UV protected paint at the front face of the signs provide a high level of visibility, long distance readability, and high optical performance.

Detailed remote monitoring of the signs' status is possible at all times from the control center using Ortana's control center software. All major and minor display errors in the pixel base are reported to the control center as WYSIWYG (what you see is what you get) and are visible to the operators at all times. Pixel errors, luminous values, heater and cooler fan status, internal sensor status, and power values are also monitored at the control center. Ortana's GIS-based integrated service management system provides plans, incident detection, alarms and events for all its VMS.

The steel structures of the VMS are designed according to Eurocode-3 standard including vertical line in compliance with EN353-1 standard. Ortana roadside cabinets are equipped with all power, data protection and UPS systems.

A plan for the future

Greater Izmir Metropolitan Municipality is planning to finish the urban traffic management project within 720 days. Intersections and parking lots will be managed with the use of approximately 700 video cameras and loop detectors; 145 traffic measurement cameras and 64 traffic detectors will be used to provide dynamic city traffic information.
Red light, speed and parking violations will be electronically monitored by video cameras and traffic sensors.

The collected traffic density information from cameras and sensors will be available to citizens on VMS displays, cell phones, websites, through call centers, and on TV and radio broadcasts. This makes it easy for users to understand where there is heavy traffic and whether they are able to take alternative routes. This system ensures the shortest travel time and the lowest possible fuel consumption. Furthermore, the system has an open structure that means it is adaptable to future needs and expansions.

Smarter data

The Fully Adaptive Traffic Management, Control and Information System will collect a vast amount of data that will be used to make journeys quicker and safer. Initially, 402 signaled intersections under the responsibility of the Metropolitan Municipality will be connected to this dynamic system, for smarter signal timings. However, the system is designed to support up to 900 intersections and is fully adaptable for the future.

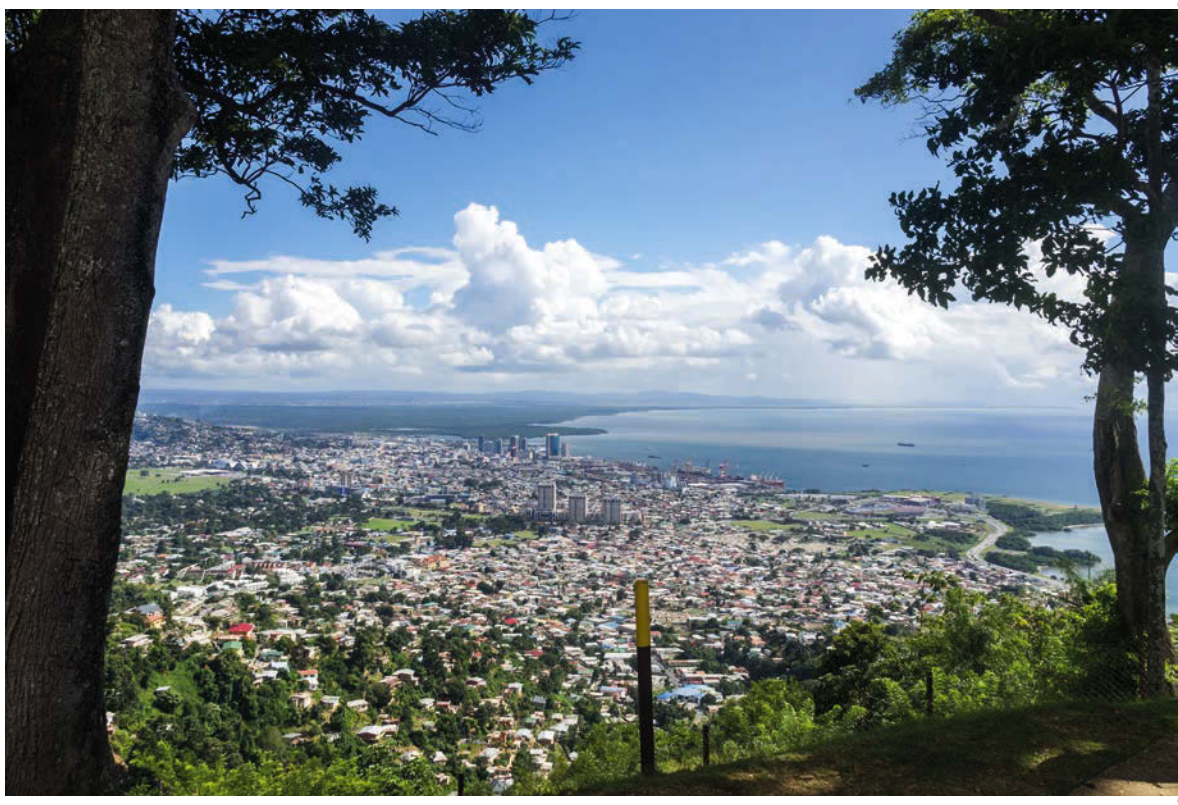
The system will also help to make roads safer for vulnerable road users. Vehicle entrance/exit to the pedestrian areas in the city will be controlled. And, in total, 182 audio tactile pedestrian controllers for vision-impaired pedestrians will be used at the city, at 61 signalized locations.

A Parking Violation Determination System will also be included and public transport priority will be taken into consideration in the adaptive signalization design.

When the system is completed, the travel and waiting time at the intersections will be reduced significantly. The new system will enhance road capabilities, improve safety for drivers and pedestrians, decrease emission oscillation ratios, reduce fuel consumption, monitor the traffic and pedestrian flow alike, control and follow up traffic violations, detect central errors, and minimize emergency service response times. ○

Modeling the future of island traffic in Trinidad and Tobago

On an island, traffic problems can quickly spiral out of control. Alternative routes are limited and traffic is usually concentrated on urban centers close to road-restricting coastlines. On the southwestern peninsula of the Caribbean island of Trinidad, roads are becoming overloaded more than most. The narrowing coastline to the north and south sandwiches between it several urban regions: Debe, Penal, Siparia, Fyzabad, La Romaine, Oropouche, La Brea and Point Fortin. Road building in the region is seen as essential, and some improvements have already been carried out. Now, a local activist group (LAG) has developed a plan for where the next essential arteries should be constructed. Transportation planning consultant Dr Rae J Furlonge used TSS-Transport Simulation Systems' Aimsun software to model exactly what effects the proposed improvements will have.



Getting active

The LAG has presented its Optimum Connectivity Proposal to the National Infrastructure Development Company Limited. The LAG wants to capitalize on improvements to the main coastal highway (the South Trunk Road) by joining it up to the inland population center of Debe, using further road improvements. It is necessary, it says, to adjust the new arterial system to be closer to the urban centers from which the high traffic is generated.

The Optimum Connectivity Proposal includes a new four-lane highway and two-lane connecting road, which would be partly constructed by improving existing roads.

Need to know

Features of Aimsun 8 Expert's new four-step demand modeling

- Transportation modeling projects can now be started from scratch with raw geographical and socioeconomic data
- New objects include transportation modes, time periods, vectors, areas, generation/attraction and distribution data sets
- New visualization modes required by the traffic-demand modeling community

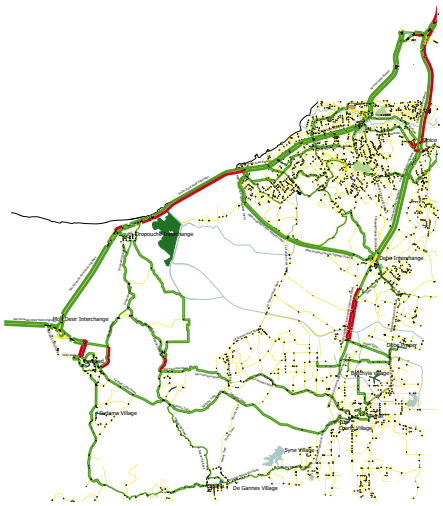
Assessing the impact

Aimsun software was used for travel-demand forecasting, as well as traffic macroscopic network modeling and analysis.

The software was able to: determine the functional road network requirements of the study area; build and edit the spatial network, including road, intersection and interchange types, as well as lane widths, number of lanes and other geometric features; determine the lane and intersection operational attributes; create traffic centroid nodes and compute OD traffic data matrix by mode, from data taken from traffic surveys collected in 2012; determine the link directional capacity and speed values; run the model using the Frank-Wolfe Method for Equilibrium Traffic Assignment; and display results on a map, showing traffic volume to capacity ratios.

Aimsun modeling established that the LAG proposals will lead to very high volume/capacity ratios (above 1.0) on key parts of the network and also significant and unnecessary overuse of the South Trunk Road expansion.

As a secondary conclusion the modeling also concluded that road hierarchy is not readily recognized by motorists in Trinidad and Tobago, with the primary consequence that they feel they should be allowed to use any roadway, in their quest for short-cuts. This practice, if permitted to continue, is likely to have dangerous consequences, such as the degradation of the quality



(Left) **Trinidad's urban centers are concentrated close to coastlines, which presents particular challenges when it comes to managing traffic**
(Above) **Aimsun software was used to model the potential effects of new road building on traffic flows in southwest Trinidad over the next 20 years**

of life for local residents and severe road safety implications.

Despite the drawbacks of the LAG proposal, the Aimsun models concluded that an urban primary arterial system is indeed urgently needed on Trinidad's southwestern peninsula to improve accessibility to the major urban centers in the region. And it will be necessary to adjust the new arterial system to be closer to urban centers from which the high traffic is generated. ○

by **Mike Schagrin**

USDOT's next big experiment – connected vehicle pilot deployments

In my previous column, I mentioned USDOT's Connected Vehicle (CV) Pilot Deployment program to establish several real-world deployments. The goal of these pilots is to demonstrate how CVs, generating vast amounts of data, can contribute to greater operational efficiencies for our roads.

The establishment of these sites is very important for the growth of the CV industry. These sites will become environments of innovation for technologies, applications and business models. These sites will provide a glimpse into the future on what a CV ecosystem can provide. And while the program being set up in 2015 may show only incremental improvements, it positions the industry for something much greater in 2017, when the feds initiate the second round of CV pilot deployments. By then, technology will be that much further along, the industry will have had more time to consider additional innovative applications, and travelers and road operators will have established more of a comfort level with the evolving CV capability and services.

Each site that gets selected is expected to establish a sustainable business model that extends beyond the federal funding. Sites are to become seeds for organic growth that also exhibit capability that has national relevance. Said another way, they are intended to operate without federal support and provide confidence to other locations that may be thinking of doing the same but may not want to be on the 'bleeding edge'.

Another interesting aspect of the CV Deployment Pilot program is that while it does not have any direct bearing on the NHTSA path toward regulation on DSRC, it does converge with this effort in a way that may be beneficial from the business model perspective. According to NHTSA's current plan, a mandate on the technology could begin around 2020. Coincidentally, the CV Pilot Deployment program concludes in 2020 as well. One of the issues with a successful launch of the DSRC is how do customers get value from the technology when it first comes out? The NHTSA regulation on DSRC pertains only to V2V safety and there won't be enough market penetration of the V2V technology to enable any noticeable benefits immediately. So, OEMs are concerned customers will think they are paying for something that has no immediate value. However, if they bundle the DSRC with other CV communications (cellular, wi-fi, satellite, etc), customers will get day-one benefits, albeit mostly from non-DSRC capability. And as DSRC penetration grows over time (both across the vehicle fleet and with the infrastructure), consumers will benefit from the additional capability and new services offered for many years to come.

"How will customers initially get value from DSRC technology?"

The connected vehicle environment is on the cusp of an industry explosion. While we hear things now and again about new developments in this area, it's the things we're not hearing about (yet) that will be truly exciting. The year 2020 will be a time of major convergence for the CV industry. And I didn't even mention 'connected automation'… ○

Mike Schagrin is former program manager for the ITS Connected Vehicle Safety and Vehicle Automation research programs at the USDOT's ITS Joint Program Office. Mike has now established Schagrin Consulting International, supporting clients in connected and automated vehicles. ***mike@schagrin-consulting.com***

Illustration: Ian Parratt, the-caricatureartist.co.uk

Copper/fiber mix cost-optimizes reliable ITS-network bandwidth

Creating a state-of-the-art ITS network requires a reliable and efficient underlying transport network. The bandwidth demands and performance expectations being imposed on that network are much more challenging now than in the past, due to the need to connect HD video cameras and to the proliferation of new IP-based sensors, electronic signs and controllers, and legacy serial devices throughout an expanding network.

Network requirements

Rock-solid reliability, Ethernet and serial connectivity, and the ability to get more bandwidth to more hard to reach places is essential. So is the ability to use fiber where you have it, and complement that fiber with broadband over copper to cost-optimize the network upgrade.

The ability to support HD video free from latency or jitter is a must. Connectivity for multiple devices is needed at each intersection,and the equipment has to be compact and mount in small vaults or cabinets which may not be ventilated and will be exposed to extreme temperatures. Plus, the operator must be able to build out more bandwidth to more places in the network quickly, while keeping installation, maintenance, and management costs low.

What is essential is a flexible transport solution that is quick, easy, and cost effective to install, is secure and manageable, and allocates and prioritizes enough high-performance bandwidth everywhere it is needed for IP/Ethernet as well as legacy serial devices. A solution that makes efficient use of available capital, facilitating the build-out and operation of larger and more sophisticated ITS networks, quickly and cost effectively.

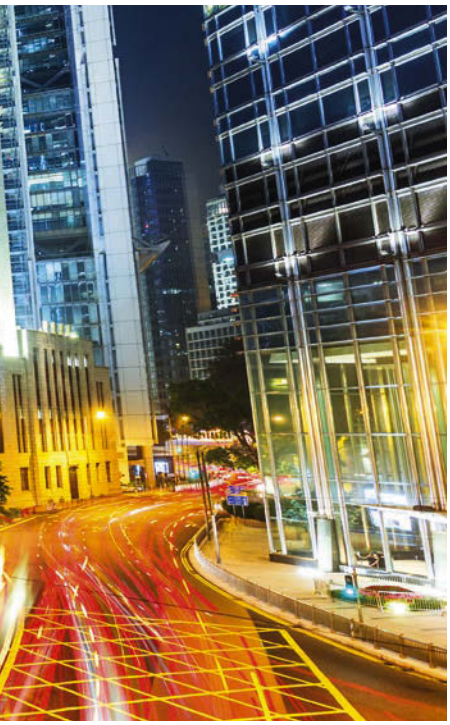
Using the right transport infrastructure is critical. Information is the life-blood of a state-of-the-art ITS network. The ability to aggregate, process and analyze data from more cameras and sensors in real time, make the right decisions, and exert appropriate controls or interact with applications to initiate and record appropriate transactions, is what it is all about. Having more real-time data available from a larger number of cameras and sensors, and connectivity to a larger number of controllers, means better decisions and more refined control of the network. Having a more cost-effective way to connect all those devices reliably makes deploying more of them everywhere needed, the key to having a more sophisticated network, affordable.

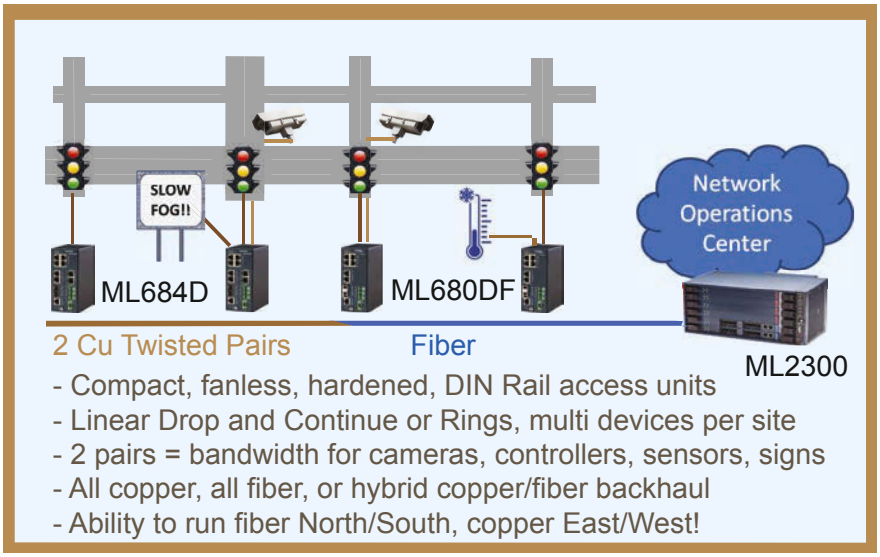
(Below) **Actelis ML680Dx Ethernet Switches are specifically designed for the needs of the ITS market**

Need to know

Copper provides the reliability and adaptability demanded by ITS networks

- Copper can complement fiber to cost-optimize and accelerate building reliable high-speed ITS networks
- Copper or fiber can be run down a major street, with copper laterals being run down side streets; this leverages fiber assets, cost-optimizes the network with copper, and enables future migration to fiber
- Actelis Bonded copper offers proven reliability and manageability, and complements existing network design and assets





(Left) **Schematic incorporating Actelis Hardened Industrial Ethernet switches to create a high-speed, reliable and cost-effective ITS network**

Using the right technology

So, where can you find a transport solution that supports IP/Ethernet as well as legacy serial devices? A network that is highly reliable, is available everywhere you need it, fits existing network topology, and leverages fiber where you have it but enables using copper as a complement or alternative to fiber to cost-optimize the network? A network that supports HD video traffic effectively, and is so cost-effective that it maximizes the number of cameras, sensors and controllers you can afford to interconnect with the ITS network?

The answer cannot be solely fiber. Extending fiber to every new location where bandwidth is required is too expensive and time-consuming. It is not microwave either; microwave involves expensive and complex case-by-case engineering and line-of-site. And it is not low-band wireless, which is subject to interference and is potentially less secure and reliable.

The Actelis solution

Actelis' highly sophisticated broadband-over-copper technology is reliable and field proven in numerous ITS networks. Leveraging years of research and numerous technology patents, Actelis' innovative and patented EFMPlus suite of Layer 1 transmission technologies overcomes the affects of electromagnetic interference and crosstalk to make copper links absolutely reliable and suitable for high speed communications.

A full suite of Layer 2 technologies provides flexibility, control, operational efficiency, and manageability. The Actelis solution logically bonds multiple copper twisted pairs using standards-based G.SHDSL technology, offering reliable, stable high-speed links that transport up to 30 Mbps over 2 pairs in drop and continue, or 60 Mbps over 4 pairs point-to-point.

The Actelis ITS networking solution consists of purpose-built Industrial Ethernet access switches, aggregation units, and management software. Offering a compact form factor, environmental hardening to -40°F (-40°C), and a DIN rail mount, the Ethernet access switches can be backhauled with fiber or copper, can extend bandwidth over either media, and offer Ethernet interfaces and serial connectivity per site at multiple locations thanks to 'drop and continue' functionality. The fanless access switches have all connectors located on the front faceplate and can be easily installed in space-constrained, unventilated vaults or cabinets, as well as within enclosures mounted on poles.

Leveraging fiber where you have it and copper where you do not, Actelis' gets high speed, reliable bandwidth out to hard-to-reach and environmentally challenging places where cameras, sensors, and controllers are needed. Purpose-built design, superior broadband over copper technology, and fiber support combined with a rich suite of

Layer 2 Ethernet QoS, VLAN and OAM capabilities make Actelis Networks the solution of choice for optimizing today's advanced ITS network builds.

The multiple benefits of video detection and ranging cameras

It is known that speed is one of the first factors to control in order to improve road safety. Although it is necessary to invest in infrastructure and upgrade vehicle crash protection systems, the matching of speed to road type will always be a key element in safety. Excess speed extends stopping distances and the distances required to avoid an obstacle.

Spot speed enforcement

The technology most used to measure speed is radar (radio detection and ranging), in which a unit emits a microwave signal that bounces off a moving object to determine its speed. However, a limitation with this technique occurs when multiple vehicles are moving in front of the radar. If more than one vehicle appears in a picture, you can not be sure which is the offender.

A newer technology that does not suffer from this problem is lidar (light detection and ranging). It is similar to radar but uses a pulsed beam of laser light, which, being highly directional, clearly indicates the offending vehicle.

A completely different approach uses two sensors that detect the passage of vehicles through two close points. These sensors typically use inductive or piezoelectric sensors installed under asphalt, which is inconvenient because they must be replaced every time the asphalt is repaired. Sensors detecting vehicle height are installed in gantries, so you don't have this problem, but they require expensive infrastructure that's not always available.

An optimum system

All current technologies for speed control have some kind of drawback or limitation to their use. Intrusive systems using sensors require expensive maintenance. Non-intrusive sensors such as radar and lidar are generally preferred, but suffer from other limitations, such as the fact that they are detectable, which can compromise safety as drivers brake sharply to avoid a fine.

Although automatic license plate recognition (ALPR) systems have evolved tremendously in recent years, few non-intrusive systems are able to read license plates at high speed. And the few that are able to do so are, in general, very sensitive to environmental conditions. They also struggle with different reflectivity of plates due to varying degrees of dirt and condition. To achieve a system that suits this variability, ALPR systems take multiple shots of vehicles with different settings and select the best one.

In many cases the speed limit on a road is different for different types of vehicles. This means that the image must not only identify the vehicle, but also should enable classification.

Clearly the most accurate technology for measuring speed is totally useless if not accompanied by appropriate elements to capture and analyze images. The ideal system of speed enforcement should therefore be passive and unintrusive, include ALPR with multi-exposure, be able to tell the speed of multiple vehicles and be able to classify vehicles.

Introducing vidar

The technology known as vidar (video detection and ranging) extends image resolution and frame rate to improve ALPR performance and enable precise speed measurement.

To analyze the speed of vehicles from video, it is essential to have at least two images and know the precise time they were captured. Vidar technology uses stereoscopic analysis to compute a 3D position (x, y, z) from 2D pictures captured by two image sensors assembled in a single body, and factory calibrated to compute real-world positions.

Stereoscopic vision uses mathematical techniques, widely used for many years in projective geometry, to locate the 3D position of a given object. Every object in the scene has features such as corners or edges that ease its matching, and projective geometry enables computation of the distance

(Left) **The stereoscopic vision in Imagsa's Chronos'Spot can analyze 1080 megapixels per second**

Need to know

Imagsa Technologie's Chronos'Spot has many benefits over other speed enforcement systems

- Non-intrusive, passive technology, with low installation and maintenance costs
- Enables multilane speed enforcement with 99% accuracy
- Can identify vehicle types and enforce variable speed limits
- Capable of detecting small vehicles such as motorbikes between lanes
- Undetectable by motorists in daytime conditions
- Capable of other useful ALPR applications in the same installation

between the camera and those features in the 3D world.

Chronos'Spot system

Imagsa Technologie is a pioneer in the use of massive parallelism that can analyze 270 2-megapixel images per second. The Chronos'Spot stereoscopic vision system combines two of these smart cameras to capture and analyze a total of 1,080 megapixels per second.

This huge volume of data is fed to a processor custom-designed for ALPR. This uses massive parallelism to measure the speed of all vehicles in a path up to 7m (23ft) wide, enabling speed control in two lanes even when several vehicles travel in parallel. A clear benefit of this technology is the ability to measure the speed of motorcycles, which often run between lanes.

The equipment is completely non-intrusive and requires no other sensor to function. Although it includes an infrared illuminator to work at night, during the day it uses sunlight, which makes it a totally passive device, undetectable by drivers.

Besides speed measurement it is also capable of reading license plates and classifying vehicles and can include a third camera for color overview.

Chronos'Spot, developed by Imagsa, manages all these functions with 99% accuracy and at a very moderate cost through the use of massive parallelism built into a custom-designed integrated circuit.

by **J J Eden**

How long can we avoid road-user charging?

Not too long ago I was talking with a legislator about the toll industry. We were discussing how to finance the additional capacity his state needs to attract businesses and also the rising cost of maintaining infrastructure. I asked how long it would be before we saw another catastrophic bridge collapse. After a roundabout discussion he said, "It will be a cold day before I support any project that includes a user fee."

This winter has been brutal. I grew up in a cold state and I am used to winter, but not this kind. Last week we had wind chills below 0°F (-17°C); today it is 70°F (21°C); and tomorrow another ice storm. I spoke with my brother-in-law in Pennsylvania and asked if he was seeing the same in the north. To my surprise, he said 'no'. Potholes were last year; now entire sections of roadway are crumbling away. The freeze-thaw sequence is having a devastating effect on our roads. Maybe the 'cold day' has come for legislators to act.

However, states are struggling with three federally based problems. First, the absence of long-term highway trust fund legislation has wreaked havoc on transportation planning. Many northern states with short construction seasons are canceling project lettings because of a lack of certainty in available funds. It is simply impossible to effectively target scarce financial resources without knowing long-term funding levels.

Second, at current levels the gas tax is not enough to maintain the existing system, let alone improve it. At this year's AASHTO legislative briefing, it was presented that typical developed countries spend 5-6% of their GDP on transportation. The USA is spending 1%.

Third is the federal role in highways. Building nice new roads and interchanges opens new land for development – and gets votes. Ongoing maintenance (heavy construction, pavement restoration) tends to be underfunded.

There is broad recognition that a long-term bill and more money are needed to protect and maintain transportation investments. But how?

Raising gas tax is an option, but it's always unpopular with politicians and the public. Since any increase has been deferred since 1993, an increase of at least US$0.70/gallon would be needed. Such a large hike would not only be tough on politicians who vote for it, but also on a recovering economy.

"Developed countries spend 5-6% of GDP on transportation. The USA is spending 1%"

Managed lanes seem to be gaining favor as they work well to relieve traffic and are optional. However, managed-lane revenues seldom raise much money and none could support major programs.

Mileage-based user fees are a good option. The state of Oregon is developing an interesting pilot program with open technologies and various ways for drivers to declare how many miles they have driven. Oregon calculates that 1.6 cents per mile in user fees will raise the same money as a 30 cent gas tax.

Tolling still has a negative stigma but offers a solution to all three problems. Its self-sustaining infrastructures raise predictable streams of revenue, ensuring that the money is available to protect the investment and service the debt. However, federal restrictions and public sentiment are blocking implementation. With all-electronic tolling and nationwide interoperability, will we consider tolling on existing Interstates?

Hurry, it's cold out here!

J J Eden, is the director of tolling at Aecom, ***james.eden@aecom.com***

Illustration: Ian Parratt, the-caricatureartist.co.uk

Optimizing ALPR performance by focusing on specific requirements

Automatic license plate recognition (ALPR) is now a mainstream data capture technology. Many purchasers believe it to be a simple solution – until they find performance is not as expected. ALPR is a prime example of the devil being in the detail. Data capture relies on image quality: the result of a complex interaction between camera, sensor, light, optics, vehicle movement and weather.

For this reason, tailor-made ALPR solutions outperform standardized ones. Even small and mid-sized users of ALPR that don't have the budget to ask for their own specifications can get close to a tailor-made solution by going through the specifics of their application with an imaging specialist.

Increased traffic safety

The Norwegian Public Roads Administration has installed automatic average speed systems on some of the country's dangerous roads. As a result, there has been a 50% reduction in serious injuries and deaths. The first systems, dating back to 1988, measured instant speed, and were based on radars and 35mm film cameras.

Strict legal requirements have since resulted in a system that comprises advanced technologies and products. The local supplier, Axicon, took on the challenge to develop and integrate the system, which includes: piezoelectric sensors in the road for speed measurement and camera triggering, sun-dominating laser illumination, ALPR to match vehicles between the entry and exit points of the speed control area, and officially certified software for data capture and time measurements.

In 2014, Lumex Traffic Solutions (LTS) was asked to improve the system's ALPR performance, which was based on standard software from a leading supplier. Processing is done on the roadside under real-time constraints.

Major improvements have been achieved by adapting LTS's high-performance ALPR software to the particular nature of the images and imaging locations. Further optimization was achieved by focusing on sequence matching between the two cameras. Customized algorithms were developed to compute the relevant match scores and confidence levels.

Hassle-free parking

ALPR enables barrier-free and ticket-free parking. LTS interacts with companies that develop and market innovative parking systems. The parking sector offers great business potential for ALPR/camera suppliers, but the parking industry players typically lack the system competence seen in the enforcement and tolling sectors. Deployment of camera-based, high-performance parking systems requires expertise in the fields of system integration and adaptation.

In addition, parking is becoming increasingly information-intensive. Data capture is no longer limited to entry and exit points. However, the parking industry has a high sensitivity for cost per camera; therefore parking cameras need to be affordable. Fortunately, parking constitutes a less demanding imaging situation than the roadside, and camera performance does not need to be quite as high.

Parking system integrators who are in need of low-cost cameras have plenty of 5MP, low-cost camera components to choose from. The real challenge is to get a low-cost solution to perform as well as it needs to. Again, competence is paramount. Low-cost cameras don't require less expertise than expensive ones – quite the opposite. When the cost of a single 5MP camera unit with local processing can be as low as €100 (US$108), the focus of the integrator can be turned

(Left) **Lumex ALPR solutions can be customized to read the maximum possible number of license plates in any given situation**

to lowering cost of system installation and maintenance.

Optimized tolling systems

Most tolling boom gates are long gone. Today, DSRC (dedicated short-range communications), RFID (radio frequency identification) and OBUs (onboard units) are the most commonly used technologies for toll collection. However, data capture by cameras also plays an essential role. These cameras provide legally valid records of illegitimate passings.

The profitability of a tolling project depends on both revenue and cost. Using the mandated ID that all vehicles carry – the license plate – is of course more economical than having to produce and distribute additional identifiers (OBUs or RFID). Furthermore, since ALPR is already needed for legal purposes, it is increasingly being used for toll collection as well as for enforcement.

The problem is, if it is not customized correctly, an ALPR solution will be less effective than DSRC or RFID. Missing or dirty license plates, or adverse weather conditions, can cause lower read rates. Purchasers of tolling systems are resourceful, large organizations with in-house competence to tailor systems to their needs. But is there also a competence gap in the tolling sector?

Ordering a custom-made tolling system does not guarantee that the installed, operated and maintained system will perform according to specification, year in, year out. Again, the devil is in the detail. The fact that volumes in tolling are high means that even a slight underperformance can have notable economic impact. The hunt for improvements should be ongoing. This is why two Norwegian tolling operators cooperate with LTS.

As a company with its own high-performance ALPR software, it may be surprising that LTS would say that there is no single, best ALPR software. Far too many things influence performance: from traffic mix (nationalities) to weather and light conditions, to speed.

All ALPR software has strengths and weaknesses, so it would, in fact, be strange if one was the best at all tasks, under all conditions. Many tolling system suppliers and purchasers know this and therefore they combine several ALPR engines. However, setting up the interplay between the engines is not straightforward. A simple rule like majority voting may actually reduce the overall performance of the system. This is another area where competence plays a decisive role in installing the correct solution. ○

Need to know

Competence boosts performance of ALPR-based systems

- Performance of average speed control system increased with new, innovative matching algorithms
- Specification and sourcing of inexpensive camera components cut cost of ALPR-based parking system by many times as performance is maintained
- Costly manual handling of images in high-volume tolling substantially reduced by fine-tuning system

Intuitive and powerful technology for modern traffic engineers

For the past 20 years, CA Traffic's design specialists have been developing products that deliver specialized solutions for traffic monitoring and automatic license plate recognition (ALPR/ANPR) applications. Although each of the company's products is designed to meet the needs of individual processes, a combination of CA's products and software can be used together to deliver a range of data from preselection or pre-enforcement data, to local authority traffic surveys.

The company's most recent developments include the EvoX ALPR and CCTV camera, CA Warning and CA Speed Vehicle Activated Signs and the Black CAT radar.

(Main) **The Black CAT acquires data to identify vehicle class, speed and weight**

(Inset) **The Evo8 ALPR camera captures vehicle license plate images**

Core technology

The company's original Black CAT inductive loop classifiers were designed with the future in mind. Modularity was a prerequisite, together with high-performance processing. It was also considered essential to be able to develop alternative products based on the Black CAT's core technology and application software.

The core range of inductive loop instruments begins with standalone solar battery-powered units with up to 24 loops and mobile communications (GSM, GPRS or 3G). For sites with greater power consumption, using Ethernet communication or WIM sensors, the mains-powered Midi provides reliable performance for up to 24 sensor inputs.

At the top of the range is the 19in rack unit for full ITS implementation. This has the full range of sensor inputs (64 channels can be provided) along with serial or switch cards to interface with external equipment, such as variable message signs (VMS) or ALPR cameras.

The versatility of the Black CAT inductive loop instruments makes them suitable for a wide variety of traffic monitoring applications. The continuity of design seen through the full product range supports the integrity of each unit.

Innovative developments

Having established the inductive loop range, CA Traffic used its Black CAT core technology to create two new products: the Black CAT Radar and the Black CAT Bluetooth Monitor. These new high-performance units benefit from the same core technology, as well as the latest radar and Bluetooth technologies.

The Black CAT Radar unit facilitates the collection of traffic data without the need for in-road traffic sensors. It is also able to detect the lane position of vehicles, and can thus monitor two lanes of traffic moving in the same direction. Improvements to the onboard algorithms ensure that vehicle length measurements are accurate, allowing for VBV classification.

Using cost-effective Bluetooth receiver technology, CA's Black CAT Bluetooth provides accurate historical or real-time traffic data for journey-time monitoring and transportation planning. Continuing the versatility of the Black CAT range, the unit has two operating modules. Firstly, the unit collects data and waits for the user to either manually collect it or dial the unit if a modem is fitted. Secondly, if connected to a catalyst in-station via GPRS, the unit can send out data automatically.

Integrated solutions

CA's Black CAT WIM was created to meet the needs of modern weigh-in-motion applications. Specifically designed to integrate with additional technologies, such as WIM sensors, it works alongside the Black CAT Midi and Rack outstations, and is also

Need to know

Sophisticated ITS requires advanced technological solutions

- The EvoX ALPR camera is a fully integrated solution incorporating a camera, image processing and communications in a single, modular unit
- The technology has been developed to fulfill UK Police NASP requirements and is suitable for use in a wide range of security applications, with surveillance effectiveness enhanced by built-in CCTV capability

by **Larry Yermack**

(Above) **CA's Black CAT Bluetooth provides accurate historical or real-time traffic data**

compatible with Class 1 Piezo sensor and Kistler WIM sensors.

The combination of CA's Evo8 ALPR camera and the Black CAT WIM outstation provides a complete speed and weight enforcement solution.

The Black CAT provides a trigger signal to the Evo8 at the point the vehicle is first detected over one of the entry loops. This timestamp ensures both sources relate to the same vehicle. While the vehicle crosses the WIM sensors and loops, the Black CAT acquires data to carry out classification, speed measurement and weight calculation. Meanwhile, the Evo8 captures a series of images for license plate recognition.

Once the vehicle clears the in-ground sensors, the Black CAT completes its data analysis and transmits a 'trigger end' signal to the Evo8. The Evo8 finalizes the process by processing an overview image with a set of metadata, which can include the location timestamp, plate read, vehicle class, weight and speed. ○

How realistic are our expectations for the next Surface Transportation Bill?

Let the food fight begin. Now that the midterm elections are behind us and the 2016 presidential race is starting to take form, the discussion about how the Surface Transportation Act will be renewed is beginning to heat up. There are two kinds of adoption procedure that I have studied: the one I learned in college and the one I learned in DC over the past several decades. They are not very alike.

The actual procedure is more like a giant food fight, involving thousands of participants, from local agencies and companies, to national organizations, to Congressional staff, to the members of Congress themselves, not to mention the Executive Branch. It's a miracle that they ever pass anything – but they always do, eventually. This column is my modest way of suggesting a few things that ought to be included in the Act.

The first fight is always about funding and while I have always been a fan of user pays and hence an increase in the gas tax, my opinion has shifted. The fact that it's politically impossible is one factor, but the other is a fairness argument. With the growth of CAFE standards, hybrids and EVs, a gas tax will no longer assess damages fairly. As a result, the alternative involving mileage-based user fees is gaining credibility.

There are numerous experiments at the state level, and combined with the announcement of rule-making to install DSRC radios in every car from 2017, the basis of a widespread usage-charging system will be in place. All Congress needs to do is nothing, which is their strong suit. The states, along with their corporate partners, will develop the most effective ways to charge for city, rural and toll driving.

My next concern is the 'Watergate question': "What did you know and when did you know it?" Enormous amounts of data is now being made available in toll, highway and transit systems, due to low-cost transmission and storage. Coming to the fore are private companies offering analytics and predictive analytics to combine disparate databases and provide management with new tools to operate more efficiently. Congress can encourage this trend with a continued emphasis on performance measurement.

All Congress needs to do is nothing, which is their strong suit

My final thought for this column is a new question: "What did you pay and how did you pay it?" The current Surface Transportation Bill has a requirement that toll systems achieve interoperability by 2016, a goal that won't be achieved. As Congress looks to the next Bill, they should think more broadly. Instead of just toll interoperability, how about transportation interoperability? Why not one account for all paid transportation services, with information on all the unpaid services? It would be possible to provide such a service to customers with benefits to them, to operators and to the entire region. Congress could expand its vision and provide direction to the entire industry. Wouldn't that be something?

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Illustration: Ian Parratt, the-caricatureartist.co.uk

Sweden upgrades its enforcement technology to improve road safety

The Swedish Transport Administration (Trafikverket) is currently in the process of expanding and updating its traffic enforcement systems. The plan involves increasing the length of roads covered by enforcement systems from 3,000km (1,700 miles) to 9,000km (5,600 miles) by 2025. The density of units along roads already covered is also being increased. All enforcement systems will be replaced with the latest generation of equipment from Sensys.

Sensys is now into its third generation of target-tracking radar solutions. Its sensor technology, with built-in secondary verification, is an enhanced version of a radar technology originally developed by the military. Advanced software completely rules out false positives for those traveling within the speed limit, making the solution both legally reliable and cost-effective. There are currently more than 1,400 Sensys speed and enforcement systems operating in Sweden. For Trafikverket, the motive behind extending and upgrading the system is to improve the safety of road users. However, the technology's flexibility means that it could also be used to achieve other goals, such as revenue generation, if required. "We're constantly working on developing our design/function/precision concept, which means adapting our products to meet the needs of different traffic authorities," says Johan Frilund CEO of Sensys. "Over the years, speed cameras have gone from being speed traps in ugly metal boxes hidden in the bushes, to being an accepted part of urban architecture. In some cities in the Middle East, they have even become a design statement."

(Above) **A Swedish road where Sensys speed enforcement cameras have been deployed** (Below left) **Sensys cameras have a sleek design that has become a desirable part of street furniture**

Need to know

The latest developments in sensor systems enable reliable violation detection

- The RS242 multi-target tracking radar is at the heart of all Sensys products and systems
- It enables versatile use in traffic counting. speed and red-light enforcement and pantograph monitoring
- The RS242 enables high performance in challenging traffic situations
- The RS242 provides a high level of legal security due to its unique dual-speed measurement capability

In addition to speeding, red-light running is one of the most serious traffic offenses around the world, as the risk of collision is high. Side-impact collisions are relatively common at junctions controlled by traffic lights, often resulting in injuries to drivers and passengers. "In Sweden some controlled junctions are now being replaced with roundabouts, as statistics indicate that, even though they may be associated with more collisions, the collisions are less serious," says Frilund. "In general, though, traffic lights are a more effective way of controlling heavy traffic."

Flexible functionality

The red-light enforcement systems from Sensys record not only red light violations but also speed violations, which often occur as drivers speed up to get through the lights. Sensys thus has the option of prosecuting for two violations. "Our system can handle complex junctions with, say, two lanes turning right, one turning left, and two going straight on, all in different phases," says Frilund. "The sensor processes the information efficiently and offers the same legal reliability as a speed camera."

A dynamic range of intelligent ALPR cameras

Not so long ago, once you'd installed a traffic camera, you were stuck with the setup. The ALPR functions were fixed and left to perform their duty – for better or worse.

Now, within MAV's range of Rapier cameras, settings can be fine-tuned and adapted in real-time by remote or integrated ALPR engines to give the best recognition possible. MAV Systems build ALPR cameras for partners around the world and are at the forefront of this new, intelligent camera technology.

"We have open architecture cameras that our partners can use at any level," confirms MAV Systems CEO Steve Walker. "This provides access to control the camera and illumination so they get tight integration with their ALPR engine or application. Our partners don't think of our cameras as being inanimate, by adjusting the settings dynamically they create their own intelligent solutions".

Rapier cameras work with all traffic speeds and changing daylight or night conditions, and give the best image every time. "It's comparable to the evolution in modern cars. You used to take them for a tune-up once a year. Now, every time the engine turns over, it's tuning itself. It's like that with our ALPR cameras, they are getting more capable and intelligent in their own right. This helps with reading the massive variability of plates worldwide whether clean, dirty or damaged."

Coming into focus

Of course, no matter how intelligent a traffic camera is, it still has to be installed before it can start delivering results. MAV's latest Rapier 50IQ intelligent cameras work with a single PoE connection, which helps this happen quickly, at low cost and efficiently. "Every camera we have has a zoom capability," explains Walker, "whereas most of our competitors use fixed lenses." Although fixed lenses may reduce up-front cost, they can end up being expensive and inadequate. "What you find with a fixed lens camera is that the customer has to do an extensive site survey to find out where to put it and define the closest lens to what they want," says Walker "Our cameras can capture two lanes anywhere from 3m to 50m and use optical zoom lenses to keep the raw resolution. Turn up, install, and set up perfectly. There's also the option to update configurations online at any time."

(Left) **The Rapier 50IQ camera provides a full intelligent solution with third-party ALPR software preloaded onto the IQ's internal memory**

"We also have truEZoom technology in Rapier cameras, which means the camera can automatically set the field of view and the focus point to be at whatever distance you specify. In this way, we've changed installation from needing specialist ALPR engineers, to it being practical for a whole range of electrical contractors and CCTV installers. We've made it so our customers can reduce their install costs dramatically."

Designed for the future

Another way that MAV support its partners is by designing in long-term availability of camera modules and circuitry. This is essential to avoid having to go through expensive approval processes more than once. "Some of our customers have built our cameras into something that's gone forward for full type approval," says Walker. "Once you've got that system approval, it's effectively a lock-down. That's why we design everything in-house, so that we can control the consistent quality and lifecycle of our entire range. Once you've spent hundreds of thousands getting type approval for a system, the last thing you want is for the next batch that comes through to find that the specifications have changed. We can assure our customers that will not happen."

Walker is confident about the coming years for MAV. "Our launch of the Rapier 50IQ in 2015 has had brilliant feedback and we have a range of exciting developments sitting behind it. We've never been more optimistic about helping our growing base of solution partners expand their markets by working with our ALPR cameras."

Need to know

What sets MAV Systems' ALPR cameras apart from the crowd?

- Open protocol allows partners to adjust settings with their own software
- Dynamic link allows for constant fine-tuning
- Full zoom capability enhances flexibility and eases installation
- truEZoom allows for field of view and focus points to be set automatically
- In-house manufacture guarantees uniform build
- Sealed units extend life and make cameras suitable for all weathers

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A flexible and accurate ALPR software solution for access control

Intelligent image processing is an essential part of accurate license plate recognition and helps to provide fast, safe and precise identification of vehicles. When combined with hardware detection systems, such as infrared cameras, ALPR software is an essential part of traffic enforcement systems around the world.

The right software

With the Carrida software engine, embedded imaging expert Vision Components offers very fast and precise ALPR, designed for integration into a wide range of surveillance systems, including access management in parking lots. The high-performance, hardware-independent OEM software, with a typical processing time of 30ms and a typical recognition accuracy of more than 96%, has been extensively tested and proven to consistently achieve high recognition accuracy, even in less than ideal conditions. It reliably identifies dirty, damaged or skewed license plates and is unaffected by the suboptimal or changing lighting conditions that often occur in access-control situations.

For other applications, the tool automatically recognizes all plates displayed in one image and vehicle plates in several lanes simultaneously. Suitable for use with Windows- or Linux-based mobile or embedded systems, Carrida reads all common still image and video formats and is easy to integrate into existing security and surveillance applications.

Carrida around the world

Due to plate variation from country to country, ALPR is usually restricted to certain regions. Carrida, however, can be used all over the world. The software engine provides high accuracies in recognizing country-specific plates – a feature that New Zealand-based company Network Imaging Solutions (NIS) has taken full advantage of. The security technology firm has developed the comprehensive NIS ALPR solution, which encompasses camera technology, software, server infrastructure and end-user customization.

Need to know

Carrida software offers a complete, customizable ALPR software solution

- Typical processing time: 30ms
- Typical recognition accuracy: >96%
- Suitable for use with Windows- or Linux-based mobile or embedded systems
- For standalone ALPR, the Carrida Cam (*above*) is a smart camera that features IP67 protection, IR illumination and uses less than 3W, making it ideal for self-sufficient outdoor applications

NIS uses Vision Components' Carrida software with additional features. The recognition algorithm has been adapted to reach high recognition rates for New Zealand plates under all conditions. NIS completes its solution with a proprietary black/white list.

Superior compatibility

The Carrida software package for PC now includes the option to integrate it into existing Skidata systems. This integration includes all Skidata features up to the latest version 25 and delivers license plate information to Skidata back-end systems. NIS has also developed a robust database system for storing captured plates with time/date stamps, which is accessible through a web interface and enables users to view real-time license plate events, as well as search the archive. Operators can edit misread plates, receive email notifications based on non-responsive software as well as IP notifications, and see a status report with the customized software module 'current occupancy'.

"The NIS ALPR database serves as a platform for integration with customer infrastructure," says John Hurford, managing director of NIS. "We create a plug-in to connect the database to existing on-site software and hardware. This enables, for example, integration into a point-of-sale system so that payment can be calculated depending on what time a vehicle entered and exited the facility."

With Carrida at its core, the open platform NIS ALPR is a flexible and powerful solution for access management systems featuring high-speed recognition and multiple engine support.

(Top left) **The smart Carrida Cam** (Left) **Network Imaging Systems in New Zealand has fine-tuned Vision Components' ALPR Carrida software to operate with Skidata systems**

Free reader inquiry service

Vision Components inquiry no. **509**
To learn more about this advertiser, please visit: www.ukipme.com/info/tfm

Vehicle detection, classification and camera triggering made easy

Vehicle detection and classification have been made easier and more accurate with OSI LaserScan's AutoSense series of scanners. The products include several dual-beam scanners for overhead mounting – the AS615, AS618 and AS825 – as well as one dual-beam scanner designed for side mount and optimized for vehicle detection and axle counting – the AS715. In addition to the dual-beam scanners, OSI LaserScan has recently launched a member of the AutoSense family, the AS9390 Vehicle Detector & Camera Trigger.

The AS615 and AS618 products are designed to cover a single lane, while the AS825 is designed to cover dual lanes. These products detect the front and rear of the vehicle and provide vehicle classification based on height, width, length and vehicle profile. The vehicle profile is used to distinguish buses from trucks, identify and separate different truck configurations, and to detect special features such as tow bars, which may facilitate highly differentiated pricing structures for toll roads.

The AS715 is typically mounted on the side of the road and provides vehicle detection and separation, along with axle counts, in a single lane coverage configuration. This non-contact solution avoids installation of loops and other detector elements in the pavement and provides a lower lifetime support and maintenance cost.

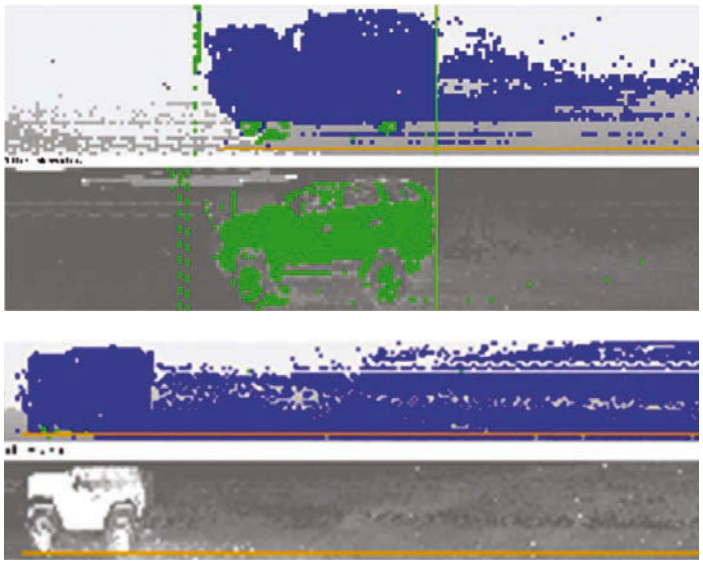
The relatively new AS9390 Vehicle Detector & Camera Trigger is a single-plane scanner with a wide 90° field of view, which is typically used for vehicle separation and counting, as well as for triggering camera-based enforcement systems. It provides continuous range and reflectivity measurements within the field of view with a 1° angular resolution and an industry-leading scan rate of 120Hz: the best performance available for high-speed vehicle detection and camera triggering.

OSI's patented dual-beam technology was first deployed in volume in the late 1990s in Toronto's highway 407 ETR, which has since been operating more than 600 AutoSense scanners (ASII, AS-605 and AS615). Now OSI LaserScan is working with 407 ETR in relation to the next generation of AutoSense scanners – the AS615-UDH-H – which is being tested for future upgrades and expansion.

Need to know

OSI LaserScan products are pushing boundaries around the world

- OSI LaserScan has developed new technology that combines range and reflectivity data to improve vehicle identification in adverse weather
- OSI LasterScan's AS618 was the first ever laser scanner used to detect vehicles in a tunnel
- Toronto's 407 ETR (express toll route) uses over 600 AutoSense scanners
- OSI LaserScan is a division of OSI Optoelectronics, an OSI Systems company (OSIS)



(Above) **Combining range data (artificially colored blue) with reflectivity data gives OSI LaserScan cameras a more complete picture of vehicles in adverse weather conditions**
(Below left) **An OSI LaserScan unit**

Technology first

OSI has a history of breaking new ground. In 2005, its LaserScan AS618 product became the first laser scanner to be used for vehicle detection and classification inside a tunnel when it was installed in the Sydney Cross-City Tunnel.

With the latest generation of product upgrades, OSI LaserScan has developed new technology that helps improve performance under adverse weather conditions. Laser-based systems have always been subject to somewhat reduced performance under extreme adverse weather such as dense fog, intense snowfall and heavy rain. By making use of the reflectivity data as well as the traditional range data, and data obtained by processing of multiple returns from each laser pulse, OSI LaserScan is now able to improve the vehicle detection and classification under these conditions. This is perhaps the most important development in the field of laser-based vehicle detection in the past 10 years.

The false color image above shows the 'tail' caused by heavy rain conditions, when using range data analysis. This is not a problem for the reflectivity data, also displayed. From this, it is clear that end-of-vehicle determination can be greatly improved using reflectivity data in addition to the range data.

Improvements such as these make OSI LaserScan an excellent choice for vehicle detection, classification and camera-triggering products.

Free reader inquiry service

First WIM system certified for legal weighing applications

For many years now, weigh-in-motion (WIM) systems have delivered valuable traffic data. However, traditional WIM systems are not allowed to be used for legal weighing applications such as weight-based toll collection and automatic weight enforcement.

As more road concessionaires wish to perform financial transactions (tolling) and governments push to implement automatic enforcement based on vehicle weight data, there has been an increasing demand for certified WIM systems, accredited according to international standards. Kistler is the first WIM manufacturer to have received the International Organization of Legal Metrology (OIML) R-134 certificate for vehicle weighing with strip sensors from 3-65km/h (2-40mph). Supported by this certificate, Kistler WIM systems based on maintenance-free Lineas quartz WIM sensors and the Kistler WIM data logger can now be used for legal weighing applications.

Toll collection

Manual toll-collection systems typically use scales, which, besides requiring complex installation and maintenance, are limited to low-speed operation – typically 10km/h (6mph).

Kistler's WIM system enables the automatic collection of weight-based toll fees without stopping vehicles. Operators and concessionaires can upgrade their manual toll collection system to electronic toll collection (ETC), allowing vehicles to pass their toll collection sites without delay.

Automatic enforcement

Automatic weight enforcement aims to detect and pursue overloaded vehicles by using a WIM system combined with an ALPR system. This requires a legal framework and the use of a certified WIM system. Obtaining an official certification for legal weighing applications can be a lengthy and costly process. Kistler's OIML-certified WIM systems can help to accelerate the approval process.

Other possible applications include weighing at ports, logistics terminals, and industrial or mining facilities – thanks to the use of quartz crystal sensors, Kistler's WIM systems are maintenance-free, and durable under any weather conditions.

Supreme accuracy

With two rows of Lineas sensors (four sensors), the system is certified according to accuracy class F(10) for measurements between 3km/h and 65km/h. The maximum speed of 65km/h (40mph) was determined by the limitations of the test site.

Class 10 states that all gross vehicle weight measurements during operation have a measurement error that is smaller than ±10%, while class F indicates that all single-axle load and axle-group load measurements during operation have a measurement error tyhat is smaller than ±8% for two-axle rigid vehicles and ±16% for all other vehicle types.

Kistler's WIM system with four rows of Lineas sensors (eight sensors) is certified according to accuracy class F(5) for measurements between 3km/h and 35km/h. Class 5 states that all measurements of gross vehicle weight taken during operation have a measurement error of no more than ±5%.

The best standard

While other international standards – COST (European Cooperation in Science and Technology) 323 and ASTM (American Society for Testing and Materials) E1318 – state that 95% of WIM measurements have an error smaller than 10%, OIML standards give assurance that 100% of measurements are accurate within the specified range. It is for this reason that instruments certified to OIML standards may be used for legal and financial transactions, while others may only be used to give an indication of the vehicle weight.

(Left) **The Kistler WIM data logger with the Lineas quartz WIM sensors is now OIML-certified for low- to medium-speed vehicle weighing**

(Above) **Kistler's quartz Lineas WIM sensors are not influenced by temperature changes or aging, and ensure precise measurements of wheel and axle loads**

Need to know

Kistler is the first WIM manufacturer to gain an OIML certificate for weighing with strip sensors up to 65km/h

- The OIML R-134 certificate allows WIM systems to be used for legal weighing
- The Kistler WIM Data Logger gathers accurate, reliable data from the Lineas WIM sensors from low to medium speed
- Kistler's OIML-certified quartz-based Lineas strip sensors are not influenced by temperature changes or aging, and ensure precise measurements

An RFID reader designed specifically for electronic toll collection

Passive RFID-based electronic toll collection (ETC) systems have been increasingly popular in recent years due to the simplicity, efficiency and cost-effectiveness of passive RFID tags. They are now widely used in the USA, South America and the Far East and their deployment is only set to increase. Although such systems are not yet an EU standard, it is widely predicted that RFID-based ETC systems will also be seen in Europe in the near future.

Great demands are placed on RFID readers in ETC systems, especially when it comes to multilane free-flow installations, which require high-speed reading, integrated with a high level of security mechanisms. Although there are many manufacturers and many models of RFID readers available in the market, most are not designed to meet the specific requirements of an ETC environment. An RFID reader used for an ETC application must have a high reading rate and must also be able to detect vehicles moving at high speeds. Moreover, it must be able to read RFID tags with special security mechanisms that protect tags against copying and cloning.

For a logistics application, the security and speed of the reader are not so crucial, but these are the key performance indicators for an ETC application.

A perfect solution

Vendeka now designs and manufactures its own RFID readers to meet all the requirements of ETC applications. After two years of intensive development, the reader is now ready for the market. Vendeka, which is already an expert on RFID-based toll collection systems, has designed the readers by listening to customers' requests and by using its own field experience on various projects. The tests have revealed that the results and the performance of the readers are outstanding.

Vendeka's new passive RFID reader, VNK-PR14P15, is compatible with ISO18000:6C and it comes with two versions of frequency band: FCC (Federal Communications Commission) and ETSI (European Telecommunications Standards Institute). It has four antenna ports and TCP/IP-based protocol, which enables users to manage and configure the reader very easily.

Perhaps the most impressive characteristic of the reader is its speed. During the field tests, the reader is able to identify the secured RFID tags on vehicles moving at speeds of up to 200km/h (124mph) with a 36° antenna. This is achieved by using a high-speed RFID chipset and an effective SW (Smith-Waterman) algorithm.

The maximum power of the reader is 33dBm (decibel milliwatts) and it can be configured from 0dBm to 33dBm, with 1dBm increments. It supports the standard available RFID antennas. The reader has a maximum 25m (82ft) of reading range when using a 13.5dBi (decibel – isotropic) gain antenna, set to maximum power level.

The reader has an IP65 casing and works in very harsh environments. The operating temperature is between -25°C (-13°F) and 60°C (140°F).

After two years of development, Vendeka has achieved a high-performance RFID reader, which can be used around the world for ETC applications. Thanks to its superior performance, VNK-PR14P15 will be a game changer.

Need to know

Key features of the Vendeka VNK-PR14P15 RFID reader that make it ideal for ETC

- Compatible with ISO 18000:6C
- Two frequency bands: FCC and ETSI approved
- Four antenna ports
- TCP/IP-based protocol
- Reads RFID tags at speeds of up to 200km/h (124mph)
- Power adjustable from 0dBm to 33dBm, with 1dBm increments
- Operating temperature between -25°C (-13°F) and 60°C (140°F)

(Left) **The VNK-PR14P15 is ideal for multilane free-flow tolling applications**

PRODUCT LAUNCH

The commercial launch of the reader will be held at Intertraffic Istanbul, May 27-29. If you want to see the reader and get some more information about how VNK-PR14P15 can meet your RFID ETC requirements, visit Vendeka at booth 10E-4.

Free reader inquiry service

Vendeka inquiry no. **512**
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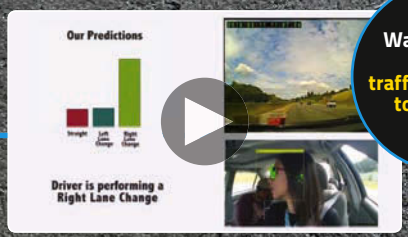
Ashutosh Saxena, assistant professor of computer science at Cornell University, developer of the new Brain4Cars driver-monitoring system



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"You can see what we are already capable of today… Being stuck in a traffic jam is no longer as unpleasant, because you have so much less to do. That is a really good feeling"

Jürgen Weissinger, speaking at the first full preview of the Mercedes F015 driverless car, for which he is project director

"It is an honor, professionally and personally, to be joining ITS America at this pivotal moment in the organization's history"

Regina Hopper, the new president and CEO of ITS America

Read the full story at trafficktechnology today.com/ regina

"Just as we do not test seatbelts and airbags in public, it is inappropriate to test autonomous critical event control systems in public"

Stephen Hamilton, partner, Mills & Reeve LLP, a key speaker at the Autonomous Vehicle Test & Development Symposium

Read more on page 13

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Model: M118ZG36X10IRP

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Stationary application in TraffiTower 2.0

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