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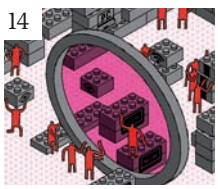

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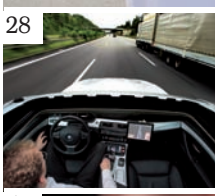

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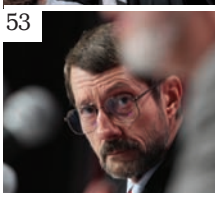

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Foreword

The UK government's proposed plans to increase the motorway speed limit from 70 to 80mph may well have been derailed by the horrific multi-vehicle crash on the M5 motorway in Taunton, Somerset, on Friday, November 4, 2011. Seven people lost their lives and 51 were injured in the country's worst traffic crash for two decades. A thorough accident investigation is still ongoing, although eyewitnesses described hitting a wall of thick, black 'fog' and a split-second later seeing the brake lights of vehicles ahead. A nearby fireworks display was implicated early on, the smoke from which may have mixed with fog to create a deadly stretch of near-zero-visibility conditions.

The sheer scale of this 37-vehicle crash – which also involved six large trucks – sparked immediate and intense discussion about the government's consultation on the 80mph limit. Raising the limit could generate significant economic benefits – some experts say potentially worth hundreds of millions of pounds a year in travel-time savings. The leading UK road safety charity Brake thinks it will lead to a 5-10% increase in motorway KSIs.

The 70mph limit was set in 1965 when cars, roads, traffic density, and drivers were completely different by 2011 standards. Traffic fatalities have fallen by 75% to 1,850 in 2010 as a result. And despite a 6.7% rise over 2010 figures in the first half of 2011 (attributable to the harsh winter at the start of 2011), all signs point to further reductions in road deaths in the future, especially as technologies such as those discussed in our intelligent vehicles focus (*p28*) penetrate further.

Whether or not autonomous functions such as those featured in the concept BMW 5 Series could have reduced the severity of the M5 crash is open to debate. But as Adrian Walsh points out in his column (*p67*), more than half of the vehicles involved did have ESC. And while media attention focused on the weather, the fireworks display, and speed limits, the human factor seems to have been downplayed, perhaps sensitively for the moment.

The importance of providing drivers with the ability to base their driving decisions on real-time, accurate data should not be underestimated. Whether this is best achieved via tools such as VMS or the latest breed of in-vehicle information systems is therefore something we decided to address for this issue's cover story. Provocatively posing the question, 'Is VMS dead?', the resounding answer was 'Hell no!'.

Nick Bradley,
Editor, Traffic Technology International

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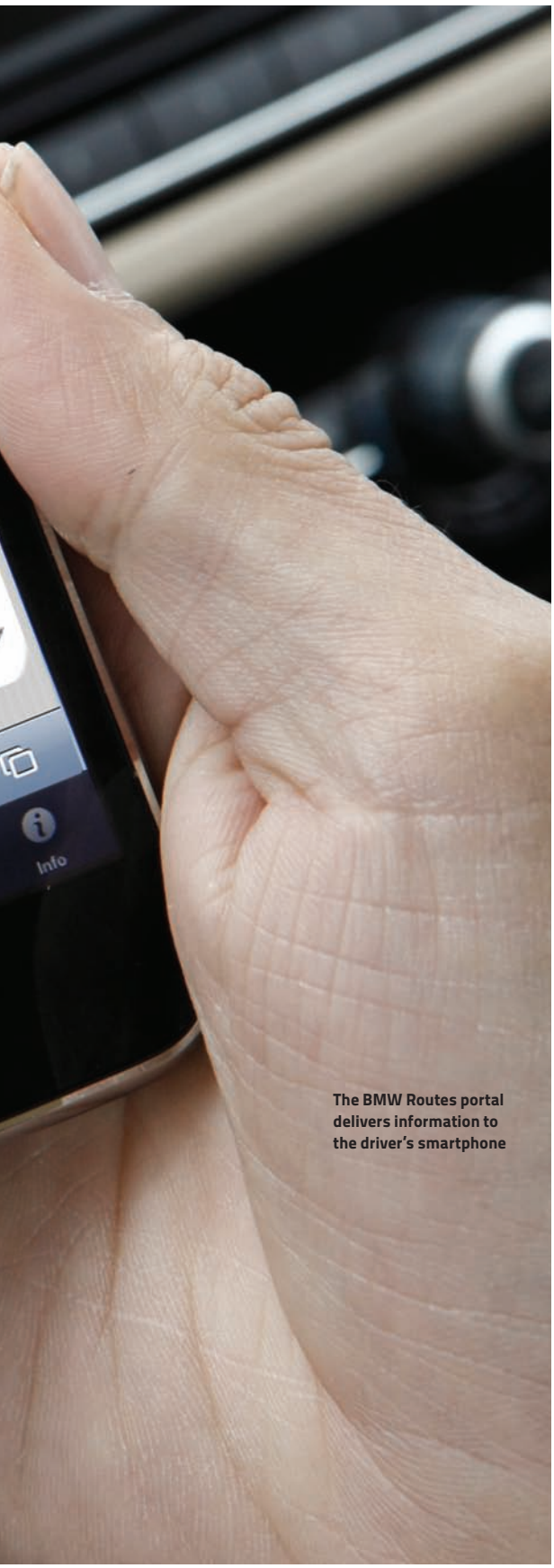
S E E I N G I S B E L I E V I N G

One day in your life

Following a recent ConnectedDrive Innovations Day in Munich, BMW's **Christoph Huss** tells **Lloyd Fuller** how intelligent navigation could get us from A to B in 2015

Photographs courtesy of BMW Group



The BMW Routes portal delivers information to the driver's smartphone

Intelligent route planning – planning a route to a given destination taking into account criteria such as speed, fuel efficiency, or intermodality – has been a development focus for car makers for many years, particularly at BMW. Such technology has already reached a high standard in the latest navigation systems, with the integration of functions such as the German OEM's BMW Routes and Real-Time Traffic Information (RTTI).

In the latest R&D projects, further innovative and useful functions are being developed with the aim of facilitating or improving various aspects of the navigation process. The following imaginary scenario, a picture painted by Christoph Huss, responsible for BMW Group's Traffic Management division, takes you through a hypothetical working day, presenting some of the systems that are already reality or are likely to be coming soon.

From A to B

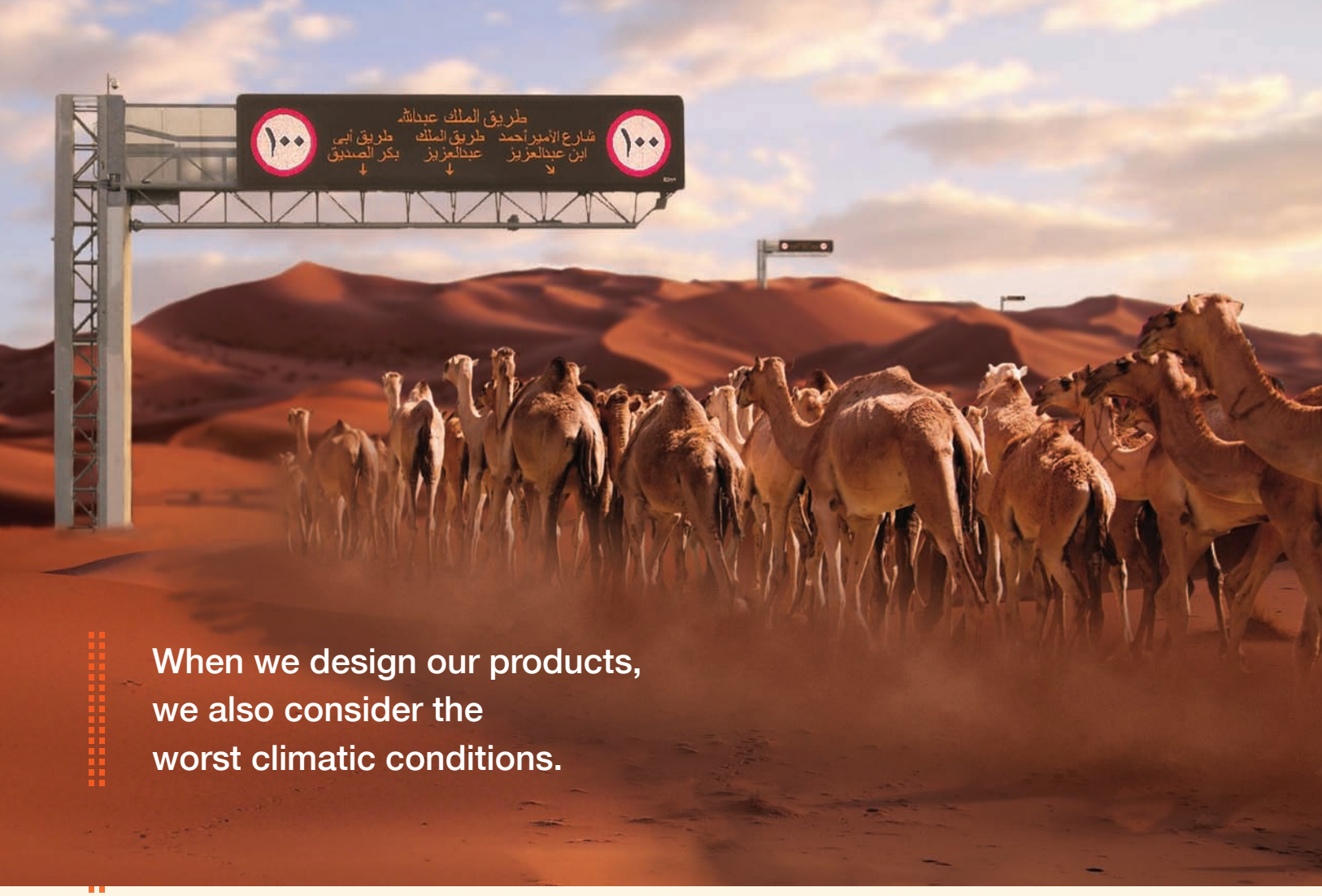
It's 08:00hrs on a Monday morning and you're preparing for your regular commute to work. This time, however, you have decided to depart a little earlier than usual. That's because an hour before you would normally leave, you received an email on your smartphone from the BMW Routes portal advising you that to arrive at work on time you would need to set off 20 minutes early. The reason is congestion on the highway, which there is no way of avoiding.

You got this message because you've already preplanned your commute to the office in the www.bmw-routes.com online portal and saved it, together with your desired time of arrival, as your standard route for weekdays. The route is also accessible on board the vehicle, where it can be imported straight into the navigation system. Available since 2008, the BMW Routes portal now also incorporates RTTI.

> "You get an email on your smartphone advising you to leave early to get to work on time because there is congestion

Solo

auto commuting reached an all-time high in the USA in 2010, increasing by 7.8 million commuters. Homeworking, though, continues to grow



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Use of real-time traffic information allows the navigation system to calculate routes and possible diversions even more accurately and reliably than before. Among other things, RTTI uses anonymous cell phone location data, analyzing the number and speed of location changes within the phone network to gain an accurate picture of current traffic flows.

Further real-time data providing information about current traffic congestion is also supplied by fleet vehicles and cabs, whose navigation systems are linked to a central control point. In this way, RTTI can precisely monitor conditions on highways, divided highways, main roads, and main and secondary roads in urban areas.

Taking all this data into account, the BMW Online internet route planner calculates the journey time for your route. If the estimated time of arrival would be later than your desired arrival time, due to traffic conditions for example, the function can optionally send you an email anything up to an hour before your planned departure recommending you set off earlier in order to arrive on time.

In other words, as well as using the RTTI function in the vehicle, BMW ConnectedDrive subscribers can also visit the portal from any internet-capable device to check RTTI information about the latest traffic situation. This online access to RTTI is now also available for smartphones via the My BMW Remote app.

In future, it is planned to enhance the route planner function using traffic predictions based on historic traffic data that has a high probability of recurrence. This alert function could potentially be extended to include text messaging or a push notification from an app.

These developments represent an important first step toward outsourcing the job of route calculation from the vehicle to a back-end server, where more processing power and information is available, the results simply being passed back to the vehicle when generated. The effect would be a further improvement in navigation quality.

Urban navigation

Continuing on our hypothetical day, you encounter the predicted congestion on the highway at 08:30hrs. But as a result of the tip-off, you still have time in hand.

You take your usual exit, but as soon as you are off the highway, the navigation system recommends you take a different route from normal. One of the main traffic routes is closed for an event due to take place in a few hours' time. Your navigation system was forewarned because it has access to local authority traffic management data. It was therefore able to calculate the quickest appropriate alternative route.

When calculating this new route, the system also took into account traffic light phasing so that you are automatically given a route that will make the most of 'green waves'. By taking into account such local authority traffic management and traffic planning data, this future routing option – known as urban navigation – is able to recommend an urban route on which the traffic is most likely to be free-flowing. This also means a more eco-friendly journey.

Finding parking without the search

It's now 09:00hrs and you are nearing the end of your journey. As usual, your vehicle informs you about parking availability in the vicinity of your destination. It not only tells you about nearby parking lots, but also shows you roads where you are most likely find a vacant roadside parking space. The choice is then up to you. Today it recommends parking on the street parallel to your office.

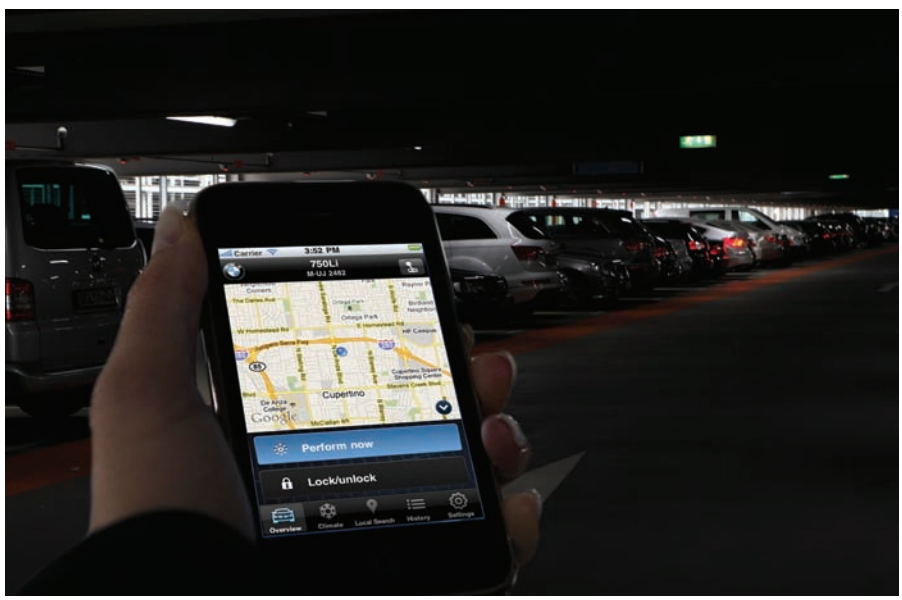
Today's systems already show the location of parking garages and other designated parking spaces. But soon it will also be possible to show how much parking is currently available at specific parking lots, so that alternative options can be recommended. However, particularly in large urban areas, a lot of parking is also available at the roadside, and many drivers prefer this option to multistorey parking lots. In this imaginary scenario, you too belong in this group.

The BMW Group is collaborating with a variety of partners such as local authorities and operators of parking ticket machines to obtain data about parking-related traffic and parking habits, and to aggregate this data over time.

This information can be used to identify streets with a high parking turnover – i.e. shorter average parking times – and therefore to predict where drivers are most likely to find a parking space. Internal BMW studies show that as much as 80% of the traffic volume in certain areas at certain times can be due to parking searches.

> "In future, it is planned to enhance the route planner function using traffic predictions based on historic traffic data that has a high probability of recurrence

The city of Amsterdam has seen a 20% drop in traffic in the inner city and a 20% decrease in traffic searching for a space to park since stricter enforcement



It will soon be possible to show how many spaces are available at specific parking lots

> While at the filling station, at 16:45hrs, you see a poster for a concert this evening that you would like to attend. You make a call to BMW Assist to book the tickets

These innovative information services therefore allow drivers to find parking much more quickly, thereby not only saving them time, but also reducing traffic volumes.

Another solution aimed at making more efficient use of parking space is ParkatmyHouse, which makes temporarily unused parking spaces available for use by the general public. ParkatmyHouse is an internet platform that allows private individuals and businesses to rent out their unused parking spaces – a concept that has all sorts of interesting applications, particularly in urban areas. For example, ParkatmyHouse provides a way for banks to rent out parking space they don't require at night, or for hotels to rent out parking spaces that would otherwise stand empty during the daytime.

Dynamic navigation

It's now mid-afternoon, 16:00hrs, you're on your way home from work and have just joined the highway. The RTTI service – which continuously monitors problems on your route – shortly gives you a local hazard warning about roadworks 3km ahead. The right-hand lane is closed and an 80km/h speed restriction is in force on this section, but there are currently no hold-ups. As a result of the warning, you are able to adjust your speed and move over to the left-hand lane in good time.

Working alongside IBM, Streetline is coming up with a new system to track parking patterns to help municipalities decrease congestion

On the final part of your journey home, at 16:30hrs, the vehicle suggests you take the opportunity to fill up at a gas station that has lowered its prices for the day. The fuel assistant has reviewed the various possibilities for refueling along the route, taking into account your current fuel tank level, route, destination, and preferred fuel brand, and made a recommendation based on present prices and filling station location.

Information generated by traffic management centers can be delivered straight to a driver's phone

Your navigation system is updated while you're on the move

While at the filling station, at 16:45hrs, you see a poster for a concert being held this evening that you would like to attend. You make a call to BMW Assist to book the tickets. BMW Assist sends you the address of the advance booking office and sets it as a stopover on your route. You stop off to pick up the tickets and drive home, pleased that you won't have to wait in line later for tickets for the performance.

To travel from your home to the concert, at 19:00, the BMW Connected App recommends that you take local public transport. Since you have purchased a BMW Group Mobility Package, you can make the journey free of charge. These packages will, in future, provide the ultimate in flexible mobility. When you signed the leasing agreement on your BMW, the mileage allowance did not refer specifically to vehicle mileage, but to personal mobility in general – because BMW has an arrangement with transport operators that permits you to use local public transport at no charge.

Before starting out, you use your app to find out when the next convenient train departs and how long it will take you to get to the station. When you arrive at the station, you won't have to wait in line for a ticket or worry about complicated fare systems, because you have already got your ticket to hand – on your smartphone.

All you need to do is log in using your smartphone when you get on the train and log out again when you get off. The journey will then be automatically docked from your mileage allowance. The same thing happens if, on the return journey, you decide to use a car-sharing vehicle after leaving the train because it has started to rain. In other words, the mobility package is integrated, convenient, and intermodal – and leaves it up to you to decide how to travel.

Some of these ideas, such as the mobility package or the roadside parking tips, are still some way off. But others, for example, ParkatmyHouse, RTTI, and advance warning of delays on a planned route, are already a reality in BMW vehicles today.

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Key ambitions

There are four key long-term goals of the MODUM project. The first is to improve the quality of life in urban environments by reducing the commuting duration by 10%, by minimizing the uncertainty of journey times, especially in multimodal journeys, and by minimizing the percentage of failed plans. The second goal is to minimize the mobility-generated emissions and noise pollution by reducing the number of vehicle-minutes on the roads by 10%. A third goal is to optimize the efficiency of the road capacity usage by 10%, and finally improve the social inclusion by providing journey plans according to identified social constraints.

A clean break

A major transport project is investigating introducing wireless networking to vehicles as a way of drastically reducing congestion and the environmental impact of traffic, writes **Dr Evtim Peytchev**

Transport congestion problems contribute ~70% of pollutants to urban environments. In the EU, the transport sector alone consumes up to ~30% of the total energy. These figures suggest that if Europe is to reduce its CO_2 emissions by making an efficient use of energy while improving the quality of life in its cities, novel approaches for the optimal management of urban transport complexity must be developed and adopted in the transport sector.

A major transport project known as MODUM (Models for Optimising Dynamic Urban Mobility) is investigating introducing mobile wireless networking to vehicles as a way of significantly reducing congestion and the environmental impact of traffic.

Harvard researchers say jams in the USA's 83 largest urban areas led to 2,200 premature deaths and a public health cost of US$18 billion in 2010

The project addresses the environmental footprint in the transport sector by aiming to develop a new approach for proactive demand-responsive management of traffic to enable energy-efficient multimodal transport choices. These choices accommodate dynamic variations, minimizing the environmental impact and improving the quality of life in cities. Moreover, MODUM will consider commuters, in combinations of both private and public transport, facing dynamic conditions such as unexpected disturbances typical of urban environments.

Nottingham Trent University is involved in this €3 million European project and is working alongside the University of Manchester and the Catholic University of Leuven in Belgium as part of the project. Also among the key partners in the consortium are Transport & Mobility Leuven in Belgium, Technolution of the Netherlands, MUSAT Sofia and Austrian Mobility Research, which is looking at incorporating ad-hoc wireless technology to vehicles to enable them to automatically gather traffic information and relay it to other commuters. Nottingham Traffic Control Centre and Sofia Mobility Centre are the public authorities advising on the research directions for the project.

Talking point

The three-year research project is investigating the possibility of building the traffic control information system around the concept of every vehicle on the road 'talking' to all other vehicles, in doing so identifying how widespread congestion is in any area, at any given time. This could enable motorists to avoid congestion and reduce journey times by identifying potential problems before and during their journeys. It is hoped that this innovative form of traffic control would result in less congestion without the need to extend the current road infrastructure.

To underpin the above deliveries, the project is focusing on the investigation of two

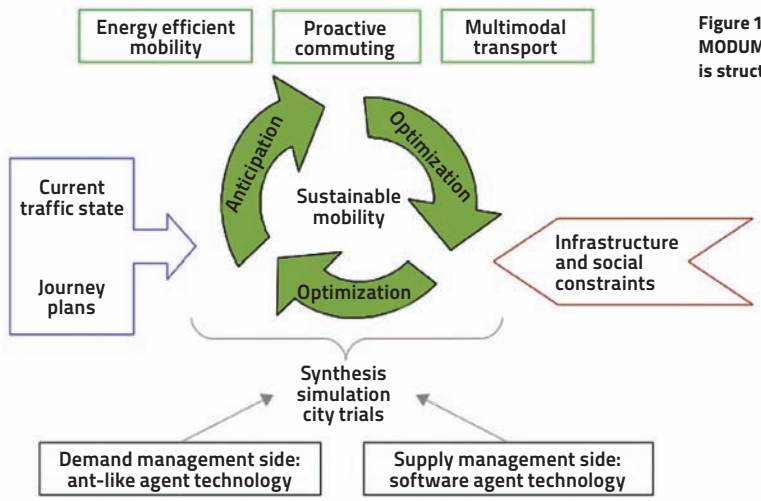

Figure 1: How the MODUM approach is structured

traffic management approaches – addressing, respectively, the demand and supply management sides of the problem – and then on their potential synthesis into a comprehensive mechanism for sustainable mobility.

Demand management side: This is a self-organizing mechanism based on ant-like agent technology representing individual commuters/vehicles that autonomously 're-structures' the traffic flows to overcome sudden unexpected disturbances. This mechanism will exploit both V2V and V2I communications.

Supply management side: A 'reverse' route-planning mechanism based on software agents in which infrastructure segments (streets, bridges, rail sections, etc) 'bid' for transport vehicles based on their 'known' traffic load, giving a higher preference to low-loaded segments to divert flows when sudden unexpected disturbances happen. This will also utilize both V2V and V2I communications.

As shown at the bottom of the Figure 1, these two traffic management approaches will be profiled using simulation experiments, and synthesized into a cooperative demand-responsive model. It will also use input data of the journey destinations and real-time information coming from the infrastructure.

The driver would plan the journey via the routing software and then traffic information – such as congestion caused by rush-hour traffic and roadworks, or unexpected circumstances such as following an accident – would be automatically detected and then communicated to the vehicle by other road users via the wireless technology. The GPS-assisted system would then automatically plan an alternative route. Prototype devices are currently being prepared in order for locations in Nottingham and Sofia in Bulgaria to be used as test sites to show the benefits of the approach.

The MODUM approach could be explained easier if we look at traditional ITS – their aim is to optimize traffic by controlling static elements of the infrastructure, such as traffic lights. The recent trends of proliferation of computational devices within cars (onboard computers) and their passengers (increasingly smart cell phones with GPS facilities and significant processing power) enable a more ambitious approach that tries to optimize the distribution of traffic throughout the transport system by controlling individual vehicles and using in-vehicle computational resources for some aspects of traffic monitoring and control. Both require substantial computations and large amounts of data to be transferred using specialist channels such as car-to-car communications in mobile ad-hoc networks. Computational clouds can take on some aspects of these computations but the overall topology of the system should be designed carefully to optimize the use of resources such as processors and communication channels.

Wireless ad-hoc networking could help us in this respect and allow us to dynamically manage the traffic in every city. The cars would effectively be talking to each other at all times, identifying a range of traffic conditions and, working as mail boxes, delivering the messages to the destination without extra help.

This approach enables each vehicle to actively participate in urban traffic control. The more cars you have, the better communication system you will have.

> "The cars would effectively be talking to each other at all times, identifying a range of traffic conditions and, working as mail boxes, delivering the messages to the destination without extra help

The global market for ETC systems – a key enabler for reducing congestion and thus emissions – is forecast to reach US$5.9 billion by 2017

The OBU offers new functionalities for GNSS metering

Eye in the sky

A European project is exploring the potential for GNSS-based metering for vehicle applications and value-added road services, explains **Klaus Aichhorn**, the project's manager

Main image courtesy of Skymeter

Pay as you go

There are a number of facets to the project's background. Most pressing are the substantial traffic increases that affect most European regions as the mobility needs of citizens continue to rise. However, the addition of more land vehicle traffic channels raises a series of problems. Therefore, existing roads have to be better maintained and the repair budgets increased. In short, the roads that we have need to be made more intelligent. The road maintenance companies, for their part, should be expected to work with smaller budgets, requiring a significantly improved process able to deliver better road systems for less. An excellent solution is a fair pay-per-use principle, but individual road pricing has to be determined.

> "The existing concept has been extended by integrating EGNOS/EDAS data

In its role as project coordinator, on June 19, 2010, TeleConsult Austria received the Austrian Champions in European Research - 2010 award

A road-user charging and parking pricing system based on vehicle onboard technology has been developed within an innovative project called GNSSmeter. The FP7 (7th Framework Programme of the European Commission) project is funded by the European Commission and managed by GSA (European GNSS Agency), although the overall product is offered by Skymeter. The project itself has been coordinated by TeleConsult Austria and the development was carried out with the partners Skymeter, CTAE – Aerospace Research & Technology Centre, DKE Aerospace Swiss, and the subcontractor, NavCert.

Focusing on the development of a parking pricing and road-user charging application system primarily for the urban environment, it's all based on vehicle onboard technology that has been integrated into an existing market product presently offered by Skymeter. In the past, GPS has been used as the primary positioning technology and generally speaking, GNSS (Global Navigation Satellite System) is the key enabler of the overall application. Within GNSSmeter, however, the existing system concept has been extended by integrating EGNOS (European Geostationary Navigation Overlay Service)/EDAS (EGNOS data access system) augmentation data in order to improve metering accuracy and therefore also greatly improve charging integrity.

The existing GPS-only receiver module (as used in the past) has been replaced by a miniaturized GPS/EGNOS receiver module that also supports a tailored acquisition-aiding functionality. The overall solution incorporates augmentation data from EGNOS and all SBAS (Satellite Based Augmentation Systems) signals in space, as well as EDAS data acquired in a communication link from TeleConsult's PANDAS (Positioning and Navigation Data Assistance Service) server. The metering calculation software running in the onboard unit (OBU) uses the GNSS raw data forwarded by the PVT (position, velocity, time) software for the metering calculation, which is then further used for road and parking pricing calculation. These newly developed functionalities have enabled a robust solution to measuring vehicle location in urban areas. This, in turn, enables a reliable, wireless, location-anonymous data service for metering road use so that the 'same-trip-equals-same-charge' principle can now be guaranteed. This same technology can now meter a parked car to its exact parking lot or on-road space, exact time and exact per-minute price. As cities and regions begin to deploy congestion pricing systems, this represents a ready-made opportunity for municipalities and private operators to use this same metering and payment service architecture to manage wide-area, infrastructure-free, hands-free parking.

GNSSmeter has effectively solved shortcomings from past GNSS-based metering solutions and is now ready to be marketed.

The solution has tackled the issue of urban canyons in cities

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Download our white paper:
Capturing a New Vision for Transportation Management and Control
www.teledynedalsa.com/geniets/dj/tti2011

TELEDYNE DALSA
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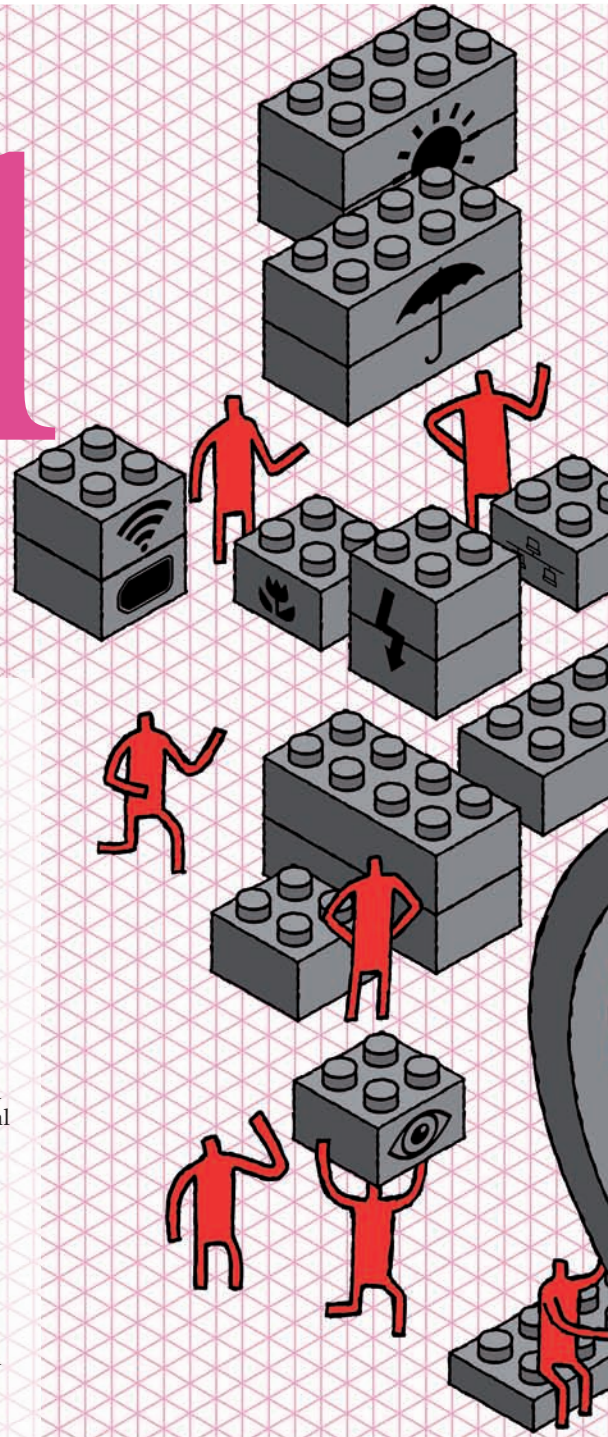
Visual appeal



It's not every day that something moves out of a niche and enters the mainstream traffic market, yet that's exactly what machine vision cameras have done. And the best thing, writes **Louise Smyth**, is that this might only be the start of things to come

Illustration courtesy of Tim Ellis

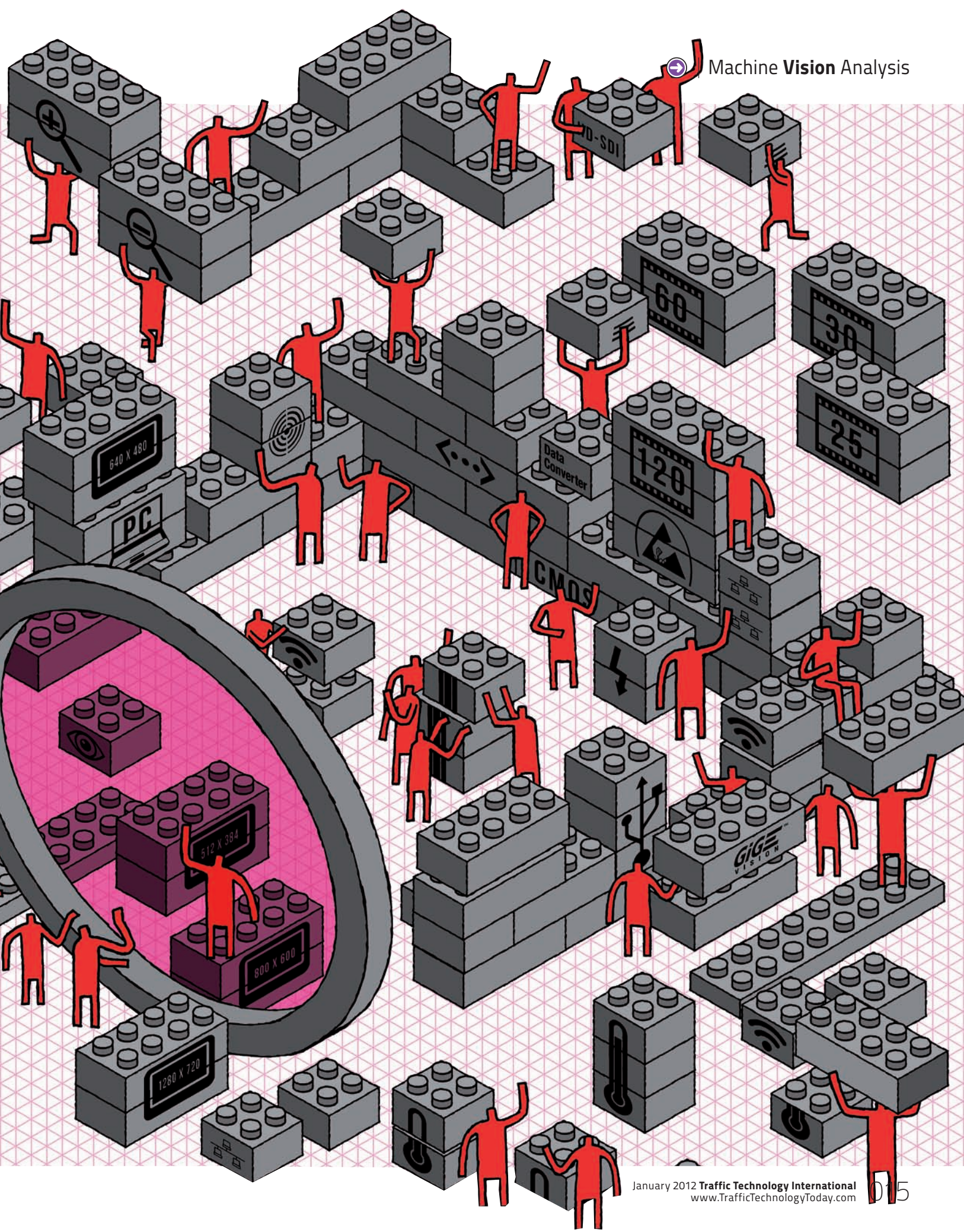
When *Traffic Technology International* first started delving into the world of machine vision and its use in ITS a few years ago, we couldn't have predicted how fast the sector would evolve. The companies interviewed were not household names in the traffic market, the applications of the technology were regarded as somewhat niche, and there was some doubt as to whether the cash-strapped ITS industry would ever be prepared to stump up the extra cost for these sophisticated cameras. But how things have changed! Today, machine vision for ITS is big business. The camera vendors are no longer on the periphery of the sector – they're actively pursuing it and the business case has been established. But what else has happened in the past few years to encourage this boom?

Each vendor proffers a number of reasons for the surge in popularity. Take Andreas Schaarschmidt, CEO of SVS Vistek, for instance. Having spent 15 years at Stemmer Imaging before joining SVS Vistek in 2009, he has been well placed to observe – and indeed encourage – the migration to the traffic market. "Our company still has its roots in industrial applications, the classical machine vision business," he says. "But to enter new markets, we've had to diversify our product offering. For the traffic market, cost is not the driving force. For speed enforcement, ALPR, tolling – or indeed any fixed outdoor application – you need high-quality cameras with long-term stability. You could buy a €200 camera but it will fail and need repairing or replacing. Our customers in this sector expect stability and service, but they're more focused on the total cost of ownership than the initial outlay."

Schaarschmidt describes the technical demands of this sector as the 'traffic triangle'. "Clients are often asking for more resolution, other times they are asking for speed (meaning frame rate), and at other times sensitivity is the most pressing demand," he explains. "If you have high speed, normally the resolution is low. If you have a high resolution, the speed tends to be low. And if you ask for sensitivity, that can have an impact on the speed. If we understand these seemingly conflicting demands, we can offer suitable products that perfectly match this triangle. For instance, lots of customers are asking for cameras with high dynamic range: in a tunnel application, the dynamic between dark and light is tremendous and the camera has to manage this."

Quick thinking

SVS Vistek has been well able to respond to these demands over the years and has


HD-SDI
60
30
25
120
640 X 480
PC
Data Converter
CMOS
512 X 384
800 X 600
1280 X 720
GiGE VISION

Required reading

Ellis Nugteren from Adimec assesses what's needed for a machine vision camera to conduct ALPR

Advances in digital camera technology enable more sophisticated intelligent traffic management and enforcement systems to better meet governments' objectives to improve road safety, increase traffic flow, and enforce traffic laws with fair payments.

The latest camera technology also improves system performance to minimize detection time in case of accidents, increase the detection rates in cases of violations, and minimize overall costs from police time and traffic jams. These systems also need to maintain reasonable costs and prove their efficacy to gain adoption by government decision makers.

License plate recognition (LPR) is one of the more common needs in traffic systems. There are several performance and system parameters to consider which can be easily solved through the appropriate camera considerations.

LPR requires a crisp, clear image of a license plate to withstand dispute upon issuance of any penalties. This means obtaining an image whenever a car appears, regardless of lighting conditions, weather, the color of the license plate, or the vehicle speed.

An infrared (IR) flash light can be used to illuminate the license plate as it is not visible to humans and the license plate material is reflective at 800nm.

> "External triggering is important as images are required exactly when a car drives by, which is unpredictable

Cameras that have significant sensitivity at this wavelength allow for the desired image quality without a complicated and costly workaround.

Blooming and smear are challenges with outdoor vision systems. Bright spots can originate from headlights, reflections off license plates, the sun at certain times of the year, or sun reflecting on the tarmac. Image processing in the system cannot correct these defects so blooming and smear must be managed in the camera to ensure that the license plate is not obscured in the original image data.

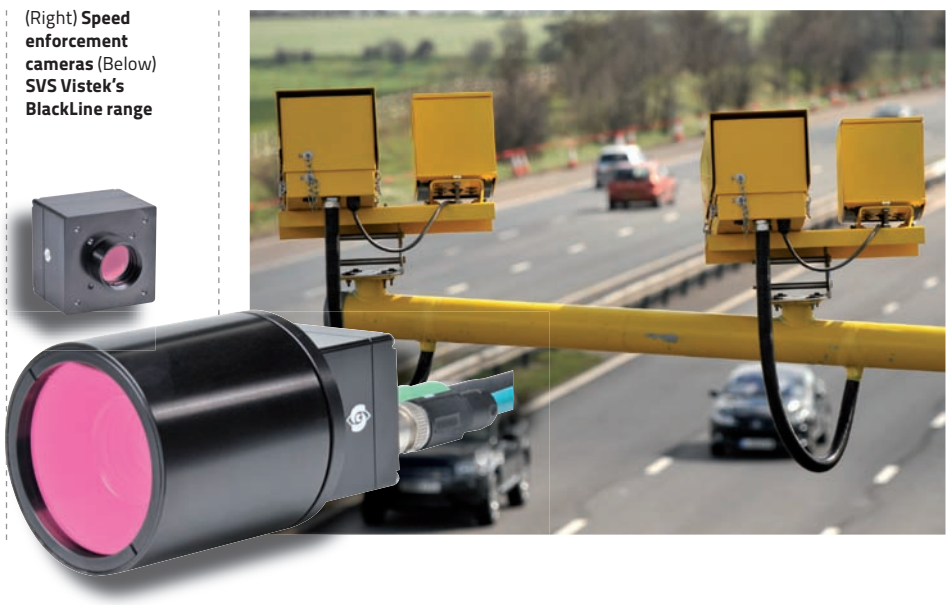
Typically, at least two good images need to be obtained on a car traveling up to 250km/h (155mph). With a controlled test, an existing two megapixel traffic camera with a frame rate of 60fps could still obtain a usable image for a car traveling at 360km/h.

The fast frame rate needs to be also combined with high resolution. High-resolution cameras mean that fewer cameras can be used to see more of the road which simplifies the system and reduces the costs. Usually, at least one megapixel resolution is required to limit a maximum of one camera per lane.

There are special considerations for the camera connectivity with regards to optical fit, electrical fit and functionality – regardless of whether it's a system upgrade or a brand-new system.

Ghost images can appear if IR lighting is used in combination with a visible light block filter. The simplest way to prevent ghost images and lens artifacts from interfering with the system performance is to utilize a supplier that also has the already gained a significant foothold in the traffic market. In fact Schaarschmidt proudly claims that if you got caught speeding in Germany, there's an extremely high chance it was an SVS Vistek camera that caught you. But as the market has grown, it's got increasingly competitive, so the company has had to up its game in terms of feature sets and products it brings to market. At the Vision show in November 2011, it launched its latest cameras, the BlackLine range. Schaarschmidt describes the cameras as tough, industrial-grade units. "They have a special housing, higher temperature range and new feature sets such as a built-in flash controller," he explains. "Although they are perfect for the industrial sector, the traffic sector sometimes has the same demands. Both sectors want stable cameras and easy-to-use

(Right) **Speed enforcement cameras** (Below) **SVS Vistek's BlackLine range**



expertise to properly integrate the filter and lens with the camera.

It is desirable to have the large, multi-lane processing part of the imaging system in a different location from the camera, such as next to the road rather than close to the cameras above each lane. This requires the use of rugged cables that can transmit large amounts of data over long distances. CoaXPress is the preferred interface that meets all of the requirements and allows for use of existing analog coax infrastructure.

The specific functionality required depends on the system design. External triggering is important as images are required exactly when a vehicle drives past, which is unpredictable. As there is no second chance when the vehicle is gone, effective automatic exposure control is often vital to have properly exposed images.

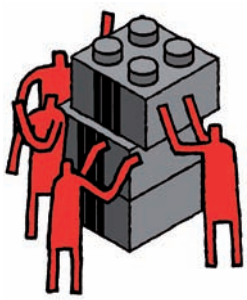
Adequate color processing with incorporated auto white balance ensures accurate representation of the colors, important for regions where license plates are different colors.

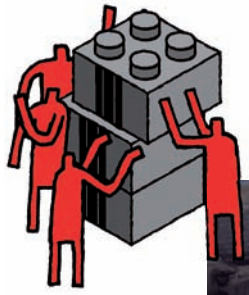
The needs of intelligent transportation systems are different from those of traditional machine vision, and therefore both markets have significantly different camera requirements. Utilizing cameras that are optimized for traffic applications can simplify the overall system design and increase performance while also reducing costs.

Adimec's technology helps to alleviate smearing and blooming

connectivity – via a cheap and standard-sized cable. I think BlackLine is the best platform for the future traffic market."

The point about connectivity is particularly relevant to the rise of machine vision cameras in ITS and links to the introduction in 2006 of the GigE Vision standard. Paul Kozik from Allied Vision Technologies (AVT) explains why this standard has been such a driver of progress: "GigE Vision is basically cable length at high bandwidth, and you combine that with low latency. That has been the winning combination in machine vision and we're also seeing it deliver a lot of value in traffic. In a tolling scenario, for example, you can now manage all of your gantry cameras to a single computer. And being able to take this off-the-shelf, low-cost Ethernet networking technology and applying





it to a high-end application means we can offer very cost-competitive products."

Cut-price copies

The demand for cost-effective products is hardly unique to the traffic sector, and Kozik feels AVT is in a good position to be truly competitive: "We have an ongoing challenge with competing manufacturers in Asia," he reveals. "They re-design our innovations and offer them at much lower prices, redefining what we believe the camera should cost. That pressure originated in the machine vision space, so we're more than capable of making lower-cost products for many markets. In fact, as we're a component offering as opposed to a solution-based package, we're definitely competitive.

"If you're doing ALPR, for instance, the price margin is in the software development. We do not currently offer ALPR software, our focus is on providing the best possible image that the customer can use for ALPR processing. We're targeting performance as a way to improve the existing traffic solutions. There's a lot of focus on ALPR accuracy. One way to improve the accuracy is to grab more images per vehicle. You can do that if you have a fast enough camera or a sensor that has a really high frame rate, and that's our game in machine vision, so we can take that and apply it to traffic."

This last point is borne out by a recent ITS contract for AVT. The company's cameras are being used by one of the biggest names in the sector, Q-Free, in its new single-gantry multi-lane free-flow tolling solution. "These are CCD sensor cameras that offer a high quantum efficiency and near-IR response – which are very much machine vision buzzwords!", Kozik says. "But this basically means they can see more in the infrared wavelength that Q-Free is concerned about. This is vital as the more sensitive the camera is, the shorter the exposure value can be; which means they can capture vehicles moving at higher speeds."

The choice of sensors – the ongoing CCD-versus-CMOS debate – is something that AVT is also responding to. In January 2012, it is adding some CMOS-based cameras to its Prosilica GT range. When it comes to selecting the right sensor Kozik says: "For us, it's been a matter of finding a CMOS device that offers good performance and can compete with the CCD sensors. The CMOS sensors we have chosen have more of an HD aspect ratio, which makes them particularly suitable for tolling or speed enforcement applications."

Of course, one way to ensure you have the right sensor for the job is to make it yourself, which is exactly what Teledyne Dalsa does. "We're the only company selling into the traffic market that's integrated in this way. We design our own sensors (for area-scan applications we are focusing more on CMOS sensors) and that gives us an edge on the competition," says the company's Manny Romero. "Our second USP is that we're a camera, software and frame grabber vendor, so in terms of the software-processing side we also have an edge that most of the FireWire camera vendors don't."

(Left) **Teledyne Dalsa's Genie TS cameras**

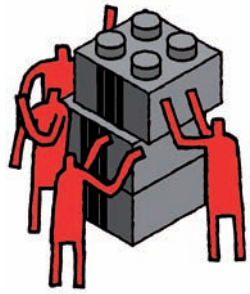
(Top) **Machine vision cameras are increasingly popular in ITS** (Above) **AVT's Prosilica GT**

One might assume that these 'added extras' would bump up the price tag, but Romero is quick to dismiss this notion. "The percentage of price drop in the past five years has been dramatic in terms of resolution speed versus price. Moving to digital or FireWire cameras used to be expensive but new technology has created cheaper VGAs. Meanwhile sensor prices have also gone down – prices have dropped across the entire market.

"The parallel is that not only have prices gone down, functionality within products has increased five to tenfold. Although image-capture speed and resolution has obviously increased, so has image quality and preprocessing, which has a snowball effect: more consistent images make the processing algorithms used in the next step work better, too. Something available now that was not a couple of years ago is the capability of having multiple images back-to-back with different exposure times, which means you can have more images with a different contrast. If your processing is for ALPR, for instance, then you've just doubled your chance of having a better image – so the odds of being able to accurately detect the right vehicle have also just doubled."

> The CMOS sensors we use have more of an HD aspect ratio, making them particularly suitable for tolling or speed enforcement
>
> **Paul Kozik, Allied Vision Technologies, Canada**

Romero also cites the widespread adoption of the GigE Vision standard as



having a beneficial effect on the industry. "It is a good thing for customers," he suggests. "They no longer feel they are stuck with one vendor – and for us vendors, it means we are no longer competing on the connectivity side, so we have to differentiate ourselves via functionality. The battle is now between the IP functionality – not the medium. So if I can offer a little twist – such as more IP or a function to control your pan and tilt – then I'll have the edge over my competitors."

This ability to tweak its offerings has enabled Teledyne Dalsa to work on many semi-customized projects, as Romero explains further: "This allows our customers (systems integrators in tolling or law enforcement, for instance) to get an edge on their competition. To be successful in ITS you need functionalities that reflect how the cameras are used in the end systems.

"Consider an application that's looking at a road. One person might say the minimum pixels needed is VGA resolution, so 640 pixels wide. Someone else might say the minimum needed is 800. Others might say when building a system, they'd rather have a single camera per lane. Others might prefer multiple lanes per camera. That's why you need a wide range of speed and resolution coupled with a good set of features."

Application-specific cameras

Point Grey is another vendor trying to achieve these aims. It designs products such as its Zebra2 specifically for the ITS market. Mike Gibbons explains how this camera differs from regular machine vision offerings: "It's a very configurable platform that uses a range of CCD sensors and supports both GigE and HDSDI. There's a battle between IP cameras that use the Ethernet interface and the HDSDI platform. Often, for traffic surveillance, a system will have two cameras mounted over an intersection: one using HDSDI or real-time low latency display and the other plugged into a video recording system through the GigE. So we've put both capabilities into a single unit."

As well as offering CCD-based products, Point Grey is not neglecting the trend for CMOS sensors, as Gibbons details: "We're integrating the latest CMOS sensors with global shutter into our cameras. The issue with rolling shutter CMOS sensors is the potential for distortion of moving objects – that's not good if you're trying to do ALPR. With global shutter we achieve the high image quality of CMOS sensors with no distortion. There's a number of low-cost, high resolution global shutter CMOS sensors coming out and I think this technology will prove very popular in the near future."

> We design our own sensors (for area scan applications we are focusing more on CMOS sensors) and that gives us an edge
>
> **Manny Romero, Teledyne Dalsa, Canada**

Point Grey's upcoming Zebra2 camera

Delivering good results with today's technology is obviously a prime focus for Point Grey. One of its biggest (and especially happy) customers in the US ITS market is Transport Data Systems (TDS). The company uses cameras to conduct a range of traffic applications from law enforcement to automatic vehicle classification and ALPR. "Machine vision cameras are an ideal choice for TDS for a number of reasons," Gibbons says. "High resolution, the ability to trigger, reliability, ease of use, and price performance. Cameras with higher resolution such as two megapixels or more can cover multiple lanes, thus requiring fewer cameras to buy, maintain and add to the network. The ability to precisely trigger the image capture is important as many LPR systems use a vehicle-position sensor to trigger the camera and lighting at the same instant."

Tom Hasselbring, TDS's president reports that he is reaping the benefits of machine vision. "Our systems are used all over the USA, day in, day out, at night, in all kinds of weather and we depend on the quality and flexibility of these cameras. Over the years, Point Grey has added features important to us such as a serial interface to control the lens and opto-isolation on GPIO ports."

Ultimately, it is traffic customers such as TDS – and indeed the likes of Q-Free – that will determine the future of machine vision in ITS. What these customers demand, the vendors above will have to deliver. And with the triple whammy of the GigE standard and its associated flexibility, the overall price reductions – and the increased performance of these cameras – this future is looking pretty damned rosy.

Visioneering for ITS

The German company Leutron Vision offers a range of GigE and smart cameras for ITS applications. "A lot of basic features that were always important for machine vision are now also necessary for ITS," says CEO Meinrad Simnacher. "These include the need for a wide range of CMOS and CCD sensors that best fit the specific application. For instance, a camera for a one-lane ALPR application will have a sensor with a smaller resolution then a two-lane camera to save costs. Very good image quality is another priority in both sectors: this translates to up to 12-bit resolution, high-dynamic range, global shutter CMOS or progressive-scan CCD without smear effects."

Image data over one cable (PoE) – which allows long cable lengths – is a priority for the ITS market as is low power consumption. But Simnacher also cites the trend for miniaturization: "Miniaturized complete vision systems and smart cameras that include the processing unit have emerged as a result of the use of applications in mobile systems, such as in police cars.

Leutron's CheckSight PC camera, a combination of a PC and a camera ticks all of the above boxes. "It is dedicated for ITS," Simnacher says. "There's a choice of 28 CCD/CMOS sensors, while a dual-sensor option to acquire different images in parallel (i.e. for LPR and color image of the car) is also available."

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Highway to hell?

The biggest traffic story of 2011 was undoubtedly the I-405 improvement project and the potential for the biggest traffic jam in US history. **John Merrill** and **Joe Quitter** reveal the 12 rules that turned 'Carmageddon' into 'Carmaheaven'

Main photograph courtesy of Jae C. Hong/AP/Press Association Images

Los Angeles' I-405 is the USA's most traveled and infamous highway. A poster child for congestion, the I-405 has five lanes in each direction, operates at a deficient level of service for the majority of the day, and handles enough travelers during those peak periods to fill a football stadium every hour.

By 2040, area population is expected to grow 11% and traffic volumes on I-405 are expected to increase significantly. To ease existing and projected traffic, LA Metro has implemented a massive I-405 high-occupancy vehicle (HOV) lane design-build project. As the major operator of bus and rail service in Los Angeles County, California, LA Metro's plan is to add a 10-mile northbound HOV lane to I-405 to connect to HOV facilities to the north and south. The additional lane will improve travel conditions and safety.

Generate consensus in the TMP

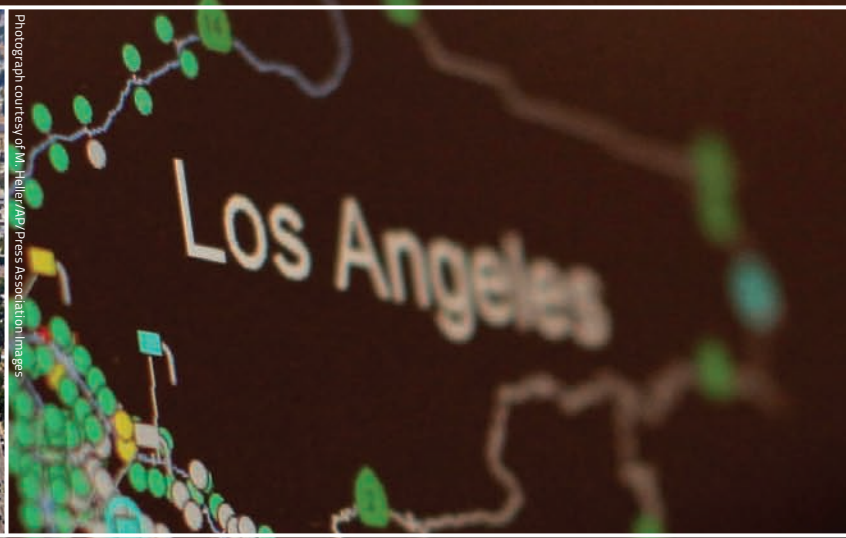
1 HNTB-Kiewit generated 360° buy-in among all stakeholders: LA Metro, the City of Los Angeles' Department of Transportation (LADOT), emergency responders, law enforcement, and Caltrans, which implemented the transportation management plan (TMP). Closure weekend would not have been a success had it not been for everyone sitting down face-to-face and agreeing to agree. The result was a TMP with four integral components.

The first was HNTB-Kiewit's TMP, which identified the freeway segments, ramps, connectors, and local streets to be closed; the schedule for closure; the freeway detour and alternate routes; the potential traffic impacts to the local street and regional freeway network; and highlights from the agency-prepared plans below. The schedule and sequencing of demolition was provided by Penhall Company, the demolition subcontractor.

LADOT's TMP identified local street alternate routes; six operations periods for incidents; enforcement deployment; command structure; locations of the Unified Command post; the department of operations center posts; designated staff; the primary impact area; and traffic control officer deployment.

The Unified Command's event action plan, prepared by LA's police and fire departments, LADOT, and the California Highway Patrol, included organizational assignments and personnel; communications channels; an incident radio communications plan; and medical, safety, and emergency evacuation plans. LA police and fire departments also pre-deployed resources such as mobile fire stations and first responders on motorcycles at strategic locations.

LA Metro's public awareness campaign consisted of three broad groups of strategies: public outreach; media relations/social media outreach; and extended outreach.



Photograph courtesy of M. Heller/AP/Press Association Images

Thorough planning meant that dynamic traffic maps at Caltrans' traffic management center stayed green throughout the closure

Appoint a leader, not a committee

2 The Los Angeles Police Department (LAPD) led the Unified Command of law enforcement, emergency responders, and city transportation officials. The Unified Command executed traffic control and established a clear, linear chain of command and communication. When there were disagreements, the California Highway Patrol made the call or was the tiebreaker. During closure weekend, the chain of command was strictly enforced.

Segment the project

4 To make this multifaceted project more manageable, HNTB-Kiewit used a divide-and-conquer strategy, distributing responsibility among four taskforces – demolition, technical, public awareness, and emergency response.

Suppress and divert

3 Angelinos were asked to cancel weekend travel. If they could not, motorists were routed around the closure area based on the distance of their trips. Those taking longer trips were presumed to be more likely to take a longer detour. They were diverted to roads furthest away from the project. Close-in capacity was reserved for short trips and local motorists. In effect, the TMP called for the movement of regional traffic out of the region but it was accomplished through the efforts of LA Metro, the organization that executed the public awareness campaign and was responsible for the unprecedented suppression and diversion of traffic.

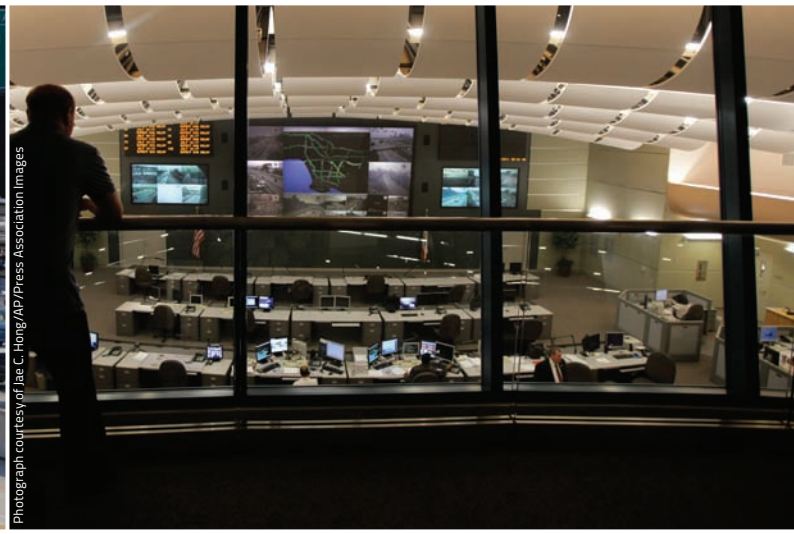
During closure weekend, HNTB-Kiewit sampled the alternate routes to see if they were being used and found motorists had listened. Volumes were higher than normal on the most remote alternate route and slightly lower on routes closer to the closure area.

Enforce continuity and consistency

5 HNTB-Kiewit had representatives at every taskforce meeting to keep the teams informed and focused. When not in meetings, they communicated via email blasts and used Microsoft Outlook to schedule meetings. One person was assigned the full-time job of scheduling taskforce meetings, developing agendas, identifying and assigning action items, distributing information, and responding to questions from the more than 50 taskforce members. The role added structure to an extremely fluid situation; its importance cannot be emphasized enough.

Photograph courtesy of Jae C. Hong/AP/Press Association Images

Photograph courtesy of Damian Dovarganes/AP/Press Association Images



Photograph courtesy of Jae C. Hong/AP/Press Association Images

Easing congestion on the infamous I-405 meant building a 10-mile high-occupancy vehicle lane

Hire a conductor

6 All the people involved in planning the closure weekend had other full-time responsibilities on the overall project. So Kiewit brought in an experienced manager whose sole responsibility was to focus on that weekend and make sure all activities dovetailed.

On the design side, HNTB dedicated a segment design manager to coordinate the planning and design teams and to lead the mammoth effort of coordinating law enforcement, emergency responders, transportation agencies, media and community relations, and elected officials.

Identify a closure date

7 Once you have identified a closure date, you have to stick to it – no matter what. Nothing motivates people better than an immovable deadline. However, picking a closure date is tricky. Select it too early, and it is likely to change. Select it too late and there will be less time to prepare. LA Metro announced the date three months in advance. For this project, three months was the 'sweet spot'.

Earn and nurture political support

8 Before publicly announcing the closure date, LA Metro generated critical buy-in from city hall to the governor's mansion. These elected officials were on the frontlines. They would get the angry phonecalls and questions. They had to know what was happening, why it was happening, and how it would be rolled out to the public. Once on board, they staged a joint news conference to endorse the event and were the first to use the term Carmageddon. Mayor Antonio Villaraigosa's support in this area was essential and highly effective. In addition, the LAPD set up a taskforce of public information officers from a variety of organizations – LAX, City of Santa Monica, UCLA, hospitals, etc – who strategized appropriate actions for their organizations as well.

To accommodate a wider I-405, the Mulholland Drive overcrossing had to be replaced with a longer span. However, as the only east-west connector of the local street network, one lane in each direction on the overcrossing had to remain open during reconstruction. Therefore, the demolition and replacement of the bridge had to be done in phases, starting with the south side.

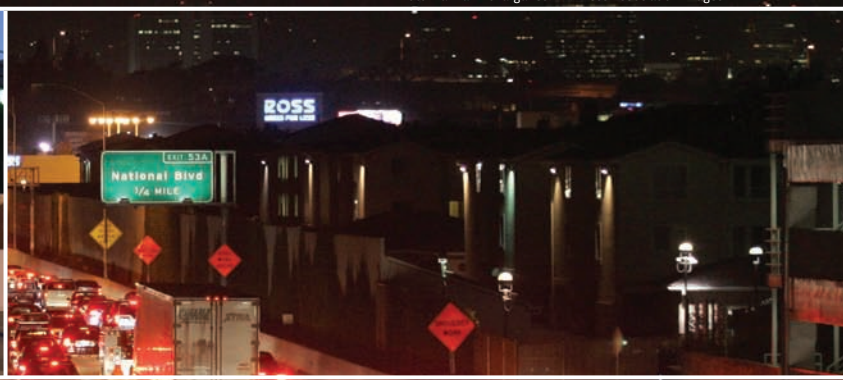
Deconstruction required closing north- and south-bound portions of I-405 for 53 hours, beginning Friday evening, July 15, 2011, and ending Monday, July 18, at 05.00hrs. The closure weekend – the largest freeway shutdown in LA history and one of the largest ever in the USA – would affect an estimated 500,000 vehicles. Those motorists would be forced to use already saturated LA arterials that were 20 miles or more to the east of downtown.

> "Closure weekend would not have been a success had it not been for everyone sitting down face-to-face and agreeing to agree

Fearing gridlock of biblical proportions, officials used the now infamous catchphrase 'Carmageddon' to grab the public's attention. They warned Angelinos to stay home or stay away, claiming traffic could back up for 64 miles.

On the eve of closure weekend, the national news media turned its eyes to LA to capture fallout from the historic event. But the mother of all traffic jams never happened. Dynamic traffic maps at Caltrans' traffic management center stayed green the entire weekend thanks to an

Photo: Damian Dovarganes/AP/Press Association Images



To accommodate an extra lane on the I-405, the Mulholland Drive overcrossing had to be replaced in phases

exhaustive transportation management plan (TMP). Despite what seemed like insurmountable obstacles, the closure was an indisputable success.

Dynamic dozen rules

The TMP, credited with turning Carmageddon into 'Carmaheaven', was the brainchild of HNTB-Kiewit, the design-builder for the I-405 improvement project, along with the City of Los Angeles, Caltrans, and LA Metro.

After numerous post-closure evaluations, HNTB-Kiewit identified 12 best practices that provide an international template for major road closures on design-build schedules. These 12 golden rules for closing a major interstate on a fast-track schedule are detailed in the boxes throughout.

The successful development and implementation of the TMP is a testament to the design-build project delivery method in that the owner, contractor, and designer were able to collaborate in real-time to plan strategies that synced with the current field conditions. HNTB-Kiewit plans to carry these rules forward in phase two of the Mulholland Drive overcrossing demolition slated for 2012. Yes, in true Tinsel Town fashion, Carmageddon will have a sequel!

• *John Merrill is the transportation management plan manager at HNTB Corporation and can be emailed on jomerrill@hntb.com. Joe Quitter is Mulholland segment design manager at HNTB Corporation and can be contacted by emailing jquitter@hntb.com*

Portions of the I-405 in both directions were closed for 53 hours, affecting an estimated 500,000 vehicles

Prepare multiple contingency plans

9 Something as dynamic as the LA freeway network can't be modeled with precision. Instead, HNTB-Kiewit focused on how capable the network was of absorbing the displaced traffic. Using multiple suppression/diversion rate scenarios, they determined what queues would be like.

During the event, they used Caltrans' system of vehicle-detection road sensors with CCTV to identify and react quickly to back-ups.

Create a catchphrase

10 Creating a catchphrase is more important than it might first appear. 'Carmageddon' as a phrase was succinct and intentionally dramatic to capture the public's attention. People embraced it.

Properly execute

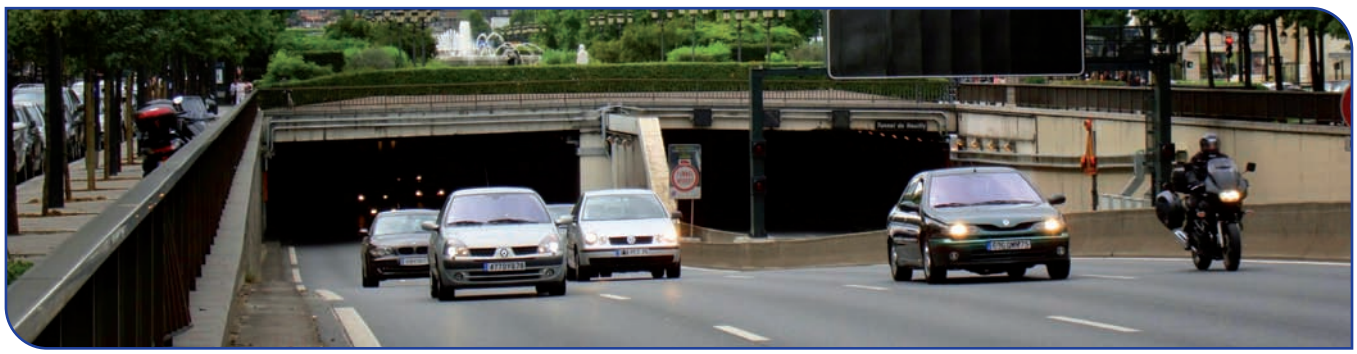
11 It's great to have a plan, but people make it happen. Everybody involved in the closure knew how important that weekend would be. Statewide Traffic Safety & Signs did an outstanding job implementing its portion of the TMP – deploying 85 portable changeable messaging signs, endless miles of cones, and 10 traffic control crews; and putting an army of mechanics and equipment on standby while Caltrans monitored and responded to issues during the event. Penhall Company, the demolition subcontractor, also performed its job flawlessly, playing an essential role in keeping events on track.

Observe and learn

12 HNTB-Kiewit documented activities during the closure and held multiple after-action reviews with each taskforce to prepare a post-evaluation study.

Steering clear of collisions and congestion in Paris

Despite technological advancements, gridlock continues to plague primary thoroughfares on a daily basis in even the most illustrious cities. Engineers and traffic authorities have, however, certainly not sat still while traffic jams get the upper hand of our roads. The result is that it's now a lot simpler to steer clear of collisions and congestion in Paris than it was a year ago.



Keeping a close watch on safety

In twenty-two tunnels around Paris, through which more than 200,000 cars drive every day, Siqura will integrate 1600 of its video servers to encode and transmit the camera streams. The images from each of these cameras are merged with AID information generated by nearly 1500 of Traficon's VIP-T boards. The Siqura codecs will compress the video into MPEG-4 and H.264 and stream it to the dedicated control room of each of the tunnels for viewing and storing footage.

A traffic management system handles the data, events and alarms generated by the detector boards and uses configured AID events to trigger the Siqura recording solution to save any relevant video clips to the system for future use. These recordings can be reviewed later to help improve the traffic monitoring system and hence the safety of the motorways in and around Paris.

Taking technology to the next level

"The extended temperature range of the Siqura encoders enables them to withstand the rugged tunnel conditions while still transmitting high quality video," explains Mr. Lemmierre. "The adoption of Siqura video recording systems in the four DIRIF control rooms allows operators to review recorded images up to 72 hours after an event occurred.

Since these recording systems are associated with Traficon's AID systems, which include spatial-temporal markers, operators are provided with an undeniably user-friendly system to improve safety in the tunnels and comply with rules and regulations."

Ultimately, this pioneering AID tunnel project uses technological advancements in the video networking industry to effectively combating bottlenecks, as well as creating safer and smoother roads for motorists.

"The extended temperature range of the Siqura encoders enables them to withstand the rugged tunnel conditions while still transmitting high quality video."

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Smart thinking

Intelligent software, vision assistance and environment detection systems are central to some car makers' attempts to bring automated driving another step closer to reality, finds **Richard Yarrow**

Photographs courtesy of BMW, Continental & Daimler

Removing human error from the driving task would slash road accidents

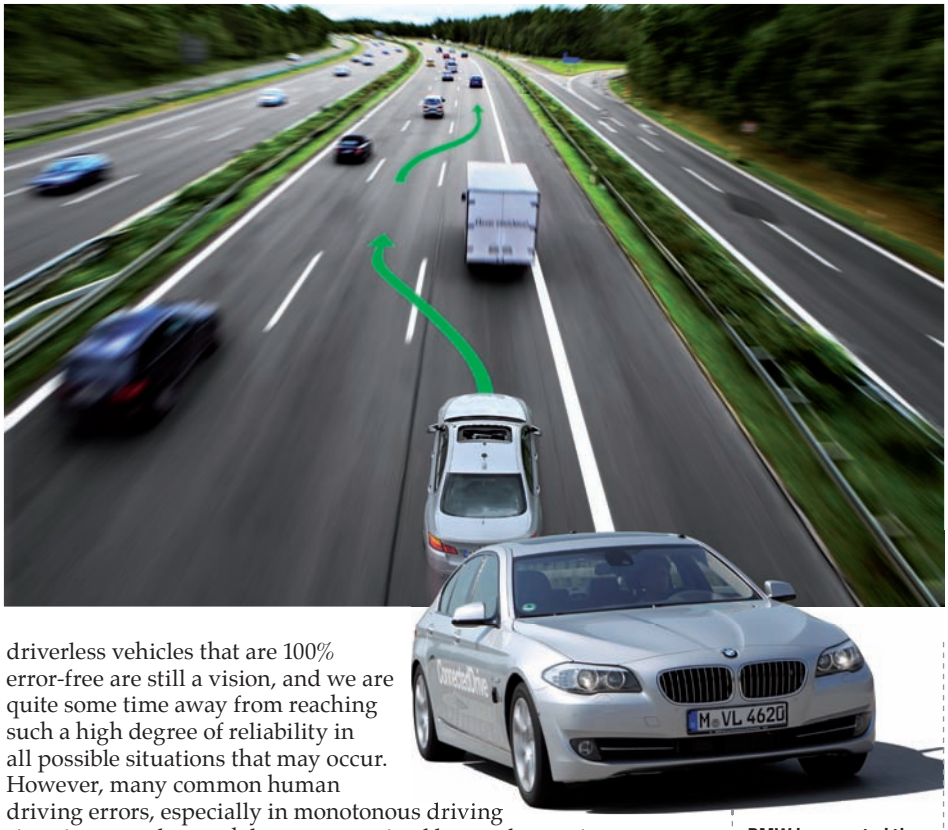
Just as we have reported in these pages many times before, driverless vehicles – or those that remove the need for the occupant to be in control at all times – have the potential to eradicate human error from our roads. As it is a contributing factor in around 85% of all crashes, this would be a significant step forward in traffic safety. The key proviso for public acceptance is proof that such machines cannot go wrong, however, or if they do they go into a failsafe mode. But can a car be as smart as a human, and is it possible to create something that can work in harmony with the restrictions enshrined in the Vienna Convention?

These are the questions being considered by engineers at BMW Group Research & Technology in Munich, who have been working for several years on the development not of a driverless car per se – the kind we have seen in the past as part of the DARPA Grand and Urban Challenges – but on an advanced electronic 'co-pilot' to support automated travel only in specific situations.

Look, no hands!

BMW recently went public with its latest innovation – a technology testbed based around a 5 Series saloon designed specifically to assist in a busy freeway environment. Known in BMW circles as 'Highly Automated Driving', the system is activated at the push of a button and can then autonomously control the vehicle's acceleration, braking and steering. The car will even overtake slower traffic, constantly monitoring and adapting to the prevailing conditions. Almost 5,000km have been completed by the team in its quest to understand the potential uses and – perhaps more crucially – the limitations of the technology.

"Humans are still the most capable system on board a car," insists Dr Helmut Spannheimer, head of the Driver Assistance and Perception team at BMW Group. "Fully



driverless vehicles that are 100% error-free are still a vision, and we are quite some time away from reaching such a high degree of reliability in all possible situations that may occur. However, many common human driving errors, especially in monotonous driving situations, can be much better recognized by an electronic system because it never gets tired and never lets down its guard."

That is where the Highly Automated Driving project comes into play. The prototype car is equipped with sensors that perform two advanced functions – vision assistance and surrounding environment detection. Together, these help to pinpoint the vehicle in its own freeway lane and recognize everything in the immediate vicinity, achieved through the use of various sensors such as radar, lidar and ultrasound, as well as video cameras. To ensure the on-road scenario is precisely and accurately assessed, at least two different measurement methods are used in every direction of view – so-called 'redundant fusion'.

"A lot of technology for Highly Automated Driving can already be found in modern production-level BMW vehicles," Spannheimer suggests. "These include video cameras, radar and ultrasonics, plus actuators for steering, brakes and throttle. Some additional systems such as a laser scanner and a highly accurate positioning system using the latest digital mapping have been required to develop this technology for freeway driving."

The car's functionality has been primarily developed by BMW Group, with university collaboration. Key to moving it from the drawing board to reality has been making the prototype look and feel as much like a normal 5 Series as possible. That meant using components that could one day be built into a production vehicle rather than more advanced and expensive ones which, for example, needed to be mounted on the roof. All sensors are integrated into the body shell, maintaining the car's design, proportions and appeal.

Combining information

Surrounding environment perception is achieved by combining the information from up to 12 sensors, installed to scan in all directions away from the vehicle. The goal is to detect all relevant road users within the immediate vicinity, including unique properties such as the type of vehicle and its speed.

BMW has created the functionality for the Highly Automated Driving project

The advanced positioning system means the location of the car can be calculated accurately to within a few centimeters, achieved by blending information from GPS satellites, vehicle dynamics data such as speed, accelerations, turn rates, camera-based lane recognition, and the detailed digital map. "By fusing multiple sources – just as we do with the surrounding environment perception – it gives the system a high degree of robustness and reliability," says Spannheimer. "This allows the car to determine exactly where it is in the world, which lane of the freeway it's in and even where within that lane."

Additional computing power has been installed in the car to allow automated and intelligent decision making followed by accurate vehicle movement, all without any driver involvement.

Constantly updating, the car decides what it should do in any given situation. A good example is considering when to make a lane-change; every decision is checked and double-checked by evaluating the available data and several key safety factors, the goal being to guarantee that any automated driving maneuver does not obstruct other road users.

The types of accidents the prototype vehicle is designed to reduce are the common freeway ones – sideswipes caused by inappropriate lane-changes and rear-end shunts. But Spannheimer refuses to speculate about how many deaths and injuries he thinks might be avoided if the Highly Automated Driving project were to become a reality and achieve a high enough market penetration. "With active driver

Despite the array of onboard computers and electronics, the driver is still responsible for the situation at all times

Stereo vision hits the road

Daimler's **Dr Uwe Franke** reveals details about the German giant's latest technology milestone – a significant step along the road to accident-free driving

Colorful pixels on the camera's grayscale image show the distance of the pixels from the camera and therefore the moving object

The concept of stereo vision is not a new one – any animal with two eyes set a small distance apart relies on it for spatial and distance perception. Our built-in twin 'cameras' create two unique images that the brain blends together seamlessly to give us a 3D view of the world. Shut one eye and look around to see how vital it is and how much we take it for granted.

Daimler has been working on the automotive equivalent of human eyes since 1996 – and in 2005 developed the principle of 6D-Vision. The innovation uses two cameras fitted a few centimeters apart behind a car's rearview mirror at the top of the windshield to generate a 3D geometry of what lies ahead. "It's an image-processing technology that opens up new possibilities for future safety assistance systems," reveals Dr Uwe Franke, Daimler's head of Image Understanding. "With the help of a stereo camera, some powerful hardware and associated algorithms, 6D-Vision is able to replicate the key ability of human beings to perceive the world around them in three dimensions and recognize potential danger. It will help us to understand the situation around the car as humans do and get to a world with zero-accident traffic."

> In 2010, around 200,000 people were injured in inner-city traffic accidents in Germany; half of the 1,400 who died were either walking or cycling

Daimler's innovation has been constantly revised over the course of the past six years, but in 2008 the research took a giant leap forward when the biggest hurdle was overcome – getting the necessary stereo analysis algorithm stored for the first time on a small, energy-efficient and inexpensive Field Programmable Gate Array (FPGA) chip. This allowed interrogation of the stereo images up to 25 times a second. In parallel, various assistance systems such as Distronic Plus have been developed and tested in real-world conditions on Mercedes-Benz production cars. The result is that 6D-Vision will make its production car debut in 2013 on the next S-Class.

The system's key benefit is not just its ability to spot moving objects out on the road – particularly those coming across the driving 'corridor' such as cyclists, pedestrians and other vehicles – but also its accuracy when predicting a future position based on current course, and then reacting accordingly.

It is called 6D-Vision because it makes it possible to calculate the precise location of a hazard in three dimensions, and the direction and speed of travel in a further three. The average human will take 500ms to process that information and instigate emergency braking, but 6D-Vision can do it in 200ms. For hazards that are 30m away, it is accurate to 10cm.

6D-Vision is a development based on a real-world need. In 2010, around 200,000 people were injured in inner-city traffic accidents in Germany; half of the 1,400 who died were either walking or cycling. Franke believes many of these accidents could have been avoided if the driver had looked in the right place at the right time. But the failing of our eyes is that only a few degrees of forward vision is sharp, the rest is peripheral and blurred. We compensate by performing fast changes of the viewing direction, known as saccades, on average twice a second. The beauty of 6D is that it is always in focus and watching all the road ahead.

Franke is clear about the benefits of the 6D system over other sensor types. "There is nothing else that can reliably detect pedestrians if they are partly hidden by other objects," he says. "In addition, the fact that the 3D position is known for all image points helps to better understand the situation that might occur. It's also cost-effective; the price of the technology will benefit because of ongoing developments in the field of consumer electronics."

In real-world terms, after investigating the risk of accidents where there is intrusion into the driving corridor from the side, Franke's team says the technology can have a major impact on road safety. "The result is that we avoided 15% of all accidents in the urban area. As 6D-Vision will become part of more systems in the future, the potential is even bigger."

Applications the company is known to be working on include an advanced evasion system specifically designed to protect pedestrians, as well as driver support for use on construction sites. Future developments also include a likely scenario where there is more than one pair of cameras monitoring the car's perimeter – that is, covering the rear and/or sides.

With Daimler's 6D vision technology, the pixels are not just measured spatially

"Future ADAS will require redundant sensors to guarantee the highest reliability," Franke clarifies. "Thus the question is not how to replace sensors but how to fuse them optimally. We do not intend to replace the Distronic radar with 6D-Vision."

A patent for 6D-Vision has been filed, but Daimler will only be using it exclusively for a short time. "Given the importance in terms of safety, we have in the past made innovations we've developed – such as the airbag and ESP – available to our competitors," Franke concludes.

"As 6D-Vision is able to contribute significantly to reducing road traffic accidents, we will in due course make this technology available to other manufacturers as well."

> To what extent customers are interested in systems such as Highly Automated Driving, which will take over the task of controlling the car completely in some cases, is not proven yet in studies

In-vehicle camera technology can help assist drivers with certain tasks

assistance systems, we expect a big potential for avoidance or mitigation of accidents," is as far as he will go.

The key challenges in getting this far have been of a technical nature, particularly development of sufficiently accurate surveillance of other traffic, situation interpretation and decision making. These have been overcome by using powerful sensor systems and by the development of specific and highly sophisticated algorithms, the latter in collaboration with Munich's Technische Universität.

One issue that came to light early in the project was how the 5 Series should react to vehicles merging onto the freeway from sliproads. But it was quickly solved and now the prototype allows the approaching traffic to join the flow; it can even change lanes to create adequate space for them to enter more safely. Such a maneuver is possible at speeds of up to 130km/h (81mph) but takes into account localized traffic regulations such as speed limits and prohibited passing zones.

Public acceptance

Public reaction to any kind of automated driving as an element of 21st century freeway use is a hurdle that has to be overcome, of course. There's no point in spending a vast development budget if no one has enough confidence in the system to press the button to activate it.

BMW says its own internal feedback on the use of its current advanced driver assistance systems, such as active cruise control (ACC), is very positive with a high level of acceptance. It also says findings on the interaction and behavior of drivers trying out the 5 Series prototype have been "very valuable".

"To what extent customers are interested in systems such as Highly Automated Driving – which will take over the task of controlling the car completely in some cases – is not proven yet in studies," Spannheimer states.

Predictive text

Spannheimer says it is easy to imagine systems such as those showcased in the Highly Automated Driving project in use on freeways as a first step, but beyond that it is hard to predict their future on other road types. "The basic functionalities – such as lane keeping, vehicle detection and positioning – can work in rural and urban driving. But the situations encountered in those environments are much more complex as well as unpredictable. The perception, positioning and decision-making elements would have to reach a higher level of advancement in order to cope and this is quite a challenge."

But although this is only a research project, it doesn't mean the program lacks ambition. The lessons being learned and the experience gained have the potential to improve next-generation versions of driver assistance systems with a lesser degree of automation that are already in use, including technologies such as ACC. It is also playing a part in a technology called Traffic Jam Assistant (TJA), due to debut on the production version of the i3 concept car. TJA is designed to help drivers in urban stop-start situations or slow-speed freeway queues. The idea is that once switched on, TJA takes control of the vehicle so it can literally 'go with the flow' and the driver can relax. A development of ACC, TJA maintains a safe distance between vehicles and automatically controls the speed and steering. It is able to stop the car completely if necessary. As long as the driver keeps one hand on the steering wheel, the car can provide assistance in keeping it precisely in its lane at speeds up to 25mph. The i3 is due on sale in 2013.

> The goal in the next decades is to develop the perfect electronic co-pilot, which can support the driver on both safety and comfort in special situations

Whatever next

The next steps for the team are to continue improving system accuracy on freeways in general, and in particular learning how to deal with sections of roadworks and also junctions. "Construction sites especially pose quite a challenge as it's not realistically possible to have a highly accurate digital map for each. That means a new approach is needed to detect the many different types of sites out there. It's about positioning the vehicle accurately and then figuring out where the vehicle is allowed to drive."

As a result of the Vienna Convention's ban on fully automated driving – where the electronics would completely take control of the vehicle for an extended period – Spannheimer believes that it is a scenario that will not be seen for a long time. "Prior to thinking about introducing such systems into production cars, proof of safety is necessary," he says. "It must show that the systems will react and perform as safely as the human driver does in comparable situations. The goal in the next decades is to develop the perfect electronic co-pilot, which can support the driver on both safety and comfort in special situations."

His last point is an interesting one, because BMW sees the use of Highly Automated Driving as providing dual benefits that also complement each other. Put simply, making driving more relaxing and removing the stress some motorists feel, particularly on higher-speed roads such as freeways, can also indirectly help prevent accidents.

The road to fatality-free driving

One of the leading Tier 1 suppliers of intelligent vehicle technology is the German company Continental, whose safety division is headed by Ralf Cramer. "It might be another 20 years before we see a limited number of accidents on the road; in the near-term, I don't so much envisage accident-free driving but I do predict driving without fatalities," says Cramer, who admits his focus has shifted recently. "In Germany in 2010, there were 3,700 fatalities, more than 500 of which were pedestrians. We see pedestrian detection as more important than we did in 2009, and are developing certain technologies with that in mind."

Away from Continental's core operations, the company has just concluded its role as one of the partners on the EU-funded HAVEit (Highly Automated Vehicles for Intelligent Transportation) program, featured in *Traffic Technology International* in January 2010. One element of the program was Automated Assistance for Roadworks and Congestion to combat the issue that many drivers have when going through road works. "We were using technologies already developed such as radar and camera systems controlled by intelligent sensor fusion," Cramer states. And although the project may have ended, the system is not forgotten. "It won't be in series production for some time but we are still working on it – and I can see it coming to fruition in the years to come."

No doubt it will be part of the car of 2050, of which Cramer's vision is quite clear: "I would like to see cars with a 360° safety shield, each monitoring the driving situation of not only that particular car but of every car around it. This would be something like a virtual bumper," he says. "All of these vehicles will be equipped with these systems and they will be able to communicate with each other. By that time, just through the application of technology, cars won't even be able to touch each other anymore," he concludes.

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End of the road?

With a dramatic expansion in the level and type of in-car information being delivered to drivers, **Timothy Compston** assesses what effect, if any, this is having on the viability of electronic roadside signage such as VMS

Illustration courtesy of Magictorch

Undoubtedly, we are witnessing a major proliferation in the way that drivers receive data regarding traffic conditions, hazards ahead, and navigation options, whether it be through the human-machine interface, on head-up displays, voice alerts, real-time alerts, or even road signage symbols delivered straight to smartphones.

For its part, though, the VMS industry is not standing still and is introducing numerous advances, as exemplified by more energy-efficient displays, the use of LED-enhanced communication with signs, the introduction of color to increase effectiveness, and enhanced user interfaces so messages can be monitored and updated in a timely manner.

Against this backdrop, there is much debate among traffic technology providers and end-users over the best way forward for driver information. Should the inexorable rise of vehicle-related technology, for instance, be seen necessarily as a negative indicator for roadside VMS? Will one grow to the exclusion of the other? Or, given the continued strong demand for electronic signage – with vendors in the ITS arena reporting major contract wins – does the reality on the ground actually tell a different story? Are we more likely to see, for example, the two approaches working in a complementary way? And is in fact the real issue how we can ensure consistency in the messages that are being delivered?

A view from the tollway

When asked about where drivers will be receiving their real-time traffic and other related data in future, Clayton Howe, assistant executive director of operations at North Texas Tollway Authority (NTTA), believes that talk of the demise of VMS is premature. In fact, Howe believes there is, if anything, likely to be an expanding role for VMS in the toll road environment.

"The key consideration is communication – how do we provide just enough information, just what the road users

Upon reflection

With the amount of electronic technology in cars continuing to rise, the rearview mirror has emerged as an ideal location to incorporate much of this electronic content.

The mirror's position in the vehicle – high on the windscreen, in the driver's line-of-sight, surrounded by glass – makes it a high-performance location for displays, microphones, antennae, receivers, and so on. And because it is surrounded by glass, it is also advantageous for sending and receiving signals.

Additionally, it's the optimal location for cameras: looking forward of the vehicle, protected by glass, and in an area swept clean by the windshield wipers.

When drivers glance at the rearview mirror, only subtle movements of their eyes are required, which allows them to view and interact with mirror-borne displays while maintaining their line-of-sight on the road ahead.

In addition, drivers look into their rearview mirror more frequently than they view the instrument panel. According to data from Japan's general insurance association, drivers glance at their rearview mirror at least every 15 seconds, or four times a minute, while viewing the instrument panel only three times a minute.

NTTA is continuing to roll out VMS for the immediate future

actually need, without too much information that overloads the driver or the same information so it gets ignored?" he asks.

"At NTTA, we are continuing to deploy a large number of VMS to provide changing information in an effective way to all our road users. Obviously technology such as smartphones and GPS can take things to a whole new level and bring it in-car with a more personal dimension, which is 'cool'. The challenging thing about any 'cool' technology, however, is that somebody has to pay for it and it takes a long time to become universal.

"From a tolling authority perspective, we simply can't rely on in-car technology being there; it can only be an enhancement of what we do," Howe continues. "We still have to find a method to put messaging out on the roadway and to be realistic, I feel we are probably at least 10 years away from a vehicle-based solution that would be effective for the masses. We have an obligation to be able to communicate travel and safety-critical information to every one of our drivers in a timely manner – not merely a certain percentage."

The NTTA does offer the option of providing information via smartphones, although Howe sees this as complementary to measures such as VMS because drivers have to opt in.

"In the longer term, it probably does make sense to have an in-car traffic application at a regional level, as opposed to traffic management related to two or three roadways," he adds. "I don't think the tolling industry is going to be the major player in this; it is more something where I'd envisage the GPS carriers leading the way."

Looking ahead, Howe expects an expansion in VMS deployment over the next few years: "This will be driven, in our sector, by the move to all-electronic toll collection. For our part, we are putting up nine more messaging signs to keep customers informed. I don't believe VMS will be replaced by smartphone applications anytime soon. We are also seeing a dynamic pricing model being applied, which needs to be communicated. In addition, there is the ongoing requirement to provide updated travel times – something that our road users really appreciate."

One of the most exciting advances in providing driver-relevant information is the head-up display (HUD), a functionality more usually associated with fighter jets. A leader in this field, from an automotive perspective, is BMW, which claims to have been the first European manufacturer to adapt the technology for use in volume-production vehicles. The initial version was rolled out in January 2004 as a driver assistance system offered for the BMW 5 Series as an integral part of its ConnectedDrive.

The latest iteration of this approach, announced by BMW in October, features a full-color display, which is now available as an option for most of the automaker's models, and offers the potential for driver-relevant information to be displayed in high resolution within their field of vision. A virtual image is projected onto the windshield, which is visible only to the driver, and appears to be 'hovering' above the hood.

"The main advantage of the HUD from a safety perspective is that drivers are not having to try to look out at the street and the instrument panel at the same time – they

> From a tolling authority perspective, we simply can't rely on in-car technology being there; it can only be an enhancement of what we do
>
> **Clayton Howe, assistant executive director, NTTA, USA**

An evaluating eye on IVIS

In-vehicle systems provide useful information but can also distract the driver, so TRL's **Dr Alan Stevens** has developed a Checklist to account for recent technological advances

The European Statement of Principles (ESoP) for in-vehicle information systems (IVIS) has emerged as a key high-level reference of human interface design and has been embodied in a European Commission Recommendation. Recent discussions in the eSafety forum have centered on the issue of how to evaluate the extent to which a particular IVIS 'complies' with the principles.

IVIS such as satellite navigation systems, traffic information systems, vehicle diagnostics, and trip computers can provide drivers with relevant and up-to-date information that supports the driving task.

In the *100-Car Naturalistic Driving Study* carried out by Virginia Tech Transportation Institute, driver inattention was a contributing factor in 78% of the crashes that occurred. Clearly this demonstrates the dangers of being distracted while driving and brings focus to the potential dangers of using IVIS, which can be a major source of distraction for drivers. It is therefore critical that IVIS are designed in a way that promotes safe use.

TRL developed a Checklist for the assessment of IVIS for the UK government in the late 1990s, the aim being to provide a structured approach for assessing the interface design of an IVIS and to identify where a design might require further development work or detailed measurements. The Checklist was based on codes of practice and international standards that were relevant at the time of development.

Since the Checklist's publication, there have been several advances in technology, along with developments in ergonomics standards and road safety. Many new technologies have emerged: touchscreens are now widely used and head-up displays – such as those in some BMW models – are expected to become more prevalent. Devices are also being combined and integrated and many satnav systems now incorporate speed alerts and traffic information.

With the development and increased use of smartphones, a large number of apps have become available that aim to make it safer to use a cell phone while driving. These range from DriveSafe.ly, which reads out text messages and emails as they are received to DriveReply – an app that restricts access to text messages and phone calls while a vehicle is moving.

> The field of ergonomics has developed since the publication of the Checklist and research has been carried out on IVIS design

Along with these technological developments, the field of ergonomics has also developed significantly since the publication of the Checklist, and innovative research has been carried out on IVIS design. As a result, new standards and guidance on the ergonomics and safety of in-vehicle technology have been developed. For instance, the ESoP was updated in 2008 and provides design guidance for the human-machine interface (HMI) of in-vehicle technologies.

Taking into account all of these factors, it became apparent that the original Checklist was in need of revision.

Consequently, TRL embarked on the task of updating it to bring it in line with recent developments and it was decided that it should be aligned with the latest edition of the ESoP. Where issues covered in the ESoP were omitted from the original Checklist, additional questions were designed and integrated. Similarly, some interface and usability issues that are not included in the ESoP were also included in the updated version to ensure it is sufficiently broad in scope.

Additional sections are provided that advise on the steps to be taken prior to conducting an assessment, as well as providing guidance for each question.

Initially, a paper version was available for use. However, following modern data collection trends, it was felt that the Checklist should also be implemented in such a way that results could be entered electronically using devices such as PDAs, touchphones, and tablet PCs.

TRL therefore developed a spreadsheet in Microsoft Excel that provides a number

(Left) **Bringing the Checklist into the electronic world makes life far easier for assessors** (Below) **TRL is acknowledging the fine line between giving useful information to drivers and distracting them**

of benefits to assessors. Questions can be answered and comments and notes can be made directly, removing the need to type up results. Assessors can also access supportive information via 'help' icons, which reduces the number of documents they need to conduct an assessment. An assessment summary sheet is automatically generated, highlighting the areas of concern.

Results from assessments may be used in a number of ways, including internal design development, benchmarking, marketing, and consumer information.

Some organizations have shown interest in using the ESoP and the Checklist as the basis for a consumer-rating scheme, but a number of factors would need to be investigated further before this is possible. Nevertheless, TRL believes the Checklist could enable consumers to make more informed choices on safety when purchasing IVIS.

• *Interested researchers can obtain a free copy of the Checklist by emailing TRL at enquiries@trl.co.uk*

never have to take their eyes off the road," says BMW's Friedbert Holz.

Holz believes providing color facilitates a more realistic and intuitive display of images and symbols such as road signs. "In aircraft, HUD is monochrome, but when you want to provide traffic sign information while driving – which is one of the options we offer – it is important to have a multicolor display to make it as authentic as possible," he says. "This means, for instance, when a driver goes into a 50km/h zone, they see a 50km/h sign within the HUD picture in exactly the same configuration and colors as the physical traffic sign at the roadside."

> When you want to provide traffic sign information while driving – which is one of the options we offer – it is important to have a multicolor display to make it as authentic as possible
>
> **Friedbert Holz, BMW Group, Germany**

Crucially, according to Holz, with an HUD the time for drivers to assimilate information is reduced by more than 50% compared with via the instrument panel, and is less tiring on the eye because there is no need to adjust between close range and remote vision.

Collective communication

The real contrast between VMS and in-car devices, according to Roger Stainforth, deputy chairman of UK company VMS

BMW's HUD delivers information to the driver's line-of-vision

Limited (VMSL), is that VMS is collective, whereas technologies such as satnavs are very much individual.

"The roadside and in-car debate has long been the subject of conference and seminar discussions," he says. "I believe they are complementary, with the information displayed on the roadside across strategic networks as the primary communication tool, because it is essentially available to all drivers. If there is a highway closure, the sign tells everybody, whereas if you are relying on potentially 20 different in-car devices, the information may not be provided consistently.

"What we are seeing with VMS now, rather than exponential leaps in technology, is a focus on important refinements such as LED design and color," Stainforth adds. "This is allowing small but useful improvements in performance, reliability, and energy consumption. Power consumption of signs, for instance, is probably 50% of what it was 10 years ago. With LEDs, you don't need so many LEDs per pixel."

The real change that Stainforth reports is in how VMS is being applied in practice: "In the UK, we now have extremely good guidelines for the application of VMS, especially those operated by the Highways Agency and the regional control centers, with staff well briefed on the messages that should be displayed in line with the conditions. Today, messages generated on the motorway network are more responsive and how communication is handled from the control centers has improved considerably."

One area of concern for Stainforth, however, relates to mobile VMS. "By contrast, in the case of roadworks, for instance, there is still a great deal of poor application out there, where operators are not skilled in using the signs and simply don't appreciate how long it takes for drivers to read, assimilate, and act on the messages they are displaying," he says. "In some of the worst-case scenarios, three or four messages may be displayed in sequence, with the characters compressed, which drivers have no hope of reading in time. They also tend to use character heights for approach speeds that are inappropriate, so signs cannot be viewed properly until very close."

On a wider note, he feels the prospects for VMS are positive and that suggestions of their demise are wide of the mark. "The demand is certainly out there – we recently secured an order for a large number of VMS and advanced motorway indicators for a scheme to widen the M25 motorway around London."

A symbol of success

In the USA, Jason Morrison, ITS market manager at Daktronics, also reports a positive take-up for color VMS; an option that now accounts for a significant proportion (approximately 25%) of the company's business in the field: "The move to color and higher resolution provides greatly enhanced flexibility for composing and delivering messages with the ability to render universally recognized symbols."

Downtown Minneapolis is reaping the benefits of VMS

Indeed, in a new project that ties in with this trend, 42 of Daktronics' digital signs featuring full-color graphics were installed across downtown Minneapolis to enable drivers to navigate around the area more easily.

> "The move to color and higher resolution provides greatly enhanced flexibility for composing and delivering messages"
>
> **Jason Morrison, ITS market manager, Daktronics, USA**

Morrison cites research conducted by the University of Rhode Island, which found, interestingly, that graphics improve the comprehension and legibility of messages on VMS, with motorists reacting on average 35% faster when the text message included a standard symbol.

"Operators are certainly seeing the benefits on the ground of being able to use symbols as well as text," Morrison reveals. "Significantly, it allows a more succinct message to be provided on the sign because everything is not having to be spelt out."

Turning to the burning question of in-car versus roadside, Morrison believes they can work in tandem, but that each has its appropriate place.

"Dynamic messaging signs have always played a very public role and are a proven method," he says. "In-car systems have come a long way – and will continue to leapfrog – but they face major challenges, including the fact that there are a lot of older vehicles on the road without this type of technology installed. At the moment, dynamic messaging signs (DMS)

provide a safer heads-up in terms of what is happening on the roadway."

A particular area where Morrison is seeing an upturn in DMS sales is where agencies, due to budgetary constraints, are looking to maximize their return on their existing roads infrastructure.

"They are turning to dynamic messaging technology to offer a more cost-effective solution, where historically they may have looked to add another lane to increase capacity," he explains. "Using our signs to provide the appropriate messages, they can implement active traffic management to alter speed limits to help the throughput of vehicles or, if congestion is too high, open up the shoulder to provide an additional lane."

The medium and the message

Mark Bodger, systems marketing manager at VMS provider Siemens Mobility, feels that whatever method is being used to deliver messages to drivers, it is imperative that it is constantly updated. "If information doesn't change or is not delivered in a timely way, then people are unsurprisingly going to question its importance," he says.

An important focus for Bodger and his colleagues is the urban environment in the UK, with local authorities one of their primary customers for VMS solutions: "Our signs may be deployed anywhere in this environment, whether it be to deliver information on car parking occupancy or dynamic messages related to the current traffic conditions."

When questioned about new product developments, Bodger reveals that Siemens' latest model has been designed to be as cost-effective as possible: "With the Electra – which is approved to the latest EN12966 specification – we have been able to employ modern technologies in manufacturing and materials to make it more economical to produce and operate and, crucially, it is compatible with other UTMC traffic management systems."

In a recent contract, the new Electra VMS was successfully commissioned on key approach roads in Newcastle-under-Lyme, England, to tackle traffic congestion. Siemens is also on track to supply the Electra VMS for projects in St Helens and Glasgow.

Agreeing with VMSL's Roger Stainforth, Bodger feels energy efficiency remains an important issue for VMS systems.

> If information doesn't change or is not delivered in a timely way, then people are unsurprisingly going to question its importance
>
> **Mark Bodger, systems marketing manager, Siemens Mobility, UK**

"We are seeing a ballpark reduction in power consumption for signs with the latest LED technology of about 30%, depending upon the overall size of sign and numbers of characters used," he says. Connectivity has also been enhanced compared with older models, so that signs can all be networked in the IP environment, as Bodger concludes. "This opens up the potential for remote diagnostics to ensure they are working properly without having necessarily to send an engineer to site."

Designs on the driver

Thomas Lindgren, interaction design engineer in R&D at Volvo Cars, is excited by some of the traffic innovations being brought to the road by the Swedish vehicle manufacturer.

"Our collision warning and distance information systems both integrate an LED HUD," he says. "For collision avoidance, the strong red light makes the warning look similar to a car's brake lights ahead, so drivers can react instinctively. A sound is added to alert the driver, should they be looking away. We also offer voice control for infotainment tasks that would otherwise take a fair amount of time and attention – for example, entering destinations in the satnav or searching the phonebook."

Considering the best way to provide information to drivers, Lindgren believes a major imperative is ensuring they do not have to divert their attention from the road: "Visual information should be positioned at a high level relative to the driver; text-to-speech is also advantageous, and of course it is vital to ensure that driving-optimized information content is displayed at the right time so appropriate action can be taken. We have, for example, an Intelligent Driver Information System that monitors the workload level and delays information that is not urgent."

Volvo is focusing on getting time-critical information to drivers and stopping non-urgent information from increasing driver workload

Volvo has ambitious plans, according to Lindgren: "We will be striving to make it easier to use in-vehicle functions in an efficient and safe way while driving. This means we will be looking to investigate the further development of our HUD technology and other elements such as voice-activated control."

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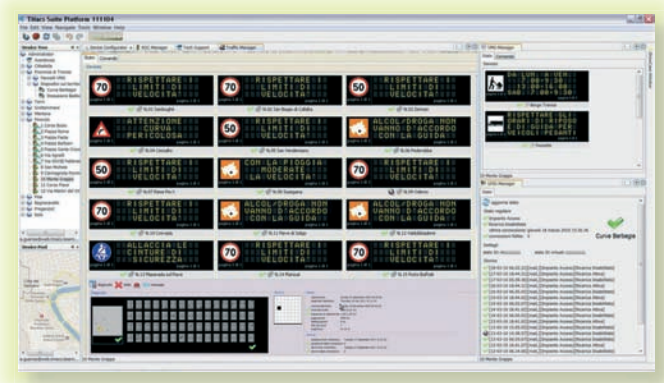

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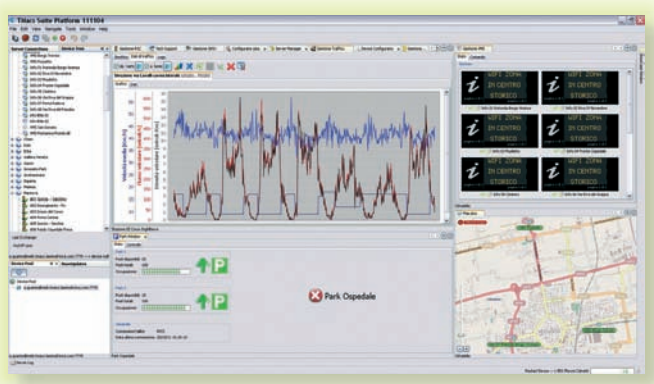

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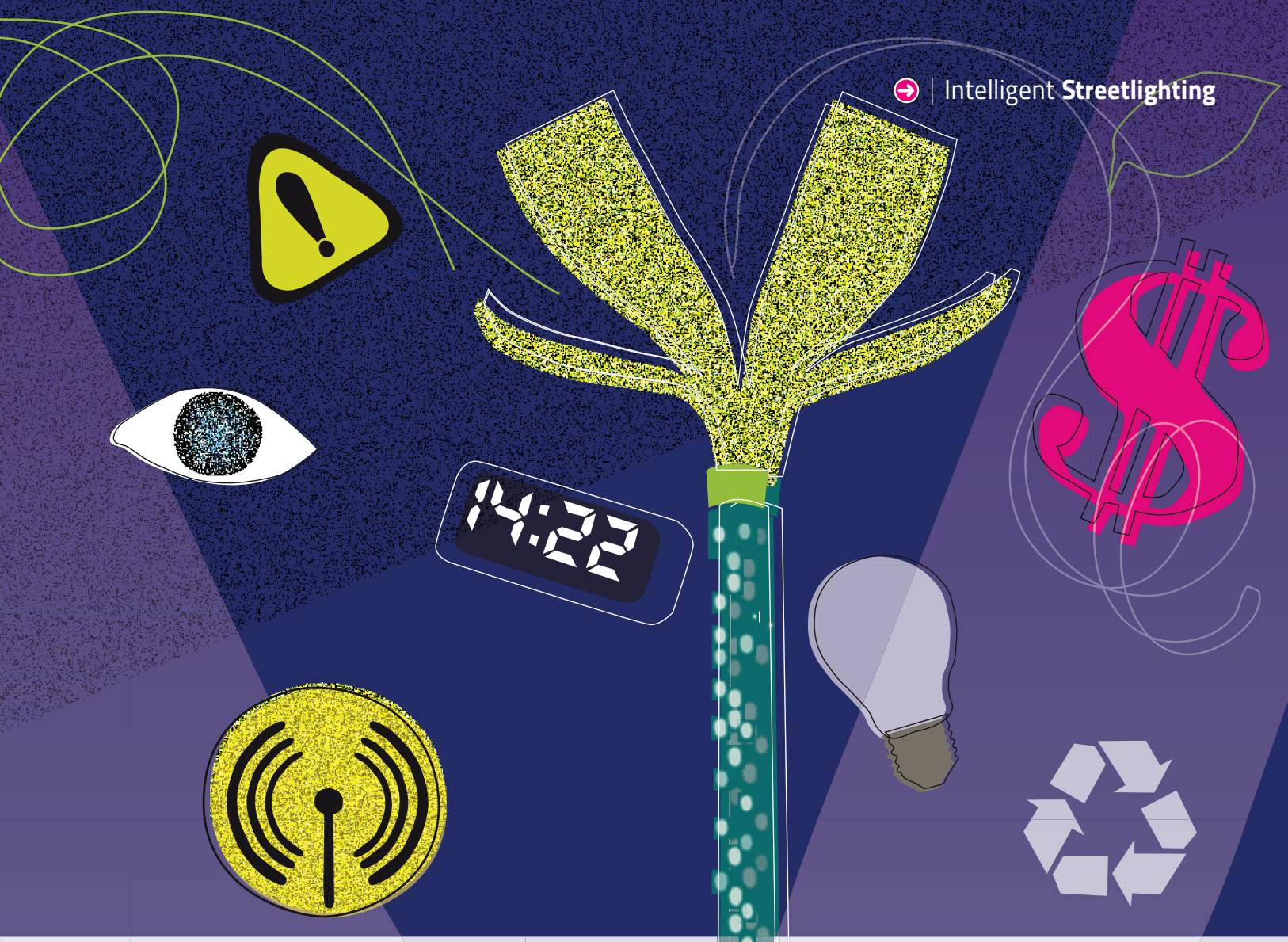
Shining examples

It's difficult to know where to start when discussing the virtues of modern streetlighting systems – energy consumption, cost reductions, and traffic safety. **Saul Wordsworth** finds out from some world-leading experts

Illustration courtesy of Anna Davie



Lighting consumes 20% of electricity generated worldwide, equating to nearly two billion tonnes of CO_2 a year. New lighting technologies have the capacity to save 75% of this energy. Ongoing research also suggests that changes to road illumination could reduce the number of accidents.

One streetlighting revolution is already underway. The use of LEDs has been shown to improve energy savings by up to 52% over mercury-vapor high-intensity discharge and 26% over sodium fixtures. There is also widespread consensus that visibility in low-light situations is considerably improved under a blanket of white light, often at a lower energy output. Although there are gradual signs of LED uptake, particularly in mainland Europe, the high capital investment cost continues to be a barrier.

"The numbers surrounding LED uptake are pretty murky," suggests Dr Ted Konnerth, president and CEO of technology specialists Egret Consulting Group. "Philips is claiming that LED adoption by 2015 could be as high as 40%. Where that breaks down is if you see the lighting industry through the traditional manufacturers' perspective you will appreciate the amount of time it takes to implement such changes."

Although the LED revolution may not have taken hold quite as firmly as first hoped, there are many shining examples of exciting research, revolutionary thinking and the application of new technologies – including LEDs – that are changing our ideas about traffic safety, traffic management, and energy consumption.

London lights

In the heart of London, service development manager for the City of Westminster Dave Franks is currently overseeing the SMART Lights program. The project, which has just completed a trial featuring 3,000 of its 15,000 lamps, covers all aspects of streetlighting including lamp technology, controls, and remote maintenance. "We expect to save £8.4 million over the 20-year life of the lights through reduced energy costs and maintenance requirements," says Franks. "Once the cost of the scheme is covered – after seven years – we expect to save nearly £500,000 annually."

The streetlighting equipment purchased by Westminster includes white-light emitting Philips Cosmopolis lamps and the Harvard Engineering LeafNut, a system that enables the council to control its assets remotely. LeafNut is based on a Wi-Mac network, which according to Franks is "like WiFi on steroids", enabling Westminster to remotely dim or increase illumination via computer, smartphone or text message. This permits

The eyes have it

Teresa Goodman is a principal research scientist at the UK's National Physical Laboratory (NPL). Her research into how our eyes perform may lead to new streetlighting standards

The human eye operates differently in low light conditions and it is essential that lighting practitioners understand the requirements and guidelines involved. Teresa Goodman explains the principles behind CIE's new photometry system and reveals the visual experiments and research carried out during the development process.

TTi – Tell us about your work relating to streetlighting: "Despite only 25% of journeys taking place during twilight hours, 40% of accidents occur during this time. Much is known about the eye's performance in bright light and low light but little is understood about its performance during the transition from one to the other.

"I've been involved in a project to investigate how the eye responds to changes with light level that has led to an international agreement on what measurement system should be used to define the result of different light changes. The document was published last year by the International Commission on Illumination (CIE). It describes how the sensitivity of the eye at different wavelengths changes as you go from daylight adaptation (photopic condition) down to night-time (scotopic condition), as well as the transition that occurs as you go through the intermediate phase (known as the mesopic region)."

> There is a lot of debate internationally about exactly how the new system should be brought into road lighting practice

TTi – What are its findings? "The eye responds differently to wavelength changes as you go through the mesopic region and it gradually becomes more sensitive to blue light, which means that light with a higher blue content tends to be more easily seen. This would include metal halide or mercury lamps rather than sodium bulbs. With LEDs you can tune the spectrum using combinations of LEDs or different LEDs. Falling into the mesopically better sources, they enable you to optimize spectral effectiveness."

TTi – What changes to streetlighting could we see as a result of this greater understanding? "The new measurement system hasn't been brought into road lighting standards yet but will be soon. When you're driving along a road at night, what happens in the periphery is important and that's where your eyes' response is changing. But what happens in the center of your vision is always measured using the photopic response. In the very center of your vision it doesn't matter what level of light you're at, as you always respond as though you are fully daylight-adapted. So at the moment

flexibility and instant adjustment and also flags up any maintenance requirements.

"Councils tend to manage lighting for the worst-case scenario, i.e. 6pm on a winter evening," says Franks. "This coincides with the highest pedestrian and vehicle traffic but tends to dissipate by 9pm. Our plan is to profile our lighting to the correct level for any given street or environment – the right light at the right time in the right place. We're calling it 'Responsible Energy Management'. We might dim during quieter times of the night or over-light deliberately on roads such as Shaftesbury Avenue, which can be busier at 3am than 3pm. Dimming is certainly safer than turning lights off to save money."

The introduction of SMART Lights, which applies best practices as advised by DEFRA and the Institute of Lighting Professionals, will provide an instant 20% reduction in energy costs through more efficient white light bulbs, which have a 20-year lifespan. A further 20% is expected to be saved through correct management of the lighting, by applying management measures such as timely dimming and improved maintenance.

Franks is a fan of LEDs. "We are playing with them," he admits, while remaining skeptical about issues surrounding color temperature, along with capital investment costs and payback periods. "Their return is excellent, and the fact that they illuminate instantly at the right level and require less maintenance is great. We will look to introduce such systems when they become cost effective."

Based on a Wi-Mac network, LeafNut enables Westminster council to control its assets remotely

NPL's Teresa Goodman is helping to make it safer to drive at twilight when light conditions are most dangerous for motorists and pedestrians

there's a lot of debate within the road lighting community as to exactly where the new system should be used and where it might be less appropriate.

"For example, in motorway driving there's a question over whether it is better simply to use the photopic function all the time because mostly you're looking ahead and there are unlikely to be things coming in from the periphery of your vision. However in the countryside or town you are much more likely to have things coming at you from the side. Currently there is a lot of debate internationally about exactly how the new system should be brought into road lighting practice. When it is, it should enhance safety for drivers and pedestrians alike."

Night vision

Steve Fotios is professor of lighting and visual perception at the University of Sheffield. His research examines how lighting affects visual perceptions and performance. In particular he focuses on how, through the use of white-light LEDs and compact fluorescents with a good color rendering index (CRI) and high S/P ratio, it may be possible to reduce the luminance to more than stated in standard BS5489-1:2003, while maintaining the same or better levels of visual amenity than would be achieved under a normal sodium source. Such a method would also save on energy.

"Our research to date has mainly been conducted for pedestrians, but there is a good chance of an extrapolation for drivers," Fotios explains. "Based on early research, it seems that headlamps are sufficient for the driver looking forward, especially with the increasing uptake of LED headlamps. What road lighting might do is assist in detecting objects or events in our peripheral vision. Using whiter light sources provides improved rod cell stimulation to the eyes, enabling a greater probability of detecting things in our peripheral vision, and in a shorter time."

What Fotios might be saying, though this is as yet unproven by his research, is that white-light street lamps could help lessen the number of accidents on roads at night. "We have to ensure that if it does work, it doesn't hinder the forward tasks," he adds. "At night-time, peripheral vision and forward vision have different spectral sensitivities, so it's no good trying to optimize one if it disadvantages the other."

Fotios has been collaborating with the Institute of Lighting Professionals in this area, in particular with Teresa Goodman of the National Physical Laboratory (see *The Eyes Have It* sidebar). "We are proposing to allow lower lighting levels in residential streets that have a white light with a higher blue content, such as an LED," she says. "Our focus for now is on pedestrians."

> The return of LEDs is excellent, and the fact that they illuminate instantly at the right level and require less maintenance is great
>
> **Dave Franks, SMART Lights Programme, City of Westminster, UK**

Can you see the way in San Jose?

In 2007, the city of San Jose adopted Green Vision, a 10-point plan to more than halve its carbon footprint by 2022. Included within the plan was the strategy to convert the city's 62,000 streetlights into zero-emission illuminators, while considering the requirements of the nearby Lick Observatory for the preservation of a clear night sky.

"At the time, we had low-pressure sodium lights from the USA, which were already highly energy efficient," says Laura Stuchinsky, sustainability officer for San Jose. "Trying to make them even more efficient required a great deal of creativity."

The existing low-pressure sodium lighting cast a yellow glow with a very narrow band or light pollution, thereby aiding the observatory.

"We spent a year talking to Lick about how we could mitigate the effect on the observatory. One of the suggestions was that if we could halve the intensity of the lights during the evening, it would help

The City of San Jose is advancing several of its 'Green Vision' goals, in particular the aim to replace 100% of its streetlights with smart, zero-emission streetlights

offset the effect of moving to a broad-spectrum light. By combining new lights and remote access, we created a highly energy-efficient LED smart system."

Using an advanced control and monitoring method based on existing IES (Illuminating Engineering Society) guidelines, Stuchinsky has been able to adjust the light during the late evening and early hours. In addition, with a reduction in the energy it is expending, San Jose approached the utilities companies to get them to bill the city only for energy consumed, rather than a flat rate as is commonplace in the USA.

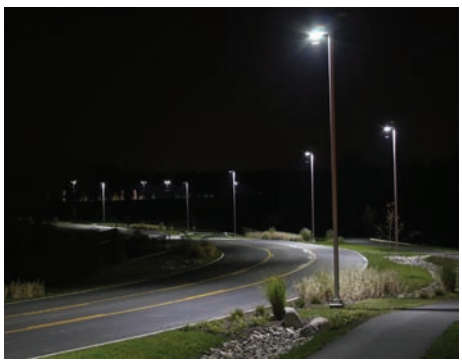
"Providing cutting-edge lamp technology, dimming facilities, and pushing for new ways of billing are pioneering advances over here," Stuchinsky says. "If we can be a success, others may jump on board."

Data transmission

LEDs are undoubtedly a revolution in streetlighting, albeit one slow to catch on. But not many of us would connect their use with high-speed data transmission. Dr Gordon Povey is head of the D-Light Project at the University of Edinburgh. His role is focused on commercializing the use of LED light fixtures to transmit data. In January, he will become CEO of a new company called Visible Light Communications (VLC).

"LED light bulbs are solid-state devices," says Povey. "They are effectively semi-conductors like silicon chips, which gives us the ability to modulate the intensity of the light. This cannot be seen by the human eye, but our photo detectors can perceive the changes and hence we can transmit very large amounts of data from these lamps."

Povey and his team have developed a way to transmit data at a rate that exceeds that of WiFi, especially over shorter distances. Putting communications into an LED light bulb is cheaper than radio communication. Moreover, the radio spectrum is currently full and there are problems with using it for data transmission, whereas it requires very little inexpensive processing in the LED driver to modulate the light as required.



LED streetlights – the future of data transmission?

With the increasing uptake of LEDs in traffic signage, signals, tail lamps, and headlights, an infrastructure is being created that is enabling communication between cars, between cars, and signage and – as they move over to LED – street lamps. In the near future, a car LED could communicate with the LED in a streetlamp (or vice versa) to let the lamp know it is coming, to brighten up or dim down, warn of hazards, and so forth.

"The more the infrastructure becomes LED-based, the greater the communication between car lights, variable message signs, and street lamps," Povey continues. "This kind of communication could revolutionize a number of industries and we have had interest from some very large organizations. Our patented methods enable us to transmit more data than others from a standard LED under real-world conditions."

For now, VLC is concentrating on data transfer within buildings as it is easier to fit out one block with LEDs than an entire roadway infrastructure. "All we are doing is adding a little bit of silicon real estate onto the chip to allow you to add communication," Povey concludes. "We are early to market so it will be some time before the technology becomes omnipresent – but watch this space."

Lighting + intelligence = safety

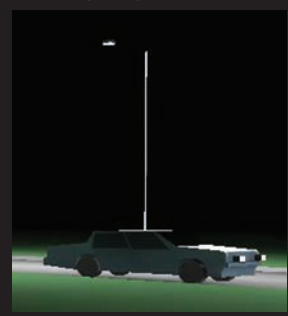
John Bullough is a research scientist at the Light Research Center, Rensselaer Polytechnic Institute, New York. His particular interest is in how road lighting can be adjusted to improve safety.

"We found some interesting statistics in Minnesota," he says. "There is a strong correlation between improvement in visibility provided by roadway lighting and the night-time crash reduction that roadway lighting provides. If you can show how much a given light level can improve visibility, you are on to something."

Bullough suggests that at night 60% of traffic occurs within the busiest four hours. Instead of picking a modest light level for 12 hours at, for instance, a rural intersection where overall illumination is poor, it would be better to use a higher wattage system to produce three times the light level, but only have it on for a third of the night.

"In other words, allocate a higher illumination that produces greater visibility at the times when it will have the largest impact on the number of accidents. Statistics from Minnesota tell us that 60% of the traffic and 50% of the accidents take place during these four hours, and using a triple light level for that period should halve the number of accidents."

Bullough is not suggesting that turning lights off for part of the night is optimal or even desirable. He does, however, believe this method deserves comparison. "But the framework could enable us to apply more intelligence to streetlighting decisions."



> At night-time, peripheral vision and forward vision have different spectral sensitivities, so it no good trying to optimize one if it disadvantages the other
>
> **Steve Fotios, professor of lighting and visual perception, University of Sheffield, UK**

Reason Foundation's **Bob Poole** discusses a vehicle miles traveled tax, tolling the interstates, the USA's funding crisis – and what he'd do if he were in charge

Interviewed by Nick Bradley

> If I were in charge, my strongest emphasis would be on removing federal barriers to tolling and public-private partnerships

Whenever you need to know anything at all about surface transportation policy, and tolling in particular, Bob Poole's name is more often than not right at the top of the list. As we speak, the director of transportation policy at Reason Foundation, the non-partisan think-tank he co-founded in 1978, has just returned from a week-long trip to Chicago, New York, and Washington DC. And he's in his office for a day before he has to depart for the airport once again to fly off to another conference. This is a man who is seriously in demand. Precisely why becomes clear when you pore over his resume.

Over the years, Poole has advised the Federal Highway Administration, the Federal Transit Administration, the White House Office of Policy Development, the Government Accountability Office, the National Economic Council – and far too many states and DOTs to fit into an entire issue of this magazine, let alone a two-page interview. He's also written hundreds of articles, papers, and policy studies on privatization and transportation issues, including for *The New York Times*, *The Wall Street Journal*, *USA Today*, *Forbes*, and, of course, *Traffic Technology International*. More impressively, the MIT-trained engineer has also advised no fewer than four presidential administrations, spanning President Ronald Reagan to President George W. Bush. Oh how the current incumbent at the White House could do with some of his words of wisdom.

Another fine mess

The USA's transportation system is in a proper mess, a hole so deep the shaft of light at the surface is a mere speck. The well for highway funding is dry and the roads are deteriorating, crumbling before Americans' eyes. To Poole, the solution is obvious.

"If I were in charge, my strongest emphasis would be on removing federal barriers to tolling and public-private partnerships," he says without hesitation.

With little in the way of barriers to PPPs at a federal level, Poole feels expanding the amount of federal approval for tax-exempt revenue bonds, the so-called private activity bonds, would be his first act if he were Ray LaHood. And in common with other authorities on transportation, he thinks the rulebook on tolling the Interstate Highway System needs to be rewritten. "That would be enormous," he states. "It's vital we do this, but that we do it with a lot of care."

There have been previous attempts in a few states to take an existing interstate and monopoly price it, but the trucking industry and auto clubs objected strongly, lobbied hard, and the plans were quickly killed off (most notably Virginia's attempt 2005-8 for I-81 and Pennsylvania's in 2009-10 for I-80).

So, as the Reason man has discussed at many conferences in the past, the smartest way to toll the interstates would be to offer a true value proposition for the users – the customers you're expecting to pay the tolls. "And you build into the lifting of the federal constraints a requirement that the tolling is done only for new construction or major reconstruction of worn-out interstates," he says, offering a proviso.

But as we all know, the worn-out interstates represent quite a few miles' worth of the overall system. "That's a several-trillion-dollar endeavor that will need to be engaged over the next two decades or so, and that would include some brand-new corridors too," he continues. "We don't have as many north-south

> The general public know they will only have to pay tolls if a project gets built that improves their travel options

corridors as east-west as a result of the way trade and travel flowed in the 1950s when the original IHS was drawn up."

Specifically, Poole cites the lack of interstate connections between Phoenix, Arizona, and Las Vegas, Nevada – two of the fastest-growing metro areas in the USA that have little choice but to utilize aging highways to get from one city to the other.

"That's the proposed I-11 and there's a degree of support to extend it all the way to the Canadian border through California, Oregon, and Washington state," he reveals. "It's an alternative that's geographically quite separated from the main north-south I-5, especially in terms of trucking."

Although a definitive cost estimation for I-11 hasn't been presented, Poole thinks US$1.5-2 trillion would be in the right ballpark for reconstructing and modernizing the entire Interstate system – potentially even US$3 trillion. And there is no way on earth the current primary funding source – the gas tax – will stretch anywhere near that far.

"The gas tax is going to be a declining revenue source in the coming decades for all kinds of energy policy and environmental policy reasons," Poole suggests, "so tolling will inevitably be the main funding source for these sorts of massive infrastructure programs. The big question is, can we get it started in the next few years?"

Political will

That is, of course, the several-trillion-dollar question. Although support for tolling is growing – with the general public apparently increasingly willing to pay for a better service, legislation is the first hurdle. The bigger obstacle, though, is finding a politician strong enough to push the plans from the drawing table to realization. And how many of those are out there right now, especially so close to election time?

"They are few and far between," Poole concurs, before naming freshman Senator Mark Kirk from Illinois, who has recently introduced legislation to expand the federal toll pilot programs. "That's a good first step," Poole feels.

He also has high hopes for a new tolling coalition announced in Washington that is working closely with a lobbying firm. "It was started by the Wisconsin Transportation Builders Association and I see that as a promising sign," he says. "I attended an organizational meeting of that group in DC back in June and I'm pleased it's actually got as far as this, particularly if Congress can't get its act together politically to enact the Reauthorization this spring – as a lot of people in transportation have been hoping for – and it gets shoved over beyond the next presidential election."

Certainly Poole doesn't hold much hope for an immediate raising of the gas tax, either, which has remained at 18.4 cents a gallon since 1993. "That resistance may not last indefinitely," he predicts. "When the economy is stronger, the next time there's a Reauthorization of the federal program, it could be that there is more political support for gas tax increases, but you never know."

A number of states, notably Washington, have garnered political support to do so, most, says Poole, through a lot of hard educational work. "They've explained to the public the realities of how much things cost and how the existing money is barely enough to properly maintain what they already have – and if they want improvements, this is how they're going to be funded. But generally there's still a lot of political resistance for an increase here."

With a hike in the gas tax seemingly off the agenda, Poole points to plenty of survey data over the past decade suggesting that if you present a serious case for tolling, backed up by how the monies will be spent on new transportation projects, Joe Public will be more inclined to listen.

"Tolls are generally at the top of the list of the most acceptable – or least bad – forms of revenue increase compared with tax increases when it's presented within such a framework," Poole suggests. "I think the reason for that is obvious: the resistance to tax increases stems from a large distrust of both state and federal government. But the general public know they will only have to pay tolls if a project gets built that improves their travel options – and if the toll rate is generally a good value for what they get in return. I'm pretty bullish about the future of US tolling for these kinds of reasons."

Political

And what of VMT, the much-touted panacea, as a future funding mechanism? Reason Foundation is a member of the newly created Mileage-Based User Fee Alliance, which is attempting to promote more serious R&D on the technology and policy issues, as well as what kind of form such a strategy would take and whether it should apply to all miles driven or only some. "My personal view has evolved to the point where I think we should use inexpensive, transponder-based and video tolling," Poole admits. "I think the privacy concerns will defeat an effort for a universal GPS-type box," he says.

But that's a challenge for another day. Poole's next mission is another airplane to catch – fortunately the route to the airport is a toll road, so he knows he's going to get there with plenty of time to spare.

Opinion on difference

As a non-partisan think-tank, a breeding ground for future policy, how does Reason Foundation's advice differ from that of other consultants?

"That's a very good question," says Bob Poole, its founder. "For one, we do not do work for hire, so we do not directly compete with consultants. And that's actually because the tax laws forbid it, so we have to be careful! When we conduct a feasibility study on, let's say, a HOT lane network for Atlanta, we'll do it at a sketch level at best. So it's very preliminary to what would actually be needed and what a consultant would do to flesh out the details of a plan. Our transportation policy studies are intended to whet people's appetites to show that an idea is plausible, that the numbers at least are in the right ballpark – we're almost a catalyst."

Reason also works a great deal with the media, often to explain why policy proposals might be a good (or a bad) thing in layman's terms.

"Unlike the trade press, reporters within the general media don't really know very much about transportation, so it's helpful to have someone they can call on who knows a whole lot and can give them the basics – in effect a crash course on certain subjects."

Having revolutionized enforcement processing in the UK, **Allan Freinkel** reveals he now has his sights set on many other markets

Interviewed by Louise Smyth

Although they spell their names differently, Allan Freinkel has a lot in common with another Alan – the famous British entrepreneur Lord Alan Sugar. Both showed a remarkable talent for making money from a young age; Freinkel bought and sold his first property (for a huge profit, naturally) while he was still a teenager. But unlike Sugar, who found his fortune in selling computers, Freinkel decided to focus on what goes into computers – the software.

While living in his home country of South Africa and training to be an accountant, a bar-room conversation one night led Freinkel to spot an opportunity that lured him away from accountancy for good. The talk was about speeding tickets – or more precisely opting not to pay them and being pretty confident you would get away with it, given the rickety enforcement system. You can almost picture the lightbulb above Freinkel's head at this point…

"I'm good at seeing a solution to a problem and banging on doors until someone listens to me," he states. "In this instance, the Pretoria City Council had a major problem in handling the amount of violations they were capturing and really needed an automated process." Freinkel devised this process and StarTraq was born. The contract for the system was signed in December 1999 and by the first quarter of 2000, Pretoria had hugely increased its throughput, from processing hundreds of violations a day to thousands.

By 2002, Freinkel had recognized the same opportunity within the emerging UK speed enforcement market. Thames Valley Police were the first to answer his knock at the door and adopt the software system that allowed them to automate their speed camera enforcement. "They'd been using a mobile camera that produced an asterisk on video frames that had a speeding violation attached," he recalls. "This video would be taken back to the office and an operator would have to watch it and freeze the frame, identify if it was a violation, capture all the information, then move on. So if you were processing three hours of VHS tape, it would take you a minimum of three hours to do one tape; whereas we watched it in

> "Because it's a web-based tool, it's very simple to deploy: the only technology needed at a client's site is an internet browser

fast-forward and vastly increased their throughput and decreased their manpower requirements. After that it was a snowball effect – many other forces recognized the value in this new solution that freed up the police to concentrate on policing."

StarTraq's latest product is called Dome, the greatest selling point of which is its flexibility. "Firstly, from a business perspective, it's extremely flexible," Freinkel says. "The end-user can buy it from us or one of our partners, they can outsource the processing to us, they can do it themselves or a third-party integrator could buy our technology and do it themselves. Secondly, it's multi-camera and multi-modal. We're not tying anyone down to using one camera type: we interface to more than 20 different camera manufacturers already. And because it processes all different types of violations, one authority that may traditionally have had several back-office solutions can now just have one to cover speed enforcement, parking tickets, bus lane enforcement, and more."

There is also a great deal of built-in flexibility in terms of how the end-user actually wants to deploy the technology. The software is available in multiple languages, which proved valuable on a recent big contract for StarTraq where enforcement notices needed to be sent out in both Welsh and English. But it also means the operators in the back-office can use the software in their native language. "Whether the operator is in Colombia speaking Spanish or in Brazil speaking Portuguese is irrelevant – they can work in their native language," Freinkel observes.

International appeal

The language point is an important one, as he is very keen for Dome to be adopted by new geographic markets. Part of the strategy to make this happen is to license the software to camera vendors so that they can sell the processing as part of their solutions. "Often, the camera vendor's product offering stops at the camera itself," he says. "So we're giving them a system they can build into their existing offering to make a complete solution. And because it's a web-based tool, it's very simple to deploy. All they need if they want the data hosted remotely or on the Cloud securely is an internet browser: the camera would be connected to the internet, it would upload the image and the back-office processing could happen anywhere. The only technology they would need at the client's site is an internet browser and perhaps a local printer to send out the tickets."

The traffic market famously loves a bit of badge engineering, and Freinkel admits that the solution "has been built specifically to allow the vendor, partner or reseller to brand it as their own", a move that ought to be a big selling point for this sector.

As well as selling to international camera vendors, Freinkel is keen to share his solution with the various integrators in the UK market. "If a consultant is taking on the whole outsourcing of an entire police force, there are many complexities involved. We've got great references in this arena – we've been doing it for years and can deliver exactly what we say we will," he says.

Not deviating from his previous form, 2012 will see Freinkel knocking on a few more doors. "I'll be talking to the big UK integrators to make sure that we are their solution of choice!"

Keeping drivers safe and informed in the desert

Population growth can be a shock to any urban road network. But what if the population increase was more than 25% in 10 years? This is the challenge of Saudi Arabia's capital city Riyadh. As the largest city on the Arabian Peninsula, the current population of 5.2 million is expected to reach 8.2 million by 2029 – on top of the 25% increase seen over the past 10 years – with corresponding traffic congestion increases.

To deal with the increased drivers and congestion, the Ar-Riyadh Development Authority (ADA) has been working on a comprehensive plan for upgrading the city's road infrastructure to facilitate traffic flow for the next 20 years.

One part of the infrastructure upgrade was developing the first smart road in Saudi Arabia. Over a 5.2km stretch of King Abdullah Road, capacity was increased from 190,000 to 520,000 vehicles per hour through the addition of six express lanes cutting through four tunnels under congested intersections.

Complete information

A key component in safely increasing vehicle capacity is the 70 variable message signs (VMS) supplied by Aesys, an Italian producer of display technologies. The signs were strategically placed along King Abdullah Road, integrating with a software system through an NTCIP protocol to deliver real-time traffic information to drivers.

Along the roadway, the software uses traffic-monitoring technology to track current road conditions and determine the ideal speed to keep cars flowing. This speed is then displayed on the speed control signs, which can also show pictograms in case of emergencies.

In the longest tunnel, at 700m, lane control signs are placed throughout to immediately notify drivers of lane closures in the event of an emergency. There are also full graphic displays that can show other messages, whether for alleviating congestion or for safety purposes.

Most important, 11 large VMS were installed to provide real-time information to drivers

Signs in the largest tunnel inform drivers of lane closures and emergencies

Need to know?

From lane control signs to large VMS, signage systems that make your roads safer and keep traffic flowing

- Lane control signs to manage lanes for safety, emergency, and traffic optimization purposes
- VMS displays can operate as a standalone system or integrated with other traffic control and management systems providing data for traffic detection, monitoring and surveillance
- Long-life LEDs are easily visible in all types of weather and through the use of a solar sensor, the brightness can be adjusted for both clear day and night viewing

in both text and pictograms. The pictogram portion is full color with 'RGBY' color technology, adding a yellow LED to the red, green, and blue for an accurate yellow chromaticity. The full graphic matrix is capable of displaying text in English, Arabic, and other languages if necessary. The display can even be used to show an abbreviated map of the road, highlighting areas with high congestion and alternate routes.

Additional smart mobility technology was implemented by a major international systems integrator to reduce congestion and improve safety, including traffic data collection, ramp metering, CCTV surveillance, fire detection control, and a software suite to integrate the technologies.

Coping with the extremes

Over in Morocco, meanwhile, another system of Aesys VMS was being installed over 500km on the Rabat-Fes-Oujda highway

READER ENQUIRY NO. 501

Aesys signs can display pictograms and text, including Arabic characters

route. Since the roads in both Morocco and Saudi Arabia pass through the desert, the environmental challenges were the same – standing up to the extreme heat of up to 50°C.

To combat this problem, Aesys developed a special door with a double skin that pumps cool air between the layers to protect the electronics. An additional roof was integrated to allow the warm air to escape and also protect against the intense solar radiation, keeping the internal temperature in the optimal range and complying with the EN 12966 T1 normative.

The bright direct sunlight was a key factor in the displays' readability. They were designed to comply with the maximum visibility standard of the European traffic directive EN 12966, which is used in both the Middle East and North Africa as a quality standard; contrast meets the requirements of R3 and luminance meets the requirements of L3.

The Aesys desert-resistant displays will continue to be installed on 1,000 additional kilometers of highway in Morocco. And in Saudi Arabia, the integration of the smart technologies and dynamic displays gives Riyadh's drivers a complete viewpoint to keep them safe and to avoid congested roads.

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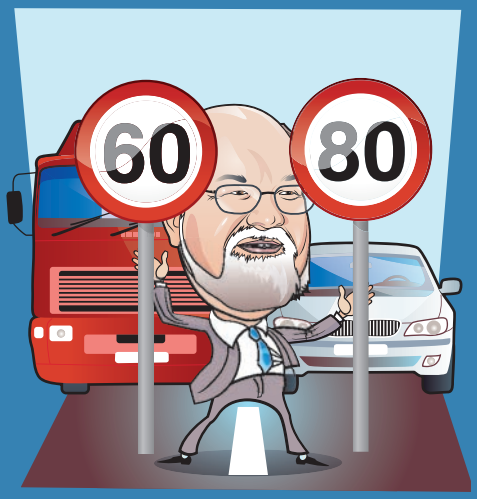

Eric **Sampson**

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Upon learning of the death of the Turkish ambassador, the 16th century French diplomat Charles Maurice de Talleyrand-Périgord is supposed to have said: "I wonder what he meant by that?" Similarly, the recent consultation by the UK's Secretary of State for Transport on raising the 70mph speed limit to 80mph prompted me to think, "I wonder what he meant by that ?"

Now the Defence Secretary, Philip Hammond seems to use two 'arguments' to justify a change – laws depend on a general consensus that they are fair and proportionate so the Government wants to legalize those who think 70 mph is inappropriate and therefore exceed it; and secondly it will be of huge benefit to business. The first point strikes me as a dangerous precedent and the second point as badly flawed.

If the first argument is going to be government policy then presumably this now opens the way to changing the legislation for 'social' drugs such as cocaine and cannabis, removing all income tax, cutting fuel duty, etc… And as for the second point, I can't see how this helps. Business has for years been screaming for decongestion of the trunk road network so that freight can move easily and above all reliably. The only potential gainers I see from 80mph are high mileage 'reps' and white vans as the trucks will still be limited to 50mph on dual carriageways (not that you'd notice on ordinary sections of the A1 motorway where 62mph seems to be the limit) and 60mph on motorways

It has been suggested that there is a political dimension to this – that it was a condition for the Lib-Dems in the coalition to give their support for extensions to inner-city 20mph zones. If this is the case, then a confused picture gets even more blurred. It should be obvious to any seasoned transport observer that the job of Secretary of State for Transport is a difficult one. Decisions are really simple one-dimensional choices; a typical transport issue will involve balancing arguments regarding throughput, safety, environmental impact, accessibility and inclusion, integration, privacy, security and above all costs.

Take the 20mph speed zone idea. It's undoubtedly of benefit to inner-city safety by slowing traffic in areas where there are many pedestrians or children. But for most vehicles at 20mph, their engine will be operating at its lowest efficiency and with maximum emissions. So we may be moving to cut deaths from collisions but instead we're gassing people.

If the Secretary of State really wants to help business, then he should try to apply some railway practice to roads and separate the slower-moving freight traffic from the faster light goods and passenger traffic. How to do it? The same way as railways do. For any road with four or more lanes, designate two of them 'slower' lanes with a 60mph maximum for freight (mandatory) or passenger vehicles accepting the reduced maximum. Designate the 80mph limit for the other two lanes from which vehicles over 7.5 tonnes are barred. If he did this then we would know what he meant.

> For most vehicles at 20mph, their engine will be operating at its lowest efficiency and with maximum emissions. So we may be moving to cut deaths from collisions but instead we're gassing people
>
> **Professor Eric Sampson, Newcastle University/ITS-UK, UK**

Lose the inductive loops

External triggers such as inductive loops, laser and (microwave) Doppler radar have long been used for tasks such as speed control, vehicle detection and peak traffic lane monitoring. However, this situation is now changing.

Although inductive loops are very accurate, their installation requires the use of a highly intrusive saw-cut method, which decreases the road surface's lifecycle and affects the integrity of the roadbed. Another frustrating issue is their short life expectancy, as they tend to become damaged by heavy vehicles. Frost, snow and ice also have a negative effect. This is why inductive loops are becoming less popular and road owners are looking for alternatives.

While the use of inductive loops has declined, Doppler radar and laser have risen to be the only reliable options left to address vehicle detection. However, a growing trend is to make use of embedded ALPR (automatic license plate recognition) readers, which comprise intelligent dedicated image-processing platforms that integrate multiple sensors, cameras and software algorithms, combined with in-image triggering. Using such readers means that a vast amount of reliable information can now be obtained in addition to simply detecting vehicle presence. This might include the number of vehicles, license plate information, trajectory path and driving direction. And as the readers make use of video analysis and image processing, there is no need for saw-cutting the road or to use any other intrusive measure.

Need to know?

Recent technical evolution has led to new solutions for vehicle detection that don't require inductive loops

- The growing trend for non-intrusive traffic detection solutions
- Recent innovations offer ALPR readers that support in-image vehicle detection without needing an external trigger
- The readers also offer extra information that can be analyzed for a number of different applications

ALPR readers offer a more convenient way of detecting vehicles

READER ENQUIRY NO. 502

Vehicle detection and ALPR

The rise of smart embedded ALPR readers including vehicle detection as a reliable alternative detection method owes much to some recent massive technological strides. In the past, in-image vehicle detection hasn't been particularly popular due to the lack of processing power and low frame rates, but the argument is no longer valid. Advanced electronic technology and processors have become more powerful, software development has continued and triggering algorithms have become more efficient. These innovations are now available in products such as the all-in-one ALPR readers from ARVOO, which fully support high-performance in-image vehicle detection without requiring the need for an external trigger.

The CAM301megaDS ALPR reader

Trajectory analysis

Vehicle detection without the use of an external trigger is a nice feature, but more useful information is also available via these smart readers. When a moving vehicle has been detected, for instance, several images where the vehicle is present within the shot are available for further analysis. These in-image triggered photos are used for the detection of license plate information, where a dedicated algorithm selects the best image for license plate recognition. Furthermore, by analyzing the sequence of these images, additional information about direction and vehicle trajectory can be determined as well. This can be of tremendous assistance in applications such as detecting wrong-way drivers, for example – to spot vehicles ignoring a one-way sign or to discriminate whether traffic using the same road is either coming or going.

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PC cameras for traffic applications

READER ENQUIRY NO. 503

Intelligent cameras offer high flexibility and great possibilities for decentralized image processing in traffic applications. Such benefits are to be found in a new generation of the CheckSight camera being introduced by Leutron Vision, which combines a machine vision camera and built-in PC to create a complete vision system. This offers specific advantages for traffic applications. As all – or at least most – of the image-processing tasks can be conducted directly on the camera, there is no need to transfer huge amounts of image data to a central image-processing computer. Images can be processed and preselected on the camera's CPU and are only transferred from the camera when needed elsewhere. This second generation of CheckSight offers a variety of interfaces for communication with other devices, a PLC or other computers. And as every camera does its own image-processing tasks, systems can be designed to have no single point of failure in the machine vision part of a multi-camera system.

The camera offers fast image acquisition, transfer and image processing on its built-in 1.6GHz Intel Atom E 6x0 Processor that uses up to 1GB DDR2 RAM. Application data can be stored on an 8GB onboard SSD or on an SD card. Bayer-decoding, meanwhile, is performed in real-time in the FPGA hardware, as well as other image-preprocessing functions, so as not to burden the CPU with these tasks and reserve computing power for actual processing tasks. Windows XP Embedded, Windows 7 Embedded and Ubuntu Linux operating systems are available preinstalled. As on any normal PC, users can choose the software they want to use. The camera is also GenTL-compatible, so every major image-processing software including Halcon, VisionPro, and Common Vision Blox is supported. Leutron also offers a comprehensive and GenTL-compliant image acquisition API that allows for quick and easy development of bespoke image-acquisition code. Along with that API comes comprehensive documentation, a source code generator and samples.

The CheckSight PC camera comes in an IP65 cabinet or as board-level camera with the possibility to connect one or two sensor heads to a single board. This is especially interesting for applications where one sensor is used to acquire images for image processing, and the other sensor takes pictures for evidence – or in systems where multiple lanes must be monitored simultaneously.

Need to know?

Powerful and versatile PC camera with Intel Atom processor and a multitude of interfaces

- Choice of 26 different CCD, CMOS, monochrome and color sensors with resolutions from VGA up to five megapixels
- Powerful and energy-efficient processor architecture
- Available interfaces include three times USB2.0, GigE, Audio I/O, DVI-D and RS232
- CheckSight cameras can help customers solve engineering tasks more quickly and easily

(Top) **The CheckSight PC machine vision camera** (Above) **The system at board level**

Sensor choices

The sensor choice includes 26 different CCD and CMOS sensors with resolutions from VGA up to five megapixel, in color or monochrome. There is also a wide range of optical filters available to meet various demands. The sensor head features a thread for standard C-mount lenses, while the camera has an integrated DC iris-controller to allow active adaptation to changing light conditions over a wide range.

The new CheckSight PC camera offers multiple ways to communicate with the outside world. For instance, it has a Gigabit Ethernet interface, which allows cable lengths up to 100m, as well as USB, Wireless LAN for data or image transfer, CANbus, RS232 and several fast TTL- and opto-isolated I/Os for the connection of flash, light barriers and other external components.

In addition, the camera has very low power consumption and can be powered over an external power supply or using power over Ethernet (PoE) technology to use the Ethernet cable to provide the necessary electricity.

Intelligent cameras such as CheckSight with integrated image processing can help to make vision systems for traffic applications more scalable and to break up complexity in smaller, easier to manage and maintain parts.

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The start of standardization in security

READER ENQUIRY NO. 504

If you can have a video conference with somebody on the other side of the planet for free, it doesn't seem as though managing and monitoring surveillance cameras just a block away should be much of a problem. Yet integrating video surveillance technologies is no easy feat.

The broadcast industry started out with watertight standards (PAL and NTSC) that could literally be used anywhere in the world; they were always the same. Digital streaming changed all of that simply because video compression standards work quite differently. There are many standards, and a wide spectrum of implementations is available for each.

H.264 in one system, for example, is not necessarily compatible with devices streaming H.264 in another network; the compression standard allows for a broad range of profiles and applications which advantageously let users customize their systems. The disadvantage of this is that networks cannot interface with one another.

Standardization involves generating unified platforms that enable devices and networks to communicate with each other while still permitting integrators to customize systems. This can be an exceedingly challenging part of video networking in general, and creating universal standards remains a dynamic process.

Until recently, security industry companies each had their own proprietary standards and companies working together would adopt each other's standards. In 2008, Axis Communications, Bosch Security Systems, and Sony Corporation launched the Open Network Video Interface Forum (ONVIF) – an organization dedicated to promoting interoperability between network products for the security market. Since its inception, ONVIF has grown to include 338 member companies and has been wholly embraced by the industry.

Suppliers such as Siqura have their own standards for integrating components

Need to know?

Looking at efforts to start creating industry-wide standards for IP-based physical security devices

- How companies are collaborating through ONVIF to create open platforms for IP video networking
- The ONVIF standard to address interoperability problems in network video, including needs such as defining interfaces for device configuration, event handling, PTZ control and similar issues
- The potential problems you'll face if you depend on ONVIF to connect IP cameras to VMS systems

How does ONVIF work?

ONVIF uses web services to send messages, which are based on a request/response system that uses a protocol known as SOAP, through which a sender transmits a message to a receiver and elicits a response. SOAP uses a web service description language (WSDL) to exchange information across the network in XML and HTTP.

Although web services make it possible for devices to communicate with each other using the ONVIF standard, there is a drawback – they substantially increase the amount of code needed to transmit data and all of this additional information has to go into the transmitting device. ONVIF only specifies how network video transmitters (NVTs) must communicate; there is nothing in the standard indicating how or if the network video client (NVC) should respond. So using the ONVIF standard is highly demanding on embedded environments.

In a bid to streamline integration efforts, a test tool has evolved with each new version of the standard. Network components are tested by ONVIF to determine if they are eligible for certification and depending on which features are tested, products are deemed ONVIF-conformant for a particular version point of the standard.

Regardless of the version number, the ONVIF standard leaves a lot of room for interpretation. Despite the immense number of options available within the standard, only the bare minimum is required to pass the certification test. Moreover, only the NVTs can be certified; there is no certification process for NVCs. The test and subsequent certification don't therefore guarantee integration with any ONVIF-compliant video management system (VMS).

Although the standard is an excellent foundation upon which to build integrated networks, it is relatively new and needs to mature before seamless integration can be expected. Moreover, its very nature as a standard can sometimes limit innovation and it isn't always the best option for a particular project. The extra code required by web services can slow down the overall system; even a system exclusively comprising conformant products will involve adjustments. Therefore, manufacturers continue to take advantage of alternatives. Many of their products were already compatible with major VMS solutions before ONVIF and some suppliers have standards of their own for combining components. Consequently, ONVIF should be used as a tool in applicable cases not as quality control. After all, the best solution is one that meets your specific needs, be it a simple feature in a camera or an entire network infrastructure.

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Walkin' in LA, nobody walks in LA (Missing Persons, 1982)

Once again, the year and genre of my music of choice is clear. They harken to my university days (spent in Los Angeles, no less), and as this columnist is wont to do, these lyrics are replete with a transportation theme. (Surprise.) Although it may seem antithetical to a Smart Cars column, let's take the lyrics literally. That is, what if your car was taken away and you had to walk?

It's illustrative to first consider the origins of the word 'commute', stemming from the advent of rail travel and a 'commuted' – or discounted – ticket. Railroads were therefore part and parcel of both the industrial revolution and dramatic changes to land use, encouraging us to commute to work. And to recite the litany, railroads led to the car, then the smart car and finally to this article. All the concomitant woes of congestion and endless hours on the road, plus those literal minutes taken to read this column, stem from the fact that our societies' economic well-being is in large part predicated on our collective commute. To add to the discussion nowadays, greenhouse gas emissions are yet another woe. In fact, according to the US Environmental Protection Agency, the average automobile produces 5.03 metric tons of CO_2 per year. Imagine, with the exception of the disappearance of this column, that these woes vanished and you literally walked to work. A major source of energy consumption and CO_2 emissions would disappear, and a purportedly idyllic existence would come into being.

Of course, our commutes would take impractical dimensions, and until society reconstructed itself such that land use and our economies were dramatically changed to perhaps the agrarian existence of our forebears, we'd go through a lot of angst. And shoes.

The question posed, therefore, is: is there a middle ground? I believe that indeed there is, and it's in the form of smart cars. 'Smart' here is defined as not necessarily or only in life-saving collision avoidance technologies extolled within this magazine, although these are part of the package. (Did you know that in many routes, about half the congestion is nonrecurring, which is to say it is caused by 'incidents' or accidents that could be, well, avoided by collision avoidance?) A smart car would also inform the driver of the most environmentally friendly route to work or even to the transit station, and by the way, reserving a parking spot near the train. It might also, in real time, link with other passengers, allowing car sharing. Or the smart 'car' could be a bus that is demand-responsive, coming to where you are at the time you want it. A smart car may even have hybrid, electric or fuel cell propulsion. Finally and importantly, a smart car could be the one parked in your garage, and you can walk to work from time to time. Now, that would be smart, even if you lived in LA.

> A smart car could be the one parked in your garage, and you can walk to work from time to time. Now, that would be smart, even if you lived in LA
>
> **Jim Misener, executive advisor, Booz Allen Hamilton, USA**

Is outsourcing the answer to shrinking budgets and road safety?

Under increasing pressure to deliver more and better services with significantly reduced funding, governments, municipal authorities, and the police worldwide are seeking ways to maintain and enhance their performance, not only through cost-cutting and efficiencies but also through the intelligent use of technology.

A 2009 study from the World Health Organization (WHO) reports that road crashes cause between 20 million and 50 million non-fatal injuries every year, and indicates that road deaths are increasing in most regions of the world. If trends continue unabated, the study stated, they will rise to around 2.4 million a year by 2030.

Enforcement cameras have been identified as making a major contribution to road safety. However, shrinking budgets are forcing cameras to be switched off in many regions.

Indeed, the IMF has recently warned that the global economy has entered a "dangerous new phase" of low growth and high public debt. In such a volatile economic climate, it makes financial sense to outsource resource-heavy functions to ensure efficiencies are maximized. An area where major cost savings can be made is in the outsourcing of enforcement resources, where a road safety program may be implemented at little or no cost to the end-user.

Police forces worldwide generally process all offenses in the traditional way – within their individual fixed penalty or back-office systems. These back-office systems offer major opportunities to benefit from automation and outsourcing through technology.

Since the late 1990s, the USA has pioneered the outsourcing of various forms of camera enforcement in states that are legally able to use camera enforcement, in doing so delivering benefits such as the ability to generate cost savings as well as providing a more effective level of enforcement. Other benefits include improved road safety and reduced inconvenience for other road users, as well as the potential for standardization and collaboration between agencies.

Redflex has been at the forefront of enforcement outsourcing developments in the USA for several years; the influence of the US camera enforcement service and outsourcing industry clearly has an important effect on the development of road safety initiatives worldwide.

Whether it is an existing enforcement program that is being transferred to a service provider for operation or a new enforcement program, outsourced enforcement consists of six key components, encompassing program design, installation, enforcement, verification, processing, and finally collection.

The different models

Enforcement models fall into one of three categories. First, there's a fully outsourced program supplied by one service provider. Second, there's a fully outsourced program supplied by multiple service providers, and lastly there's a partially outsourced program where the functions are shared by the jurisdiction and the service provider.

Various models of such systems are in operation around the world, typically employing revenue from the offending drivers to fund further safety improvements, additional education services, and increasing enforcement through returned income to the local legislative system.

These operations use 'end-to-end' outsourcing, where one supplier or consortium supplies certified camera equipment and back-office systems, and provides capture and evaluation of the evidence, as well as issuing of citations, through to prosecution and counsel defence in court if necessary.

The service provider carries out all administrative services, from back-office and violation processing to citation, printing and call center duties on a secure in-house network, and acts as the point of contact for the support requirements of internal and external customers. Although preliminary viewing of violations is performed by

Need to know?

Why you don't have to sacrifice traffic safety in times of economic hardship – and how an enforcement outsourcing strategy can pay returns

- Analyzing three typical enforcement models – and their benefits
- How an effective enforcement outsourcing program will help to allocate much-needed resources elsewhere
- The emerging European trend toward the US model
- How technology has streamlined the whole enforcement process

READER ENQUIRY NO. 505

Outsourcing camera-based enforcement can bring a host of benefits to municipalities and police forces – and it can ultimately help to improve road safety as well

the service provider's staff, the police department has the ultimate responsibility for reviewing and authorizing the issuing of all citations.

Typical citations or Notices of Intended Prosecution (NIPs) include details of the driver and the offending vehicle, together with a secure web address where the driver can view digital images or video clips of the transgression. The entire process typically takes 48 hours to complete, usually with few contested prosecutions, coupled with maximum efficiency in fine collection and ongoing safety.

Slowly but surely

Away from US shores, many countries prefer to buy or rent their enforcement systems, although outsourcing programs have been successful in Poland, Ireland, and the Middle East. Outsourcing is slowly but surely gaining momentum in Europe, where the European Community is increasing in size and many countries arguably have higher accident rates, poorer developed highways, and financial inability to fund their own safety camera operations.

A report from Invest East states: "The CEE region accounts for 12% of the world's fatalities, almost twice its share by population or motor vehicles (6-7%)."

A trend toward outsourcing of traffic enforcement offenses would lead to increased interest in a number of areas, including the use of new technology to improve road safety, while at the same time justifying European investment from the World Bank and European Bank of Reconstruction and Development into the local highway infrastructure rebuilding program. It would also generate interest in areas such as the generation of development funds from road fines, increased security with vehicle tracking through various systems, and the combination of point-to-point and spot-speed enforcement. Digital still images could be combined with continuous video and surveillance, while new forms of non-invasive speed and presence detection could be encouraged.

Photo enforcement provides irrefutable evidence that will hold up in court – outsourcing provides authorities with the means to substantially improve road safety while significantly reducing their overheads and offering other benefits. These would include increased efficiency by saving time and allocating resources more constructively, as well as minimizing financial risk by employing an experienced service provider to get it right first time. And in addition to reducing accident frequency and severity and changing driver behavior, public security could be improved by allowing police to focus resources on more important matters

The overriding principle of any enforcement strategy should be to improve driver behavior. Any entity considering outsourcing traffic enforcement to a private company should ensure that the police maintain control of all deployment of enforcement activity and setting of enforcement thresholds.

Partnering with an experienced service provider such as Redflex will deliver the strong commitment to customer service, combined with positive enforcement outcomes and contribution to road safety that is fundamental to the success of any outsourcing strategy.

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Effective traffic management for cities of all sizes

READER ENQUIRY NO. 506

Despite all the associated costs that congestion causes society, there has still been a noticeable reduction in the amount of money available that countries have to spend on traffic management, especially so in Italy. The need for effective traffic management was in the past deemed to be just for the larger cities, which started implementing centralized systems and then more recently adaptive ones.

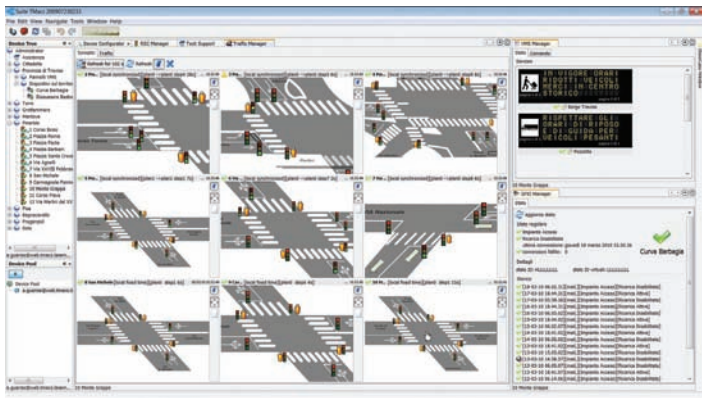
But traffic problems are now filtering down to smaller towns, too, as an increasing number of people abandon the big cities to live further afield and commute to work every day. However, smaller public administrations can seldom afford such centralization systems, which are traditionally very expensive to implement, mainly as a result of the costs of the necessary network infrastructure.

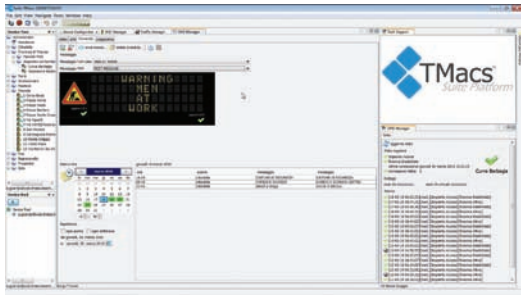
For all shapes and sizes

What's needed, therefore, is a centralization system that is affordable for these smaller administrations – one that can be employed cost-effectively on small traffic networks, potentially even on single intersections. In order to be really cost-effective, such systems must be capable of using any of the most modern wireless network technologies, such as WiFi or GPRS, and the information must travel as much as possible over the internet.

With these factors in mind, the Padova, Italy-based company La Semaforica has developed the TMacs (Traffic Management Advanced Centralization System) suite, a modern and extendible ITS platform. This new innovation is a server/client system that can communicate with the peripheral equipment using any network infrastructure available. In Italy, most devices are connected via GPRS, which is particularly cost-effective for public administrations. All the interactions with the equipment take place via a server and users can manage their traffic networks from wherever they are using any device able to access the internet (computer, tablets or smartphones).

The centralized traffic controller brings a host of benefits to small towns and big cities alike





Screenshots from the TMacs software

Moreover, the server can run on a virtual machine so there's no need for a town with a small network to set up a costly server or even a control room. On this note, La Semaforica has its own server up and running, which is currently controlling just over 300 devices belonging to more than 40 separate customers.

Despite the focus on cost-effectiveness, the TMacs provides all of the services normally required from a centralization system. The first benefit for users is the capability of coordinating intersections without having to perform any civil work to physically link them with cabling. Although this may seem a trivial aspect, the cost of civil works is the reason why so many intersections in Italy that are close to each other are still running independently. They would greatly benefit from coordination. If coordination is really crucial, TMacs can work as a dynamic plan selection system or as an adaptive one.

Then, because WiFi and GPRS guarantee a continuous communication with peripheral devices, TMacs can send messages (email or SMS) to

Need to know?

A new system for the control of urban traffic has been keeping cities – small and large – moving smoothly

- Adaptive, complete and customizable, TMacs has proved to be an essential instrument for the monitoring and control of traffic intersections
- Offers a simple way of connecting existing infrastructure (traffic controllers, measurement sensors, control devices for public lighting, VMS, etc.)
- Provides local authorities with the possibility to delegate the operations, management and maintenance of the systems

report any fault detected in devices under its control.

Where loops or other traffic detectors with counting capabilities are installed in a network, TMacs stores all the traffic data in a database that can be used for any purpose, the most common being calculating proper cycles for the network or intersection.

The open architecture of TMacs means it's possible to integrate different devices, besides traffic controllers. So far, VMS, parking guidance systems, and AVM have all been successfully integrated.

One instance where TMacs was installed to very good effect is the town of Erba in northern Italy. The center of Erba has a main road with three equally spaced intersections that used to run vehicle actuation (VA) with independent cycles. Following the installation of TMacs, the three junctions have been coordinated when necessary during the day and the cycle times have been calculated using the data collected by the system. It's been estimated that the installation of the system has resulted in fuel savings of about €20,000 a year.

The fact that TMacs was developed with the needs of small centers in mind does not mean it cannot also be used in larger cities – it's now used in Rome where it's managing a network of 25 intersections along the Tiber River. In this project, TMacs was greatly appreciated for the speed of its deployment. ○

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Adrian **Walsh**

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In early November 2011, the worst UK motorway crash in 20 years resulted in the deaths of seven people and shocked the public. The horror of this high-speed crash focused media attention on the safety design of roads and the speed vehicles were traveling.

The crash involved 34 vehicles; there were also more than 50 injuries. Its investigation will take many weeks and it is certain that the cause will be attributed to many factors. An early examination of the many safety systems that certainly prevented a worse outcome, however, illustrates just how important continued investment in passive and active safety systems is.

Well over half of the vehicles involved had ESC, which ensured that they did not skid out of control but collided with safety barriers or other vehicles in a managed way, while almost all had ABS. Most had airbags but it was not clear just how many drivers and passengers were wearing seatbelts. Significantly, the crash barriers all worked and prevented vehicles from drifting into oncoming traffic. The automated traffic monitoring and information systems worked and warned other drivers of the incident, thereby preventing further tragedy.

There are almost 3,000 electronic message signs on England's trunk road and motorway network, located at key decision points. They're operated by the Highways Agency to help manage the network by providing advanced warning to drivers of emergencies and incidents. These messaging signs are also used to warn drivers of incidents such as this crash or of other incidents or public events that may cause delays in the future, such as roadworks and major events. When an incident such as this crash occurs, the signs activate automatically to warn drivers.

One aspect of the crash that the media hardly touched on was the competence of the drivers themselves. Blame was attributed to the weather, a firework display at a local rugby club and on the road itself – even the government was implicated for its intention to consider raising the maximum speed limit on motorways from 70mph to 80mph.

Road safety professionals all know how to design perfectly safe systems that should see no one killed, and indeed many vehicle manufacturers have their own such visions in their sights.

Crash avoidance technology is now becoming available on cars and each new model sees such advances being brought to a wider market. But all know only too well that a safe road system sees the road user as the weakest link in the transport chain, unpredictable and capable of error (education and information efforts notwithstanding).

So there is still room for much more innovation and the application of technology. But above all else, there is room for much better integration between the road and the vehicle to ensure the highest levels of safety. A recently issued report from EuroNCAP, *Roads that Cars can Read*, highlights this technology. But it shows that obscured signs or faded road markings are hard to read whether using the naked eye or an in-car camera. Worse still, the report probes how signing and marking practice still varies around Europe even after more than 50 years of international conventions. Without innovation and a good measure of harmonization, terrible crashes such as the one on the M5 in Somerset will still occur.

> Above all else, there is room for much better integration between the road and the vehicle to ensure the highest levels of safety
>
> **Adrian Walsh, director, Roadsafe, UK**

Monitoring average speeds for safety

READER ENQUIRY NO. 507

A journey through the Plabutsch tunnel on the Pyhrn highway (A9) in Graz, Austria, should not take less than six minutes and 10 seconds. This is how long it takes to drive through the longest road tunnel in Europe (almost 10km in length) at the permitted maximum speed of 100km/h. Some 33,000 vehicles pass through the Plabutsch tunnel daily, and accidents frequently occur due to excess speed.

"We are making Austria's motorways the safest in Europe," says the mission statement of ASFINAG, the company that plans, finances, maintains, and tolls the entire Austrian highway and expressway network.

This extensive program of measures also provides for the use of TraffiSection systems from Jenoptik to detect vehicles that have a higher average speed than the maximum permitted within a given stretch of road.

The systems, which entered service in October 2011, automatically acquire a photo of the vehicle and the driver so that any resulting violations can be processed. Both images are then communicated in encrypted form to the police, who apply for the fine. Capturing an image of the driver also enables the prosecution of motorists from other countries.

The TraffiSection installation designated 'section control' in the Austrian system can differentiate between motorcycles, private cars, private cars with trailers, trucks, and buses, thereby enabling speed restrictions applicable to specific vehicle classes to be monitored.

The system is also connected to a variable message sign (VMS) unit, which feeds the display-specific limits into the TraffiSection system. The VMS display systems are filmed by digital cameras, which supply incident-specific images with the incident data record to document any infringements.

Need to know?

The effect on safety of determining average speed through Europe's longest tunnel

- Following two mobile TraffiSection installations, the first stationary Jenoptik unit for determining average speed entered service in Austria's Plabutsch tunnel in October 2011.
- Section control is part of an ambitious scheme to make Austria's highways "the safest in Europe".
- Additional systems will be deployed in the future as part of a five-year project.
- The Austrian scheme proves the benefits of this technology and acts as a benchmark for deployments in other countries.

TraffiSection systems determine average speed on different stretches of road

Data protection

Use of the section control installation complies with all data protection regulations. ASFINAG can access only operating data such as fault messages, and only the executive is allowed access to acquired infringement data.

Recorded violations are made available, encrypted, and signed on the suspected case server in the ASFINAG network for subsequent analysis by the executive, and communication to the district commission and the magistrate for prosecution.

Reduction in accidents

Conclusive evidence provided by the TraffiSection installations has already convinced ASFINAG of the effectiveness of the system. To date, the deployed units have yielded positive results, including improved traffic flow, a reduction in road speeds, and fewer accidents involving injuries and fatalities.

Senior project manager Uwe Urban is confident that "ASFINAG will be putting further systems into service during the course of the five-year framework agreement with the Jenoptik Traffic Solutions division."

TraffiSection systems are already in operation in Switzerland and Kuwait. In Germany, it has not been possible to determine average speed until now because of issues concerning the protection of personal data.

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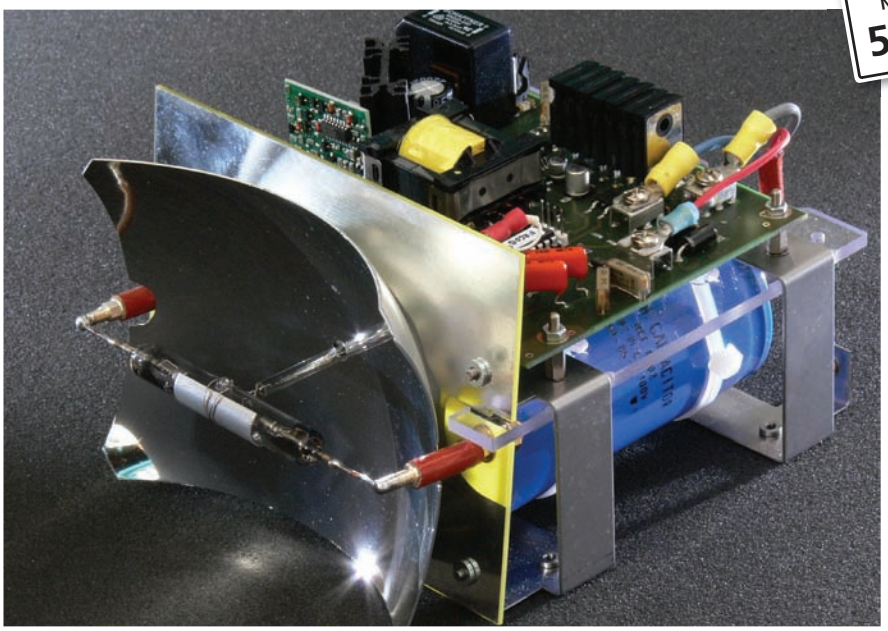
Flash illuminators for ITS tasks

READER ENQUIRY NO. 508

The implementation of traffic enforcement cameras – be it for speeding or red-light running – necessitates a full cluster of technical solutions. These encompass everything from speed measurement, image sensors and optics, to illuminators and power supply. If there is a weak link in any of these components in the chain, the overall system will suffer. Of particular importance for image quality is the issue of illumination. However, history has shown that this vital component is far too often neglected. Systems integrators have long been guilty of simply trying to take illumination solutions from general engineering fields and applying them to traffic systems.



The Lumix illuminators are tailored for the ITS market

Leave it to the experts

The above approach leaves a lot to be desired. The simple fact is that there is no way around it: image capture involves light and photography. These are matters best left to skilled professionals.

Deeply rooted in power optoelectronics for years, and more than familiar with professional photography, Lumix is a designer and manufacturer of flash illuminators. Among other products, since 2006 the company has offered a range of what it describes as 'turnkey' flash illuminators, especially designed for traffic control.

These illuminators set themselves apart by using an operating mode based on what's known as 'energy buffer' technology. It enables the delivery of multiple, individually-controlled shots of light, even without recharge. Another technical refinement consists of an optical formula specifically developed for this application. The result is a rectangular beam pattern, which allows a precise aiming to where illumination is required. This yields the maximum efficiency in terms of beam usefulness versus electrical power requirement, which is an asset when dealing with driver facial recognition or retroreflective licence plates.

In real-world use, this boils down to a number of key points. Firstly, it offers a quasi-permanent ability to obtain a shot upon request, even under fast repetition rates – although that's for a limited number of shots within a fast sequence, i.e. enough for multiple cars or red-light violations. Next, it enables a significant reduction in heat build-up. It also means a drastic reduction in maintenance, and a major leap in mean time between failure (MTBF). Finally, it offers a six-fold reduction in power supply compared to an equivalent traditional illuminator.

Choice of solutions for individual needs

These flash illuminators come in small weights and sizes (≈ 1-4kg, depending on the model) for an output on par with much heavier and power-consuming illuminators. Their reduced sizes save on power, yet they produce light like giants!

And for those uncomfortable with 3D geometry, solid angles, and analysis of photographic parameters, Lumix offers consultancy services to help define the best parameters for any road configuration (roadside, gantry, single pole, multi pole, for instance). Lumix guides operators straight to optimal results, saving cost on development and painstaking field-tests. Additionally, in many countries the company offers a solution to the problem of over-exposed retroreflective licence plates.

Need to know?

Why it's so important to choose the right illumination tools for the job of enforcement

- Many traffic enforcement systems have tried to 'borrow' illumination solutions from other sectors: this approach is not ideal for ITS
- Expert advice states that the latest generation of flash illuminators has great potential for the traffic market
- Offering a range of different versions – plus consultancy services if needed – ensures high-quality image capture

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Accurate detection for urbanized areas

READER ENQUIRY NO. 509

(Left) **The LeddarTech D-tec system**

Urbanization and densification around the globe are growing. In 1950, for example, only 29% of the world's population lived in an urban environment, a number that is expected to reach 57% by 2025. This demographic shift from rural to urban settings has created an increase in traffic congestion, in doing so placing a heavy burden on transportation infrastructure.

With this rise in vehicle traffic density, the need for efficient and safer roads and highways has become a major concern for communities, transportation agencies and citizens alike. What's clear is that municipalities around the world are already grappling with traffic congestion – and those that aren't probably will be in the near future. Although constructing new roadways is always a solution, it requires very significant investment. Improving vehicle throughput with current infrastructure using innovative technologies is the immediate and affordable solution with notable returns. Moreover, not only can these intelligent solutions assist in alleviating traffic congestion, they can also predict and anticipate potential traffic dilemmas, thereby providing motorists and transportation agencies the opportunity to take pre-emptive action.

The need to provide affordable, scalable, accurate, reliable, easily installed and non-intrusive detection information is a key component in optimizing traffic flow with existing infrastructure. Numerous technological solutions exist, although few are scalable and adapted to the various applications within ITS.

Accurate data requires accurate vehicle detection information, a call that is answered by a recent technology known as 'Leddar' – short for Light Emitting Diode Detection And Ranging. As a result of several patent-pending techniques and advanced signal processing, the time-of-flight of the light-based Leddar technology enables the use of LED lighting, either in the visible or infrared spectrum, for detection and ranging.

Contrary to collimated types of emitters (laser), the LED emitters of the Leddar sensor actively illuminate the area of interest, which greatly facilitates the alignment of the system. In return, the multichannel sensor receiver collects the backscatter of the reflected light and measures the time taken for the emitted light to return.

As the measurement is based on the speed of light, the accuracy, reliability and speed of the data information is very high. The processed data, meanwhile, can provide precise vehicle detection, classification and speed information of every vehicle – not an average as with some systems.

The combined advantages of the Leddar technological platform enables it to be deployed in a variety of ITS applications, notably in traffic intersection control, arterial/traffic monitoring, electronic toll collection and traffic law enforcement systems.

Point-to-point enforcement

A company within the Safran Group, Morpho, recently approached LeddarTech in order to find a vehicle detection solution that was able to provide a trigger output to actuate the ALPR camera.

Among the numerous challenges, the non-intrusive solution needed to detect all types of vehicles traveling on open highways at speeds of up to 250km/h – in all weather conditions. Furthermore, the position of the vehicle was critical as the ALPR camera needed to be triggered at a very precise location. In other words, when the vehicle crosses a specific line, the system triggers the camera, regardless of the lane in which the vehicle is located. LeddarTech provided a non-intrusive, reliable and accurate solution, and the French

(Below) **Signalized intersections benefit from improved detection technology**

Need to know?

Non-intrusive vehicle detection with very accurate 3D performance

- Rapid installation thanks to single cat 5e cable (Power over Ethernet)
- Simple calibration with on-board image sensor
- Measurement is based on the speed of light, which ensures maximum performance and accuracy
- Multichannel Leddar sensor provides excellent lateral discrimination of detected objects

company is now deploying the systems in Europe.

Traffic detection

The Leddar technology accurately detects vehicles in adverse weather conditions by discriminating solid objects in the background from the 'soft' ones such as rain, snow and fog. This functionality was vital for a project in the City of Davis, California. Home to around 64,000 residents, the University of California campus in the city has a student body of 30,000, many of whom commute via bicycles. With so many commuters on two wheels it made sense to detect and accommodate them at signalized intersections.

The state of California also recently adopted legislation that requires new signalized intersections and certain existing ones to incorporate systems that can automatically and reliably detect bicycles.

City of Davis officials addressed this challenge at the intersection of Covell Boulevard and Sycamore Lane by installing four detection units. A city representative has since confirmed bicycles, motorized vehicles, and pedestrians are successfully being detected regardless of the weather or lighting conditions, which was an important requirement as Davis encounters periods of heavy fog. For Davis, the 3D Leddar technology ticked all of the boxes, working perfectly in dense fog, high wind and heavy rain.

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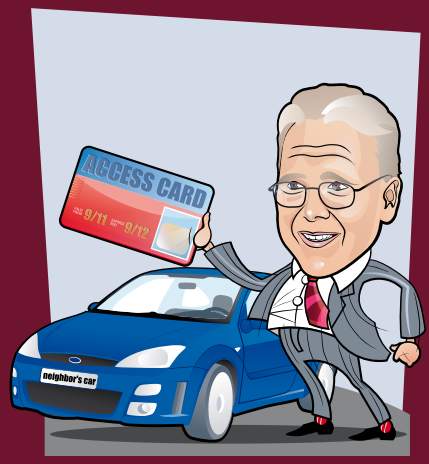

bg@berngrush.com

Last column, I wrote about peer-to-peer (P2P) carsharing as a form of collaborative consumption, coining the phrase 'collaborative telematics' for the systems that would maximize the flexibility in business models for this form of automobile financing.

Automobile financing? A key business difference between traditional carsharing and P2P carsharing is that while the motivation to use the service is the same, the business purpose and structure is entirely different. Traditional carsharing is quite similar to car rental. The biggest differences are how the supply of shared cars is decentralized throughout an urban area and its focus on hourly versus daily rentals. P2P carsharing, on the other hand, is less like traditional carsharing and more about your neighbor having you to make his car payments for him.

The key distinction between traditional carsharing and P2P carsharing is asset ownership. In the case of traditional carshare companies such as ZipCar, the carshare operator decides which vehicles to own and may create a relatively uniform fleet as buying in bulk makes good business sense. Such operators would be concerned with fleet maintenance, and a uniform fleet is easier to manage. Dedicated, widely distributed parking spots must be found, negotiated and managed throughout a city. And such a company can sometimes profit from buying in bulk, then selling vehicles in an optimum turnover cycle.

In the case of P2P carsharing, all this evaporates. There are no vehicles to purchase, maintain or sell since P2P service subscribers own the fleet. There are no staging spots to be found and managed. Suddenly we have more vehicle miles traveled from a smaller total fleet. And the technology that manages vehicle location, registration, access, contract initiation/termination and a several other administrative steps are very similar to what a traditional carshare operator uses.

So what does a P2P carshare operator have to worry about? The P2P operator must rely entirely on match-and-manage services for subscribers and drivers – there is no profit for investing in the fleet itself, since much of the rental fee goes to the subscribers. Hence the P2P operator must make up in volume what is lost in per-contract revenue. To generate that volume, P2P operators need to ensure that a lot of subscribers feel comfortable having strangers drive their personal vehicle and that a lot of drivers are comfortable driving a vehicle provided by a stranger. A negative user experience or renter experience will dampen sales more quickly than sales will be increased by positive experiences. The comforting, impersonal nature of a rental car or a traditional carshare is lost.

Anyone who looks after a personal vehicle to extend its useful life and re-sale value or to ensure it is in good working order for his own use would want to be sure that vehicle is driven responsibly and safely. Telemetric systems are now available for metering both eco-driving and usage-based insurance that can produce a driver report card measuring things such as aggressive acceleration, speed or steering. If such a report card were to be automatically associated anonymously with each driver, a matching algorithm can ensure car owners can select for car renters specific to their preferences related to vehicle handling.

P2P carsharing has enormous social and environmental potential for us. Any way that we can increase the portion of trips made in P2P vehicles as opposed to driver-owned, leased or rented vehicles will be valuable.

> P2P operators need to ensure that a lot of subscribers feel comfortable having strangers drive their personal vehicle
>
> **Bern Grush, principal, Bern Grush Associates, Canada**

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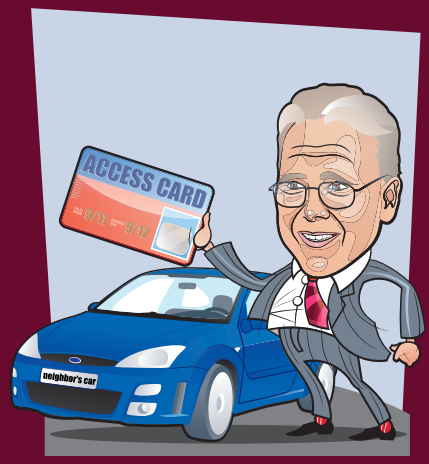

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The key distinction between traditional car pooling and P2P car pooling is asset ownership. In the case of traditional car pool companies such as ZipCar, the car pool operator decides which vehicles to own and may create a relatively uniform fleet as buying in bulk makes good business sense. Such operators would be concerned with fleet maintenance, and a uniform fleet is easier to manage. Dedicated, widely distributed parking spots must be found, negotiated and managed throughout a city. And such a company can sometimes profit from buying in bulk, then selling vehicles in an optimum turnover cycle.

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Anyone who looks after a personal vehicle to extend its useful life and resale value or to ensure it is in good working order for his own use would want to be sure that it is driven responsibly and safely. There are telemetric systems now available for metering both eco-driving and usage-based insurance that can produce a driver report card measuring things such as aggressive acceleration, speed or steering. If a report card were to be automatically associated anonymously with each driver, a matching algorithm can ensure that car owners can select for car renters specific to their preferences related to vehicle handling.

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>
> **Bern Grush, principal, Bern Grush Associates, Canada**

With authorities switching off streetlights to save money, how do you strike the balance between increased safety and reduced costs?

"The decision to install lighting on a previously unlit road may be made using a cost-benefit analysis that weighs the cost of providing road lighting against the cost saving arising from a reduction in road accidents. Such an analysis will assume a certain reduction in accidents – for divided highways in the UK, this assumption is a 10% reduction in personal injury accidents – and this is assumed to be constant along all sections of a road and at all times of darkness. John Bullough's comments in the article in this edition (*p46*) highlight the temporal variation in accident rates. Interpretation of US road accident data using the daylight-saving approach (a comparison of accident rates before and after clock changes) suggested that lighting affects some types of accidents (for example, pedestrian collision) more than others (such as a single vehicle leaving the roadway), and this suggests a strategy for determining where road lighting is effective. Measuring the effectiveness of road lighting in reducing accidents is not simple; road accidents on a particular section of road are (thankfully) few, and there are many confounds. Although several studies have been carried out to find out whether lighting is indeed effective at preventing traffic accidents, the recent review of these by the Cochrane Collaboration concluded that the methodological quality of the trials was generally poor. It appears that lighting is effective, but we do not yet fully understand when, where, and by how much it is effective. What is needed is a more robust review of road traffic accident data to evaluate the effectiveness of road lighting as an accident countermeasure."

Steve Fotios
professor of lighting and visual perception, University of Sheffield, UK

"Switch off every second light, and keep those at intersections switched on. I would suggest a remote-controlled switch at every bulb – by doing this, if it was felt that there should be a different combination of on and off at some point in the future, it's easy to adjust. The on-off switch could be activated by an engineer at the base of the streetlight. Although engineering standards will have driven the amount of light currently being provided, we know they can be over-engineered. Reduction might lead to more traffic accidents, so this should also be monitored. Ultimately, a more realistic standard would emerge."

Paul Minett
managing director, Trip Convergence, New Zealand

"You can turn off residential lights at appropriate hours (midnight on weekdays) by starting with every other light. You could also turn off traffic lights only in non-residential areas, with signs at the right locations (similar to traffic warning signs) to advise motorists. The cost savings in energy would be worthwhile and the safety concern should be minimal. Communication to the public is key, which would vary from area to area – both on methods used and decisions as to how far to carry the lights-out measures. It should be a local and not a federal- or state-mandated decision, and would need to involve local police and government. Solar power could be an option for future construction. Lights could be dimmed or turned off in every other street, and so on."

Bob Ohman
business manager, URS Corporation, USA

"Removing streetlighting only makes roads less safe when and where it made roads safer to begin with! Our research suggests we often overestimate the safety impact of lighting because it often gets installed along with markings, signals, signs, and other improvements that collectively improve safety. Nonetheless, streetlighting – especially at intersections and other conflict points – does appear to reduce night-time crashes by perhaps as much as 10% compared with unlit locations. Further, since the safety increment from streetlighting seems to be proportional to the visibility improvement – and since visibility can be estimated before the lighting system is installed – it seems possible to be able to predict how much safer a given streetlighting installation should be, at least in terms of vehicle crashes. Benefit-cost analyses can provide very useful insights to decision makers. For example, streetlighting has fixed costs (equipment and energy), regardless of whether there is any traffic at a given place and time, but the benefits (the economic value of avoided deaths, injuries and property damage) are directly related to the traffic volume. Allocating the energy costs of streetlighting more strategically, by using higher levels during denser traffic and lower levels during sparse traffic, is not only technically feasible, but is becoming pragmatically defensible."

John Bullough
scientist, Lighting Research Center, Rensselaer Polytechnic Institute, USA

Readers are invited to answer the Burning Question for the February/March 2012 issue:

Traffic software has come on leaps and bounds in recent years. How has it impacted positively on your job – and what more do you need from vendors?

email answers to:
louise.smyth@ukipme.com

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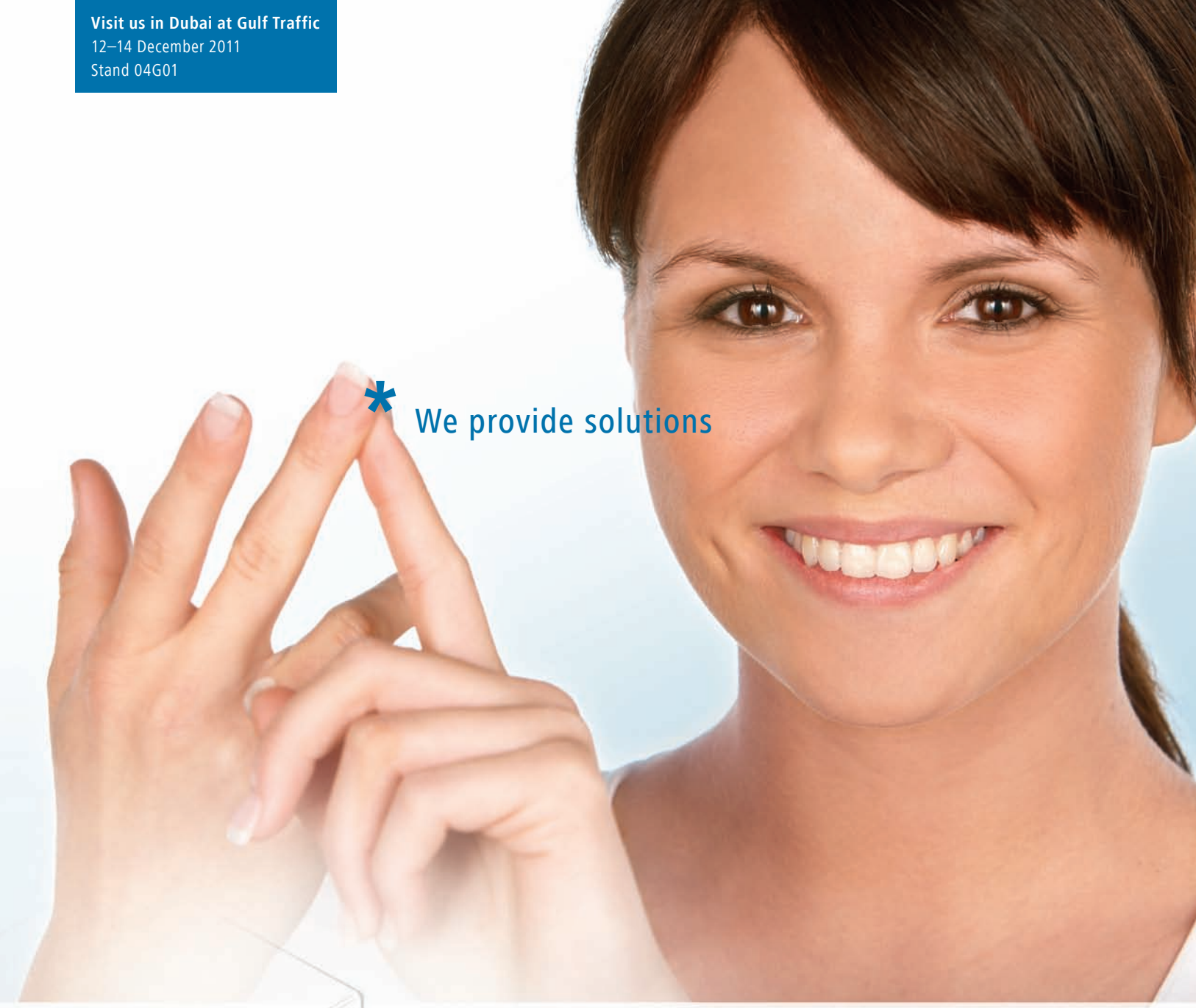

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