August/September 2014

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TECHNOLOGY INTERNATIONAL

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Celebrating 20 years of Traffic Technology International
20 YEAR Anniversary

20 TRAFFIC INNOVATIONS THAT WILL CHANGE THE WORLD FOREVER

As we celebrate our 20th year, top industry experts map the road to 2034

PLUS

Autonomous vehicles
The next stage of driverless vehicle testing is already underway, we ask where it will take us in 20 years

The future of speed
Predicting the changing face of speed enforcement over the next two decades

William Clay Ford Jr
The chairman of the Ford Motor Company reveals his vision of mobility for the next 20 years

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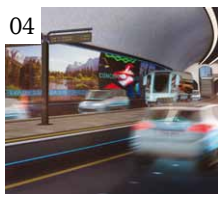
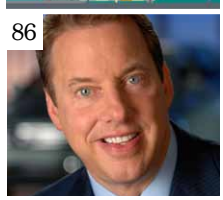
Cover story

16 The road to 2034

A celebration of *Traffic Technology International*'s 20th anniversary

Plus, there's more throughout the issue... turn to the back page for an index that lists the 20 innovations you can't afford to ignore





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Technology Profiles

Editor's letter

Welcome to a very special issue of *Traffic Technology International*: our 20th Anniversary Special. We've pulled out all the stops to bring you the very best from across the industry. Huge thanks go to everyone who has helped put it together. I'd particularly like to thank the 20 members of our anniversary panel, who took the time to assess, not only how far we've come in the last two decades, but also to have a bit of fun by attempting to predict where we are heading on the road to 2034. Since their combined experience spans every field of ITS from navigation and autonomous vehicles to road-pricing and tolling, you're unlikely to find a more complete picture of the industry anywhere else. The party begins on page 16. But celebrations aren't just limited to the one feature; throughout this edition you'll find us taking the 20-year view on every subject we touch on, turn to the back page to find out more, and look for the 20th Anniversary ribbon (above) throughout the issue.

In Detroit, Michigan, there will be a party of a different kind going on in September: the 21st ITS World Congress. If you are planning to attend, or are reading this actually at the event, you won't want to miss our preview feature that will help you navigate the highlights (see page 68); nor our interview with congress keynote speaker Bill Ford. It feels only right that the current leader of the most famous auto-manufacturing family in the world should be joining us in our 20th celebrations by sharing his vision. Find out what he has to say about the future of ITS and mobility on page 86. And there's no need to get the blues when the congress packs up on September 11, either: the party continues a few days later in Austin, Texas with the IBTTA Toll Excellence Awards. We meet the winners on page 60.

But before you get really stuck in, turn the page for a very special foreword from the man who set up this publication back in 1994, *TTi*'s first editor and company CEO, Tony Robinson.

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SEEING IS BELIEVING

What the world needs now: 20 years later

Founder and first editor of *Traffic Technology International* **Tony Robinson** reflects on an eventful two decades in advanced traffic management and looks forward to more radical change ahead

Illustration: Magictorch

Nineteen-ninety four was a vintage year in the world of Advanced Traffic Management Technology and ITS. In January the year was kicked off by the launch of *Traffic Technology International*. From the outset it was evident that we'd hit a nerve; the phone hardly stopped ringing with people clamoring to get copies. The excitement continued at InterTraffic 1994 in Amsterdam, where we presented the publication at a show for the first time and ran out of copies on the first day, much to the relief of our competitors who struggled to get interest in their 'traditional' road-building magazines. As the year progressed we were treated in October to the Final Meeting of Prometheus staged in Paris, the then collaborative

> Imagine the increase in the currently available highway network if the rail environment was replaced with fully automated highways, which would then be compatible with and connect perfectly and seamlessly with the existing road network
>
> **Tony Robinson, founder, *Traffic Technology International***

research and development program between European car manufacturers, which was set up to develop technologies such as ESP and Lane Keeping Assistance, Collision Mitigation Technologies, Night Vision and more: the systems that in some cases are now mandatory or soon to be so in European vehicles. Weeks later in 1994, and also in Paris, we saw the first ever ITS World Congress, where *TTi* was the only publication that really covered the newly emerging and highly progressive technologies that we know as ATMS and ITS. Oh, what a year that was!

Twenty years have passed and it's been fascinating to see the progress. The slow lane has been taken up by government-funded infrastructure-based programs, while the fastest and most dramatic changes have come from the post-Prometheus phase of independently supported in-vehicle developments created by the leading car manufacturers; it's these that have turned out to be the real game changers. We've seen ramp metering being adopted from America and now operating in the UK, for example; we've seen variable message and variable speed signs coming into use all over the world but with dubious levels of real-time fidelity; we've seen improvements in traffic signal sequencing and network management, and of course surveillance, but alas only sporadic and limited shifts of a quantum stature in highway infrastructures.

I like what I've seen when it comes to Applied Common Sense (ACS), something that has been used very successfully in Sweden, a country notorious for well-thought-out logic. It was the Swedes who changed from driving on the left (UK style) to driving on the right in an incredible overnight but substantially pre-planned maneuver in September 1967; they were also the people who realized that the use of daytime running lights radically reduced

accidents and mandated it 10 years later in 1977. And it's the very same nation that in the last 20 years has extensively modified its highway infrastructure to achieve big safety improvements merely by utilizing ACS. Cutting down trees along the highways to create safe run-off and to give better visibility of approaching wildlife and installing easily deformable crash-friendly street furniture are just two very good examples of how once again these people have applied common sense to achieve considerable gains in their quest to target zero fatalities on their highways.

> In this new environment it would also be possible to envisage the installation of induction charging so that next-generation battery cars, trucks and buses could operate with infinite range
>
> **Tony Robinson, founder, *Traffic Technology International***

A brave new world

What the world needs now is significant and rapid change. For example, I think railways are an anachronism; a transport form that is not compatible with other surface transportation types – namely cars, trucks and buses. Trams, for example, are slow moving, cumbersome and infrastructure dependent. They hark back 100 years and can't really be the answer to inner-city congestion. No more so can subway and underground networks, also conceived in Victorian England, that desperately struggle to provide efficient and desirable under- and over-ground urban travel, not just in the UK, but in many countries worldwide. Trains don't interface with other surface transport either; you'll never find one that takes you to your front door or one that dovetails with road vehicles at all well. This means that in many parts of the world, we have great rail networks in place, using valuable space, that are crying out for modernization. Adaptation of these networks by removing costly and cumbersome railway lines and complex signaling equipment could give rise to the same routes being used as fully automated driving environments for private vehicles and 'coaches' for multiple occupancy travelers. Imagine the increase in the currently available highway network if the rail environment was replaced with fully automated highways, which would then be compatible with and connect perfectly and seamlessly with the existing road network. We'd have integrable and compatible systems instead of the clunky mismatch that exists at present.

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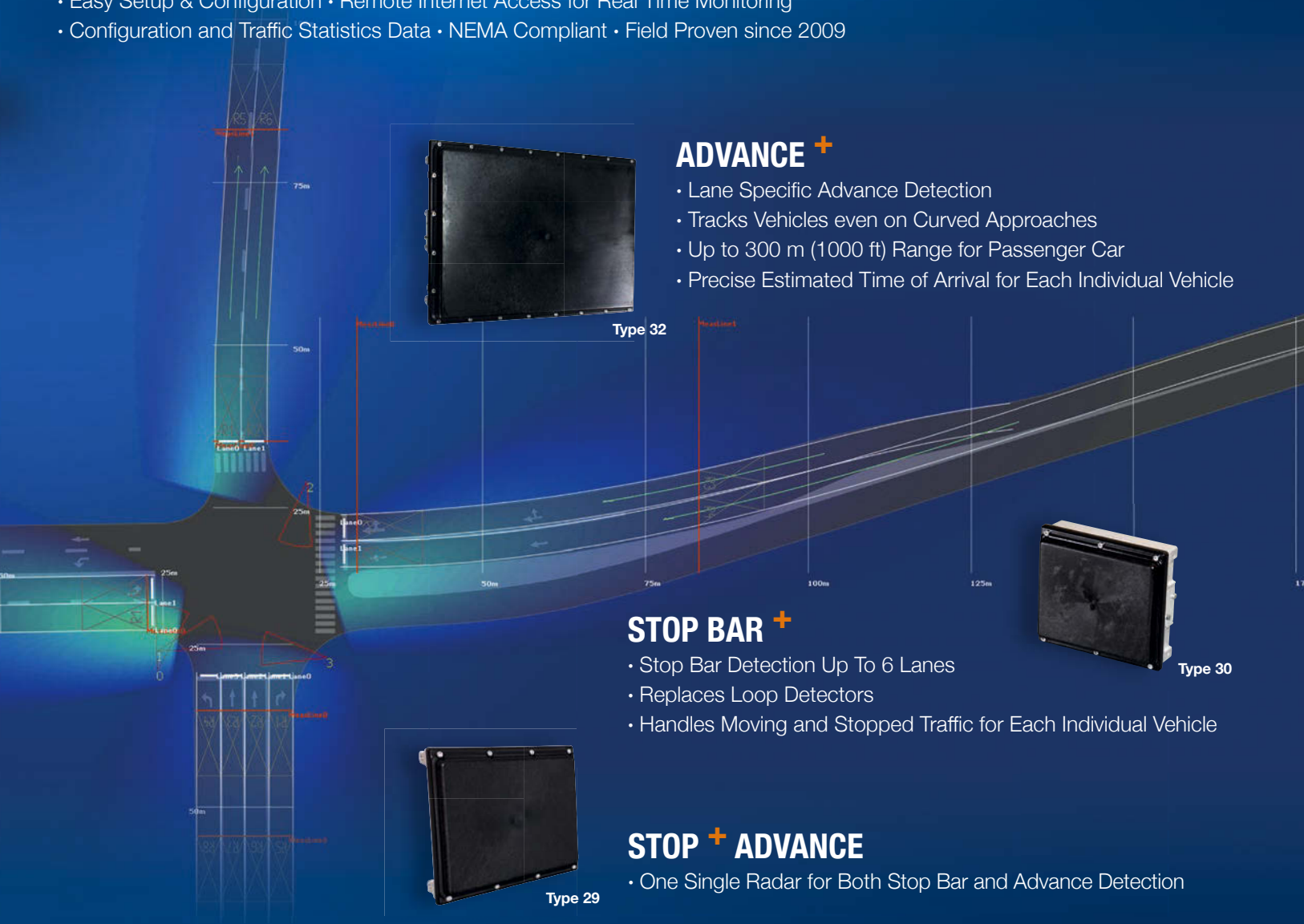

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In this new environment it would also be possible to envisage the installation of induction charging so that next-generation battery cars, trucks and buses could operate with infinite range. With near-term fully realizable improvements in solar and wind power, there is the potential for fully environmentally friendly and totally sustainable transport for the future.

Rethinking crash management

On my wish list for the short term for reducing extreme traffic congestion would also be a big shift in the way that accidents are managed; these are, after all, normally the cause of the worst and most extensive traffic jams and, as is comprehensively and regularly documented, they cost billions of dollars in losses around the world.

We have terribly outdated ways of removing vehicles from crash scenes and for dealing with injured occupants. Tow trucks, police cars and ambulances typically take far too long to reach incidents and should be relegated to secondary roles. For example, helicopters could be used to lift vehicles away from crash sites to restore traffic flow quickly and efficiently; the fitment of 'soft' lifting cradles that would prevent additional damage to mildly damaged cars, vans and trucks can easily be envisaged. Similarly, while at present helicopter paramedics attend to the seriously injured at crash sites, their work could be greatly enhanced by lifting vehicles and their occupants after initial first aid to specialist crash management centers where extrication specialists and medics could work hand-in-hand to remove and treat injured occupants in highly specialized units.

Crash forensics need to be radically rethought as well. Current methods are slow and often take days to complete. Yet we have the technological capabilities for cars to be fitted with data recorders; 'black boxes' that would record the 60 seconds prior to an accident with voice, data and image capture both inside and outside the vehicle from multiple angles and directions. Much of the technology is already in the cars we drive; it merely requires adaptation and inclusion.

The road to excellence

And that for me sums up the last 20 years of being at the observational level of *Traffic Technology International*. To use a phrase often used by one of the world's greatest automotive industry journalists, the late Leonard Setright, "So far, so good."

> As much as images of flying vehicles in urban landscapes excite me, I don't expect to see them anytime soon
>
> **Tony Robinson, founder, *Traffic Technology International***

(Left) ***TTi* has never been shy of radical predictions of the future, as this June/July 2007 cover proves**

Yes, indeed, the last 20 years have played host to a mild revolution. But as a working colleague of mine also regularly states, "Good is not good enough." What we have at present is a global scenario where the prevailing ingenuity of car manufacturers and traffic technologists will be limited if governments fail to grasp the potential for radical change. Without governments getting behind the bigger picture, the future of surface transportation will remain stifled and increasingly gridlocked, and the potential to utilize fully automated driving technologies will at best reach a level of two out of four.

Since the first words that we wrote in the launch issue of *TTi*, the keys to success and to realizing change have been ingenuity-based, whether they are ACS, ITS, ATMS or any one of hundreds of acronyms that the traffic and transport telematics community has been rather good at creating. I'm pleased to say that over the years not much has been missed by the editors of this magazine, who have successfully given exposure to the technology leaders and highly innovative projects going on around the world. My personal pride in this product extends from its earliest days when we cleared the first issue for press and to it winning the much coveted PPA International Magazine of the Year Award six years after its launch.

What the world needs now is for surface transportation to be taken to the next level. As much as images of flying vehicles in urban landscapes excite me, I don't expect to see them anytime soon. The future will for the time being be on the surface, and it will be in the hands of traffic technologists, government leaders and technology innovators to push on with radical changes. What our readers can continue to expect is that it will be reported on, encouraged and I hope driven forward in the lively and colorful pages of *Traffic Technology International*.

Great British trials

Lauren Ansell reflects on the UK government's recent announcement that it is giving the industry the green light to begin testing driverless vehicles on public roads in early 2015

Just a few weeks after Google revealed that it would start building its own self-driving cars in the USA, the UK's business secretary, Vince Cable, revealed that driverless cars will be allowed on public roads in Britain from January 2015. Currently they are only allowed on private roads. A £10m (US$16.9m) fund is being made available by the Department for Business, Innovation and Skills and the Department for Transport for autonomous-vehicle research, and the government is calling on cities to join with businesses and research organizations to put forward proposals to become test locations. The Technology Strategy Board will select three UK cities to host the trials, which will begin in January and last between 18 and 36 months.

Ministers have meanwhile launched a review to ensure that there is an appropriate regime for testing driverless cars. Vehicles will need to comply with construction and safety regulations, traffic laws and relevant aspects of the Highway Code, as well as with the licensing, liability, insurance and driverless regulations that are already in place in other countries. Semi-autonomous and fully autonomous vehicles will both be considered.

"The excellence of our scientists and engineers has established the UK as a pioneer in the development of driverless vehicles through pilot projects," said Cable. "Driverless cars will take to our streets in less than six months, putting us at the forefront of this transformational technology and opening up new opportunities for our economy and society. Through the government's industrial strategy, we are backing the automotive sector as it goes from strength to strength. We are providing the right environment to give businesses the confidence to invest."

How will we navigate the road ahead?

Prana Tharthiharan Natarajan, automotive and transportation specialist at global consultants Frost & Sullivan, predicts technical challenges

The key to making driverless cars a success [in mixed-vehicle environments] is to ensure that fully automated vehicles behave in a similar way to manually driven vehicles. This is especially critical in terms of braking and normative driving behavior.

That is to say, if a human driver needs five seconds to react to an imminent danger by applying the brakes and bringing the vehicle to a halt, the driverless car should always provide at least that amount of time to the vehicle behind it. Driverless cars may be capable of reacting in a fraction of a second, but the reaction times of humans will remain a crucial factor.

Future drivers will also need to be trained in how to operate a driverless car – which commands to override in which situations, and when to trust the car more than their own instinct.

The reshaping of transportation

How far can the new announcement take Britain?

"The public has not yet embraced the concept of autonomous cars trundling around Britain's roads, but the reality is that, within a decade, technology will allow driverless cars to become the norm," says David Raistrick, UK Automotive leader at Deloitte. "The government's announcement will remove some of the current hurdles, while encouraging the UK to become an early adopter."

Raistrick says that in the future, driver requirements will change completely. "Engine size will become less relevant, as will driver experience, with connectivity of the vehicle becoming more important," he predicts. "The benefits are far more than just driver safety. Large haulage vehicles could potentially become driverless, thus safeguarding other road users. Computer modeling suggests that as cars can then safely travel closer together, our existing infrastructure will accommodate substantially more vehicles, reducing congestion."

700,000
miles have already been driven by Google's self-driving cars: 28 times round the world

What will the next 20 years hold for autonomous vehicles worldwide? Turn to page 26 to find out

Global interest

The UK now joins the USA, Japan and Sweden in the drive toward autonomy

Similar trials have been taking place in the USA since 2011, where autonomous vehicles are now allowed in four states: California, Nevada, Michigan and Florida. Meanwhile, Nissan carried out its first test of an autonomous car on a Japanese motorway in 2013. Volvo also began testing 100 of its self-driving cars on public roads around the Swedish city of Gothenburg earlier this year.

"Driverless cars will take to our streets in less than six months, putting us at the forefront of this transformational technology

Vince Cable, UK business secretary

Capital gains

Lloyd Fuller highlights the latest technologies making city parking operations in Europe more efficient, cost-effective and sustainable

Mobile network

Amsterdam uses parking enforcement car

The company responsible for paid parking in Amsterdam is using a new car for mobile parking enforcement. Cition currently enforces payment with mobile units, including scooters and cars that are equipped with ALPR technology, and has now started using the first car fitted with a Scan Genius roof unit from ARVOO. For the automatic identification of parked vehicles, the roof unit uses six smart cameras running an embedded version of Q-Free's Intrada ALPR software. Intrada uses OCR technologies and features a library of license plates from more than 100 countries and states around the world.

Green machines

Madrid introduces 'smart' parking meters

The city of Madrid has begun a project that uses parking meters to reduce air pollution. 'Smart' meters in the Spanish capital charge higher parking fees to vehicles that use large amounts of fuel, or emit clouds of exhaust fumes. After pulling into a parking space, drivers are prompted to enter their license plate number on a keypad on the meter, which is networked into Spain's vehicle-registration database. The meter then sets a parking rate based on the car's age and model. Hybrids and other newer, more fuel-efficient cars get a discount of up to 20%, while older vehicles and diesel-powered models pay a surcharge. The meters can also be used to discourage parking in congested areas. By linking with sensors that determine how many parking spaces are available in the area, they impose a surcharge for parking on streets where most spaces are already taken.

German efficiency

Cloud-based pilot helps drivers find parking spaces

A pilot project in Hanover, Germany, will use a cloud-based platform to help drivers locate parking and fast-food outlets. The project is the result of a multi-year partnership and co-innovation investment by SAP AG, Volkswagen and other partners. Initially focused on eliminating the frustrations and inefficiencies drivers encounter while searching for parking in cities, the pilot is envisioned to further extend beyond parking to include location-based services for quick-service

restaurants, offering drivers location-based food offers once they have parked. Built on SAP's HANA Cloud Platform, the pilot plans to aggregate information on parking locations, vehicles' location and route. The processes and information will be integrated via the SAP Cloud portfolio and presented in an app on the user's smartphone.

Smart sunshine

Antwerp pilots solar-powered parking terminals

Touchscreen 'Pay & Display' parking machines are common in Belgium, the Netherlands and Luxembourg. While this technology provides an enhanced user experience,

powering the equipment with electricity is costly. In response to this, Parkeon is undertaking a project in the Belgian city of Antwerp that involves the implementation of the company's Strada terminals that are equipped with touchscreens powered by solar energy. Five terminals have so far been deployed around the city. The locations of the machines have been carefully selected, and include places that receive variable amounts of sunshine. Antwerp has simultaneously installed 70 Strada cashless terminals, which do not offer payment by coins or bank notes. According to the results of the test, the city could see 2,000 terminals being replaced with cashless equipment in the future.

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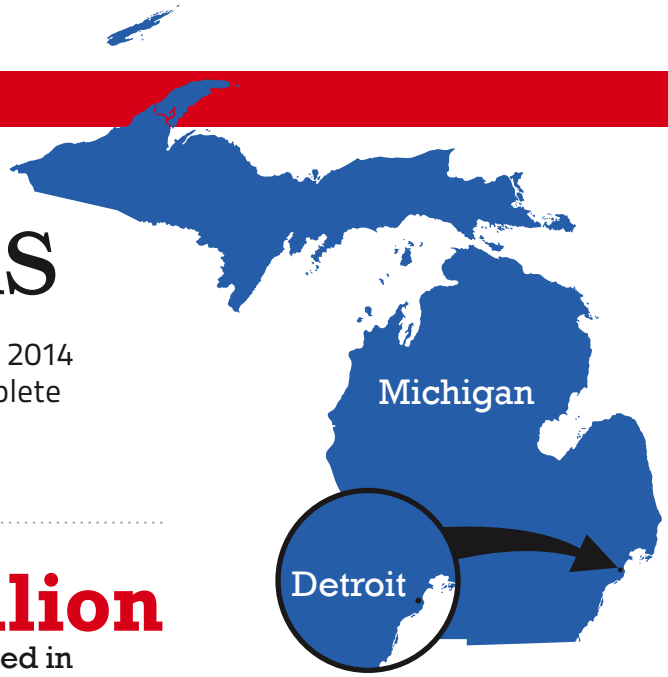
Motor metropolis

As the ITS industry descends on **Detroit**, Michigan, for the 2014 World Congress, we crunch the traffic numbers for a complete overview of the city and its surrounding urban area

Infographics: Louise Adams



Detroit's Tri-County area (commonly referred to as Metro Detroit) encompasses Macomb, Oakland and Wayne counties, and covers 1,967 square miles

An estimated **3.8 million** people live in the Detroit Tri-County area

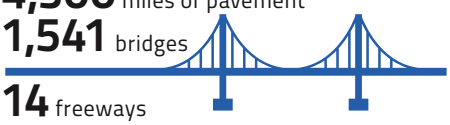
Each year, Metro Detroit receives **US$200m** from the government for road and bridge construction and maintenance

Detroit has an extensive Freeway Courtesy Patrol (FCP) unit that uses 24 vans to patrol more than 200 miles of freeway. The FCP averages more than 47,000 assists per year, with drivers on duty 24 hours a day, seven days a week

Out of the **13.8 billion** vehicle miles traveled in Detroit each year, **1.5 billion** are by commercial vehicles

Metro Detroit has a toll-free highway system comprising:

4,300 miles of pavement
1,541 bridges
14 freeways
19 freeway-to-freeway interchanges



61 of the top 100 automotive suppliers in the world are headquartered in Michigan

DID YOU KNOW

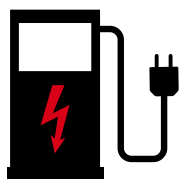
Detroit is the only city in the USA where the nearest Canadian border is due south

Metro Detroit is home to **33%** of the bridges, **46%** of the pavement and **40%** of the traffic in Michigan

In the 1960s, Detroit's freeways were fitted with the first roadway CCTV monitoring system. Michigan now has one of the largest deployments of video imaging technology for traffic management in the world

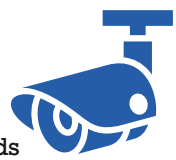
Michigan is home to automotive research and development centers – more than the rest of the USA and Mexico combined **375**

US$6bn has been invested in electric vehicles and plug-in hybrids in Detroit since 2008

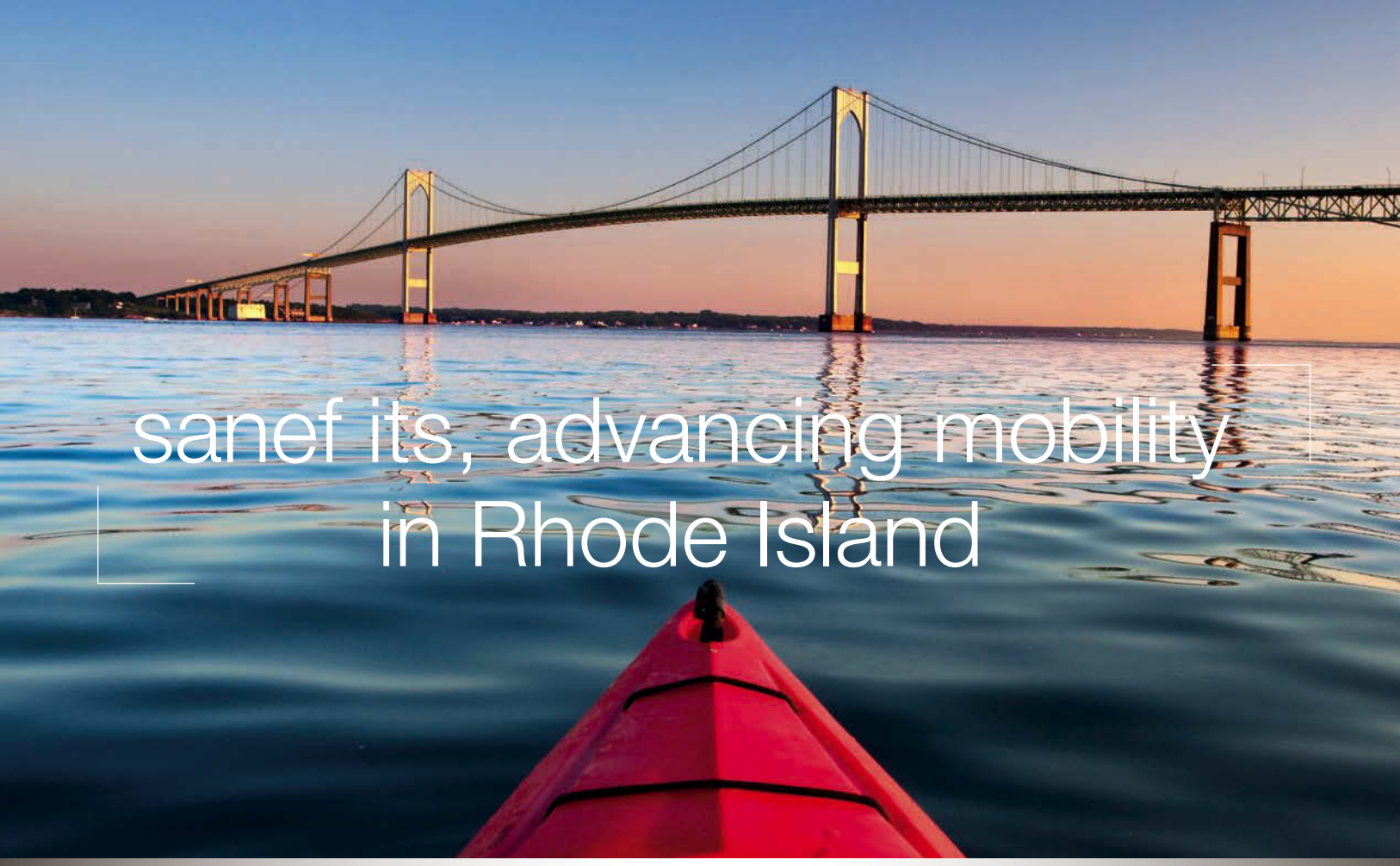


The Southeast Michigan Traffic Operations Center (SEMTOC) uses

170 cameras
69 message boards
2,200 traffic sensors



to collect and share real-time information



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Over the past 20 years, traffic management has attracted some of the finest analytical, problem-solving and business minds in the world – and they've all at some point featured in the pages of this magazine. As part of our birthday celebrations, we've reunited 20 of them, creating the best-informed panel of ITS experts ever put together. Over the following 13 pages, they reflect on just how far we've come and, as the rate of change accelerates, consider where mobility will be in two decades' time

Illustration: Adam Quest

THE ROAD TO 2034


2034
TRAFFIC
40
40

20 of the best

Our hand-picked anniversary panel is made up of the finest minds in advanced traffic management systems. They have been instrumental in the changes we've seen in mobility over past two decades and are therefore ideally placed to predict what the next 20 years will hold...

Richard Bishop
chairman of the International Task Force on Vehicle-Highway Automation

Jim Barbaresso
chair of the 2014 ITS World Congress, vice president ITS HNTB

Phil Charles
professor of transport at the University of Queensland

Bern Grush
principal GNSS road-use charging consultant at Bern Grush Associates

Richard Harris
secretary of the World Road Association's Technical Committee for Network Operations

Randy Iwasaki
executive director of Contra Costa Transportation Authority

Peter Jesty
independent traffic specialist, director of Peter Jesty Consulting

Edmund King
president of the Automobile Association (AA), UK

Todd Litman
executive director of Victoria Transport Policy Institute (VTPI)

Jennie Martin
secretary general of ITS UK

Hermann Meyer
chief executive officer of ERTICO – ITS Europe

Brian Negus
president of ITS Australia, general manager public policy RACV

Jack Opiola
president of D'Artagnan Consulting, technical advisor at Oregon DOT

Robert Poole
director of transportation policy at the Reason Foundation

Eric Sampson, CBE
ambassador for ITS UK

Peter Samuel
founder and former editor of *Tollroads News*

T Russell Shields
founder and chair of Ygomi LLC, former chief executive officer of NAVTEQ (sold to Nokia for US$8 billion)

Phil Tarnoff
chairman of Traffax, former director of the Center for Advanced Transportation, University of Maryland

Shelley Row
chief executive officer of Shelley Row Associates, former director of the ITS Joint Program Office, USDOT

Bernie Wagenblast
founder and editor of the *Transportation Communications Newsletter*

How did we get here?

Before looking to the future, our panel takes stock of the road we've taken from 1994 to 2014, highlighting innovations and success stories, as well as outlining lessons that can be learned from missed opportunities

Q What has had the greatest impact on the traffic sector over the past 20 years?

A The implementation of technology-based safety measures, such as anti-lock brakes, airbags, electronic stability control, and the installation of sensors and cameras, have dramatically reduced accident fatalities. Since these technology-based safety features can be correlated with accident survival rates, consumers have begun to analyze new car purchases through the lens of included and available safety features instead of how quickly the car accelerates.
Randy Iwasaki *Contra Costa Transportation Authority*

A Affordable maps and location fixing have changed navigation; fast in-vehicle telecoms have changed real-time information.
Eric Sampson *ITS UK*

A The rise of big data, cloud-based computing, software as a service, e-payment systems, real-time travel information, integrated ticketing and smartphones have dramatically changed transport services in the past decade or more – for transport agencies, operators and users.
Phil Charles *University of Queensland*

OUR PANEL'S NOMINATIONS FOR BEST TRAFFIC DEPARTMENT OF THE PAST 20 YEARS

SWEDEN
For being at the forefront of innovative thinking, policies and deployment during the last 20 years. Their vision zero road safety initiative, smart ticketing, road pricing and road design etc led the way for many countries.

UK
For introducing the EuroNCAP crash testing program in 1997, which has been adopted across Europe and has helped save thousands of lives.

USA
For the Congestion Pricing Program managed by Patrick DeCorla-Souza.

DENMARK
For having clear objectives, clear strategies for delivering them and the political will to succeed.

OREGON DOT (USA)
For progressing RUC and for pushing for legislation to secure a financially sustainable future for their network. For advanced organization: creating a new 'utility' model with a network improvement and maintenance arm, plus a customer/financial management arm.

CALTRANS (CALIFORNIA, USA)
For building the first fog warning system in the early 1990s; being the first to deploy predicted travel times on VMS; and for introducing one of the first car sharing and smart parking pilots.

TRANSPORT FOR LONDON (UK)
For persistently being an early adopter, even in times of austerity and using 21st century ITS to get the best out of Roman street layouts. TfL has been a pioneer in bringing back walking and cycling as credible urban transport modes.

> There are a number of innovative and creative DOT's working to solve ITS issues… although some still see themselves as road builders rather than holders of the state mobility trust
>
> **Jack Opiloa** *D'Artagnan Consulting*

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Q What is the most important highway finance development of the past 20 years?

A The realization that fuel taxes are no longer viable in the current world. They have been a great subsidy for road use, but increasing fuel efficiency, hybrid-drive technology, alternative fuels and fully electric vehicles have broken that link and the gas tax is no longer a sustainable means of funding our transportation infrastructure.
Jack Opiola *D'Artagnan Consulting*

A Revenue collection has been greatly enhanced through electronic payment systems, which have improved the efficiency of toll collection and enabled the existence of congestion pricing schemes around the world.
Phil Tarnoff *Traffax*

A Governments' failure to raise fuel prices to keep up with inflation means that real revenue is declining.
Todd Litman *VTPI*

A Toll technology has advanced hugely; from a battery powered plastic box costing US$30 apiece, the RFID tag has evolved into a windshield sticker costing less than US$1. It's now also a multipurpose data device.
Peter Samuel *Tollroads News*

Q During the past 20 years, has surface transportation infrastructure taken advantage of the IT revolution that has occurred in the same period?

YES

A To a great extent it has, but it seems to comprise lots of individual solutions rather than a single comprehensive one. In fact this is probably a good thing because we are still feeling our way forward and do not want too many things set in concrete yet – they will be very difficult to undo. I think we keep forgetting that we are actually in the very early days of computing/information technology/the internet and, with a few (simple) exceptions, we are still 'playing'.
Peter Jesty *transportation consultant*

A Up to a point. For the first 10-15 of those 20 years, in-vehicle technology left infrastructure technology standing as highway engineers clung to the ideal of cement and tarmac to improve throughput, but the advantages of ITS solutions are now being addressed quite successfully.
Eric Sampson *ITS UK*

MAYBE

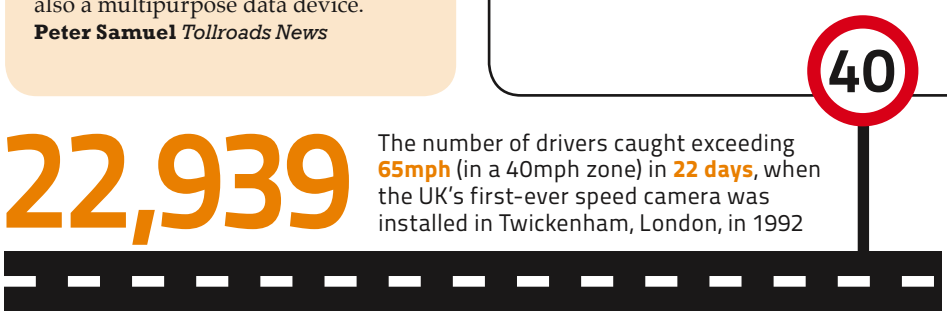
A Initially yes, but more recently no. While it is difficult to continuously invest in the latest techniques (particularly when maintaining existing infrastructure) the organizational and institutional aspects continue to delay our exploitation of technology. Our administrative boundaries were determined in a bygone age and have little relevance to our modern society when it comes to transport and the environment.
Richard Harris *World Road Association*

NO

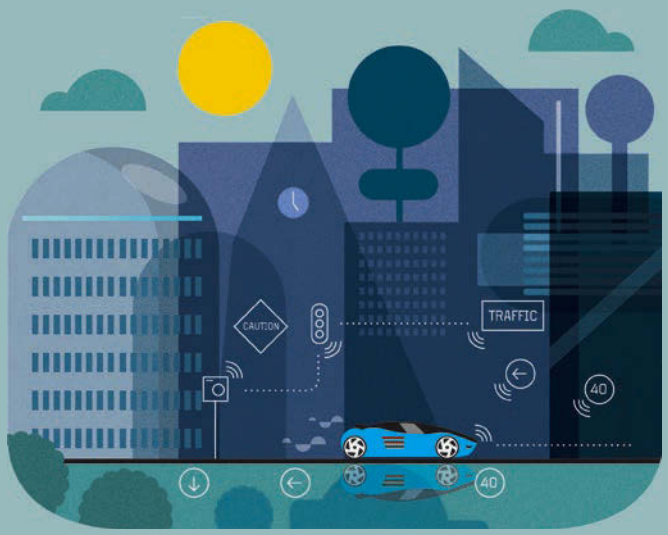
A IT advances are modest – and somewhat disappointing – in view of what might have been. More than 90% of the USA's jurisdictions continue to use traffic signal control strategies from the 1970s, in spite of new technologies that offer more effective control. Similarly, freeway management continues to use old-fashioned VMS with equally old-fashioned messages that do little to manage traffic. It is as if we have erected a new façade on a crumbling building. The exterior (displays and fancy control centers) appears modern while the interior (the management strategies) remains unchanged.
Phil Tarnoff *Traffax*

A We have had a great deal of fumbling and stumbling in the application of new ideas and technology. For the most part we have run mini-demonstrations and applied IT in drips and drabs. If we were committed, we would have wireless networks and fiber optics along our interstates and streets. 'Big data' would not be a scary concept, but a means to trawl data lakes and improve services. We are in the shallow end of the IT pool when we should be in the deep end.
Jack Opiola *D'Artagnan Consulting*

A Surface transportation technology has lagged behind in-car and general IT over the last couple of decades. Even getting highway authorities to change messages on overhead gantries was met by suspicion and resistance 20 years ago. There was a reluctance to give drivers more information on the somewhat condescending assumption that they wouldn't understand it or it would detract from emergency messaging.
Edmund King *The AA (UK)*

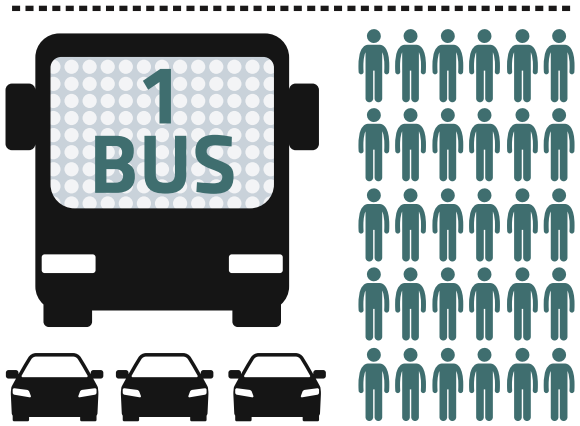


22,939 The number of drivers caught exceeding **65mph** (in a 40mph zone) in **22 days**, when the UK's first-ever speed camera was installed in Twickenham, London, in 1992



Where are we going?

The next 20 years is certain to be an eventful journey. Our anniversary panel picks what to look out for on the way



...can carry the same number of people as 30 cars, while occupying the road space of only three cars (IRU)

Q How are travel demands changing and how can we better serve those demands?

A There's a slight slowdown in the number of younger people taking their driving test at the age of 17 in the UK. Some of this may be due to financial pressures or indeed due to some people interacting more on the superhighway (social media) rather than the actual highway. However this only appears to be delaying their introduction to driving, rather than meaning a whole generation are foregoing the automobile altogether.
Edmund King *The AA (UK)*

A City-based travel is already changing and new generations are likely to be more accepting of mobility as a service-type model. Rural transportation patterns will continue to be under pressure as consumers travel from further afield.
Richard Harris *World Road Association*

A In the USA, urban region traffic patterns have changed dramatically over the past 40 years. Most trips are suburb-to-suburb, yet too much transport planning focuses on suburb-to-downtown travel. Urban planners need to get over their nostalgia for the monocentric urban area. It's gone and is not likely to come back. Let's get serious about making it easier for people to make the trips they actually want to make.
Robert Poole *Reason Foundation*

A We now live in a connected world where it's possible to search the internet on a handheld device just about anywhere at anytime. Consequently, users expect to have on-demand travel services, as well as timetables and links to social media. Users want seamless travel with through ticketing, and a choice of formats for payment and reservation. They want consistent service reliability and quality, coupled with real-time information about any changes or shortcomings.
Eric Sampson *ITS UK*

A There are enormous changes occurring in society that will affect future travel demand: population growth is continuing, there's an increasing proportion of people aged 60+ and younger people have different travel patterns to previous generations. Also, increasing congestion is resulting in higher costs and reduced reliability, with users looking for more efficient modes of travel. Public transport must be easy to use, cost effective and flexible, and users should have access to information that enables them to make informed choices.
Phil Charles *University of Queensland*

A An aging population, rising fuel prices, urbanization, increasing health and environmental concerns, changing consumer preferences and improved accessibility options are causing automobile travel demand to peak, and increasing demand for walking, cycling and public transit. Responding to these demands requires improving transport options. The 20th century was the period of automobile ascendency; the 21st century should be the period of diversity – where we create a transportation system that is responsive to varying consumer demands, and is therefore more economically efficient.
Todd Litman *VTPI*

Q Can ITS make a difference to modal choice?

A Yes, particularly now with the explosion in personal, handheld devices, when well-sourced and packaged travel information (including cost, accessibility and environmental impact, as well as journey time) can enable intelligent and appropriate travel decisions to be taken with ease before and during the trip.
Jennie Martin *ITS UK*

A Absolutely yes. ITS can help by better matching supply and demand, informing travelers and by linking between modes. Unless people are educated and shown new ways of traveling, they will continue to stick to their normal routines.
Richard Harris *World Road Association*

A Yes, improved user information, such as mobile schedules and real-time bus/train arrival information, makes public transit travel much easier.
Todd Litman *VTPI*

A Today's travelers are more empowered than ever before – because they have access to information and choice. Mobile devices enable people to navigate to where they want to go. It's very exciting to think about where this technology will be in 20 years. You'll be able to move seamlessly between transport modes, payment systems and parking. It's going to be great.
Jim Barbaresso *ITS World Congress*

A ITS can make a difference if we're smart about it. It doesn't work having a static sign advising drivers to take the train, they need to know real-time information, such as where they can park, how much it costs, and when the next train is.
Edmund King *The AA (UK)*

A ITS can deliver mild or strong demand management, which eventually filters through as a mode choice.
Eric Sampson *ITS UK*

> "ITS can affect modal choice by providing suitable information at or before the decision time"
>
> **Peter Jesty** *transportation consultant*

Q Will our love affair with the car ever fade?

YES

A It already has faded. Many young people are being drawn to cities where cars are more of burden than a symbol of freedom. Autonomous vehicles will further lessen the love affair, as cars will just be seen as a way to get from A to B.
Bernie Wagenblast *Transport Communications News*

A Of course. Our love affairs with horse and cart, trams and mule trains are over, and walking has not been considered a serious option in the developed world for years. There is no final, optimum transport solution, as there is no final, optimum answer to any human need.
Jennie Martin *ITS UK*

A Many of the younger generation do not have such a love affair – it's all too expensive, especially with the current cost of housing.
Peter Jesty *transportation consultant*

A For many people, the love affair is just a practical relationship of convenience. Cars are useful and so will not disappear, but per capita motor vehicle travel is declining. This will continue.
Todd Litman *VTPI*

NO

A There is so much investment in car transport by individuals and the community, so we cannot afford to dramatically change this in the short term. In low-density urban and rural areas, the car is the most appropriate and cost-effective means of transport.
Phil Charles *University of Queensland*

A The personal motor vehicle is highly correlated with affluence. Consequently, personal mobility will continue to be highly valued and that means individual motor vehicles. This will still be true if and when fully autonomous vehicles become a reality.
Robert Poole *Reason Foundation*

A Our love affair will change, but it won't end. The friendly box on four wheels waiting outside your house has enhanced many of our lives. Sometimes we take the car for granted or just talk up the negative aspects, forgetting how it enhances our mobility.
Edmund King *The AA (UK)*

A It will diminish but never end, as every 18 years there is a generation refresh and a new batch of car enthusiasts appears.
Eric Sampson *ITS UK*

Q The rapid changes in technology we've seen will only accelerate over the next 20 years. How will that affect the quality of our lives and general economic prosperity?

A Economic prosperity will only be enhanced if we are successful in both unlocking the community-wide benefits of ITS and breaking the link between economic activity and transportation.
Richard Harris *World Road Association*

A If we are smart, we should be able to use technology to counter congestion and hence boost economic prosperity. Drivers want more reliable and predictable journeys. Connected cars should help drivers plan journeys at the best times and warn them of any problems in advance.
Edmund King *The AA (UK)*

A It should make it better, but I have a horrible feeling that we will soon have a period of 'nastiness' due to the misuse of the internet. In the early days of the World Wide Web, I remember reading of a proposal to have (at least) two internets: one for domestic use (with little security); and one for commercial use (with lots of security – and would cost money to use). This made a lot of sense to me, but those who controlled the internet at the time wanted 'total freedom' for everybody, so this is what we have got. I feel very uneasy about what we have and every time I use the internet, it is with great trepidation.
Peter Jesty *transportation consultant*

A Information can address some problems (such as providing real-time information on traffic conditions and facilitating car sharing) but not others. I am skeptical that autonomous vehicles will actually reduce traffic congestion or greatly increase traffic safety. Some of the greatest potential benefits, such as more efficient pricing, will be difficult to achieve due to privacy concerns and political opposition.
Todd Litman *VTPI*

70%

The proportion of the world's population who will live in urban areas by 2050, according to the UN

Q How will funding for transport develop over the next 20 years?

A The only way will be road-user charging. The funding of our current transport infrastructure is archaic; we send the wrong price signals and depend too much on the political process to budget our mobility assets. The next 20 years has to see the progression to a more rational 'utility' model. Charging by type of vehicle, distance or engine run-time has come of age. We are poised with the technology and capabilities to implement a system that is respectful of privacy, while collecting revenues to sustain our transportation system in the future.
Jack Opiola *D'Artagnan Consulting*

A Funding should transition from per-gallon taxes to mileage-based user fees, but this is unlikely to result in a single system for all vehicles on all roads. The most cost-effective and privacy-friendly approach will consist of two systems. One, based on inexpensive transponders, will be used for AET on limited-access highways. The second, for all other miles driven, can be an annual odometer reading with a per-mile charge based on vehicle class. This could be tied in with existing vehicle registration fee payments.
Robert Poole *Reason Foundation*

A The toll sector is working toward a 2016 deadline for interoperability. It will probably be able to meet that deadline – albeit with some cobbled-together arrangements. Tolls can also be used to make other roads self-financing. Road pricing will be more palatable if it's linked to apps that optimize routing based on real-time traffic data. Florida's Turnpike will have premium-priced lanes alongside flat-rate toll lanes. This could be a prototype of the future.
Peter Samuel *Tollroads News*

> The funding for transport is moving toward 'user pays', as a distance charge and a loading for areas where demand exceeds capacity at certain times and locations
>
> **Todd Litman** *VTPI*

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Q What impact will automated vehicles have on the future of transportation?

A Surface transportation in the future will be more like air transportation. Most people travel by air in an organized, cooperative system; there are comparatively few private pilots who own and operate their own aircraft. Similarly, most of us will use self-driving vehicles that are subscription-based. Some will have private cars that – like airplanes – must conform to the rules of the road that support the organized, cooperative system. Cars, as we know them today, will fill a niche for automotive aficionados. Furthermore, roadside hardware will become unnecessary; pavement and bridge design will change as cars become lighter and freight movement shifts. In the short term, self-driving cars will look like regular cars. In the long term, the form of a car will be freed from history (just as current cars only slightly resemble a carriage). We're in for an amazing ride.
Shelley Row *transportation consultant*

A Eventually, there will be some improvement in traffic congestion on limited access highways in city areas. There will also be some extension of commutes, as people find they can do other things as their car drives them to work. However, the impact of autonomous vehicles will be limited for a long time.
T Russell Shields *Ygomi LLC*

A They could reduce collisions but at the cost of slower flows. If shared, rather than owned individually, they could reduce congestion by lowering the numbers of vehicles on the road.
Eric Sampson *ITS UK*

A You will have a chauffeur. Your kids will have a chauffeur. Your chauffeur will always arrive within a few minutes. You will be dropped only steps from your destination. Parking facilities will both shrink and shift away from city centers, increasing the vitality of the city.
Richard Bishop *Intl. Taskforce on Vehicle-Highway Automation*

A They will reduce insurance claims for low-speed shunts.
Edmund King *The AA (UK)*

A They'll reduce the need for vehicle ownership.
Richard Harris *World Road Association*

A Some technologies, like improved navigation and automated driving on highways, will be deployed over the next 20 years, but it will be longer before driverless cars are fully operational.
Todd Litman *VTPI*

How will we get around?

The future of mobility, it is widely agreed, is autonomous. But just how long will it take us to reach the 'driverless utopia'? And how will different modes of transportation become more integrated with each other as the years roll by? Members of our anniversary panel reveal their answers...

Q How will transportation agencies integrate their systems and services with rapidly evolving vehicle systems?

A Within a few years, most cars sold in developed countries will have internet access. Public agencies should get their information 'out there' by uploading key data to the cloud so intelligent vehicles can download and adapt to it. This is important for workzones. For instance, how are lanes marked in the workzone: concrete barriers, cones, or by other means? This will help onboard sensor systems immensely. This imperative to 'upload' also applies to traffic signals. In the automated future, cars should be able to download signal phase and timing information several seconds before arriving at an intersection, in order to best adapt speed and route. Demand-responsive signals present some challenges here, but even brief advance notice can be helpful. Traffic signal data based on I2V communications will remain important for safety, but there is no reason not to have similar information available for eco-driving and navigation.
Richard Bishop *International Taskforce on Vehicle-Highway Automation*

A We need more communication between industry and transportation owners, as it's hard for agencies to plan when so much about autonomous vehicles remains unclear. Will automated vehicles begin on controlled access roadways where conflicts are few but speeds are high? Or will they emerge in downtown areas, where conflicts are high but speeds are low?

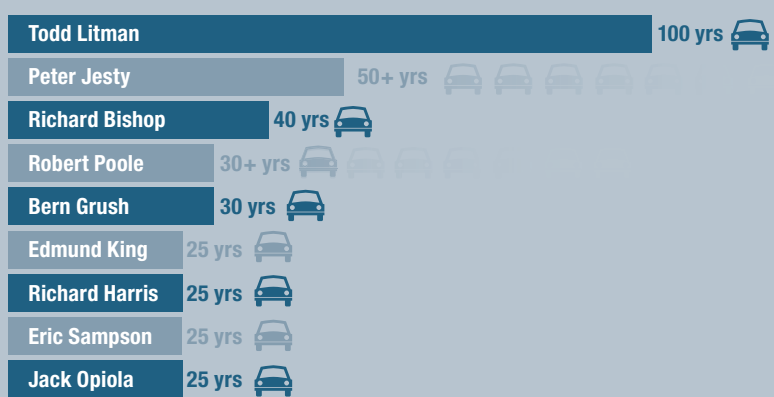
Major vehicle fleet changes will occur within the current public agency planning horizon. For example, a 20-year long-range plan is likely to include investments with 20- to 40-year lifespans. But change is happening so rapidly that flexibility is needed in order to adjust.

As navigation, transit and parking apps continue to spread information and enable personalized decisions, governments will have less and less control over transportation behavior. Influencing decisions will be the best option. They need to trust that reasonable people will make reasonable choices and give them the information they need to make those choices.
Shelley Row *transportation consultant*

A Public agencies will need to develop regulations and standards that must be met by autonomous vehicles in order for them to operate safely on public roads. They'll also need to determine which technologies should be applied, and at what point (if ever) some traffic lanes should be reserved for connected vehicles.
Todd Litman *VTPI*

> There will be increased deployment and sharing of collected data to help unlock community-wide benefits
>
> **Richard Harris** *World Road Association*

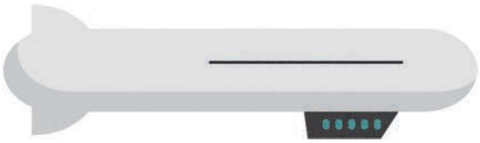
Q How many years before most (80%) of the vehicles in the fleet are autonomous?



Q What do you recommend that the 2016 NHTSA V2V regulation should include?

A There should be a certification process for the positioning that guarantees the accuracy of all devices.
T Russell Shields *Ygomi LLC*

A Collision avoidance based on swapping GPS location fixes seems too slow to be reliable. NHTSA should not ignore infrastructure – V2I should be mandated as well.
Eric Sampson *ITS UK*



Q Will autonomous vehicles help us in the goal of achieving Vision Zero?

A Automated vehicles will have very little impact on safety.
T Russell Shields *Ygomi LLC*

A In one sense, automated vehicles are the best solution for Vision Zero, but this assumes we will get all the engineering 'correct'. We probably can, but you cannot legislate for the idiot.
Peter Jesty *independent traffic specialist*

A Autonomous vehicles will reduce some risks, such as driver error, but will increase others, such as crashes caused by software or sensor error.
Todd Litman *VTPI*

A Connected vehicles could deliver 85% of the gains more quickly, more cheaply and, for the average driver, more acceptably.
Eric Sampson *ITS UK*

A The solution for approaching Vision Zero is already here – crash avoidance systems. The sensors and intelligence in these systems form the foundation for automated driving, but automated driving is a very different animal. Crash avoidance systems are 'always on' and assist the driver in a rare, safety critical situation; they are for when things go 'wrong'. Automated driving systems, which may or may not be activated by the driver, are about automating normal driving, where nothing is actually 'wrong'. If every vehicle on the road were to be equipped with the crash avoidance systems currently on the market – automated emergency braking, lane departure avoidance, pedestrian avoidance and more – we would see the crash rate plummet rapidly toward the zero mark.
Richard Bishop *International Taskforce on Vehicle-Highway Automation*

2020
Nissan's target date for making a self-driving car available to the public

Q Where do you see connected mobility in 2034?

A Connectivity will facilitate people to make informed choices concerning the modes of transportation they use and it will facilitate its usage in the context of access and/or driving. Mobility will be more comfortable, safer, more environmentally friendly and more reliable than ever before.
Hermann Meyer *ERTICO – ITS Europe*

A Drivers will have to be prepared to surrender some of their freedom to drive as they wish in order to ensure a better average trip for everyone.
Eric Sampson *ITS UK*

A I suspect they'll only have limited applications, since many potential benefits (easing congestion, eliminating traffic signals) require that road systems be dedicated to such vehicles.
Todd Litman *VTPI*

Q What are the next steps we should take toward self-driving vehicles?

A The best way forward for autonomous vehicles is evolutionary: prove out individual driver-assistance features for safety and reliability on a large scale, before even considering full automation with the driver in place as back-up.
Robert Poole *Reason Foundation*

A It is important to understand this is a market-driven activity. The public sector role is limited. The regulatory environment in the USA, in particular, is conducive in this respect. Federal regulators must ensure automated vehicles do not endanger passengers or others, and they are working with the car industry in this regard. This has spurred important government-funded research. However, market forces are sufficiently strong that increasingly capable automated vehicle products will continue to roll out. So the important focus is on the market itself – how will people receive new systems? The media indicates the current view is quite positive. Assuming there are no mishaps with automated vehicle testing on-road, I expect this to continue.

With automated driving, we must understand a fundamental point – none of the automotive innovations in past decades have offered the driver the opportunity to reclaim productive time (by not driving). Given how much people value their time, this is very important and could affect uptake significantly.
Richard Bishop *International Taskforce on Vehicle-Highway Automation*

A Vehicles with automated driving capabilities will be available early in the next decade. Slowly, capabilities will be added for other areas.
T Russell Shields *Ygomi LLC*

> As most drivers are reluctant to give up control of vehicles, semi-autonomous cars will be the way forward
>
> **Edmund King** *The AA (UK)*

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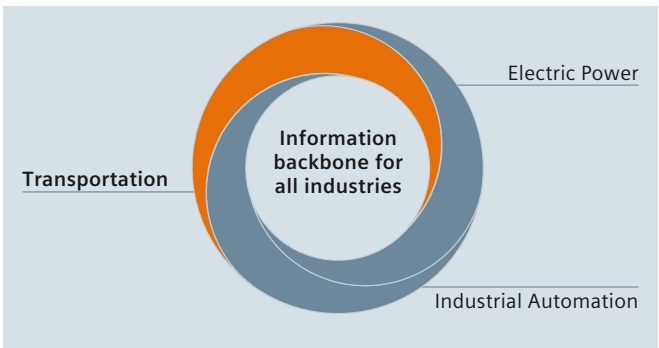

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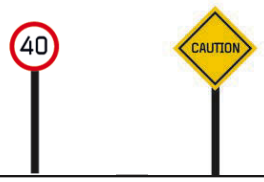
Challenges ahead…

One thing is for certain, the journey to a more efficient transportation system will not be smooth. Our panel predicts the roadblocks ahead

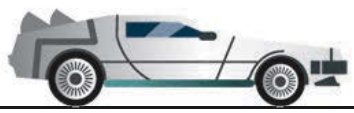


Q It took 15 years for route guidance to go from concept to mass-market. How do we get better at advancing technology that really improves transportation?

A When it comes to innovation, a decentralized, localized approach pervades transportation. Each US state does things a bit differently, as does each city. An innovation that finds a foothold in one agency must start over in another. That repetition makes innovation slow and costly and as an organizational habit no longer serves in a rapidly changing environment. Today, ideas emerge from neighboring jurisdictions and other sectors. We must create a new habit of being willing to try new things.

I remember my first trip to the Consumer Electronics Show in Las Vegas. I was running the ITS program for the USDOT and thought I was forward-looking. I couldn't have been more wrong. CES changed my view and it was about time. It is easy to get caught up in doing the daily list of activities and forget to look to the future. Perhaps we need to make time to participate in events in other industries, engage in dialog with those outside transportation, and give ourselves the freedom to imagine.

Shelley Row *transportation consultant*



Q What are the biggest challenges of the next 20 years?

A Funding. Pure and simple. Today's funding is archaic. There's little connection between the funding necessary for maintenance and budgets allocated. For years we have been given a budget and told to do the best we can. Fifty years ago, new infrastructure and interstates needed little maintenance. But traffic grew, while funding was cut. In the US we don't have the money to regenerate our network. The Highway Trust Fund is broke and all Congress sees fit to do is push the problem forward by spot transfers, making it solvent for another six months. Reliance on gas tax is misplaced. It is an anachronism in the age of increased fuel efficiency, hybrids and electric cars.

In parallel, fuel prices increase as worldwide demand rises. Under the outdated fuel excise taxes, fewer people will be paying more, creating an inequitable situation in our societies. The amount collected to maintain our transportation network is still shockingly short. We need to switch to a different paradigm. We need to switch to a road usage charge where distance traveled (and weight for haulage) are charged their fair share. So, no matter what type of drive train your car or truck employs, you are paying for the transportation network just like we pay for other utilities – power, water and gas. It is time to shift to a utility model in our transportation system before it is too late. We can squeeze maybe 10 more years out of the gas tax, provided we have the political will to increase it. But it is not a long-term solution. In the next two decades, we need to shift to a road usage charge and charge all vehicles their fair share.

Jack Opiola *D'Artagnan Consulting*

A The major challenge will be applying new toll collection technology to the existing highway network. There will be new highways in a handful of above-average growth states in the US. But with per-capita driving flat, the big effort needs to be in maintaining and improving the existing network. Gasoline tax will decline as a source of revenue and various kinds of fees for use will replace that and help manage traffic with variable pricing.

Peter Samuel *Tollroads News*

A Automation could change the way we build highways. What will the standards be in the future in an automotive world where cars won't crash? Will we need 12 foot lanes? Doubtful. We will fit many more vehicles into the existing footprint. And what about cars? Will they need windshields and headlights? The car could look totally different from what it is today.

Jim Barbaresso *ITS World Congress*

A Vehicle safety technologies, such as autonomous emergency braking (AEB), have the potential to greatly reduce the occurrence and severity of crashes. Unfortunately, they often take years to become available, and even then are optional extras rather than standard. Governments need to support the development and implementation of new technologies through legislative reform.
Brian Negus *ITS Australia*

A I'm not convinced we can ever be reliable at picking and backing winners. The best thing government can do is sponsor trials, so good ideas have a chance to be seen and assessed without going through the cost-benefit calculation. We need to accept more risk: half of new ideas will not make it to production.
Eric Sampson *ITS UK*

A Over the past 15 years, the absolute control of all aspects of transportation by government agencies has been diminished, particularly in recent years with the increase in smartphone ownership and the rise of social media. Monitoring developments is critical: facilitating rather than trying to control them. Recent examples of car sharing by Zipcars and ride sharing by Uber illustrate how the market will challenge traditional transportation.
Phil Charles *University of Queensland*

A Transportation is complicated because it is co-supplied by users, businesses and governments. Progress requires cooperation.
Todd Litman *VTPI*

Q What are the barriers to implementing transportation system improvements?

A In the USA, the biggest barrier is not technological but political. It is increasingly difficult for transportation funding to be passed in Congress. While it used to be a bipartisan issue, transportation has become just a player in a bigger battle between two widely different visions of the role of government. States will have to take a bigger role in funding.
Bernie Wagenblast *Transportation Communications News*

A It can be difficult to deploy new technologies that require public and private cooperation. Many technologies require information that can only be collected by governments, but we are seeing cutbacks in national censuses.
Todd Litman *VTPI*

There are far too many transport-decision authorities in the UK – around 320. Consequently, expertise is thinly spread. The policy of 'localism' is flawed for transportation. Bigger units are needed to remove local squabbles and to streamline planning, procurement and the deployment of experts. We need a radical shake-up of local government.
Eric Sampson *ITS UK*

Disruptive trends

Shelley Row predicts rapid change that could send us off-course

Investment
At best, it is awkward to make sound investments during times of rapid change. At worst, change is not considered at all. The risk is that big dollars will be spent on expensive infrastructure/systems that will have an unusually short life.

Data & Privacy
The emerging generation of transportation technology creates and feeds on data. How will evolving privacy concerns affect us? Are we watching and ensuring/safeguarding our needs? How will this impact on connected vehicles?

Regulation
Über's disruption of the taxi industry calls into question the value of regulatory structure. Consumers vote with their money. It appears they do not place commensurate value on the extra safety afforded by regulations.

Personalization
Increasingly, services are customized. Superstores mine data and customize mailings. This approach contrasts sharply with public agencies' one-size-fits-all traveler info. Can public agencies evolve to provide a personalized approach?

By **2017**, the number of smartphones in the world is expected to top

3 billion

(IBM)

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In an ideal world…

We're all entitled to our dreams… Our panel share their specific wishes for the future of transportation

Q What roles will walking, cycling and public transport play in future mobility?

A All will play an increasingly important role. We're already seeing new facilities that take pedestrians and cyclists into consideration, and existing facilities are being adapted to better serve both groups.
Bernie Wagenblast *Transport Communications News*

A Pedestrians need more consideration. We have seen backward steps recently – streetlights have been turned off at night in places where people walk. This is dressed up as an environmental measure, but is pure cost-cutting. The future of public transport, meanwhile, depends on private funding and imagination.
Edmund King *The AA (UK)*

They will hopefully play a much greater role and with more separation.
Peter Jesty *transportation consultant*

These are all essential components of an efficient system. Now that automobile travel has peaked and demand for other modes is growing, it's important to devote more resources to these options.
Todd Litman *VTPI*

3.3m
The target (in millions) for the number of electric cars on US roads by 2025 (Multi-State Zero-Emission Vehicles Action Plan)

> Cities in 2034 will be a mixture of public transport, cycling on segregated lanes and walking, with use of private vehicles hugely reduced
>
> **Eric Sampson** *ITS UK*

Q If you were designing a city from scratch, how would you manage the traffic?

A I would use only roundabouts and yield signs, no signaled intersections and no stop signs. I would set speed limits low – 15mph on most streets, 25mph on arterials. I would separate bike lanes. I would use speed cameras and send graduated speeding citations automatically, allocating 100% of net revenue to children's charities. I would use only machines to measure speed and distribute fines to avoid human error. The cost of traffic control would be borne by drivers – non-drivers see neither cost nor benefit from the citation system. Of course, this will go away with the arrival of autonomous vehicles.
Bern Grush *GNSS RUC consultant*

A It would be truly multimodal. I would use pricing and regulations to give more space-efficient modes (buses and HOVs) and higher value trips (commercial vehicles and urgent errands) priority in traffic. I would use technology to help users navigate.
Todd Litman *VTPI*

A I'd keep all private vehicles out of the city center during daylight hours (including delivery vehicles) and have a fast, cheap public transport network connecting the city's key locations and joining the center to out-of-town park-and-ride and rail services.
Eric Sampson *ITS UK*

Q How do you solve a problem like congestion?

A Technology has the potential to ease congestion by improving the way we manage mobility, and telematics will play an increasing role in providing safer and more efficient use of networks. Connected vehicle applications that inform drivers about road conditions, emergencies and the proximity of other road users will be a major thrust. Governments should invest in trials of this technology and engage with the private sector to develop and roll out real-time multimodal traveler information and trip planning tools so that people can make informed choices about when, where and how they travel.
Brian Negus *ITS Australia*

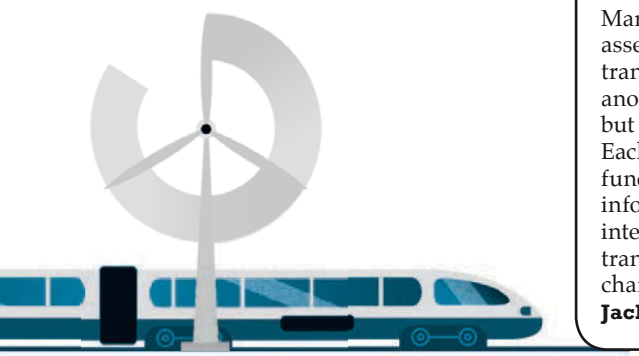
A You cannot solve congestion, you can only mitigate it. Congestion is an index of poorly managed demand. To address this, elected politicians should be removed from municipal transportation oversight and replaced with better demand managers. Road pricing is the gold standard but autonomous vehicles will arrive sooner. AVs will have to be tracked, so the cost of pricing systems can be reduced to the current cost of collecting fuel duties. In the meantime, we should stop studying road pricing and forward autonomous vehicles with investment in policy, trials and infrastructure.
Bern Grush *GNSS RUC consultant*

A Persuade drivers that there is a better way to allocate road space than queuing for it, coupled with road-user charging.
Eric Sampson *ITS UK*

> My biggest wish is to reduce accidents to zero. Technically we are far advanced, but there is still a lot of work to do on standardization, policy framework, HMI and deployment strategies
>
> **Hermann Meyer** *ERTICO – ITS Europe*

757

The hours saved, in millions per year, due to reduced traffic jams, if 10% of lone drivers in the US shifted to car sharing (Deloitte)



Q What are your wishes for future mobility and what are the biggest challenges ahead?

A 'Complete streets' with pavement given over to pedestrians and cyclists. Most Americans won't give up their cars. Indeed, as we approach self-driving vehicles, more people will be able to use motor vehicles. But there's a movement toward local street commerce and working wherever there's a wi-fi connection. Traffic flows may be less peaked and in some places may decline.
Peter Samuel *Tollroads News*

A My main wish is that we acknowledge transportation as a mobility network that can be self-funding and self sufficient. Many people still see transportation assets as silos: rail is one silo; public transport is another; and the roads are another. These divisions are historical, but in today's world they are a disservice. Each silo fights over customers and funding, and fails to integrate schedules, information and performance. It's time to integrate our resources. The transportation network should then be charged like a utility.
Jack Opiola *D'Artagnan Consulting*

A My greatest hope is that we will figure out how, politically, to reduce chronic traffic congestion in urban regions. The best way to do this is with variable pricing. Willingness to pay varies enormously, so there is no one-price-fits-all during peak periods. The most practical approach is two-tier pricing, with regular lanes having some kind of peak/off-peak price difference and premium lanes charging market-clearing (no-congestion) prices. The best opportunity to implement a system such as this is as part of the transition from per-gallon taxes to per-mile charges.
Robert Poole *Reason Foundation*

I hope we develop a really sensible understanding of when travel is necessary and when it's not.
Peter Jesty *transportation consultant*

My main concern is that new technologies will focus on increasing motor-vehicle traffic rather than increasing overall system efficiency.
Todd Litman *VTPI*

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The rebirth of Motor City

It is no coincidence that this year's ITS World Congress is taking place in Detroit, Michigan. As **David W Smith** discovers, the state is at the forefront of futuristic transport innovation

Detroit is famous as the birthplace of the automotive industry, but the city's iconic car manufacturers can no longer rely on their glorious past. Innovation is the only way to stay ahead of global rivals. The near-collapse of the Michigan car industry after the 2008 financial crisis was a wake-up call. Sales plummeted and only an US$89bn government bailout saved General Motors and Chrysler from bankruptcy.

The automotive industry is of one mind in believing that the next step will be driverless cars, and Detroit is positioning itself to dominate the market. An essential component of the evolution of these vehicles will be testing the various technologies required. To this end, the University of Michigan (U-M) is building a sophisticated US$6.5m 32-acre autonomous vehicle test site on its North Campus.

"We're simulating dense and complex urban situations as they're the most challenging for automated vehicles," says Peter Sweatman, director of U-M's Transportation Research Institute.

"We've installed signalized intersections, building façades and mechatronic pedestrians emerging from behind parked cars. The goal is to reduce risk by doing as much testing as possible off roadway."

General Motors, Ford and Toyota have all signed up to an inner circle of 15 manufacturers with full access to the Mobility Transformation Facility (MTF), which is part of the newly formed Mobility Transformation Center (MTC). This privileged group also includes the ITS providers Econolite and Xerox. A larger group of affiliate members will have restricted access. A company wishing to test-park smart sensors, for example, would not need full membership.

"We see it as an opportunity to provide thought leadership," explains Sweatman. "There will be a lot of technology testing, especially of sensors, but circle members will also discuss bigger questions about how automation and connectivity will be deployed on a large scale. There will be lots of policy questions relating to liability and insurance, as well as payment systems and who will operate them. Joint tests will sometimes be necessary to confirm the interoperability of vehicles and infrastructure."

The Michigan Department of Transportation (MDOT) is sharing costs with U-M and will be an important voice in the debate. The MDOT will be able to enter discussions about infrastructure needs with the manufacturers, as well as doing some of its own testing.

"We can test, for example, different paint systems without having to put them on miles and miles of freeways, only to find they don't work," says the agency's director, Kirk Steudle. "Or we can experiment with putting RFID chips in the paint lines."

Michigan is well placed to lead the driverless revolution. The state has 450 research and development facilities within 150 miles of Detroit. "It is the global center of R&D and has bounced back well from the crisis," says Steudle. "As the place that put the world on wheels, we want to be sure we're the one to reinvent the industry."

Data and development

Daniel Flores, manager for GM communications, says that the MTF will trial both automated and vehicle-to-vehicle (V2V) technologies. The convergence of the two will be essential for driverless cars to function safely. "Most automated technology is based on sensors, cameras and radars," he explains. "They enable the car to see what's going on around it and, as the sensors get better, GM and makers will be able to give the cars greater ability to make decisions on their own."

(Right) **Cadillac's Super Cruise system is capable of semi-automated driving including hands-off lane-following, braking and speed control under certain driving conditions** (Below) **GM's V2V-equipped Cadillacs are capable of warning drivers of potential danger** (Bottom) **Michigan is rapidly becoming the world center of mobility research**

> Detroit is the global center of R&D and has bounced back well from the crisis. As the place that put the world on wheels, we want to be sure we're the one to reinvent the industry
>
> **Peter Sweatman, director of U-M's Transportation Research Institute, USA**

"But V2V is equally important," he continues. "All auto makers involved in the U-M project are developing V2V technologies and hoping to test them out. With V2V, the car has a radio transponder that broadcasts information about where it's going and how fast, 10 times a second through a dedicated frequency. As the technology permeates the marketplace and all cars begin to communicate, it will make cars safer, which is the crux of it."

The U-M researchers will be able to analyze a wealth of data about connected vehicles gathered from the US Department of Transportation's (USDOT) Connected Vehicle Safety Pilot project, which is based in Ann Arbor. In partnership with the Michigan

DOT, U-M is road testing up to 20,000 intelligent vehicles interconnected with wi-fi to check the technology's practicality in traffic. Hundreds of connected intersections all over Michigan – many of them at accident blackspots – will also collect information about vehicle-to-infrastructure (V2I). Some of this roadside infrastructure will be on show at the 2014 ITS World Congress in Detroit. After the congress it will be redeployed on the roads.

Sweatman sees the dedicated short-range communications (DSRC) used in the pilot project as an effective and affordable method of getting data. "We need to think about the DSRC connection between vehicles and infrastructure as another sensor – the best one in the car – which sees around corners, or past the vehicle in front, and the one in front of that, to the next one," he suggests. "It can also reach inside those vehicles and tell you what's happening, such as whether a vehicle is braking around you. The secret to getting automation to work quickly is to have a connected environment using DSRC. That's why the safety pilot was so important."

Seeing the future

A critical aspect of automated technology will be visual computing, which processes incoming sensor data using complex algorithms. Danny Shapiro, directive of automotive at technology company Nvidia, says his company's graphics processing units (GPUs) enable the processing of hundreds of distinct objects simultaneously.

IMAGES: JURIY/SHUTTERSTOCK

Although Nvidia is not yet involved with the U-M project, the company is working closely with Audi on its driverless car technology. "The algorithms are extremely complex and detailed in order to take into consideration unpredictable factors, which may be immobile obstructions such as potholes, as well as moving objects such as erratic drivers, where instant decisions must be made," Shapiro explains. "This is why real-time processing is so important."

Shapiro says that three critical elements must be resolved by the companies that supply car makers with these important technologies. "First, we need high-performance processors with supercomputing capability in a low-power package," he begins.

(Below right) **Nvidia's Tegra K1 processor will drive camera-based, advanced driver assistance systems (ADAS) – such as pedestrian detection and blind-spot monitoring**

"Second, we need a modular system design with ease of programmability. Third, the technology companies must provide a safety-critical virtual cockpit, or cluster, acting as a point of aggregation for the driver. Without these three elements, car makers will be stuck with great racks of expensive desktop computers in their piloted cars."

The beginnings of full-scale autonomous driving are already seen in cars. Pedestrian detection, lane departure warnings, assisted parking and speed-sign detection are small steps toward a fully autonomous driving experience. The driverless car will emerge incrementally from such technologies.

GM's Cadillacs are one example of cars using semi-autonomous sensors. "If

The next steps

U-M facility is the ideal place for further tests and research

Hideki Hada, Toyota's general manager of integrated vehicle systems in the USA, says that a long list of potential research projects could be created for the U-M test facility.

He suggests that it would be a good place to trial onboard sensor detection, or the performance of a new traffic control system. For example, can a new onboard camera see the signal? It would also be an ideal place to test V2I communication between a prototype traffic signal and production-level vehicles, as well as a test bed for lane marking or delineators.

Tests at the facility could determine the impact on traffic flow and dynamics when an automated vehicle is driven among manually driven vehicles. This would be accompanied by behavioral research of driver actions and reactions during automated driving.

Interaction between pedestrians and vehicles involving pedestrian collision avoidance systems (in-vehicle and intersection systems) could also be tested.

The test facility would also be an ideal location to evaluate V2V wireless (DSRC transceiver) performance.

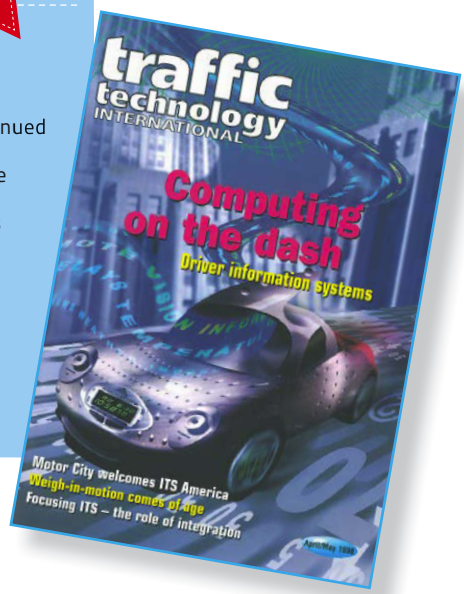
Innovation hot spot

Michigan and Detroit are steeped in ITS history

It's not the first time the ITS industry has visited Motor City. ITS America's 8th annual meeting also took place in Detroit, back in 1998. In our April/May issue that year, former editor Ian Nuttall spoke to then congress chairman Brent Bair in an article entitled *Hitsville ITS*. The article, which described the city as "one of the hot spots of ITS activity in the world", identified the numerous ITS advances taking place in Detroit and the wider Michigan area. They included real-time adaptive signal control, video detection, weather monitoring, GPS-vehicle tracking, dynamic route guidance and radio data system (RDS) applications, among others.

Bair explained that the University of Michigan championed RDS and was involving other industry authorities in a wide-scale test of the technology in the metro area.

Michigan has continued to serve as a test bed for innovation over the ensuing years, and although autonomous vehicles were but a dream in 1998, the stage was already set for the 2013 announcement from U-M that is was going to pursue testing of driverless cars.



(Above) **In April 2014, Google announced that its vehicles had logged nearly 700,000 autonomous miles**

> Do we allow cars with no humans inside to be tested? At the end of the day it is all about safety, as a serious incident could kill the industry
>
> **Kirk Steudle, state transportation director, Michigan DOT, USA**

the driver is doing 75mph and the car in front is doing 60mph, 'collision-imminent braking' means that the car will slow down automatically," explains GM's Flores. "Or, if a car is reversing and fails to notice a pedestrian on the sidewalk because of a big hedge, the Cadillac's 'safety alert seat' will send a warning vibration that the driver can feel in his legs and bottom."

The G factor

In contrast to the manufacturers involved in the Detroit project, Google has already tested driverless cars that are Level 4, meaning they drive on roads without human control (although laws decree that a driver must be on board at all times to take ultimate responsibility should something go wrong). Google's seemingly advanced stage of testing does not necessarily mean, however, that the company is further ahead than its rivals.

The Google cars are still some way from full autonomy. They have not traveled on open roads, but only along meticulously mapped streets. The cars are programmed with tiny details about the prescribed routes, such as the position and height of every curb. Computation takes place remotely and, although results have been impressive, the cars are not reading random urban environments spontaneously.

To date, testing of driverless cars is permitted in the states of Nevada, California, Florida and Michigan. But the Michigan legislation, which Governor Rick Snyder signed last December, does not allow Level 4 automation. "We've issued 28,000 manufacturers' license plates in Michigan for driverless cars," says Steudle. "The legislation requires us to come back in two years and say how the industry has developed. Do we allow cars with no humans inside to be tested? At the end of the day it is all about safety, as a serious incident could kill the industry."

To hasten the process of getting the technology up to the desired levels, Steudle says that more test facilities are needed. Other sites have been mooted. General Motors' former Willow Run plant – where bombers were made in World War II – is being redeveloped as a connected vehicle research center.

As for the University of Michigan's site, it is due to open in time for the start of the ITS World Congress. "We wanted to bring the congress to Detroit to show others the new direction of the automotive industry," says U-M's Sweatman. "In the past we've not always had the high level of automotive industry involvement in the World Congress that we are seeing in Detroit. It will take it to a new level for this region, where we're creating the future of autonomous vehicles."

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Fast forward

Saul Wordsworth finds out how road authorities around the world could benefit from the latest developments in enforcement technology, and discovers what barriers stand in the way of greater speed compliance and safer roads

The speed of technological development means we continue to live in a world where the sands shift under our feet. Nowhere is this truer than in the field of speed enforcement technology. One innovation crosses over with another, only for both to be overtaken by a third. But what of the future? According to Ruth Purdie, manager of leading safe driving organization TISPOL, "Speed enforcement will remain an essential speed-management measure as long as the speed problem is not solved in a structural way by road design, engineering measures or in-vehicle technology."

Let us consider the next couple of years of enforcement, which is likely to be dominated by speed-management processes, before dusting off our crystal ball and gazing 15 years into the future when perhaps in-vehicle technology will predominate.

(Above) **Digital signs inform drivers of variable speed limits on Australia's roads**

"Wet-film cameras are becoming life-expired even if their technology isn't overtaken," says Richard Allsopp, emeritus professor of transport studies at University College London. "In the coming years I would expect to see areas that intend to sustain their camera enforcement, progressively replacing their analog cameras with digital, although not necessarily one-for-one. They'll need to do that if they want to continue. Digital camera reliability is better. Moving to digital is a good barometer of whether you wish to continue with camera enforcement."

Most of western Europe has been fully digital for several years. The UK, however, is a little behind. Two years ago, fixed speed cameras were turned off in Birmingham, but a new trial of digital sites is about to go live. When the fixed cameras were switched off, there was a greater reliance on mobile vans. The new pilot project will mean lower officer and technology costs. However, not everyone sees the future in purely digital terms.

"A lot of cameras in the UK are still film-based and I don't see that changing especially quickly," says Brian Lawton, road safety consultant at the UK's Transport Research Laboratory (TRL). "Obviously the cost of film is cheaper, but I do not anticipate a groundswell of shift. For now, the tendency remains to remove old cameras and not replace them."

International progress

In Australia, the majority of states and territories have already moved to digital. "We are ahead of most, but everyone in Australia is going that way," says Matthew Leyson, manager of safer vehicles and technologies for the South Australian Department of Planning, Transport and Infrastructure (DPTI). "Our cameras now range from 2MP to 11MP units. For us, however, the emerging technology is speed enforcement that relies less on expensive on-road infrastructure and we're working closely with our camera supplier to trial a radar-based speed measurement system. This involves various components, such as mapping radar, and we are moving over to infrared and LED-based flashes to reduce the impact on surrounding neighborhoods. We are also using lower-cost communication systems such as 3G/4G and NextG in lieu of wired ADSL communications."

> For a long time, the technology for average speed cameras wasn't approved in the UK, but now it is; it comes down to how much it is accepted by the public
>
> **Brian Lawton, TRL, UK**

Leyson has also been working on the introduction of average speed cameras, two of which came online for the first time in July this year. "The research undertaken in Europe with these systems

PHOTOGRAPHS: SHUTTERSTOCK

provides promising results with regard to reducing the number of those killed or seriously injured [KSI]," he remarks.

Research by leading traffic controls provider, Vysionics, has shown that, as a result of this technology, the number of KSIs is reduced by 70%, and only 0.01% of journeys result in a ticket. The introduction of such cameras – originally used as a means of slowing down traffic in a workzone – is a move that many agree will shape the coming years of enforcement technology.

Point-to-point enforcement has been trialed in various locations worldwide, including Scotland's notorious 136-mile (220km) A9. The fact that the technology shows high levels of compliance is an excellent counterbalance to suggestions that all cameras are about revenue generation.

"Average speed cameras modify driver behavior," asserts University College London's Allsopp. "The whole question of time-over-distance is an important one as it produces some of the effects you might get with hidden cameras. Risk is distributed rather than situated on a particular bend or village. Spot-speed cameras only have a range of 200m. I anticipate point-to-point cameras finding an increasingly wide application across Europe."

"For a long time, the technology for average speed cameras wasn't approved in the UK, but now it is; it comes down to how much it is accepted by the public," adds Lawton of TRL. "In the

(Above) **Success in Europe with average speed cameras is now driving their implementation around the world**

near future I see them being used more, but not a lot more. It depends where they are located. Generally you need roads without junctions. Areas such as schools and hospitals could become prime locations for deployment."

Historically, mainland Europe has had fewer cameras than the UK – which boasts more than 3,000 fixed units – but over the past decade, it has been catching up.

"With Britain consistently within Europe's top-three safest countries based on casualties per kilometer, there is a tendency for other European countries, particularly the less developed, to copy this approach," says Lawton. Yet it must be remembered that there remain many parts of the western world where no speed cameras are deployed, and won't be for some time.

"In my state, we are prohibited from using speed enforcement cameras," reveals Robert Hull, engineer of traffic and safety at Utah's Department of Transportation (UDOT). "Most of us would be in favor of cameras but the political environment is complex. There's a bit of the wild country about us out here in the west. However, when talking about the longer term, I believe in-vehicle technology is the critical element that will really change things."

Legality and acceptance

In-vehicle solutions of the future pose a different series of challenges. While the technology exists and is often proven, there remain a host of legislative challenges related to privacy and data protection. Black boxes are a prime example.

"Black box technology is already quite active in the UK," says James Bradford, global operations manager for iRAP, the International Road Assessment Programme. "The motor insurance industry sees it as very cost-effective for drivers under 25, as they are able to offer them a 20-30% discount. As a result, there is a marked reduction in claims. I believe the technology will become increasingly prevalent in Europe due to market forces, although it is unlikely to ever remove the necessity for outside enforcement due to the need for external verification."

Such a solution is not for everyone. The use of transponders in Germany, for instance, is contentious in a country already deeply concerned about inside and outside surveillance.

"In Germany we have very strict data protection laws," says Christian Burkhardt, traffic specialist with the Berlin Police. "Any thought about using GPS or a black box transponder is a question of law. Whether anyone will install these is dependent on jurisdiction laws. Right now, we couldn't use such systems."

Much will need to be ironed out in terms of a legal framework and the kind of strong governance surrounding existing solutions before black box technology becomes both ubiquitous and accepted by all. The same is true of autonomous driving, which shows huge possibilities but remains weighed down by potential legal issues, not to mention the matter of liability in the event of an accident.

"Autonomous vehicles will have their speed programmed in, meaning no speeding at all," says Allsopp. "There is no question this is on the horizon, it is simply a matter of how long the technology will take to mature, then be adopted."

According to Allsopp, intelligent speed assistance (ISA) is a proven solution. "A prerequisite is for authorities to produce and maintain up-to-date digital maps of their speed limits," he says. "However, the issue remains that while half of drivers like it, the other half do not."

The speed debate

Speed limits and safety precautions must strike a balance with individual privacy and free will

What speed is safe? It seems that either nobody knows, or is willing to implement it. Two years ago, the British government proposed to increase the speed limit on highways from 70 to 80mph, the argument being that some European highways have limits of 130km/h (approximately 80mph). However, Britain's highways are currently among the safest in Europe, so this would be to argue that safer highways should be given the same speed limit as others that may not be as safe. For now, the government has stepped back from pursuing the increase and is instead chasing a different kind of policy, to reduce the limit on parts of the M3 and M1 and thus lessen air pollution.

There has also been a push from both central and local government in Britain toward reducing speed limits in many residential areas to from 30 to 20mph. Some 20mph zones might be compared to 'home zones' (where pedestrians have priority), which have been used to good effect elsewhere in Europe. Like home zones, 20mph zones can be effective at reducing speeds and hence casualties, but are more expensive to introduce than 20mph speed limits alone.

In South Australia, a number of highways have, in recent years, been reduced from 110km/h (68mph) to 100km/h (62mph), metropolitan areas from 60km/h (37mph) to 50km/h (31mph) and some rural areas from 90km/h (56mph) to 80km/h (50mph).

"We are different to the UK in that we have to travel long distances and local communities have strong views about travel times," says the DPTI's Leyson. "Due to public pressure, the Northern Territory recently ran a 12-month trial with an open limit. We are watching the outcome carefully. All research says it's the wrong thing to do."

According to Ferdinand Dudenhöffer, director of the Centre for Automotive Research at the University of Duisburg-Essen in Germany, the ruling Christian and Social Democrat parties have no interest in implementing any speed limits on the country's autobahns.

"Politicians believe it challenges the interpretation of personal freedom," he says. "However, if you took a poll of public opinion, the majority will say it's not bad to set limits. Sometimes people on the autobahn drive like hell and jeopardize the safety of others."

Last year in the USA, five states raised their speed limits, most to 85mph.

(Left) **New fixed cameras in Australia can operate in a variable speed environment, distinguishing trucks from cars**

"We have been running a few trials in Australia and monitoring the European ISA trials," says Leyson. "We have a number of states with digital speed limit maps up and running and intelligent speed assist programs operating. I think the future is moving this toward ISA and offering solutions to large businesses – providing data for self-monitoring, possibly for insurance companies, just as black box technology is already doing for recidivist speeders."

Beyond that, Leyson sees fixed-enforcement technology becoming near portable, battery based, including wireless identification of traffic signals for red-light offences, and the use of speed-limit zone information from geospatial maps.

"Traditionally you put a fixed camera on site for 7 to 10 years," Leyson explains. "In the future, I see greater ability for the inexpensive rotation of cameras throughout a number of sites, spreading the road safety benefit to many sites rather than just one. This moveable solution could be deployed state-wide and easily include both metropolitan and rural sites with the one camera. Mobile vehicle-mounted enforcement similar to the French system, detecting speeding vehicles on the move in all directions and speed zones, is definitely a possibility."

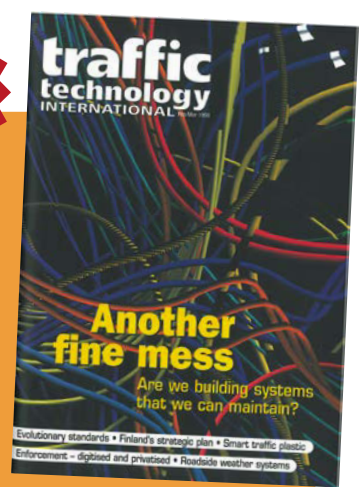
Wise words

Whatever the future holds – black boxes, autonomous vehicles, even a reward system for not speeding – as long as there are drivers with individual free will, there will always be a place for external enforcement.

"Evolution will mean a mixed integration of old and new vehicles," says Lawton. "We may remain in an interim period for a very long time, perhaps never making it 'there', but instead always existing in transition. I don't see a future where every car is autonomous, for instance. Thus the same old enforcement solutions will need exist alongside their more recent counterparts."

"WIM or ISA, black box or autonomous?" says Bradford. "You never know what is going to be popular. It's like VHS versus Betamax – in the end external influences will decide what becomes the technology of choice."

> "In the future, I see greater ability for the inexpensive rotation of cameras throughout a number of sites"
>
> **Matthew Leyson, DPTI, South Australia**



Digital revolution?

There have always been barriers to implementing new technologies

In the February/March 1998 issue of *Traffic Technology International*, Nick Bagot reported on the emergence of digital camera technology for enforcement. "Cameras without film, carriage down a telephone line, and a vastly reduced amount of manpower, mean great cost control," he wrote. "But for the moment, the problems (and the price) are still proving to be a sturdy barrier to their rapid implementation."

In addition to the cost of this new technology, which is described as being "abhorrently expensive", road authorities were also concerned about the quality of the new digital alternative. "Anyone who thinks that digital cameras can simply replace their film counterparts can think again," wrote Bagot, followed by Bill Adaway, managing director of Computer Recognition Systems, who added, "For the equivalent lens, you can get five times the field-of-view with a film camera."

Regulations created further difficulties. "The legislation is not allowing developers to take advantage of the solutions that are already here," reported Adaway.

The capabilities of digital cameras have improved drastically since 1998, but it seems the same legal and cost barriers continue to impede the benefits of new enforcement technologies.

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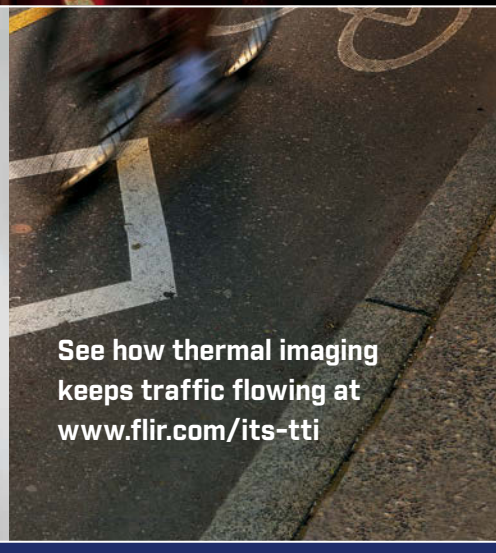

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Data driven

As infrastructure, vehicles and people become more and more connected, the volume of data available for analysis is set to increase exponentially. **David W Smith** investigates how current systems are coping, and how they will need to be upgraded in the near future

Illustration: Infomen

When big data expert Jorgen Pedersen heard that the Ohio Department of Transportation (ODOT) had built a state traffic management center for US$75,000, he assumed it was "rubbish". But when he observed it close up, he was flabbergasted by its efficiency.

Pedersen, VP of advanced technologies for ITS company Iteris, had assumed that good operational centers came at high cost. He was instrumental in planning Transport for London's £5m (US$8.4m) Surface Transport and Traffic Operations Centre (STTOC), so he knew what millions of pounds could achieve. But US$75,000?

"Then I went there and I was blown away," he says." It's one of the best operating solutions I've seen. Ohio has a limited budget and can't afford to pay systems integrators. It has forced them to innovate. Fortunately, they have the right caliber of staff and are making good use of big data."

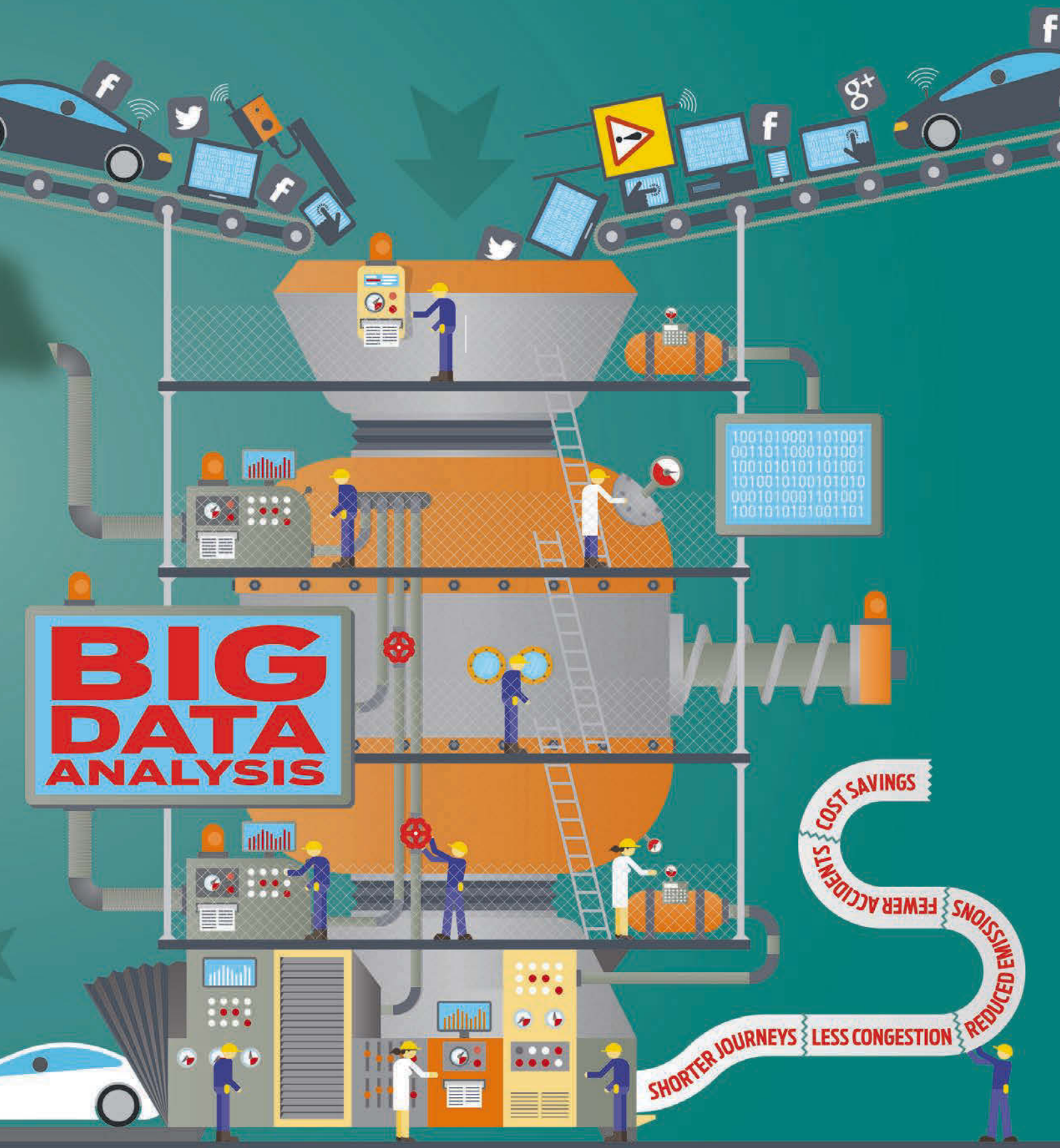
Pedersen, however, says ODOT is a rare exception. Most DOTs, he says, are poorly prepared to exploit the massive on-rush of data. But he does not blame the cash-strapped DOTs, some of whom were stripped of half their workforce after the 2008 financial crisis.

"Most DOTs don't have the in-house expertise and they rely on systems integrators, but they are mired in a dog-eat-dog battle that is not in the spirit of big data," he explains. "Most are only interested in selling more of their own systems. They're not interested in merging data, or collecting other people's data."

John MacAdam, an ITS engineer in ODOT's Office of Traffic, says the state has adopted a different philosophy to many counterparts. ODOT realized early on that big data was the future. Instead of waiting for the Federal Highway Administration to give guidance, the authority instructed its in-house experts to find solutions.

"Management gave us the freedom to experiment and be creative," says MacAdam. "I found it empowering and so did my colleagues. We came up with a number of apps to exploit the data."

ODOT's principle use of big data has been to refine performance measurements. One important application in this northerly state was to evaluate how quickly routes recovered following snow storms. MacAdam wrote a program that inputs data and models snow events to work out whether routes were clear, or still blocked.


BIG DATA ANALYSIS
COST SAVINGS
FEWER ACCIDENTS
REDUCED EMISSIONS
SHORTER JOURNEYS
LESS CONGESTION

"Traditional measures using snow spotters relied too much on human subjectivity," MacAdam describes. "Our program combines speed and weather data to get more accurate information. We built the system in-house and taught ourselves how to handle all the data."

Intelligent management

Inrix provides the historical speed data for all of Ohio's maintenance routes on any given day. The engineers fused it with data from Ohio's road weather information system (RWIS), which gathers information from 174 sensors across 88 counties. "Ohio's weather stations collect things like ground-level precipitation, ground-level temperatures and pavement conditions, or if it's wet and icy," MacAdam explains. "Maintenance managers use it to track storms in their counties and make decisions about deploying resources. But when it's tied together with Inrix speed data, it enables us to objectively rate our performance. This includes comparing different counties, and pinpointing personnel and resource issues. Managers make wiser decisions for spend and hire."

Ohio uses a separate provider for real-time traffic data, California's Real Speed, which has installed sensors on every mile of freeway. This data feeds the state's travel time reliability (TTRI) program at the website OHGO.com. "It's likely we will use one provider for both speed and historical data in the next few years to make it more affordable," says MacAdam.

Budgetary restrictions inspired the decision to have just one state-wide traffic management center based in Columbus.

Previously, Ohio had a huge standalone system in Cincinnati, a second one in Columbus, and four more in smaller cities. They built the center for US$75,000, yet still managed to impress Jorgen Pedersen. "Some DOTs have been slower to streamline operations," MacAdam observes. "But we figured that as data became smarter, we didn't need to have an operator guess what speed the roadway was, or manually find problem areas. Data tells you these things and where to look, so you don't need as many operators or centers."

ODOT's IT department developed a software program for the center, called Buckeye Traffic, that automatically tells operators when something is amiss. "If there's a speed alert, they pull up the cameras and get on the radio with the freeway patrols," explains MacAdam.

Too much information?

More personal data means more pressing questions about privacy

The emergence of big data has brought up major privacy concerns. Companies and governments can potentially get an inside look into personal lives through the collection, processing and analysis of data.

Academics and industry leaders are working hard to understand the challenges and use technology to find solutions. MIT Computer Science and Artificial Intelligence Lab, for example, has set up a Big Data and Privacy Working Group.

Dr Caitlin Cottrill, from the School of Geosciences at Aberdeen University, has written extensively about privacy issues. "Technology is constantly gathering personal data from roadway counters, cameras and sensors about patterns of travel over time," she says. "And there's also personal data from smartphones, smartcards and card readers.

"We need a framework of data protection to look at privacy in the transport context. Federal agencies aggregate data and aren't as concerned about each individual. It's more worrying what might happen to the data afterward. There are a number of private agencies working in the field and data could potentially be sold on when people might prefer it not to be. Also, many agencies are able to gather data without people being aware.

"Policies have to provide adequate precautions around access management and enable personal autonomy over the decision to allow access to the data."

> "As data became smarter, we didn't need to have an operator guess what speed the roadway was, or manually find problem areas. Data tells you these things and where to look"
>
> **John MacAdam, ITS engineer, Ohio DOT Office of Traffic, USA**

Ohio is also building apps for cell phones. The state sees the mobile space as key to the future of transportation. "We're working on an app that enables people to sign up for personalized alerts about congested routes," says MacAdam. "People don't have to come to us; we go to them."

Pockets of excellence

ODOT's ability to develop useful software applications is uncommon, according to Richard Wallace, the director of the Transportation Systems Analysis Group at the Center for Automotive Research (CAR). "State DOTs – aided by the state IT organization, if there is one – tend to have in-house talent on the database side," he says. "But most have far less talent on the application side. The big opportunities for efficiency tend to be on the application side, although poor data structures and back-end systems can make application development treacherous."

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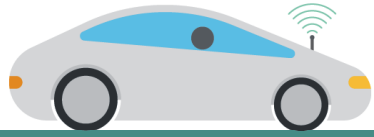


1,150%

The predicted growth of the digital universe in the next six years: from 3.2 zettabytes today to 40 zettabytes in 2020. (One zettabyte is 1 billion terabytes) *(Hadoop Summit 2014)*

12%

The percentage of their data that most companies estimate they're analyzing *(Forrester Research)*

5%

The predicted growth per year in global IT spending *(McKinsey)*

30 billion

The predicted number of wirelessly connected devices by 2020 *(ABI Research)*

1.5 million

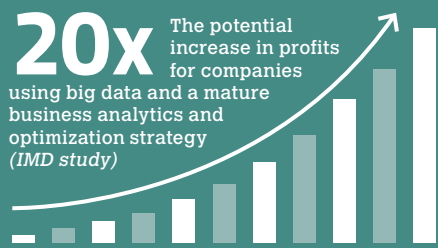
The predicted US shortage of managers and analysts with the know-how to use the analysis of big data to make effective decisions *(McKinsey Global Institute)*

US$50bn

The estimated value of the big data market by 2017 *(Wikibon.org)*

20x

The potential increase in profits for companies using big data and a mature business analytics and optimization strategy *(IMD study)*



152 million

The number of actively connected vehicles predicted to be on roads globally by 2020, generating over 11 petabytes of data on an annual basis, or about 30 terabytes a day *(IHS Automotive study)*

500 MILLION

The number of Tweets sent every day worldwide in 2014 – up from 175 million tweets per day in early 2012 *(Twitter)*

Piyushimita Thakuriah, director of the Urban Big Data Centre at Glasgow University, agrees broadly with Jorgen Pedersen that many DOTs have been slow to exploit the potential of big data. But she argues that in some ways DOTs have been pioneers at collecting large volumes of data from road sensors, or electronic toll card transactions. And that there are pockets of excellence at DOTs.

"I like the overall model of the Chicago Transit Authority," she says. "They have done several things right such as instrumenting their fleet to collect the data and using the 'software as a service' approach to let developers and analysts mine their data. They are fortunate to be located in Chicago, which is well-known in the open data movement with a healthy civic hacking presence using open data in collaborative ways. There is also widespread instrumentation of the city's assets with sensors measuring different aspects that can be connected together."

To date, however, most DOTs have primarily used big data sources for well-defined reasons, such as assessing congestion levels and formulating operational plans, but Thakuriah says the big data debate is moving on swiftly and the ideas of data-driven modeling and knowledge discovery are at the forefront.

"What can you learn from the data with new analytics and mining methods when you look at, say, patterns and trends over a long period of time, or for certain types of traffic?" she questions. "How can you turn that into some sort of value proposition in terms of operational policies or long-range plans?"

DOTs can derive great value from connecting separate data streams to gain integrated insights, and they're are in a good position to do this because they have often archived years of loop-detector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data. "Being able to combine that with longitudinal economic, weather or property transactions can be a really value-added proposition to multiple sectors, including real-estate companies and location-based services," says Thakuriah. "This is the challenge facing DOTs – to decide how their data can be linked to other data. What is the appropriate model for putting a value on the knowledge that comes out from it?"

There are a number of data streams not being exploited fully in transportation planning, including text, multimedia and social media data. "A lot of the conversation in big data is about how to work with such 'unstructured' data by extracting and processing information from them," Thakuriah explains. DOTs are already using cell phones to provide crowdsourced data about incidents, but the potential of Twitter has not been mined yet. "You'd have to have machine-based processes to clean the input stream, recognize exactly what is being tweeted about, and also what is being said about it," she adds. "These processes are not common yet in transportation practice."

A connected future

CAR's Richard Wallace says the potential to extract data from connected vehicles is vast. "Some DOTs, such as Michigan, are already obtaining connected vehicle probe data as part of their highway management and operations area," he reveals. "Electronic tolling, a simple version of connected vehicle (CV) technology generally based on RFID, is widespread. MDOT's DUAP is a systematic effort to develop a data engine for all sorts of connected vehicle data. Automated vehicles promise to expand the potential dramatically. And a V2V mandate will open the floodgates of available data."

> Some DOTs, such as Michigan, are already obtaining connected vehicle probe data as part of their highway management and operations area
>
> **Richard Wallace, Center for Automotive Research, USA**

Tip Franklin, a senior advisor for smart infrastructure at Schneider Electric, agrees that connected vehicles will revolutionize the amount of raw data available. But he argues that few DOTs have adequate filters to make the on-rush of data usable. "Much has been written about the value of the CV in terms of safety," he says. "What I don't see is a parallel discussion of how to best use the data and what must be done by the traffic community to change policies to be able to influence the onboard guidance and information systems of these vehicles to adapt to the activation of incident response plans, or changes in traffic flows."

Carlo Ratti, director of the MIT SENSEable City Laboratory, believes that beyond big data, self-driving vehicles will be a game changer. A recent paper by the Massachusetts Institute of Technology's Smart Future Mobility team shows that the mobility needs of a city like Singapore – potentially host to the world's first public fleet of self-driving cars – could be met with 30% of existing vehicles.

"Researchers found this number could be cut by another 40% if passengers traveling similar routes were willing to share vehicles – an estimate supported by an analysis of New York City Taxis shareability networks," says Ratti. "This implies a city in which everyone can travel on demand with just one-fifth of the number of cars in use today. This is the data DOTs should be collecting and analyzing in order to provide a more efficient transportation system. The solution to tomorrow's urban traffic problems is not more asphalt, but more silicon." ○

The long view

Fifteen years ago, quantity of data wasn't a big concern, but quality was

In December 1998, we ran an article entitled *Fit For A Purpose?* It looked at the new concept of urban traffic management and control (UTMC) systems in the UK. It charted the beginnings of a project that led to systems now in use across the country. One key challenge in these early systems was to get all the different bits of hardware involved 'speaking the same language' so that data streams could be interchangeable and analysis possible at one central traffic management center.

"It is entirely reasonable that we now want to explore ways to add meaning to the data and to define more precisely the way in which data is used," wrote the UTMC project team, who put the article together for *TTI*. "Very simply, in the context of traffic management and control data, 'quality' is intended to determine whether or not any data item is fit for the purpose for which it is being used."

The standardization of the data in the UTMC systems has led to an effective way to link and integrate different itelligent transport systems. By 2001, four demonstration projects were set up – in Preston, Reading, Stratford-upon-Avon and York. Now, over 100 local authorities in the UK use UTMC.

Such success in the consolidation of disparate data streams (which now include CCTV, ALPR, real-time public transport and pedestrian information, VMS, parking guidance and air quality) chimes an optimistic note for our prospects of making sense of the oncoming big data tsunami. The lesson from the past is that we need to ensure data is 'fit for a purpose', and to do that a common language is key.

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Streets ahead

Max Glaskin talks to the winners of this year's IBTTA Awards to find out how they did it and what the industry can learn from their innovative approaches to tolling operations

The annual Toll Excellence Awards from the International Bridge, Tunnel and Turnpike Association (IBTTA) are industry accolades sought keenly from around the world. The 2014 presentations will be made at the organization's 84th annual meeting in Austin, Texas, on September 15.

Here we are proud to announce the awards in the following five categories: Administration and Finance; Customer Service and Marketing Outreach; Toll Operations, Engineering and Maintenance; Social Responsibility; and Technology. In addition to the individual category awards, one special project will also be the recipient of the prestigious President's Award for Excellence. The winner will not be revealed until the meeting itself.

Hosted by the Central Texas Regional Mobility Authority and the Texas Department of Transportation (TxDOT), those tasked with optimizing transport

in the fastest-growing state in the USA, this year's event promises to deliver cutting-edge insight from both home experience and global best practice. With a focus on technology and innovation, sessions will address the future of tolling and look at important topics such as the customer experience, smart cities, financing, managed lanes and cross-border tolling. For anyone involved in the global tolling industry, the IBTTA's annual meeting is an event not to be missed.

IBTTA Award: **Customer Service and Marketing Outreach**
Winner: **North Texas Tollway Authority**

Fair dues

An innovative scheme in Texas has succeeded in halving the number of habitual toll violations and raising US$9m in extra revenue

The confidence gained when you know you're doing the right thing helps to overcome challenges. That's what North Texas Tollway Authority (NTTA) experienced when trying to guarantee fairness for all its customers.

"By 2011, more than 50,000 toll violators owed almost US$40m since the toll scheme started," reveals Kimberly Jackson, senior director of public affairs at NTTA. "That wasn't fair on the 92% of customers who do pay to use the region's toll roads."

So they made a three-year plan, based on a commitment to fairness and designed to make violators pay their dues. "The first step was to talk to our customers, both to those who were paying and those who weren't, pointing out the inequality," says Jackson. "It was a risk for us, admitting we had non-payers." Through some careful and persistent communications, the right messages got through – the system was going to be equitable and there would be consequences for non-payers.

With the ground prepared, Carrie Rogers, director of government affairs, reached out to key partners and allies to share ideas about how best able to achieve meaningful consequences for those dodging tolls. "From them we learned about best practices and that one solution doesn't solve every problem," says Rogers. "We ended up with a compendium of possible remedies from around the world."

All the hard work paid off when the Texas Legislature adopted a bill that gave real teeth to the remedies. Habitual violators now face the prospect of having their vehicle registrations blocked and being banned from toll roads until they have paid what they owe.

The results were little short of sensational. In a six month grace period, the number of habitual violators halved. NTTA handled almost 700,000 calls to discuss pre-payment and payment of fines, and served another 71,000 people at the counter. TollTag distribution grew by 22% annually. Financially, US$4m was received immediately and another US$5m is coming through on payment plans.

"It was beyond our expectations," says Jackson. Having taken risks, NTTA has the support of customers, the media, key partners and elected leaders. It's only fair that the work will continue.

Thanks to the efforts of the North Texas Tollway Authority, the state's roads are now a fairer place to drive

> By 2011, more than 50,000 toll violators owed almost US$40m
>
> **Kimberly Jackson, senior director of public affairs, NTTA**

IBTTA Award: **Social Responsibility**
Winner: **Oklahoma Turnpike Authority**

Heroes of the hour

When a tornado struck, the Oklahoma Turnpike Authority mounted an emergency operation involving 71 workers over eight days

One afternoon in May last year, a deadly tornado hit the community of Moore, just south of Oklahoma City. Twenty-four people died, 377 were injured and 3,937 homes and businesses were destroyed. The city's department of emergency management called on the Oklahoma Turnpike Authority (OTA) to restore infrastructure and, by 7:00am next morning, crews from OTA were on the ground, clearing roadways for residents, relief workers and volunteers.

"We were practiced at responding to snow and flood emergencies because we had just come off winter rotation," says Tim Stewart, OTA's executive director. "We went into alert immediately and set up using every communications channel to contact our crews."

"We had 34 workers out there every day, for eight days," adds Jack Damrill, public information officer. "In total, 71 OTA workers helped, some doing 14 hour shifts."

They deployed equipment appropriate to the challenge –

large front-end loaders to clear major debris, then switching to more maneuverable skid-steer loaders for the confined spaces of city streets.

OTA's PikePass director Glen Branscum happens to live in Moore. "Across the street everything was flattened by the tornado; a three- or four-story hospital was obliterated," he says. "A Russian TV crew said it was inspiring to see everyone working together to clear it up."

Stewart believes experience increased the camaraderie among the OTA crews, established closer bonds with the community and showed how tolling agencies can help citizens in a time of emergency and devastation.

Also, lessons were learned that can enhance the response to

IBTTA Award: **Toll Operations, Maintenance and Engineering**
Winner: **Autostrade per l'Italia SPA**

Cold comfort

Italians have a newfound confidence in their freeway system during winter thanks to a headline-grabbing maintenance program

Winter is not a friend to toll road operators. For Autostrade per l'Italia SPA, the 2011/2012 season was particularly harsh. Snowfall triggered congestion and standstills, and the cost of salting and maintenance drained resources. So Enrico Valeri, operating network coordinator, launched a three-year, €4m (US$5.5m) project to make winter roads as good as they are in the spring.

The strategy included a control room, which receives information about weather, road conditions and traffic flow. It then coordinates salting and snowplow operations, optimizing their movements and reducing unnecessary passes.

> "We adopted the approach that is used by the aerospace industry: with several elements of control"
>
> **Enrico Valeri, coordinator of the operating network, Autostrade per l'Italia**

(Above) **Autostrade per l'Italia SPA's stockpile of salt was sufficient to tackle even the harshest of winters**

Ninety percent of the budget was spent on new vehicles with new technology, boosting the fleet of salt-spreaders to 104. Savings were made by more efficient use of snowplows, increasing salt storage capacity and improving buying practices to get lower salt prices. The human element is also vital,

> Everything was flattened by the tornado; a three- or four-story hospital was obliterated
>
> **Tim Stewart, executive director, OTA**

future emergencies. "Depending on the area, it's worth doing an initial reconnaissance so you arrive with the most appropriate equipment," says Stewart. "And get hold of maps and grids of the area more quickly – we didn't get them on day one.

"We already found out, when fire destroyed our PikePass offices the previous year, how important redundancy is," Stewart continues. "Now we fully understand how important it is to test your emergency response protocols regularly. Nobody in the OTA area wants another emergency, but the community is fortunate to have such a well-prepared organization to call on."

with flexible crews being set up to lay road signs, monitor traffic flow and clear the snow.

"We adopted the approach that is used by the aerospace industry: with several elements of control," says Valeri. "This dramatically increases the likelihood of detecting a problem as soon as it occurs."

The results were dramatic. Gridlock from snow was eliminated. Congestion was cut by 93%. The provision of timely and accurate information soared. Salting costs fell by 20% and winter maintenance costs plummeted by 75%. In 2013, two years after starting the project, the organization received ISO 9001 certification for winter operations management.

It's not just the certification bodies that have noticed the revolution. "In February 2012, after 15 days of snow, the top story in the national media was that although the country was paralyzed, you could still travel on the autostrade," recalls Lorenzo Grosso, assistant road coordinator.

Yet, just as winter is a repeating event, so is Autostrade per l'Italia's approach to improvement. "Every year there's something that can be done better," says Grosso. "We brainstorm at the end of the season to identify possible improvements. We'll bring in top people to enhance operations. We get out on the road in the better seasons to learn more about specific locations. Every year is different and we want our success to continue."

IBTTA Award: **Administration and Finance**
Winner: **Central Nippon Expressway Company**

Road to the future

Japan's Shin Tomei Expressway applied leading-edge technologies during construction to deliver a year ahead of schedule

Big projects provide opportunities for big discoveries. Few come bigger than Central Nippon Expressway Company's (NEXCO-Central) massive new toll road. The Tomei Expressway has connected Tokyo and Nagoya since 1969 and, not surprisingly, had become seriously congested. So the Shin Tomei Expressway, 100 miles in length, was designed to share the burden.

The project began in 1993 and NEXCO-Central raised the necessary US$25.7bn from the bond market. The obligation of the redemption was transferred to Japan Expressway Holding Debt Repayment Agency (JEHDRA), which took ownership when the road was completed, a year ahead of schedule.

"Our concept was to build the world's most developed expressway system, which would unite people, cars and roads," says Takahisa Takamatsu, senior managing officer and director general of the Tokyo branch of NEXCO-Central. "Moreover, we wanted to contribute to activating local communities, improving people's lives and developing Japan."

As well as minimizing the road's impact on many sensitive environmental sites en route, planning focused on applying leading-edge technologies during design, construction and operation.

"NEXCO-Central was not only responsible for the construction but also for the management and maintenance," says Takamatsu. "Therefore, we were able to obtain useful information regarding the effectiveness of each new technology and method at the beginning of construction. We performed cost-lowering schemes such as constructing with heavy equipment and new-design bridge foundations, which made it possible for us to shorten construction by a year and reduce the cost by one-tenth, compared to the original plan."

These lessons are valued because they can be applied to other construction projects. In fact, the experience will be exploited further as the expressway is eventually extended to reach Kobe.

"We extended our knowledge of the latest technologies and management ability in the earthquake-resistant and steep-terrain procedures," Takamatsu continues. "From now on, we can exploit the obtained knowledge not only domestically but also internationally. Now we are responsible for ensuring the Shin Tomei Expressway continues to use the latest technologies. We are certain that we will develop these technologies and introduce innovative approaches into various fields such as inspection, research, maintenance, traffic control and toll collection."

(Top) **Japan's newest toll road eases congestion on the Tomei expressway**
(Above) **The new road traverses steep, earthquake-prone terrain**

> "Our concept was to build the world's most developed expressway system, which would unite people, cars and roads
>
> **Takahisa Takamatsu, senior managing officer, NEXCO-Central**

IBTTA Award: **Technology**
Winner: **Roads & Transport Authority, Dubai, UAE**

Easing the pressure

Cooperation and the latest technology has led to the construction of the world's longest tolling gantry and greatly enhanced traffic management in Dubai

Salik, Dubai's open-road tolling system, launched in 2007, but within five years it faced pressure from increased traffic. So a project to fast-track three new tolling points began in June 2012. It included the world's widest open-road tolling zone spanning seven lanes in a single direction of traffic. The gantry was designed to avoid disrupting existing traffic, to keep to existing plazas' footprints, to capture images of every vehicle for enforcement and to maximize reliability.

"It began with extensive field surveys to determine the appropriate locations for the required traffic charging zones, taking into consideration existing infrastructure and gantry design constraints," says Maitha Bin Adai, chief executive for Traffic and Roads. "Coordination with various government stakeholders was important at this stage, enabling the quick approvals that were crucial to the timeline."

The project experienced several major challenges, including structural design in a tunnel environment, limited availability of utilities and unusual road alignments in the vicinity of the tolling zones. The main contractor, TransCore LP Dubai, partnered with local contractors and 350 people were directly involved.

Within nine months the job was done, with operational readiness testing taking place on March 14, 2013. Following a successful soft launch, the system went live on April 15. "The expansion project was seamlessly integrated with the main Salik system within the required nine-month plan and is recognized as an outstanding success," says Sofiene Jegham, senior manager of ITS design and implementation. "It has further enhanced RTA's traffic management ability and these three new locations alone see on average 16 million transactions per month."

> "The project was seamlessly integrated with the main Salik system within the required nine-month plan and is recognized as an outstanding success
>
> **Sofiene Jegham, senior ITS manager, Roads & Transport Authority, Dubai**

A willingness to share was crucial. "Having trusted partners that are experienced in the local requirements is of paramount importance, as is involving key stakeholders to ensure buy-in and commitment to the success of the project," believes Bin Adai. "The ability to find innovative solutions to seemingly impossible situations can be achieved through collaboration with key stakeholders, including specialist subcontractors who are sometimes left out of critical project-related decision making."

Where are they now?

Updates from the 2013 IBTTA Toll Excellence Award winners

The **E-470 Public Highway Authority** installed photovoltaic arrays to cut energy costs and duly received the Social Responsibility award last year. "We projected they would cover 47% of our needs but they are achieving 54%," says Walt Adamson, operations manager. "We're considering expanding from the current 17-mile stretch of road to an additional 20 miles."

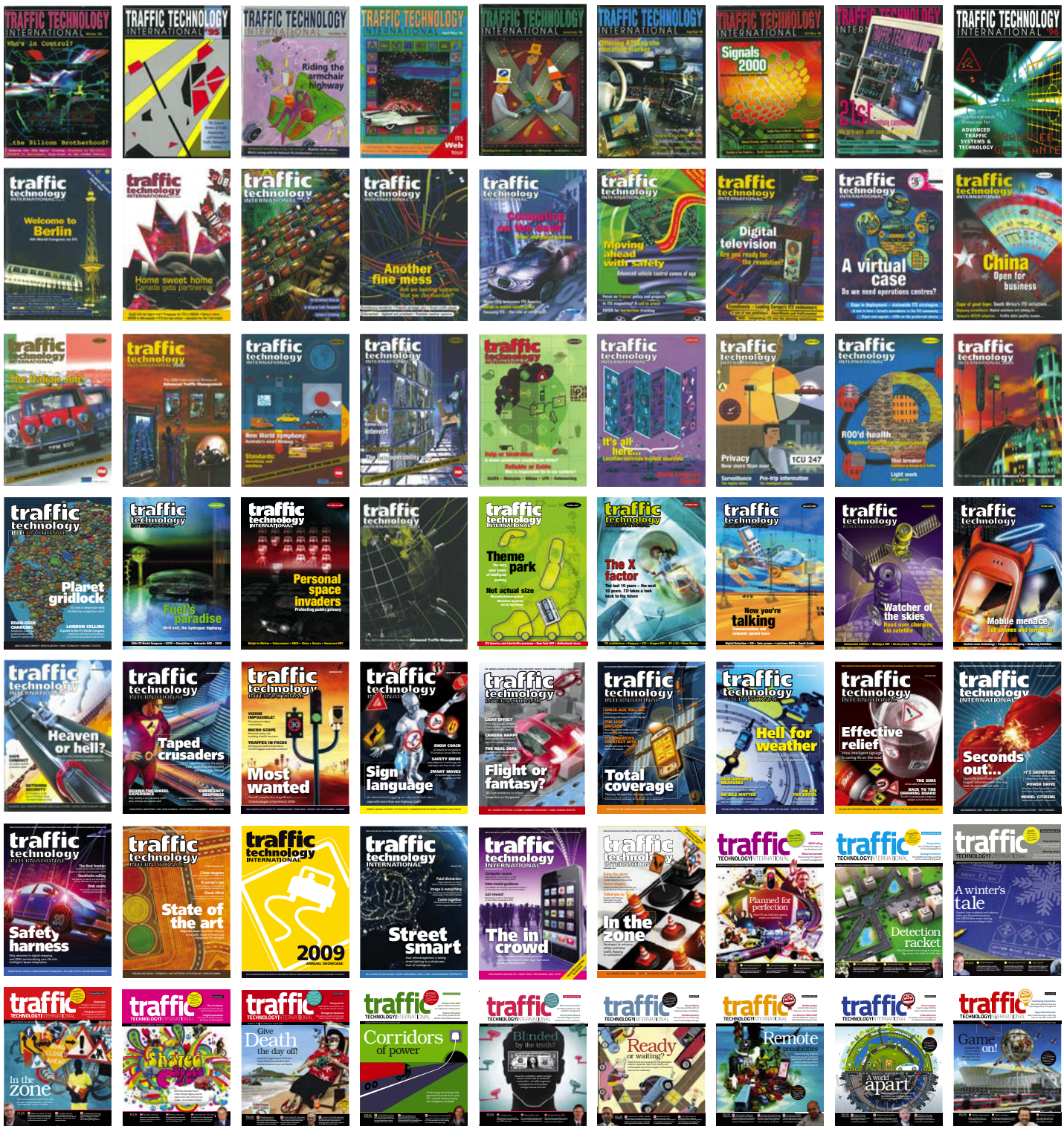
Georgia SRTA won the Customer Service Award for its US$60m HOT lane on the I-85. In the past year daily trips have grown to 21,000 and a new monthly record of 558,000 was set in May. "We're exceeding forecasts for trips and revenue," says Chris Tomlinson, executive director. "Now we're planning to extend it by another 10 miles."

The Technology award was won by South Africa's **SANRAL** for its open-road tolling system. It has gone live in sections and a SANRAL spokesperson says that, despite difficulties with public acceptance and its use as an election issue, those that have registered laud the system. SANRAL reviews the collection system continuously to make it more user-friendly and improve customer services.

An astonishing recovery from a fire at its PikePass HQ won the **Oklahoma Turnpike Authority** the Operations Award in 2013. "Since then we've taken storage to where it is fire- and tornado-resistant," says Glenn Branscum, PikePass director. All transponders are in fire-resistant safes and failsafe systems, back-ups and redundancy are now uppermost in planning.

Twenty years on the road

We've come a long way in the past two decades. In celebration, we've thrown open the archives to present every cover of every edition, right back to the first one in 1994. Here's to the next 120 issues!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Game on!

Urban inspiration

This month the 21st ITS World Congress comes to Detroit, Michigan. Here, Jim Barbaresso, the chairman of the organizing committee, reveals the highlights attendees should be watching out for, at what promises to be the greatest mobility showcase ever

From September 7-11, 2014, more than 10,000 leading international transportation policy makers, researchers, high-tech innovators and business professionals will fill Detroit's newly refurbished Cobo Hall to share information, gather knowledge and explore the possibilities ahead in the field of ITS. With technology showcases, innovation demonstrations, technical tours, hands-on experiences, networking events and an exhibition full of experts, specializing in everything from connected vehicles to freight management, smart parking and ITS architecture applications, the 21st ITS World Congress is an event not to be missed.

ITS America says that it selected Detroit to host this year's event in recognition of the region's automotive heritage, and its leadership in developing and deploying the technologies that will define the future of transportation in America. Fittingly, the theme of the congress is 'reinventing transportation in our connected world'.

"The theme is really all about connectivity – both in terms of V2I and V2V," explains Jim Barbaresso, vice president of ITS at HNTB Corporation and the 2014 World Congress organizing

> You can't avoid ITS when you're at the World Congress – it's everywhere and you're a part of it
>
> **Jim Barbaresso, Organizing Committee Chairman, ITS World Congress 2014**

committee chairman. "It's about connecting vehicle occupants with the outside world, making cars safer and improving mobility through connectivity. It's also about reinvention: reinvention of our transportation systems, reinvention of the iconic city of Detroit – the Motor City – and reinvention of the American automotive industry, because connectivity really is a game changer for the industry, and for safety and mobility too."

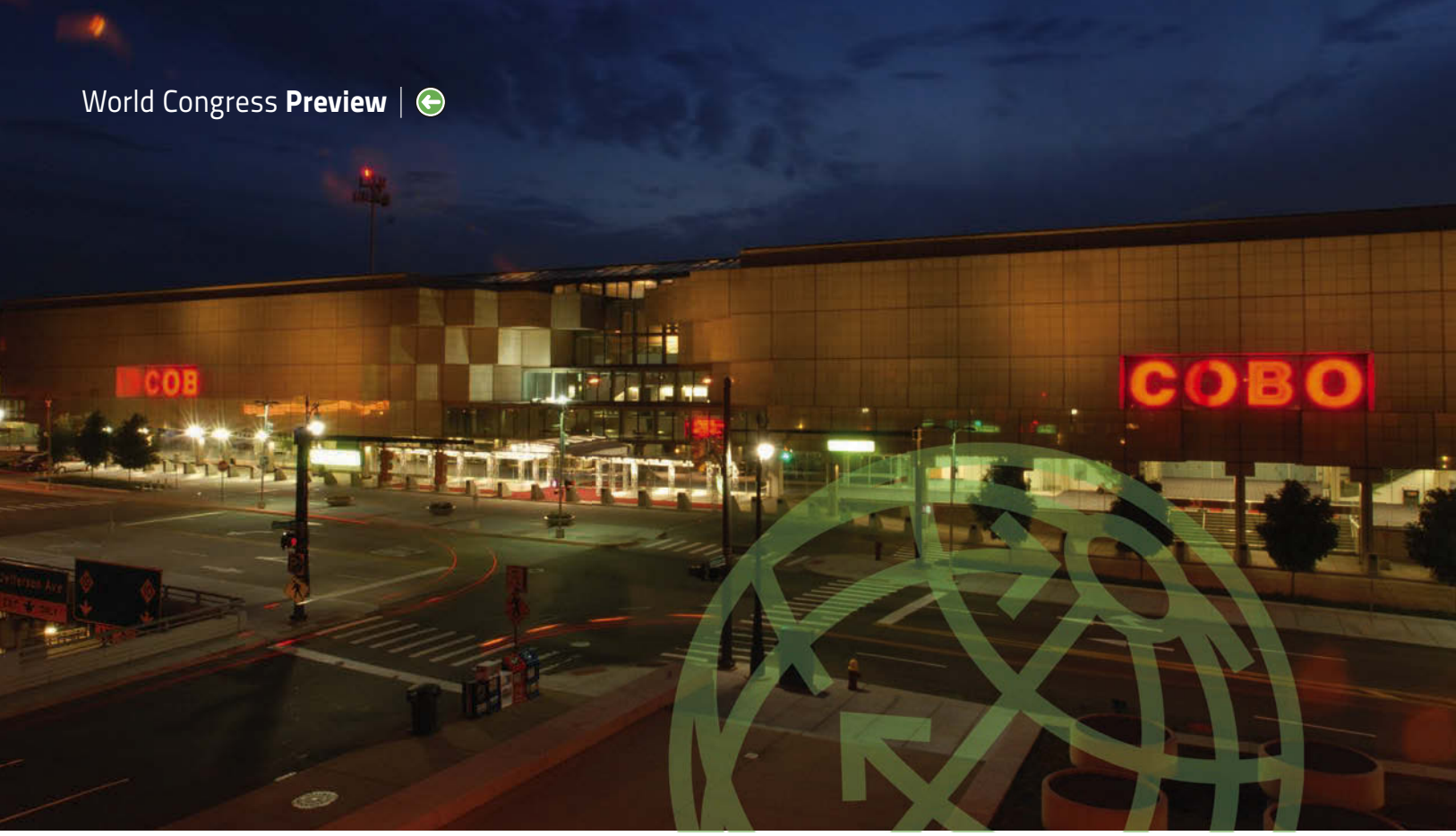
It certainly is an exciting time for our industry with regard to technology and how it's being applied to transportation systems. "That's what this story is all about and we're going to tell it in a very compelling way," says Barbaresso. "We've got some really innovative features to the World Congress this year."

One element that Barbaresso is particularly looking forward to is the technology showcase – demonstrations that will take place throughout the week of the congress. "They're going to be fabulous," he enthuses. "And it will be the largest set of demonstrations to ever take place at a World Congress."

(Main) **The city of Detroit has an iconic skyline** (Inset) **Belle Isle, situated in the middle of the Detroit River, will host a variety of ITS demonstrations**

More than 30 demonstrations will be held during the week of the event, most of which will be on Belle Isle in the Detroit River. "It's where the Detroit Grand Prix takes place, so there's a lot of pavement there," Barbaresso explains. DSRC radios will be set up to enable connected vehicle demonstrations, which will be accompanied by demonstrations of automated vehicles, safety innovations, traffic signals, and tolling and pricing solutions.

"It's going to be very exciting," says Barbaresso. "And it'll be fun for



participants, too. There will even be demonstrations on the bus as they get transported out to the island. You can't avoid ITS when you're at the World Congress – it's everywhere and you're a part of it."

The demonstrations are designed to explain how the ITS industry is reinventing transportation. By promoting awareness and a greater understanding of the capabilities of modern ITS, the congress organizers aim to increase connectivity throughout the ITS community and foster international collaboration – uniting the roadway and vehicle industries.

"In the late 1980s/early 1990s, ITS was known as IVHS – intelligent vehicle highway systems," explains Barbaresso. "At that time, everybody recognized that we needed integrated solutions, where vehicles and highways were looked at systematically rather than as individual subsystems that didn't talk to one another."

Both industries have rapidly advanced over the past 20 years, and we're now at the point where integration can take place. "It's brilliant because this was the original vision of our predecessors," says Barbaresso.

And Detroit is the perfect place to showcase this fusion of technology. "We are going to make sure that we capture that whole other side of ITS and engage the auto industry to a greater degree than we have before," the chairman continues. "We've played around the edges for many years. We've had demonstrations of connected vehicles – and even some automated vehicles – at past World Congresses, but this will be a major focal point in Detroit when September comes around."

Detroit's Cobo Center is one of the largest convention and exhibition facilities in the USA

Sharing expertise

In addition to the innovative demonstrations taking place, the always-popular technical program will continue to be a congress highlight. The impressive line-up of speakers includes Mary Barra, the CEO of General Motors; Bill Ford, the executive chairman of Ford Motor Company (see page 86 for our interview with him); Lowell McAdam, the CEO and chairman of Verizon Wireless; and key personnel from the USDOT.

To kick things off, there will be a State Department of Transportation and Ministerial Roundtable before the opening ceremony on Sunday, September 7. "We're expecting about 30 state DOT executives and up to 20 foreign ministers of transportation to attend this round-table session," Barbaresso reveals. "We'll set up the room in a United Nations-type format and we'll ask them questions about policies going forward, what the future's going to look like for transportation agencies, and how they will continue operations in the new environment that will come about. We hope they'll talk about connectivity, vehicle automation, big data, etc – the big issues they'll be facing over the next 20 years – and how they're preparing for these disruptive changes."

> We are going to make sure that we capture that whole other side of ITS and engage the auto industry to a greater degree than we have before
>
> **Jim Barbaresso, Organizing Committee Chairman, ITS World Congress 2014**

Another congress highlight will follow Bill Ford's opening speech on Monday, September 8. The Chief Technology Officer Summit will gather CTOs from the automotive, communications and IT industries to talk about connectivity, automation and big

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data, from a technical standpoint. "We'll be looking at what is being done in these industries, and what can they do together to advance transportation safety and mobility," explains Barbaresso. "We'll also have sessions that will continue this dialog and advance the discussion. Hopefully we'll have a report at the end that will identify what the major issues are and how we can resolve them."

Excitement and ingenuity

Throughout the congress, the show floor will host a number of interactive and educational networking opportunities. The Youth Connections Showcase, for example, will expose some 1,000 local high school and college students to the ITS industry through guided tours, breakout sessions, demonstrations and competitions.

"For one of the challenges, the students will actually be building electric and connected vehicles," says Barbaresso. "They'll be given kits and will compete to build their cars and get them around the indoor track. Whoever completes the track first will win!"

Another area to keep an eye on will be the Entrepreneurial Village. Here, emerging companies will have a dedicated space to promote their most innovative technologies and ideas for improving the way to get around.

"We will bring groups around to the Entrepreneurial Village and run speed-dating-type activities," says Barbaresso. "The start-ups will be able to do a one-minute pitch about their service or product to various VIPs throughout the week."

> The start-ups will be able to do a one-minute pitch about their service or product to the various VIPs throughout the week
>
> **Jim Barbaresso, Organizing Committee Chairman, ITS World Congress 2014**

There will also be a Michigan Spotlight pavilion, which will include a number of agencies in the Michigan state government, as well as the University of Michigan Transport and Research Institute (UMTRI) and its Mobility Transformation Center, the Michigan State Police, the Michigan Economic Development Corporation, and the Michigan Department of Transportation (MDOT), which is leading the effort.

The Mobility pavilion, meanwhile, will house several transit agencies, as well as the innovators that are working to enhance public transportation and non-traditional modes of transport.

Innovation showcase

Of course, an ITS World Congress would not be complete without the industry experts that will be on hand in the exhibition hall to talk about their state-of-the-art transportation and in-vehicle solutions. Over the next few pages, you'll get a sneak peak at what some of the exhibitors are planning to demonstrate at the show.

This year's event promises to deliver some of the largest exhibits ever seen at a US-based World Congress. "Numerous major companies, including General Motors and Toyota, have taken huge footprints on the show floor to showcase what they're doing in the ITS sector," says Barbaresso. "It's great to have these companies participating in the program and demonstrations. With the show being in Detroit this year, they see it as a great opportunity to really show off what they're doing. We're really happy with that."

Show highlights

Data delivery

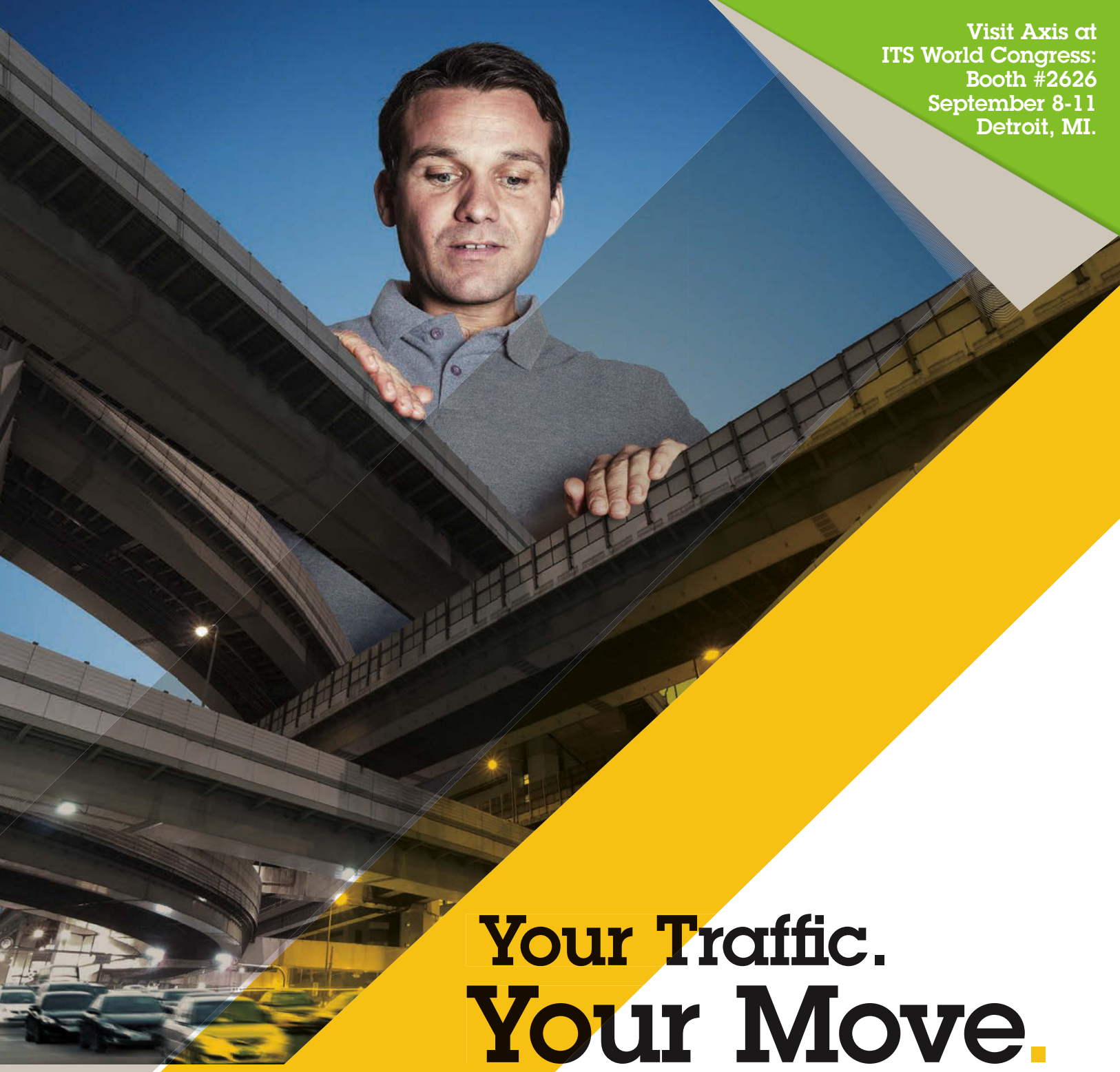
IRD
Booth 1322

At this year's World Congress, IRD will be presenting advanced traffic management and ITS solutions for commercial vehicle enforcement, infrastructure asset management, traffic data collection, access control, and toll roads. For many attendees, this will be the first exposure to the company's VectorSense tire sensor, a completely new type of sensor for ITS.

"The VectorSense tire sensor provides previously unavailable data for commercial vehicle operations, toll road operations, and traffic data collection applications," explains IRD president and CEO Terry Bergan. "At the NATMEC conference for data collection program managers in Chicago,

IRD presented a working demo of the VectorSense tire sensor, and an alpha version of the VI²M (vehicle information in motion) footprint software. Attendees were clearly excited to see a technology that will provide new information for pavement design, differentiate tire width, and detect all types of vehicle configuration."

In other news, IRD recently provided weigh-in-motion (WIM) and e-screening technology for the Oklahoma Department of Transportation, with the enforcement goal of screening all commercial vehicles on the basis of weights, dimensions and credentials. "It is a comprehensive, automated solution incorporating highly accurate weigh-in-motion scales, non-intrusive sensing and machine vision," details Bergan.



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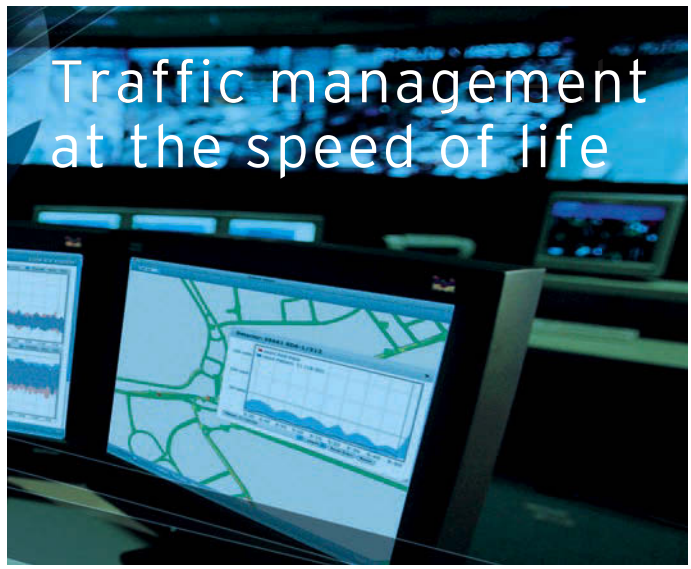

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Show highlights

Safety the Swedish way

Sensys
Booth 2015

For ultimate Vision Zero expertise, World Congress visitors should speak to Sensys Traffic. The Sweden-based company is a leading provider of smart solutions for traffic safety and informatics; its speed and red-light enforcement solutions have contributed to improving safety in the countries that now have the lowest traffic-related fatality rates in the world.

Sensys Traffic experts will be on hand at the show to guide visitors through the company's 'Design: Function: Precision' concept, where cutting-edge technology is tailored to individual customer needs.

Last year Sensys Traffic signed a nine-year contract in Sweden to replace the installed base of 1,100 speed cameras within first three years and implement 200-300 new speed cameras per year. The contract included design and delivery, as well as installation, commissioning and maintenance. The program is now in full swing, and one-and-half years in, Sensys Traffic will have designed, delivered and commissioned 700 cameras.

Not wanting to rest on his laurels, CEO Johan Frilund is full of ideas for the future. "We will definitely see further development of sensor technologies that will provide more versatile functionality for enforcement," he says. "We will also see downsizing and cost reductions. We can only imagine the potential the vast improvements in picture and video quality will bring. We also foresee a further integration between enforcement and other ITS-applications based on the fast development of technologies."

Taking the initiative

TSS
Booth 921

Since it went live in March 2013, the San Diego Integrated Corridor Management (ICM) project has won the ITS America Best of ITS award for Best New Innovative Practices in April 2013, and the CTF award for Operational Efficiency Program of the Year in May 2014. "This is not a one-off, but rather the first fruit of a national initiative," says Matthew Juckes, senior project manager at TSS-Traffic Simulation Systems. "The FHWA identified promising sites, and analyzed the potential benefits of implementing ICM. There are two projects – one of which is in San Diego."

One of San Diego's core ICM strategies is the configuration and implementation of the Aimsun Online real-time decision support system from TSS. "This 'smart' traffic management system gives operators comprehensive awareness of the current and predicted performance of the entire corridor," says Juckes. "Building upon the advanced systems already in use on the I-15, it enables traffic operators to anticipate congestion before it happens and take measures to prevent it."

In February 2014, the project owner, SANDAG, completed a coordinated test plan for a fully automated response to a freeway incident. "This may be the first time in the USA that a traffic management decision has been made based entirely on automatically triggered real-time simulations of the multimodal transport network," says Juckes.

TSS will be exhibiting its Aimsun Online software, as well as the latest version of its Aimsun traffic modeling software at the 2014 ITS World Congress.

Innovation in transportation

Siemens
Booth 2001

Visitors to the ITS World Congress can expect to see Siemens' full portfolio of solutions developed to address the challenges facing today's traffic systems. Solutions include organizing expanding traffic control center operations and making the influx of traffic data actionable; mitigating congestion with predictive and real-time adaptive traffic technologies; preparing for resiliency and developing effective evacuation management systems; integrating next-generation solutions; and managing the growth of bus rapid transit (BRT) systems by integrating virtual solutions into their systems.

The company will also be unveiling new products that it says will bring greater intelligence to traffic operations."Cities are facing a unique opportunity to improve their infrastructures, and it couldn't come at a better time," says Dirk John, CEO of road and city mobility for Siemens' Infrastructure & Cities Sector.

"In the USA, infrastructure grades have been near failing since 1998. This is reflected in the frustrations that Americans experience as they drive on roads and bridges built in the 1950s, and ride on rail lines that were placed in the ground a century ago.

"We need to incorporate more intelligent technologies into our transportation systems, to create a true 'software infrastructure'. Integrating smart technology into a transportation system can simplify modernization without requiring cities to completely rebuild."

Siemens continues to work on innovative projects around the world. In San Antonio, Texas, the company teamed up with Trapeze Group to create a GPS-based BRT system that keeps the city's new VIA Primo bus fleet on schedule with minimal impact to traffic flow.

"I'm also proud of our work with connected vehicles and our partnership with the USDOT," says John. "We recently joined a testbed, organized by the Intelligent Transportation Systems Joint Program Office (ITS JPO) of the USDOT, that aims to expand deployment of V2I. This is in addition to our participation in a connected vehicle testbed with the USDOT in Detroit."

Show highlights

Korean expertise

SK C&C
Booth 1011

Visitors to the Korea Pavilion can discover the advanced ITS services and products offered by SK C&C – the IT arm of South Korea's SK Group, which is ranked 57th in the Fortune Global 500.

"SK C&C is one of Korea's top IT service providers and a leading ITS company with nearly two decades of experience," says Sang Joon Lee, business developer. "We offer 12 services in five key ITS areas and more than 60 ITS products, including ALPR, VMS and TSC."

SK C&C has completed more than 50 ITS projects in both Korea and abroad, in a wide variety of fields. This includes the first-ever ITS systems for Baku, Azerbaijan and Ulaanbaatar, Mongolia.

Developments in enforcement

Vitronic
Booth 607

According to Vitronic's Daniel Scholz, there are three trends that are shaping the demand for enforcement technology. "The first is that technology is getting more flexible and enabling authorities to enforce several violations simultaneously," he describes. "This started a few years ago with speed and red-light enforcement; and now includes tailgating, spot and point-to-point speed enforcement, and ALPR."

The second trend is networked enforcement systems. "There are tremendous benefits in having enforcement systems permanently online – ranging from more efficient import and processing of cases, to optimizing traffic flow by feeding the data from speed cameras into traffic management systems," Scholz explains.

The third trend is a partial privatization of traffic enforcement. With increasing demand for additional services, privatizing operations frees up human and financial resources, and enables authorities to concentrate on the core responsibilities of public administration.

At the ITS World Congress, Vitronic will be showcasing the next generation of lidar-based traffic enforcement. The new model, which builds on the effective measurement technology present in the PoliScan model, can be applied to a variety of enforcement

scenarios. Visitors that are interested in free-flow tolling can also see the latest TollChecker, a flexible system that can be applied to highways as well as rural roads, or for road-user charging in cities.

Vitronic has recently won the tender to build one of the largest automated enforcement management systems in the world, in Abu Dhabi. "The project is a very good example of what ITS is capable of today," says Scholz. "It includes the enforcement of traffic violations through a network of over 500 PoliScan systems. Each system will be permanently connected to an operating center and Vitronic will not only deliver the enforcement hardware, but also the software for remote control, case processing and asset management."

A connected future

Heusch Boesefeldt
Booth 3023

For Frank Offermann, business development manager of active traffic management specialist Heusch Boesefeldt, the integration of connected-vehicle technology will be essential to achieve success in the future. "This involves processing data and communicating value-added navigation or cruising advice directly from and to individual vehicles in a spatially disaggregated environment," he explains. "We have already expanded our portfolio to cope

with these new requirements. We are actively involved in research in this field on both sides of the Atlantic."

The company developed the traffic management center for SimTD in Germany and is currently developing next-generation workzone cooperative management tools as part of UR:BAN. In the USA, Heusch Boesefeldt is leading the development of a simulation-based testbed for dynamic mobility applications and active transportation demand management strategies for USDOT.

Visitors to the ITS World Congress can discover the capabilities of the company's ATM control software suite, GeoDyn2-Control. "It supports 12 ATM strategies, enabling the user to fully customize each of them through parameter settings," says Offermann. "Furthermore, GeoDyn2-Control is future-proof, with a processing capability for

connected vehicle data.

Heusch Boesefeldt will also be showcasing its PLATO tool for North American-style ring-barrier controllers. PLATO optimizes local timing for up to one cycle in advance based on real-time traffic conditions.

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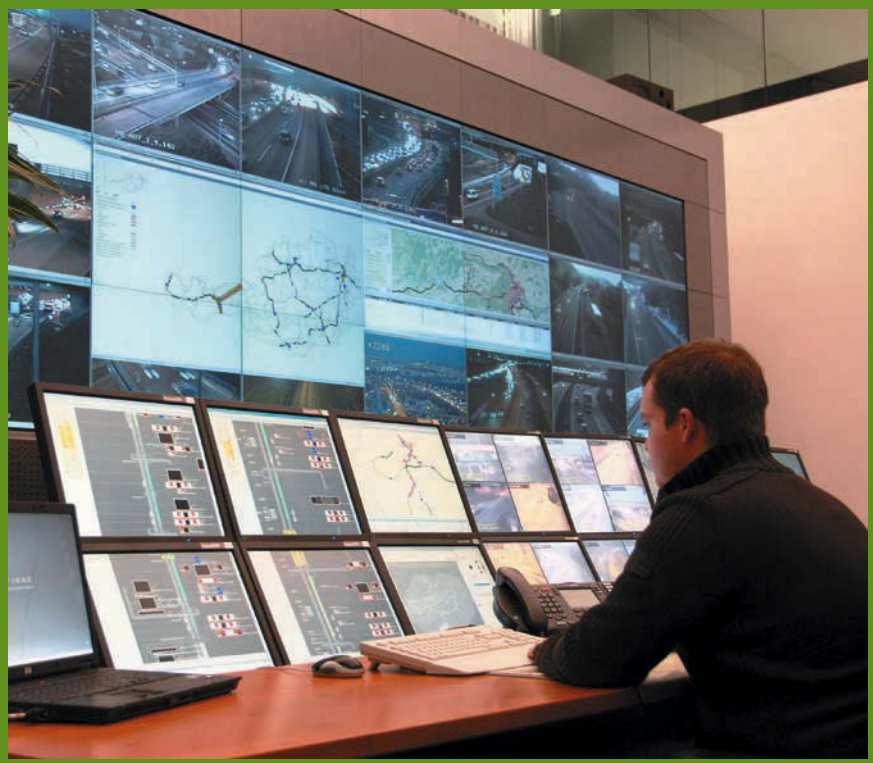

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Power play

As the volume of traffic is driven ever higher, **Timothy Compston** investigates the technology that keeps critical roadside infrastructure up and running when the electricity supply fails

Despite a multitude of technological innovations being brought to market, the installed base for uninterrupted power supply (UPS) and battery back-up systems in the traffic industry remains relatively small. It is currently estimated that no more than 1 in 10 intersections have such systems. In fact, for some DOTs the figure is even lower – so much so that they are only really starting to dip their toes into the water.

One place taking a cautious approach is Oklahoma City, USA. The city currently only has two battery back-up systems to serve approximately 760 signalized intersections. "The ones that we do have are at the signals for the on/off ramps of the major interstate highway, which runs from downtown," says Richard McCubbin, a principal engineer with the traffic management division of the Public Works Department. "They were put in at the same time as the relocation of the highway." The systems were actually selected by Oklahoma DOT and then given to the city to manage.

However, a safety program where Oklahoma is relighting some of its intersections is opening up the possibility of wider battery back-up deployment. "These signals are going from incandescent to LED lights," says McCubbin. "It is still early days. At the moment, not even 10% of our intersections have LED signals."

As part of this project, McCubbin says that for one pivotal intersection, a new battery back-up solution is firmly in the works. "The battery back-up is for a SPUI [single point urban interchange]," he explains. "The thinking is that if the power went out at such a large-scale interchange, it would create chaos. This is really our first foray into battery back-up where it is of our own choosing."

Through the project, which is out to bid at the moment, Oklahoma is looking for something that can run a traffic signal system for four to six hours. "Our electricity supplier is pretty quick at getting things back online so it is basically to give them enough time to get out there and get the power restored to an area," says McCubbin.

The plan is to put the selected solution in at this major interchange and then to carefully evaluate it to guide future installations. Looking further ahead, Oklahoma is also seriously thinking about putting battery back-ups in at other major intersections and section line roads.

Early days

There is still a long way to go before we are likely to see UPS solutions deployed at every traffic signal, but there is a growing consensus that things are starting to move in the right direction. The limited capacity of lead-acid batteries and the old-style incandescent signals had, in the past, put the brakes on any expansion of UPS and battery back-up beyond the most critical of junctions. However, the introduction of LED signals means that the signal load has fallen substantially. "Typically we see, with the move from an incandescent style signal to an LED signal, a drop of 75%, or even more, in terms of the load requirement," says Keith Manston, head of product management for Siemens Traffic Solutions in the UK.

The increasing deployment of LED signals has been coupled with new battery technologies that are unlocking greater energy densities, longer run times and easier installation.

> Typically we see, with the move from an incandescent style signal to an LED signal, a drop of 75%, or even more, in terms of the load requirement
>
> **Keith Manston, Siemens Traffic Solutions, UK**

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> The problem is not how long a battery back-up lasts under normal conditions; we wanted to know how long these systems could potentially function in extreme temperatures
>
> **Rahim Benekohal, University of Illinois, USA**

"The momentum is definitely picking up, as more and more people are realizing the value of a UPS solution, not just for safety, but to extend the life of their existing controller equipment and all of the electronics," adds Dennis Bennett, director of business development for Alpha Technologies in the USA. "The UPS can filter and condition power to protect the electronics. In addition, agencies have fewer call-outs caused by intersections going black or into flash mode when they lose power, or there is a power glitch."

Bennett believes that line-interactive UPS is "the perfect typology" for a non-controlled environment. "It runs cooler and it is a true UPS because it doesn't flat-line on the output, so you don't lose output voltage protection," he argues. "Double conversion accounts for about 10% of the market and line-interactive takes the rest."

(Below right) **Siemens' UPS system installed at the side of the road**

Testing times for temperature

Given the vital role that UPS and battery back-up systems play in keeping ITS infrastructure online, one might question how temperature impacts the performance of these 'protectors'. One person who sought to find the answer is Rahim (Ray) Benekohal, professor of civil and environmental engineering at the University of Illinois in Urbana-Champaign, through Traffic Operations Laboratory (TOL) research sponsored by Illinois DOT back in 2005.

Benekohal says that the issue around temperature came into the frame because UPS systems rely so much on their batteries. "The problem is not how long a battery back-up lasts under normal conditions; we wanted to know how long these systems could potentially function in extreme temperatures, so the DOT could plan on getting there should the electricity fail," he explains.

Four UPS systems were tested at sub-zero and hot temperatures, from -25°C (-13°F) to +72°C (+162°F). "We cycled them a few times because we didn't want to rely on just one test result," says Benekohal. "And we were particularly interested in the cumulative effect – if you go from one extreme cold to the next, is it going to keep reducing performance or is it almost the same as for one cycle?"

The standout finding was that temperature does notably affect the performance of UPS systems. Interestingly, all of the UPS systems tested showed longer run times as temperature increased and dramatically shorter run times as the temperature decreased. For normal signal operation at +72°C, the percentage change in time, relative to room temperature, ranged from +6% to +26% whereas for -25°C the corresponding figures were -32% to -80% – a considerable reduction in performance. One recommendation from the study is for users to switch to flashing or a combination of normal and flashing modes of operation in cold temperatures to increase the available run time.

Better in Texas

BBUs are proving to be a real asset in the city of Dallas

Frequent power outages that lead to signals going dark at key interchanges can be extremely disruptive to the smooth flow of traffic. This was an issue that the city of Dallas, Texas, was keen to address using BBUs (battery back-up units), especially given the propensity of the city's signals to drop out when faced with severe weather.

"As an established city, some of our infrastructure dates back 50 to 60 years and the same is true of our power grid system," explains Auro Majumdar, assistant director of transportation services in the department of street services. "When we have major weather events, overhead lines are taken out and lightning strikes disrupt overhead transformers."

Majumdar says that the new BBUs can handle at least two hours on 'full color' and a further three hours of follow-on flash operation.

Regarding the installed footprint of the BBUs, he reports that the program has been ramped up dramatically over the past 12 months. "In the past year we have been pretty aggressive and I would say about 20% of our signals – around 300 – now have BBUs."

To put the experience of Dallas with the BBUs into perspective, Majumdar compares what happened with a major storm last year to the situation now. "Then, over 250 signals went dark," he recalls. "This contrasts with a similar storm recently where only about 90 signals were affected."

In extreme temperatures, lead crystal technology has a distinct advantage over lead-acid batteries. "The electrolyte is crystalline in structure, which means that the lead crystal battery is able to withstand a much larger temperature range," says Manston. "We have been doing cold and hot temperature tests, and have found that although the battery capacity does change with temperature, it is not nearly as marked as it would be with a lead-acid battery."

The latest lead crystal batteries offer an operational life of 6-12 years – compared with only 2-4 years for standard lead-acid batteries – and, potentially, a faster charge time. Another benefit is that lead crystal batteries are classified as non-hazardous, making them easier to transport.

A fair wind for solar

More advanced solutions are also becoming available in the field of renewable energy. One gaining traction on the plains of Nebraska, at a signalized interchange in the city of Lincoln, is a roadway wind/solar hybrid power and distribution system (RHPS) that features a 1kW turbine and two solar panels, as well as battery back-up.

Mo Zhao, a research student from the department of civil engineering at the University of Nebraska-Lincoln, believes it makes sense to combine wind and solar power. "The good thing about a hybrid system is that when there is

(Above) **The solar/wind hybrid back-up power system being trialed in Lincoln, Nebraska**

Resilience in adversity

Hurricane Sandy was the ultimate test for back-up power systems on the USA's east coast

When Hurricane Sandy thundered across the east coast of the USA in October 2012, it left a trail of destruction in its wake. Cedrick Fulton, the director of the tunnels, bridge and terminals department at the Port Authority of New York and New Jersey is quick to underline the enormity of what happened. "In this particular area we are very much tied together through bridges, tunnels, highways, roadways and transit," he says. "There were periods of time when almost every single mode of transportation was shut down. It was literally the darkest of the dark."

Talking specifically about the solutions that came into play to assist the evacuation and recovery effort, Fulton's colleague Rizwan Baig, the assistant traffic engineer for the Port Authority, reports that at the Holland Tunnel, one of the busiest corridors in the region feeding the New York downtown area, traffic signals were supported by redundant power feeds as well as permanent back-up generators. "Our signals kept running even during the Sandy event," he reveals, adding that the UPS and battery back-up systems

really came into their own, as Sandy rolled through, at the ring road around Newark Liberty International Airport, which feeds terminals A, B and C. "The traffic signals at these critical intersections ran on UPS for four hours during Sandy until portable generators were brought in, so this worked very well," he explains.

With regard to the lessons learned from Sandy and UPS operation, Baig reveals that its traffic signal design guidelines now require solutions to run for a minimum of four hours. "This is enough time to get the generators out and we are constrained by cabinet space and battery size," he says.

For signals associated with intersections at Port Newark and Port Elizabeth, Baig explains that the Port Authority is looking for longer UPS back-up of eight hours. "There isn't the same 24/7 cover from our technicians so we needed to reflect that," he says. Interestingly, moving forward, the UPS installations run by the Port Authority for traffic signals and ITS devices are also to feature a network connection so their status can be monitored remotely.

Powering the next two decades

Our experts predict where UPS technologies will be by 2034

It's going to be interesting to keep track of how the technology behind UPS and BBS solutions develops in the months and years ahead. What is clear is that even DOTs that have not yet taken this route are increasingly seeking to specify back-up solutions as a result of the disruption they can face when the unexpected happens, with Hurricane Sandy being very much a case in point.

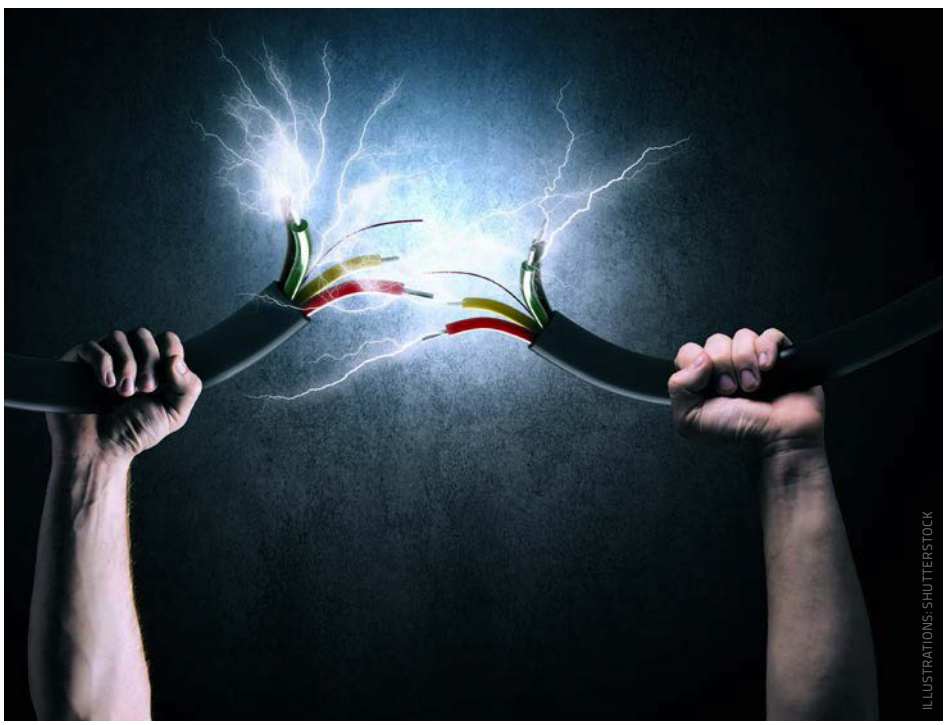
Renewable energy sources might not have taken over completely from traditional batteries in 20 years' time, but Mo Zhao from the University of Nebraska-Lincoln nevertheless believes wind/solar hybrid solutions will become a familiar sight. "We already see numerous applications in the traffic area for solar-powered portable signals," she says. And with technological developments, the cost of combining wind with solar is decreasing

quickly, making this solution more attractive to agencies that have a strong interest in accommodating renewable energy.

Alpha Technologies' Dennis Bennett is confident that in 20 years' time, UPS and battery back-up solutions will be deployed at every intersection. Another trend that he feels is likely to come to fruition is remote management. "In order to operate, all UPS systems must have batteries, regardless of the technology," he says. "If you can't physically look, then there needs to be a way to electronically check if the batteries are in good condition."

Siemens' Manston believes the shape of the sector depends on whether traffic signals will last that long. "I think they will because it is too big a step to take them out in that timeframe, but more and more information will be in the cars, and consequently less and less traffic control will be done at street level," he says. With regard to battery back-up technology, as the pressure is on to generate more efficient and smaller batteries, Manston feels research in the burgeoning electric car market might, potentially, generate something that could transfer across to the back-up power scenario.

> It is not like putting a wind turbine by a farm – there is the potential for drivers to be distracted here
>
> **Mo Zhao, Department of Civil Engineering, University of Nebraska-Lincoln, USA**



ILLUSTRATIONS: SHUTTERSTOCK

not enough sunshine, we can simply use the wind resource," she says.

The system was designed so that the turbine would be mounted on the traffic signal pole itself. A structural analysis found that the pole was strong enough to support both the weight and vibration of a small turbine plus two solar panels.

The only potential everyday pollution caused by the system is the noise generated by the turbine, but this has not created too many problems. "We did some calculations, as we needed to limit the noise, but at a traffic intersection there is a lot of background traffic noise anyway," she says.

Another point that Zhao is keen to make is that further study is needed regarding the impact of wind turbines at intersections on drivers. "It is not like putting a wind turbine by a farm – there is the potential for drivers to be distracted here," she says. The results from initial simulator tests on turbine distraction are encouraging, however. Based on heart rate, eye movement and reaction times, there was no notable impact on driver performance. The next stage is to collect field data to see how this stacks up compared with the simulator findings.

In terms of the future, Zhao acknowledges that there is still work to finish off before further tests can be done. This relates to a new wind turbine controller being designed by the University's electrical engineering faculty. "This will optimize control of the turbine and enable us to do a 'before and after' study to see if production can be improved," says Zhao.

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New eyes for industry

> We are on the cusp of a number of revolutions. Not just to the car itself, but to the way the car interacts with society around it

On the gray Tuesday morning on which we catch up with Ford's executive chairman in his home city of Dearborn, Michigan, the local transport infrastructure is recovering from its wettest day in 89 years. Monday saw floods close five freeways, leaving over 1,000 cars stranded. However, as soon as we start talking, it's clear that it would take more than a little water to dampen Bill Ford's buoyant mood and long-term optimism about the future of mobility.

"This is the most exciting time in my 35 years at Ford. I love it!" he says. "In the first 100 years of the Ford Motor Company, we had a series of evolutions, but really no revolutions. Now we are on the cusp of a number of revolutions. Not just to the car itself, but to the way the car interacts with the society around it. Whether it's new kinds of fuels for the powertrain, new ownership models, autonomous driving, vehicle-to-infrastructure communications… all these kinds of things are coming at us fast and furious and it's really exciting."

As a keynote speaker at this year's ITS World Congress, Ford is keenly aware of the way in which the automobile manufactures must begin to work even more closely with the designers and users of intelligent traffic systems. "I anticipated this some years ago," he says. "I founded my own venture capital group that started investing in this mobility space at a time when the OEMs weren't really that interested."

Now that the rest of the world is beginning to catch up with Ford's vision, he's keen to drive cooperation between industries. "There's no shortage of things we can work on together," he says. "We can work on the hardware side, on V2V and V2I communication. We can work on safety, which will ultimately lead to autonomous driving. We can work on policy issues as they pertain to the adoption of new technologies. And also we can work with city planners as we think about optimizing urban driving."

The autonomous revolution

In the research labs and testing centers owned and sponsored by Ford, work has already begun on developing next-stage vehicle technology. "We are working on pilot programs for both V2V and V2I in the USA and in Europe – in some cases with consortium companies, in other cases with universities. A lot of these features are going to be coming in really soon.

"On the road today we already have park assist, we already have lane-keeping, cruise control… adaptive cruise control that keeps the same distance between cars. We are starting to migrate these technologies into

Part of the most famous auto-manufacturing dynasty in the world, **William Clay Ford Jr** is a man on a mission to revolutionize mobility, and a leader with a vision that stretches over the next 20 years and beyond

Interviewed by Tom Stone

more vehicles. We are doing our best to try to democratize technology and bring it to as many people as we can."

Furthermore, the next major step toward driverless cars is already at an advanced stage of testing at Ford. It's a dramatic illustration of just how quickly autonomous features are being developed. "We are working on something we call Traffic Jam Assist," explains Ford. "This will basically allow the car to accelerate, steer and brake autonomously in tough traffic conditions. That's just one step short of full autonomy.

"It's funny because people often ask me, 'When will we get to autonomous driving?' and my thought at the moment – subject to change, because everything is changing so quickly – is that by the time we get there it won't be a big deal because a lot of these features will already start to come into the vehicle. It's really that last step to full autonomy that is really the most difficult. Because after that nothing can go wrong. It's hard to predict the absolute timing for that, but all the elements that will lead up to it will start to come quickly.

"The ultimate goal of fully autonomous driving is to have much safer vehicles. If you eliminate driver error you can eliminate a lot of issues with safety. I think two things are really driving a lot of these innovations that we're talking about: one is safety and the other is congestion. They both require a level of technology that we've not seen before."

Solving global gridlock

Back in 2011, Bill Ford was the first leader in the automotive industry to put the brakes on the forecasts for car sales. While some saw

A short history of the Ford family at the Ford Motor Company

1896 Henry Ford builds his first vehicle. The Quadricycle is a buggy frame with four bicycle wheels.

1903 Eleven original investors officially incorporate the Ford Motor Company. Its first car, the Model A "Fordmobile' is launched; 1,708 of them are built.

1908 The legendary Model T is introduced. Henry Ford said, "I will build a car for the great multitude. It will be large enough for the family, but small enough for the individual to run and care for." 15 million are made up until 1927.

1919 Henry Ford's son Edsel succeeds him as company president.

1921 Ford produces over one million cars per year, almost 10 times more than its nearest rival, Chevrolet.

1945 Edsel's eldest son Henry Ford II becomes president of the company.

1949 Edsel Ford's youngest son William Clay Ford Sr becomes an employee of Ford Motor Company, joining elder brothers Benson and Henry Ford II.

1962 The first generation Ford Cortina is launched. It dominated the European mid-size family market for 20 years.

1964 The Ford Mustang is launched. It started the 'pony car' class of affordable, high-performance vehicles.

1968 In the USA, the Lincoln Mark Series, the company's first luxury car, is launched. Ford of Europe launches the first-generation Ford Escort.

1979 William Clay Ford Jr (Bill Ford) joins Ford Motor Company as a product planning analyst.

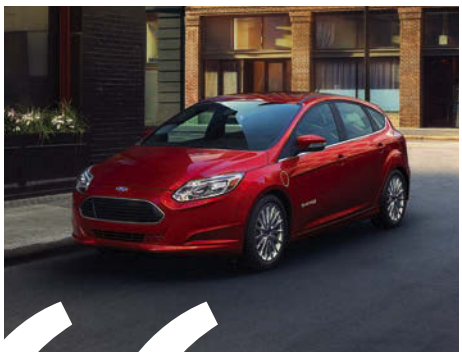
1997 Ford sells the first taxicabs run on natural gas to New York City.

1999 Bill Ford is elected chairman.

2005 The Ford Escape Hybrid, the world's first hybrid-electric sport utility vehicle, is named North American Truck of the Year.

2011 Bill Ford first raises the issue of urban mobility at the TED thought leadership conference.

2012 Bill Ford outlines his Blueprint For Mobility at the Mobile World Congress.



(Far left) **The 2015 Ford Focus Electric is part of the company's move to alternative fuel types** (Left) **Ford's Traffic Jam Assist takes over braking and steering duties when its forward-looking radar detects traffic ahead**

> We're a mobility company. We're not just a car and truck company… The purpose of any corporation is to make people's lives better

a world population growing from seven billion today to nine billion by mid-century as simply an expanding market, Ford had a different take on the situation.

"People in our industry were just looking at those numbers and saying, 'Great, we're going to sell a ton more vehicles in the next 50 years,'" he says. "I took a step back and I said, 'I don't think so. Because, where are they going to go? And how are they going to move?' We need to urgently get involved solving urban mobility problems."

Ford sees this not simply as a business or economic issue. For him it's even bigger: it's about human rights. If gridlock gets so bad that essential services like food and healthcare can't get through, then a traffic jam could become something that causes real, long-lasting harm.

"Governments all have a self-interest in solving this issue," he says. "Right now everyone is adopting different Band-Aids, if you will. Some cities ban cars from their centers, others only allow license plates on odd/even days. Others charge high fees to drive into city centers. Cities around the world are all grappling with this. Ultimately we need to take a better and more coordinated leap forward."

Ford sees the coming autonomous driving revolution as key to coordinating efforts and solving one of the most potentially serious global problems of the coming century: "As we start to bring on stream some of the V2V and V2I stuff, it opens up more possibilities. For instance, one thing you can do with autonomous driving is to have denser driving and parking patterns, which will deliver better flow. Technology will enable vehicles to find spaces and let their owners go right to them."

Reducing congestion today

While clearly no one wants the 21st century to grind to a halt halfway through, traffic jams are something industry and road users alike would like to tackle immediately, without having to wait for the benefits of autonomous technologies to start gaining traction. Ford's more immediate solution isn't tied up with selling more cars. If anything, he believes a better world, at least in the short term, will be one where we can limit the number of vehicles on our roads. He points to car-sharing schemes such as Zipcar, and smartphone-based taxi services such as Uber and Lyft, as the forward-thinking technologies of today that will help to shape the future of mobility.

"A few years ago I was speaking at an environmental conference and the CEO of Zipcar spoke too. I grabbed him afterward and said, 'Let's go and have a cup of coffee and we'll figure out how we can work together.' He said, 'Didn't you listen to my pitch? My pitch was about getting more cars off the road." And I said, 'Yeah, I did. But it's going to happen with or without us and I'd rather it happened with us.' So the net result was that Zipcar and Ford together went onto over 250 college campuses and it's been a great program for both companies."

Fueling the future

The final piece of the jigsaw in Bill Ford's vision of the transportation of tomorrow is fuel type. Whatever replaces the internal combustion engine, its success will be critically dependent on big changes to infrastructure. In the current atmosphere of change, Ford is bullish about the possibilities. "I think it's very promising," he says, "partly because so many other technologies we've discussed will also require big changes to the infrastructure.

"Fuel type seems to change every few years. It used to be that the Holy Grail was hydrogen, then it became biofuels, and we're still working on both of those as well as on compressed natural gas and clean diesel. But at Ford we are placing a big, big bet on electrification – both pure electric and hybrids."

Better together

Ultimately for Ford, the future is about cooperation. The challenges facing mobility over the next 50 years are too huge for one company or organization to solve alone. As proof of this, rather than seeing the young 'automotive upstarts' at Google as challengers to the reign of the old guard, Ford welcomes them into the fold as allies in the battle for a better future: "We can look on everyone who is coming into our space either as potential enemies or potential friends and I tend to look at them as the latter. Whether they're marketing new forms of ownership, or they're new technology providers, there are a lot of great companies out there who are interested in this space and we want to work with all of them."

Ford's vision extends even beyond automobiles, however, to a world where all modes of transportation seamlessly interconnect. "Everything is going to have to be on a single network if we're really going to optimize how people move around large cities," says Ford. "We're a mobility company. We're not just a car and truck company. I believe – and I've always believed – that the purpose of any corporation is to make people's lives better. If I believe that (and I do) then you can't get stuck in any rigid business model. You have to anticipate change and be part of a that, if you're going to make people's lives better."

And that change is beginning now, right here in Motor City – a metropolis ready to boom again. "Michigan has more engineers than any other state," says Ford, "and they are the ones who are going to be developing these technologies." ○

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VicRoads' director of operations, Dean Zabrieszach, knows advanced traffic management will play a vital role in shaping Melbourne's future

Interviewed by Max Glaskin

> You feel invigorated when you do well and disappointed when you don't – but at least satisfied that you're making a difference

It's the end of another working day and Dean Zabrieszach, who's now in his 15th year as director of road operations for VicRoads, is preparing to join the hundreds of thousands of other commuters on the roads of Australia's fastest-growing city. "It's dark, it's rainy, it's windy and it's cold: it's Melbourne at its worst," he says. "I'm dreading walking outside."

However, there's no hint in his voice that life is anything but sunny and his energy could change climates.

Zabrieszach arrived Down Under as an infant immigrant with his Italian parents in the 1950s and was unable to speak English when he started school. Nevertheless, he is now a university graduate, with a 30-year career at VicRoads under his belt.

"As immigrants from a less privileged European country, my parents were always very much about improving yourself, forging a career, becoming a university graduate," he says. "I had an aptitude for the sciences, so engineering became a possibility. I would've loved to get involved with aeronautical engineering but I chose civil engineering because it makes a visible difference to everyday community life, whether it's roads, bridges or buildings."

For the first four years after graduating, Zabrieszach found work in mechanical engineering, for a company making centrifugal pumps. Then, in 1984, a friend working for the predecessor of VicRoads told him they needed people to work in the emerging area of dynamic traffic signals. He got the job.

"I soon realized that what I did there made a real difference to the community," Zabrieszach remembers. "In the transport industry, everything you do on a daily basis can be seen when you walk out the door. You feel invigorated when you do well and disappointed when you don't – but at least satisfied that you're making a difference."

Zabrieszach first made a difference by implementing SCATS (Sydney Coordinated Adaptive Traffic System) in Melbourne, the first such implementation outside Sydney. It's now in 150 cities worldwide. "With others, including Brian Negus, the current president of ITS Australia, we converted every Melbourne traffic signal to SCATS," he describes. "This put in my mind the idea of traffic management, transport management or ITS."

Growth and intelligence

Zabrieszach has occasionally strayed from ITS during his 30 years at VicRoads, albeit briefly. For a short period he worked in legal services, where he helped write the road safety traffic regulations in plain English. He also managed a construction project to extend a tram route. During a period when he had to recommend how such road maintenance funds should be allocated, his eyes were opened, widely, to the costs.

VicRoads also evolved during this period. Its infrastructure is valued at up to A$20bn (US$18.6bn) and its ITS infrastructure at up to A$1bn (US$900m). "Maintenance is at the forefront of our minds because you've got to keep it operating well in order for people to see the value of it," says Zabrieszach.

Victoria is the smallest of the five mainland states in Australia, but it is the most densely populated, with 5.5 million citizens, 4.5 million of whom live in the city of Melbourne. Its traffic signals may

be adaptive but so must the city be because it has to prepare for rapid growth. By 2030 it's expected 6 million people will be living there and 8 million just 20 years later.

VicRoads has 2,500 people aiming to keep 13,980 miles of roads flowing smoothly. The authority is also responsible for handling the registration and licensing of all drivers in the state. Zabrieszach's department of road operations has a team of 125 people, spread across the traffic management center: incident response crews, intelligent transport systems staff and administrators. "My remit is to get as much out of the road network as possible," he says.

Like the roads it administers, VicRoads is itself part of a network. It shares its knowledge and experience regularly with its equivalents from the other five Australian states and New Zealand, through the umbrella organization AustRoads.

"We also work closely with a number of toll road operators," says Zabrieszach. "Melbourne was the first city in the world to have multilane free-flow tolling via the Transurban company on the CityLink road. No one slows down, no one throws money in buckets, every lane is free flow. Right now we're working with Transurban to improve their road in addition to improving state roads, with contributions both from the company and the state government, to get more out of the existing network."

The plan is to add extra lanes to the tolled section of Tullamarine Freeway, which runs from the city towards the airport, by narrowing existing lanes in the next couple of years. "We are also forging ahead with our managed motorway system," says Zabrieszach. "We have coordinated metering on every ramp into the freeway – each ramp communicates with upstream and downstream ramps, so, collectively, they control the amount of traffic entering the freeway."

Expense and expectations

Such advances do not come cheap. Part of the CityLink project was to put two tunnels under Melbourne for an east-west corridor and this was upgraded in the mid-2000s for A$1.4bn (US$1.3bn), with a motorway management system costing A$120m (US$112m). The A$2.5bn (US$2.3bn) upgrade to the western ring road is nearing completion and it has a managed motorway system, too. The government is expected to sign contracts soon on an A$8bn (US$7.4bn) tunnel to the north, which will create a massive ring around the city. Work is also about to start on a rail link from the airport to the central business district.

"The pressure on systems is enormous and this is matched by the expectations of the public," describes Zabrieszach. "Twenty years ago people accepted that government was doing what it did. These days the community has much broader expectations and they expect things to be done quickly and correctly. They expect us to manage the network on a day-to-day, minute-to-minute basis, in a way that minimizes impacts on them. My biggest challenge is to make sure that people get home as quickly as they can and can enjoy the city they live in."

'Livability' is a touchstone for Melbourne and transportation is crucial to this quality. Indeed, the city won the right to host the 2016 ITS World Congress partly through having been voted the world's most livable city five times in the last decade. Of course, its widespread application of advanced ITS will also have swayed the decision, as will the city's pleasant spring climate.

"My daily commute is typical of so many people in Melbourne," says Zabrieszach. "It's approximately a 45-minute drive and it's been that for quite a while. Occasionally it'll be about an hour, but being in the industry I know there will be a good reason for that. You've got to have some patience, you need to tolerate adverse weather conditions and incidents because trying to get home those few minutes earlier isn't worth it if you end up not getting home at all. First and foremost, it's about safety."

A day in the life

Dealing well with emergencies is one of the hallmarks of a well-run government department. And at VicRoads they get plenty of practice. "Incidents, delays, injuries, fatalities – they happen on the network all the time and they are a part of my typical day. When one occurs, when the pressure's on, we all lift our game," says Zabrieszach. "In my job the pressure's on all the time – every morning, every evening, whenever there's a major event.

"It's all about making sure my traffic management center is well staffed; that it's getting through the 350,000 annual calls from the public; that we've got enough resources in there. The incident response team needs to be able to get to the site of the incident as soon as possible. They need to be able to phone me – at any time of the day or night. These are the days that keep me enthused. The days that are a bit more mundane are few and far between. I love my job, I seriously do."

(Left) **Variable message signs are just one of the many tools available to operatives charged with keeping Melbourne moving, at VicRoads TMC**

> My biggest challenge is to make sure that people get home as quickly as they can and can enjoy the city they live in

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  World´s first nationwide single gantry solution for multi-lane free-flow tolling – now in the fourth generation

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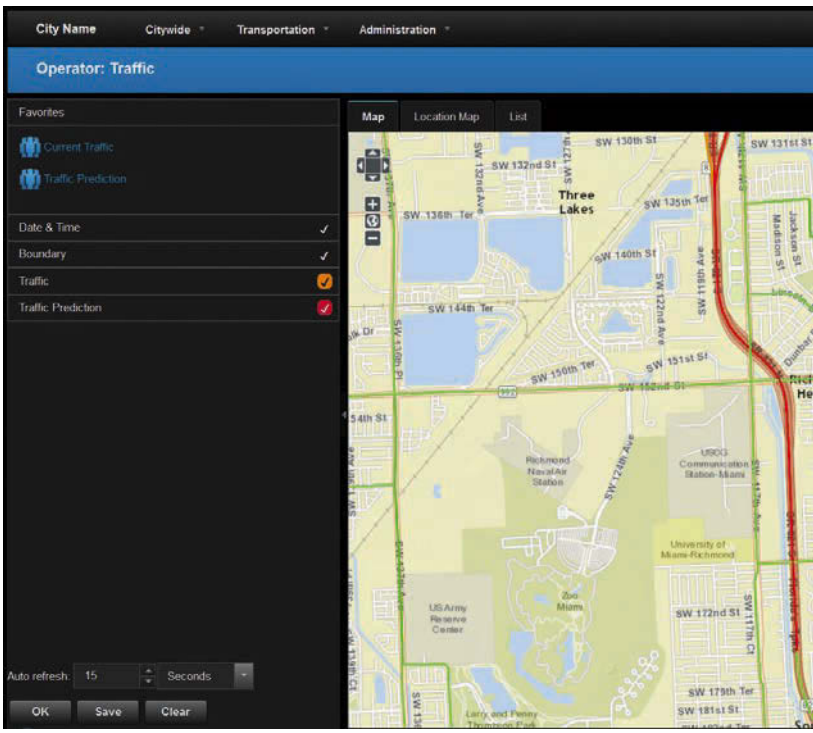
The predictive transportation management center for smarter cities

According to forecasts by the Organisation for Economic Cooperation and Development (OECD), the number of vehicles on the world's roads will exceed 2.5 billion by 2050 (from an estimated 1.1 billion in 2011), and freight volumes could meanwhile grow by a factor of four. In many cities, the current transportation network will not be sufficient to handle the increase in capacity and, with shrinking budgets, DOTs will be unable to afford to expand or upgrade their infrastructure. Also, fast-growing cities in emerging markets will struggle to keep up with the required growth.

"Building more roads is not the answer," says Eric-Mark Huitema, global manager for smarter transportation at IBM. "Not only is it too expensive, it is not sustainable, nor practical. As a result, transportation problems, such as congested freeways, city gridlock, pollution and ineffective parking, will escalate, along with over-crowding and inefficiency of public transport. The only solution is to exploit advances in technology to optimize existing assets.

IBM's intelligent transport systems enable city authorities to maximize the capacity of their existing infrastructure without the need for expensive upgrades. The company's latest solution – the Transportation Management Center (IBM TMC) – has been devised to facilitate reduced congestion, improved operational efficiency, improved traveler safety, faster incident response and reduced pollution in urban environments.

"The IBM TMC is an important part of our Smarter Cities strategy," explains Huitema. "We've spoken to road and city authorities around the world. They have told us that they need a flexible solution that enables the collection and distribution of real-time information in an accessible format. IBM's TMC has been engineered to provide DOTs with accurate insight on the current and future traffic situation, combined with the ability to influence transport demand and provide personalized travel information to citizens in real time.



Need to know

Modern cities need a predictive Transport Management Center with open architecture

- The IBM TMC integrates multiple sources of data relating to traffic conditions, operations, assets and incidents into a standard information model that supports advanced analytics
- In July 2013, IBM signed an agreement with Apple that will see the two companies working together to create smarter, more accessible transportation solutions

A connected world

Modern travelers are becoming increasingly reliant on the dynamic, real-time information provided by smartphones and social media.

"This can be a challenge for traffic managers because people can ignore information presented by variable message signs (VMS) and other roadside infrastructure in favor of mobile-based intelligence," reveals Huitema. "As a result, travelers can often know more about the traffic situation sooner than the traffic managers do."

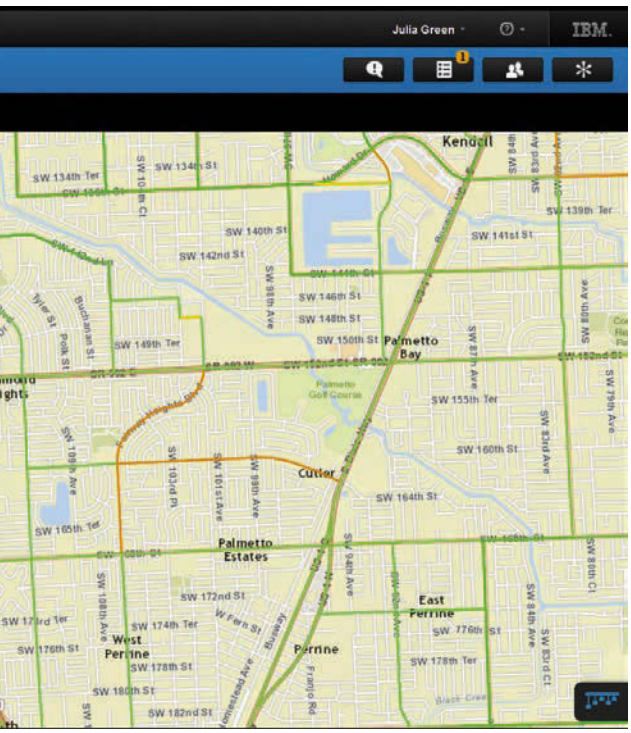
As IBM's TMC solution is not affiliated with any equipment vendors, it has the flexibility to amalgamate and manage traditional equipment together with open-data fusion and emerging sources, such as in-vehicle information gathered from connected-car sensors.

Most traffic management centers are limited by the fact that they only cover one particular area and only monitor road traffic. If cities are to become smarter and more multimodal, all forms of transport within a city need to be managed as one integrated network. By collecting and analyzing information from all available data sources, the TMC is able to provide transport managers with situational awareness for all modes of transportation throughout an entire city.

Incidents and events

IBM's TMC approach to congestion is unique in that it uses traffic-flow data and prediction models to estimate where and when a traffic incident is likely to occur. "This way, cities are able to deploy recovery vehicles or police cars in anticipation of a road incident," says Huitema. "To prevent accidents from happening, based on TMC predictions, vehicles can be rerouted, or managed using ramp metering and traffic lights.

"Furthermore, the solution enables traffic managers to send out messages via individual messaging systems, like 4G and digital radio, or social media,



(Right) **The benefits of IBM's TMC solution**
(Left) **The TMC solution provides traffic predictions based on real-time data and advanced algorithms**

Reduce costs and operational inefficiency **Up to 10%** ☑	**Improve** commuter safety and travel experiences **Up to 15%** ☑	**Accelerate** incident response times **Up to 25%** ☑
Provide more-accurate and timely citizen advisories **Up to 60 minutes earlier** ☑	**Increase** traffic flow, transit ridership, occupancy and revenue **Up to 25%** ☑	**Decrease** or defer infrastructure investments **Up to 20%** ☑

Result: Transformative, centralized management of traffic and transit operations built on advanced analytics and collaborative processes

to provide drivers with highly personalized information."

This is particularly relevant in the case of a major event. "Our transport management capabilities were used to analyze and predict, and therefore manage transportation during the 2012 Olympic Games in London and the 2014 FIFA World Cup in Brazil," Huitema reveals. "Transport is a fundamental part of a city's functionality. The TMC enables authorities to predict and prepare for how a traffic incident will affect city operation as a whole."

Another major cause of congestion is freight traffic. "If there are a number of heavy-goods vehicles all heading toward one depot at 9:00am, it will hugely impact congestion in that area," says Huitema. "However, using intelligence gathered by the TMC, we can advise half of those vehicles to visit an alternative depot. Not only does this reduce localized congestion, it also ensures that the freight vehicles are able to get where they need to be more quickly, reducing fuel consumption and enhancing efficiency. It's a win-win."

Flexible friend

As the IBM TMC is a modular and open system, it can be implemented as a solution to exploit existing transportation infrastructure, or as a transportation management system in its own right.

"It's ideal for cities in emerging markets as it's much more cost effective than implementing traditional TMCs," says Huitema. "The solution is already proving successful in numerous cities in Asia and the Middle East." It is also suitable for smaller urban areas that have less money available than major cities.

When used as part of a city-wide management system, the TMC can also be extended to manage other assets, such as water, and to manage emergencies in greater detail.

Various elements of the TMC have already been implemented in numerous cities all over the world, including the German city of Cologne, where a smarter-traffic pilot took place last year to predict and better manage traffic flow in the city, using existing infrastructure.

The solution can also be integrated with parking applications. "The system communicates with drivers in real time to let them know where there are parking spaces available," describes Huitema. "This reduces the amount of time that drivers spend on the roads looking for a parking space and therefore reduces congestion. At the same time, profitability for parking operators is maximized as spaces will not be left empty."

The advanced flexibility of the TMC means that it can be used as part of wider transportation solutions, such as road-user charging and multimodal transport.

It can also be extended to handle real-time data gathered from emerging in-car and connected vehicle technologies.

"We're already working with several large car manufacturers to develop solutions for the connected vehicles of the future," says Huitema.

A personal journey

As cities grow, people will be increasingly encouraged to opt for the most efficient, sustainable mode of transport. This could be a combination of cars, public transport, cycling and walking.

"It's difficult to create change as people are, in general, resistant to it," says Huitema. "But, with the intelligence gathered by our TMC, DOTs are able to send out highly personalized travel information to individuals, advising them of the easiest, quickest and cheapest way to make their journey. Furthermore, by tapping into social media and mobile applications, cities can connect with their modern travelers in a meaningful way. ○

Never stop – continuing the path of traffic camera trends

Machine vision (MV) cameras have come a long way since the days when they were used solely in industrial applications. As their use has grown, mass production has driven down prices, opening up new markets and increasing their affordability.

Basler is an expert in the manufacture of both MV and IP (internet protocol) cameras, and as such is well positioned to provide a wide range of cameras for versatile ITS solutions.

"For industrial MV you usually need raw, uncompressed images," says Enzio Schneider, ITS market manager for Basler. "On the IP side, this isn't the right way to collect the data. The images are compressed to JPEG or H.264 so that you can have a lot of cameras on one network without overloading the bandwidth."

The choice of camera in ITS depends on what it is being used for. "One of the main segments in ITS that we focus on is enforcement," says Schneider. "Another field is tolling. And there are some other applications, such as tunnel security, where you have video analytics to detect accidents to make sure that emergency alerts are issued as quickly as possible.

"And then you have what I would call low-end traffic applications. Or in other words regular traffic surveillance, which can be done with cheap analog and IP cameras. Basler focuses more on high-end, high-performance applications like ALPR, which is a big part of ITS.

"Usually for this our customers use a combination of two MV cameras. In Europe we have pretty simple license plates and our customers can capture them with IR light with an 850nm wavelength. This doesn't distract the driver because it is almost invisible."

Basler's IP Fixed Box with lens fitted

Modern MV cameras in the tolling and enforcement fields have a very good image quality for the ALPR algorithms. "For this you need very crisp images and highly sensitive cameras, because the cars are usually passing very quickly," says Schneider. "So the exposure time for getting the snapshot needs to be very short, otherwise you will have motion blur, etc."

Sensor revolution

The traffic business is highly focused on specific sensors. The sensor is a key factor in choosing the right camera for the different applications. "Sony CCD sensors have been very successful over the past 10-15 years in traffic,"says Schneider. "But this recently changed because CMOS is becoming more attractive in terms of performance and price.

"You don't get any blooming or smearing with CMOS, which can be caused by bright sunlight. The sun or a very bright light source will cause distortions through the whole image, from the top to the bottom. This is a problem with CCD, but not with CMOS. This is why CMOS is much more attractive for traffic, because in many situations you will have a very bright light sources in the image: either from the headlights on the cars or the sun. So CMOS is much better performance-wise than CCD nowadays."

Basler predicts that the upcoming Sony CMOS sensor with Global Shutter (IMX174) will be very attractive for the traffic market. This sensor will be provided on Basler's new models in the 'ace' series and soon in the BIP2 family.

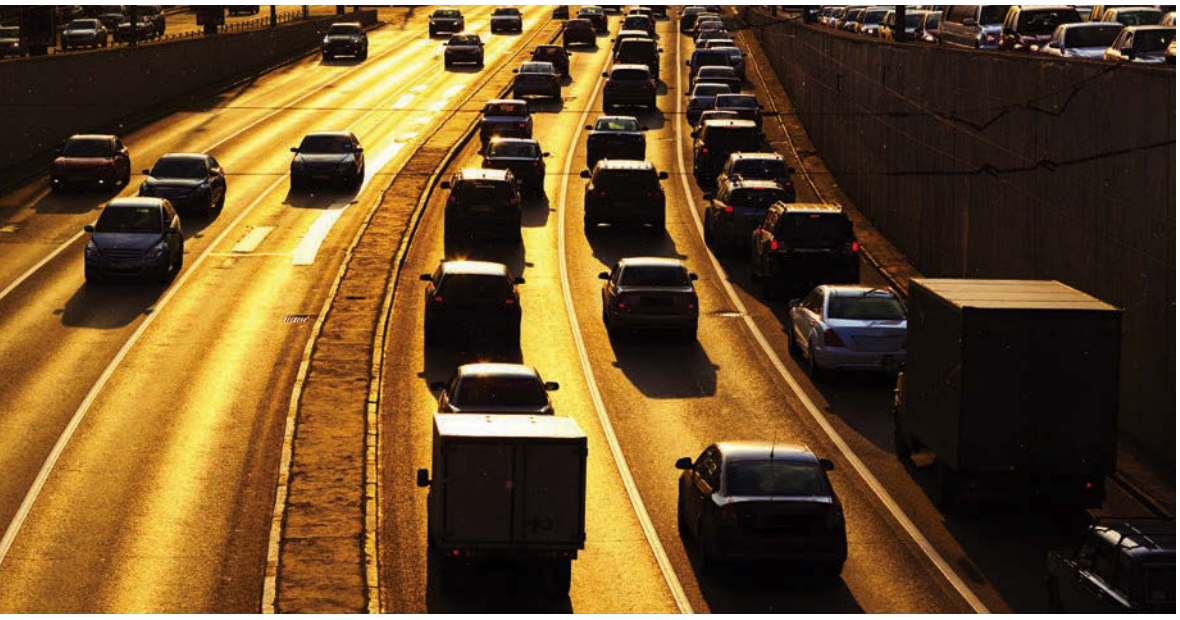
"If you are only looking at the traffic sector, CCD cameras are not the right choice," says Schneider. "They are overpriced and the technology is not developing as quickly as CMOS right now.

"Ten years ago it was different, because CCD had a much higher sensitivity and lower noise levels, so you got better image quality. Nowadays CMOS is as good as or even better than CCD."

Need to know

Why CMOS sensors have overtaken CCD to become the new traffic standard

- **Price point** CMOS sensors are significantly cheaper than CCD
- **Frame rate** CCD can only achieve 5-10 frames per second at high resolution. With CMOS you can get 30, 60, 100 or 150 frames per second
- **Image quality** With CMOS you get none of the 'blooming' or 'smearing' associated with CCD



(Above) **Fast-moving traffic requires advanced cameras**
(Left) **The Basler ace MV camera and IP Fixed Box without lens**

Switching from a CCD to a CMOS setup is straightforward as the back-end data and interface is the same on both types. "It's easy," says Schneider. "You get better results and a higher speed at a lower price."

Double vision

While MV cameras are at the cutting edge of technology, the fact that Basler manufactures IP cameras as well is convenient for customers as, for some ITS applications, both types are necessary. "For red light enforcement, you usually take a snapshot of the driver, and you also need a video nowadays so that you can prove that the car really passed the light when it was red," says Schneider. "A video stream would provide 100% proof in the event that the driver contests the case."

In these situations, it makes sense to combine an MV camera, to capture the license plates, with an IP camera, to grab a video of the offense. These cameras can be triggered by ground loops or, in applications like speed enforcement, by a laser or radar device.

Future thinking

Looking ahead to the future of camera technology, Schneider sees potential for consolidation of many systems into one streamlined solution.

"In some places in China, you can see traffic lights that have 10 cameras on top of them," says Schneider. "This doesn't make sense at all, especially from an investment point of view."

However there are currently legislative barriers to complete integration of technologies. In Europe there are stringent privacy regulations that mean you aren't allowed to mix enforcement systems with regular surveillance applications. "In some regions you don't have this limitation" says Schneider.

"I think that the next logical step is that most of the systems are standardized, so you have just one or two cameras, or one camera per lane, to capture license plates and do all the front-end stuff. All the differentiation, such as enforcement, tolling and regular surveillance, will be done at the back end. A first step has been made in one of Basler's projects, where the integrated IP camera of a red light enforcement system also provides a constant security video stream to a traffic control center, alongside the red light enforcement duties."

Schneider even points to the possibility that in 20 years some ITS cameras will be obsolete. "With interconnected cars we will always be able to tell how fast and where cars are going," he says. "So you probably won't need any kind of speed enforcement."

Nevertheless, having moved with from industrial machine vision to ITS, Basler is adept at expanding into new markets.

"In 20 years Basler will still make cameras," says Schneider. "It's hard to say exactly what their applications will be – 20 years is a long time. Beside ITS there are other segments and applications which might be interesting for Basler in the future like retail, security, face recognition and medical applications." ○

Smart traffic sensors help to alleviate congestion in Moscow

Moscow is one of the largest urban centers in Europe. The city surges with up to 16 million people during the day, and about six million cars – the number of which is growing rapidly. This results in very high traffic density. Recently, the city of Moscow was ranked number one in a congestion index of the world's major cities. While the average time it takes to get from one point to another during rush hour is increasing in Moscow, the city also has the highest percentage of delays compared with others in Europe. Istanbul, Warsaw and Marseille are ranked second, third and fourth respectively.

In order to tackle this problem, Moscow city authorities mandated the creation of ITS Moscow, a joint project between the federal government and city officials, aimed at fighting Moscow's traffic jams. Approximately €200m (US$268m) is planned for investment in ITS as part of the project, which is expected to last through 2015. ITS Moscow includes the development and maintenance of an intelligent transport system, which should reduce major road problems and congestion in the city. Officials hope the system will reduce traffic by more than 20%.

(Left) **More than 3,000 TrafiCam x-stream sensors will be installed at traffic light controlled junctions** (Right top) **The device provides MPEG-4 or H.264 streaming color video at full frame rate** (Right bottom) **The sensor combines a CMOS camera and video detector**

Need to know

Intelligent technology enables highly efficient traffic light operation in Russia's capital

- Moscow's road network comprises 22,324 miles, including 231 miles of highway
- The TomTom 2014 European Traffic Index rated the city's congestion level at 74%
- According to the report, the busiest times to travel are Tuesday mornings and Thursday evenings; the quietest times are Friday evenings and Monday mornings

Smart intersections

An important part of the ITS Moscow program is the creation of 'smart intersections', where smart sensors from FLIR Systems are monitoring the city traffic. More than 3,000 TrafiCam x-stream vehicle presence sensors are installed at various busy road junctions controlled by traffic signals.

With four TrafiCam x-stream sensor units per intersection, FLIR's technology ensures the efficient operation of more than 750 intersections. By detecting both waiting and approaching vehicles, these intelligent all-in-one cameras will be used for the optimization of traffic signal timings. As such, FLIR's TrafiCam x-stream sensors help cut waiting times at traffic lights.

"Based on information from the TrafiCam x-stream sensors, the intelligent system can alter traffic signal cycles in real time to respond to changing traffic conditions," explains Artem Kryvobok, international business development manager at FLIR Systems. "Once fully operational, the total amount of FLIR sensors is expected to noticeably cut waiting times at Moscow traffic signals."

The TrafiCam x-stream vehicle presence sensor combines a CMOS camera and video detector in a single unit. The integrated sensor is an affordable solution for the detection and monitoring of moving and stationary vehicles at signalized intersections. Via detection outputs or IP protocol, vehicle presence information is transmitted to the traffic controller so that signal timing can be adjusted dynamically.

This way, traffic flows are optimized. The smart TrafiCam x-stream sensors are a reliable alternative to inductive loops.

The FLIR TrafiCam series enables traffic operators to precisely position and verify the vehicle presence detection zones. Since these zones are displayed on a video image, they can easily be repositioned as the traffic demands.

Optimum performance

"A pilot project with TrafiCam x-stream sensors from FLIR Systems was previously carried out in the streets of Moscow in 2012," says Kryvobok. "After thorough evaluation by the project authorities, the system was rated as the most effective technology solution.

The FLIR sensor was able to provide accurate detection, even in the heavily polluted conditions of Moscow. High

levels of vehicle emissions can cause traffic-camera lenses to become dirty, which can jeopardize detection, but TrafiCam x-stream had no issues with that."

Moscow city authorities also value the ability to visualize the camera streams in the traffic management control room. TrafiCam x-stream is an IP-addressable device that provides MPEG-4 or H.264 streaming color video at full-frame rate to the control center for general intersection surveillance. A user-friendly web interface enables the control room operators to manage their video sources online.

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According to the New York City Taxi & Limousine Commission, there are currently about 13,500 yellow taxis in New York – some 1,700 more than when I was Traffic Commissioner for the city in the early 1980s, and a few hundred less than when the taxi fleet became regulated during the Great Depression.

Society relies on regulation to create stability and provide for public interests. The regulation of taxis through a controlled supply of medallions – which govern the privilege of picking up passengers on the street – was introduced to address the problem of too many taxis in destructive competition.

But we are also a technologically inclined species, always pursuing innovations that will benefit society. The ubiquity of mobility technology in just the past few years has enabled peer-to-peer ride-sharing services such as Uber, Via, Lyft, Sidecar and Bridj – a pop-up mass transit system being piloted in Boston. These services are relied upon by the younger generations.

Unfortunately innovations in transport technology and the potential benefits to the public are becoming mired in a policy gridlock. In the face-off between the taxi industry and ride-sharing start-ups, there are valid arguments on both sides. Taxi operators who have made investments based on certain realities cry foul over changing the rules of the game, while consumers and entrepreneurs bemoan what seem like unfair restrictions.

Before we can extricate ourselves from these quagmires, we need to understand the contexts that created them. While technological innovation is enabling the traveling public to make faster, more dynamic choices, the rules regulating our transportation system haven't changed much in over a century. The taxi medallion system in New York is exemplary. Operating under a restricted supply for nearly 80 years, it has inadvertently established deeply entrenched property rights. A single medallion that sold for US$300,000 in the year 2000 now fetches about US$1m.

So how do we handle all these new de facto transit systems created by apps? Carefully, I say. Taxi owners already feel threatened and recently filed suit in Chicago over the perceived regulatory double standard. Do we wipe out the assets of existing taxi license holders? Does Bridj lead to big losses for existing transit systems? If we go to the individual car service model for everyone, will we end up by reducing mobility as gridlock ensues? Then again, how can we not take advantage of the very latest technology?

I also recognize that good transport is fundamental to economic competitiveness. With the global economy still in recovery, it's a shame when beneficial innovations aren't adopted quickly. Lengthy legal battles, regardless of who 'wins', swamp good ideas in controversy. Instead, we need industry to collaborate with government, creating technology-supporting policies that will gain support, benefit the public, incentivize greater innovation and actually increase mobility.

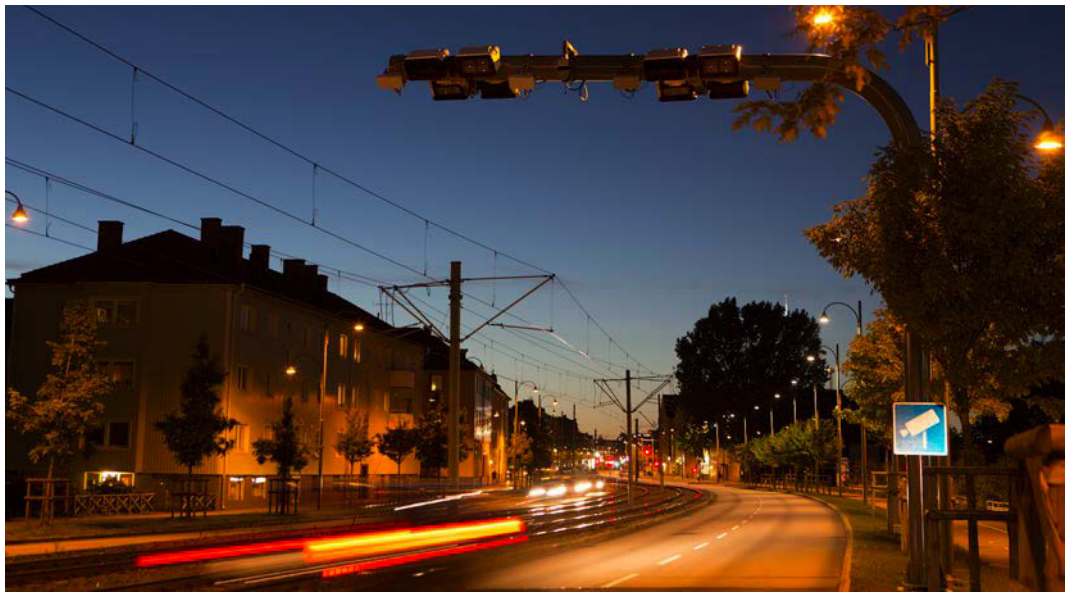
> While technological innovation is enabling the traveling public to make faster, more dynamic choices, the rules regulating our transportation system haven't changed much in over a century
>
> Sam Schwartz, Sam Schwartz Engineering, USA

The technology that will prevent global gridlock

With 30 years' experience and a presence in 18 countries, Q-Free is one of the few international companies totally focused on ITS. As CEO Thomas Falck puts it, "We have been dedicated to traffic technology throughout our history. We have no second agenda. This is what we do."

Q-Free's particular area of expertise in recent years has been in road user charging. It's an area where Falck still sees an abundance of growth and innovation potential.

"Today there are close to 500 cities with more than a million inhabitants," says Falck. "In 15 or 20 years, I can't imagine any cities without a traffic management system.



(Above) **Road user charging is evolving from traditional gantries to free-flow methods**
(Left) **A traffic control center using the latest hardware developed by Q-Free's Elcom**

"Traffic is grinding to a halt all over the world and access to roads will have to be priced. So I see there being a traffic regulation system, some sort of payment system for using the roads."

The new tech

As the needs of cities develop, so Q-Free is developing its technology to meet them. "We have been very much focused on DSRC protocols for the tags and the roadside equipment to monitor passage and carry out transactions," says Falck. "But we are playing with a multitude of technologies. Over the next five to 10 years, things will pan out in terms of what kind of standards will be used for different applications.

"We're playing with RFID-based tags and readers; we are playing with cell phone-based monitoring systems. Often now new vehicles themselves have enough intelligence and technology to monitor and report." But it's not just about trying out new technologies in established fields. Q-Free is also looking at how existing technologies can be given new and innovative applications. "We see ALPR as a technology that can be used not just for enforcement but also as a method of monitoring traffic," says Falck.

In addition to the traditional tags and sensors, Q-Free is now expanding into providing the software that will help traffic managers analyze the data they collect. A more rounded portfolio is helping Q-Free push further than ever into advanced traffic management systems.

"Through our recent acquisition of Open Roads Consulting in the USA, we can build an integrating layer of software on top of sensors that will assemble and provide data to traffic managers and also to drivers. We'll have traffic governance systems for monitoring and guiding traffic, so all our sensors can feed into them to provide a unified standard of data from all those sensors. It will communicate with those who monitor and regulate traffic and could easily communicate with new vehicles in the future."

With this new umbrella software, which all the sensor

Need to know

Through new acquisitions, Q-Free is able to provide complete ITS solutions

- **Open Roads Consulting** Provides traffic analysis at the software level (acquired July 2014)
- **Traffic Design** Specialists in electronic road tolling and traffic control (acquired in April 2014)
- **TDC** Weigh-in-motion, pollution monitoring, cycle and pedestrian monitoring (acquired March 2014)
- **Elcom** Traffic signals, controllers and LED signs (acquired October 2013)
- **TCS** Parking guidance and data specialists (acquired December 2012)

(Left and above) **The latest ALPR cameras capture traffic in all conditions**
(Above right) **Q-Free CEO Thomas Falck is driving innovation**

data will feed into, Q-Free is able to provide a total traffic management solution to customers. Each division of Q-Free will work more closely together in the future.

"We really see now that ITS is becoming a reality," says Falck. "Over the next five years, a lot of testing will be going on but also some standards will be emerging. There is a strong drive in the USA toward open standards, which we have been focusing on since our beginnings. We will be one of the winners that has open-standard technology and sensors on the roadside that provide information to both traffic managers and vehicle operators. This is really where we are going as a company."

The next 20 years

When it comes to long-term plans, Falck is more than happy to also engage in some forward thinking. "We see a few major trends converging," he says. "IT is being applied in a major way to traffic, enabled by a combination of high-precision navigation tools and situation awareness technologies – where the vehicle navigates and orients itself to its immediate surroundings. For this, you must have some sort of GPS or overall navigation system and situation awareness, and this is where we come in. We assemble data and provide information to the motorists, the cars and also to traffic managers.

"We see this as a gradual evolution. Everything in the automotive industry takes a long while. There are a billion-plus cars on the road today and most of them are going to remain there for the foreseeable future, so any new technology being introduced will evolve into the fleet over 10 to 20 years. All these technologies have to coexist."

Part of this evolution isn't just about making vehicles more connected, Falck points to the need to ensure vehicles also communicate with infrastructure. "We have technologies that will communicate with the vehicle and provide data and information to the cars themselves," he says. "We are also in traffic control rooms, intersection management and parking environments.

"We have traffic information that is valuable to drivers, whether they are machines or human. Our information helps with traffic flow and gets it where it needs to be."

The near future

A much closer junction that Falck foresees on the journey to a more connected world is the total merging of the information superhighway with real highways: "We are seeing in the 2017-18 timeframe that there will be a conflux, with the internet making its way into traffic in a major way. We see cars being much more intelligent. We see the standards coming together for communication across the world for vehicles and roadside. We see a strong push toward active safety and for optimizing traffic flow to help avoid unnecessary pollution."

However, Falck predicts that the speed at which change will occur won't always be certain: "We see a lot of technologies are currently in, and evolving into, the marketplace, but politicians and privacy laws will probably slow the speed of implementation. Q-Free is monitoring and playing along with several of these trends."

Ultimately, Q-Free's huge ITS-dedicated knowledge base will ensure it is always at the forefront of innovation. "ITS is not just part of our business. We have total dedication to the sector. We employ 450 people. We have known and seen everything that works and we have known and seen everything that doesn't work. We now touch most of the key areas of ITS and we are putting everything we do together with new acquisitions to make something exciting."

Achieving improved traffic flow with smart, automated solutions

Current estimates suggest that almost 60% of the world's population will live in urban areas by 2025. As a result, some 6.2 billion private motorized trips will take place in cities globally, every day. In order to improve and manage the expected traffic flows, traffic management centers (TMCs) will need to be able to detect traffic deviations early, efficiently and reliably – gathering information about the density of traffic flow and about incidents such as vehicle breakdowns, accidents and fires.

Cameras are a cost-effective way to observe traffic flow in real time, but it is impossible for traffic operators to monitor hundreds, or even thousands, of cameras at the same time. Currently, most TMCs also rely on commuters to report incidents on the roads.

Over the next few years, however, with the unstoppable shift from analog to network video, intelligent video analysis will become much more instrumental in traffic management. Intelligent camera capabilities – often based on detection, tracking or recognition algorithms – are already making it possible for network cameras to automatically alert security operators about incidents such as congestion, stopped vehicles and wrong-way driving. This helps authorities to more efficiently manage the traffic.

Unlike analog solutions, network cameras record images as digital data inside the camera. Each camera features a powerful processor, which can be used to analyze the digital video stream in real time, in parallel with delivering high-quality video. Smart video applications can be downloaded into the cameras themselves – in much the same way that apps reside in smartphones – so there is no longer a need to send a large number of video streams to one central server for processing. Each camera becomes an intelligent device that can independently monitor the traffic in its field of view and decide when to trigger an alarm.

A smart solution

Current intelligent video applications include automatic alerts for slow traffic, queues, vehicles in the emergency lane, accidents and smoke or fire in a tunnel. As incidents are detected early, traffic management centers can react quickly, for example by adjusting variable message signs or traffic lights to minimize the impact on traffic flow. They can make sure that important live traffic information reaches all the relevant stakeholders, and that dangerous situations are dealt with promptly.

A network camera is therefore not only an efficient traffic monitoring tool used to provide a detailed view of the traffic situation, it can also be used as a sensor to automatically detect traffic deviations and incidents. This, in fact, eliminates the need to constantly transfer video from all installed cameras to the TMC for monitoring. The system can be set to automatically display video in the TMC from relevant cameras only when an incident occurs or when an operator requests a live view – achieving a huge reduction in bandwidth consumption.

Image quality is important

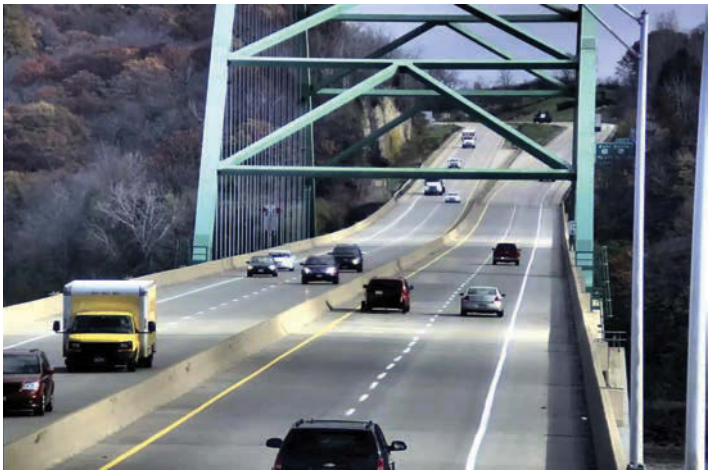
The traffic environment can be demanding with blinding sunlight, bright headlights and wet pavement reflections, which can be difficult for some cameras to manage. At night, it can be hard for traditional traffic

Need to know

Intelligent network cameras are beginning to play an integral role in detecting and managing road incidents

- The collection and sharing of real-time traffic data minimizes injuries and casualties, as well as the time taken to clear the incident and to get back to normal traffic flow. Furthermore, other commuters can take alternative routes and reduce their travel time
- As a result, society benefits from increased efficiency, and pollution is minimized

(Left) **Real-time traffic feeds are monitored in the traffic management center in Manila, the Philippines**



(Right) **Roads in the city of Dubuque are monitored by an IP camera system**

cameras to separate one vehicle from another in the constant stream of moving headlights.

High-end network cameras comprise clever technologies that improve the image quality. A network camera with wide dynamic range technology manages different light levels by using different exposures for different objects in the scene – enabling objects in both bright and dark areas to be visible. This provides a more balanced image scene and a more detailed overview of the traffic situation, and helps TMCs see vehicle and traffic details in challenging light and weather conditions.

Other image quality enhancing technologies that are available in outdoor cameras include electronic image stabilization, which reduces the effects of camera vibrations from wind or traffic itself; and automatic defogging, which automatically detects fog in a scene and digitally filters it out of view.

Intelligent sharing

As network cameras are based on open IP standards, the video stream can be accessed securely and flexibly via a computer or mobile device from anywhere, enabling stakeholder groups such as police, road service crews and emergency services to start assessing a situation even before they arrive at the scene. The cameras can, in fact, produce multiple parallel video streams. For example, they could send a high-resolution video stream to the TMC and a low-resolution stream to the emergency team's mobile devices while they are driving.

If required, network cameras can also be set up so the incident alarm triggers the video stream from the scene to be recorded. Although video streams from analog cameras are not currently recorded as standard, due to bandwidth and storage challenges, the targeted recording of video in the case of an incident can prove very useful in investigating and reconstructing what happened. The high image quality provided by a network camera would make it a powerful tool in understanding the details.

ITS integration

In the city of Dubuque, Iowa, USA, the police use the footage from 260 installed network cameras in order to obtain an accurate account of accidents and other incidents on the roads. Local citizens even use the video to settle disputes over accidents without the need to go to court. The IP cameras have become an integral component of the city's intelligent transportation system.

As the shift from analog to digital technology continues to progress, it has started to make its mark in traffic management. While adoption of the new technologies may be slower in traffic applications than it has been in security, the advantages are obvious and it is only a matter of time before more TMCs switch over to more future-proof, IP-based technologies.

Working together to mitigate the detrimental effects of road transport

Our mobility comes with a heavy burden: every year over a million people are killed on our roads and many more are injured. In addition, a growing number of cities are experiencing high levels of air pollution as a result of road traffic, while people waste hours of valuable time in traffic jams.

Technology helps to lessen the burden; passive and active safety measures in cars are already helping to reduce the number of road casualties. Meanwhile, combustion engines are being designed to produce less exhaust fumes, and hybrid and electrical powertrains are on the rise. Also data collected through connected vehicles and smartphones has improved the quality and quantity of traffic information, which helps to reduce traffic jams.

However, there is a limit to the capabilities of current technologies and new solutions are needed to reduce the burden further, with a view to achieving Vision Zero. It is sometimes thought that autonomous vehicles will solve the problem, but research has shown that simply automating the driving task will not bring about the necessary revolution.

The safety buffers required to drive autonomously are larger than for human drivers. As a result, autonomous vehicles might even make things worse. Take for example existing adaptive cruise control algorithms. They need more driving distance to operate safely than do human drivers, which results in a reduction in capacity on our highways.

What is needed is a paradigm shift. Cars should not operate autonomously, but should be part of a networked system that shares relevant information between network nodes: enter the growing world of cooperative driving.

Advanced facilities

The Netherlands is a leader in the field of cooperative driving. Several years ago, the industry, government and knowledge institutes came to the conclusion that cooperation is needed to solve the major societal challenges that surround traffic. This not only involves vehicle to vehicle (V2V) and vehicle to infrastructure (V2I) cooperation, but also cooperation between companies, governments and knowledge institutes.

DITCM (Dutch Integrated Testsite Cooperative Mobility) is an organization of 30 partners working together to deploy cooperative mobility. The physical results of this partnership are the DITCM facilities, which are close to the automotive campus in Helmond, the Netherlands. As a result of cooperation between Tass International, TNO (the Netherlands organization for applied scientific research), the municipality of Helmond, the province of Noord-Brabant and the national Dutch government, advanced test facilities exist on and around the A270 highway, including a control room and a fleet of automated and cooperative vehicles.

These test facilities have been used for several research studies over the past few years, but with the technology now being ready for market, the facilities have been opened to anyone interested in cooperative or automated driving experiments. For specific experiments, the highway can be shut to operate the facilities as a closed track. Furthermore, all the traffic lights in Helmond can be accessed through the DITCM control room.

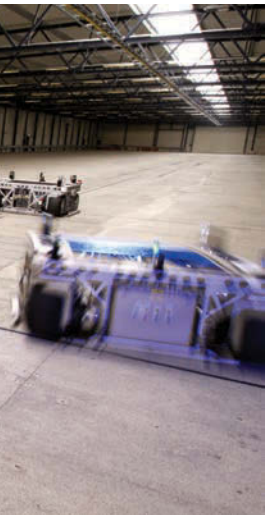
Development tools

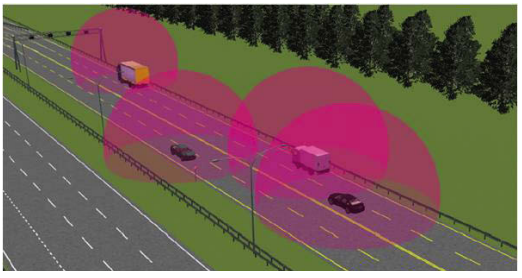
Such real-world facilities are necessary for the development of cooperative and automated systems. Development typically moves in phases – complete system simulation is followed by gradual replacement with physical systems.

Need to know

To improve road safety, cooperation between industry, government and knowledge institutes is crucial

- The Netherlands has signed an agreement with Germany and Austria to develop a cooperative ITS corridor from the harbor of Rotterdam in the Netherlands, through Germany, to the Austrian city of Vienna
- The Dutch are also deploying a cooperative service in thousands of vehicles, which will reduce shockwave traffic jams on the A58 highway





(Left) **The VeHIL laboratory** (Left below) **Tass International reference vehicle** (Above) **DITCM facilities' cooperative, automated vehicles** (Right) **PreScan simulation tool**

First, the impact of a cooperative system (e.g. cooperative adaptive cruise control) is simulated for a road network the size of a city, for example using the ITS Modeler software. With such a simulation, it can be proved that a cooperative system with a certain penetration grade achieves the desired results.

Subsequent simulations, using PreScan software, will be performed in more detail, between several vehicles. PreScan integrates vehicle dynamics, sensor models and V2X communication simulation to develop the correct algorithms at the vehicle level. The software can then be used to perform a gradual move from simulation to real-world testing by going from 'model-in-the-loop', through 'hardware-in-the-loop' and 'driver-in-the-loop' to even complete 'vehicle-in-the-loop' testing in the unique VeHIL laboratory.

Finally, testing can take place on the A270 to prove that what was initially simulated actually works in practice.

Replay the real world

As the simulated world needs to resemble the real world as much as possible, real-world scenarios need to be generated. Although PreScan has an intuitive interface for scenario development, it still takes some effort to build scenarios and the question remains as to how realistic they are.

Tass International has built a reference vehicle that is equipped with multiple Ibeo laser scanners to map the environment around the vehicle while driving. Ibeo software classifies objects (vehicles, bikes, pedestrians) and stores their trajectories in a database. This database can subsequently be downloaded directly into PreScan, so that a real-world scenario is automatically built into a virtual world.

Now that this scenario can be used for simulation, it can also be adapted to 'what-if' scenarios. Furthermore, one scanner maps the road infrastructure, including the lines and arrows on the road. This information provides a realistic road-markings map for simulation purposes. This is much better than the perfect road markings generally used in simulation environments.

The ability to bring the real world into the virtual realm is a prerequisite for automated driving development. Automated vehicles encounter so many unique situations as many more test-drive miles are needed compared with current test driving. Only simulation can provide an affordable, yet robust, test environment for such complex development.

Handling complexity

The world of cooperative driving is complex. One of the most difficult things to manage is the interdependence of suppliers of different systems. Until now, cars have been standalone units that only use information collected by their own sensors. For an OEM, this is an environment they can completely control. But in a cooperative world, the car acts as a node in a network that is out of the control of the OEM. By increasing the amount of other nodes and the information shared, the complexity increases very quickly. This is why testing for interoperability is vital. A dedicated test environment like the DITCM facilities is needed to verify adherence to standards and interoperability between suppliers and versions of cooperative systems.

Eventually, it is expected that a certification process will ensure interoperability between systems from different vendors.

Immediate results

While fully automated driving is still years away, cooperative driving technology is ready for large-scale deployment within current legislative boundaries, and will positively affect safety, emissions and traffic congestion. Additionally, cooperative driving provides a steady base for the implementation of automated driving; first because more information will be available to the automated vehicle, but also because similar testing tools, from simulation to real-world testing, are required to handle system complexity. The software simulation and laboratory testing facilities are already available to support such complex developments.

Broad information sharing through the internet has hugely benefited society. Bringing such information sharing into the largest network of the pre-internet age – our road network – will bring us closer to Vision Zero. In a few years' time we won't be able to imagine a world without cooperative driving.

Free-flow applications call for specialized imaging solutions

Free-flow tolling is a major trend in the ITS world. But the concept of 'free flow', which is characterized by the ability to accurately identify vehicles while they are in motion, at moderate to high speeds, in rapid succession, and in any lighting condition, can also be extended to a range of other ITS applications. These include average speed control, congestion charging, weigh-in-motion, and even red-light enforcement, all of which have similar requirements with respect to the accurate identification of fast-moving vehicles.

This is in contrast to applications such as parking and gated access control where precise identification may be needed, but vehicles are stationary or slow moving. It also differs from applications such as traffic monitoring, where vehicles are in motion but precise identification is not required.

The use of imaging technology

What ties all these applications together is the use of specialized ITS imaging technology. Even in tolling, where transponders do most of the identification, high quality plate images are still needed to handle unregistered vehicles, including violators and on-demand users. In many of the other applications there is no transponder, leaving image-based identification as the only option.

This is where the challenge for free flow becomes evident. Though it is a relatively simple matter to capture a plate image from a stopped vehicle at a well-lit barrier or toll gate, a free-flow application requires a more sophisticated purpose-built imaging solution.

(Above) **The ETC project on Taiwan's national freeway system required a specialized imaging solution**

Need to know

Accurate imaging of vehicles in motion is required for a variety of ITS projects

- Even with a good real-time exposure system, retro-reflective plates can easily get overexposed when the sun is at a low angle
- A total system dynamic range (imager plus real-time exposure control) of at least 120dB is needed to keep plates readable in high contrast lighting situations

Free-flow imaging requirements

For companies implementing free-flow ITS projects, the following can help to identify the right imaging solution.

To begin with, a free-flow imaging system must have a high-speed shutter capability with enough sensitivity to freeze fast-moving vehicles at night when the only illumination is from near-infrared flash units. Road authorities should look for a system that can provide good night-time exposures at shutter speeds of 1ms or less.

Since free-flow vehicles are not restricted to narrow toll booths or gates, the imaging system must be able to capture a lane of moving traffic (plus overlap) with sufficient pixel density across the license plate area (minimum 140 pixels) to maximize readability by OCR software. To achieve this, the requirements are more than 3MP for a single lane and more than 5MP for anything wider.

A sophisticated auto-exposure capability is mandatory to handle the continuously changing lighting conditions that occur throughout the day. Auto-iris lenses are too slow to adjust and are failure-prone due to their moving parts. Instead, there should be an intelligent shutter/gain control that can instantaneously adjust to minimize the effects of shadows, glare and other conditions that cause plates to be over- or underexposed.

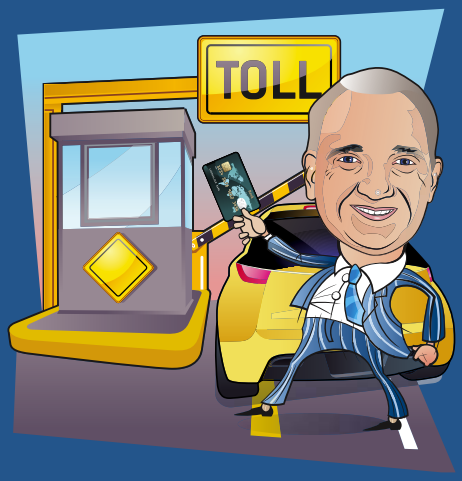
Because most free-flow applications require high-quality imaging around the clock, the best solutions should be able to capture color images in the daylight and use invisible near-infrared flash technology at night, without requiring the cost of two separate cameras or the use of mechanical day-night filters.

(Above) **Free-flow imaging requirements also apply to a range of non-tolling applications, such as average speed control and weigh-in-motion**

A final consideration for a free-flow imaging system is whether to use triggering instead of continuous image capture. While both approaches can work, triggering can ensure that all vehicles are captured at roughly the same location in the field-of-view. This not only leads to optimal resolution and plate readability, but provides a one-image-per-vehicle approach that avoids bottlenecks caused by the number and size of images that must be processed or stored.

Go with the flow

With all the benefits provided by the free-flow concept, demand for specialized ITS imaging systems will continue to grow. Road authorities should use these ideas to seek out the types of solutions that can ensure a successful project. ○



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Over the past year I have written several articles on how tolling customers have changed. People are, in general, more willing to accept user fees and are more concerned about speed and convenience than privacy. Technology has played a big part in this attitude change. Tolling has gone from a stop-and-talk cash business, to a slow-down-and-pay drive-thru transaction, and finally to the ultimate solution: highway speed payments. As a result, the conversation about tolling the interstates has progressed from "no way that will ever happen" to a point where US political figures have softened and may be in a position to remove the 'no interstate toll' restriction. Of course, this would be a state and local issue, and actually paying an interstate toll would still be years away.

So what is next? Will the states that have existing tolling agencies have their DOTs call them up and ask them to add the interstates to their existing networks? Will neighboring DOTs call the closest toll agency for assistance? Will DOTs assume more responsibility for tolling? Will tolling and ITS experts be called in to plan the conversion? Who will write the legislation needed for tolling and enforcement? How about lane and back office systems? This could be foreign territory for agencies that have only been tasked with highway design and maintenance. Will highway designers understand the needs of specialty toll systems? Will adding interstates to the inventory lead to new players in the system-integration field, or to more consolidation?

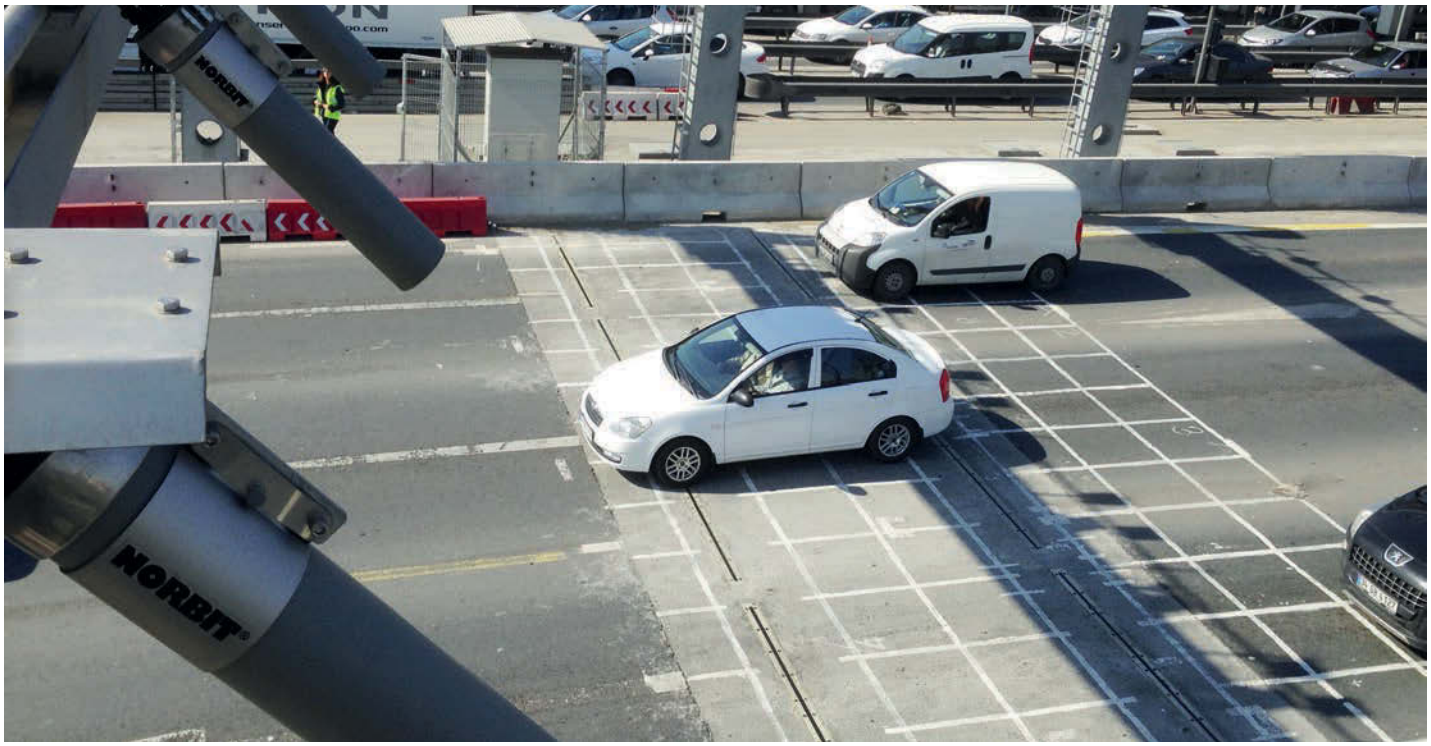
One of the negatives of the evolution of all electronic tolling systems is the over simplification of what it takes to not only toll a highway but also to operate it as a toll road. Even if the systems for the highway (roadside) and customer service centers are both specified and installed correctly, how the business side works depends on the systems' capabilities. More importantly, as tolling is a business, how do the rules, legislation, public relations, customer service, billing, collections and budget processes all get rolled up into one package that can be sold to the public? Even toll agencies tend to focus on the roadside when considering transponders and classification systems. The complexities of operating a customer service center while ensuring that the purpose of tolling is fulfilled (collection of revenue while satisfying consumer/political entities) is much more difficult and often overlooked.

If you look at similar industries, the early trend will be to bring these new projects under existing agencies. Where toll agencies and highway departments have good relationships, it will be an easy call. However, where this relationship doesn't exist, is strained or there is an absence of a toll agency, the conversion of an interstate to tolling may be a simple civil project with some ITS components.

If we start seeing tolls on interstates in the next five to 10 years, we should not only seize the opportunity for revenue but also the ability to take our experts in ITS, operations, and tolling and civil design, and build a 'new interstate system' that the next generation of highway users will benefit from and want to use.

> Tolling has gone from a stop-and-talk cash business to a slow-down-and-pay drive-thru transaction to the ultimate solution: highway speed payments
>
> **James Eden, director of tolling, Aecom, USA**

Maximizing efficiency and flow on toll roads



Electronic toll collection (ETC) has been used for decades and will continue to play an important role in maintaining good traffic flow as the volume of road traffic continues to increase. CEN DSRC is a well-established technology based on international standards, and there are now numerous suppliers of both vehicle-mounted onboard units (OBUs) and roadside units (RSUs).

One of the advantages of the CEN DSRC standards is that products from different manufacturers are interoperable, meaning that customers are able to purchase products and solutions from different providers. The trend in recent years, however, has been toward a more vertical integration of products, systems and, to a certain degree, system operation. Some of the major suppliers in the market have developed turnkey systems that almost entirely consist of in-house products integrated into a standard system. These systems can be adapted to individual customer requirements or preferences.

This trend is challenging for system integrators that do not have in-house DSRC products and, in some cases, companies have to purchase DSRC products from their competitors. Furthermore, contractual or technical limitations may affect the choice of OBU. This means that additional OBUs may have to be purchased from the original system supplier, possibly at a cost substantially above market price.

Advanced functionality

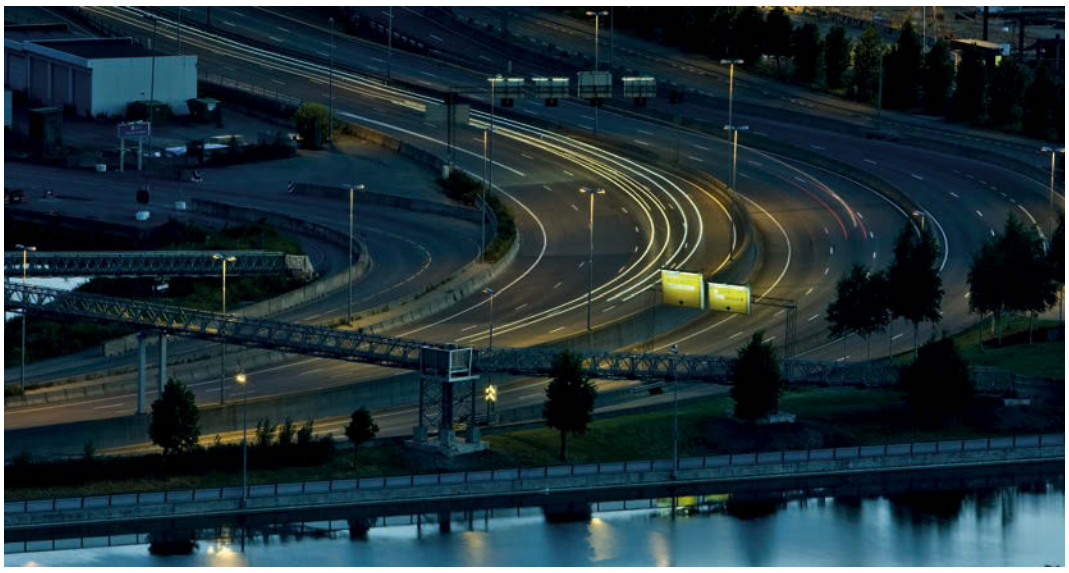
Customer requirements are evolving. OBUs are getting smaller, are supporting more applications and are expected to have a longer battery life. GNSS-based OBUs using DSRC technology for enforcement and DSRC tolling compatibility has been on the rise for a while, requiring more advanced functionality on DSRC components. RSUs, meanwhile, are required to support multi-lane systems and redundancy, while being easy to integrate, install and maintain.

Developing, maintaining and supporting successful DSRC products requires substantial resources in addition to a team that has a solid understanding of DSRC technology and the practical aspects of its use.

Need to know

Industry expertise and flexibility ensure optimization in CEN DSRC applications

- Norbit Group's OBUs and DSRC modules employ state-of-the-art ASIC (application-specific integrated circuit) technology to ensure a compact size, long lifetime and a high degree of flexibility
- OBUs and DSRC modules are compliant with all relevant standards and contain a large number of application elements



(Opposite) **RSUs in a fully redundant multi-lane system** (Left) **Norbit DSRC products are used for tolling and enforcement** (Below left) **The VTR850 is a compact OBU with a long lifetime** (Below right) **Norbit's CEO, Per Jørgen Weisethaunet**

For OBU purchasers, seamless compatibility with an existing base is essential. This applies to both operation on the road and to individual customer personalization that is used in some markets. In addition to the technical merits of the OBUs, custom profile labeling, short delivery times and flexible packaging may be important.

Tolling or enforcement system purchasers often have detailed requirements on how they want their system to work. System integrators setting up and maintaining ETC or enforcement systems want flexible and scalable RSU systems where the same solution principles can be used from project to project, independent of OBU variants, whether single-lane or multi-lane tolling is used, and in systems with varying redundancy requirements. Once in operation, consistent and trouble-free system operation is the main priority. A key factor in achieving this is to ensure efficient support from the RSU system supplier.

A flexible solution

One supplier of CEN DSRC products is Norbit ITS, which The company has been involved in DSRC standards development since the 1990s, and has been in the market with its own DSRC products for over a decade. Norbit ITS concentrates on DSRC products. This enables systems integrators to provide solutions, including DSRC functionality without any conflict of interest, while providing purchasers with a wide choice of compatible OBUs.

As a result, system integrators can concentrate on what they do best – projecting, installing and maintaining tolling and enforcement systems – without needing to focus on DSRC technology. And OBU purchasers can procure the products they find most economically beneficial.

Norbit ITS has a range of CEN DSRC products, which includes both OBUs and RSU solutions. The current OBU generation is equipped with the most advanced functionality and flexibility. The company also provides DSRC modules for integration into systems such as GNSS. RSU solutions cover both single- and multi-lane use, as well as various modes of redundancy. Norbit ITS DSRC products are compliant with all relevant standards, and have been homologized in a number of countries. As such, the company is an independent alternative to the OBU and RSU suppliers that also provide turnkey solutions.

Scandinavian success

In Norway, Norbit ITS has delivered more than 75% of the installed base of over 1.7 million OBUs. In 2013, the company entered into a four-year frame agreement with the Norwegian Public Roads Administration for the delivery of EN15509-compliant OBUs with another manufacturer, and has, so far been awarded the vast majority of deliveries. Norbit ITS has also delivered RSUs for the majority of the country's toll systems.

"The quality and technical merits of our products, together with our high volume capability, have enabled us to be a market leader in this very tough market," says Norbit CEO Per Jørgen Weisethaunet. "We are seeing numerous possibilities as an independent supplier of DSRC products to the world market." ○

Mobile speed enforcement improves safety on Ireland's roads

The first mobile safety cameras in Ireland were deployed in November 2010. The cameras, which used radar technology, were implemented as part of the government's Road Safety Strategy 2007-2012. The objective was to increase compliance with speed limits and reduce driving fatalities. As a result, vehicle speeds at locations with a speed-related collision history fell. With the mobile cameras acting as a deterrent to excessive speeds, fewer accidents occurred in their vicinity.

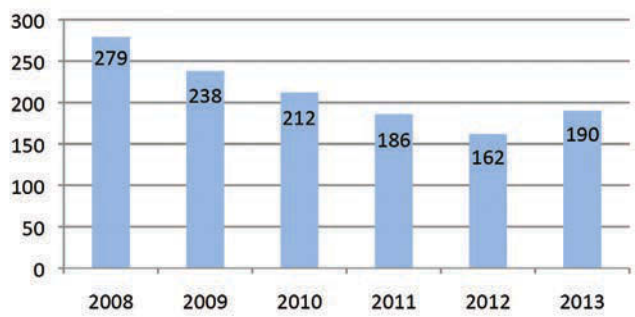
As the operator is paid per hour of roadside monitoring, rather than per infringement, the focus is on saving lives through modifying driver behavior rather than generating revenue. By 2010, when the cameras were introduced, Ireland had already experienced a reduction in road fatalities of more than 40% since 2001, and the introduction of mobile safety cameras was intended to boost this momentum.

IMAGES: GERARD BEGLEY

From June 2005 to June 2006, there were 412 fatalities on Irish roads – an average of 34 deaths per month or an annual 98 fatalities per million people (population 4.2 million). In 2012, two years into the program, road deaths had decreased to 13.5 per month, or 38 fatalities per million people each year (Figure 1).

Key to the success was the intelligence-led approach to speed enforcement by An Garda Síochána (AGS, the Irish police), which manages the program. Enforcement priorities are guided by statistically supported knowledge gathered from the key stakeholders involved in road safety, and the results are clear (Figure 2). The locations monitored by safety cameras (the 'collision-prone' zones) are selected based on analysis of speed-related collisions over a five-year period. This ensures that the safety cameras are deployed where they are needed most.

(Below) **Figure 1: Irish Road Fatalities 2008-2013**



Need to know

A transparent approach to enforcement has reduced serious road collisions

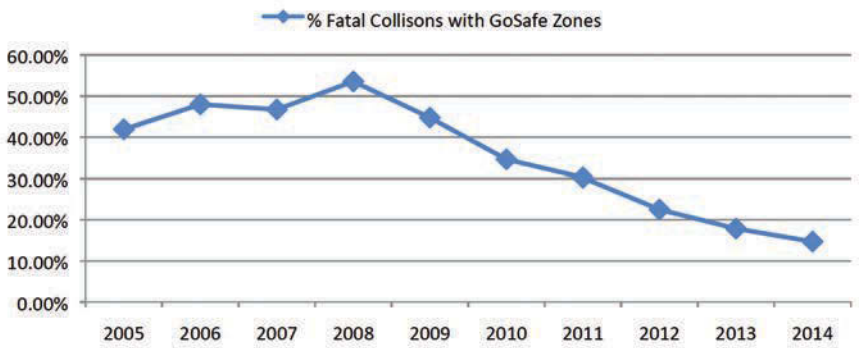
- Speed-camera monitoring takes place only within the collision-prone zones and is weighted toward the times when most incidents occur
- Deployment is reviewed continually to ensure that the focus is on zones where drivers are less compliant with speed limits, thereby supporting the deterrent effect of the highly visible cameras

Clear objectives

In 2010, AGS outsourced speed enforcement to GoSafe, a private, independent contractor, to provide mobile safety cameras and deliver 7,475 hours per month of speed enforcement and surveying. GoSafe is an Egis Projects joint venture with MIL (Ireland) and Redflex (Australia). It operates 24 hours a day, seven days a week, 365 days a year, across 727 designated zones, covering every county in Ireland. The camera vans monitor speeds and gather data that contributes to the intelligence-led enforcement approach.

	Population 2013 (millions)	miles of roads	Motor vehicles per 100 people (2008)	Vehicles per mile of road	Population density
Ireland	4.58	60,300	513	24	66.4
Finland	5.43	49,100	532	36	17.73
UK	63.26	261,000	523	77	259.4

(Left) **The safety-camera vans are positioned in plain sight of approaching vehicles**
(Above) **Table 1: Demographics of Ireland, Finland and the UK**
(Right) **Figure 2: Irish road fatalities in safety camera zones 2005-20014**



Ireland is a fairly small country with a high density of roads and a low population density. Given the demographics illustrated in Table 1, mobile cameras enable coverage of a much larger area than fixed cameras.

AGS also opted for overt monitoring, with highly visible camera vans. The locations of all the monitoring zones are published on its website and are marked with roadside signs.

Positive results

The halo effect of highly visible mobile operations (the length of time that the effects of enforcement on driver behavior continue after the zone has ended and the distance over which the effects of enforcement continue after passing a camera) enable a relatively small number of mobile safety cameras to have a greater impact on driver behavior than a similar number of fixed cameras.

Between May 29 and June 2, 2014, GoSafe checked the speeds of 457,895 vehicles on Irish roads – almost 19% of all registered vehicles in the country. The vans all operated in collision-prone zones with a history of serious collisions. The driver compliance with speed limits monitored by the safety cameras during this period, a designated Road Safety Weekend, was 99%.

This analysis should be transformed into a strategy that identifies geographical areas and enforcement sites that enable the optimum balance of general and specific deterrents in a manner that secures the achievement of 'critical mass' coverage of the driving population. In brief, critical mass is the magnitude of outputs necessary (speed checks) for the driving population to develop the perception that if you exceed the speed limit, you face an unacceptable risk of being detected and prosecuted.

The results are positive. AGS reported to the Oireachtas Joint Committee on Transport and Communications on April 16, 2014, that in the five years prior to the commencement of GoSafe operations, approximately 30% of fatal collisions annually were occurring in the collision-prone zones. In 2013, there were 40% fewer fatal collisions in these zones – a reduction of 23 road fatalities.

Speed survey and monitoring data in January 2011 showed that average compliance rates across all speed limits were 81%. Similar data from January 2014 showed compliance rates of 95%, an increase of 14%.

Safety first

There is further international evidence that safety cameras reduce collisions. Since the 1992 introduction of speed cameras in the UK, deaths on UK roads have more than halved from 4,229 in 1992 to 1,850 in 2009. Road safety has, of course, improved in many other ways, but there is substantial data to support the effectiveness of cameras.

Anecdotal evidence and support were also provided by a 2011 article in UK newspaper *The Guardian* on the very public decision in July 2010 to switch off fixed safety cameras in Oxfordshire and then, following a review, to switch them back on in March 2011. In the 31 days before the cameras were switched off (July 2010), the machines registered 2,286 speeding motorists. In the 30 days after they were switched back on (March 2011), they registered 5,917.

Another study took place at 21 sites in west London in 1997. Monitored over 36 months before and after installation, fatalities dropped by 69.4% .

Ireland's intelligence-led approach to focus on collision-prone zones with highly visible mobile safety cameras seems to be achieving critical mass and contributing to saving lives. Crucially, it has been supported by an extensive media campaign by the Road Safety Authority to emphasize the need to reduce speeds in the collision-prone zones, and thereby save lives.

Next steps

In the third quarter of 2014, GoSafe will introduce enhanced radar units to enable monitoring on up to five lanes at a time.

Furthermore, Leo Varadkar, the former Irish Minister for Transport, Tourism and Sport, has proposed introducing average speed systems on the country's motorways in 2015, in a further effort to reduce road deaths.

The emerging markets benefit from South Korean ITS expertise

Compared with the USA, which began implementing road traffic management methodologies in the 1950s, and other ITS-advanced regions, such as western Europe and Japan, South Korea started its ITS journey quite late. Systematic implementation began in the late 1990s, with a strong focus on road traffic management, and after two decades of continuous improvement and implementation, South Korea has reached an advanced phase of ITS operation.

Despite the late start, the government's strong promotion of the 'national ITS architecture', combined with rapid developments in wired and wireless networks, and ICT developments, enabled the nation to develop sophisticated systems in a relatively short timeframe. Advanced ITS is now implemented and in operation in most metropolitan and medium-sized cities, on all highways and more than 20% of roads, and is in continuous expansion.

Local expertise

Since its foundation in 1991, SK C&C, the ICT sector of the SK Group (one of the Fortune Global 500 and the third-largest conglomerate in South Korea), has contributed to the country's ITS development through more than 50 projects in numerous major urban areas including Seoul City, Seoul metropolitan region, and the metropolitan cities of Busan, Gwang-ju, An-san, Yong-In, Jaeju, Bucheon, Gwacheon and Suwon.

Over the past few years, SK C&C has created the country's first private traffic information center, a navigation solution, and near-field communication (NFC)-based mobile traffic solutions. The company has also provided advanced ITS services, including a multimodal transportation information systems, such as TAGO (Traffic Advice on Going Anywhere), UTIS (Urban Traffic Information System) and the Greater Metropolitan Bus Information System. These have promoted the adoption of an advanced traffic culture where fast and easy access to information has become the norm, both through smart devices as well as within transportation infrastructure, such as bus stations.

With over a decade of ITS experience and successful project implementation, South Korea, as a nation, has worked to export its ITS globally. In 2008, SK C&C won the tender for Baku City's ITS project in Azerbaijan and in 2009 it was asked to supply ITS for Ulaanbaatar City in Mongolia. This made it the first South Korean company to export its ITS services.

Need to know

The implementation of advanced ITS requires strategic planning and personalized solutions

- SK Group comprises 81 affiliates, including: SK Telecom, which owns 50% of South Korea's telecommunications market; SK Energy, a leading energy company; SK E&S; and SK Construction
- Cooperation among the affiliates makes SK Group technologically capable of developing and operating an entire urban infrastructure with ICT

ITS in emerging markets

In many cases, emerging market countries aim to achieve a quantum leap in IT system development by incorporating the most advanced systems from mature countries. However, these countries may not be have the sufficient infrastructure, methodologies or plans to properly implement such intricate systems all at once.

Foreign companies may offer their best practices based on local experience and the systems that they own; however, as desirable as those systems may be, there is a process that should

(Above and Right) **Baku's traffic control operators use state-of-the art technology to manage the city's roadways**

be adhered to in order to enable optimal implementation of ITS in the emerging markets.

Along with the realization of advanced systems, there is a need for law formation, traffic policy making, road organization, technology transfer, and traffic culture advancement. All of these factors, which already exist in more advanced countries, are essential to achieve a truly comprehensive ITS.

The value of ITS

Based on years of experience and knowledge, SK C&C offers services that cover the entire spectrum of ITS, from premium consulting, to system design, to implementation and operation. The company aims to provide comprehensive ITS at whatever level is desired by the country.

In the US$138m Baku ITS project, the 'as-is' status of the roads and crossroads was assessed, in order to configure what the city required, before any traffic management system was installed. As a result of this assessment, concurrent with the project, campaigns such as user and driver training for bus management systems and bus station maintenance were executed.

As this was the first time the city of Baku had initiated ITS, simply developing and installing the equipment and the system was not going to suffice. SK C&C implemented its very own knowledge transfer and training methodology developed over decades of IT service experience. The training enabled the city of Baku to build its own system operation capacity, with the aim of optimizing the sustainability of systems. This has subsequently minimized operation costs.

Based on lessons learned from South Korea, SK C&C assisted in creating Baku's road traffic vision, remembering that the aftermath of implementation is even more important than the system itself.

Legacy planning

Countries all over the world continue to incur economic losses from traffic congestion. ITS can definitely be a solution, but system implementation alone will not suffice. In order to realize a successful system, the host country must be prepared for the years to come. SK C&C's comprehensive ITS and premium consulting service are an effective solution for the emerging markets.

Laser-based solutions for advanced traffic control

It is becoming increasingly important for road authorities and DOTs to be able to maintain optimal control of complex street traffic. Today's agencies are looking to reduce traffic jams, determine pollution levels, increase road safety and collect data within the framework of reoccurring traffic counts. They require intelligent vehicle classification systems that can be used with flexibility.

The German Federal Highway Research Institute (Bundesanstalt für Straßenwesen or BASt) provides standards for such classification systems through its technical delivery conditions for route stations (TLS).

RTB's SLP-integrated system (called TOPO.slp) is BASt certified, and can measure the length and speed of a vehicle, as well as its acoustic features. By identifying the axles and engine position, the system is able to classify vehicles according to 8+1 classes (as well as differences that go beyond this, such as the differences between trucks and buses or motorcycles and compact cars).

(Left) **Multibeam lidar sensors positioned at the roadside** (Below) **The three different types of system are suitable for different applications**

Need to know

Innovative vehicle classification systems can handle complex traffic applications

- Lidar stands for 'light detecting and ranging', and describes detection using light and distance
- Lidar sensors transmit invisible infrared laser beams. If this light is reflected by an object and picked up by the sensor, the system can determine the position of the object using elapsed time measurement (how long it takes for the light to travel to and from the object)

Data collection

Three types of classification system are currently available. The first is installed at a height of 250cm on a mast. It has an integrated charging device and can be used as a permanent counting station. The second type is integrated into a standard guide post (SLP) and can be installed on roads outside of city limits. This type does not affect the appearance of a street. The third type is integrated into a small box, which can be quickly installed at the side of the road. It can be used for a variety of temporary or permanent applications.

Generally it is only possible to survey one traffic lane in the direction of measurement. However, the SLP-integrated system and the box-type system are also able to survey one lane in the opposite direction, with limitations.

The traffic data collected by the devices can be transmitted via GPRS to an internet server. The prerequisite for this is the integration of a GSM module and the provision of a mobile SIM. The data transfer rate can be individually configured.

It is also possible to connect a GPS module to the GSM interface. This enables the location coordinates of the device to be stored together with the collected traffic data. Furthermore, if a device is removed without authorization, the GPS module automatically sends an alarm message along with the current position.

Sensor innovation

In order to enhance its classification capabilities, RTB has launched a new system based on cutting-edge laser technology. The system uses multibeam lidar sensors to detect vehicles on multilane streets from the side of the road. It can also detect partially or completely masked vehicles.

One sensor is positioned at 90° to the street, so that it can detect the lateral height profile of vehicles and allocate them to the appropriate lane. The other sensor detects vehicles from the rear and the right side. This sensor tracks the vehicle and determines its speed using a tracking algorithm.

The system combines the measurement data from both sensors to make a very precise vehicle classification. The first system of this type was installed in Denmark in June 2014.

The new development is funded, in part, by the Central Innovation Program Mid-size Companies (ZIM) of the Federal Ministry for Economy.

While a lot of progress has been made since the launch of the project in June 2012, the ultimate goal is to invent a more mobile vehicle classification system for use on multilane streets. The company's signal processing hardware already substantially minimizes energy consumption, but the housing will be designed to be less obvious in the future.

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In the last issue of *TTi*, I reported on my visit to the University of Michigan Transportation Research Institute conference on The Connected Vehicle. I began by recalling my experience 18 years ago at the demonstration of the automated highway in San Diego. Since then, I was reminded that the idea of connected cars is much older than that.

I suggest that you search for a 1958 Disney cartoon, *Disney's Magic Highway*. It's quite amusing and a bit prescient. It predicted large VMS, in-vehicle radar, and rearview cameras. It's only eight minutes long, so even good for those of us with short attention spans.

As amusing as it is, there is value in comparing the 1958 vision and the 1996 visions of the highway of the future, and those continue to play out today. In both cases there was a lot of information provided to the driver from infrastructure. The difference is that Disney envisioned autonomous vehicles under the control of the driver and the automated highway saw vehicles controlled in platoons.

Today both trends are in evidence. OEMs are installing more and more autonomous safety equipment that can offer parking assist, lane keeping and blind-spot assistance. They are also working toward more autonomous cars in the next decade, responsive to the infrastructure, requiring little or no driver involvement. There is, however, a blind spot: OEMs talk about their 'driver'; railroads talk about their 'customers'. The reality is that we are not mono-modal, but travelers trying to get from A to B.

In my last column I was concerned about how long it will take for connected vehicles to be deployed, with regard to federal rule-making. I'm beginning to sound more and more like the comedian Lewis Black, always complaining, but we are, after all, about the same age. There has to be a quicker way. Let me suggest it now. It goes back to a decision in the Bush Administration to separate the application layer from the communications layer. That supported the proliferation of internet connectivity in vehicles well in advance of DSRC connectivity for V2V.

The internet provides infotainment: connectivity and music. There are lots of traffic apps and even a few reservation systems. Safety apps will either standalone or be connected via DSRC, but there is room in infotainment to start to bridge the gap by connecting to the transportation system. How about integrated real-time information on parking and transit, reservations at lots, and a connection to payment systems for tolling and parking?

We are moving toward an increasingly urban and multimodal world and the in-vehicle devices, like the infotainment system, can begin to support it. Let's recognize that sophisticated travelers want to use their connections to ease the logistics of the trip as much to enjoy it. They can already get information, but let's allow them to connect to it as well and to do it with a single account. I will have more to say about this next month.

Autonomous vehicles are on the way as are V2V safety systems, both slowly, but the power of connectivity is in our hands.

> We are moving toward an increasingly urban and multimodal world and the in-vehicle devices, like the infotainment system, can begin to support it
>
> Larry Yermack, Wendover Consult, USA

Improving night-time road safety with solar-LED markers

Night-time conditions present unique challenges for both the users of roads and those responsible for their operation. The risk is even greater in workzone areas, particularly on high-speed highways.

To mitigate the risk, solar-LED markers can be used to highlight danger zones and provide traffic management during the hours of darkness. By ensuring increased visibility, their use substantially reduces the risk of collisions.

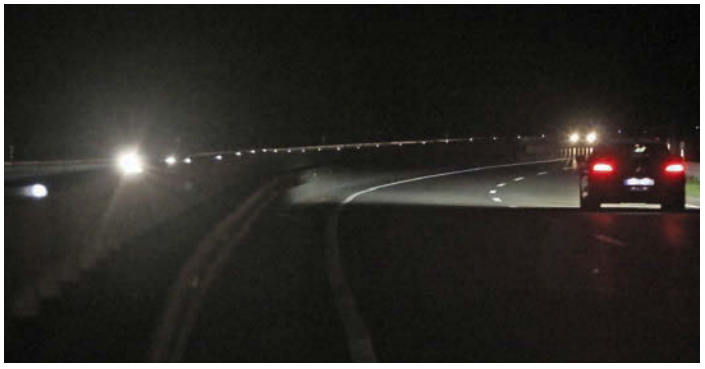
The markers can be attached flush with any surface – be it the pavement, the curb, or a steel or concrete crash barrier.

The markers have proved very successful in Germany, where they have been attached to steel crash barriers on the autobahn. The unique traffic routing solution is better perceived by drivers in darkness than are indications on the road. The highly visible light trail reduces driver uncertainty, especially through the unpredictable path of a construction area, and makes traveling much safer.

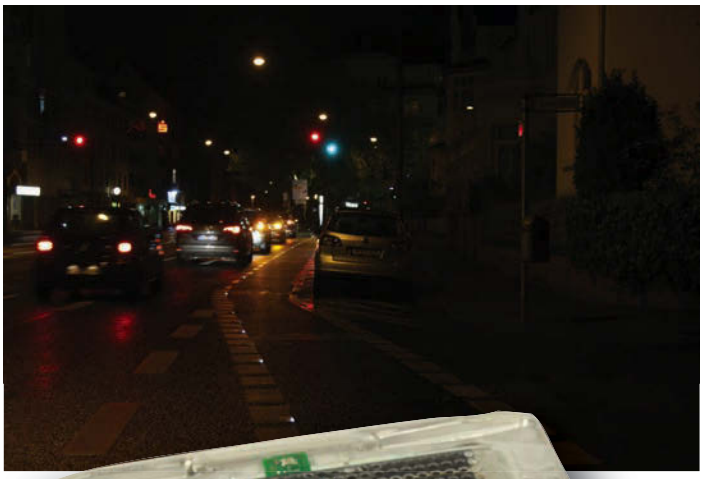
Need to know

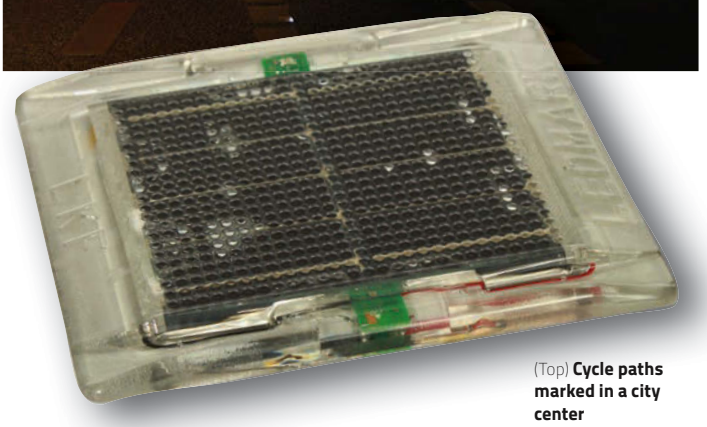
A simple, sustainable solution to enhance visibility during the hours of darkness

- Geveko's solar-LED markers have a built-in temperature sensor and warn against frost with a blinking light
- Each marker can provide light for approximately 4,000 hours without the need for charging
- When installed in the road, the markers do not affect traffic and are designed to withstand snow plows and other road maintenance vehicles



(Below) **Pedestrian crossing with Solar-LED markers**
(Bottom) **Lights highlighting crash barriers in Germany**





(Top) **Cycle paths marked in a city center**
(Above) **The Solar-LED marker unit**

City solutions

In urban environments, solar-LED markers can be used to highlight cycling routes. This not only makes journeys safer for cyclists, but also provides greater visibility for motorists, which enables better traffic flow in darkness and wet conditions.

Similarly, pedestrian crossings marked with solar-LED markers are more visible to motorists, which means that drivers are more likely to identify the crossing in good time and adapt their driving accordingly.

Solar-LED markers can be white, green, yellow, blue or red. Each is equipped with an intelligent on/off function; after 24 hours in the dark (in a box, for example) they go into sleep mode. They wake up again after 30 minutes of being exposed to light, and are active until they are confined to darkness again. And as the lights are powered by the sun, there is no need for an external power source.

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Future-proof systems for optimum versatility

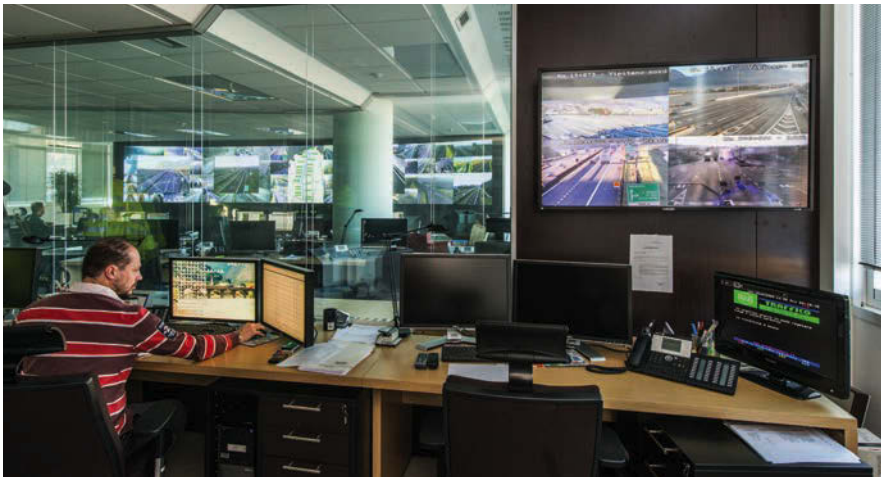
Control room designers have a difficult job. As well as being responsible for the delivery of complex data management and visualization systems, they also have to peer a long way into the future to try to determine, and plan for, future requirements – not an easy task against a backdrop of changing goalposts and rapidly evolving technology.

Versatility is the key here. IP topographies, for example, enable devices to be added, moved or taken away easily, without major cabling upgrades. Individual system components can easily be upgraded to extend the lifespan of the system at minimal cost.

But what about the control room where all this data is ultimately flowing? While upgrading a camera maybe fairly straightforward, the screen on which it's monitored is a different matter. High-resolution cameras need high-resolution displays; the explosion of connected devices means finding ever more powerful ways to manage and display a growing volume of data. And, of course, what's required today may not necessarily be what's required in 5 or 10 years' time. How can versatility be built into major system components like the control room display system?

A modular approach

One solution being adopted by companies such as Mitsubishi Electric is hardware modularity; treating a control room display not as a single entity but a sub-subsystem of interchangeable components. Most modern control rooms are now based on DLP (digital light processing) rear projection cubes employing DMD (digital micro-mirror device) technology developed by Texas Instruments. The technology is widely used, but is not without its limitations.



(Left and below) **The traffic control room for the A22 highway in Italy had its existing analog camera system and software platform combined with the latest in display technology**

Need to know

Flexibility is essential to ensure the long-term functionality of traffic control rooms

- Mitsubishi Electric displays are fully compatible with leading controllers, such as Billfinger-Mauell's X-Omnium, enabling an optimal overview in control rooms, network control centers and data centers.
- The IP-based X-Omnium is universally applicable to display videos, camera feeds, software applications, graphics and processes in whatever configuration is required

Previous generations of DLP projectors used mercury lamps as the light source, which have limited lifespans and whose performance characteristics change over time. With budgets being squeezed ever tighter, traffic authorities may be forced to use outdated, expensive systems because there simply isn't the budget to refit to a more modern solution.

Mitsubishi's answer was to create a family of displays and related hardware based around a common set of components and architecture. The Seventy Series is a range of DLP cubes and narrow bezel LCD displays.

A key feature is that, rather like building a custom PC, component parts can be specified to order and upgraded as required. For example, replacement DLP projectors enable customers to upgrade their older mercury lamp-lit display walls with the latest LED technology, dramatically extending the lifespan of their facilities and reducing maintenance costs to practically zero.

Mercury lamps have an average lifespan of 6,000 hours – less than a year of 24/7 operation – before they need to be replaced. At a cost of around €1,000 (US$1,400) each, this represents a large operating expense. Mitsubishi Electric's 50PE78 LED cubes, by contrast, have a lifespan of around

100,000 hours, or 10 years of continuous 24-hour operation.

Versatility in the architecture behind the control room display is also vital. Seventy Series displays feature user-specified input card options, including OPS on some models, which enables users to select the best solution for their project and has the ability to adapt in the future, if needs change.

High-tech sensors successfully monitor traffic in Australia

In late 2013, VicRoads, the state of Victoria's DOT, teamed up with Laser Technology Australia (LTA) to launch a traffic technology test site on Melbourne's M80 ring road. The aim was to validate the accuracy of the various sensors being used on the road network, which feed data to the DOT's central STREAMS traffic management system. This 38km-long stretch of freeway around Melbourne links with various other freeways and arterial roads in Australia's second-largest city.

An overhead gantry was selected that spanned five lanes and afforded good access to mount several sets of Laser Technology's TruSense T100/T200 lasers. LTA was also commissioned to write custom software that would take in data from the TruSense T-series and compare it with data collected by other sensors, which included in-ground studs, microwave sensors and infrared across-the-road beams.

Initially, multiple sets of LTA sensors were installed over a single lane to compare different baselines, and their effect on the measured speeds and vehicle lengths. The dual TruSense laser systems had baselines between 1.8m and 3m, and were configured to capture vehicle speeds within 0.1km/h (0.06mph). The sensors also measured vehicle length and profile, and the traveling distance between vehicles (headway) to centimeter precision, with the sensors pulsing up to 25kHz. The occupancy of each lane was then calculated based upon the measured data.

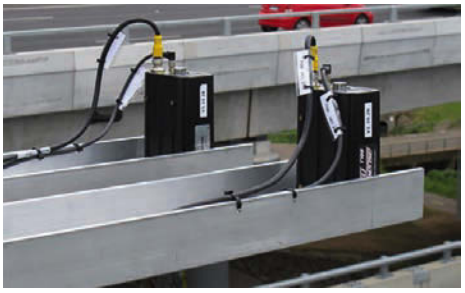
Accuracy and reliability

The test concluded that LTA's laser sensors were very accurate in detecting the leading and trailing edges of vehicles. As a result of the laser system's dual sensors, it was able to calculate the required parameters at a higher degree of accuracy than others previously used.

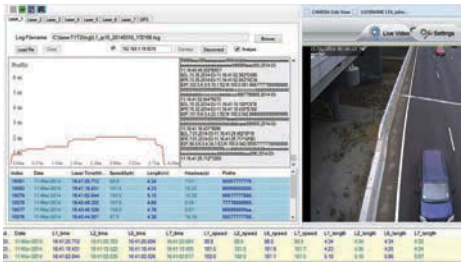
The LTA system was to be used as a benchmark from which to compare other sensors and was itself to be validated using a high-speed video to verify speed, length and headway accuracy. Since the lasers could also measure range very precisely, a series of rapid pulses was recorded to create a visual profile of each vehicle in real time.

IP video cameras were installed above each lane and connected through a hard-wired Ethernet network to a 4G wireless modem, enabling remote monitoring of the site. Engineers could view a live feed of traffic passing under the lasers and see the corresponding profile appear on their PC, with length and speed data.

The lasers have been in operation since late September 2013 and have not skipped a beat, detecting approximately 100,000 vehicles per day on the M80 ring road at typical speeds of 100km/h (62mph). The project is ongoing and VicRoads hopes to use TruSense over the next five years to evaluate various new technologies before making a commitment to implement them into their road network. Reliability and accuracy are critical. LTA's sensors have proven to deliver a high level of reliability and precision.



(Above) **The dual sensors provide highly accurate measurements**
(Left) **The technology is installed on a gantry**
(Below) **Remote monitoring and analysis**



Need to know

A dual-laser system gathers highly accurate vehicle data on the M80 in Melbourne

- LTA is currently testing a new sensor that uses the company's proprietary algorithms to track vehicles through an optically enhanced 'beam' pattern, capable of covering an entire single lane and measure ranges and speeds
- The advantage of having the measurements made at closer proximity is the potential to integrate with ANPR and speed cameras

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Effective customer service in tolling operations

Budget restrictions and the need to upgrade road infrastructure are requiring road authorities to find new ways to fund the operation and maintenance of their roads. As a result, roadways that were previously free and open to all traffic are being converted to toll operations. With this move not always being welcomed by road users, Anna Van Buren, president and chief executive officer of US-based Faneuil, explains how road authorities can make the transition as painless as possible.

(Above left) **Faneuil call center** (Above) **Anna Van Buren believes good customer service is essential**

How can transportation authorities increase public acceptance of tolling?
While it's understandable that customers might not initially be receptive to paying for something that had previously been free, our job as customer care partner to our clients is to highlight the advantages of using toll roads, and promote the ease and convenience of transponder usage. That outreach is especially effective when it's one-on-one, i.e. one customer service representative interacting with one customer at a time.

What does Faneuil do to help road authorities that are establishing new toll roads?
I can't overemphasize the importance of the personal touch in easing frustration and turning around public sentiment. Here's an example of how we applied it recently. On February 1, 2014, two heavily traveled roadways in the mid-Atlantic region converted from free-use to tolled operations. Because pay-for-use roadways were a new concept for many local residents, the road authority authorized a media campaign in advance of the launch to advise them that tolling was coming.

Faneuil complemented that by working with the state transportation department to expand its network of Faneuil-managed regional offices by opening additional customer care locations in close proximity to the toll roads. We also established locations inside branches of the Department of Motor Vehicles and on a third well-traveled roadway nearby. Faneuil staff answered questions, helped customers open transponder accounts and accepted payments.

As February 1 approached, the demand for transponders grew substantially. We extended the hours of all locations, and three centers nearest the roadways were open until midnight the week before tolling began to accommodate everyone in line. We served cookies to waiting families and soothed tired children.

Faneuil staff at the primary center we operate for a partnering client, located across the state, also worked extended hours, seven days a week, to process mail, telephone, online and walk-in orders. Data lines were added to increase website capacity tenfold, and the process of shipping transponders to online customers was shortened from five days to one, by setting up a local fulfillment operation.

Did you use any other distribution channels?
We also established distribution partnerships with local retailers to increase the availability of transponders. Shortening a process that normally would have taken three weeks to just three days, we trained retailers on the transponder program and made same-day deliveries to replenish their inventories and avoid sell-outs.

As retailers are often reluctant to stock transponders without assurance of public acceptance, our flexibility and commitment to quick restocking helped us overcome that and gain their trust. In turn, their participation was also integral to the success of the program.

Need to know

The personal touch strengthens public acceptance of new toll roads

- Faneuil's customer care professionals process more than half a billion customer interactions each year on behalf of governmental and commercial clients
- More than 85% of Faneuil's growth has been derived from the expansion of its client partnerships through contract extensions and additional contracts awarded through competitive solicitations

A custom-built solution to improve highway safety and management

The Dom Pedro I corridor comprises five highways that serve the cities of Campinas and Paraíba Valley, in São Paulo, Brazil. These are two of the most developed regions in the country and together represent 20% of the Brazilian GDP.

The corridor includes the Dom Pedro I highway (SP-065); the Romildo Prado highway (SP-063), which connects Louveira and Itatiba; the José Roberto Magalhaes Teixeira highway (SP-083); the Rodovia Professor Zeferino Vaz (SP-332), connecting Campinas and Conchal; and the Engineer Constancio Cintra highway (SP-360), which connects the Itatiba to Jundiaí.

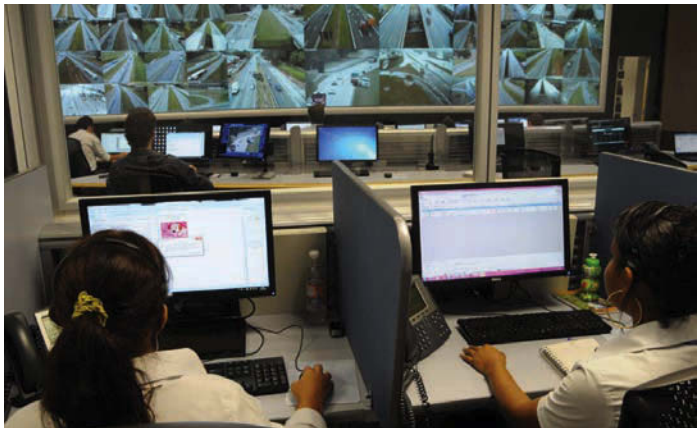
Since 2009, the corridor has been managed by Rota das Bandeiras, part of the Odebrecht Group. Each day the concessionaire is responsible for 117,000 vehicles traveling on the corridor's five highways.

Eyes on the road

To better manage the 296km of highways under its control, the concessionaire recently deployed video surveillance cameras with long-range lenses that can cover more than 80% of the roads. All the cameras were installed at carefully selected locations that were chosen according to their incident rate, perceived risk and dangerous junctions. All camera images are sent to a control center that has an Intelligent Security Systems (ISS) SecurOS platform that has been custom-designed to control and manage the entire Dom Pedro I corridor.

Rota das Bandeiras currently has in place 90 Pelco cameras for highway monitoring and 180 Samsung cameras for toll plaza monitoring. These models were chosen based on their quality, low maintenance and good vendor support. Highway monitoring requires very robust equipment and the concessionaire has found Pelco's cameras to be ideal for this application.

With so many miles of highway to monitor, Rota das Bandeiras wanted to be able to access information quickly to enable fast emergency response. It also required video management services (VMS) and analytical software that could address issues such as vandalism, integration with variable-message highway signs, automobile theft, weather, broken-down vehicles, and even kidnappings. In short, it wanted to build a security ring around the São Paulo highway system.



Control center operators are able to effectively manage the Dom Pedro I corridor with advanced VMS and analytics software

Need to know

Advanced technology safeguards São Paulo's strategic road network

- Two of the toll plazas in the corridor currently deploy license plate recognition (LPR) so that stolen vehicles can be identified
- Operators also have a comprehensive view of the weather over the entire corridor system. This is particularly important in the summer when there are torrential storms

Fit for purpose

ISS has extensive experience in creating custom solutions for highway safety applications. The company's VMS and analytics software is currently being used on thousands of miles of highways around the world. Working with the integrator PGLOBAL, ISS was able to create a bespoke security and monitoring system for Rota das Bandeiras.

ISS customized the operator interface and integrated a very large video wall from Barco. From the same interface, operators can control and monitor the video wall layout, which helps with improving response times.

It also enabled a new recording mode that facilitates

three ways to record images from a single camera. This reduces storage and frees up more bandwidth.

ISS enabled two modes of video information, based on a Flash Media Server for websites and customized so that television clients can purchase and broadcast images, which produces additional revenue.

The cameras are programmed to focus on phone booths if they are being vandalized or harmed in any way, enabling operators to see what is happening. The phone booths also have integrated cameras so that when callers report a broken down vehicle or other issue, the operator can immediately see which mile marker they are at and dispatch a vehicle. Incorrect reporting of mile markers from callers was previously very common, and was both time consuming and costly for Rota das Bandeiras.

"The demands of this situation are very specific," says Eduardo Arce, country manager of PGLOBAL. "With so many miles of highway, and response times in an emergency situation a great consideration, we needed to ensure that operators would have everything they needed at their fingertips. Our prior experience made the whole process much easier. The staff at Rota das Bandeiras could see that we all knew the ins and outs of highway safety, and appreciated how a few seconds in an emergency situation can make all the difference."

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I am quite earnest in stating the importance of standards to our smart, collision-avoiding and communicating cars. Nowadays inter- and intra-vehicle connectivity and interoperability are paramount to successful data exchange. In other words, our cars and the devices we bring into them must talk and listen to one another in ways they can understand. The Tower of Babel was a failure; we can't have that again.

Vehicular safety systems put the stakes quite high. In but a few years, cars may be equipped with mandatory dedicated short-range communications (DSRC) radios, which when combined with GPS, enable accurate vehicle movements to be broadcast over several hundreds of meters. For DSRC to work, cars must talk and listen to one another in ways that their crash avoidance systems can understand. If they don't, the life-saving potential extolled by regulatory and road authorities will not be realized.

Back to standards jargon: devices must be interoperable in all sorts of ways. Interfaces and standardization are essential – from radio channel selection, through layers of communication protocols, to the types of messages that are exchanged. Furthermore, when we invoke the infrastructure, cars may be able to communicate with traffic signals as their red, yellow or green states may be broadcast via DSRC. Therefore we must add another dialect and its rules to the safety communications grammar.

Clearly the days when the interface between cars was their bumpers – and between the car and the road were the tires – are behind us. In this brave new connected world, interoperability is not simply jargon; it will be essential. Automotive engineers must work with traffic engineers, and both must work with wireless engineers. (Yes, I am an engineer, but let's not forget the policy makers and planners whose wise policy decisions and planning start and nurture interoperability.) And there's more. If I am to listen to my neighboring vehicle, I had better trust it. Safety and security – and concomitant standards to ensure them – are in many ways the linchpin to a workable, scalable and therefore beneficial system.

This column is not a call to action, however. It is a call for reassurance. Worldwide standardization is already underway. (I am in fact writing this in the air, bound for Oslo to participate in one such standards meeting, where efforts from regional standards development organizations are working toward world harmonization on the inter-vehicle and V2I front.) Thankfully there are experts who fully understand what's at stake and nod their heads knowingly at this tribute.

I therefore state with confidence that standards are important. Safety and standardized safety messages enable the, um, killer app. These apps are brought to us better, more cheaply and plug-and-play by standards. And standards experts make it all happen. Indeed, we are important (and I hope I've convinced you of that).

> For DSRC to work, cars must talk and listen to one another in ways that their crash avoidance systems can understand
>
> **Jim Misener, transportation and technology consultant, USA**

Improving road safety in adverse weather

Weather-related traffic accidents have a large societal and economic impact. On average, there are some 5,870,000 vehicle crashes on the USA's roads each year and 23% of these (nearly 1,312,000) are associated with weather conditions. As a result, approximately 6,250 people are killed and more than 480,000 people are injured every year.[1]

Weather instrumentation is just one tool that can be used to change driver behavior, and potentially reduce road accidents and save lives. High Sierra Electronics (HSE) is dedicated to helping the road weather and ITS community develop such equipment.

HSE has developed road weather instrumentation that can do much more than simply send data to a software system. The company's 5433 IceSight and new 5439 Surface Sentinel non-intrusive road surface sensors, for example, can activate ITS devices directly from the sensor without any other processing units.

The IceSight sensor provides information about the road surface condition (dry, wet, snow, ice); surface friction or grip; surface temperature; ambient temperature; and relative humidity. A contact output can be activated when the surface is anything but dry and the surface temperature is below freezing.

The Surface Sentinel sensor is a lower-cost unit that provides the road surface temperature, air temperature and relative humidity. The user can set thresholds to activate a contact output for low temperature, high temperature and frost.

Dynamic warnings

While there are already numerous static roadway or bridge signs in place across the USA that warn about ice, they are often ignored by drivers who take the same route every day. A road surface sensor can be used to add dynamic functionality to these signs, encouraging drivers to become more aware of the warnings.

To automatically activate an 'icy bridge' warning system, a sensor is mounted on a pole at the bridge location. The sensor transmits information (wired or wirelessly) to a sign located ahead of the bridge that states 'bridge may be icy when flashing'.

The sensor is set by the user to either turn on flashing lights or an LED message sign. The IceSight sensor can be used to turn on the sign only when there is ice on the bridge. Alternatively, the Surface Sentinel can be used to activate the sign whenever the temperature of the bridge falls below freezing. The sign remains active as long as the sensor thresholds have been met.

Often a bridge will freeze before the main road does. This makes it difficult for motorists to determine whether or not to slow down while crossing the bridge. The information provided by a dynamic sign enables drivers to make better decisions, and to slow down as they approach the bridge, if necessary.

By changing motorist behavior and preventing accidents at a given location, the system pays for itself.

1) Ten-year averages from 2002 to 2012 analyzed by Booz Allen Hamilton, based on NHTSA data

A bridge warning system (above) **can be implemented using the Surface Sentinel non-intrusive road temperature sensor** (left)

Need to know

Intelligent sensors can be used to increase driver awareness about hazardous conditions

- HSE's IceSight sensor uses advanced laser and infrared technology to gather information about the road surface
- The Surface Sentinel housing has been engineered to ensure the most accurate atmospheric and surface measurements. The three-tube radiation shield design provides maximum airflow, while protecting the air temperature and relative humidity sensor from solar radiation

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An advanced tolling system has modernized Turkey's highways

Traditional toll collection operations can often create congestion problems on busy roads and highways. To overcome this problem, electronic toll collection (ETC) has become a popular and effective solution.

Vendeka's passive ETC solution is based on RFID technology and was implemented on all the highways in Turkey last year. The project, which involved removing all the existing barriers on the toll collection plazas, is known as HGS (the abbreviation for 'high-speed tolling system' in Turkish).

Since September 17, 2013, HGS has operated with a success rate of 99.7%. It serves 2,000km of highways, 387 toll collection lanes and 11 million users.

(Above) **The HGS solution has made Turkey's tolling operations more efficient**
(Right) **Many of Turkey's highway bridges are tolled**

Intelligent integration

As the old system was based on dedicated short-range communications (DSRC), immediately transferring all users to RFID would have been neither easy nor practical. Therefore Vendeka created a solution that incorporated RFID and DSRC within the same toll lane. As the dual system enables all drivers to use any lane, congestion has been kept to a minimum.

According to Baki Kuran, general manager of Vendeka, the dual lanes ensure that customers are not negatively affected during the changeover from DSRC to RFID.

"There are still a few drivers using the old system and we need to consider their needs as well as those of the new users," he says. "Having separate lanes for the new and old systems was inefficient and resulted in congestion. The dual-lane system minimizes traffic density in the toll lanes."

The HGS system comprises RFID tags, a detection and classification system, RFID readers, ALPR cameras, a communications network, a data center, back office applications, and provision for providing charging information to banks.

The system collects data from both RFID and DSRC users within a single back office hardware infrastructure and the data is processed by back office software. The simplicity of the structure makes the process much easier for toll operators.

Progress and expansion

As a result of the success of the RFID-based ETC system on Turkey's highways, an opportunity has arisen to implement a similar system in Southeast Asia. In March 2014, Vendeka signed a contract with San Miguel Cooperation (SMC) to implement its hybrid ETC system on three major toll highways in the Philippines. The Turkish ICT company will provide its technology for a project that incorporates three tollways, 60 toll plazas, 300 lanes and 200,000 RFID tags.

Need to know

An RFID-based ETC solution has made tolling operations simple and efficient

- The main advantage of passive RFID over DSRC is the unit cost of the tags: RFID tags only cost a few dollars, whereas DSRC onboard units cost US$30-40
- Passive RFID tags also do not require any maintenance and their lifetime is much longer than DSRC units

Optimizing highway and intersection management

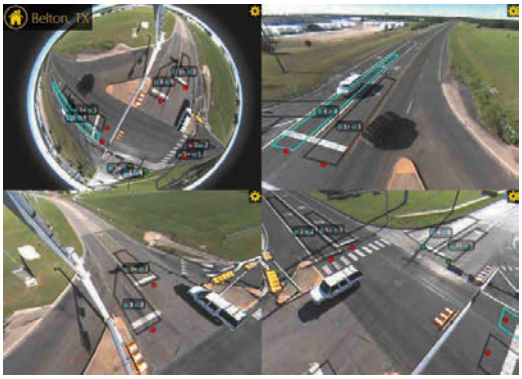
As traffic volumes continue to increase, and road and highway management becomes increasingly complex, it is essential that road authorities are able to monitor and govern their roadways in a flexible and efficient way.

GridSmart has been developed to achieve these objectives. The highly effective single-camera, tracking-based vision solution is specifically engineered for actuation and data collection at intersections and on highways.

The solution comprises four core elements: a powerful processor; a sophisticated engine, which is the tracking intelligence behind the scenes; an elegant 'fisheye' camera; and GridSmart Client – sleek client software that can be used freely on multiple computers.

Traffic professionals use the common-sense GridSmart Client to configure and manage intersections and highway sites exactly the way they want, with only about 30 minutes of training required. With the built-in GridSmart Client liaison, intersections and highway configurations are automatically and securely backed up whenever their computers are online. GridSmart Cloud will even synchronize configurations between multiple authorized users. This, just like every part of the solution, is built on the fundamental principles of simplicity, flexibility and transparency.

The solution's Counts Module can easily create reports based on volume, turning movement and vehicle classification. Furthermore, with the new auto reports functionality and a connected GridSmart site, traffic professionals can configure the processor to automatically email reports according to a personalized schedule.



(Above) **The solution provides a detailed view of individual vehicles** (Right) **Signal phasing control based on real-time conditions**

(Above) **GridSmart Client enables additional modules to be added as required**

Need to know

A simple, flexible and highly efficient solution for modern traffic management

- GridSmart's fisheye camera design enables traffic operators to see an entire roadway intersection, rather than just one part of it
- As the software solution enables optimized traffic management, resulting in smoother traffic flows, fuel consumption and vehicle emissions in the local area are reduced
- The solution is compatible with popular adaptive protocols such as SCATS, SCOOTS, Traffic Responsive System Interface, Real-Time Module and API

Data integration

With its real-time data module, the GridSmart processor is able to provide minute-by-minute performance data for the past hour. This data includes traffic signal 'green time', percent of arrivals on green, volume and occupancy. A summary of live data for the current hour can be observed in the GridSmart Client while the complete minute-by-minute data can be accessed via the GridSmart API.

The solution also incorporates an Alerts Module, which enables a connected GridSmart processor to send emails on user-configured site or zone events. Site alerts can include system events such as system restart, camera offline, etc, as well as loss of visibility, and 'volume exceeded'. Zone alerts include 'zone activated' and 'volume exceeded'. Zone activated alerts can be used for wrong-way or breakdown lane detection.

Meanwhile GridSmart's Pedestrian Module can detect pedestrians moving through crosswalks. This can be used to improve intersection safety by extending pedestrian phases or signaling to turning traffic that there are pedestrians in the crosswalk.

"GridSmart's ability to give us access to so much data from a single camera at a moment's notice has been key in ensuring our commuters arrive safely, efficiently, and without the frustrations typically associated with huge construction projects," says Tim Deitz, traffic control supervisor for the city of Lancaster, Pennsylvania.

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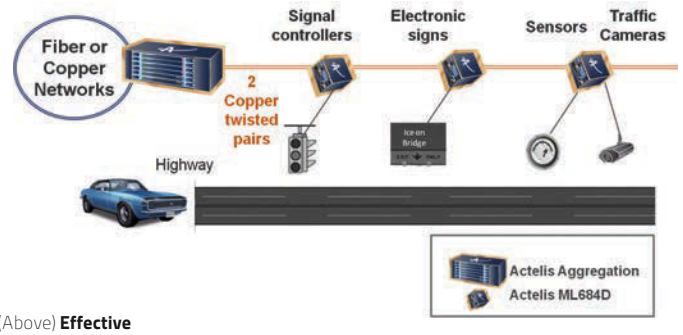
Optimized bandwidth for advanced ITS applications

Advanced ITS technologies provide road authorities everywhere with a tremendous opportunity to better monitor and more precisely control traffic, while fully employing highways and roads. Coordinated use of advanced traffic and environmental sensors, traffic and video controllers, electronic signs, and HD cameras enable the automation and precise control that makes achieving those objectives possible. The result is increased safety and enhanced traffic flow, decreased commute times, reduced fuel consumption, lower emissions, and a decreasing need for additional highway and road construction.

Achieving these goals takes more than simply selecting and installing the right mix of advanced sensors, controllers and cameras. A road authority must also find a way to build a more cost-effective, high-speed and reliable IP network. It must get higher-speed Ethernet connectivity to more places with a lower capital investment to interconnect and control new devices, while supporting the installed base of sensors, controllers and cameras, which typically require a legacy (often serial) interface.

What is the best transport technology for building this network? Not fiber optics, because unless it already exists where needed, fiber represents extremely expensive overkill. Microwave could theoretically be used, but it is also far from ideal for ITS networks. Achieving line of sight, dealing with the technology's inconsistent performance under varying weather conditions, and absorbing the overall cost and complexity associated with site engineering, mounts and spectrum is too high. Non-line-of-sight wireless, by contrast, simply does not offer the required reliability or bandwidth over distance.



(Above) **Effective infrastructure network design**
(Left) **The ML684D is compact and fanless**

Need to know

State DOTs can migrate and future-proof transport networks with broadband over copper

- DOTs can use the ML684D in a 'daisy chain' – using two copper pairs to drop up to 30Mbps of high-speed broadband among multiple devices at each node along the way. This supports both legacy ITS devices requiring a serial interface, as well as newer sensors, controllers, electronic signs, HD cameras and video controllers that require Ethernet connectivity
- The ML684D will be on display at booth 1624 at the 2014 ITS World Congress

A much simpler, more practical and more cost-effective way of building out bandwidth for ITS networks is required. That solution must be quick and easy to install, minimize the initial capital investment required, and be completely reliable and trouble-free to operate. It must fit the traffic network's topology, fit into tight cabinets, offer Ethernet as well as serial interfaces, be manageable, and provide enough bandwidth for current and future needs

An intelligent solution

Actelis Networks addresses these needs with broadband over copper. The company's patented EFMplus suite of technologies makes broadband over copper extremely reliable and enables high-speed broadband over greater distances.

Already field proven in traffic networks around the world, this technology has been incorporated into the new Actelis ML684D Ethernet access device, which offers up to 30Mbps using only two twisted pairs, and supports distances up to 10,000ft (3,000m).

Designed specifically with the needs of advanced ITS networks in mind, this small, environmentally hardened, fanless unit features a DIN rail mount and can easily be installed within space-constrained cabinets or vaults. Providing Ethernet switching among all ports, the ML684D has two copper pairs in and two pairs out, supports 'drop and continue' functionality, and provides two fiber SFPs, a s well as six Ethernet interfaces and one serial interface.

Quick and simple to install, fully manageable and with a comprehensive suite of Ethernet OAM features, the ML684D extends a copper-based network in conjunction with an Actelis aggregation switch, or can be 'bookended'. It also provides excellent results when used in conjunction with a fiber network.

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Revolutionary drive

Throughout this anniversary issue we've focused on ideas that will change the world over the next 20 years. Here are the expert-driven Top 20 innovations, and the pages where you'll find them

20 Congestion reduction systems
"Telematics will play an increasing role in providing safer and more efficient use of road networks" *Brian Negus, ITS Australia (p34)*

19 Driverless-car testing
"We are providing the right environment to give businesses the confidence to invest" *Vince Cable, UK business secretary (p10)*

18 Alternative funding methods
"Reliance on gas tax is misplaced. It is an anachronism in the age of increased fuel efficiency, hybrids and electric cars" *Jack Opiola, D'Artagnan Consulting (p30)*

17 Real-time traffic information
"Personal, handheld devices enable intelligent and appropriate travel decisions to be taken with ease" *Jennie Martin, ITS UK (p23)*

16 Privacy protection software
"We need a framework of data protection to look at privacy in the transport context" *Dr Caitlin Cottrill, Aberdeen University (p54)*

15 Multimodal access
"Automobile travel demand is peaking ... increasing demand for walking, cycling and public transit" *Todd Litman, VTPI (p22)*

14 Reduction of car ownership
"It's going to happen with or without us and I'd rather it happened with us" *Bill Ford, Ford Motor Company (p88)*

13 Free-flow tolling systems
"No one slows down, no one throws money in buckets" *Dean Zabrieszach, VicRoads (p92)*

12 Intelligent speed assistance
"We have digital speed limit maps up and running and intelligent speed assist programs operating" *Matthew Leyson, Department of Planning, Transport and Infrastructure , South Australia (p50)*

11 Dedicated short-range communications
"[DSRC] sees around corners, or past the vehicle in front, and the one in front of that" *Peter Sweatman, University of Michigan (p39)*

10 Next generation road-user charging
"We are poised with the technology and capabilities to implement [the right] system" *Jack Opiola, D'Artagnan Consulting (p24)*

9 Black-box technology
"I believe it will become increasingly prevalent in Europe" *James Bradford, International Road Assessment Programme (p49)*

8 Smartphone transportation services
"Uber's disruption of the taxi industry calls into question the value of regulatory structure" *Shelley Row, transportation consultant (p31)*

7 Electric vehicles
"We are placing a big bet on electrification – both pure electric and hybrids" *Bill Ford, Ford Motor Company (p88)*

6 Crash avoidance systems
"If every vehicle were equipped with the systems currently on the market, we'd see the crash rate plummet rapidly toward the zero mark" *Richard Bishop, Int'l Taskforce on Vehicle-Highway Automation (p28)*

5 Big data systems
"As data becomes smarter, your don't need to have an operator guess what speed the roadway is" *John MacAdam, Ohio DOT (p54)*

4 Induction charging
"Next-generation battery cars, trucks and buses could operate with infinite range" *Tony Robinson, TTi (p8)*

3 Connected vehicles
"V2V and V2I opens up more possibilities... you can have denser driving and parking patterns" *Bill Ford, Ford Motor Company (p88)*

2 Autonomous vehicles
"Most of us will use self-driving vehicles that are subscription-based" *Shelley Row, transportation consultant (p26)*

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