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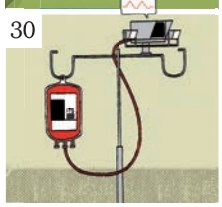
Cover story

54 Pull out the stops

The natural path to clean, efficient autonomous vehicles

Bern Grush looks at how biomimicry can help us nurture a sustainable transportation future



Foreword

Myrmecophobics be warned: there's a rather large picture of an Argentinian ant in our biomimicry article on page 57, something you probably wouldn't expect to read about or see in this publication.

This isn't any run-of-the-mill ant, though. *Linepithema humile* could eventually help scientists to develop new, intelligent software able to solve a raft of common logistical problems as well as maximize efficiency in many human industries. For us in traffic management, think route guidance, satnavs – anything that involves getting from A to Z.

The ants aren't sitting there in front of a PC jumping up and down on a keyboard, though. Boffins are studying their dynamic problem-solving ability. In this particular Australian investigation, a maze based on the Towers of Hanoi puzzle was placed between the ants and a food source. With only two optimal paths out of a total of 32,768, they cracked it in under an hour.

Admittedly that didn't especially impress me at first, as I, too, am pretty adept at finding the quickest path to a Burger King when required. But these ants will also readjust dynamically. If, for instance, the two optimal routes were blocked, they'll march off for a while on other suboptimal paths until – after roughly 60 minutes – they find one of the two, new optimal paths. Stick some roadworks in between me and my BK Whopper, though, and I'll soon lose interest!

Now, I would almost certainly splat one of the little beasties if I was ever to catch one crawling up my leg – I've never been an insect fan after being bitten 96 times in Corfu by a solitary mosquito (my wife, unbitten, counted as she applied the antihistamine cream) – but I certainly appreciate more than I did why scientists and researchers are turning to nature for inspiration.

We all know what a single slam on the brakes will do to traffic flow on a highway – a ripple at first forming into a full-on jam that could last hours. Ants, though, travel on their own chemically marked pheromone roads. Several studies have shown that no matter how dense the traffic gets on their path, they'll never alter their speed – jams simply don't wash in ant world so they've evolved a way to keep moving at optimal ant speed. Scientists therefore think that if they can work out how they self-organize into groups when on the move, they might be able to cut the time and energy we humans waste in rush hours. Elsewhere in the animal kingdom, locusts, fish, birds and bats have also all been studied as a result of their ability to avoid collisions.

It's difficult not to conjure up images of a traffic utopia in 2050 – quick and crash-free – all of us traveling around as ants are doing in these labs. Mankind hasn't done too badly at cutting congestion and accidents, though, albeit we're effectively cleaning up our own mess. And we haven't had 130 million years to hone our skills yet either. But you only have to drive to work five days a week to see how far we are from ant-like efficiency. Exciting solutions are on the way. But maybe biomimicry will deliver them more quickly.

Enjoy the read!

Nick Bradley, Editor

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

Facing facts

Researchers in Texas, USA, are devising ways to reduce the number of deaths from head-on collisions caused by wrong-way driving. **Izzy Kington** investigates what they have found can be done about this global problem

Images courtesy of Geveko, Texas DOT & Texas Transportation Institute

In 2011, there were 31 events in San Antonio, Texas, where the wrong-way driver was apprehended or killed in a collision. In 27 cases, the driver was found to be intoxicated, while in four events, the driver was found to be disoriented because of a medical condition – two were elderly drivers, one was determined to have early onset Alzheimer's and one was released from hospital earlier in the day. "WWD can result from driver unfamiliarity with an area, intoxicated drivers, and drivers who are disoriented due to a medical condition," says Brian Fariello, traffic management engineer at TxDOT. "In situations where a sober, cognizant driver is driving in the wrong direction due to unfamiliarity with an area, the chances they'll recognize the situation and take corrective actions are very high. In 2011 in San Antonio, there were no documented events where a sober, cognizant driver caused a WWD accident."

A key contributing factor of WWD is time of day. In 2011, 80% of events reported to the San Antonio Police Department occurred between 10:00pm and 6:00am, and 45% happened between 2:00am and 4:00am.

All of the fatal accidents recorded in the San Antonio area of Texas in 2011 were head-on collisions. "While these are the worst possible outcome, there are many different scenarios that can arise from this dangerous driving behavior," says TxDOT's Brian Fariello. "Wrong-way drivers can side-swipe a vehicle traveling in the correct direction or strike a barrier, guard rail or other object after swerving to avoid a head-on collision."

Providing a startling reminder of the violence and horror of wrong-way driving (WWD) crashes, particularly those on freeways, Scott Cooner, program manager for the North Texas region at the Texas A&M Transportation Institute (TTI), points out that "photographs of WWD crashes often show two or more vehicles that are so mangled and burned (as a result of the high impact speeds) that the makes/models may not be discernible".

Due to the nature of these crashes – often high-speed and head-on – their human cost is immense. In Texas, the most recent picture was compiled by *San Antonio Express News* in June 2012 using data provided by the Texas Department of Transportation (TxDOT) on the five most populated counties in the state for the period between 2007 and 2011. "The data shows about 20 fatalities a year and 100 crashes a year involving WWD," Cooner says. "This corresponds well with our research from 2002, which looked at the 1997-2000 time period and found similar numbers for annual crashes (approximately 80) and fatalities (approximately 20). The bottom line is that WWD crashes are still an extremely rare event – but often, in more than 50% of cases, result in fatal or incapacitating injuries."

> "WWD crashes are still an extremely rare event – but often, in more than 50% of cases, result in fatal or incapacitating injuries

Public pressure

Although Cooner doesn't believe the frequency of these tragedies is getting worse, they are very emotive, and catch the public's attention. "There was a rash of fatal WWD crashes in the Fort Worth area in the 2000-2001 timeframe that led to the TTI's initial research," he reveals. Published in 2004, the key finding of the investigation was that countermeasures needed to be designed for night-time and intoxicated drivers. Cooner says the latter are the primary cause of WWD accidents – impaired driving is a factor in 60-75% of the cases he's studied. "For 100 wrong-way drivers whose blood-alcohol content (BAC) data was available on the crash record, the average BAC was 0.19, which is more than twice the legal limit (0.08) in Texas," he says.

27 bus
passengers were killed and 34 injured out of a total of 66 when, in May 1988 on I-71 in Kentucky, a drunk wrong-way driver struck the bus head-on

The study also found 80% or more of WWD crashes happen between 9:00pm and 6:00am, with frequency peaking around 2:00am, corresponding with bars closing. "Another key finding is that most WWD crashes occur in the left, high-speed lane of travel in the right direction, as wrong-way drivers tend to stay to their right, putting them in the left lane," Cooner adds. "If you're out driving late at night, it is safer to be in the right or middle lanes."

Factors such as driver confusion and ease of wrong-way movement are regarded by Cooner as smaller parts of the overall problem. "Engineering countermeasures aimed at intoxicated drivers at night are likely to have the most benefit in terms of prevention; however, not much can be done to stop an intoxicated driver."

Around 350 people die and thousands of others are injured each year in the USA as a result of automobile accidents caused by wrong-way drivers on highways, including those driving the wrong way on highway ramps

> Having in-vehicle devices that do not allow the vehicle to be operated by an intoxicated driver or having a vehicle be safely disabled once it is going the wrong way are possibilities

Some of the strategies that were found to be effective include reflective pavement arrows and lowered signs, which are therefore some of the measures that have been deployed in the wake of the report, particularly by the North Texas Tollway Authority (NTTA). "Agencies in Texas should be commended for being progressive," feels Cooner. "The NTTA is the first to expend resources and go through the process of formally crash testing and getting approval from the FHWA to deploy lowered 'Do Not Enter' and 'Wrong Way' signs. This is a significant hurdle that will allow many agencies to consider them, because of the need to adhere to the FHWA's *Manual on Uniform Traffic Control Devices* (*MUTCD*) standard on sign-mounting height, which is typically 7ft or more above the pavement."

Technological solutions

"Technology is certainly part of the solution now and in the future," Cooner acknowledges. "LED activated warning signs, wrong-way detection, the use of dynamic message signs to alert right-way drivers, and systems that automatically alert law enforcement are all examples currently being used in Texas, and some other states, to combat WWD."

Cooner is not keen the use of spikes though. "The most common suggestion for an engineering solution from the public is to have spikes that disable vehicles that go the wrong way," he says. "California tested this approach and revealed it's not a good solution. Although it works well for low-speed applications such as parking lots and rental car facilities, in the scenario we are looking at, the spikes eventually start to puncture the tires of vehicles traveling in the correct direction."

But Cooner says the concept of disabling wrong-way vehicles is "intuitively good" and thinks technological tools might provide a better solution. "Having in-vehicle devices that do not allow the vehicle to be operated by an intoxicated driver or having a vehicle be safely disabled once it is going the wrong way are possibilities that will exist in the not too distant future," he says. "Technology such as vehicle-to-vehicle or vehicle-to-roadside is definitely a way to eliminate these crashes, taking driver behavior out of the equation."

Drunk
wrong-way driver Pal Korbely was given eight months in prison in August for driving three miles down the UK's M6 (with his lights off). Nobody was killed or injured

(Top right) **According to the Texas Transportation Institute, lowering the mounting height of 'Do Not Enter' and 'Wrong Way' signs may be an effective countermeasure for preventing wrong-way entries onto highways** (Below) **A wrong-way vehicle triggers this system, turning on a 'Wrong Way' sign with flashing red LED lights**

Gaining momentum

TTI's research and NTTA's measures are not the end of the road for the state's efforts. Lessons from these endeavors are now being honed by a focus group in the San Antonio area formed in May 2011 by experts from TxDOT, FHWA and TTI, as well as the San Antonio Police Department (SAPD), the City of San Antonio Public Works Department (CoSA), and the Bexar County Sheriff's Department (BCSD). A USDOT/FHWA safety engineer is also a member of the team.

The effort was kick-started by the death in March 2011 of SAPD patrol officer Stephanie Brown, victim of a WWD accident. "TxDOT, TTI and SAPD had discussed the WWD issue previously following fatal accidents, but recognized that there was a need to coordinate efforts to better address this issue," says Brian Fariello, traffic management engineer at TxDOT. "Multi-agency coordination has many benefits; combining engineering and financial resources allows each agency to bring its own unique resources and experience to the effort, and combining the previous knowledge, available data, research efforts and lessons learned from the agencies' staff results in a greater return on time and effort invested."

Since March 2011, TxDOT has kept records of all WWD reports in the area, not just accidents. That year, in fact, TxDOT's TransGuide system logged 185 WWD incidents in the San Antonio area, including 21 accidents, four of which resulted in the death of seven people.

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Maintenance, liability and access issues

The Southern Illinois University Edwardsville (SIUE) is currently involved in a WWD report for Illinois DOT. Ryan Fries, assistant professor and graduate program director in SIUE's civil engineering department, says there are good tools for identifying wrong-way drivers entering freeways, but also challenges in implementation: "Many drivers either correct themselves (by turning around) or crash before law enforcement can reasonably arrive," he says. "Many more enter the freeway than are recorded in our crash databases. Because these events historically occur in the evening and when law enforcement has reduced personnel, quick response is challenging."

Fries also says there are limitations to countermeasure technologies, especially in terms of maintenance, liability, and emergency access. "I have heard about maintenance problems with directional spikes being damaged by snow plows and concern that low-mounted signs could be covered under snow banks.

"Liability is another constraint, because not all US state governments are immune to torts. Even those that are, are still cautious about implementing a system that could harm users' vehicles. Further, emergency responders frequently need to enter the freeway in the wrong direction to arrive at a scene quickly; preventing the use of directional spikes."

(Left) **Wrong-way driving is a killer on roads all around the world** (Above) **Geveko from Denmark has developed a 'ghost' driver warning system that relies on intelligent road studs**

Saving precious time

The SAPD's traffic dispatchers are co-located with TxDOT's ITS operators in the TransGuide Operations Center. Since May 2011, there have been 20 documented events where a 911 caller alerted SAPD's dispatcher of a wrong-way driver, who was then located by a TransGuide operator using CCTV and apprehended by SAPD officers. However, the task force decided using automated sensors on exit ramps could pinpoint wrong-way drivers with more precision and much more quickly. It also concluded that the countermeasures would have to be deployed over an entire corridor for best results, and to provide a clearer before-and-after picture.

Radar detection devices were placed on all exit ramps and at seven locations on the test corridor's main lanes. TxDOT selected radar detectors from two manufacturers – one for exit ramps and another for main-lane locations. Both are integrated with TxDOT's Lonestar software.

The task force also adopted the LED-illuminated 'Wrong Way' sign approach previously implemented by NTTA. In San Antonio, two such signs are placed on each exit ramp in the targeted area, in addition to the standard signs. They are photocell-activated to operate at night. For main-lane systems, LED-illuminated Wrong Way signs and blank-out signs are installed on each shoulder at the selected locations. These are activated by a connected radar device and programmed to remain active until the driver passes. Other WWD countermeasures applied included enhanced static signing and pavement markings, and onsite driveway channelization.

Before and after

From March 15, 2011 through December 31, 2011, the US 281 North corridor accounted for the highest number of reported WWD events in the area – 18%. The corridor from I-35 to Stone Oak Parkway, a distance of 15 miles, was therefore selected to test the countermeasures. In the three months following their installation, the corridor dropped to being the scene for just 3% of the WWD events reported in San Antonio, a reduction of approximately 83%, which is also an 81% reduction in the annual rate on the corridor compared with 2011. "We hope that the before-and-after statistics taken from the US 281 corridor project will result in funding of additional WWD countermeasure projects in the area," says Fariello. "We look forward to participating in a continued national dialog on solutions to address the WWD issue."

Meanwhile, the TTI has embarked on a big TxDOT-funded project to research the effectiveness of all the WWD countermeasures implemented so far in Texas. The issue is also on the federal radar, with NTSB working on its own national study, which is due to be published by the end of the year. In addition, the Illinois DOT is also currently reviewing a WWD report. The team intends to organize a national peer-to-peer workshop/conference on countermeasures for mid-2013, and develop a guidebook for highway and safety engineers, as well as maintenance staff. It seems that in the USA at least, the *vox populi* is spurring traffic safety researchers to make a real difference on this issue.

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Tunnel vision

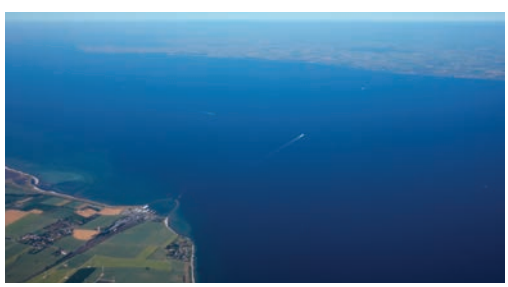
A new fixed link across the Fehmarnbelt region will, **Kim Smedegard Andersen** reveals, provide road and rail traffic with a quick, safe coast-to-coast transit between Denmark and Germany

A technical comparison of an immersed tunnel and a bored tunnel confirmed the former as the preferred structure

The Fehmarnbelt fixed link between Germany and Denmark is a scheme of international dimensions – its physical size alone unquestionably making it one of the world's largest infrastructure projects.

It will provide many new opportunities for the approximately nine million people and thousands of businesses in the Fehmarnbelt region of northern Germany, Denmark and the Scania region in Sweden. New economic, cultural and societal relations will arise to foster trade, tourism, jobs and opportunities for those living and working in the region.

With financial support from the EU, the Fehmarnbelt fixed link has high priority on the EU list of major traffic corridors, the objective being to strengthen capacity for goods transport by rail. The concept of establishing a fixed link across the Fehmarnbelt has surfaced on a number of occasions ever since the Puttgarden-Rødbyhavn ferry route opened in 1963. After the opening of the fixed Øresund link between Denmark and Sweden in 2000, the project has been further developed and in 2008 Germany and Denmark signed a treaty on turning the vision into a reality.



The Fehmarnbelt strait between Denmark and Germany

Going underground

The Fehmarnbelt fixed link will be constructed as a 17.6km-long immersed tunnel for combined road and rail traffic, as this has been assessed to be the best solution in terms of traffic, safety and environmental factors. At a speed of 110km/h, this would offer motorists a tunnel transit time of 10 minutes. Train passengers will spend seven minutes traveling from coast to coast. When the fixed link opens, an average of around 8,000 vehicles – as well as 78 goods trains and 40 passenger trains – are expected to drive through the tunnel every day. Many vehicles are already crossing the Fehmarnbelt, and in 2011 the average daily traffic on the Rødby-Puttgarden ferries amounted to approximately 5,400 vehicles a day; the fixed link is supposed to replace the existing ferry service.

The Fehmarnbelt tunnel will be the longest combined road and rail tunnel to date, and it is also envisaged to be one of the safest and most advanced of its kind in the world. Although the design and construction methods are tried and tested, the unprecedented scale of the project and the depth of the belt – up to 30m – will present technical challenges.

The 2012

EuroTAP results are likely to be released in October, according to ADAC's Nicolas Adunka. In 2004, 44% of tunnels examined failed to meet Directive 2004/54/EC

Money matters

As the owner of the project, Denmark is responsible for financing the coast-to-coast link and the Danish hinterland infrastructure, while the German government is financing the associated German hinterland infrastructures. The project – estimated to cost €5.5 billion (2008 prices) to construct – will be financed by loans guaranteed by the Danish government together with EU subsidies. The fare for driving a car through will be approximately €56 (comparable with the Rødbyhavn-Puttgarden ferry). As a result, the loans taken out for construction will be repaid by the users, as in the case of the Øresund and the Great Belt Bridge. The repayment period including the Danish hinterland infrastructure is expected to be in the region of 39 years.

Timeline

Germany and Denmark signed a treaty on realizing a fixed link across the Fehmarnbelt with a twin-track railway and a four-lane motorway in September 2008. Since April 2009, the Danish government-owned Femern A/S has worked on designing a project that both the Danish and German authorities would be able to approve pursuant to applicable national rules and legislation.

In February 2011, the Danish politicians behind the project declared an immersed tunnel to be the preferred technical solution. The project is expected to be approved in 2015, at which time construction can commence. The aim is for the fixed link to be completed by 2021.

The Fehmarnbelt tunnel will be the world's longest combined car and rail tunnel

Construction elements

The alignment for the immersed tunnel passes east of the existing ferry ports in Puttgarden and Rødbyhavn. The new tunnel will be constructed from prefabricated elements, produced in a purpose-built factory onshore in Rødbyhavn and towed to the alignment for immersion in an excavated trench on the seabed.

There are two types of tunnel elements – standard and special. The former will represent the cross-section for most of the immersed tunnel. All of these standard elements will have the same geometric layout, will be around 217m long and weigh 70,000 tonnes each. The two road tubes in the standard elements will be approximately 11m wide. Each tube will contain two traffic lanes, one emergency lane, marginal strips and step barriers along the walls.

Built in
2000, Norway's 15-mile Lærdal is currently the world's longest road tunnel and takes an average time of 20 minutes to get from one end to the other

An approximately 2m-wide central gallery will be located between the two road tubes, and will contain service installations and provide space for maintenance staff and a place of temporary refuge in the event of an evacuation from one road tube to the other.

Two 6m-wide railway tubes, meanwhile, will provide space for one track in each tube. Emergency walkways will be located on both sides of each track, and the tubes will include space for ventilation jet fans.

Special elements will be located every 1.8km or so and will serve a number of functions. In addition to providing more space for technical installations, they will allow for maintenance access to all areas of the tunnel with minimum disruption to traffic. There will be 10 special elements along the length of the immersed tunnel that will house the mechanical and electrical equipment required for the operations systems. These will be deeper than the standard elements to accommodate a lower level for equipment rooms beneath the rail and road level, e.g. for transformers. Access to the lower levels will be from the western road tube where there will be a layby, outside the emergency lane, for maintenance staff and emergency services.

Light show

The fixed link under the Fehmarnbelt will be one of the longest drives through a tunnel in the world, a future motorist experience that is significantly influencing the design and appearance of the interior. Aesthetic effects such as varied lighting will, for instance, ensure they have a feeling of quality and safety during their passage throughout the 18km tunnel.

When entering the Fehmarnbelt, the first impression will be the mobile lighting along one of the tunnel walls. Over a distance of 1.5km, the tunnel's right wall will display moving images powered by LED diodes; these motifs will be repeated along a 1.5km section midway through and along the last 1.5km before exiting.

To sharpen drivers' awareness, there will be differently colored illuminated zones during the tunnel journey. At intervals, the normal white light – which also illuminates the carriageway – will be interspersed by strong colors over a length of approximately 50m. The colored zones and the varying distance between them will indicate to motorists how far they have driven. As they proceed on their journey, the colors will become lighter, more pronounced and more frequent the closer that they get to the tunnel's midway point. This will also provide a clear indication to motorists of when they reach the middle and that they are now heading toward the exit. As a result of this lighting strategy, motorists in the tunnel will feel that their trip is divided into less monotonous sections – just as the landscape changes when driving along normal roads.

In the preliminary tunnel design, the LED motifs of flocks of birds in flight were meant to symbolize the traffic corridor known as the *fugleflugtslinjen* (translated as 'bird flight line'), of which Fehmarnbelt is a part

• *Kim Smedegaard Andersen is contract director, Immersed Tunnel at Femern Bælt A/S, Denmark*

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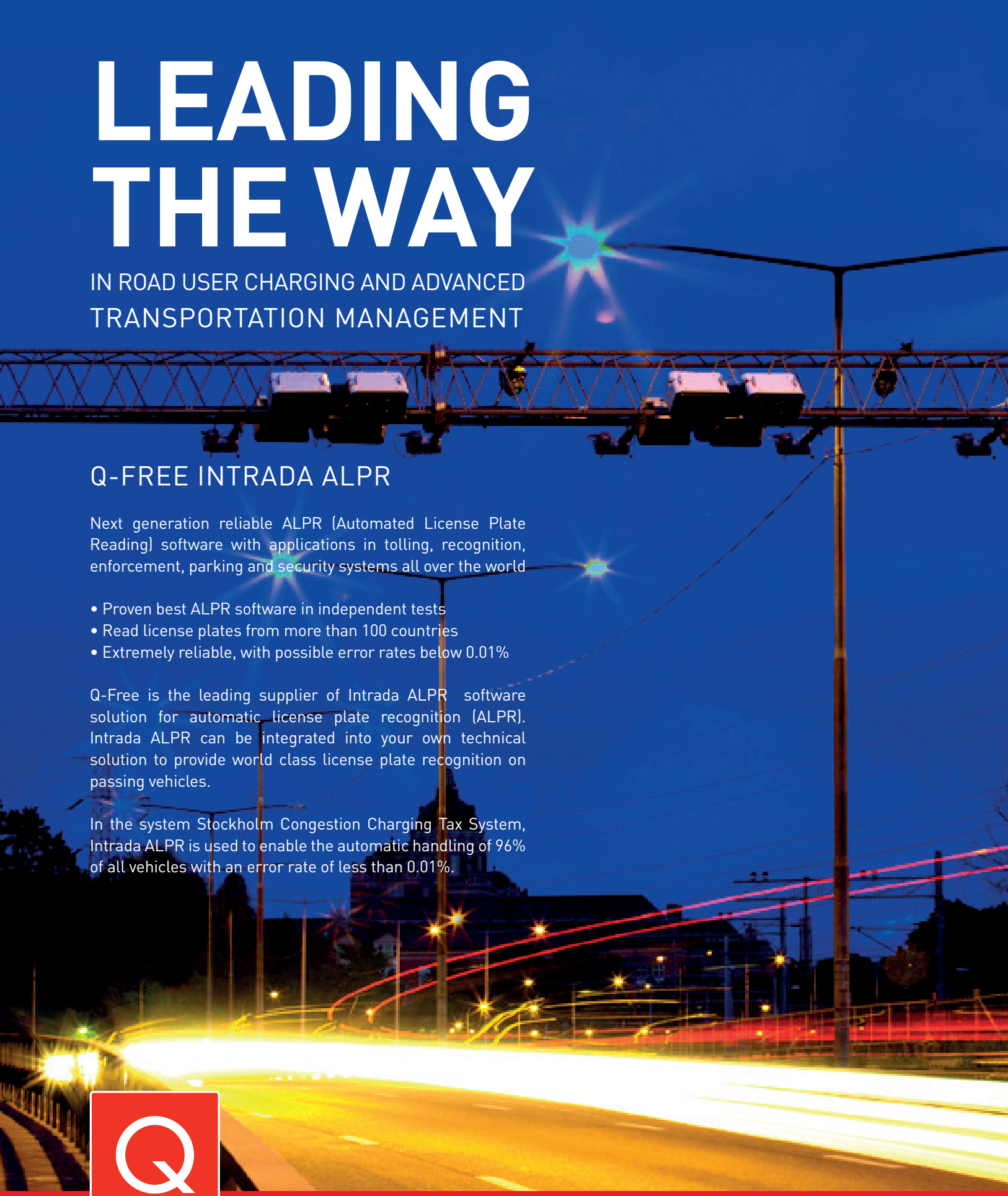

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Inside information

New Jersey is effectively using advanced crash data software to increase road safety in the state. Rutgers' **Carissa Sestito** reports

Accessible data

Plan4Safety's crash filtering and analysis functions let users investigate crash issues meticulously without the high costs associated with manual calculations. In minutes, users can build specific crash queries with any combination of the software's 144 data fields, such as crash type, injury level, cell phone use, time of day, alcohol impairment, occupant restraints, age, and gender.

By implementing methodologies used by federal and state safety professionals, Plan4Safety can also rank high-risk crash locations, view crash factor frequencies, produce visual representations of simultaneous crash events, and display crashes on an interactive GIS map.

"One of our most widely used applications is the crash cluster finder," says Mitra Fetrat, lead engineering researcher on Plan4Safety at TSRC. "Users can input a roadway and ask it to identify mile markers where crash clusters occur. This helps them to deploy resources to precisely targeted areas."

New Jersey's infrastructure comprises an intricate network of highways, bridges, and tunnels that are vital to the state's economy. More than one million vehicles travel its roads daily, so it's not surprising that an average of 300,000 collisions occur annually.

Making roads safer is one of the state's top priorities. But in January 2006, Patricia Ott, former director of the Traffic Engineering and Safety division of New Jersey Department of Transportation (NJDOT), received disheartening information from the National Highway Traffic Safety Administration's Fatal Accident Reporting System – traffic fatalities in the state had increased by 4% since 2003.

32,885
people were killed on the USA's highways in 2010 (the lowest level since 1949) according to the USDOT. However, fatalities rose among pedestrians and motorcycle riders

Why did this happen?

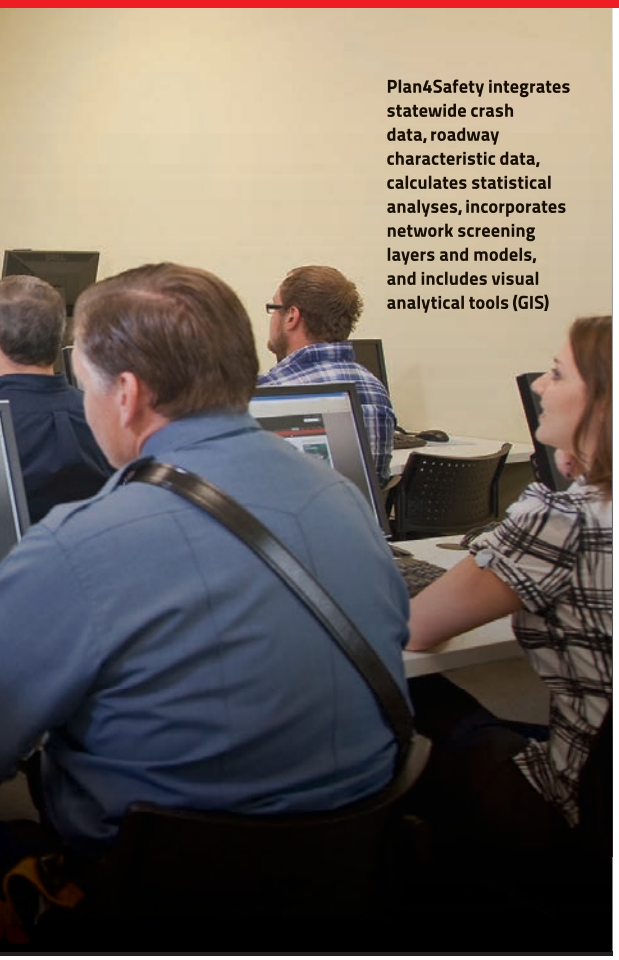
With recently enacted laws – such as lowering the drunk-driving threshold and placing first-year drivers under provisionary regulations – fatalities should have been decreasing, not rising. However, six years ago, local traffic safety efforts were driven primarily through observation; reactive countermeasures were applied to deter crashes with causal factors that, at the time, were largely unknown. This approach was not as sustainable as using proactive, data-driven plans.

In 2006, NJDOT professionals had full access to nearly every official crash record in the state, but safety professionals at the local and county levels did not. That meant state-directed projects were able to employ preventative countermeasures, but the same wasn't true for local agencies. Ott's realization of this disparity led to the birth of New Jersey's only crash data analysis software, Plan4Safety.

"The goal of the sofware is to give local and county departments the same access to data that employees at the DOT level have," Ott says. That data comprises every piece of non-identifiable information from every one of the state's official NJTR-1 crash reports, such as time of day, date, location, number of drivers and occupants involved, weather, road type, and level of injury.

However, Ott knew that making these crash records more accessible wouldn't conquer safety obstacles entirely. Even if data was readily available, these agencies – many of which struggle with budget constraints – would still have to invest time and labor sifting through piles of crash paperwork. Why not make the database electronic? And if this database could filter out user-specified crash report queries, Ott wondered, why not map them with emerging GIS technologies? Why not find crash clusters and trends? Why not even give FHWA-recommended countermeasures, intersection analyses, and crash factor frequencies?

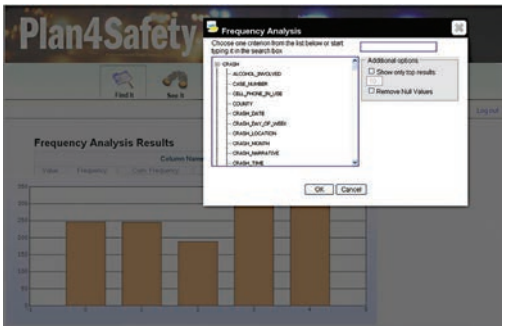
Meanwhile, just 35 miles from NJDOT headquarters, Ott was placing the finishing



Plan4Safety integrates statewide crash data, roadway characteristic data, calculates statistical analyses, incorporates network screening layers and models, and includes visual analytical tools (GIS)

touches on another safety project: the Transportation Safety Resource Center (TSRC) at Rutgers' Center for Advanced Infrastructure and Transportation (CAIT), a USDOT Tier I University Transportation Center located in Piscataway, New Jersey. TSRC was conceived to become the 'go-to' for engineering guidance, technical assistance, and educational materials. It made sense that it could also bridge the gap between crash data and local and county agencies. "It was my eureka moment," she says. "I had envisioned TSRC as a provider of all sorts of products and services for local, county, and state agencies. So, what about a way for these agencies to get crash data? The pieces just fell into place." Four months later, Rutgers' CAIT introduced TSRC as the state's premiere traffic safety resource center, and as the developer of its first and only crash analysis software, Plan4Safety.

Led by Mohsen Jafari at CAIT, TSRC built a comprehensive database that communicates with Plan4Safety's tiered analysis functions. Plan4Safety's data framework corresponds to each data field from the NJTR-1, enabling seamless integration of records into the software. In coordination with the NJDOT Bureau of Safety Programs and the New Jersey State Police, TSRC uploads every NJTR-1 crash record from 2003 onward. According to Mitra Fetrat, TSRC's lead engineering researcher on the project, more



than two million records have been entered into the system, with fresh uploads bi-weekly. "With Plan4Safety, TSRC provides a way to efficiently create and evaluate data-driven safety plans for more than 600 safety professionals statewide," Fetrat says. "We store 144 pieces of non-identifiable data in our system – this not only offers limitless possibilities in examining crash issues, but it saves months of work, too."

Work in progress

Plan4Safety is still evolving. In April 2012, the team introduced a new user interface that simplifies the filtering and analysis process, incorporating an 'a la carte' menu and intuitive workflow. "The users were really the ones who redesigned this upgrade," says Fetrat, describing a development team effort that required several weeks of training and user focus groups to rank the usability of the software and its tools. "We wanted our users to be able to automatically filter, map, and analyze data with a simple questionnaire. We also upgraded our GIS map to a more dynamic interface, and we linked each crash location in the system to Google StreetView so users can actually see the roads they're working with."

The team is also constructing a framework that will potentially enable the integration of external data such as trauma unit records, insurance histories, and pavement conditions. "Trauma unit records will allow users to see if someone died from injuries sustained at the crash scene," says Fetrat. "This additional data may revolutionize the way agencies prioritize high-risk locations."

Plan4Safety will also provide cost-benefit analysis by evaluating crash data against the cost of countermeasures. "Part of the reason Plan4Safety exists is to help agencies make smart, proactive decisions," says Ott. "In 2012, if you're not creating data-driven plans, don't expect to see results."

And Plan4Safety is paying off. Data-driven plans have helped to reduce traffic fatalities from 700 to under 550. "In six years, agencies have gone from having no data to data with endless possibilities. Sometimes, I can't even believe how far we've come," Ott concludes. "But until we reach zero deaths, our work is still not done."

NHTSA reports that, in 2010, the use of seatbelts in passenger vehicles saved an estimated 12,546 lives. They've saved more than 69,000 lives in the USA from 2006 to 2010

Hidden extras

Plan4Safety provides as many insights to data as it does opportunities to use it. Since its inception, the system has contributed to a range of safety improvement projects at the local, county, and state levels – and not just to find and analyze crashes.

The New Jersey Division of Highway Traffic Safety requires all grant applicants to use Plan4Safety data in their proposals. The state's metropolitan planning organizations use it to rank high-risk rural road segments and direct funding to road owners. Local police departments use it to plan DUI and seatbelt enforcement campaigns, and engineering departments use it to find crashes linked to road geometry. Municipalities, meanwhile, use it to make pedestrian and bicycle safety improvements. And alcohol and substance abuse organizations use it to support impaired driving education programs. TSRC even uses Plan4Safety to evaluate localized educational campaigns by examining before-and-after crash trends.

> "The goal is to give local and county departments the same access to data that employees at the DOT level have

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Light fantastic

Intelligent streetlight management as part of holistic ITS architectures has huge potential – as **Dr Thomas Novak** reveals

In recent years, some effort has been made to integrate intelligent functionality in today's streetlights. The basic idea is to include a communication and control module into each luminaire, making it possible to control and monitor each light unit individually from a central station via wireless or wired communication. This strategy has been introduced one step at a time with growing levels of 'intelligence'.

In the first stage, the focus was on integrating a monitoring functionality that could reduce maintenance costs by reading back, for example, operational status and light failures. "Successively and due to the emerging use of LED technology in outdoor lighting, sensor-based control functionalities were included in order to save energy," says Manuel Milli, technical project manager of the EU-funded COSMO project. All approaches, however, propose a closed system, totally independent of any other system, such as an ITS platform.

The way of realizing intelligent streetlighting for sustainable traffic management is to include it as an application into an ITS platform to efficiently meet requirements on future integrated systems. The advantage is that overall traffic strategies – due to the holistic ITS architecture approach – can be applied.

Application and services

Market research and feedback coming from customers has shown that intelligent streetlight management should cover at least four main types of applications that are, in turn, based on four general services.

The first application is called 'demand-responsive streetlights', in which the streetlights are switched on/off or luminosity level is changed in a predefined area, only if a local sensor receives a trigger. Such an application can be used for bus stops where the lights are turned on depending on the presence of buses.

'Traffic-adapted luminous path' is another application. When traffic flow is low (e.g. non-peak times or during the night), a lower level of luminosity is sufficient and streetlights can be dimmed in a specific area. If a car or pedestrian enters the area, only the lights in front of the car raise their luminosity level. Lights already passed decrease their level again.

Additionally, 'improvement of road safety' is included as an application into the intelligent streetlight management. Hotspot areas on the road are lit with a higher luminosity level than surrounding areas. If a pedestrian is crossing a road, for example, luminosity level of streetlights before and after the pedestrian crossing area are increased during the night to make the pedestrian visible to an approaching car.

Finally, the 'remote diagnostic and optimized maintenance' application is used to monitor broken luminaires and report their location.

Use case

In the city of Utrecht in the Netherlands, Hoeflake Infratechniek installed 300 luminaires from Swarco with remote monitoring and control via Powerline Communication in July 2012. A so-called 'segment builder' manages up to 3,000 streetlights over a maximum length of 10km. In addition, environmental sensors such as photocells, weather stations and traffic sensors are integrated into the system. An application-specific Powerline Communication protocol was developed in order to gain maximum data throughput and reliable communication. This is used to exchange data among sensors, segment builder and streetlights.

Philips

Lighting is investigating the potential of IP network control for streetlights as the next step on from LEDs in terms of energy-efficient lighting

Key services

Services are the basis for realizing the four main applications. Thus, intelligent streetlighting as part of an ITS platform is implemented by four services that are integrated into the TMS (traffic management system) software.

Event-triggered service: Action is taken on the occurrence of a certain event. For instance, the luminosity level changes if a pedestrian enters a road or the weather situation is changing (e.g. fog or rain).

Time-triggered service: Action is taken at a predefined time. For example, every second streetlight is switched off or reduced in power during the night.

Location based service: Action is taken within a predefined geographic area. An example of this is reducing the power of all lights in a street apart from the ones near school zones.

Diagnostic and maintenance service: Get information on the status of streetlights, such as read-back parameters.

BLISS

(Better Lighting In Sustainable Streets) is a European project aiming to find ways to reduce the energy consumed by street lighting and reduce CO_2 emissions

Maintenance expenses (materials, routing, labor, etc) can be minimized by considering the remaining life of any nearby luminaires that can be replaced during the same service call.

Physical architecture

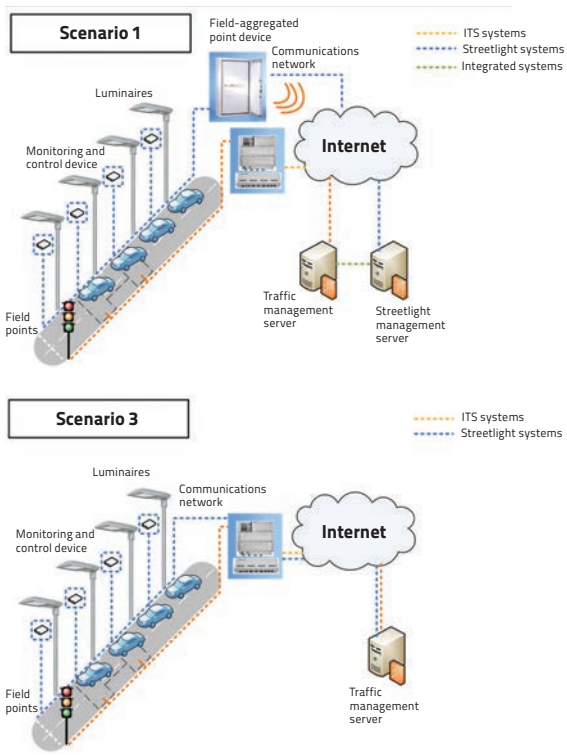
Applications and services are realized in software in the TMS as part of the ITS platform. Another important topic and key factor for success is integration in the field. This depends strongly on existing installations and legacy systems. Typically, streetlight installations have a lifetime of up to 30 years; consequently, integration into existing infrastructure as well as new installations has to be supported. These requirements result in three integration scenarios.

Scenario 1 (pictured right) is integration at the management level mostly used in existing installations. Coexistence in the field remains unchanged, but data exchange is between streetlight and ITS central management server. The advantage is an easy-to-handle integration into existing systems. However, overhead in terms of devices and data exchanged is given.

Scenario 2 uses the same field-level gateway, but logical integration remains at management level with two independent servers. This scenario is a hybrid approach and might be of interest where parts of streetlights installations are retrofitted. Still, integration effort at field level is rather low, but overhead regarding the number of devices and data exchange is given.

Scenario 3 (also pictured) is integration at field level where only a single system is used at field and management level. This is preferable in general but applicable almost only for new installations as a result of the effort to install and interconnect devices at the field level. This approach to integration also reduces the amount of equipment to be deployed in the field.

Ultimately, there are several key benefits of integrated intelligent streetlights systems. "It is maintained that the proposed applications can have a positive impact on energy and subsequently cost savings, as less luminosity level results in less energy consumption and carbon emissions," states Michael Schuch, Swarco Futurit's managing director. However, road and personal safety is not lowered as the luminosity level is increased every time it is required. Moreover, effects of LED technology – such as better quality of light for increased safety or reduced light pollution and increased dark sky friendliness – reinforce the positive impact. As a consequence, user acceptance of such an approach with LED streetlights is clearly rising.



Two of the three scenarios depicting different types of system integration

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And now for the weather

Nick Bradley discovers increasing excitement within the meteorological community relating to how the connected vehicle could improve road weather operations. But is this a snowball in the face for traditional RWIS technologies?

Illustration courtesy of Ben White

Not all that long ago, the suggestion that your car, through its subsystems, would one day collect information about weather conditions – an icy surface, a patch of fog or a flooded road – and alert following vehicles or maintenance teams would have seen you laughed out of events such as SIRWEC or the International Conference on Winter Maintenance and Surface Transportation Weather. Now the subject has tracks of its own and not just increasing interest but real belief that the vision isn't only technically feasible but an inevitability. The big question is when.

Another sizeable question, according to Professor Wilfrid Nixon from the Department of Civil and Environmental Engineering at the University of Iowa, is how best to use all the data that you collect. "Extracting the information, then knowledge and finally wisdom from this enormous quantity of data is our most significant challenge," he says. "The process of wisdom extraction is what will totally transform road weather management over the coming decade."

There are more than two schools of thought on this issue though. Some people feel there's no such thing as having too much data. But despite acknowledging the paradigm shift such mobile data sources could bring about, Dr Lee Chapman, senior lecturer in applied climatology at the University of Birmingham's School of Geography, Earth & Environmental Sciences in the UK, believes for the moment there are "ongoing concerns about data quality that would suggest the technology is a long way from being suitable for data assimilation in forecast models". This now familiar name to our road weather management articles does

Let's change it up

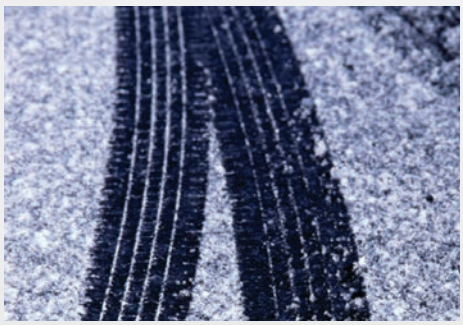
The quantitative friction value is, writes Vaisala's **Jon Tarleton**, beginning to have a huge impact on the future of road weather technology and its integration with other ITS systems

Pretty much as long as there have been roads and vehicles, there have been winter maintenance operations, with the practices formulated over the years very much tried and tested.

One of the game-changers, however, has been the invention and deployment of pavement sensors that no longer need to be installed directly in the road surface. These non-intrusive or non-invasive sensors can collect data about pavement temperature, pavement condition (dry, wet, snow, etc), thickness of the layer of water or ice on the surface, and a value of road friction.

But why change? Isn't road weather data from a sensor in the road surface the same as data from one on the side of the road? No. The major difference that non-intrusive sensors such as Vaisala's Pavement Condition Sensor DSC111 offer is the reporting of a surface friction value. This is a relatively new concept for road weather stations and will likely have far-reaching effects.

What non-intrusive weather sensors cannot do is measure the presence of deicing chemicals on the road surface. As all road chemicals must dissolve in water to do their job, it is impossible with current science to measure this dissolved chemical in the water on the road. A manufacturer that claims to be able to detect a chemical value such as freeze point from a non-intrusive sensor is merely reporting the pavement temperature at the moment when ice is detected. This is only valid at that moment in time, and it will not report freeze point when there is no ice present. This method therefore calls into question the reason for using freeze point values as a decision point at all.



> "Why do you need chemical freeze point that is nothing more than a middle point to the final answer?

For years, embedded sensors have been both passively and actively reporting the amount of chemical on the road as a freeze point – i.e. the point at which the current water on the road would freeze if the road surface reached that temperature. As long as the road temperature is above the freeze point, you have a wet road. But that's where the simplicity ends.

Once the road surface reaches the freeze point of the current water/chemical on the road, it doesn't mean the road will instantly turn to ice – it means ice crystals only begin to form, hence that freeze point alone is not a clear-cut decision data point to determine road condition.

In fact, looking at the true amount of chemical on the road may be more challenging than it is worth. Some deicing chemical, for instance, might still be in a solid form, which does nothing for road condition other than provide some minor traction.

As the Vaisala Non-intrusive Condition Sensor cannot see road chemicals (like all non-intrusive sensors), a value of friction was derived to still provide a quantitative value of road condition. For two main reasons, the result is a much better decision point than freeze point or other chemical values. First, in-pavement chemical readings are typically taken at a single point, so the relation to the rest of the road may not be accurate. Second, the embedded sensors use pavement temperature and measurements of the flowing water to calculate the amount of ice – they cannot 'see' ice.

Vaisala's Non-Intrusive Condition Sensor isn't reading a single point but instead scanning a 1ft^2 area, giving it a better view of road conditions – and it optically 'sees' the ice forming so you get a much more accurate and faster detection of ice or snow.

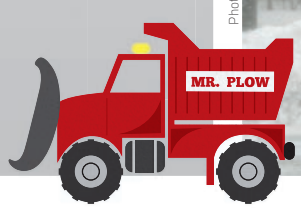
In the end, aren't we searching for a quantitative number that tells us if the road is getting better or worse? Before an event, typically the temperature of the pavement is critical because as it begins snowing, raining or forming frost, we need to know if what is falling will freeze. Once the event is underway our needs and mindset shift to worrying about keeping the transportation safe and operating. We need to know if our activities are having the desired effect. Is the chemical in fact keeping the road safe and free of ice? The information we need to know is how the tires will respond to the pavement at that point in time. Freeze point can change erratically as new chemicals are applied or as water flows and moves over the surface of the sensor. If the end result is to monitor the formation or reduction of ice and snow, why do you need chemical freeze point that is nothing more than a middle point to the final answer?

Friction is a lot easier to integrate with other decision models, thus we can do more

Using non-intrusive technology, Vaisala's DSC111 is able to measure road conditions safely from the side of the road. The sensor provides important conditions such as surface state, thickness of moisture, and grip or road friction

with the value than simply gather it. Friction data will also have a major impact on mobile road weather data collection. Determining surface condition from a moving vehicle using a chemical reading such as freeze point will be very challenging, because a sample of the water on the road must be collected. To do this from a moving vehicle is difficult, not to mention the vehicle has since passed the area you collected, making it near impossible to determine where the sample came from. Again, friction is the answer because it can be collected without collecting water from the road and can be read instantaneously. The biggest user advantage, however, is that by using friction both in a fixed and mobile application means that users can compare readings from both types of data collection and be able to make correlations.

Throughout time we have counted on technology to make major changes to our society and improve our lives. Non-intrusive sensors such as the Vaisala Pavement Condition Sensor and data parameters such as friction are becoming the next significant steps in improving travel and safety during adverse weather conditions. If you still need a value such as freeze point because 'that's the way you do it', ask yourself this question. When was the last time you looked for a pay phone when away from home or the office? Technology changed you.



> Extracting the information, then knowledge and finally wisdom from this enormous quantity of data is our most significant challenge…
>
> **Wilfrid Nixon, professor of Civil and Environmental Engineering, University of Iowa, USA**

however note the gradual shift in the meteorology community that perhaps it is actually better to have some data – even if there are compromises – than none at all.

The Finnish experience

You might expect any discussion about connected vehicles and road weather to focus first on Ann Arbor, Michigan, and the USDOT's nigh-on 3,000-car model deployment. But the results of this widescale examination of talking cars – groundbreaking as they could be – are more than a year away. The European Eureka/Celtic WiSafeCar (Wireless traffic Safety Network Cars) project, on the other hand, concluded this March and saw participants from Finland, Luxembourg and South Korea join forces with a fleet of five to seven vehicles to establish how connected vehicles and road weather might converge.

Although much smaller in size than the USDOT tests in the USA, a main objective of WiSafeCar was to pilot systems and services based on the C2C communication standards developed by CEN and ETSI. "The ultimate goal was to create an intelligent communication

The USA alone spends US$2.3 billion annually to keep roads clear of snow and ice

Photograph courtesy of Ed Betz/Press Association Images

Harmonizing the RWIS community

EN15518 is the European Standard for RWIS, a hot topic at SIRWEC in May. "We started our standardization work with the fixed equipment and now we are moving to mobile equipment," reveals Pierre-Alain Brodard, COO of Boschung Mecatronic. "Efficient winter service is based on timely operations with appropriate resources," he adds. The 'timely' part of the job implies that the maintenance people receive reliable information about future road status so they can get ready with the equipment and be on site before conditions turn bad. "The 'appropriate' part means they not only know when something is going to happen but what kind of problem and how severe it's going to be," Brodard explains. "Taking care of a morning's hoarfrost doesn't, for instance, require the same weapons as dealing with freezing rain."

Hence the decision process leading to efficient winter operations relies mostly on the quality of information that the decision-maker receives. "This was the starting point of our standardization work," Brodard continues. "How can we ensure that the maintenance manager firstly knows what information he receives – i.e the meaning of the data? Second, how can he trust this information? And third, if verified, can he then build a valuable decision-making process to ensure proper reaction to incoming events?

"New available information from floating car data is interesting but we must remember maintenance managers have to think ahead of the current situation. A smart combination between sensors and weather forecast will still deliver the best piece of information in my opinion."

platform and mechanism for vehicles to exploit the services generated, partially based on their own observations of traffic, road and weather conditions, seamlessly delivered to the platform core," reveals Pekka Eloranta, director, EU projects at Mobisoft, Finland.

WiSafeCar included testing of short-range data transfer compliant with IEEE 802.11p and long-range GPRS/3G communication. "The vehicles transmitted traffic and weather observations to our traffic service center server, LinkingPoint, at which the data was analyzed and conveyed to other vehicles on the road, together with information concerning road conditions," the Finn adds. The system also alerted drivers in case of imminent danger of an accident due to a slippery road.

Taken from the CAN

The sources of data and the sensors used consisted of ambient temperature sensors, road surface temperature sensors, stereo camera-based road friction detection, lightbulb status measurements, warning lights status, ABS pump status, windshield status, vehicle position, 3D accelerations, vehicle speed, etc.

"The idea was to use 'low-cost' sensors that could be installed in any vehicle at a reasonable costs and effort," Eloranta explains. "But the main target was to show that nomadic, aftermarket implementations can offer a sound and economic solution to collect weather- and road condition-related data to be used in road weather models, forecasts, incident warnings, etc."

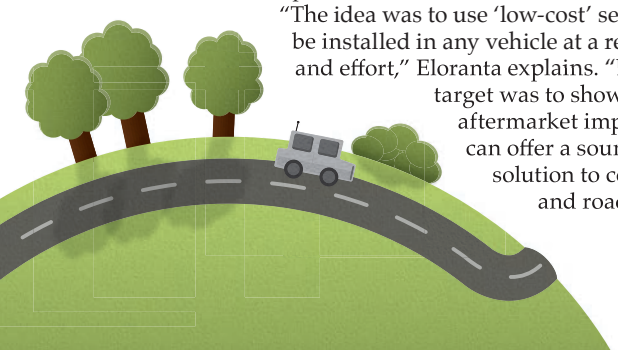
> The main target was to show that nomadic, aftermarket implementations offer a sound and economic solution to collect weather- and road-related data
>
> **Pekka Eloranta, director, EU projects, Mobisoft, Finland**

The field piloting in Finland started gradually in spring 2011. By March 2012, sensor data and observation-based data was successfully being collected by the vehicles and delivered both by WLAN and cellular connection to the LinkingPoint server, which subsequently passed the information on to the Finnish Meteorological Institute (FMI) to be used in their road weather models. Ultimately, WiSafeCar proved the value of connected vehicles in the road weather information mix, so what happens next? "Our work will continue in the CoMoSeF – Cooperative Mobility Services of the Future project," Eloranta reveals.

The WiSafeCar project has developed a communication system for drivers to provide them with the weather-related information needed

The next step

CoMoSeF started in July 2012 and aims to promote the creation and deployment of cooperative mobility solutions, including devices and applications, feasible for large-scale deployment that support the objectives of the EC's ITS Action Plan COM(2008) 886 and national ITS strategies. "It will bring existing and emerging sensor



(Right and below) **By using a well-described, -defined, and -detailed planning system that begins 10 days prior to any storm, McHenry County DOT was able to provide customers with an excellent storm response**

units, service platforms and communication technologies and solutions closer to market introduction and will create the much needed business models to promote and speed that deployment." One of the important issues to be dealt with, says Eloranta, is the use of a vehicle bus (e.g. CAN) as a data source (collection and fusion of data from vehicle bus of several vehicles).

In Finland, CoMoSeF will be closely related and linked to the FP7 ICT project DRIVE C2X and will provide material and results for the cooperative test site in Finland, where there will be special emphasis on harsh winter condition testing.

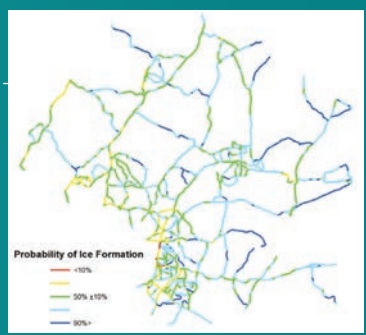
The implementation of the commercial system in Finland based on the results of WiSafeCar and CoMoSeF will kick off by approaching the stakeholders that already have commercial vehicles on Finland's roads. Most of these vehicles are equipped with technology capable of being connected to the CoMoSeF platform and services. "But the deployment in Finland is highly dependent on the activities and support of the authorities," says Eloranta. "The activities carried out and the successful piloting can be used to promote the CoMoSeF services in the discussions with the public sector. The key phrase, though, is increased safety, which just happens to be one of the cornerstones of the Finnish national transport policy."

On the ground

The involvement of FMI in the CoMoSeF and WiSafeCar projects is a timely reminder that any data extracted from a connected vehicle network is first and foremost of value to weather maintenance operations on the ground. Platforms such as SIRWEC and the International Conference on Winter Maintenance and Surface Transportation Weather are priceless in showcasing the progress being made in numerous fields, particularly when it comes to the sharing of real-world best practice and user experience.

On February 1 and 2, 2011, a particularly severe winter storm swept across a swathe of the USA, hitting the Midwest especially hard. Areas around Chicago received close to 2ft of snow while 50mph winds resulted in drifts of 6ft. The TV footage on the news reports showed cars stranded on Lakeshore Drive. Around 50 miles north of Chicago is McHenry County, which bore the brunt of 22in in the storm. But as a result of the sustainable winter management practices of the County Division of Transportation, its planning and preparation, by 6:00pm on February 2, all County roads were passable and more than 70% of

What are the chances?



The new paradigm of route-based forecasting and decision support systems provides the perfect framework to develop what Dr Lee Chapman refers to as 'probabilistic road weather forecasting'. "The technology to support this is already in place and producing a basic forecast is straightforward," he says. Producing 'sharp' forecasts is, he adds, non-trivial and requires the integration of several emerging technologies and significant extensions to the state of the art. Before fully embracing the potential, though, Chapman thinks there needs to be proof that practical benefit can be leveraged with improved probabilistic forecasts. "There is evidence in the scientific literature, but this hasn't been tested in the winter road maintenance community," he explains. A detailed study's needed to ensure the added information doesn't reverse the advances made in reducing salt usage in recent years. "If there is a 10% chance of ice on a stretch of road, does the highway engineer have a duty of care to mitigate that risk? If that's the mindset, then an oversalted network beckons. However, detailed verification of probabilistic forecasts and thresholds will lead to the opposite."

Chapman feels probabilistic forecasting deserves to be trialed in the sector, although the nervousness among practitioners is a concern and may well render the technology obsolete even before it becomes operational. "Even without probabilistic forecasts, the sector will still benefit from ever-increasing computational resource by improvements in numerical weather prediction," he says.

The connected vehicle could facilitate this needed verification. "The development of operational mesoscale models to the sub-kilometer scale is in the not-too distant future and will allow the resolution of surface features currently only accounted for in downscaling models. Perhaps this is the true future of RWIS and where future research efforts should be focused."

the lane miles were, according to Mark DeVries, in a "bare and wet" condition. DeVries is superintendent of the McHenry County DOT and says the amount of salt used in this storm was arguably more remarkable than the sterling efforts to keep travelers moving. "Some people in the winter maintenance community believe that when it comes to the use of salt on highways during winter storms, if some is good, more is better," he says. DeVries disagrees.

He subsequently wrote a paper detailing the winter maintenance efforts of February 2011 with the University of Iowa's Professor Wilfrid Nixon. "Our goal was to examine this postulate and if the data supported us, to refute it," Nixon reveals. "The answer is not to use less chemical but to use the right amount of chemical for the storm in question and to meet the specific needs of the community that you're protecting," Nixon adds.

"In terms of persuading others of this fact, that will take time," he continues. "But by showing how successful this approach can be, we can persuade others to try it." The secret of McHenry County's success was a well thought-out storm strategy – a 10-day countdown. "Most forecasts will not go beyond 10 days," DeVries says. "Indeed, beyond three days, forecasts become significantly less reliable due to the chaotic nature of weather systems." He also points out that 10 days provides a reasonable timeframe for all steps that need to be taken to actually happen.

> The economics of utilizing chloride alternatives will become financially feasible and the adverse environmental costs of sodium chlorides will also aid in this transition
>
> **Andrew Betts, School of Engineering, University of Guelph, Canada**

(Above) **Traffic management center staff coordinating operations during a severe winter snowstorm**

Regardless of how prepared you are, though, Nixon is keen to stress that Mother Nature should never be taken for granted – she'll bite you once or twice in a season, he adds. "Myself and Mark [DeVries] are currently training 60 or so city and county maintenance supervisors in Iowa City on these techniques. We'll have at least four more of these training sessions this fall. But just because you do the training doesn't mean that practice will change. It's much harder to change practice if you cannot show people that the approach you advocate works in the most severe of situations."

Environmental considerations

Salt usage is something that's been on the mind of Andrew Betts, who has investigated a method to use readily available GIS data to evaluate the impact the application of salts has on vulnerable road areas. "We also wanted to quantify the risk to identified salt vulnerable areas (SVAs) in order to prioritize implementation of best management practices," he explains.

SVAs are defined as any area susceptible to adverse impacts to the health of the surface water environment or quality of groundwater drinking water sources, caused by the application of road salts during winter maintenance.

Betts, from the University of Guelph's School of Engineering in Ontario, reports that Canada uses approximately five million tonnes of road salts a year, with sodium chloride by far the most widely applied. In the USA, around 18 million tonnes are spread onto roads each year, although there are currently no regulations in either country regulating the use of sodium chloride as a deicing agent.

Canadian drinking water standards outline aesthetic objectives only for chloride and sodium at 250mg/l and 200mg/l respectively. The US Environmental Protection Agency has developed toxicity

thresholds for chlorides, which include chronic freshwater quality criterion of 230mg/l and acute criterion of 640mg/l. During his research, however, Betts discovered that mean annual chloride concentrations in some urban rivers reached as high as 760mg/l, with peak instantaneous concentrations as high as 11,640mg/l (Highland Creek, Toronto). A commercial parking lot in Guelph measured an astonishing 24,000mg/l, while groundwater concentration in surface water in Highland Creek was recorded at 350mg/l. Clearly this isn't good news for the biota.

Betts developed an equation that estimated the mean annual chloride concentration in surface water, which divided the annual weighted chloride loading by mean annual stream flow. "This methodology investigates both surface runoff chloride contributions and baseflow chloride contributions," he says.

It's all rather scientific but for road maintenance agencies potentially quite significant. Betts' research will allow those that apply road salts to identify the areas within their jurisdictions most sensitive to chloride contamination and provide a means to prioritize implementation of best management practices.

But surely contamination is an inevitable and unavoidable side effect of using salt to de-ice roads? "Emerging technologies that have the capacity to capture chlorides and attenuate their migration through surface waters have a large measure of applicability in SVAs, especially those areas where sensitive species are present in receiving waters," Betts says. "Although it's not a permanent immobilization solution, the technologies that capture chlorides – even for a short duration – can dampen peak concentrations in chloride-laden melt water, serving to protect diminishing aquatic species populations from acute toxicity contamination, especially in our urban areas. In the years to come, I think the economics of utilizing chloride alternatives will be financially feasible and the adverse environmental costs of sodium chlorides will also aid in this transition."

RWIS as a lifesaver

Balancing the environmental, economic and societal needs pertaining to winter roads maintenance is a divisive topic. But the fact remains there are 7,100 weather-related fatalities in the USA a year, amounting to 24% of all the people killed on the nation's roads. Does a strategy such as that employed in McHenry County save lives? Could a wider RWIS network actually help reduce accidents? Paul Bridge has been working hard to answer that last question. You would expect his answer to be 'yes', given he works for Vaisala, but it was actually Idaho Transportation Department (ITD) that requested he and his Vaisala colleagues examine if a well-maintained RWIS network has any effect on accident rates. "A number of ITD staff noticed that where environmental sensor stations (ESS) were installed there appeared to be a corresponding drop in accidents," he says. Given the type of data that was available, Bridge and his team didn't feel it was possible to correlate the data for specific points so instead opted to conduct a statewide study. The data had to be 'normalized' to take into account things such as winter storm severity and the underlying declining trend in general accident rates in the USA, while as long a time series as possible was obtained so they could be sure of their findings.

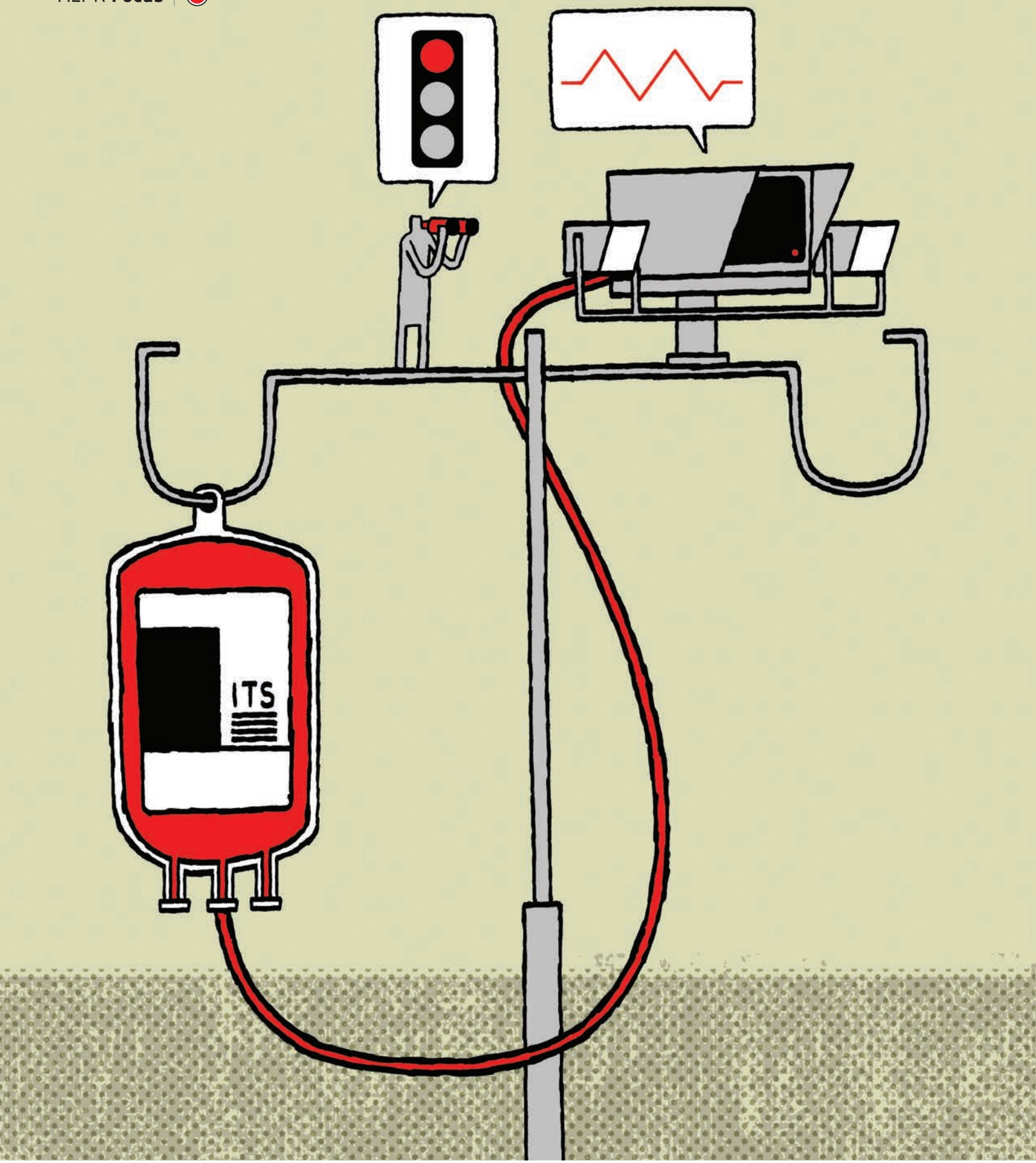
> We calculated that there has been an average reduction of around 2,300 crashes a year in Idaho since RWIS was introduced
>
> **Paul Bridge, offering manager, Vaisala, USA**

(Above left and top left) **Road authorities need to better manage their use of road salts in a way that reduces their impacts on the environment while maintaining road safety**

Voyage of discovery

And what did they discover? "We calculated an average reduction of around 2,300 crashes a year in Idaho since RWIS was introduced," he responds. To put a monetary value on this, Bridge broke the figure down to categories ranging from 'property damage only' up to 'fatalities' and applied some conservative percentages. "We're looking at savings of around US$240 million a year," he says. "Even taking an ultra-conservative view, this is still considerable, not to mention the lives saved." But how was this achieved? "We decided there was no one magic wand but an accumulation of initiatives and approaches as to how the system was used and applied."

One of the initiatives that yielded the most objective and identifiable results was the introduction of a storm performance indicator developed by ITD. "This is a numerical value calculated from a set of measured ESS parameters, which shows how well road maintenance has been performed," Bridge reveals. "In simple but elegant terms, the lower the value, the better the performance. This is allowing ITD to evaluate and share best practice, but also to objectively measure their effectiveness. Other knock-on effects include a general reduction in deicing materials." And this is obviously both good for the wallet and for the environment.


ITS

Life story

Louise Smyth reports on the ALPR solutions that are the lifeblood of the ITS sector across the world

Illustration courtesy of Tim Ellis

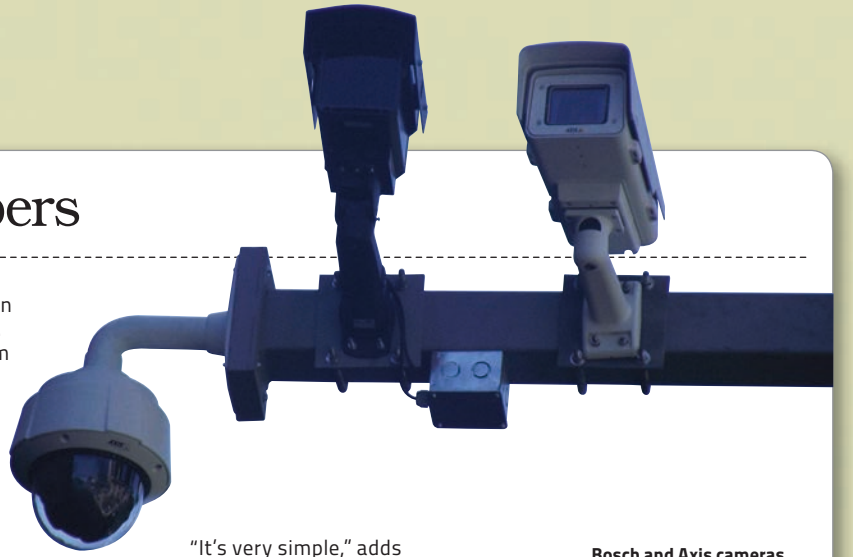
The previous time a detailed report on ALPR ran in this publication, the industry was in a state of flux. Ailing companies were being forced out, while up-and-coming organizations were, well, up and coming. In the months since, a number of developments have shed new light on exactly how this subsector of the overall ITS market is really doing – and the results make for interesting reading.

The case studies, new applications and solutions over the following pages demonstrate that the ALPR market is currently in very good health indeed. And you'll read that – despite the cost-cutting and reduced budgets across the entire traffic management sector, the technology is alive and kicking. And its applications continue to diversify. In past times, anything involving the use of decent cameras and sophisticated OCR algorithms came with a high price tag. Today, things have changed. ALPR is no longer an elite solution used only by those with fat wallets; it's a viable (and widely used) option for access control, tolling, city security, border control and more. In *Traffic Technology International's* home, the UK, there is a national network of ALPR cameras – albeit one that has recently come under fire for its 'patchy' coverage. But even the idea of using this technology across such a vast swathe of land shows how far things have come. The UK's main highways, most of its motorways, town centers and gas stations are all covered by ALPR cameras. And there's a national ALPR data center to deal with the vast amounts of information generated by the cameras. Although the UK network example is arguably more security-focused than traffic management, it remains proof that this is one technology that's not going away any time soon. Of course, there's always talk of revolutionizing the entire way vehicles are registered and monitored – moving toward EVR, getting rid of license plates altogether, etc. But for the near future at least, the plates are set to stay – and as a consequence the technology used to read and keep an eye on them will also remain in place.

More to come...

And although initial deployments may be primarily for security purposes, the data from these networks can be used for all manner of traffic management applications. This is, in fact, one area of the ALPR sphere that's not yet being fully exploited. Doing more with the data that ALPR offers us is where we should now focus our efforts. Many are well aware of this and are moving in that direction, although there's a long way to go before the true potential of ALPR data is fully realized. But that aside, as you'll discover over the next four pages, from arterial roads to the perimeter of a city, ALPR is keeping the heart of ITS pumping.

Red hot Chile peepers



Anyone who's driven in a big city has seen the lanes that are marked for bus and/or emergency vehicles. Some may have wondered how cities can enforce traffic laws related to these lanes, in particular drivers of private vehicles who pay no mind to various restrictions and regularly drive in these lanes. The city of Santiago, Chile, however, has come up with a solution.

For years, drivers in the South American city have regularly ignored ordinances forbidding them from being in a bus lane unless they were going to make a right-hand turn at a particular intersection. The reasons they're not allowed in the bus lane are to do with maintaining traffic flow and safety. Drivers who proceed straight ahead in such circumstances can contribute to gridlock as well as cause accidents.

There were simply not enough officers available to monitor such situations, so the transportation department in Santiago sought a solution that was both automated and cost-efficient. They decided their best bet would involve a combination of video surveillance and LPR. After consulting with many vendors, they decided to use Bosch and Axis IP video surveillance cameras and SecurOS LPR software from Intelligent Security Systems (ISS), which has successfully monitored similar situations all over the world for various cities.

The technology has been installed at various problematic intersections in the city, while the software integration was handled by Protab.

With the LPR system in place, vehicles that violate bus lane regulations have their plate number captured. Video surveillance cameras capture an image of the vehicle in question, which assures that it matches the vehicle type associated with the plate. These images are then relayed to a server at the transportation department and then reviewed. A ticket can be automatically issued through the computer system and sent to the driver.

Carlos Aranda, who is the infrastructure manager for the Ministry of Transport and Telecommunications (MTT) in Santiago, comments: "We had great concerns about how this would all work. We wanted to minimize the possibility of errors, whether in failing to capture violators or ticketing those who – in fact – were not in violation. This had to be win-win right from the beginning because public pushback of any kind could really work against us.

"As a result of ISS's lengthy experience in this arena and the type of comprehensive platform the company offered, we had assurance right from the start that any issues could be easily addressed and resolved."

With the cameras in place along with SecurOS LPR, intersections in Santiago that were ordinarily quite problematic with drivers violating bus lane rules have already seen great improvement.

"It's very simple," adds Sebastian Muñoz, country manager for ISS in Chile. "Drivers have been forced to be accountable by our new system: if they are in the bus lane to turn right and continue straight ahead, they know now that we will capture their license plate and an image of their car, and that a substantial fine will be sent automatically. Signs give them ample notice to exit the lane if they plan to continue straight, so there's no reason for them not to do so if they're not going to turn."

Muñoz also mentions that this security system has had the knock-on effect of improving traffic flow. "Buses travel faster now because they're not being held up by drivers trying to proceed illegally from the turn lane. So it's actually making our bus system more efficient, saving both money and time.

"I cannot overstate the reliability and convenience of these automated features, from capturing violators to issuing tickets," he concludes. "The images are very clear and the process is seamless. Also, we don't need as many traffic safety officers in such areas, which is definitely being looked at in the bigger picture for further cost savings to the city."

Bosch and Axis cameras capture license plate data that's read by ISS's SecureOS system

Free-range Turkey

An innovative city security project is ensuring the safe and unhindered progress of traffic through one of Turkey's hotspots.

Ankara's City Security Management System project is one of the biggest and most complex projects in Turkey, consisting of many aspects working together to create a complete city security system.

The project's key elements include red-light violation detection systems at 78 locations, speed detection systems at 19 locations, and ALPR systems at 71 locations. In total, 825 city monitoring units have been installed in the busiest locations, including the entry and exit routes of the city. All of the cameras used project streams in full HD (1,920 x 1,080 at 25fps) resolution.

Additionally, the individual systems are integrated with the central city security management system and monitored at the city's security management center via 18 70in DLP screens.

"Our smart video content analysis software analyzes all images coming from the city security management cameras," reveals Erdem Eray from technology supplier Telefunken Security. "The software collects license plate information of all vehicles and matches them to the stolen plate, stolen vehicle and seized vehicle inquiries in the database of the Directorate General of Security. Once there is a match, an alert is submitted at the workstations.

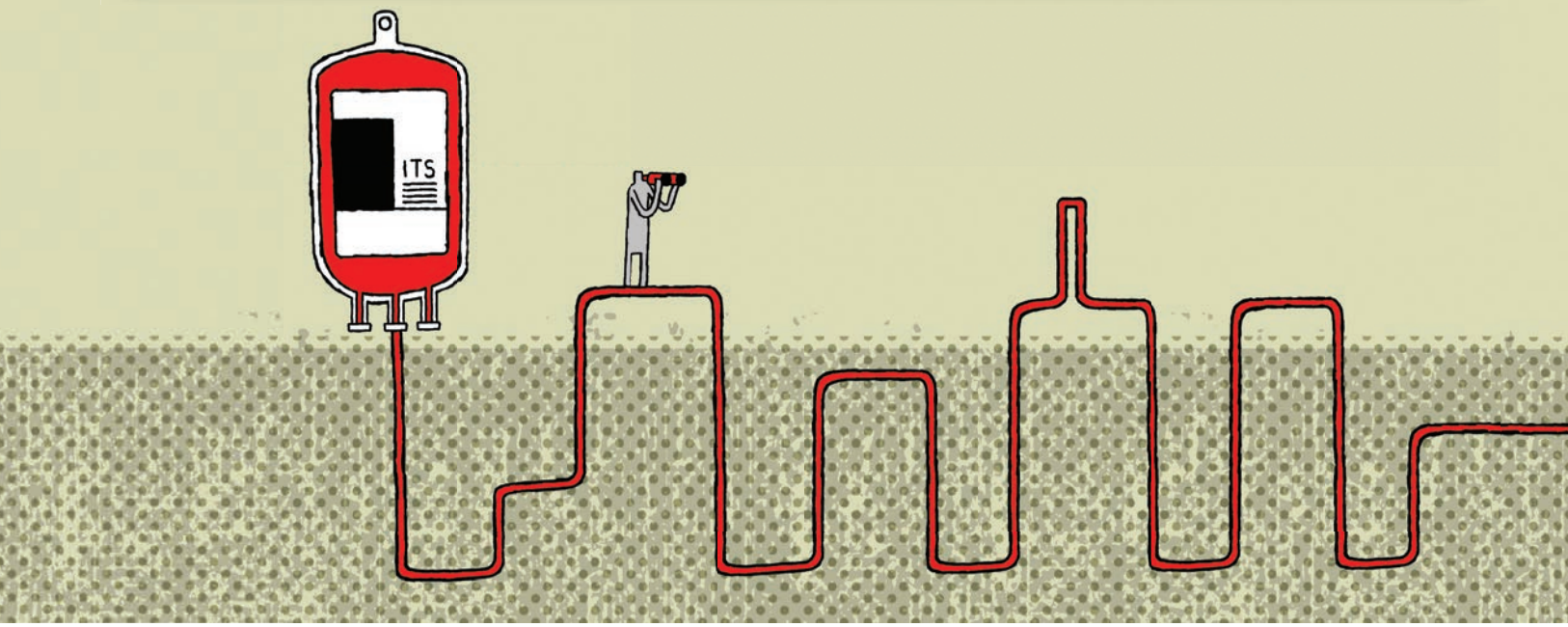
Ankara's security management center receives feeds from various types of camera

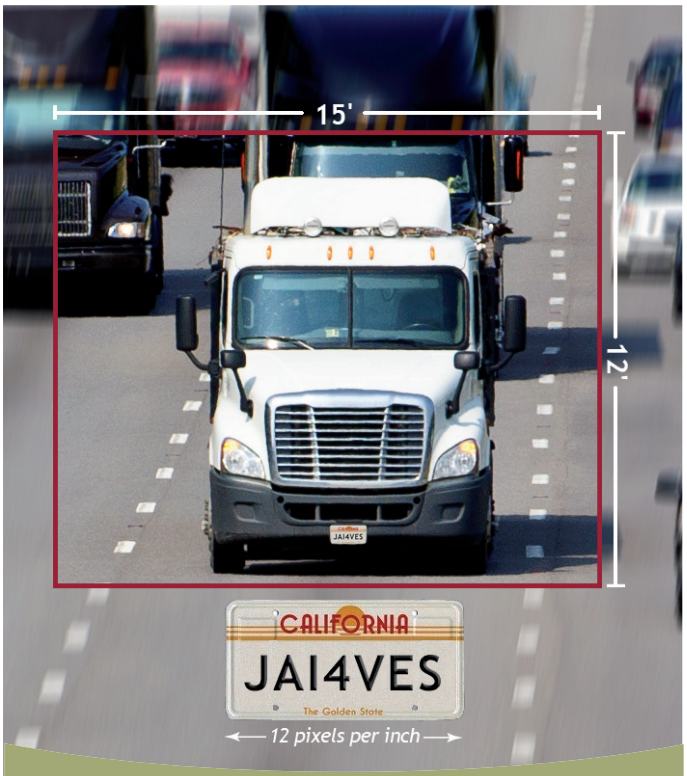
ALPR is improving traffic enforcement in Ankara

"In case of a violation (red light or speed), the alert is again forwarded to the workstations along with the driver's registration information." Using this approach means that enforcement officers are able to issue tickets and send them out to the drivers without having to keep track of every single vehicle or event that occurs.

"As the number of security departments and police stations has increased, secondary monitoring and management centers have been established at 62 different locations in addition to the city security management center," Eray says. "The monitoring software, call management system (police emergency number 155), map integration, mobile and various security applications that are managed over a single platform via the central management software have been introduced within the scope of this project."

Eray believes that ALPR is the glue that binds this diverse range of application together. "Without ALPR, there simply is no traffic security," he concludes. "Our TraffiSecPlate solution is keeping Ankara safe and traffic flowing while ensuring that traffic violators and criminals do not go unpunished."





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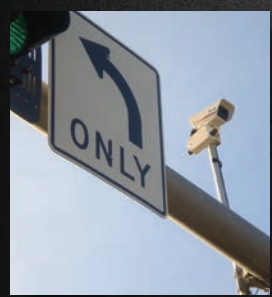

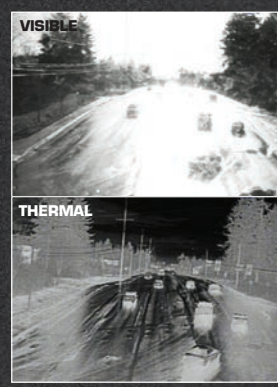

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One application that encompasses both traffic management and security is access control. And one vendor with news in this field is perhaps better known within these pages for its expertise in the tolling sector. "We recently received Lenel factory certification for the interface of our Insignia ALPR solution to the OnGuard access control system," reveals Jim Kennedy, CEO of INEX/Zamir. "Our system integrates with the OnGuard access control infrastructure and provides accurate LPR to grant or deny access of vehicles to a particular facility or area.

"This integration enables an immediate, actionable vehicle event to be sent to the OnGuard system, allowing comprehensive management of that data," he continues. "Benefits to the end user include the ability to provide a variety of double-credentialing access control configurations along with a higher level of security screening."

Kennedy is especially proud of this latest development (as well as his other partnering agreements with access control and security customers such as Tyco, Verint and NICE) as it helps prove a theory he has honed over his years of experience in various parts of the ALPR sector.

"A benefit of addressing several markets is that knowledge acquired from one area helps you improve in another," he says. "This is especially true in the ALPR world where lessons learned from, say, high-speed tolling can provide insight to other areas such as secure city or parking projects. Recently we attended two key shows at the same time: the IBTTA Annual Meeting and the ASIS (American Society of Industrial Security) conference: what we've taken away from both events is that there is a continual consolidation of technologies.

"One major theme running through the sessions at the IBTTA event was the merging of technologies of ITS and ETC," Kennedy notes. "To a large degree (over and above apprehension of toll violators) there has already been some crossover between data collected at ETC points and law enforcement – Amber Alerts and stolen vehicle alerts come to mind. But even greater data sharing will provide a more effective path for transport management systems where accurate information on traffic load, travel times, incident detection, vehicle miles traveled, and a number of other collectable data sets can be incorporated for more efficient use by authorities and law enforcement agencies.

INEX/Zamir LPR software is used for a variety of security and access control applications

"This marriage of various sets of available data is not a new idea to the security market. Quite apparent at the ASIS conference was the view that high-end systems suppliers are looking to incorporate data from all of the available technologies into a single, all-encompassing system. Such systems will take information from ALPR and CCTV cameras, gunshot detection sensors, stolen vehicle lists, BOLO lists and other data points, creating a true central command capability. Data mining efforts like this provide lots of useful information in a timely manner.

"The eventual outcome of both of these initiatives for more centralized repositories of data will be a single location where information from both disciplines is compiled and available to whoever has authorized access."

Light reading

ALPR systems must quickly and accurately identify vehicles through the use of OCR. The overall accuracy of an ALPR system is dependent on high-quality illumination, as it determines the quality of the image being captured.

Capturing quality images from long-range distances is a requirement for many in the ALPR sector. Direct, more focused, brighter light sources are therefore required. High-density, chip-on-board technology provides brighter compact illumination solutions in a range of wavelengths. Chip-on-board LED illuminators also have an added advantage of providing longer lifetimes.

ALPR vendors are realizing the merits of using such illuminators within their offerings. One successful example of this approach is the cooperation between two key players in their respective sector. ProPhotonix supplies LED illuminators to NDI Recognition Systems (NDI-RS), a US- and UK-based designer and manufacturer of ALPR systems for the high-technology security, surveillance and traffic management markets.

NDI-RS operates globally and is required to offer its systems in a range of IR wavelengths to accommodate the variability from one jurisdiction to another. IR wavelengths are often preferred because they are not visible to the driver and as a result of the retroreflective qualities of many license plates.

For most European ALPR systems, 870nm is the suitable wavelength. In the USA, however – where license plate regulations vary by region – alternative IR wavelengths (e.g. 940nm) are sometimes found to be more suitable for use.

To meet varying market expectations, ProPhotonix has developed strobable 810nm, 870nm and 940nm SpecBright spotlights for NDI-RS, capable of providing high-quality illumination over a 15-25m range. The SpecBright lights have been incorporated into the NDI C320 and V220 camera systems, which are currently utilized in a large number of applications in the security sector. These include the UK's London, Manchester and Brighton 'rings of steel' security and surveillance cordons, which monitor vehicle entry and exit, to and from a defined city limit.

Ultimately, ProPhotonix reports that it has received nothing but positive feedback on the lights from NDI-RS.

ProPhotonix is providing NDI-RS with LED illuminators for its ALPR cameras

Safe harbor

There is a new project in Brazil that's showcasing how the power of ALPR can be put to use for a number of different applications. DERSA (Desenvolvimento Rodoviário S/A), the national roads company, has awarded HTS (Hi-Tech Solutions) with a contract that allows the company to show how its technology makes a positive difference at a number of levels – from security to traffic management and even logistics.

HTS's Brazilian subsidiary will supply more than 30 LPR systems at the country's coastal ferry crossings to monitor vehicles as they pass in and out of the entry and exit gates. HTS Brazil will act as the turnkey contractor for the entire project, which will include the installation of LPR cameras, CCTV security cameras, video analytics, electrical infrastructure, and communications systems.

DERSA is a partially state-owned company that is responsible for the delivery of transportation infrastructure and logistics systems for the development of São Paulo and Brazil. The Brazilian government has also mandated DERSA to take over the administration of the country's coastal crossings, which transport large numbers of vehicles on ferries. To make the entire process safer and more efficient, DERSA is upgrading its operational control center, which manages and monitors all the vehicles on board the ferries, as well as those waiting in line to embark. This will include measurement of waiting times, count and classification of vehicles, communications, and variable message signs (VMS) that will be deployed across the network of coastal crossings. Seven crossings will be automated in this first phase of the project.

"We have undertaken this technology and automation project in order to effectively monitor and manage the process of the coastal crossings, as well as to learn from ongoing activities, to provide better service, and to plan logistics and infrastructure in the best manner possible for the future," details Joao Poiani, DERSA's operational director.

Adds Maxwell Rodrigues from HTS Brazil, "With the ferry crossings being used as such an integral part of our country's transportation system, we are excited about taking part in this project, which will enable DERSA to monitor and manage traffic flow in real time, responding quickly to changing circumstances."

HTS is supplying more than 30 LPR systems to DERSA

Recognize this?

Over the years, a familiar name featured in these ALPR articles was CitySync. When the UK company was acquired by the USA's Image Sensing Systems (ISS), we wondered what would happen next. And now we know...

ISS recently announced the introduction of its CitySync ALPR solution. The system assists law enforcement by reading license plates, checking them against national and local law enforcement agency databases and then storing the data in a back-office system called Jet-BOF.

"With shrinking budgets and reduced personnel, law enforcement agencies are turning to technology to become more efficient and help tackle crime," explains Kris Tufto, ISS's interim CEO. "The CitySync ALPR solution is a complete system that includes our LPR cameras, recognition software and a sophisticated back-office system that ties everything together. We are pleased to offer an end-to-end solution that automates crime detection and helps law enforcement agencies run efficiently."

CitySync Jet-BOF is a web-based back-office system that provides storage, matching and reporting of LPR data. It is capable of receiving, processing and storing more than six million reads and plate images a day. It also features an analytical toolset that includes data-rich reports and analysis tools.

The reports that are produced using the compiled LPR data are invaluable to ITS and security operations. The location report, for instance, allows the user to interrogate the data to give a list of vehicle plates captured around the time(s) and location(s) of a particular event or series of events. And the intercept report is used to attempt to identify any patterns in the behavior of individual vehicles or hotlists of vehicles. It will also indicate where and at what times these vehicles are likely to be spotted. In another example, the convoy report is used to try and identify occasions where vehicles are being used in convoy to facilitate criminal activity.

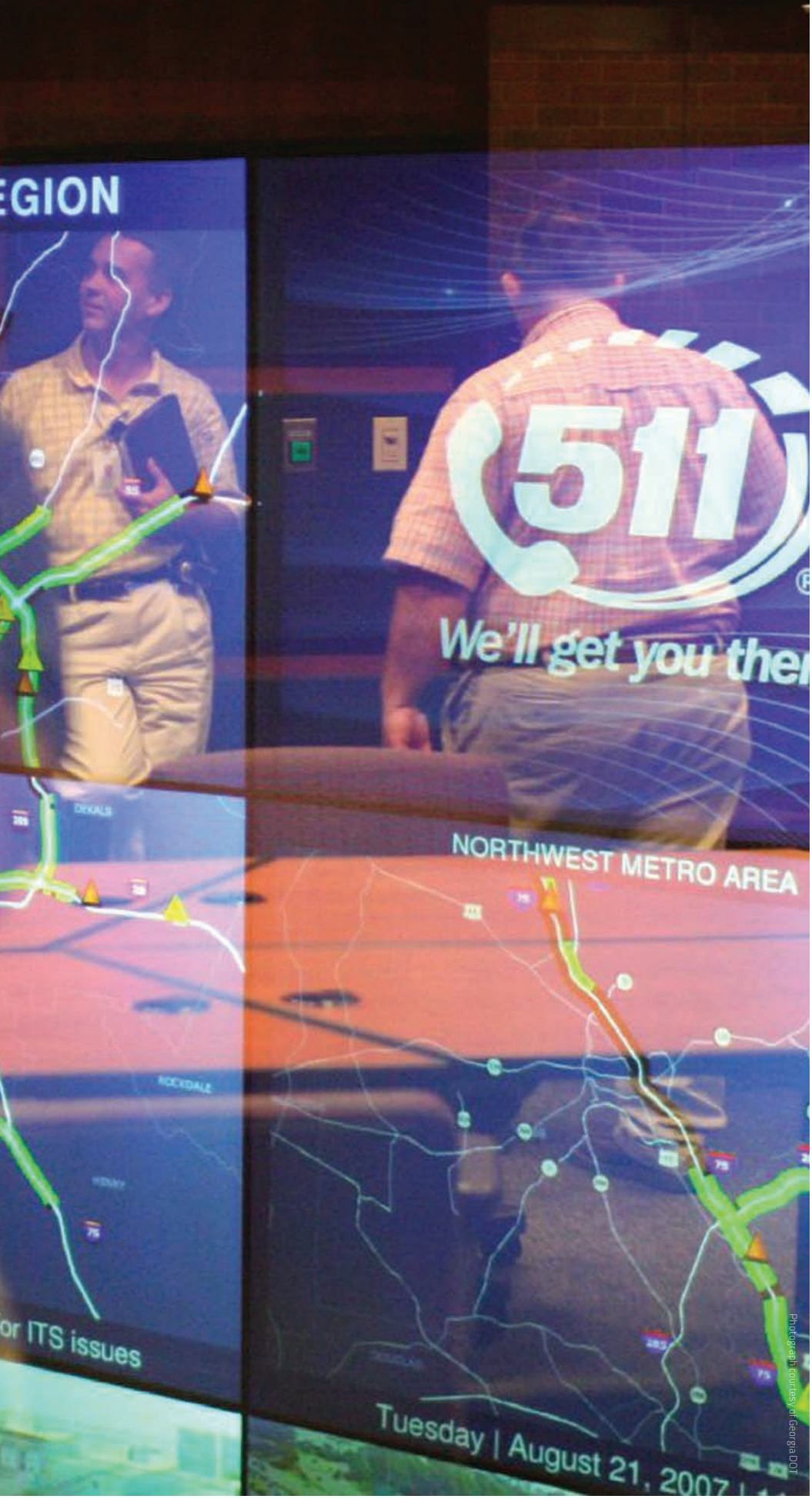
The overall solution also includes the Jet-Aludra HD camera, an intelligent LPR imager with integrated processor, which allows the images to be processed at the point of capture. The system is fast enough to process at full-frame rate as each vehicle passes the camera at high speed, resulting in a highly accurate, intelligent LPR camera.

Screenshot of the CitySync intercept report

Think tank

Charged with traffic reliability, safety and efficiency – and all on a tight budget – challenges abound for TMC managers. But **Timothy Compston** discovers an FHWA-backed initiative is allowing them to pool resources to succeed on the frontline

Photographs courtesy of Atlanta DOT, Caltrans, Georgia DOT & WSDOT



Photograph courtesy of Georgia DOT

Jim McGee is an enthusiastic advocate of the Federal Highway Administration-supported TMC Pooled-Fund Study (TMC PFS), which is unsurprising given he is its long-time chairman. Yet his day job is the highway program administrator for the ITS section of Nebraska DOT, so he understands and appreciates the rationale for having something such as the TMC PFS in place. "The study originated with the states and the FHWA more than a decade ago when a system was established so that anyone who wanted to could be in a position to pool their resources," McGee says. "To my knowledge, there are probably a couple of hundred of these PFSs but as a result of the way in which we address the issues, the TMC Pooled-Fund Study tends to be one of the best known."

Mission, control

Contemplating the specific goals of the initiative, McGee says there are a number of strands. "We are tasked, for instance, with identifying human-centered and operational issues. We suggest approaches to these issues, initiate and monitor related projects, and provide guidance and recommendations nationally. It's about offering leadership and coordinating our efforts with a broad array of stakeholders as well as promoting technology transfer."

According to McGee, a key point to make is that this essentially provides a positive framework so that resources can be pooled and research jointly funded into critical areas that would otherwise be simply unaffordable for a state DOT. To date, 18 projects have been initiated or completed with seven additional projects chosen by members for 2012-2013. McGee says these range from defining transportation management center operator requirements to focusing on consistency of

Photograph courtesy of MassDOT

the messages provided to drivers via dynamic message signs: "If possible, you ideally want a message to mean the same thing in New Jersey as it does in California," McGee says.

One project he singles out as being close to fruition concerns the impact of advances in technology on TMC operations: "This should be coming out in January 2013 at the Transportation Research Board meeting in Washington and I am sure it will generate a high level of interest. We are really looking 10 years down the road for this.

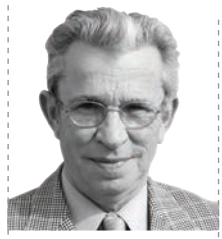
"Of particular interest is the increasing involvement of third parties gathering, selling and adding value to ITS data," adds McGee. Another trend is the diversity of sources and types of data: "Some of this is from DOTs, some from government agencies such as the National Weather Service; others are from proprietary sources such as those that have their own sensors on the road."

When questioned about the elements of the design and management of McGee's Nebraska District 2 Operations Center in Omaha that have been influenced by the TMC Pooled-Fund Study, he points to the co-location of the Nebraska Department of Roads and the Nebraska State Patrol within the same facility. "This was sparked by viewing best practice in other jurisdictions," he says.

Information exchange

Turning to California, Mike Jenkinson is the chief of transportation management centers and traveler information for the division of traffic operations, MS-36, at Caltrans. Similar to McGee, he also has

> Of particular interest is the increasing involvement of third parties gathering, selling and adding value to ITS data
>
> **Jim McGee, highway programs administrator, Nebraska Department of Roads/chairman, TMC Pooled-Fund Study, USA**



(Top left) **Massachusetts DOT High Operations Center, which shows feeds from the roadside cameras and the message boards offering real-time traffic information along I-93**

his finger in the TMC PFS pie as vice chairman. He says that a major benefit of being part of the TMC-Pooled Fund Study is the information exchanged between members.

"Working in a state as large as California, there is a diverse range of issues coming at you all of the time from metropolitan and rural areas that need to be addressed," he explains. "Having the ability to reach out to 29 other states about their experiences – and how they have dealt with something – is invaluable. You are able to weigh up the pros and cons and even offer up a contact in another state that colleagues can then cross reference with before any decisions are made."

In practical terms, Jenkinson says that it is possible for the information exchange that goes on between fellow TMC operators to drill down as far as the component level, to the extent of asking who has tried out which surveillance cameras, for instance. In addition, he feels that help is also at hand at a procedural level. "There's a push to move things out of government into public-private partnerships and states are at different

Wellington drives ahead

A purpose-built US$1.5 million (NZ$1.9 million) TOC opened in Wellington last year is transforming highway operations for the better and providing timely travel information that can be delivered to drivers through roadside VMS. Mark Owen from the New Zealand Transport Agency (NZTA), who is the operations manager at the TOC, says the facility is shortly to double the number of its operators to 12, plus three other staff. This, he says, will allow monitoring to be extended beyond the central and lower North Island regions to the South Island. "What we had before was just too small for our requirements," he feels. "Now we have a facility that offers what we need with scope for expansion."

Operators at the TOC are tasked with monitoring traffic speed and directing lane speeds via lane control signs, closing lanes if there is an incident, and giving people ample warning that there's something ahead. Another focus for the TOC is the two road tunnels in the Wellington area, one having recently been upgraded with new heat and fire detection and suppression capabilities and overheight detection of vehicles. In addition,

CCTV in and around the busy motorway and expressway area of Wellington – and cameras scattered across the network – are monitored and VMS activated right through to the central and lower North Island.

"We plan to work closely with local councils to improve the use of the total road network and not just the highways," Owen says. "The vision is that we would have traffic signal people sitting in the center as well optimizing and managing the total roads network around the urban areas."

points here, so under the umbrella of the TMC-Pooled Fund Study, we can find out what has been considered and where the difficulties may lie."

An area of focus for the TMC PFS spotlighted by Jenkinson is bringing consistency to the specific roles of TMC workers. Every state traditionally had their own definition of job descriptions: "We conducted some research and actually came up with a whole series of classifications in order for us to map out a whole career path for someone – from coming into the TMC as a dispatcher all the way up to the manager of a facility." Jenkinson sees the TMC-Pooled Fund Study as a great enabler allowing various facets to be studied and implemented which otherwise wouldn't have been possible: "You don't have to do all the work or provide the funding yourself."

The Caltrans man confirms that there are a number of projects starting this year, with discussion facilitated by conference call or face-to-face meetings. One of the main areas that materializes that he is particularly interested in is how TMC operations can be backed-up effectively: "Do I need to have one TMC for back-up or can this be achieved virtually with a cloud-type structure? Is there something I can employ without having to maintain a specific building? There are, of course, technical issues with this that require further investigation."

Another major challenge being discussed concerns social media and the development and growth of the cell phone and associated apps: "This increasingly crops up," he says. "Should we develop our own apps or make data easily available for others to do it?" Alongside this, Jenkinson notes debate about the role of the cell phone, which was initially regarded as a portal to deliver information direct from the TMC yet there are growing concerns being expressed over the potential for drivers to be distracted. With the USDOT's focus on driver distraction, spearheaded by US Secretary of Transportation Ray LaHood, it's a topic that will no doubt continue to be discussed by TMC PFS members.

Come together

When probed about the membership profile of the TMC-Pooled Fund Study, Jenkinson reveals it's moved beyond the state DOTs that were originally looking to pool their research efforts. "We have now brought in coalitions that have come together – for instance on I-95 – and public-private partnerships as they are already managing TMCs for some states. The next layer from the states, the counties and big urban areas are also now becoming members. Ultimately it's a place for practitioners."

ADOT upgrades Phoenix TMC

Arizona DOT, also part of the TMC Pooled-Fund Study, recently completed a US$2.1 million refurbishment of its TOC in Phoenix. Funded through the FHWA, the TOC has been upgraded with advanced new tools to monitor traffic in Phoenix, Tucson and across the state's 7,000 miles of highways. The TOC coordinates a wide variety of tools that are in place to help the state's road users. These include roadway sensors, overhead VMS, video CCTV, an en-route travel time estimation system, ramp

meters, and the Arizona 511 traveler information system. As part of the modernization project, 40 reconfigurable 140cm (55in) flat-panel displays have been installed to monitor traffic conditions. The same freeway traffic camera images are also available to the public on the agency's Az511 website and can also be accessed by many Phoenix and Tucson television stations.

"Our goal is simple: to keep drivers moving safely around the state, whether it's for their daily commute or on a trip to another region of Arizona," says Rob Samour, ADOT's senior deputy state engineer. "As a result of the modernization of TOC, we think we're among the best in the country for monitoring traffic flow and providing options to drivers when there are problems on our highways."

> This increasingly crops up … Should we develop our own apps or make data easily available for others to do it?
>
> **Mike Jenkinson, chief of TMCs and traveler information, Traffic Operations, MS-36, Caltrans, USA**

Considering what Caltrans is doing with regard to TMCs, Jenkinson reports that a new center has been opened in the San Bernardino area in the eastern part of the Los Angeles basin. This, he explains, is a cooperative center involving the California Highway Patrol and local metropolitan areas. For California being primarily a car-centric transportation network and folks having long commutes, Jenkinson says there is great deal of interest in creating and managing commuter corridors and leveraging the experience of projects such as I-95.

Further up the west coast, Washington State Department of Transportation (WSDOT) is also taking an integrated approach to corridor management in Seattle, according to Vinh Dang, freeway operations engineer, North West Region. Dang believes that the TMC Pooled-Fund Study was influential in the direction that WSDOT ultimately followed: "Initially we were talking about more of a coordinated freeway/arterial operation, recognizing the correlation between the two with what happens on one impacting on the other as well. From discussions with others involved

Photograph courtesy of Missouri DOT

Kansas City Scout is an ITS project in the Missouri city that monitors around 75 miles of Kansas City highways

in the TMC Pooled-Fund Study, it became apparent that what was really needed was a managed corridor. This means that whatever control strategy is applied on the freeway, it has to be compatible with what's going on with a parallel arterial route as well – and not just the arterial in the freeway but the different modes of transportation, too, as we have light rail running fairly close to I-5."

Adding value

Another person on the committee associated with the TMC-Pooled Fund Study is Atlanta-based Mark Demidovich, assistant state traffic engineer, Georgia Department of Transportation, Traffic Operations. In line with many of the other TMC PFS participants, Demidovich points to the ability to leverage the dollars of multiple states as especially attractive: "Each state contributes a small amount but when you pool all of that money together, the outcome is that a significant amount of research is possible. Georgia, for example, put in around US$30,000 a year, which would only be about a tenth of the cost of one project."

Of the research projects that Demidovich has had involvement with, he says that those on DMS (dynamic message signs) have been particularly helpful: "Advice as to how messages should be structured and placed have certainly been taken on board by us here in Georgia." When asked if the approach involved standardizing the messages, Demidovich explains that there was some resistance as each region of the country has their own kind of vocabulary. "At least we were learning about the best practice of each state and pulling those out so other people could copy."

Demidovich cites a study into posting travel times on signs as particularly valuable. "We are somewhat of a leader in this area and so were able to pass our findings on," he says. Studies related to staffing of TMCs were helpful, too. "This concerned the skill sets necessary to be a good traffic operator. Before, in our own job adverts, things were not defined so well."

Photograph courtesy of New York 511

> Whatever control strategy is applied on the freeway, it has to be compatible with what's going on with a parallel arterial route as well
>
> **Vinh Dang, freeway operations engineer, North West Region, WSDOT, USA**

Photograph courtesy of Arizona DOT

(Top right) **The Operations Floor, Hudson Valley TMC in New York State** (Left) **The 2,100ft² Arizona TOC control room includes 32 video monitors mounted on a wall, and large screens**

Although Demidovich doesn't have any specific TMC developments to report from Georgia – no new centers have been added recently – one advance that's paying dividends is probe-based data, which is being utilized by the Atlanta TMC after being extracted from outlying parts of the I-95 on the coastline and which traverses the more isolated rural areas: "The probe data is based in transponders in the truck fleets and also those people who have signed-up for an app on their smartphone," he says. "Having this data coming into the TMC means that even though we may be 250 miles away we can monitor the road to discover incidents quickly. Before this move, there were no ITS elements out in those areas so we were really relying on the local police department to call us if something went wrong." In addition to this, Demidovich explains that Georgia is about to embark on a variable speed limit project that will be more cost-effective by deploying signs for the whole roadway as opposed to lane by lane.

Ultimately, as state DOTs and other TMC operators seek to maximize the effectiveness of their operations, the work of the TMC Pooled-Fund Study is proving to be increasingly influential in TMC circles. The real appeal is that by bringing together regional, state, local transportation agencies and the FHWA, the issues faced by today's TMC operators can be actively addressed by tapping into the expertise of those who are actually dealing with these operational and technical challenges on the traffic management frontline.

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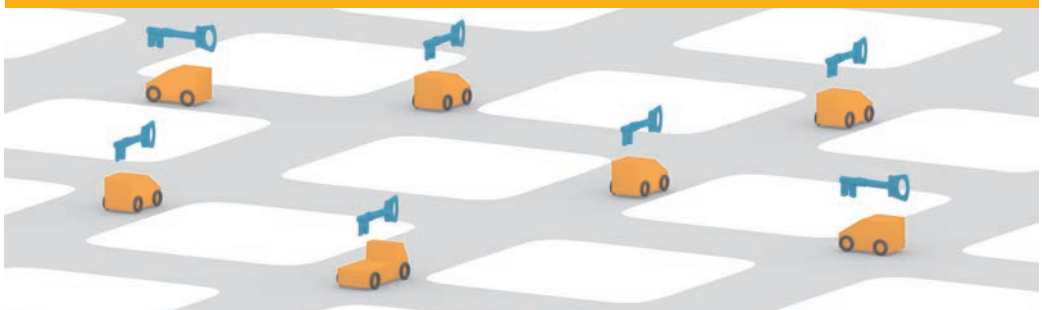
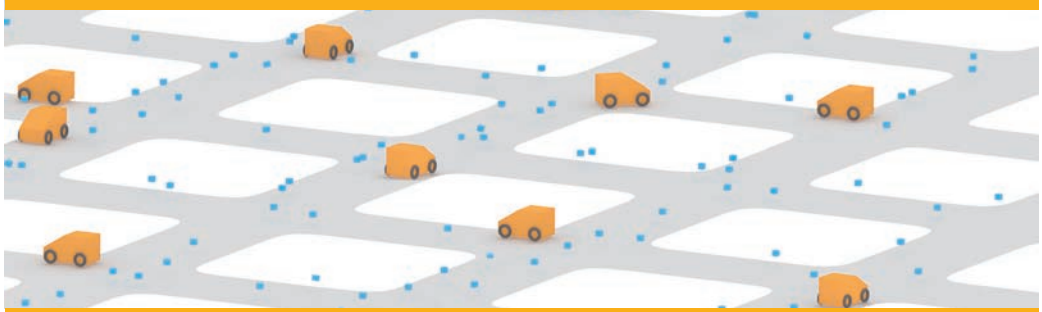


xFCD – extended Floating Car Data

xFCD – anonymous data carpet



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Victory parade

The IBTTA's Toll Excellence Awards are a powerful showcase for the latest agenda-setting developments in the sphere. **Timothy Compston** flew off to Orlando to meet the 2012 lineup signaling the right route to innovation

Main image courtesy of Ingrid Prats/shutterstock.com

Operators chosen as IBTTA Toll Excellence Award winners very much reflect the best of the best. They win because they strive to extend the scope of what can be achieved on the ground, at an operational and project level and, crucially, they signpost the way ahead for the sector. The successful entries for 2012 who got their hands on tolling's most coveted prizes in Orlando in early September are no exception in this drive to innovate.

Considering the trends spotlighted by the winning entries in the highly competitive 'Administration', 'Customer Service', 'Operations', 'Technology', and 'Social Responsibility' categories, the executive director and CEO of the International Bridge, Tunnel and Turnpike Association, Pat Jones, believes there are several key areas that have really come to the fore this year: "For example, we have witnessed a huge move toward cashless tolling," he says. "This is perhaps not surprising as it greatly simplifies operations given there's no need for physical toll collection. Toll agencies are also learning from each other in terms of removing the barriers, going cashless, and how to recover revenues that may be lost to violations." Jones also points to a stronger emphasis on sustainability and green initiatives: "This is now a vital part of the process from the beginning as opposed to an afterthought," he feels. Another aspect singled out by the IBTTA's man at the top is the effective use of information and technology to better serve customers.

Moving forward

When questioned on the future of tolling and the wider transportation arena, Jones expects several critical elements to have a major impact moving ahead: "State and national governments are searching for new revenues to support surface transportation projects, and I expect tolling to be at the top of their list," he predicts. This drive, he feels, can be supported by cashless tolling, alternatively fueled vehicles, and moves toward nationwide interoperability. Paralleling this, Jones says there is likely to be greater attention paid to the research and testing of distance-based user fees. In addition, he expects connected vehicle technology and self-driving vehicles to become a more practical proposition.

Winner

Illinois Tollway

for the Balmoral Avenue Interchange Project

Kristi Lafleur, executive director of the Illinois Tollway

Illinois Tollway's US$25 million Balmoral Avenue Interchange Project underlines the potential for large schemes to be delivered in a tough economy through close cooperation and, vitally, clever thinking when it comes to the issue of cost sharing between state and local agencies.

"Toll agencies are under constant pressure to do more with less," says Kristi Lafleur, executive director, Illinois Tollway. "And yet it's necessary to continue making investments in transportation to help stimulate economic growth, create jobs, and relieve congestion. Thankfully, with the encouragement of Illinois Governor Pat Quinn, at the Illinois Tollway, we've been able to buck the trend and take a leadership role, working with other transportation agencies and local communities to accomplish these goals."

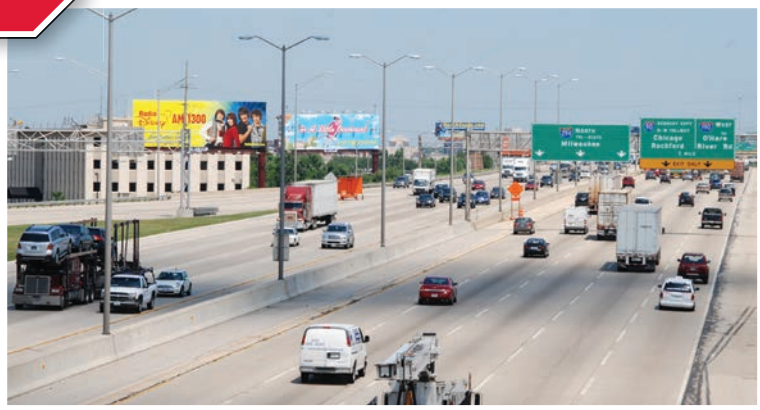
This approach is reflected in the Balmoral Avenue Interchange Project, the origins of which can be traced back to the move by the Tollway back in 2007 to formalize its Interchange and Roadway Cost Sharing Policy and address the requests it was receiving for schemes that often lacked adequate funding. "Now," says Lafleur, "with this in place, local communities are required to contribute 50% of project costs, which puts the onus on them to move things forward."

To implement the Balmoral Avenue Interchange Project, a new all-electronic exit ramp was constructed running from the northbound Tri-State Tollway (I-294) to Balmoral Avenue in Rosemont, a suburb of Chicago near O'Hare International Airport, while improvements were made to the existing entrance ramp. The project was green-lighted under an intergovernmental agreement – the first for the Illinois Tollway – that was signed in February 2011. Rosemont was to provide the upfront funding and Illinois Tollway partnered with the municipality by taking the lead in construction and agreeing to pay back half the costs through tolls received over a maximum of 25 years. Construction started in May 2011 and finished eight months later.

Addressing the measurable benefits delivered by the new ramp, Lafleur says the village at Rosemont is extremely pleased with the interest shown in its "new front door" to the world: "Average daily traffic on the exit ramp is significantly higher than anticipated," she details. "We are now projecting annual traffic of 1.7 million vehicles compared to a predicted one million when the ramp opened in December 2011. As the economic development in Rosemont continues to thrive, it is attracting even more visitors."

At a wider level, Lafleur believes other agencies can learn a great deal from Illinois Tollway's experience: "It provides a best-practice example of how to use and work with local communities to finance infrastructure improvements. The intergovernmental agreement can, for example, serve as an alternate model to fund future requests and the Tollway Interchange and Roadway Cost Sharing Policy offers a detailed roadmap of how to work best with local interests."

Administration Award 2012



Winner

Autostrada del Brennero

for Noise Barrier Integrated with Photovoltaic Plant

Operations Award 2012

Autostrada del Brennero, home of the A22 motorway in Northern Italy, stood out as a result of an ambitious €6.7 million (US$8.8 million) dual-purpose project combining a much needed sound-absorbing noise barrier and the very latest eco-friendly photovoltaic technology for energy production.

"We take great pride in our achievement," says Carlo Costa, the operator's general technical director. "Research and development, such as the noise barrier, is essential for the tolling industry so we don't lose competitiveness and are well placed to improve areas such as environmental performance."

Carlo Costa, technical director, Autostrada del Brennero

The massive sound-absorbing structure stretches to a length of 1,067m and an average height of 5.6m on the southbound motorway. Put in place specifically to protect the provincial town of Marano from traffic noise, figures provided by the A22 motorway operators show that the decrease in noise due to this barrier are between 7-8dB(A) for measured equivalent levels.

The barrier's solar power generation is produced through 5,036m² of cladding, constructed from mono-crystalline silicon solar panels, and supported by the structure of the noise protection wall behind. Costa reports that a total of 3,944 photovoltaic modules are capable of delivering an impressive output of 690,000KWh every year, the equivalent he says to the household energy consumption of 600 inhabitants of the Municipality of Isera. Since going live, it is estimated that this eco scheme has prevented the emission of 913 tonnes of CO_2 impacting positively in air quality and global warming.

For the future, Costa confirms that the A22 is planning to roll out multifunctional barriers, whenever and wherever possible across its motorway network. As a strong advocate of a 'green' focus, he stresses that this is just one of a series of initiatives that Autostrada del Brennero has been involved in – work that he is keen to continue: "We have a number of projects in the pipeline devoted to alternative energy sources, pollution protection, and the conservation of the environment," he confirms.

Winner

Toll Operation Division, Texas DOT

for TxTag Fleet Program

Toll agencies today are having to face up to how they provide the right level of customer service for large vehicle fleets against a backdrop of a move to cashless tolling, and the need to ensure effective revenue collection of current and outstanding fees. Texas Department of Transportation's (TxDOT) TxTag Fleet Program – which operates as a license plate-based prepaid customer account – is a case in point, having been designed especially to offer an efficient and cost-effective solution for rental agency fleets. "We feel we have made great strides in this area," feels Kelli Reyna, spokesperson for the Toll Operation Division of TxDOT.

"With the economy as it is, and organizations making cutbacks, a project creating efficiencies in process and collection was likely to catch the judges' attention.

"Working with customers and industry professionals, we streamlined fleet service billing in a way that's more efficient than the previous exchange process."

Coby Chase, TxDOT's government and public affairs director, picked up the IBTTA award

The TxTag Fleet Program focused on three pivotal areas in implementation: back-office functionality to meet the special requirements of vehicle rental fleets; the collection of payment for outstanding 'Pay By Mail' account balances; and, significantly, administrative approval on a fee negotiation policy so a more reasonable fee settlement amount could be offered in light of outstanding toll volumes.

Customer Service Award 2012

The financial benefits to TxDOT have been considerable: "It is all about the results," Reyna says. "Where we saw a gap in collection, we now see revenue. Where we expanded resources to manually resolve issues, we now have an automated data-exchange process. And most importantly, we have a better relationship with our customers and private industry, which facilitates more efficient problem resolution."

TxDOT reports that there are currently 2.2 million vehicles active under the TxTag Program and since March 2010 has resulted in more than US$3.56 million in toll and fee revenue collection as well as savings in the region of US$280,000.

Winner

The Pennsylvania Turnpike Commission

for Trip Talk

Craig Shuey, chief operating officer, Pennsylvania Turnpike Commission

Following on from its win in last year's Toll Excellence Awards, the Pennsylvania Turnpike Commission (PTC) is celebrating a double success in 2012, having claimed a trophy both in the Technology category as well as the prestigious President's Award for the best overall entry.

The project that's receiving all the plaudits this time around is called 'Trip Talk' – a hands-free, eyes-free, smart-phone application capable of broadcasting timely and relevant travel advisories to drivers. As it requires no interaction while a vehicle is moving, PTC says that Trip Talk – developed in partnership with Philadelphia-based Voicenet Communications – satisfies state and national anti-texting and distracted driving laws.

Craig Shuey, chief operating officer, Pennsylvania Turnpike Commission, emphasizes the unique features of Trip Talk, which in his view signifies a step change in approach to in-vehicle information delivery: "This is the first app that we are aware of that actually keeps customers informed of roadway and weather conditions without compromising their safety," he feels. "Significantly, it leverages existing technologies, namely GPS and text-to-voice, in a pioneering way with an easy-to-use interface. As an added benefit, the anonymous probe data the interface supplies helps with wider traffic management."

In practical terms, Shuey explains that customers simply have to launch Trip Talk before they put their vehicle in drive: "Once on the road, the app will automatically play an audio alert when there is a problem ahead. A custom broadcast queue of advisories is created as they travel."

Technology & President's Award 2012

To fund the initiative, Trip Talk offers the potential for sponsorship messages to be inserted into the broadcast stream. This feature has already helped to encourage State Farm Insurance to support PTC's broader TRIP (Turnpike Roadway Information Program) offering.

Given the pressing need for an initiative such as Trip Talk, Shuey says that other agencies are keen to follow Pennsylvania's example: "Similar to all travel agencies, toll operators have a responsibility to promote safer driving," he states. "It seemed somewhat hypocritical for us to send travel advisories to customers' handheld devices urging them to avoid distracted driving. With Trip Talk, we can deliver word of incidents to motorists without worrying that they are reading emails or text messages behind the wheel. We have had multiple inquiries from agencies in the USA, and further afield, that are now using the technology in Trip Talk to offer a similar app to their customers."

Quantifying the impact of this award-winning innovation, Shuey reports that PTC has seen more than 23,000 downloads in the first year alone: "This means that there are 23,000 of our customers who are keeping their hands on the wheel and their eyes on the road." He also says that PTC is seeking to increase this uptake further with plans in place for a big marketing push in conjunction with sponsor State Farm.

Winner

Central Texas Regional Mobility Authority

for Green Initiative

Mike Heiligenstein, executive director of CTRMA (Greater Austin region)

When it comes to social responsibility, the Central Texas Regional Mobility Authority (CTRMA) is leading the way as a result of a major Green Initiative that went 'live' at the start of 2010. Mike Heiligenstein, executive director at the CTRMA, is the driving force behind the project and the recent award win: "Building new capacity on our highways is more than just concrete and steel; it's about how we interact with the community and the environment," he says. "We feel strongly that you need to look at the bigger picture."

The Green Initiative, he goes on to explain, puts sustainability at the very heart of the CTRMA's transportation projects, and comprises three critical elements that include: Green Construction Practices; Green Credits; and the Green Mobility Challenge.

Green Construction Practices were introduced for projects already under construction: "These were two design-bid-build toll projects – the 183A Northern Extension and Phase I of the Manor Expressway," says Heiligenstein. Contractors adopting 'green' practices at no extra cost was a key outcome. The CTRMA also issued change orders so more expensive and appropriate elements could be utilized, ranging from warm-mix asphalt to recycling at the construction sites.

The second stage focuses on future work, with Green Credits providing certificates to transportation projects: "This covers a multitude of elements," Heiligenstein reveals. "We've found that if you place an emphasis on sustainability, particularly during procurement, and put in associated rewards, you are going to have a lot more interest."

Touching on the final aspect of this three-pronged environmental focus, the Green Mobility Challenge was a sustainable design competition (pictured bottom right), developed in conjunction with Texas DOT, which saw teams of engineers, planners, and architects putting forward ideas for two toll projects in Central Texas: "There was significant buy-in, with the final event seeing winners selected by a panel featuring local and industry leaders."

When asked about the impact of the Green Initiative, Heiligenstein acknowledges that the positive community reaction has been a critical factor: "As environmentally committed as our region is, I don't think anybody has seen anything like this," he reports. "The thing that has perhaps surprised the key stakeholders – public officials and citizens – is that we are doing more than paying lip service and suggesting ideas. We are actually following through."

Addressing the question of whether something such as the Green Initiative is an affordable and practical proposition for other toll road operators, Heiligenstein concludes: "In most cases, we have found that it doesn't actually increase cost that much and – given the significant benefit to the community – it is worth doing. Really this kind of environmental approach needs to be done up front instead of being tacked on at the end when things are much more difficult and expensive."

Social Responsibility Award 2012

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Driving standards

The FOTsis project is pushing forward the harmonization of ITS services across Europe. And as **Jorge Alfonso** explains, this could also have an impact at a global level

Images courtesy of the FOTsis project

The successful deployment of cooperative services such as eCall and congestion management is widely seen as holding the key to safer and more sustainable road transport in the future. Current efforts relating to ITS services and systems development are a direct response to the authorities' push to harmonize the development and deployment of more advanced road applications. In Europe, this requirement is embodied in the ITS Directive and Mandate M/453, which establishes a need for standardization bodies to push forward the activities that would ultimately result in a number of standards in the field of ITS so that interoperability between compliant devices can be guaranteed.

We are now at a point in which a large part of the work has already been achieved and is currently in the testing stage. To date, there have been numerous research initiatives at a national and European level that have sought to promote the deployment of such cooperative systems via the implementation of large-scale field operational tests (FOTs). Yet the majority of the demonstrations have been conducted from the car maker's perspective and pay little attention to the operational needs of road operators. In this context, the FOTsis project represents the missing link in FOTs.

The architecture

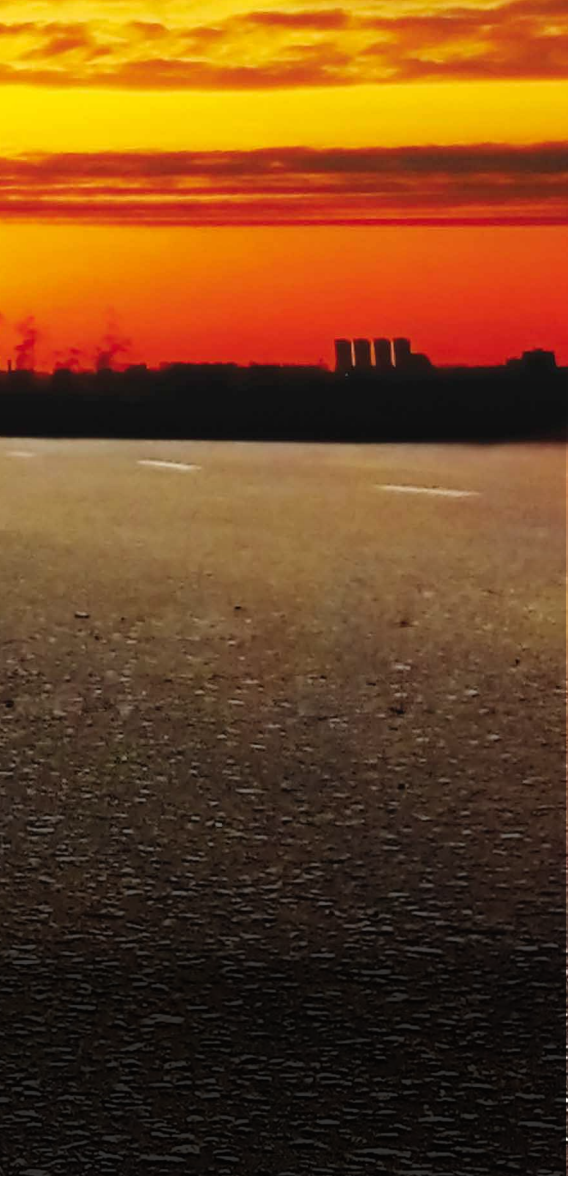
One of the most important and difficult milestones of any FOT is to set up a communications framework that complies with regulatory standardization requirements. The challenge for FOTsis has been no less significant and includes seven distinct services and a much bigger number of use cases, covering a wide range of user needs, and they therefore posed a difficult – but at the same time realistic – set of features the FOTsis architecture has had to face and meet.

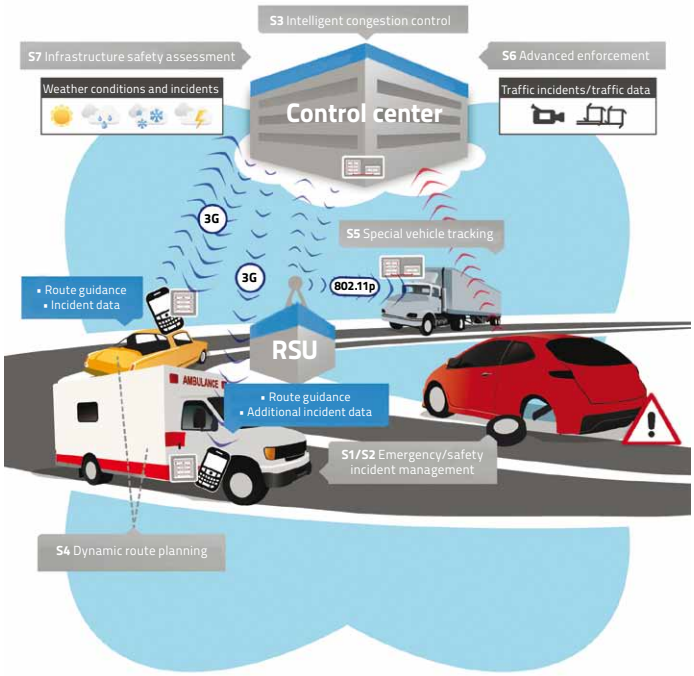
The main ideas of the architecture deployment model are that road users will always be connected to the road infrastructure through long-range 3G connections or with the roadside units through short-range links over 802.11p. Long-range, wide-area links can provide the greater coverage, at the expense of longer latency times, while short-range links provide selective coverage to road vehicles and tighter latency time control.

IEEE 802.11p issues

As a 5.9GHz-based radio access technology, IEEE 802.11p is the first wireless concept specified to the requirements of a mobile scenario. It has ITS applications in mind, focusing on the performance of the communications link between fixed and mobile entities, or between two mobile entities – at high speeds, changing channel conditions and latency constraints. 802.11p enables communication transactions to be completed in timeframes shorter than other wireless technologies and protocols, and uses specifically allocated frequency bands. Together, these two aspects ensure vehicles moving at the usual speeds on motorways complete communication exchanges with more information and data. This opens a new perspective in terms of accurate position tracking and information provision to road emergency services en-route to an incident, or the provision of enriched local toll-related information to road users.

There are, however, some significant differences in the approach with which IEEE





FOTsis will test the road infrastructure's capability to incorporate the latest cooperative systems technology at nine test sites in four European test-communities (Spain, Portugal, Germany, and Greece)

A tested development

FOTsis is one of the European initiatives that can be seen as test activities for certain aspects of the global ITS standardization effort. It will conduct large-scale field testing of the road infrastructure management systems required for the operation of seven close-to-market cooperative I2V, V2I and I2I technologies (the FOTsis services) in order to assess in detail both their effectiveness and their potential for a full-scale development in European roads.

These seven technologies include emergency management, safety incident management, intelligent congestion control, dynamic route planning, special vehicle tracking, advanced enforcement, and infrastructure safety assessment.

802.11p is integrated in the different ETSI, ISO, and IEEE standards framework for ITS services' design and deployment.

The ISO CALM concept implies a very complex architecture with many different management and sub-layer entities to ensure all communication parties – regardless of the layer they are using – can contribute and make use of the somewhat monolithic CALM communications structure. The CALM M5 communications module is designed to be compliant with IEEE 802.11 specifications, but the CALM M5 specification implies compliance with a number of related, relevant ISO CALM elements (at least five standards at access, management, and network layers). This makes the integration with non-CALM-compliant systems a very complicated task.

ETSI ITS-G5, meanwhile, seems to have selected a subset of IEEE 802.11 and IEEE 802.11p specifications to define a functional DSRC module concept that should, in principle, be immediately compliant with the ETSI ITS station reference architecture.

Finally, WAVE is again an overall concept similar to ISO CALM but with a much more straightforward and pragmatic approach. It builds on the IEEE 802.11 and IEEE 802.11p standards but, rather than attempting to create a full architecture, the idea behind it is to identify and complete existing gaps for the intended applications.

In brief, all three approaches described above (ISO CALM, ETSI ITS-G5, and WAVE) seem to be compatible at the PHY and MAC level because they are all based around the IEEE 802.11p standard. Integration with the CEN DSRC is achieved by means of a non-interference policy in IEEE 802.11p, which implies that – while applications are not compatible – it should be possible to use them simultaneously.

The problem, however, is the assessment of compatibility outside PHY and MAC level. The three developments (IEEE 802.11p WAVE, ETSI ITS-G5, and ISO CALM M5) cannot be considered outside the general communications framework they are part of, particularly as FOTsis aims at providing a holistic framework. The choice of a given access DSRC technology in this case implies, to a point, the choice of the whole architecture, which is definitely stronger in the case of ISO CALM, and in principle it seems WAVE should be easier to integrate in the general ETSI ITS framework. However, detailed knowledge about the current development status of the three overall frameworks will be necessary to properly address this issue.

Progress and next steps

Although initially a response to the requirements of the different services and use cases established in the project, the FOTsis architecture proposal has been extended to provide a complex and complete data flow infrastructure that involves all the relevant actors in the provision of advanced road services. The 802.11p wireless access link has been addressed specifically, in the context of its potential in ITS environments and the approaches of different organizations for its adoption.

As a next step, the FOTsis team is planning a joint architecture demo during the World Congress on ITS in Vienna, together with the ITSSv6 project, to show how an IPv6 stack provided by ITSSv6 can be integrated in a communications management center provided by FOTsis, as well as how 802.11p communications could be used in roadside units.

Driving standards

The FOTsis project is pushing forward the harmonization of ITS services across Europe. And as **Konstandinos Diamandouros** explains, this could also have an impact at a global level

Images courtesy of the European Road Federation

The successful deployment of cooperative services such as eCall and congestion management is widely seen as holding the key to safer and more sustainable road transport in the future. Current efforts relating to ITS services and systems development are a direct response to the authorities' push to harmonize the development and deployment of more advanced road applications. In Europe, this requirement is embodied in the ITS Directive and Mandate M/453, which establishes a need for standardization bodies to push forward the activities that would ultimately result in a number of standards in the field of ITS so that interoperability between compliant devices can be guaranteed.

We are now at a point in which a large part of the work has already been achieved and is currently in the testing stage. To date, there have been numerous research initiatives at a national and European level that have sought to promote the deployment of such cooperative systems via the implementation of large-scale field operational tests (FOTs). Yet the majority of the demonstrations have been conducted from the car maker's perspective and pay little attention to the operational needs of road operators. In this context, the FOTsis project represents the missing link in FOTs.

The architecture

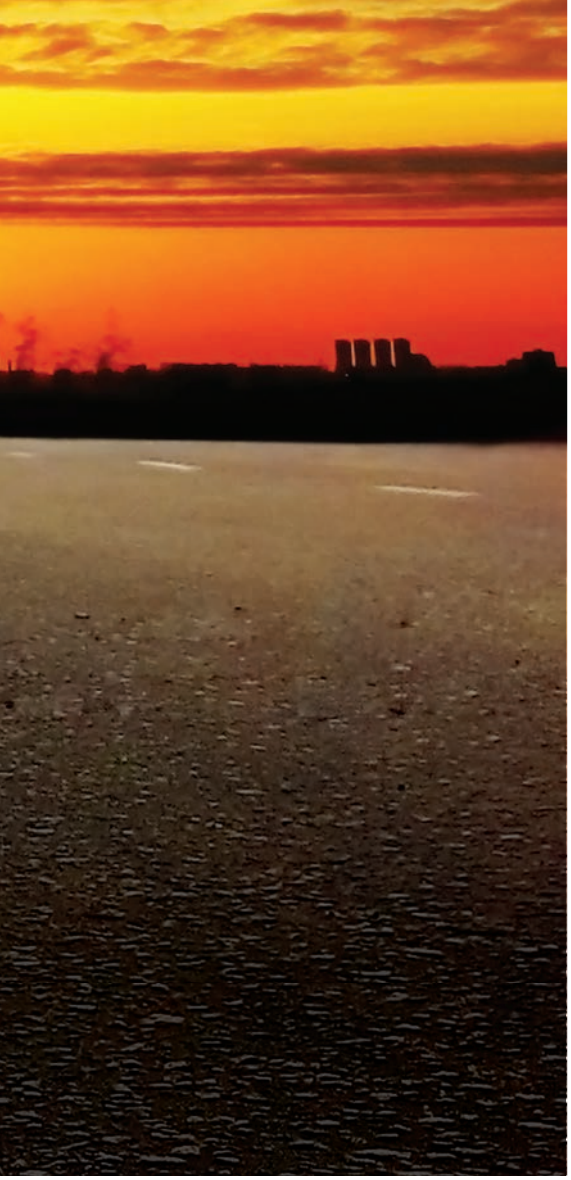
One of the most important and difficult milestones of any FOT is to set up a communications framework that complies with regulatory standardization requirements. The challenge for FOTsis has been no less significant and includes seven distinct services and a much bigger number of use cases, covering a wide range of user needs, and they therefore posed a difficult – but at the same time realistic – set of features the FOTsis architecture has had to face and meet.

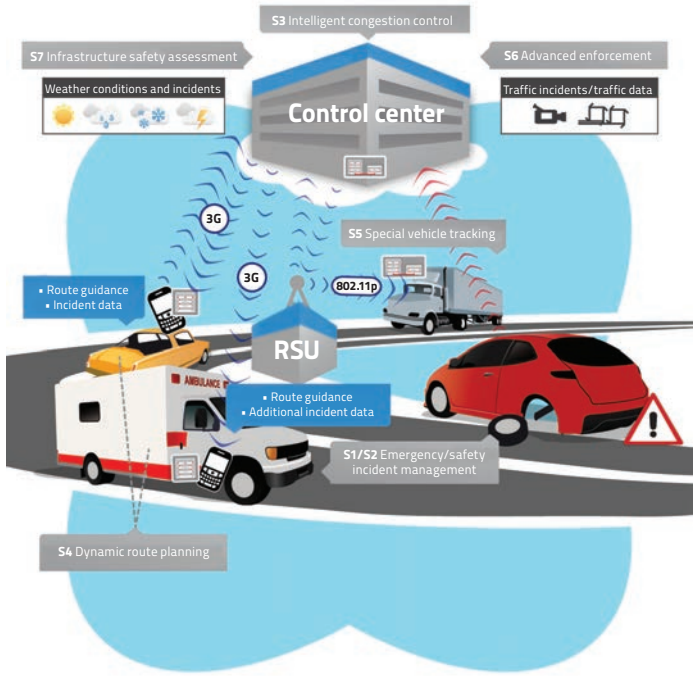
The main ideas of the architecture deployment model are that road users will always be connected to the road infrastructure through long-range 3G connections or with the roadside units through short-range links over 802.11p. Long-range, wide-area links can provide the greater coverage, at the expense of longer latency times, while short-range links provide selective coverage to road vehicles and tighter latency time control.

IEEE 802.11p issues

As a 5.9GHz-based radio access technology, IEEE 802.11p is the first wireless concept specified to the requirements of a mobile scenario. It has ITS applications in mind, focusing on the performance of the communications link between fixed and mobile entities, or between two mobile entities – at high speeds, changing channel conditions and latency constraints. 802.11p enables communication transactions to be completed in timeframes shorter than other wireless technologies and protocols, and uses specifically allocated frequency bands. Together, these two aspects ensure vehicles moving at the usual speeds on motorways complete communication exchanges with more information and data. This opens a new perspective in terms of accurate position tracking and information provision to road emergency services en-route to an incident, or the provision of enriched local toll-related information to road users.

There are, however, some significant differences in the approach with which IEEE





FOTsis will test the road infrastructure's capability to incorporate the latest cooperative systems technology at nine test sites in four European test-communities (Spain, Portugal, Germany, and Greece)

A tested development

FOTsis is one of the European initiatives that can be seen as test activities for certain aspects of the global ITS standardization effort. It will conduct large-scale field testing of the road infrastructure management systems required for the operation of seven close-to-market cooperative I2V, V2I and I2I technologies (the FOTsis services) in order to assess in detail both their effectiveness and their potential for a full-scale development in European roads.

These seven technologies include emergency management, safety incident management, intelligent congestion control, dynamic route planning, special vehicle tracking, advanced enforcement, and infrastructure safety assessment.

802.11p is integrated in the different ETSI, ISO, and IEEE standards framework for ITS services' design and deployment.

The ISO CALM concept implies a very complex architecture with many different management and sub-layer entities to ensure all communication parties – regardless of the layer they are using – can contribute and make use of the somewhat monolithic CALM communications structure. The CALM M5 communications module is designed to be compliant with IEEE 802.11 specifications, but the CALM M5 specification implies compliance with a number of related, relevant ISO CALM elements (at least five standards at access, management, and network layers). This makes the integration with non-CALM-compliant systems a very complicated task.

ETSI ITS-G5, meanwhile, seems to have selected a subset of IEEE 802.11 and IEEE 802.11p specifications to define a functional DSRC module concept that should, in principle, be immediately compliant with the ETSI ITS station reference architecture.

Finally, WAVE is again an overall concept similar to ISO CALM but with a much more straightforward and pragmatic approach. It builds on the IEEE 802.11 and IEEE 802.11p standards but, rather than attempting to create a full architecture, the idea behind it is to identify and complete existing gaps for the intended applications.

In brief, all three approaches described above (ISO CALM, ETSI ITS-G5, and WAVE) seem to be compatible at the PHY and MAC level because they are all based around the IEEE 802.11p standard. Integration with the CEN DSRC is achieved by means of a non-interference policy in IEEE 802.11p, which implies that – while applications are not compatible – it should be possible to use them simultaneously.

The problem, however, is the assessment of compatibility outside PHY and MAC level. The three developments (IEEE 802.11p WAVE, ETSI ITS-G5, and ISO CALM M5) cannot be considered outside the general communications framework they are part of, particularly as FOTsis aims at providing a holistic framework. The choice of a given access DSRC technology in this case implies, to a point, the choice of the whole architecture, which is definitely stronger in the case of ISO CALM, and in principle it seems WAVE should be easier to integrate in the general ETSI ITS framework. However, detailed knowledge about the current development status of the three overall frameworks will be necessary to properly address this issue.

Progress and next steps

Although initially a response to the requirements of the different services and user cases established in the project, the FOTsis architecture proposal has been extended to provide a complex and complete data flow infrastructure that involves all the relevant actors in the provision of advanced road services. The 802.11p wireless access link has been addressed specifically, in the context of its potential in ITS environments and the approaches of different organizations for its adoption.

As a next step, the FOTsis team is planning a joint architecture demo during the World Congress on ITS in Vienna, together with the ITSSv6 project, to show how an IPv6 stack provided by ITSSv6 can be integrated in a communications management center provided by FOTsis, as well as how 802.11 communications could be used in roadside units.

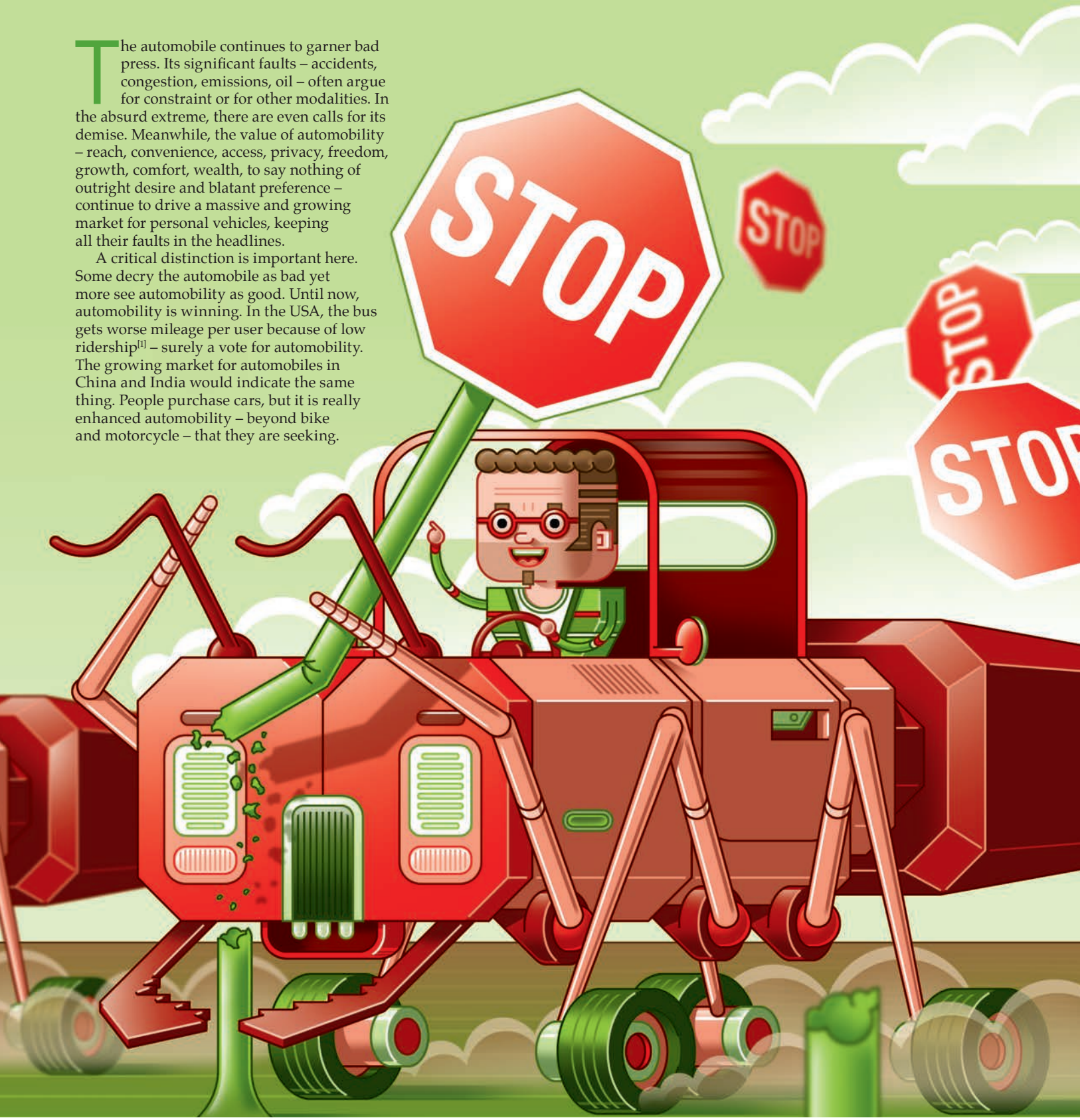
Pull out the stops

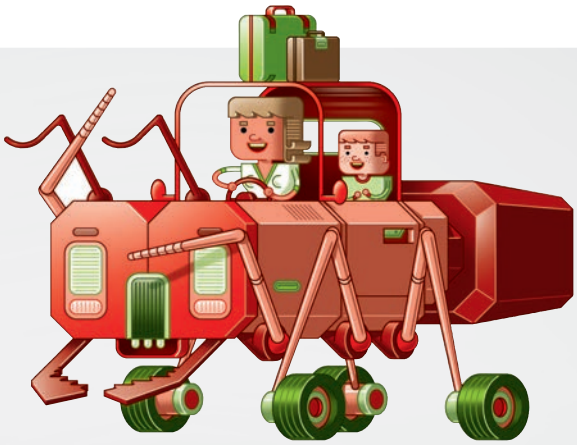
Bern Grush is adamant that we should be doing anything and everything possible to introduce clean, safe and efficient autonomous vehicle infrastructure. But could turning to biomimicry help us to reach that goal more quickly?

Illustration courtesy of Lee Hasler

The automobile continues to garner bad press. Its significant faults – accidents, congestion, emissions, oil – often argue for constraint or for other modalities. In the absurd extreme, there are even calls for its demise. Meanwhile, the value of automobility – reach, convenience, access, privacy, freedom, growth, comfort, wealth, to say nothing of outright desire and blatant preference – continue to drive a massive and growing market for personal vehicles, keeping all their faults in the headlines.

A critical distinction is important here. Some decry the automobile as bad yet more see automobility as good. Until now, automobility is winning. In the USA, the bus gets worse mileage per user because of low ridership[1] – surely a vote for automobility. The growing market for automobiles in China and India would indicate the same thing. People purchase cars, but it is really enhanced automobility – beyond bike and motorcycle – that they are seeking.





Getting from A to B

Even the most simple of creatures have the ability to overcome complex and dynamic problems in nature. **Lloyd Fuller** asks if the humble ant could inspire future generations of route-optimization software

Finding the most efficient (or shortest) path through a busy network is a common challenge faced by any of us who have to get from A to B by a specific time. For delivery drivers, where on-time delivery is a prerequisite, optimizing route schedules is even more critical. To solve such optimization problems using software, computer scientists have often sought inspiration from ant colonies by creating algorithms that simulate the behavior of ants that find the most efficient routes from their nests to food sources by following each other's volatile pheromone trails. The most widely used of these ant-inspired algorithms is known as ant colony optimization (ACO).

> "Discovering how ants are able to solve dynamic problems can provide new inspiration for optimization algorithms

"Although inspired by nature, these algorithms often do not represent the real world as they are static and designed to solve a single, unchanging problem," says Chris Reid from the Behavior and Genetics of Social Insects Laboratory at the University of Sydney. Reid decided to test whether Argentine ants could solve a dynamic optimization with a problem based on the Towers of Hanoi math puzzle. "Nature is full of unpredictability and one solution does not fit all. So we turned to ants to see how well their problem-solving skills respond to change. Are they fixed to a single solution or can they adapt?"

The researchers tested the ants using the three-rod, three-disk version of the Towers of Hanoi conundrum, which requires players to move disks between rods while obeying certain rules and using the fewest possible moves. Ants clearly cannot move disks, so here a maze was devised: the shortest path corresponds to the solution with fewest moves in the puzzle. At the maze entry, the ants could choose between 32,768 paths to get to the food source on the other side, with only two paths being the shortest path and thus the optimal solution.

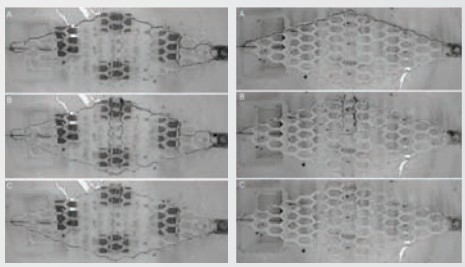
The ants were given one hour to solve the maze by creating a high traffic path between their nest and the food source, after which time the researchers blocked off paths and opened up new areas of the maze to test their dynamic problem-solving ability.

Critical condition

There are two critical factors – perhaps a bit more pronounced in the USA than elsewhere – that we cannot easily set aside: a marked preference for automobility and a structural and economic environment heavily invested in automobiles. So if we are going to fix the problems of automobility, we'll need to do three things: preserve what is good about automobility; repurpose much of what we have already built; and evolve (or innovate) away from the things that are bad about the automobile. To assume that automobility will 'just go away' is wishful thinking, at best.

Historically, the majority of automotive innovations have been small incremental improvements – styling, conveniences, features, increases in power and size – mostly consumer pheromones compared with what is now needed. While generally

By 2030, urban areas will be home to more than 60% of the world's eight billion people, putting tremendous pressure on the already choked infrastructure



Scientists hoped this humble insect's amazing puzzle-solving abilities could offer new ways to improve man-made networks

The ants solved the Towers of Hanoi within the hour. But when that path was blocked off, they responded first by curving their original path around the obstacle and establishing a longer, suboptimal route. Following a further hour, though, the ants had successfully resolved the maze by abandoning their suboptimal route and establishing a path that traversed through the maze's center on the new optimal route.

"Discovering how ants solve dynamic problems can provide new inspiration for optimization algorithms, which can lead to better problem-solving software and hence more efficiency for many industries."

increasing upgrade purchases, these innovations have much less often addressed safety, congestion, emissions or fuel consumption. In fact, until the past several years much about the commercial success of automotive design (and policy) has managed to perpetuate congestion and fuel consumption. Although we have made some progress in safety and emissions mitigation, both remain notable problems from a fleet-wide perspective.

A long time coming

The more we wish to improve our automobiles, the more we might want to look at some 3.8 billion-year-old designs. Thus we are learning from a small but growing cadre of researchers and designers pondering the animal and plant kingdoms for inspired design improvements.

Biomimicry, framed as a new trend in design innovation, has been around for millennia. Anyone who has observed the behavior or properties of any life form and used that observation to propose or create a solution is a practitioner. We have done this for millennia. Leonardo's contemplation of bird wings is a relatively recent example. But biology writer and lecturer Janine Benyus[2] points out we have turned away from this access to insight in the past couple of hundred years of synthetic design. And we do so to our detriment.

Traffic lights and stop signs assist human drivers in conducting their vehicles safely through the cross traffic. In the future, though, with computers 'behind the wheel', will it make sense to have intersection control mechanisms that were designed with today's human drivers in mind?

Buggy journalism

If locusts, ants, fish or birds were automotive journalists, they would have a field day with the way our cars bolt and lurch, screech and drift, are constrained to one-way streets, stop at little red signs and idle at intersections while another car jerks past in front of it or – worse – when nothing is moving but the breeze.

In contrast to biological design, much of the evolution of the automobile has tended to enhance its bulk and preserve its inflexibility. The automobile has maintained its clumsy inefficiency relative to the weight of its passengers. Its evolution has not yet

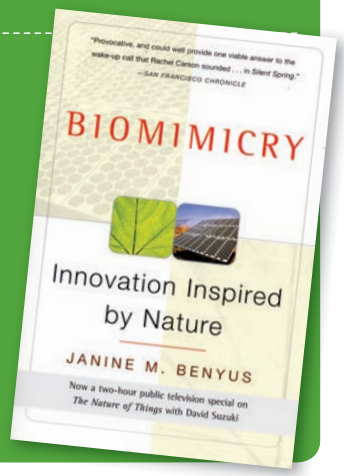
> Unlike animals designed in scale, speed and reaction time to swim, run or fly, in herds, schools, swarms or flocks, the automobile is a brute offering no lesson for biologists

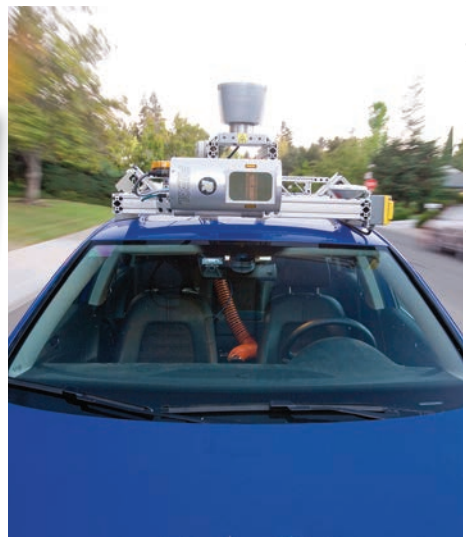
mutated away the danger to its cohort, or its passengers, to say nothing of cyclists or pedestrians. Unlike animals designed in scale, speed and reaction time to swim, run or fly, in herds, schools, swarms or flocks, the automobile is a brute offering no lesson for biologists.

Evolution elegantly scales the maneuverability factors of each species. This includes humans relative to our body scale for walking, running, and fighting at our naked size and weight and speed. But when one of us is ensconced in a car this elegance is lost as the combination moves at 10 to 15 times human speed, weight, and size. If we

Natural selection

Interest in biologically inspired innovation has grown very rapidly. Since Janine Benyus, the acclaimed popularizer of the field, first published *Biomimicry: Innovation Inspired by Nature* in 1997, there has been an explosion in interest by way of articles, inventions, university departments[7] and a 2011 kids' book that even includes a mention of Dr Claire Rind's work with locust neurons.[8] Interestingly, the only reference to anything automotive in the original Benyus 1997 book was a single paragraph on page 113 regarding thin film crystal structures inspired by hard-bodied nature such as sea shells. This, a researcher named Peter Rieke points out, might have application as coatings for the plastic windshields of electric cars. The growth in the number of biomimetic references in automotive-related design and innovation over the past 15 years is truly notable.[9,10]





Photograph courtesy of Stanford Racing Team

wish to address this with smaller, nimbler, lighter, automated and eventually autonomous vehicles, then the biomimeticists are right that it might be useful to study the methods of the insects, fish and fowl that would laugh at our cars.

What about now?

The past few years have seen a focus on three critical automotive innovations. The most evident is alternate fuels and engine types. Although the population of electric vehicles on our streets remains sparse, they are starting to make inroads in a few dozen cities with some level of municipal commitment to charging infrastructure.[3] Alternative power technology, when pervasive, can address emissions and energy, but without other, parallel innovations it does not address safety and it could make congestion worse as automobility continues to become more affordable.

Second, in the past year, journalists have enthused ad nauseum about the autonomous car. When pervasive, it is assumed these vehicles would dramatically affect safety and congestion, but we'd need to marry this with alternate power sources to address emissions and energy, as well.

And third, for more than a decade, we have looked to road use charging policies and technologies to address a looming and nasty funding problem. But we keep postponing this evident solution. Whether we need new infrastructure for the expected electric or autonomous vehicles, or we wish to maintain what we have for the traditional vehicles that will linger with us for some decades, we need money.

> From the perspectives of traffic, environment and society, the success of the automobile and the methods of its management have created a significant enemy

Photograph courtesy of General Motors

(Top right) **The driverless Junior in the DARPA Urban Challenge** (Below) **The EN-V, short for Electric Networked-Vehicle, is GM's future driverless concept**

Like heavy traffic, all these critical innovations advance very slowly. Optimistic projections see 2050 as a halfway point for electrification, but our new love affair with shale mining is threatening this projection as it saps the urgency from alternative engine innovation. Any projections regarding the timing for a significant self-driving fleet verge on journalistic irresponsibility at this early juncture. Recent projections of eight and 10 years are a case in point. An early milestone in EU road pricing policy and technology had been planned for 2012 but has been delayed – and remains uncertain.[4]

Cars or traffic?

Even if we nailed point solutions for alternative power, vehicular robotics and infrastructure funding, as successfully as Henry Ford addressed affordability, we'd still have a bigger design problem: traffic. Automotive technology is about the individual and is designed to sell cars, while traffic technology is designed to organize massive numbers of vehicles and manage

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> If driving competence depends largely on driver skill and attention, traffic flow depends on drivers' common sense and willingness to cooperate. All four of these can be in short supply

flow (notice how little traffic technology figures into consumer automotive advertising!). If driving competence depends largely on driver skill and attention, traffic flow depends on drivers' common sense and willingness to cooperate. All four of these driver attributes can be in short supply.

A summary message one might take from these four major automotive design focuses is that our cars, currently using a harmful energy source, are operated by poor drivers, are subject to inefficient pricing regimes, and are managed by wasteful and frustrating traffic management paradigms. Regardless of how we might agree on solutions – and we are far from that – fixing all this will not be easy. Indeed, we are constrained to incremental change, weak political understanding, slow public acceptance, and our current 1.5D infrastructure.

Since one expectation of autonomous vehicles is that it will increase roadway performance, many think we should continue to refrain from building more roads – even where we could afford to – and that we should make do with roughly what we have. This means we are faced with a complex transition of mixed fleets, re-purposed infrastructure, and multipurpose traffic controls compounded by poor funding to get to the urban utopia of clean, safe, self-driving vehicles at the touch of a smartphone. In spite of any focus on these worthy scenarios, this century will be defined by the paths we use to get there.

(Top left and inset) **Nissan's fish-inspired EPORO** (Bottom right) **Biologist Janine Benyus is the author of *Biomimicry: Innovation Inspired by Nature***

Bio insight

Biomimicry has two critical meta-insights for us. The obvious one is the fact that there are existing solutions to similar problems that have been long worked out and successful. This implies there is a lot of untapped opportunity to advance the cause of safe, clean, effective automobility even during the long transition phase. That makes it our task to discover the bio-analogies of ants, bees, birds, fish and locusts, extract the blueprints and synthesize new solutions.

The less obvious one is something Benyrus said on *TED.com*: "Life creates conditions conducive to life". Taking some

Photograph courtesy of The Biomimicry Institute

Flocking to autonomy

Without evident discussion of biologically inspired design, inventors Nicholas Maxemchuk, Patcharinee Tientrakool and Theodore Willke have filed a patent that would have groups of vehicles communicate with arbitrarily large, overlapping groups of proximate 'neighborhoods' of vehicles. Entitled 'Systems and Methods for Implementing Reliable Neighborcast Protocol', it is likely to be more complex behaviorally than locust neuron sensors or ant travel behavior in crowded conditions.[9] Of course, a patent is not a guarantee of workability, but knowledge of the bio-achievement of the locust and ant now prevent any of us from looking at this patent and saying, 'It cannot be done'.

What US 20100223332A1 does is to set up methods to enlist and de-enlist proximate vehicles that maintain "substantially continuous communication". In a typical circumstance, the neighborhood of two proximate vehicles would have some overlap permitting the transfer of information from neighborhood to neighborhood. Hence permitting local information such as "speed, position, direction, acceleration and state" that would be used for collision avoidance and local control applications to ripple beyond the local neighborhood of a particular vehicle.

If you have ever watched a massive flock of birds change direction suddenly, you get the sense there may be more going on than every bird managing not to collide with its immediate neighbors. Maybe such flocking behaviour is simply a property that arises from thousands upon thousands of pair-wise agreements, just as the mind might be simply an emerging property of our neurons. This is the extra property that Maxemchuk et al are seeking. Maybe they are bird watchers, too.

liberty with her point, consider the assertion, 'Automobility creates conditions conducive to automobility'. In a vicious irony, this cuts two ways. We have long been harangued by urbanists and environmentalists who say that automobiles defeat transit, and diminished transit increases demand for automobiles. Those automobiles created suburbs, which in turn engender vehicle miles traveled. In this perverse sense, automobility has indeed created conditions conducive to automobility. But that is not the analogy Benyrus would have us contemplate.

From the perspectives of traffic, environment and society, the success of the automobile and the methods of its management have created a significant enemy. In that sense, the kind of automobility we have allowed to overwhelm our cities and highways is hardly conducive to more automobility. Unaltered, the automobile endangers it own survival. There is a small but growing number of urban dwellers, especially young adults in the developed world, that are intentionally turning away from automobile ownership. In spite of this, the doubling time of the world automobile fleet is now estimated at 20 years.[5] The billion motorized vehicles on the planet today will become two billion sometime around 2030.

Now, more than ever

Bio-analogous design means taking inspiration, rather than technology, from established biological solutions. Dr Claire Rind[6] worked with Volvo to study the behavior of a large neuron behind the eyes of the African Locust. Since it acts as a sensor for objects rapidly closing on the insect, researchers asked themselves if the locusts' solution could help us think about ways to have cars avoid collisions.

By now, several other car makers have collision warning sensors, and many are building or providing systems that apply brakes in certain circumstances. When combined with technology such as adaptive cruise control and lane keeping, these OEMs are not only some way to making much safer vehicles but they are narrowing the gap between the 20th century vehicle we are accustomed to and the driverless vehicle we expect to appear soon.

Photographs courtesy of Volvo Cars

> We have long been harangued by urbanists and environmentalists who say that automobiles defeat transit, and diminished transit increases demand for automobiles

(Top) **Volvo was inspired by research into collision-avoiding locusts by Dr Claire Rind at the University of Newcastle** (Below) **Will autonomous vehicles lead to an accident-free society?**

As humans seldom volunteer for dramatic change, the path to the driverless vehicle will be incremental. It is likely that the number of innovations required to smooth this path will considerably exceed the number finally embodied in the mature driverless vehicles of 2050. For this reason, it is likely that there will be far more automotive innovation in the next 38 years than in the previous 125. And for that, perhaps we need every possible source of inspiration – including plant and animal. ○

• *Bern Grush is the principal of Bern Grush Associates, a Toronto transportation consultancy*

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Fit for purpose

Despite the industry's inexorable push for AET, it actually proved too transparent for motorists traveling Louisiana Highway 1 to Grand Isle and Port Fourchon. **Rick Herrington** reveals how a demographically focused system increased collection to 97%

Photographs courtesy of the LA 1 Coalition

An all-electronic tolling facility on Louisiana Highway 1 (LA 1) was so transparent that an estimated 20% of motorists ended up gliding past without even paying. "Some people didn't even realize they were going through a toll facility, even with the signage," reports Rhett Desselle, Louisiana Department of Transportation and Development's assistant secretary of operations. "It was too easy."

So DOTD took a second look at the system and decided to equip one of the toll lanes with an automated toll payment machine that provides multiple payment options. "We are very pleased with the way the ATPM new system is performing," says Henri Boulet, executive director of the LA 1 Coalition. "This is a huge win-win for the state because we need to collect enough revenue to pay down the bond debt for this portion of the LA 1 elevation so we can get funding for the rest."

LA Highway 1 in southern Lafourche Parish is the USA's 'Access to Energy' as it supports 18% of the nation's total oil and gas supply

New toll team takes over

In November 2010, DOTD awarded HNTB Corporation a US$3 million, three-year contract to perform as general engineering consultant for toll system assessment and cash lane implementation on LA 1. When the firm took on the contract, LA 1 had a relatively large percentage of leakage with people driving away without paying tolls; the expected revenue, determined by counting vehicles with their assigned toll, didn't match their collected revenue. HNTB soon discovered the leakage was due to a combination of the unproven, off-the-roadway kiosk system and the unique population that the toll facility served. "All-electronic toll facilities usually target local, commuter traffic but both Grand Isle and Port Fourchon attract a high percentage of out-of-state, once-a-year, even once-a-lifetime users," Desselle reveals. In short, when these people drove through without paying, it was difficult to track them down as violators. The pre-pay/post-pay option proved inconvenient for customers and inefficient to audit and reconcile back to the actual transaction. "We were not getting the collections we needed and we were having high violation rates," Desselle notes.

With the old system, even once-in-a-lifetime LA 1 drivers would have to walk into the customer service center or a local business to access a kiosk to pre- or post-pay. The machine, which looked like an ATM, required customers to input their license


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All system components are UK designed and manufactured to European Standards

Sinking highway

This critical piece of infrastructure has been literally sinking due to coastal erosion and subsidence. The highway floods more often with each passing year – even with low-level storms – stranding local residents, tourists and oil industry workers as a result. "A 2011 US Department of Homeland Security study concluded that a 90-day closure of 7.1 miles along existing at-grade LA 1 could result in a US$7.8 billion loss in US GDP," reveals Henri Boulet, executive director of the LA 1 Coalition. "A concurrent 90-day closure of Port Fourchon would significantly reduce domestic oil and gas supplies for 10 years following the closure."

Boulet says the National Oceanic and Atmospheric Administration has predicted that, by 2027, inundation levels will obligate officials to close a seven-mile section of the existing highway between Golden Meadow and Leeville more than 30 days a year, in doing so restricting access to Port Fourchon and adversely impacting hurricane evacuation.

plate number to pay the tolls, the idea being that the license would be reconciled with a photo taken by a camera on the gantry.

"First of all, there are more than 200 different formats of license plates in Louisiana," Desselle explains. "Some have spaces and some don't. When someone goes into a kiosk and enters that license with or without a space, the kiosk would interpret that a certain way. The cameras would take a picture of the license plate, and the optical character recognition software had difficulty with the spaces." Essentially, the system couldn't reconcile vehicles to pictures, even for those who were honest and tried to sign up.

The cash solution

Without the cost of widening the bridge to add a cash lane, the team had to come up with a solution for customers who wanted to pay cash. HNTB's recommended solution allows people to pay on site with cash, credit or debit in the ATPM lane. The firm took the right GeauxPass lane, put in an island, and installed the machine. The bridge is three lanes wide: the northbound lane has no tolling, while the two southbound toll lanes are covered by the gantry. The goal was to take that same structure and find a way to collect cash.

One of the hurdles was that the remote location of the bridge and the small amount of traffic on the bridge made it inefficient for collecting cash the traditional way, with a toll attendant in a booth. According to Desselle, the average daily traffic between 6,000-7,000 vehicles a day, with peak flows between 2-4am and 2-4pm, when people are going to work at the port or for shifts offshore.

A seven-year window of costs was analyzed, comparing the cost to collect tolls using collectors with the costs of ATPM. This revealed the ATPM capital cost is 33% less than it would have been for a 24-hour toll attendant. Now drivers have the option of using the ATPM or GeauxPass.

To allow greater flexibility and enhanced convenience for LA 1 toll payments, the new in-lane cash and charge APTMs were installed at the expressway in mid-2012

The split between cashless and cash is below 50% so the team expected to have cars backing up to pay cash. The solution was some restriping on the approach, the addition of a small shoulder and signage to ensure vehicles could back up 30 or 40 deep without affecting traffic using the GeauxPass lane.

Queues are anticipated at peak times for oil industry worker commutes as well as for special events such as the Grand Isle

> A 2011 US Department of Homeland Security study concluded that a 90-day closure of 7.1 miles along existing at-grade LA 1 could result in a US$7.8 billion loss in American gross domestic product

Lifeline to Louisiana's coast

LA 1 is the southernmost reaching highway in the state and connects to two primary destinations – Port Fourchon and Grand Isle. The latter is Louisiana's only inhabited barrier island, offering unblemished views of the Gulf of Mexico, miles of beaches, birding habitat and more than 280 species of fish in its salty waters. Grand Isle is renowned for its world-class fishing and attracts anglers from all over the world. It is also home to the Grand Isle Tarpon Rodeo, established in 1928, the oldest fishing tournament in the USA, which attracts thousands of visitors each and every year.

Port Fourchon, meanwhile, is the hub of Gulf of Mexico energy production and the Louisiana Offshore Oil Port, which offloads supertankers and transmits oil by pipeline to other US refineries. The LA 1 Coalition calls the highway 'America's Access to Energy' as it supports 18% of the total US oil and gas supply.

Restoring the lifeline

In 2000, DOTD began working on replacing the existing highway near Leeville, Louisiana, with an 18-mile elevated bridge. When complete, the LA 1 Bridge will be almost as long as the nearby Lake Pontchartrain Causeway Bridge, generally regarded as the world's longest bridge over water. The project is being built in phases as funding permits with the most critical, southernmost sections first. The initial nine miles are complete, with the portion of the bridge from Leeville to Port Fourchon open.

To pay the bond debt service on the project,

DOTD opted to establish the bridge at Leeville as an all-electronic toll facility when it opened in August 2009. Only southbound drivers were required to pay a toll, which could be paid by GeauxPass (pronounced Go-Pass), automatic vehicle identification transponders or a single-trip GeauxPass, which could be pre- or post-paid through kiosks located in local businesses and the nearby Golden Meadow Customer Service Center. A gantry over both lanes of the bridge reads the transponders and license plates.

Tarpon Rodeo, until people realize the benefits of purchasing a GeauxPass, the most inexpensive and efficient way to pay the toll. DOTD was selling about 20 transponders a day prior to the ATPM installation although since the ATPM went live, that figure has increased to an average of 125 a day.

Rodeo tests ATPM

The lane began operation June 20, 2012 – just weeks before the 2012 Grand Isle Tarpon Rodeo, which was held July 26-28. A number of standard operating procedures were put together by HNTB for the weekend to help DOTD staff and customers deal with the extra traffic and anticipated backup expected as a result of the influx of people to the Rodeo. Toll collectors were on-hand to take cash and disburse change for faster transaction times when the traffic backed up beyond an acceptable level.

DOTD also installed a high-speed internet connection to increase the ATPM's credit card approval time. Once customers get used to the machine, most transaction times will be between 6 and 18 seconds; the fastest transaction is a credit card and the slowest is paying with US$1 bills. The toll is US$2.50 for a two-axle car and US$12 for a five- or six-axle vehicle.

The winning combination has increased efficiency and toll collections. "Our initial numbers are showing we are above 97%, and the national average for this type of collection is 95%," Desselle enthuses. The increased collection will, Boulet says, ensure the state meets its bond debt and clear the path for future funding requests to the US Department of Transportation. "We don't want a failed toll collection process to impact future requests with USDOT. This is good news and something we will be able to write about in upcoming applications."

DOTD took the five kiosks out of service the day the new ATPM lane opened, but customers may still use the Golden Meadow Customer Service Center to purchase transponders. The switch did cost DOTD a "small, capital investment, including the island, a crash attenuator, some other retrofits, and the ATPM", notes

Louisiana residents and businesses agreed to pay tolls for the next 30 years to repay a federal transportation loan and bond sales that funded construction of Phase 1 of the LA 1 project

> We don't want a failed toll collection process to impact future requests with USDOT. This is good news and something we will be able to write about in upcoming applications

(Left) **GeauxPass readers as part of the all-electronic toll system** (Below) **The ATPMs are accessed from the right-hand lane of LA 1**

Desselle. The DOTD also has a second ATPM on order to serve as a backup in case of any failure or maintenance issues. Shortly after the ATPMs went into service, for instance, problems arose as a result of driving rain, so an enclosure canopy has been installed over the ATPM to protect the machine and customer against any inclement weather. Designed by Structural Consultants of Baton Rouge, the canopy is a 12ft-wide metal structure that was installed in late August 2012.

ATPMs have been a good fit on Trans Corridor Agency facilities in California, the Kansas Turnpike, as well as several facilities in Australia. They perform well on ramps or in places that are remote and have a minimal amount of transactions.

Everyone involved in the LA 1 project, Desselle included, learned that tolling is not one-size-fits-all. "Going forward with tolling systems in Louisiana and elsewhere, it is important to really look at the demographics of customers we are providing services to," he concludes. "We need to make sure the tolling systems we choose meet their needs and way of life." ○

• Rick Herrington has 28 years industry experience and is vice president and toll services director for HNTB Corporation

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PACTS executive director **Rob Gifford** explains how – and why – the UK Government needs to change its approach to road safety

Interviewed by David W. Smith

> It's a pity the current government hasn't maintained the same impetus as its predecessors. The 2011 figures should concern ministers

As befits a man who began his career as an English teacher, Robert Gifford is passionate about educating the UK government on how to improve road safety standards. He has been executive director of the Parliamentary Advisory Committee on Transport Safety (PACTS) since 1994 and for most of that time, successive governments have listened carefully to his advice. But, just as his passionate words about Shakespeare weren't always guaranteed to reach the ears of his pupils, the current government doesn't appear to be paying attention.

"We're at a crossroads in the UK," he suggests. "We had an excellent track record of achievement in road safety from 1987 to 2010 and we ought to continue making progress, but today's government doesn't seem to be as committed to road safety as their Conservative or Labour predecessors. Right now, it could go either way."

Gifford is proud of what registered charity PACTS has achieved with its budget of around £190,000 (US$309,000) a year and a skeleton staff of two full-time employees and one part-timer. Its small income comes mainly from members' subscriptions and sponsorship of two annual conferences.

But over the years, PACTS has exerted an influence on government policy out of proportion to its size. One of its greatest accomplishments, in fact, came early in its existence, when Huddersfield member of parliament Barry Sheerman – PACTS' founding member – was instrumental in making it mandatory to wear seatbelts. The measure was enshrined in statute in the Transport Act 1981.

Pushing for change

More recently, PACTS successfully lobbied for the introduction of police powers to seize unlicensed and uninsured vehicles, as well as carry out roadside evidential breath testing. These two powers were both introduced in the Serious Organised Crime and Police Act 2005.

A constant underlying theme of its advice to successive governments has been the importance of setting targets. "Road safety in the UK has never been a party political issue so both the Tories [Conservatives] in 1987 and Labour in 1999 continued the target-setting approach," Gifford says. "It helped maintain focus and both governments exceeded their aims."

The Conservative government introduced the first national casualty reduction target in 1987, which aimed to achieve a one-third drop in casualties by 2000 in comparison with average figures for the years 1981-1985. They performed even better, with a 39% drop in fatalities and a 45% fall in serious injuries. The Labour government introduced more targets for the years 2000-2010, which were again exceeded. The number of fatalities dropped from 3,409 to 1,857 and the number of deaths from drink driving fell from 450 in the mid-2000s to a provisional total of 250 in 2011.

To meet their ambitious targets, successive British governments maintained

> It's not always about more money. Local governments can be smart with the money they've got and the national government can exercise its responsibility to give leadership

long-term commitments to speed management programs, especially cameras, the strategic use of traffic-calming schemes such as speed humps, chicanes and road narrowing. During this period, governments also made a strenuous effort to raise awareness through the media.

But this long period of success shuddered to a halt last year. For the first time in a decade, the number of fatalities rose from 1,857 in 2010 to 1,901 in 2011. Last year also saw the first rise in serious injuries since 1994. "It's a pity the current government hasn't maintained the same impetus," Gifford laments. "The figures should concern ministers, especially as those for the first quarter of 2012 are broadly in line with 2011. With their focus on deficit reduction above everything else, I fear we won't maintain our progress on the roads."

Local heroes

PACTS' research shows that cuts to local authority budgets are having an adverse effect. Councils have had to dispense with a lot of road safety expertise and spend less on road safety engineering. 'Short-termism' is common, with roads being patched up rather than redesigned. Local politicians, though, remain acutely aware of the importance of road safety to their local constituents. "It's harder to maintain political interest at Westminster when there are no obvious political benefits. Road traffic statistics are not debating points in elections, unlike school standards and health. Deaths might fall but we will never know whose lives have been saved."

Swedish message

Sweden's Vision Zero has proved highly effective, with fatalities involving unprotected pedestrians in the country falling by almost 50% over five years. The number of children killed in traffic accidents has also been cut; in 2008 the first traffic death involving a child didn't occur until October 22. The Swedish Government has now set even more ambitious targets, believing it can cut the death toll by a further 90% by eliminating technical system failures, the failure to wear seatbelts, speeding, and drink driving.

"Setting ambitious targets would make the British government take a leadership role and give better guidance to the road safety profession," says Rob Gifford. "I'd like to see the government take up the Safe Systems Approach and set a target of reducing fatalities to between 500-1,000 deaths a year, which is half the number at the moment and an achievable goal."

Gifford believes one of the reasons for the worsening statistics in 2011 is that the government has been sending out the wrong messages. "They have spoken about 'ending the war on motorists', tried for a while to lengthen the time between MOTs, have talked a lot about increasing the motorway speed limit to drive the economy. What all that implies is that road safety isn't important anymore," he says.

Government policy has also had an inadequate document governing its actions for the past 18 months. "The *Strategic Framework for Road Safety* – which was published in May 2011 – is not robust enough, Gifford notes. "I'd like to see key experts getting round a table and giving advice on beefing it up so we can make sure the progress is maintained."

According to Gifford, the government needs to be more ambitious and introduce a UK version of the Swedish 'Vision Zero' approach to road safety, which places the main burden on system design rather than individual error (see *Swedish message* sidebar).

The PACTS man argues the government could make a significant dent in the fatality rates by introducing a series of measures that wouldn't cost a great deal. The first would be to fit all government vehicles with Intelligent Speed Adaptation, which signals when a driver is exceeding the speed limit. "I would make a speech about its importance and advise others to use it voluntarily," he says. "Then I would give the Secretary of State for Transport statutory responsibility to make the roads safe."

The biggest and quickest gains could arise from reducing the drink drive limit from 80mg/100ml to 50mg/100ml. According to Gifford, research clearly shows that the risk of impairment to driving is already significant at 50mg/100ml, and there is public support for the measure. "Not bringing this in is the biggest failure of government policy in the past two decades," he says.

Finally, Gifford would adopt central European time (CET) in the UK, which would put vulnerable road users at a much lower risk of injury in the winter months. Children are less likely to be in the streets as the light grows dim.

"It's not always about more money. Local governments can be smart with the money they've got and the national government can exercise its rightful responsibility to give leadership," he concludes.

Right on track

Rob Gifford says the road system needs to move closer to the rail network's safety record. The last death for which a rail operator was held responsible came in February 2007. Over the same period, there have been about 11,000 deaths on the roads. "But the rail system is highly regulated and you need to train to be a driver," Gifford acknowledges. "And the rails are fixed. The road network is also used by vulnerable people. Travel by road can never be as safe, but we can aim to narrow the gap."

One of the reasons the rail network is highly regulated is that accidents are not tolerated and make the front pages as a result of their rarity. Car crashes only make headlines if there is something spectacular or unusual about the story. "Last year's crash on the M5 in fog was a case in point. There was an enquiry about whether a fireworks display caused the accident."

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LED lighting enhances traffic imaging

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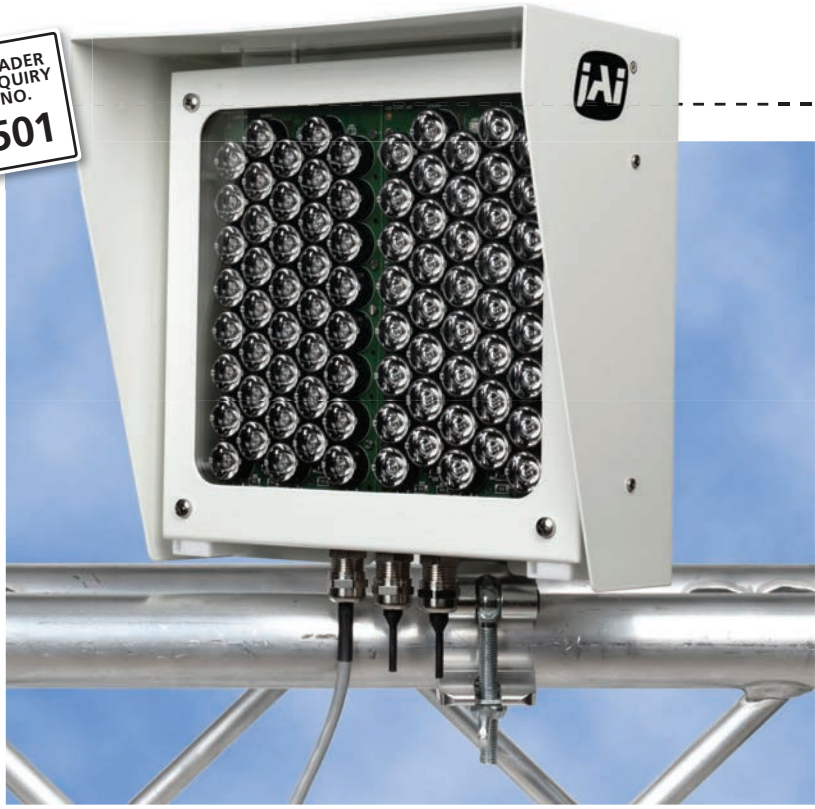

(Above) **The TNL-50 from JAI is part of a new generation of LED-based lighting designed for traffic imaging applications**

The LED revolution began with vehicle tail lights. Old tungsten bulbs were replaced with multiple LEDs. Then LED-based stoplights appeared. And lately, LEDs have made their way into roadway lighting, toll plazas, and roadside task lighting.

The growing popularity of LED-based lighting solutions for traffic applications is not hard to understand. Their solid-state nature offers a number of key advantages over traditional tungsten or gas-based lighting technologies, including lower power consumption, better directionality, longer product life, simplified field maintenance, better reliability, and a variety of environmental considerations.

Today, LED lighting is not only expanding in the applications mentioned above but is also becoming a hot trend in the area of traffic imaging. Here, the challenge is 24/7 image capture of moving vehicles and their license plates for the purpose of tolling/toll enforcement, speed control, congestion charging, red-light enforcement, and other applications. During night hours – as well as during some periods of inclement weather – supplemental lighting is essential for this task.

Light sources used for traffic imaging applications must provide a sufficient amount of evenly distributed light to produce both a readable plate image and a good exposure of the vehicle itself. However, care must be taken to minimize the impact on the driver's vision.

Traditionally, for most free-flowing traffic applications, xenon strobe lights have been used. These fixtures produce a white light that is excellent for capturing color images. However, the high-power flashes (typically around 500μs in length) can be a considerable distraction and/or safety hazard to drivers. For this reason, many installations sacrifice color imaging and use filters to block most of the visible light, relying on cameras with good sensitivity to wavelengths at the edges of the visible spectrum to capture monochrome images.

In comparison, the latest LED lights for traffic imaging have features that allow them to be operated in a different manner. Unlike the glowing gas of a xenon light, the intensity level of LEDs can be very quickly adjusted without damage or negative impact on lifespan.

For example, a new LED flash fixture such as JAI's TNL-50 allows operators to take advantage of visible (white) lighting for color imaging with a minimal impact on driver safety. This is achieved with a mode that causes the LED unit to provide a continuous low-intensity light level, avoiding any uncomfortable

The goal of night lighting is to illuminate both vehicle license plate and scene without blinding or distracting the driver

Need to know?

The popularity of LED lighting is now making its way to the traffic imaging sector

- LED lighting offers lower power consumption, better reliability, and environmental benefits compared to other lighting solutions
- Traffic imaging applications demand evenly distributed light that does not distract drivers; LED lighting perfectly fits the bill
- The intensity of LED lights can easily be adjusted
- An LED fixture can be triggered up to 50 times per second, meaning it can easily handle high-speed traffic environments

glare for approaching drivers. When the passing vehicle triggers the camera system, the TNL-50 produces a high-intensity flash sufficient for color image capture. But because this pulse is only 50μs, it is virtually invisible to the driver's already partially adjusted eyes.

Tailored to suit the task

Similar to the xenon strobe lights, the TNL-50 can also be configured to provide only deep blue or near-infrared wavelengths when that is better suited to a particular imaging application. Yet even with a continuous operating mode, the solid-state nature of LED technology gives products such as the TNL-50 a predicted lifespan longer than typical filament or gas-based solutions.

Similar to what has taken place in the television market, LED light fixtures are also generally thinner than other types of lighting. JAI's TNL-50, for example, can provide coverage of two lanes in a housing that is less than 3in deep (76 mm). And while most xenon flashes can only be cycled two to four times a second, an LED fixture can be triggered up to 50 times a second, ensuring that it can handle nearly any high-speed traffic application.

When all of these benefits are combined with the low power consumption and high energy efficiency of LED lighting, it is easy to predict a bright future for this technology in traffic imaging installations. ○

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Social media has become a ubiquitous part of our everyday lives, changing how we network, share information, and interact with one another. Everything from how we acquire news to sharing a photo among friends has turned 'social' by allowing everyone to provide their own input. The other day I saw a refrigerator with a Twitter account. So it was only a matter of time before traffic and transportation turned social too. And we're starting to see some of the novel ways that the power of the social network can help improve the way we travel.

Casual carpooling, also known as slugging, is a transportation service that has really benefitted from the advent of social media. Typically, drivers would pick up passengers at informal 'slug lines' in order to use the faster HOV lanes or take advantage of toll reductions. The whole process was generally unorganized, however, and finding a random group of people going to the same general location was often a difficult task. A company called Avego saw an opportunity to improve this by developing its own real-time ridesharing app. Drivers are matched in real-time with anyone in need of a ride along their route. Riders simply input their destination and the app finds any nearby lifts using GPS. By connecting all interested parties into one service, Avego has developed an efficient way to better manage casual carpooling.

In the realm of public transportation, official transit service alerts often aren't truly real-time and there is a discernible lag between when a delay occurs and when that information is available to the public. This could mean the difference between hopping on a subway train that gets stuck in a tunnel for 30 minutes or being notified of the delay in time to switch routes. Roadify is a transportation-related app that attempts to address this problem with the help of social media.

As with other transportation apps, Roadify uses publically available transit information such as maps, schedules and service alerts to generate directions to your destination. The data is also supplemented with comments from users and even Tweets to provide real-time, accurate service conditions. There is arguably no faster way to find out if there's a delay within a transportation system than from people actually in the system and Roadify has figured out a way to take advantage of this. Users are able to know of delays in the system well before they appear on traditional service alert websites, allowing users to take alternate routes before it is too late.

In New York City, I write a traffic column, *Gridlock Sam*, for the *NY Daily News*. Like a weather forecast, I predict traffic jams a day ahead. But conditions change so quickly that I've started my own twitter account (@GridlockSam) and I now have nearly 6,000 followers.

The advantages of social media in transportation aren't restricted to just the end users either. Transportation officials have also begun to realize the potential. The Daily Pothole, an online citywide pothole tracker started by NYCDOT, lets the public post the location and pictures of potholes that they come across in NYC. With this information, the City has increased the average number of potholes repaired to between 3,000 to 4,000 per day, on pace for a record number of potholes repaired for the fiscal year.

There are yet many more untapped opportunities for this in transportation. The amount of useful information to be had from the general public is immeasurable and is a resource we've only just begun to explore, and brings yet another effective tool for increasing efficiencies. It's exciting to see the innovative uses that have emerged so far and I expect even more as more people embrace the social web. You can be sure I'm putting on my thinking cap!

> I expect there to be even more effective applications as more people embrace the social web – you can be sure I'm putting my thinking cap on
>
> **Sam Schwartz, Sam Schwartz Engineering, USA**

Streamlining traffic in the City of Kings

The city of Lima in Peru is taking extensive measures to tackle its increasing problem of heavy traffic congestion and pollution. As part of the solution, Lima city authorities recently called upon Traficon to help them improve urban traffic flows.

Although Lima boasts a rich colonial architecture and a wealthy historical and cultural past, it is not the typical hotspot for the average foreign traveler or tourist. Unknown and unloved, the city makes foreigners conjure up images of urban chaos and traffic congestion. This is undeserved. Whereas 5-10 years ago, Lima might have come across as loud and chaotic, the city has now shaped up to become a bustling, more modern, and cleaner place to stay.

Traffic congestion

This is not to say that Lima is without some serious traffic problems. Traffic congestion is still a daily nuisance for commuters. For many, navigating around the city can be a truly nerve-wracking and time-consuming experience. The local economy also faces the consequences of congestion as productivity is seriously hampered. Last but not least, traffic pollution poses a serious health risk to the city's inhabitants.

City authorities are well aware of the problem, and are taking some steps to help free up the traffic flow. Investments in public transport include an expansion of the city's rapid bus transport system, the Metropolitano, as well as an expansion of the electric train line, the Tren Eléctrico. Both of these measures are intended to increase the mobility of the daily Lima commuter and to make public transport a more attractive option.

Still, this will not be enough. Peruvian incomes are expected to rise within the next few years, which means that growing numbers of people will be able to buy their first car. According to Tráfico Lima, a citizen's group that works to reduce traffic accidents and environmental damage, this trend will also have an impact on Lima's traffic.

Intelligent traffic technology

With this trend in mind, it is clear that Lima's road infrastructure requires some attention. In an effort to improve the city's road traffic, authorities have installed a new traffic control center in 2011. The center was built to monitor and optimize traffic along the city's main streets and avenues. In total, the control center integrates a new traffic light network at 218 road intersections, featuring TrafiCam video detection sensors. As a result of Traficon's vehicle presence sensors, vehicle density levels can be monitored, determining the peaks and troughs in the day's traffic, which in turn allows the control center to regulate the traffic lights' green waves.

The integration of the TrafiCam units into the traffic light network was performed by ITS integrator SICE. In total, the company installed some 618 video detection sensors in Lima's main avenues. Both the TrafiCam vehicle presence sensor and the TrafiCam

Need to know?

The city of Lima, Peru is using smart detection technologies to improve traffic flow for residents and visitors alike

- Though it has suffered from an image problem in the past, Lima is now embracing its place as a vibrant, attractive city – its traffic-busting strategies are following suit
- The city has deployed video detection sensors at 218 of its key intersections
- Easy to install, the sensors have proved a very popular choice for the systems integrator

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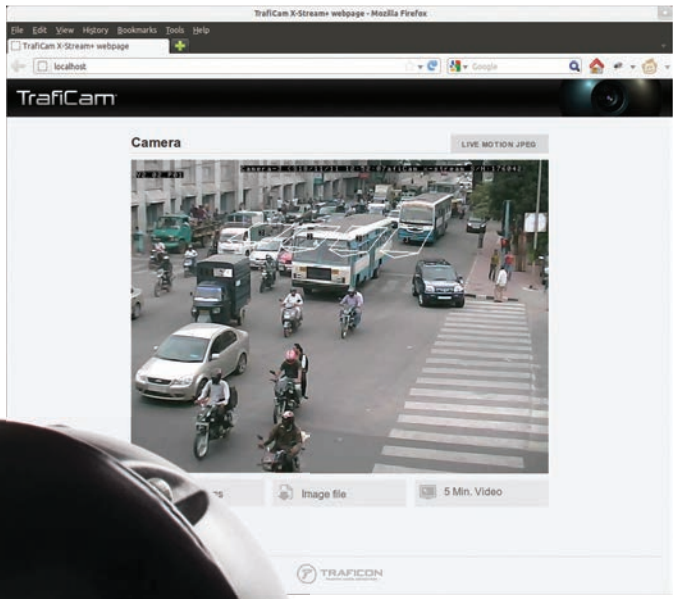

(Main image and left) **Lima suffers from a congestion problem that city authorities are determined to resolve**

x-stream vehicle presence sensor with streaming video were chosen for the project.

As well as the regulation of traffic lights, Traficon's video sensors are also deployed for access control, calculation of vehicle occupancy, and for the calculation of queue lengths.

The fact that all images and video captured by the sensors are sent to the control center for visual check by the operators is in particular a major asset for this project.

Challenges

On average, Lima's traffic light network is around 25 years old, which you could imagine would pose a real challenge. However, SICE was able to establish the link with the TrafiCam sensors without any problems. In fact, the sensors are easy to install and require little configuration.

(Above) **Traficam units monitor intersections and feed their video data** (Top right) **back to the control center**

Hope for the future

You shouldn't always believe travel guides. Despite the dreary city image that lives in the minds of many travelers, Lima is still a place worth visiting. And with the steady efforts of the city authorities for the improvement of public and road transport, the city might yet be experiencing smoother and safer traffic in the near future.

The purpose of this entire project was to reduce traffic accidents, reduce delays, make traffic smoother, and the environment cleaner. It might be too early to present clear results, but Traficon hopes that city authorities will be able to do that soon – and that these results will show how the company's technology makes a positive difference.

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Urban traffic management center

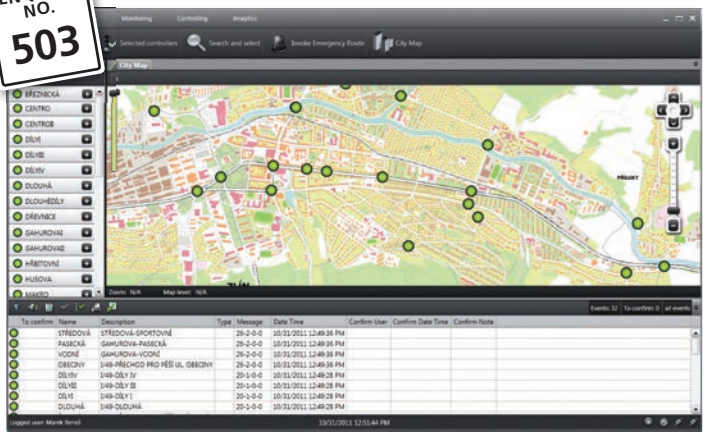
READER ENQUIRY NO. 503

With the increasing amount of traffic in cities and urban agglomerations, it is increasingly important to control and regulate traffic in terms of the amount of vehicles – not only at individual road intersections but also with respect to transport correlations across an entire area.

An urban traffic management center (TMC) called eDAPTIVA – jointly developed by AŽD Praha and Cross Zlin – fully complies with all requirements of the latest trends in the area of road traffic management. The latest knowledge in the area of ergonomics and software applications is taken into consideration, with an emphasis on being user friendly for operators.

Communication between the TMC and traffic signal controllers uses not only proprietary protocols from AŽD and Cross but also the standardized protocol OCIT-O V2.0 (open communication interface for road traffic control of system).

The TMC is designed as a modular solution in order to cover different installations, from monitoring in small towns with few traffic signal controllers to full-featured control of large agglomerations with many ITS technologies (traffic light signaling systems, camera surveillance systems, VMS, navigation systems, meteorological systems, speed measurement systems, public transport priority systems, etc). The modularity is also present in the optional configuration of the number of assigned roles in the systems and their privileges. The structure is based on client/server architecture with firmly defined distributed objects connected for communication through a local area network (LAN) using the TCP/IP protocol.



(Left) **The Workbench GUI** (Below) **Bar diagram** (Bottom) **Intersection view**

Need to know?

The story behind a new traffic management center designed for urban locations

- A high-tech approach to managing traffic in cities
- The new traffic management center is modular, so can be used in small towns right through to huge metropolises
- Operators can choose between manual and automatic control, depending on which tasks they are working on
- Successfully in use in its home country, the TMC's creators are now looking to the global marketplace

How operations work

There are three basic levels used for the operation: monitoring (of the status of the equipment); control (manual control of the controlled equipment or automatic adaptive control); and analytic functions (functions for the evaluation of statistics and traffic simulation).

The control module distinguishes between manual control (carried out or planned by the operators), and automatic control, i.e. adaptive control in which the traffic intensity is evaluated automatically and the most suitable traffic models are selected.

Manual control is used primarily for quick plan switching based on particular requests (such as a request by the police in the event of an emergency incident) or for scheduled switching (the scheduled end of a sports or cultural event, for example).

A specific mode of the manual control is the creation and launching of predefined routes (response routes for the integrated rescue system units and priority routes – such as for passage of the convoys of official visitors through a city). The launch is carried out by the operator based on a request by making a selection out of the predefined routes that are created and entered in the application by a traffic engineer.

Automatic adaptive control can be defined in the ESDA (event-based control on scenario application) module using logical conditions, possible controller statuses, and limiting conditions. The scenarios are subsequently called-up automatically whenever the criteria for the particular status is met (e.g. failure of one controller causes a change in the settings of the adjacent controllers).

Many years of research and development experience in road and city traffic have led to the creation of this new TMC, which will certainly find its application in the market. In fact, it is currently installed successfully in some of the Czech Republic's largest cities, Brno and Zlín.

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An end to traffic jams?

READER ENQUIRY NO. 504

Many traffic problems can be solved quickly and inexpensively with real-time vehicle data. The technology is ready; politicians must now react.

Cars are by far the most important means of transport for passenger traffic, while 70% of freight traffic is accounted for by trucks. But many cities are now threatened by gridlock. In the European Union, the traffic load will increase to eight billion passenger kilometers by 2025, according to the European Commission. For the sake of comparison, in 2000 the number stood at around five billion kilometers. And freight traffic will, according to the Association of the Automotive Industry in Germany, grow to around 935 billion tonne-kilometers by 2025 – an increase of approximately 46% compared with 2011.

The logical solution would be to expand the transport infrastructure, but in view of growing environmental requirements and upcoming fiscal consolidation in many European countries, this would be difficult. It is therefore important to use the existing road network more effectively.

Overloaded routes and traffic jams are simply unnecessary. Floating car data (FCD) offers an effective solution. For this approach, 'floating' vehicles are used as mobile data transmitters in traffic. In an expanded version of the concept, called xFCD, it is not only the position and velocity of the vehicle that are collected (as with traditional FCD data); data from the CANbus is also utilized. This data includes things such as the activation of hazard warning lights, fuel consumption data and temperature values. All of this information is read and submitted over a secure network to traffic management centers via mobile communications. "In this way, very precise conclusions about the current traffic situation can be drawn – and in real-time," says Raimund Wagner, CEO of Austrian organization AMV Networks. The company specializes in the collection of xFCD data and offers its system under the name AMV. Calculations show that commuters who travel 20km daily could save around €100 on fuel and 40 hours of driving time a year via the intelligent control of traffic based on real-time data. In addition, free-flowing traffic produces reduced emissions. Per car per year this translates to a 25% reduction in CO_2 emissions, a 40% reduction in NOx and a 25% reduction of particulate matter. These reductions are possible in large part due to the fact that traffic jams are prevented. xFCD data can therefore be a key to solving traffic problems in Europe. It becomes even more attractive when you consider the low system costs. "The upgrade costs around €100. If the onboard unit is installed directly on the conveyor belt of the OEM, the cost is just €10," Wagner explains.

xFCD could hold the key to eliminating congestion

Need to know?

The huge potential impact that the use of floating car data could have on Europe's roads

- Traffic volumes are not going to decrease any time soon – so we have to embrace modern technologies to assist in the fight against congestion
- xFCD has the potential to eliminate traffic jams, reduce harmful emissions and create free-flowing traffic conditions
- The technology is proven and available: we now need to ensure it gets widely deployed

No problem with privacy

AMV Networks has been conducting research and development in this field for years and produces an onboard unit called ASG (anonymous sensor data gateway). The ASG black box records essential data that remains completely anonymous. The driver must actively provide access to it. "The protection of personal privacy is our top priority," adds Wagner. The necessary technology for this issue has been designed by AMV Networks – and privacy experts have confirmed its effectiveness. When personal rights are protected, xFCD data can make the breakthrough in Europe and help many countries in eliminating the traffic problems they face today. The technology exists, works and has already been tested in pilot projects. In view of the situation on many roads, it is important to act now. Hence, politicians should step up and drive forward this new technology to make a real change for the better.

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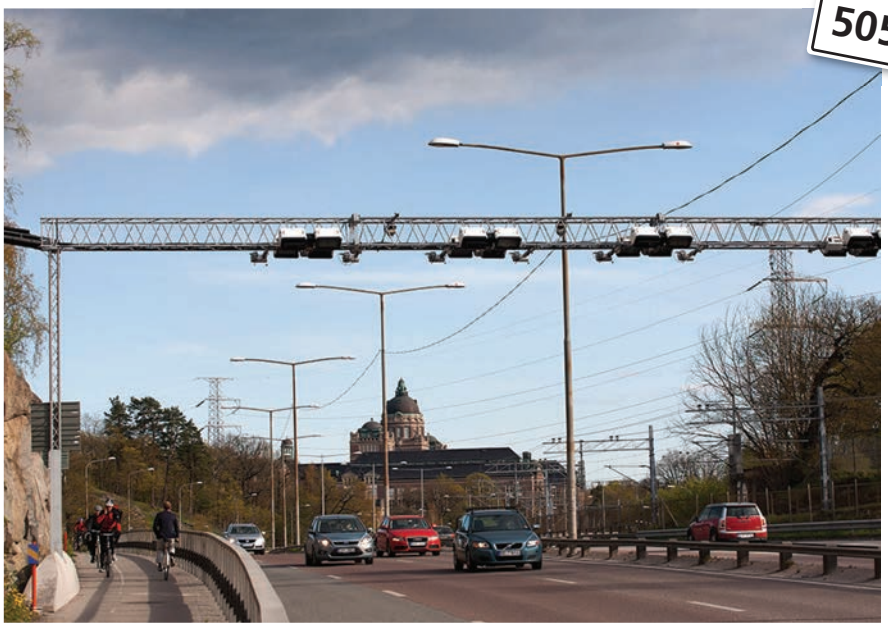
Benefits of high-performance video processing technology

READER ENQUIRY NO. 505

For numerous types of traffic applications, images of cars are taken with the purpose of identifying them using the information on the license plate. In access control situations, gates automatically open where entrance, payment and exit can be matched. Speeding tickets are issued based on the pictures. And for road user charging, the video is used as enforcement or to charge the road users.

With this in mind, the importance and expectations in automatic handling quality have dramatically increased. Identifying their origins leads us to the various image processing technologies that can fulfill these needs.

Handling the pictures automatically reduces the operational cost for identification, which is mainly beneficial to enforcement and tolling systems where millions of images may need to be processed daily. Security, travel time and parking applications also benefit from an instant identification process, where both the traffic flow and user experience are affected.



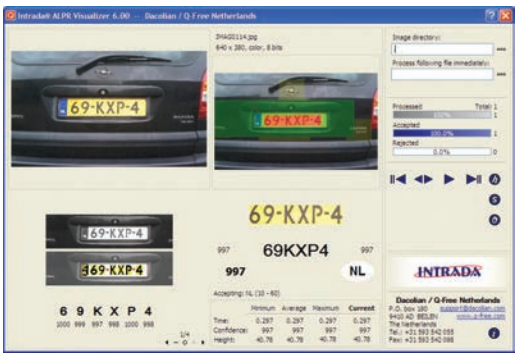
ALPR has become a key part of everyday business in the ITS sector

Quality control

Among others, quality of identification can be expressed in terms of the percentage of images being processed automatically, the part of these processed images being identified correctly, and the time needed to fulfill the processing task. This quality is a product of the quality of the acquisition – for instance, the resolution, sharpness and contrast – as well as the processes and software used to handle the acquired footage.

Given a video stream of particular quality, the characteristics of the outcome are still a trade-off between the amount of video handled correctly and the errors made. For tolling and enforcement applications, such errors imply additional costs and a possible threat to public opinion and acceptance. On the other hand, for tolling back-offices, the operational costs grow almost linear with the images that are handled automatically. Finally, any misreads in access control applications will frustrate automatic matching, and also therefore the traffic flow as gates will not open immediately.

As such, moving from a 'nice to have' additional feature, automatic license plate recognition (ALPR) has become a key part of our everyday business. Consequently, the requirements expected of the automatic handling have also increased. Improvements on the acquisition side run hand in hand with the software making use of these improvements.



Effective OCR software allows license plate data to be captured

Software solutions

Software can support the identification process in various ways. The most prominent technology is optical character recognition (OCR), which automatically reads registration numbers of passing vehicles – what we refer to as ALPR.

Alternatively, the software can match passing cars with a previous observation using their environment-independent visual characteristics, also referred to as the vehicle fingerprint. This enables the automatic identification of vehicles that for whatever reason could not be read through ALPR – such as fixed objects (e.g. tow bars) partially occluding the license plate.

Well-designed working processes can further enhance the identification quality, where they smartly weave the abovementioned software modules with the possibility of manual review into an effective workflow.

With the various Intrada variants, such as Intrada VSR and Intrada Synergy, Q-Free offers software solutions that address the specific needs of the different traffic domains. In the environmental zone in the Netherlands, for instance, 95% of the images are handled

Need to know?

ITS applications that rely on images are driving developments on the processing side

- A growing number of traffic management solutions are based on vehicle identification via images: software to conduct this identification must be accurate, proven, and reliable
- Processing software plays a key role in achieving a system's end results – and in ITS, there is no room for big errors
- One expert offers a range of software to efficiently match the needs of many ITS applications, from tolling to access control

automatically, with less than 0.02% errors. In the Stockholm Congestion Charging system, Intrada ALPR and a fully tuned workflow on the images from front and rear cameras enable the automatic handing of 96% of all vehicles with an error rate of less than 0.01%.

With a growing dependency on identification with video, the demands on the corresponding processes and software have increased. With Intrada technology, Q-Free can supply a solution that fits the high needs of the specific domain within various markets.

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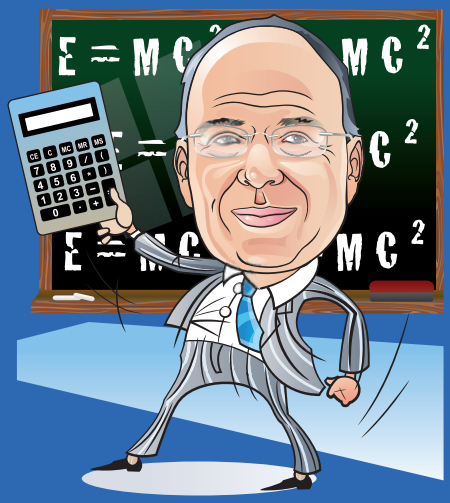

Larry Yermack

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In my previous column, I wrote about mileage-based user fees and this time I'll continue the discussion by talking about toll interoperability, since they are two approaches to the same problem. How do we charge drivers based on usage of specific roads and facilities?

The US Congress finally approved – and President Obama quickly signed into law – a multi-year transportation bill at current funding levels, but needed several legislative tricks to do it. Few in this industry believe that Congress can pull the same rabbit out of the hat again in two years, so the search is on for alternative funding sources. It's already complicated and it's about to get even more complicated. The process of getting a bill takes input from literally hundreds of groups and individuals over a multi-year process to boil it all down into a funding scheme and assorted policy statements. Usually the fight is over how big the bill is, but the policy statements are also contentious. This year one of those statements was to mandate toll interoperability by 2016.

The language of the bill does not make it clear what that means or how it is to be achieved so the industry – led by IBTTA – is on its own to define it and to make it happen or face the prospect of being told what to do either by the DOT or Congress. IBTTA is rising to the challenge with a major national interoperability effort underway, but I have a few concerns and with this column the opportunity to raise them.

Interoperability will impose costs on operating agencies either for new hardware, software or operations that they will be reluctant to incur, unless it makes business sense for them. Most agencies don't even receive federal funds so the mandate bites a lot less for them. They will make investments if it serves their customers and makes business sense, not just to meet a mandate or be a good IBTTA member.

Who really needs interoperability? Some long-haul truckers surely, but who else? An important first step would be to quantify the issue and identify how many customers would want to use an automatic toll payment scheme where they do not have an account. Equally important is to determine how much these individual users would be willing to pay for the privilege. The industry needs to know the business case first before designing a business solution.

Then how is it to be provided? I can imagine one model where anybody with a toll account at one agency could expect to use any other toll road in the USA and have the charges show up on their account. That would be a pretty broad and expensive interpretation of the mandate. On the other hand, it could mean that an account holder at one agency could apply for the ability to use other roads and would be willing to pay something extra for the convenience, a narrow and more feasible solution.

National interoperability sounds nice, but to accomplish it we really need to know how big the market is and how to engage those users in the solution. It has been a dream for more than 20 years. I always believed in the dream but I also know how to count – and this solution has to add up for the operators for it ever to be implemented.

> I always believed in the dream but I also know how to count, and this solution has to add up for the operators for it ever to be implemented
>
> **Larry Yermack, Wendover Consult, USA**

Smarter wireless tools for ITS

READER ENQUIRY NO. 506

Proxim offers a wide range of wireless radio solutions for the ITS market

The rapid urbanization and shifts in population density coupled with limited road system capabilities have resulted in constantly increasing commute times, fuel consumption, and air pollution – thereby reducing the efficiency of the transportation infrastructure. Building new roads to meet the transportation demand can be prohibitively expensive, and adding new lanes in highly congested urban areas is often impossible. To keep traffic moving, a tried-and-tested solution is an intelligent transportation system (ITS) that consists of advanced traffic signal control, including many different components – from weather sensors and dynamic message signs (DMS) to video surveillance cameras and speed enforcement technologies.

The Tsunami 8200 is a high-power, reliable, cost-effective, non-line-of-sight 4G point-to-point (PtP), and point-to-multipoint (PtMP) wireless solution. It delivers data rates of 300Mbps, and features 24dBm high-power radios for extended coverage, and support for mobility applications at speeds up to 180km/h. With its wide channel capacity, high spectrum efficiency, and robust prioritization platform, the Tsunami 8200 effectively binds all the different components of a transportation system over hundreds of square miles, with an end-to-end wireless network, thereby enabling a wide variety of high-uptime and bandwidth-intensive applications. These range from real-time traffic updates to traffic officials and residents of a city over websites to warning drivers of road conditions, accidents, and detours via DMS – hence facilitating a scalable, reliable, and a cost-effective transportation system.

Need to know?

How an intelligent wireless solution can enable the power of ITS to be fully reaped

- Latest wireless tools from an expert in the sector
- An effective wireless network is the glue that binds various ITS components together and enables them to function efficiently
- Operators can control bandwidth size and direction to tailor the solution to the needs of their specific network
- Reliable and secure data transmission is a key selling point for end users

Embedded in the core of the Tsunami 8200 radios, WORP (Proxim's proprietary wireless outdoor routing protocol) is a reliable, secure and efficient protocol designed to optimize the performance of multiplay outdoor wireless PtP and PtMP links using packet radio technology.

Enabling smarter solutions

An 802.11-based outdoor PtMP solution may connect several remote nodes. However, in heavy traffic deployments, performance starts to suffer from collisions with as few as two remote nodes. The Tsunami 8200 can connect more than 250 remote nodes without adverse effects on usable bandwidth, allowing more concurrent subscriber units (SUs) to be active in a wireless multipoint environment. This is made possible by allowing operators to control network bandwidth size and direction allocated to each SU individually, protecting the network from excessive use by any one SU. Further, overhead of a Tsunami 8200 link is minimized by the use of super-packeting, fragmentation and bursting – enabling extended subscriber support with high scalability.

As a result of WORP's windowing mechanism, reliable data transmission is achieved by means of acknowledgement and selective retransmission of data that is typically lost during transmission. The use of AES 128 hardware encryption ensures confidentiality of data traveling over the air while secure management (SSL, SSH, and SNMPv3) and a robust IP67 enclosure protect the device from external aggression. Finally, multiple built-in tools help select the best transmission channel (spectrum analyzer), measure the radio link performance (IPerf), and control the sanity of the wireless network (sFlow probe).

By enabling 8200 base station units (BSU) to dynamically decide how frequently an SU should be polled – based on advanced QoS setting and current traffic to and from each SU – WORP avoids wasting bandwidth on SUs that have no traffic to be sent, while maintaining guaranteed interface rate to each SU. This enables the high-definition and bandwidth-intensive tasks often required in ITS.

Traditionally, an SU roaming between wireless coverage areas terminates the session with the current BSU and registers with another. However, with FastConnect, SUs continuously monitor the local signal-to-noise ratio (SNR) and data rate for all the frames received from the connected BSU. As long as the local SNR and data rate is greater than the set threshold, the SU does not scan for other BSUs. When the SNR and data rate breach the threshold, the SU scans and connects to a BSU with a better signal strength. This way, FastConnect is able to establish hand-off times within 40ms and support delay-sensitive applications while the SU roams from one BSU to the other.

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A winning combination

Through combining laser-based red light and speed enforcement technology, one player in the field has successfully completed a six-month open road test in Saudi Arabia to prove the capability and performance of its system. The intensive product testing was carried out to prove the system's compliance with the requirements of the Automated Traffic Violations Administering and Monitoring (ATVAM) program tendered by the Ministry of Interior in the Kingdom of Saudi Arabia (KSA).

Monitoring four lanes with high-resolution digital cameras and detection units, Vitronic's PoliScan red+speed test system captured rear and front license plate images, a digital photo of the offending drivers and a video sequence of the red light and speeding offenses on both red and green.

As an example, for a one-day test period, more than 100 offenses were captured; 10% were red light and speeding violations occurring at the same time. Test results for speed-on-green offenses exceeded 180 for the same period.

Analysis of the long-term test results confirmed that the daily number of offenses dropped by 75%, thus improving road safety dramatically. These figures demonstrate that traffic enforcement has a calming effect on speeding and red light running. At a technical level, all of the agreed performance requirements and additional applications of the ATVAM program have been achieved.

Without the need for sensors or loops integrated into the road, the fully automated PoliScan systems use LIDAR (light detection and ranging) technology to scan the road area multiple times a second, construct an accurate image of the traffic and create calibrated stop lines. All vehicles present in the scanning area are tracked simultaneously and offenses are attributed to specific vehicles. If a vehicle passes a calibrated stop line when the light is red, the first image is captured; if the vehicle continues to travel into the middle of the area, a second image is taken.

The system is connected to the traffic signal via a certified traffic light detector. When an offense occurs it instructs the cameras to capture the scene. All cases are precisely documented, including statistical data such as vehicle classification and lane identification for multiple or simultaneous offenses, the time and date, location, time into red, type of offense, and speed traveled at the time of the offense. All images and data are combined into an encrypted case file that is then securely transmitted to a violation processing center.

A safer future

PoliScan systems for speed enforcement are already operating in high numbers in the cities of Makkah and Madinah under the ATVAM program. However, with red light violations being one of the top reasons for accidents and fatalities, an efficient system for enforcement is still an important element in road safety schemes such as this. "With the successful completion of the tests, another important milestone in our contribution to more road safety in the KSA has been achieved," says Vitronic's Daniel Scholz. "We will continue to deploy the latest enforcement solutions to fight speed and red light violations and increase road safety."

(Above) **Traffic enforcement in the KSA** (Below left) **The PoliScan red+speed unit**

Need to know?

How the Kingdom of Saudi Arabia is deploying the latest enforcement tools

- The scope of the ITS technologies to be delivered under the ATVAM program includes the industry's latest technology in law enforcement transportation, security subsystems and services
- Law enforcement includes the installation, deployment and operations of red-light and speed enforcement as well as integrated central control systems

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Reducing traffic jams in Verona

READER ENQUIRY NO. 508

Axis cameras are being deployed to beat traffic congestion in Verona, Italy

Verona is one of the main tourist attractions in the north of Italy, largely owing to the wealth of history steeped in its town center. The large numbers of tourists combined with local traffic can often cause delays in the city, potentially resulting in chaos for city travel.

The implementation of a video surveillance system placed strategically around the city has allowed the Traffic Coordination and Management Unit to control any problems regarding road conditions in real-time and act promptly in emergencies, communicating with users through mobile communication channels (web, SMS, email, etc).

The opportunity to monitor road conditions in real-time and intervene immediately in the event of a critical situation has allowed authorities to adopt specific strategies for traffic signal control.

The inner city traffic video surveillance system is managed and configured by Axis's partner, Reteco, and runs on the Milestone video management software platform. The system is composed of 32 strategically placed network cameras and will be integrated to incorporate a total of more than 100 cameras.

Installation of video surveillance links individual network cameras with the Central Traffic Unit, at which operators are in continuous contact with the city's police control room. The use of video surveillance in the city center primarily allows rapid and effective monitoring of urban road conditions but also plays a strategic role in traffic management through the use of cameras integrated with centralization of traffic signals, and addressing users through traffic information panels, which can alter traffic flow at any given moment depending on requirements at that time.

The choice of models installed was governed by the requirement to monitor large areas while at the same time allowing the possibility of registering certain details at certain moments. The cameras installed have a powerful 35x optical zoom and a 12x digital zoom, which enlarge small and distant objects up to 160m away, such as car license plates. They also include a function that allows the camera to continue to track an object recognized to be following certain movements. A couple of the characteristics that make these models extremely practical for the role developed by the Municipality of Verona include high power-over-Ethernet and arctic temperature control. The first system simplifies installation – to the point where a single network cable is used for power supply, video transmission, and PTZ commands. Arctic temperature control ensures the cameras will work at temperatures from -40°C to 55°C, but also enables them to restart at these temperatures following a power outage.

Need to know?

How a historical city is using the latest surveillance tools to improve traffic control

- Like many busy cities, Verona suffers from persistent congestion – both from local commuters and tourists
- The city has invested in smart surveillance solutions to assist in its management of all traffic
- The end system will see more than 100 cameras integrated into one overall network
- The city is already reaping the benefits of the camera technology

Happy customer

"Using Axis network cameras is the perfect compromise between surveillance requirements and traffic control, owing to the high-quality images and their hugely versatile nature, being available in both H.264 and HDTV," says Bruno Pezzuto, head of the Verona Central Traffic Unit. "The potential to optimize camera operation remotely and use the images without requiring specific decoders means we can use them in real-time on our website for quick and updated information about current traffic conditions."

The collaboration between Axis and the city of Verona was an opportunity to celebrate the 95th Giro d'Italia cycling event in this historic city. On this occasion, the municipality was able to monitor the vast numbers of people in the city center far more accurately using the three Axis network cameras strategically installed for the occasion.

"The reasons we are satisfied with Axis include the good price-quality ratio and versatility," Pezzuto concludes: "By using such an extensive camera surveillance system, we can in each case employ the best adapted model – which varies, for example, according to when and where the camera is installed."

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Why green is good for signal priority

The green light in front of you cycles to red. Suddenly you hear the distinctive sound of a siren in the distance. As the emergency vehicle approaches from your left, you notice the intersection is now clear of cross traffic. The vehicle cruises through the intersection unimpeded – its top priority being to reach the scene as quickly and safely as possible.

With the inclusion of priority control systems in a growing number of traffic control installations throughout the world, first responders can reach the emergency scene in a fraction of the time it once took. Transit services can meet schedule requirements. And thousands of motorists face fewer risks on the road.

EVP and TSP

Emergency vehicle preemption (EVP) systems are designed to give emergency response vehicles a green light on their approach to a signalized intersection and to clear the traffic queues at highly congested intersections. The emergency vehicle is assured that all cross traffic is stopped as it passes through the intersection. Police cars, ambulances, fire trucks, and other emergency service vehicles can respond more quickly and safely.

Transit signal priority (TSP) systems are used to help make transit services faster, more reliable, and cost effective. If implemented correctly, TSP can make a major impact without affecting general traffic flow and traffic signal coordination – is an inexpensive way to help make transit a more competitive travel option for commuters.

Several manufacturers and vendors offer priority control equipment or implementation

READER ENQUIRY NO. 509

(Left) **EVP is hugely beneficial for emergency services** (Below) **The Opticom multimode setup**

Need to know?

How agencies can benefit from new traffic signal priority control technologies

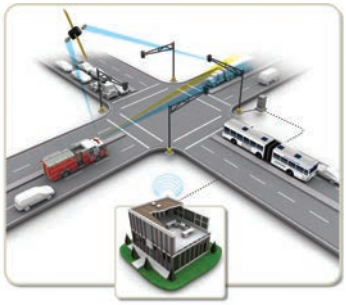
- EVP allows authorized emergency response vehicles to interrupt traffic light phasing and trigger a green light as the vehicle approaches the intersection
- TSP extends a current green light or truncates a red signal to allow transit vehicles to pass through unimpeded

services. In the past, though, municipalities had to choose between infrared or GPS radio technologies. Even if provided by the same vendor, they were not interoperable and couldn't be used together – until now.

With the introduction of the Opticom multimode hardware platform and Opticom central management software, Global Traffic Technologies (GTT) offers seamless integration and interoperability of Opticom infrared and Opticom radio/GPS priority control systems. Multimode technology is ideal for mutual-aid EVP operations and cross-jurisdiction transit operations, where multiple communities using different priority control technologies can work together with ease.

Using its expertise in infrared and GPS/radio preemption systems, GTT is actively pursuing new ways to improve priority control using several enabling technologies, including WiFi, WiMax, cellular, DSRC, and 4.9GHz public safety radios for wireless communications to roadside or central equipment. These technologies also offer greater communications coverage to intersection equipment, enable more accurate schedule adherence for transit, and provide adaptive control software to link multiple traffic controllers.

EVP and TSP operations can be further enhanced if a customer transitions from an Opticom GPS system to a connected mobility DSRC system, or a fully centralized priority control system.



A connected mobility DSRC system offers excellent data exchange capacities – including broadcast intersection preemption status, collision alert messages, and more – to give a city's traffic engineer all the information needed to manage intersections more cohesively from a remote location. But how can this new technology be implemented without compromising legacy GPS/radio investment? By adding a 5.9GHz DSRC radio module to existing Opticom GPS vehicles, the municipality gains seamless interoperability and backward compatibility. It also offers a high level of flexibility: the modules can be removed, allows the system to operate as a pure, connected mobility implementation.

Centralized management

One big challenge for traffic engineers is how to improve service for emergency and transit providers without disrupting normal traffic operations. EVP control of traffic signals can cause some level of disruption to signal timing and coordination. TSP operation is usually less disruptive in most applications, but municipalities can certainly benefit from a systems management approach to optimize its effectiveness. Fortunately, disruptions can be minimized with centralized management from the TMC.

Using GTT's Opticom central management software (CMS), traffic engineers can manage deployed equipment inventory, devise configurations and implement system security remotely. This is also valuable for maintaining system performance and for monitoring usage across the system and at each intersection in real-time.

Recently, the availability of lower-cost wired and wireless low-latency communications technologies and advanced capability adaptive controller software packages have allowed system designers to integrate CMS into their priority control system quickly to improve performance.

These advanced concepts are working today, and indeed were presented at the 2011 World Congress on ITS in Orlando, at which GTT and Siemens demonstrated DSRC-based EVP and TSP control of signalized intersections.

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Through my several years of writing this column, it has suddenly explicitly dawned on me that the column topic, Smart Cars, may mean different things to different readers. Certainly, I've known this at some level, as I write about most any smart car subtopic and some that aren't. But really, what is a Smart Car? First and foremost, it needn't be a car – or even a vehicle. In my very broad view, it is a smart road user or operator, where intelligence is imbued via sensing and perception, processing and logic, then action. The sensing and perception may be autonomous or it may arise from communications technology. The action could be a safety action, or it could even be something that entertains.

This broad view enables a traveler who carries a cell phone handset to drive or ride a Smart Car. It allows cooperative systems of connected vehicles to be Smart Cars, opening the door for the fixed infrastructure or landside that enables such a system to be part of the Smart Car community. And certainly, it allows autonomous vehicles to be Smart Cars. This broad sense of the Smart Car community of stakeholders carries with it a broad array of needs, allowing the very definition of 'smart' to vary.

Therefore, according to this columnist, a Smart Car could provide entertainment and convenience features from telematics. It could be tracked for insurance or to a road user-based fee. It could be part of a cooperative system that interacts with other Smart Cars, or with other phone-carrying road users, to help enable and benefit from mobility, environmental, road weather or safety systems. A Smart Car need not cooperate; it could autonomously sense the rest of the world and provide a sort of safety cocoon to the participants. It could be fully automated, cooperative and therefore provide a whole host of services to the user and to society. That is, Smart Cars could have different IQs, and the particular IQ of a Smart Car may depend on the test so-administered. (I wouldn't want the Smart Car to take the Stanford-Binet test for sure!)

I flag that not all the categories of applications I list would be considered smart by all of you. The key to intelligence should always be smart, sensible implementation of the right combination of applications – all at the right time. Interacting with a Smart Car's user interface while cruising at 100km/h through an intersection would be very unsmart, made smarter – possibly – if your Smart Car was autonomous and itself a genius car. For sure, there's much intelligence that needs to be applied to this type of Smart Car.

The point I make is that you, by virtue of being a surface transportation system user, operator, supplier or simply an aficionado – or some combination of these – are part of the Smart Car ecosystem. Some of the applications and degree of interaction may not be so smart, but on the aggregate, this is an exciting time to be part of the larger Smart Car movement, literally and figuratively. This column, therefore, and to the extent of authority I can muster in mere words, fully embraces one and all of you Smart Car column readers.

> Smart Cars could have different IQs, and the particular IQ of a Smart Car may depend on the test so-administered

Jim Misener, executive advisor, Booz Allen Hamilton, USA

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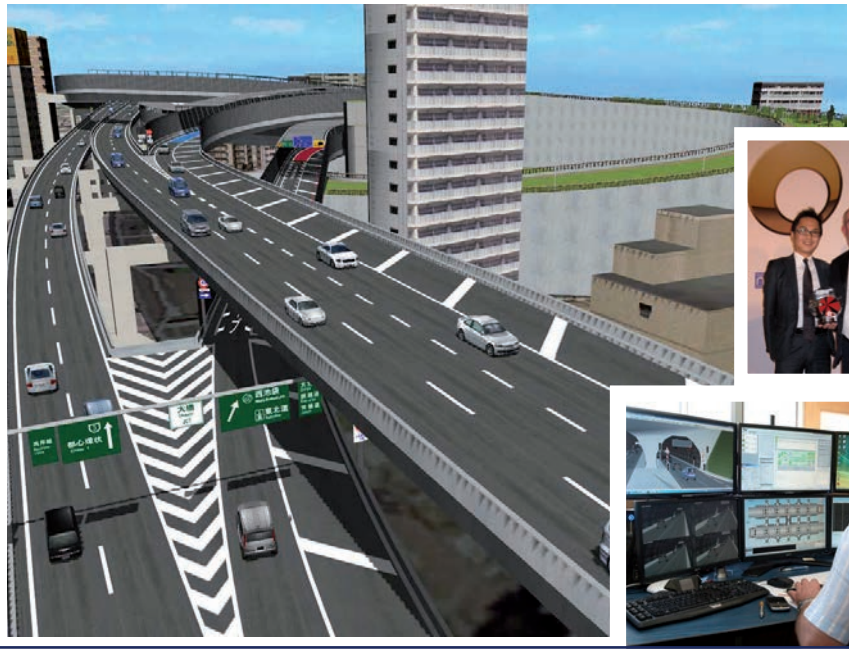

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Interactive 3D simulation for ITS

READER ENQUIRY NO. 510

The combination of modern simulation and modeling technologies provides highway and tunnel designers, planners and operators with a means of building 3D environments quickly and easily, testing design ideas, building consensus, and even providing managers with training platforms.

As transport specialist Forum8 develops more software plug-ins for its interactive 3D simulation and modeling software, VR-Design Studio (formally UC-win/Road), more market opportunities appear.

In addition to plug-ins for civil engineering and BIM products from AutoDesk, Bentley, and Nemetschek Allplan, VR-Design Studio also accepts data from leading microsimulation pedestrian and traffic applications, as well as being able to turn raw point cloud data into usable, interactive 3D environments.

Pre-built 3D city models from around the world are available, along with a free database of more than 4,000 CAD models of street furniture, vehicles, etc.

Forum8 and its partner companies are continuing to expand the data that benefits from being 'relocated' into an interactive 3D VR environment. The ability to enable users – whether professionals or members of the public – to interact with 3D models of the real world is proving particularly popular in the process of consensus building and stakeholder consultation.

Apart from the ability to bring engineering drawings to life within a highly photorealistic 3D space, the interactive nature of VR-Design Studio means that planners can test multiple design scenarios and stakeholders can interact with proposed developments in ways not previously possible.

A recent development that makes such consensus building even easier is VR-Cloud, which enables VR-Design Studio interactive 3D environments to be broadcast over the cloud and accessed and interacted with by anyone with a PC or Android system.

Road operators are reaping the benefits of real-time, interactive 3D simulation

Need to know?

The latest product developments from an expert in interactive visual simulation

- How technological evolution has opened up more applications for 3D interactive simulation and modeling
- Road and tunnel operators can benefit from the latest technologies in terms of improving consensus building and stakeholder consultation
- Realistic simulation tools enable operators to efficiently train their staff on how to manage complex traffic events

This one development could revolutionize the whole concept of stakeholder consultation.

One of the many reasons for such new developments is the intrinsic flexibility and functionality of the software, plus the availability of a software development kit (SDK).

An example of this is shown by a partner company in the USA, Virtual Simulation & Training (VSAT). The company has used the SDK to integrate VR-Design Studio into its driving simulator package, which is designed to help reduce accidents by targeting one of the most high-risk groups – teenage drivers. In addition, VSAT is utilizing the power of the Eco Drive plug-in to record the actions of the driver as well as log fuel consumption and CO_2 output.

Real-time simulation

Another collaborative development between Forum8 and French partner BMIA is the G'Val product. This provides real-time interactive 3D visual simulation of traffic for road and tunnel management, using either existing or proposed networks.

G'Val has been designed to overcome the inherent problems of highway and tunnel operator training and management. One of the many problems with training operators – and indeed managing complex traffic events – is the inability to accurately visualize the events realistically in real-time and in the classroom. G'Val solves these problems while delivering added value to highway and tunnel operators.

The realistic and accurate visual simulation capability of G'Val allows communication both internally within the design team (prior to and during the project), and externally with stakeholders and the media.

Driven by the SCADA system, G'Val allows tunnel and road operators to be trained in a realistic environment using the real operational HMI. A wide range of scenarios provides the ability to replicate and evaluate the impact of every conceivable potential emergency incident.

Customized to precisely reflect each project, G'Val provides invaluable benefits at every stage of the project, from initial study to final operation.

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Future tolling technologies are here today

READER ENQUIRY NO. 511

We are at a pivotal moment in the history of tolling. The shift to free-flow systems is completely changing the way toll collection systems are implemented and operated. The agents of change – going cashless, improved safety, and less congestion – are the catalysts for all types of innovative new technologies and interoperability initiatives. Mileage-based user fees and the merging of transit and tolling systems are also on the horizon.

Toll authorities and operators face many challenges in this new age of free-flow tolling. This paradigm shift requires substantial investment in new technologies at the roadside and back-office software upgrades. Free-flow systems fundamentally change the way toll operators conduct their business. Lane-level sensor accuracy and a highly automated back-office system are therefore mission critical.

Returning from the IBTTA Summit on AET in Atlanta last July, it was obvious that there are many issues and challenges facing tolling agencies in the transition to free-flow tolling. Should I convert now or later? Open road tolling (ORT) or all-electronic tolling (AET)? Should I outsource back-office operations or do them in-house? What about interoperability?

These are the questions toll authorities face as they contemplate upgrades to new technologies, such as multiprotocol readers to support interoperability, and sophisticated image processing hardware and software. When you move from a cash environment to free-flow, there's an entirely new class of roadside and back-office systems required. At the roadside, sensor-rich gantries with high-resolution cameras are required for image processing and vehicle classification. The back-office account management software must be feature-rich and support highly automated business processes. Participation in interoperability models requires the ability to efficiently process out-of-state transactions.

End-to-end solutions

CS ITS offers end-to-end solutions for authorities to meet the challenge of converting existing facilities to free-flow tolling and interoperability. Its FastFlow ORT, FastFlow AET, and FastToll ERP back-office use the very latest technologies and are highly reliable and scalable.

There are a number of key emerging technologies to support free-flow systems. For instance, accurate automatic vehicle classification systems (smart loops and overhead sensors) are important. Likewise, high-resolution cameras and plate/vehicle fingerprinting are prerequisites. Declarative tags for HOT and HOV lanes must be considered. Multiprotocol readers, single-gantry solutions, GPS/GNSS, and smartphone apps complete the line up.

CS ITS's recent projects and R&D activities have been focused on bringing these innovative technologies to the market today. Its recent implementation at the Port Mann Bridge in Vancouver uses smart loops and multiprotocol readers for device interoperability (6C, Title 21, and ASTMv6). Its FastToll ERP

Need to know?

Free-flow tolling is proven, available, and now being deployed: it is changing the entire face of the toll industry

- Toll collection systems are undergoing huge changes as they move to free-flow; operators must embrace this new phase in toll road operations
- Expert guidance can assist operators in the transition to free-flow and interoperable tolling
- It is important to distinguish between ORT and AET when specifying new models

(Main and above) **The Golden Ears Bridge AET system** (right) **Toll gantry on NewPort Pell Bridge**

back-office lowers the cost of operations and supports all the account types required for free-flow systems: tag registered; video registered; unregistered; and violation processing.

There are many types of free-flow systems – ORT, AET, HOT, congestion pricing, and so on. The decision as to which scheme to implement depends upon the authority's business model. No matter what model authorities might choose on the technical side, CS offers solutions for any configuration.

Ease of migration is a key factor in any upgrade. That's why CS developed its systems to be implemented in an open architecture model, adhering to open-standard specifications. For example, it supports all tag technologies (6C, Title-21, IAG) and provides a mediation server in its interoperability hub to support all the common regional interoperability blocks: E-ZPass, CTOC, SunPass, and Team Texas.

The open architecture also eases migrations and system upgrades without disruption to the toll road user or operator. CS ITS has integrated every open standard in the USA (and some proprietary ones) without trouble because its FastToll product comes with a full library of available interfaces for smooth migration in adopting a new protocol.

For the toll authority or operator, selecting a systems integrator that offers its own proprietary solution might be attractive, but vendor lock-in is never a good business practice. Moving to open standards will become costly when locked into a proprietary solution. CS ITS subscribes to the open architecture standard by integrating the best-in-class products from multiple vendors to provide the best solution.

Interoperability

National interoperability requires a hub system to process all away-agency transactions no matter what tag technology or back-office system the home agency uses. CS ITS provides interoperability software for all the major schemes, including EETS, ATI in the USA, and regional standards such as E-ZPass in the northeast USA and CTOC in California. The ATI hub was highly successful in the pilot phase, recovering more than US$1 million in revenue over a three-month period for transactions that would have been unrecoverable. The pilot phase included only five participants, so there will be exponential growth when more agencies join the next phase. The exciting point about the ATI hub is that it could become an avenue for value-added services such as transit, parking, and violation processing and account management, at a low cost for smaller agencies.

Multiprotocol readers are another technology driving the movement toward national interoperability in the USA. At the Port Mann Bridge, CS ITS recently implemented multiprotocol readers. "We've got to read three protocols: ISO 18006C, Title 21, and ASTMv6," says Christian Pathé, CS's free-flow technology manager. "For this protocol combination it works, but things become much more complicated when you add slower protocols because the AVI is done on a real-time basis in free-flow conditions, and multiprotocol antennas try to read every protocol one by one." Multi-protocol antennae can solve interoperability issues in a specific area but cannot integrate all the existing tags – at least in free-flow conditions.

AET or ORT?

It is important to understand the difference between ORT and AET. The terms are often used interchangeably, but the tolling industry has come to an agreement on their exact meaning. In the ORT model, the cash option remains a choice for the toll road user. It describes a configuration where the middle of the road is free-flow at highway speeds and toll booths are located on the side in each direction. With AET there is no cash option; gantries collect all transaction information.

ORT is a more conservative approach to free-flow than AET. With ORT, users passing a gantry without a registered tag are considered violators. These unregistered users are supposed to use cash lanes to pay their toll. This type of system does enable operators to increase tag usage for the facility. Also, implementation can be achieved in a short timeframe. For example, CS ITS installed an ORT system in June 2012 at the NewPort Pell Bridge for the Rhode Island Turnpike and Bridge Authority in a little more than two months. CS ITS's adherence and commitment to open architecture standards was crucial in making that project a success.

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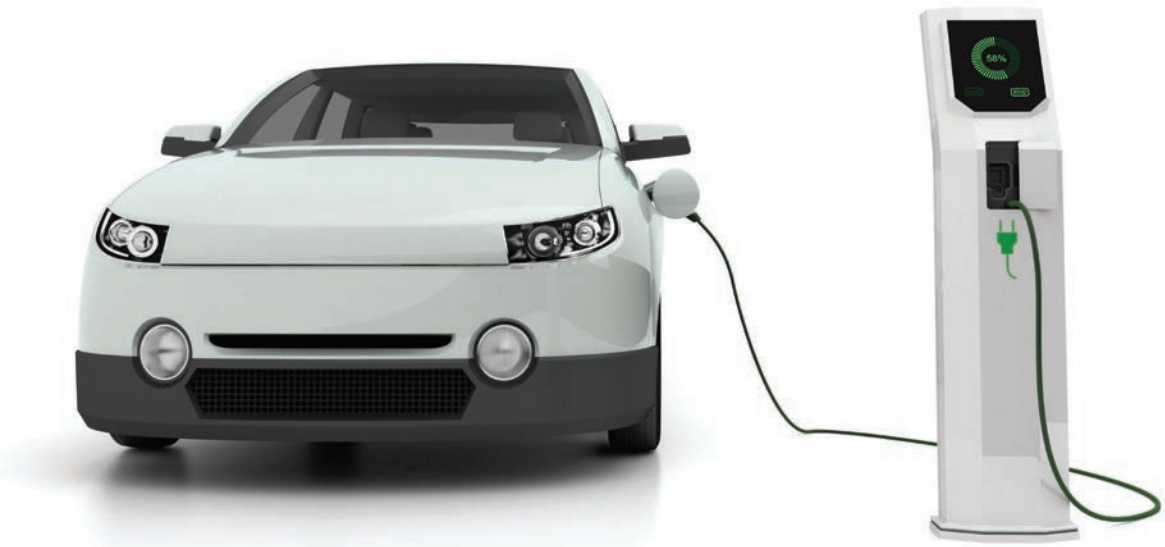

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Cloud-based solution for Fiji

READER ENQUIRY NO. 512

Although there may be local differences when it comes to laws and regulations globally, police forces and traffic authorities are facing similar challenges when it comes to the processing of repetitive tasks such as traffic offenses: an increasing need for improved performance on a reduced budget.

An example of how to achieve this is the work that StarTraq, a UK-based offense management solutions provider, has embarked on with the Fiji Land Transport Authority (LTA), in conjunction with speed camera manufacturer, Truvelo.

The LTA is a government organization set up to improve land transportation in Fiji and above all else ensure that road safety is enhanced. It is the principal licensing agency for all forms of land transportation, irrespective of whether it is driven on private or public roads. It occupies a key role in ensuring efficient and safe transportation throughout Fiji.

The LTA was looking for a solution to enable a more efficient, streamlined and automated process for red-light and speeding offenses. Previously, these offenses were processed manually and paper-based tickets were issued at the roadside and then manually stored within a local database before being sent on to court if the offender failed to pay the fine.

One of the key challenges the LTA is facing is in creating an infrastructure that is able to process high volumes of offenses promptly and efficiently. By deciding to work with StarTraq and Truvelo, the LTA has been able to implement an end-to-end enforcement solution that is designed to change the behavior of drivers within Fiji. With StarTraq Dome (Dynamic Offence Management and Enforcement), the offenses can be captured, adjudicated and processed with very little manual processing required.

It was critical to the LTA that the solution was flexible enough to work with three systems: Truvelo's D-Cam camera; Interbase – the Fijian database that holds all the registered keeper details of the vehicles; and the LTA's existing document management system. The LTA also had future considerations with needing to ensure that it was installing a system that has scalability to grow with its intention to reduce deaths on Fijian roads, as well as technology that is future-proofed. As StarTraq Dome is a cloud-based solution, the installation (which is currently underway) is being conducted remotely from StarTraq's Oxfordshire headquarters, which is leading to significant cost savings for the LTA.

Offense processing can now be conducted in the cloud

Need to know?

How Fiji's LTA has adopted a new method for enforcement processing

- The LTA was looking to streamline the way it tackled speed and red-light enforcement processing
- Two experts in their respective sectors joined forces to create a future-focused solution that brings a host of benefits
- The new scheme will ultimately help the LTA achieve its goal of creating safer roads by modifying driver behavior

Three major components

The solution that has been implemented in Fiji includes three key elements. The first is StarTraq Dome, for the adjudication and reporting on red light and speeding offenses, and the system interfaces with the Interbase database. The next component is StarPrintServer – the bulk print solution that also archives an electronic copy of all outgoing correspondence. The final element is three of Truvelo's D-Cam cameras, which can either be fixed or mobile variants.

Looking ahead, as StarTraq's Dome and the Truvelo D-Cam cameras are implemented, the LTA will be able to identify and prosecute more offenders, which will ultimately lead to a reduction in the number of deaths on Fiji's roads.

StarTraq also provides the LTA with the future capability to enhance its other enforcement objectives. "The opportunity to work with Fiji's LTA is groundbreaking on many fronts," comments StarTraq CEO Allan Freinkel. "The fact that it selected our cloud-based technology for the backbone of its enforcement program demonstrates the LTA's commitment to adopting innovative technology in order to save lives."

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How can color cameras improve results in ITS?

Vision has evolved to become a fast and reliable tool for quality inspection, traffic surveillance, target tracking, and so on. In many cases, a vision system can perform optical tasks more quickly and accurately than humans and at a lower cost. However, can a machine 'see' in color? Moreover, does introducing color into the equation help improve the quality of results?

A vision system acquires images of an object with a camera and then uses computers to process, analyze, and measure various characteristics of that object so that decisions can be made. One of the characteristics analyzed can be the color of an object. In the past, color was not widely used in vision systems as a result of the cost and processing power required. However, as costs decreased and processing power ceased to be an issue, solution providers began looking at incorporating color into vision systems in order to yield greater quality.

Need to know?

The color cameras that are being embraced by the ITS industry offer a range of useful features

- Machine vision cameras have crossed over into the ITS sector and are being widely embraced – particularly color cameras
- Color machine vision provides a more effective measuring tool than human color vision ever could
- The color cameras are well suited to ITS applications such as license plate recognition and speed enforcement
- Research suggests the use of color is set to increase even more in the future

The use of color imaging is increasingly popular in the ITS sector

Do machines 'see' in color?

Of course, a machine cannot actually see in color. Machines use mathematical models to approximate human color detection. A machine can be calibrated against the average human response to color and hence 'see' in that it gives consistent responses to colors observed in a controlled setting. This 'calibrated color vision' is useful for measuring and matching colorants in paint, plastics, fabrics, etc. Although human color vision has low resolution, color machine vision is not influenced by nearby colors, can have high resolution, does not vary much from machine to machine, and is therefore a better measuring tool than human color vision.

The use of color in ITS

One area where color vision is used is in ITS. Traffic applications such as license plate recognition (LPR), speed and red-light enforcement, toll management, traffic control/monitoring – and even transportation applications beyond automobiles, such as rail-car inspection – are increasingly present in today's vision world. In many applications, color is used for the purpose of visualization, while processing algorithms are applied to the monochrome component only. In LPR, for example, the identification of the plate number is often performed using monochrome information, while for legal purposes (such as bringing evidence to court), the storage of color images is mandatory.

Most color vision systems use a mix of hardware and software to detect colors. The main types of color cameras used in vision applications are 3CCD, tri-linear and color filter array (CFA), such as Bayer pattern. Teledyne Dalsa offers several color cameras each based on either CFA or tri-linear technology. Its new Genie TS Color camera is ideal for traffic systems and combines the latest image sensor technology with an optimized camera platform that delivers a wide and powerful feature set.

The future of color vision

Market studies conducted by the Automated Imaging Association

READER ENQUIRY NO. 513

Teledyne Dalsa's Genie TS camera range

show that around 20% of cameras sold for imaging applications up to the end of 2011 were color cameras. Most experts in the field believe this will expand. Color provides far more visual detail than monochrome grayscale and adds a new dimension in analyzing data in the real world. Color imaging can, for instance, be used for traffic surveillance to help identify key information such as color of traffic lights or pictures on the background of license plates.

Teledyne Dalsa has developed both tri-linear and CFA technologies and has been supplying high-performance color cameras to the industry with much success. Better color fidelity, lower cost, and ease of use are the primary drivers in the market, and new technologies being developed in the near future must address these needs to meet the increasing demand for these products.

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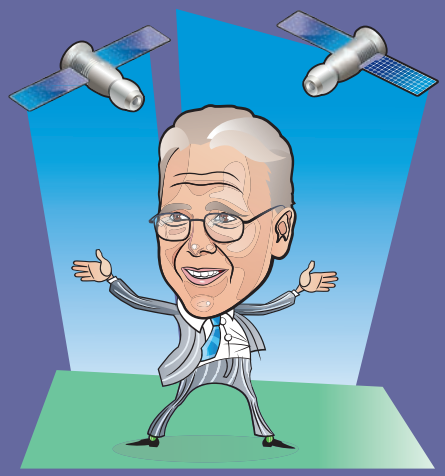

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Of hundreds of GPS-based telematics applications, the majority are related to transportation. Two major examples are asset tracking and usage-based charging. Most asset tracking applications involve fleet management in logistics environments, but are by no means limited to this. Key usage-based charging applications are road-use charging or usage-based insurance.

Asset tracking and usage-based charging share underlying technologies and GPS vocabulary, but involve very different purposes, user applications and business models. This makes their system architectures, sales, deployments, and operations distinct from each other.

At base, both applications focus on managing (knowing, identifying, describing) location of and information flow from mobile assets. Both are concerned with equipment, data, and measurement reliability.

Asset tracking focuses on safety, security, use optimization, and work value of the assets being monitored, hence asset tracking applications seek high-value assets. Asset tracking is mature, with many competing suppliers.

Usage-based charging focuses on high-frequency, small value financial transactions for automotive vehicles (including cargo vehicles) for infrastructure use (road fees, insurance premiums, parking fees, shared vehicles with associated usage fees/costs, etc). Hence this application will be more concerned with systems that are autonomous and embedded in large fleets (high vehicle count), so low system cost is an obsession. Usage-based charging is nascent and has only a handful of suppliers. Its system count can be expected to become far larger than that for asset tracking.

Of the two, asset tracking is more traditional, better understood, and more highly competitive. It has few or no political sales barriers. The buyer will have only modest comprehension barriers. By contrast, the usage-based charging business is less traditional with a commercial history less than a decade old. Its government buyers (road tolling) incur some political barriers and its private buyers have regulatory barriers (insurance) and some comprehension barriers (parking and insurance).

Both businesses use hardware, firmware, and software that is location, communication, M2M, and measurement focused – i.e., location-aware, M2M telemetrics. This implies strong engineering similarity relative to telecomm, GPS, and other sensors. Beyond that base, the applications, their markets, and their sales differ considerably.

Asset tracking focuses on asset management – measurement, monitoring, real-time communication. Usage-based charging focuses on payment management – data privacy, measurement repeatability, evidentiary weight, driver acceptance, and 'charging performance'.

GPS-based asset tracking operates best in 'open sky', usually depending on line-of-sight to the navigation satellites. Loss of GPS signal occurs for some applications, but these are a minority concern. Usage-based charging, if it is automotive related, may sometimes operate in degraded signal environments including cellular blind spots and urban canyon, so that must be resolved. Usage-based charging is 'liability critical' and tends to view mobile events as financial transactions. Since it cannot always resolve a correct charge with 'just GPS', it must rely on other algorithms to determine a correct charge in the case of compromised GPS signals.

Driver safety measurement/monitoring and vehicle sharing are crossover applications that both asset tracking and usage-based charging architectures may address.

> Asset tracking and usage-based charging share underlying technologies, but involve very different purposes, user applications and business models
>
> **Bern Grush, principal, Bern Grush Associates, Canada**

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CCTV digital migration journey for the ITS sector

READER ENQUIRY NO. 514

Closed-circuit television (CCTV) is used by many authorities for successful traffic management and is a vital element of the toolkit. Cities, mega-cities, and other highways transport authorities are currently having to wrestle with the migration from analog to an IP-based (also labeled digital) approach while maintaining their operational ability every second of every day. Some of the challenges they face and the benefits derived are similar to any analog-to-digital migration; others are unique to the traffic management and control room environment.

Simulation Systems has many years of experience in dealing with these issues, most recently when designing, implementing, and deploying its OpenStream digital CCTV system for Transport for London (TfL) as part of its CCTV analog-to-digital migration.

The migration to digital offers challenges to the ITS sector

Migration and testing

Older analog systems can often have evolved over many years into complicated arrangements, not all of which may have been captured in documentation or drawings. An intelligent and well-thought-out migration plan with a number of clearly understood, detailed steps is critical to project success and should be 'baked in' to all aspects, from design to implementation and installation. All stakeholders should be involved, from contractors and clients to maintainers. Testing at stages throughout the project with as much 'real' equipment as possible is also crucial to avoid problems on site and delays in implementation.

Number of users

One of the key differences between large traffic management systems and other CCTV systems (e.g. casino or retail) is the number of users. Systems for government authorities responsible for cities or large highway areas can often require hundreds of users to be able to concurrently access the system – all of whom may wish to view the same camera at the same time following an incident. This has a very big impact on the way in which video is delivered over the IP network and should be factored into design decisions on the particular type of multicast delivery used. In addition, the encoders or digital cameras used on the system may impose limits to the number of client requests even if they are multicasting, which should be identified and overcome.

With large numbers of users also comes issues relating to access control. A digital system should enable easy addition and modification of users through an administrative interface and the capability to control what the users have access to do on which cameras. It might be necessary, for example, that a certain set of users can view some cameras but not control them or record them. Similarly, it could be required that there is a need to temporarily bar access to a camera for a certain user or set of users. The way this has been overcome in Simulation Systems' OpenStream digital system is to enable cameras to be grouped into one or more groups, and similarly users to be grouped into one or more user groups. Relationships can then be made between camera groups and user groups.

Need to know?

It pays to take some expert advice on the CCTV digital migration journey for traffic management

- The need for a well defined migration plan is important to ensuring a smooth transition to digital
- How many users a system has – and precisely what they need access to – is a key consideration
- Operator training can be eased by employing some key techniques
- Vendor lock-in should be discouraged in favor of an open approach

New user interfaces

Training operators to use a new system is a challenge but it can be resolved by employing some key techniques. By integrating concepts that people are

familiar with from their use of everyday ICT, the transition to a new system can be made more easily. For the TfL project, Simulation Systems used a couple of techniques to achieve this. Finding cameras on large systems is an issue so the company developed an 'omni bar' search facility, familiar to anyone who has used a web browser or search engine. As the user types in characters, camera records that match these characters are displayed in a filtered list – camera numbers, descriptions, names or geographical information. Another technique used was to integrate a GIS system that could be navigated quickly and in a similar manner to the mapping systems people are currently used to. Finally, a 'virtual joystick' was implemented, which users could operate with the mouse and key presses. Although a physical joystick was also provided, users are increasingly operating the application with just the keyboard and mouse – as with any other ICT application.

Combined with these new ICT- based approaches, the company also ensured that operations that had always been used in the past (such as typing in the camera number) were still supported. These techniques all helped a smooth transition for users operating the new system and greatly reduced training time.

(Above) **GUI complete with virtual joystick** (Right) **The omni-bar search facility**

Maintenance

A digital system is significantly different to an analog one and requires very different skills for maintaining it, server administration and networking. In addition, IP skills are often needed for fault finding. For a period of time during migration, both sets of skills will be required to maintain the system. There are many benefits to an IP-based system and these should be taken advantage of during the maintenance period. Traditionally the addition of cameras or new user positions was an activity only a contractor could carry out. With a digital system, the administrative interface should enable this to happen as a day-to-day maintenance activity. With this in mind, significant development has been put into ensuring that the administrative interface in the OpenStream system is able to be used to carry out any maintenance activity required.

Camera sharing

Sharing between CCTV systems occurs in the UK through TfL's television network protocol (TVNP) and also the Highways Agency's video information highway (VIH). This has enabled systems from different manufacturers to allow sharing of their cameras to each other's operators, creating major benefits. This has been completed successfully for many years and needs to be considered as part of the transition to digital where either protocol is in use. Currently, when sharing cameras the video is always shared via an analog link. This therefore requires digital video to be decoded when being exported to the other CCTV system, and analog video to be encoded when being received from the remote system. The OpenStream system implements both TVNP and VIH protocols and utilizes 'intelligent display devices' to perform the decoding into analog video for enabling sharing.

Vendor lock-in

Moving to a digital platform should result in more choice in the number of types of camera outstation or encoder that can be used. Encoders will often be placed in front of legacy analog cameras before new IP cameras are rolled out. Increasingly, it is being recognized by outstation manufacturers that it should be possible to integrate them with any different instation. The ONVIF and PSIA standards promoting RTSP/RTP have greatly helped in this regard, but problems of interoperability still exist and need to be verified and tested beforehand.

The increasing use of global standards should ensure in the future that plug and play of any encoder or camera into any system is a reality, but interoperability should never be assumed. Simulation Systems has embraced an open approach since the inception of its CCTV systems and is keen to implement global standards and utilize open source software wherever possible.

Despite the challenges listed above, these should not take away from the major benefits of moving to a digital approach. The flexibility it provides in terms of only requiring a network connection to provide an operator position should not be underestimated. This connection could be wired, wireless, or even based on mobile communications. Combining this with an ICT approach to ensure the configuration of the system can be changed quickly and safely means the CCTV system can be used and accessed much more easily and reliably. The transition to digital also enables future developments such as HD video to become viable at a suitable stage and removes obsolescence concerns around older equipment and communications lines.

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The new generation of electronic toll collection

First introduced in Norway in the mid-1980s, electronic toll collection (ETC) has since been adopted and implemented in many countries around the globe. ETC brings many benefits, including vehicle free-flow, reduced traffic congestion, a decrease in harmful emissions, and lower vehicle operating costs to name just a few. Traditionally, an ETC installation consists of three gantries, two featuring a set of cameras that respectively capture front and rear images of vehicle license plates (plus one for vehicle classification) and radio system equipment to collect electronic toll fees of vehicles equipped with onboard transponders.

The next generation

Q-Free has developed an ETC installation based on a single gantry, which relies on the latest machine imaging systems, radio systems, and automatic license plate recognition (ALPR) software technologies to collect toll data. This versatile system is designed to perform pure video tolling or a combination of video and radio tolling, depending on the needs of the authority where it's installed.

Q-Free's single gantry currently features two Prosilica GX1920 digital cameras from Allied Vision Technologies (AVT) per lane and on both sides of the gantry to capture high-quality images of a vehicle's front and rear license plates. In addition, the single gantry also features two AVT Manta G-125B monochrome cameras per lane. These cameras are used to track each individual vehicle as they enter and leave the detection zone around the gantry, and when a lane change occurs. Accurate vehicle tracking ensures that front and rear pictures of vehicles' license plates are reliably captured in all lighting and weather conditions, as well as in situations ranging from urban environments to multi-lane free-flow highway infrastructures. It is this combination of accurate vehicle tracking and the machine vision cameras' superior image quality output that guarantees a high ALPR accuracy rate.

The single-gantry solution uses the latest imaging systems for ALPR

The gantry also features DSRC units to electronically collect fees from vehicles equipped with transponders, a Sick LMS500 3D laser to classify vehicles (i.e. passenger or commercial), and Q-Free's Intrada ALPR software for automatically reading the registration numbers from the pictures. The ALPR data is then processed by an operational back-office for fee charging and subsequent billing by the local authorities based on each vehicle's road usage and the tariff in charge. The video tracking ability is used to reliably integrate the input for all these sensors into single transactions.

Multiple benefits realized

A single gantry offers many benefits including a reduced need for infrastructure, civil work, physical space, and maintenance. It is linked to the operational base via an Ethernet network and can

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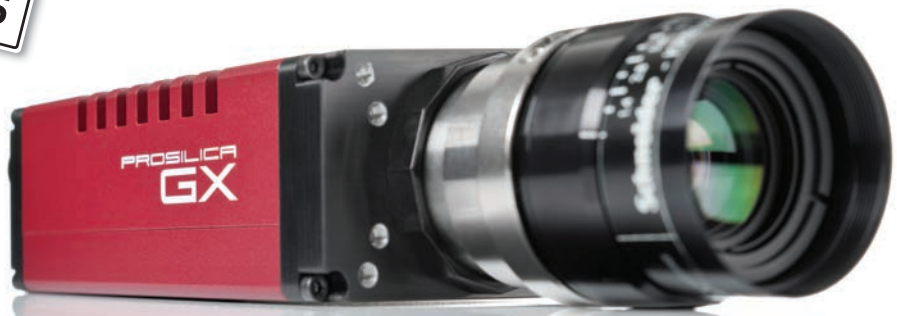

Q-Free's solution uses two Prosilica GX1920 cameras per lane

Need to know?

The benefits being brought to ETC systems via the use of machine vision cameras

- Because ETC relies on license plate recognition and vehicle classification, the choice of camera is critical
- Machine vision cameras offer high levels of image accuracy with lower operating costs
- Such cameras also enable single-gantry solutions to be deployed for video tolling – an attractive proposition for toll road operators

Two Manta G-125B monochrome cameras per lane are deployed

be remotely serviced and configured by operators.

Video tolling: lower operating costs

Q-Free's single gantry can be operated in pure video tolling mode as identification performance is extremely high. Video tolling is commonly used in 'closed zones' (motorways, city centers, bridges, etc) and continues to gain popularity in many areas where vehicle registry is good. Video tolling technology has vastly improved in the past few years as a result of high-performance machine vision cameras which – when combined with infrared flash – can handle vehicle speeds of up to 250km/h and volumes of more than 2,500 vehicles per lane per hour in a multi-lane, free-flow environment. The Prosilica GX1920 used in Q-Free's single gantry is a 2.82 megapixel camera with high-definition resolution. The GX1920 features the Sony ICX674 EXview HAD CCD II sensor that provides high-sensitivity and near-IR performance, making it ideal for night-time imaging using an IR light source, minimizing shutter times, and producing sharp, high-quality images with excellent dynamic range in all weather conditions. The Manta G-125B/C, used for tracking, is a versatile 1.2 megapixel GigE Vision camera featuring the Sony ICX445 EXview HAD CCD sensor, which provides high sensitivity and high image quality.

Machine vision cameras offer many benefits for tolling and outdoor imaging applications due to a wide array of advanced features. These include low-latency trigger for timely image capture when vehicles enter the detection zone, flexible exposure, gain and binning modes to adapt to any outdoor lighting conditions, and digital shutter. They also benefit from high sensitivity to minimize motion blur and image distortion, as well as configurable I/O to synchronize the image-capture process with traffic system peripherals such as IR lights, ground loops, radar or laser triggers.

Free-flow for safer roads

Q-Free's single gantry can be used in all segments of the road user charging market, including road tolling, congestion charging, and truck tolling. But high-performance machine vision cameras take video tolling to the next level.

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Rethinking temporary traffic measurement

READER ENQUIRY NO. 516

With new technology and existing cellular infrastructure there is no longer the need for costly and unsafe manual labor on the roads for collecting temporary traffic data.

Traditional methods such as pneumatic tubes, ambulating loops, radar, and manual surveys have long been the only way to collect traffic data from temporary measurement points. In recent years, however, advances in sensor technology, wireless communication, and cellular infrastructure have brought a whole new way of thinking about traffic data

collection from temporary measurement points.

A new type of vehicle detector, STMS WD-300, developed by the Swedish company Sensebit is pioneering this new approach. The sensor is installed in the road in less than 15 minutes and requires no roadside infrastructure. It connects directly to the internet via the existing cellular network and is powered via an internal battery for up to 10 years, during which the user can schedule measurements via a simple web interface from the office. By reducing the number of visits to each measurement location to one, the potential savings for users are substantial.

By using the latest in energy-efficient passive sensor technology combined with advanced neural-network data processing, the sensor delivers speed and classification for each vehicle that compares to the most advanced inductive loops and pneumatic tubes.

Quick and easy deployment, measurement initiation from the office and accurate per-vehicle data allows end users to focus on analyzing and utilizing traffic data rather than collecting it.

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Reducing speed to save lives

READER ENQUIRY NO. 517

Sensys Traffic's advanced automatic monitoring systems help to reduce average speeds on the roads and minimize the number of red-light offenses. These are just two examples of how the company's products contribute to reducing the number of fatal accidents and serious injuries on the roads. These systems also indirectly assist with the reduction of traffic-related noise and COx/NOx emissions.

At the heart of all Sensys systems is the RS240 multi-target tracking radar series. This features the functionality to allow versatile use in the following applications: speed enforcement; red-light monitoring and enforcement; and video monitoring.

The multi-target tracking functionality enables extremely accurate measurement of each vehicle's location and speed – in all environmental and traffic conditions. Due to its unique dual-algorithm speed

measurement capability, the RS240 series systems provide a high level of legal security.

The robust and cost-efficient RS240 series includes the well-proven RS240 radar along with the RS242 radar, which features Sensys' '4D technology', tailored for the most complex and demanding operating conditions. This 4D technology approach means having the ability to measure speed, distance, lane identification, and vehicle class.

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Sustainable solutions

READER ENQUIRY NO. 518

In all mobility projects, human behavior plays a key role. The interplay between human behavior and the transport system helps us obtain a picture of traffic problems, as well as presenting potential solutions. Scarcity of physical infrastructure and increasing availability of digital information lead to new mobility and networking concepts such as the New World of Work and the hub.

Specialist knowledge of environmental impact, sustainable transport modes and systems, and safe road design is needed to plan traffic hubs. This knowledge can also be used for the design and management of installations for tunnels, bridges and motorways, so that innovative functional designs, masterplans and clear tender documents can then be

turned into successful contracts and realization of projects.

As one of Europe's prime project management, engineering and consultancy service providers, Royal HaskoningDHV takes an inventive approach to traffic and transport questions, with key aspects being that the company helps think things through, bring parties together, and make knowledge available, to bring smart and sustainable mobility solutions in reach.

The company's customers come from the public and private/industrial sectors. It provides them support in the development, management, and commercial operation of their assets. The company is prepared to take on risk-bearing responsibility, letting it achieve the best results for its customers. Its knowledge and experience enable it to shoulder the customers' worries in full.

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How will the advent of the Connected Vehicle transform the landscape of road weather management?

"Forecast verification has always been a challenge for the winter maintenance community. New spatial forecasting technologies such as MDSS and route-based forecasting have only exacerbated the challenge. How can you verify a forecast at thousands of sites around the road network? It's impossible with the current paradigm of site-specific weather outstations with limited spatial coverage and thermal mapping with limited temporal coverage. The connected vehicle could be the answer. The high-resolution data available would enable verification on a scale previously impossible. But there's debate in the sector that such data could be utilized for assimilation in forecast models (e.g. for nowcasting), although this is where considerable caution needs to be exercised. On-vehicle instrumentation is far below the standard available at dedicated outstations sites. Onboard sensors are cheap and will suffer from a lack of ongoing maintenance and calibration, resulting in big data quality question marks. As such, the connected vehicle is probably a temporary fix on our journey toward a new generation of sensor networks for road weather."

Dr Lee Chapman
senior lecturer in Applied Climatology and secretary of SIRWEC, University of Birmingham, UK

"The Connected Vehicle program will be a milestone in the evolution of road weather as well as the entire transportation industry. We've made great strides over the years in making our roads and vehicles safer but the driver is still the one piece of the puzzle with the most room for improvement. The use of in-vehicle communications will provide valuable data that will ultimately be useful information to help drivers make better and safer decisions behind the wheel – yet will also be directly beneficial to agencies in managing road weather conditions. Windshield wiper status, for example, can aid in detection of precipitation, while the measurement of roadway friction can be improved through communicating with ABS or vehicle accelerometers. These many measurements give us a 'scatter' of values when measuring many different locations and times, representing the natural variability of a measured parameter."

Chris Albrecht
researcher and program manager of the Aurora Program, Iowa State University, USA

"Connected Vehicle technology will likely have an impact on road weather management, but the outcome is still very much in question. There are two basic schools of thought: use equipment already on vehicles (such as temperature sensors, traction control, and windshield wipers); or place new sensors on the vehicle to monitor road weather conditions. Using existing sensors will be the easiest and most cost-effective solution but will the information provide any real value? It is possible it will be enough for the general public but perhaps not for the road weather management decision maker. Windshield wipers 'on', for example, doesn't tell you what's causing them to be on. Placing sensors on personal vehicles presents its own set of challenges, including cost and who will maintain them. If these challenges are not met, the solution might be to equip government and fleet vehicles with weather sensors."

Jon Tarleton
Vaisala road and rail marketing manager, USA

"Coverage will expand and providers will be able to mature and deepen the data sets that identify the hazards to inform drivers. Fixed site and mobile platform data will amalgamate into total data sets. And satellite or cellular delivered data to the vehicle will become commonplace in a few years. Do drivers visualize it on their dashboard ('hands free', of course), or get an audible message that says there's a hazard identified, coming up in three miles ('reduce speed, please')? Technology companies will answer those questions by the products they bring to the market to communicate this information to the driver. As the 'vehicle-to-vehicle' technology also matures, information can be communicated to other nearby and passing vehicles. But the current state of weather observations taken from vehicles is dependent on third-party instrumentation for accuracy. This will likely be the case for years to come because auto manufacturers' instrumentation for temperature and pressure tend to be coarse in resolution, or subject to frequent irregularities. Only time will tell if the car is equipped at the time of manufacture with instruments of quality to make and provide valuable weather information to the traveling public."

Paul Heppner
program manager, Global Science & Technology Inc, USA

Readers are invited to answer the Burning Question for the January 2013 issue:

What are the biggest challenges facing the ITS industry over the course of the next 12 months?

email answers to:
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