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tolltrans

2018

PAY PER MILE IN THE UK

Steven Norris on the pressing need for road user charging

S.O.S. COMMS

Pennsylvania Turnpike has a new way to contact drivers in an emergency

MAGIC MONEY?

The plus points – and pitfalls – of using P3 funding to build toll roads

TURNPIKE TROOPERS

How toll roads must work closely with the police

EXCLUSIVE INTERVIEW

'FEWER CARS, PLEASE'

Georgia's **Chris Tomlinson** is the toll road director aiming for *less* traffic on his road

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FOREWORD

Reassuringly in our smart-device-dominated world, there's still nothing quite as rewarding, or enlightening, as talking to another human, face-to-face. This simple fact goes a long way to explaining the enduring popularity of industry gatherings, expos and conferences. Industry events are great places not only to exchange ideas, but also to get new perspectives on perennial problems. These new perspectives and theories only become fully refined when there's the opportunity to ask questions and debate outcomes with knowledgeable peers.

Two such meetings at industry events led to two related articles you will find in this year's *Tolltrans*. Firstly, back in April 2017, the *Tolltrans* team traveled up the road to attend Traffex at the NEC (National Exhibition Centre) in Birmingham. One familiar face at the event was Steven Norris, former British Member of Parliament and Transport Minister, and now a commissioner at the Independent Transport Commission. He spoke passionately about the need for road user charging (RUC) in the UK. His personal insight into the workings of, and budgetary pressures upon, government make his case for change seem urgent, if not critical (you can read his opinion piece on page 40). However, at a separate event, seven months later – the ITS World Congress in Montreal – Bern Grush put a different perspective on the problem…

I had spoken to Grush, a well-known industry consultant, on the phone before, but had never had the pleasure of meeting him. Our chat over lunch was focused primarily on the future of transportation. One of his particular areas of interest at the moment is the effects of what he likes to term 'robotaxis' on the wider transportation network. One of his major predictions is that these autonomous cabs will ultimately lead to the dismantling of our bus networks as riders opt for privacy over public transit. But, while this may be one of the less-desirable 'unintended consequences' of AVs, another that he flagged might be more beneficial: they will create the ideal opportunity to transition from gas tax to pay-per-mile RUC, as such fees could be easily 'hidden' in the overall fare. His opinion is that we'll never get to RUC in the form that Norris would like to see. You can read his opposing vision of the future on the back page (p72).

When it comes to industry events more specifically focused on tolling, the big one is undoubtedly the IBTTA's Annual Meeting, which took place in Atlanta, Georgia, in September 2017. Here, Mark Compton, chief executive of Pennsylvania Turnpike Commission, picked up the Toll Excellence Technology Award for his road's groundbreaking 511PAConnect system. This new technology harnesses the power of ubiquitous mobile devices to create a method of communicating directly with all drivers on a specific area of the Turnpike, in the event of an emergency. It's already improving customer satisfaction. Read more from Compton on page 34.

The IBTTA meeting was on home turf for our cover star Chris Tomlinson, whose innovative efforts in reducing solo-trips by car and encouraging more commuters to use the bus justly won him the event's Customer Service and Marketing Outreach Award, and the President's Award. Tomlinson's unique position as executive director of both the State Road and Tollway Authority and the Georgia Regional Transportation Authority, means he is well placed to instigate this kind of 'joined-up' thinking and can clearly see the benefits of reducing the number of cars on his road, which might seem counterintuitive to other toll-road operators (read more on page 10). As he puts it, "We're not just in the tolls business or the transit business. We're in the mobility business."

Tom Stone
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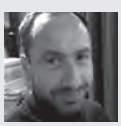

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by James Allen

TOLL NATIONS

A roundup of the biggest tolling-related stories from around the globe in 2017

Radar technology

Major engineering project to include remote traffic microwave sensor units

In 2017, Minnesota-based Image Sensing Systems' (ISS) UK partner Techmiracle Technologies (TT) deployed radar-based equipment to provide incident detection and data collection for the Mersey Gateway six-lane cable toll bridge project.

The system that the company has deployed for the major civil engineering project includes 55 of ISS's remote traffic microwave sensor (RTMS) Sx-300 radar units, TT's RIUD (Radar Interface Unit), data collectors and a purpose-designed instation that was developed with a partner specifically for the project to provide a complete roadside end-to-end solution. For more on this bridge project, don't miss the January 2018 edition of *Traffic Technology International*.

Breaking records

French multinational awarded contract for largest toll station in Mexico

In 2017, Electronics company Thales was awarded a contract to deploy a high-tech multilane tolling system at San Martín Texmelucan on Mexican Federal Highway 150D linking Mexico City to Puebla, 80 miles (130km) southeast of the federal capital.

The highway is currently being upgraded, and the San Martín toll station will ultimately include 38 lanes equipped by Thales. It will become the largest toll station in the country, surpassing the Tepotzotlan station, which currently has 24 lanes and was also equipped by Thales.

Testing relationship

Bridge trial marks the first step toward adoption of AET

In November 2017, the Florida Department of Transportation (FDOT), Florida's Turnpike Enterprise and Florida Polytechnic University (FPU), held a groundbreaking ceremony to mark the start of construction of SunTrax, a high-tech automotive test facility.

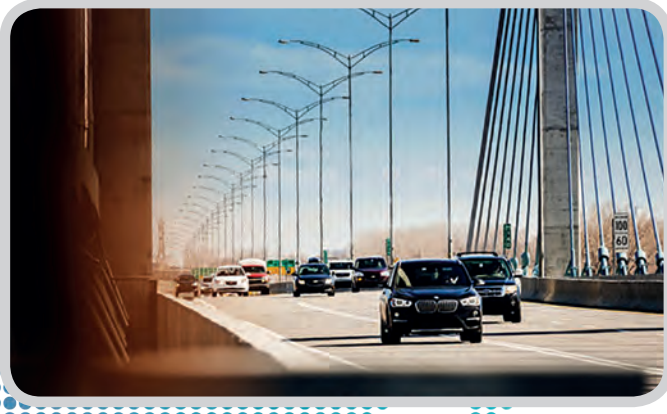
The project's initial phase focuses on an innovative toll testing facility expected to offer certification for tolling technologies. The 2.25-mile (3.6km) oval track has been designed to support high-speed testing of toll technologies with multiple lanes and parallel tolled express lanes, similar to those being constructed in the state and across the USA.

Electronic upgrade

All-electronic tolling system completed on Montreal highway

In October, Emovis completed the end-to-end upgrade of Concession A25's all-electronic tolling (AET) system, which operates on a strategic highway corridor in the Montreal metropolitan area of Canada.

The tolling system on Canada's A25 operates on the Olivier Charbonneau Bridge and uses an RFID transponder, with video-based tolling for vehicles without a toll tag.



African adventure

Austrian tolling operator awarded Zambian traffic management contract

In September, Kapsch TrafficCom won a national concession contract to improve road safety and traffic management in the Republic of Zambia.

This scope of service will be realized step-by-step during a ramp-up phase as part of a 17-year contract, which has come into force with immediate effect. Revenues in the first three years of operation are projected to be in the range of €90-110m (US$108-132m).

Three times a reader

North Carolina implements first US triple protocol technology

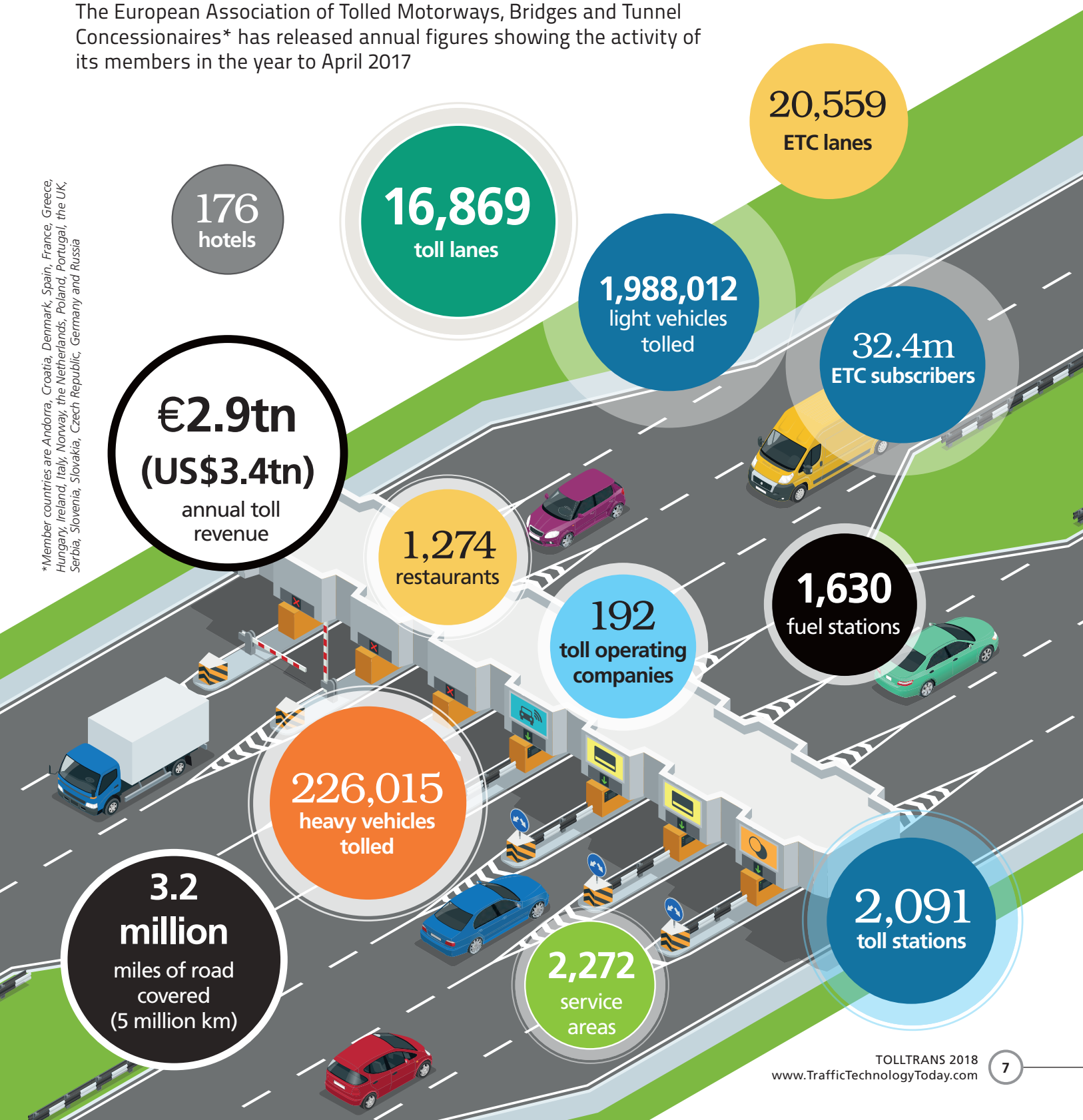
In August, the North Carolina Turnpike Authority became the first US agency to implement the equipment needed to read all three of the tolling transponder technologies being considered for national interoperability.

There are at present three tolled turnpikes in the state – the Triangle Expressway around Raleigh, the I-77 Express Lanes near Charlotte, and the Monroe Expressway. Other tolling systems that have been approved by local planning authorities and are in development include I-485 Express Lanes around Charlotte, the Complete 540 project around Raleigh, and the Mid-Currituck Bridge.

TOLLINGEUROPE

HOW EUROPE CHARGES FOR ROAD USE

The European Association of Tolled Motorways, Bridges and Tunnel Concessionaires* has released annual figures showing the activity of its members in the year to April 2017



*Member countries are Andorra, Croatia, Denmark, Spain, France, Greece, Hungary, Ireland, Italy, Norway, the Netherlands, Poland, Portugal, the UK, Serbia, Slovenia, Slovakia, Czech Republic, Germany and Russia

By James Allen

Electronic tolling on the new Mersey Gateway Bridge relies on dedicated communication bandwidth

EXCLUSIVESPACE

SHOULD TOLLING BANDWIDTHS BE SHARED?

Road tolling operators could struggle to carry out their duties if a reserved bandwidth is opened up to the public, warns ITS (UK)

Broadband transmissions reserved for road tolling in the UK could be opened up for wider use, under plans being considered by industry regulator Ofcom.

A consultation on whether to enable the Broadband Fixed Wireless Access (BFWA) protocol to use part of the 5.8GHz band was brought to a close by the communications regulator in autumn 2017.

The 5.8GHz spectrum is a popular BFWA band, with around 12,000 locations currently registered under Ofcom's light licensing scheme.

An Ofcom spokesman said, "Currently, BFWA can use frequencies across the 5.8GHz band except for a 20MHz frequency 'notch' between 5,795MHz and 5,815MHz, which is used for road tolling systems; however, road tolling makes light use of these frequencies in the UK.

"We have reviewed this arrangement and think that the notch is no longer a proportionate approach to managing coexistence in these frequencies. We are therefore proposing to remove this restriction and to allow BFWA to access these frequencies."

The Dartford Crossing toll bridge could be adversely affected by opening up the 5.8GHz bandwidth to the public

20MHz

Breadth of frequency reserved specifically for road tolling in the UK (5,795-5,815MHz)

VOICES AGAINST

The proposal has been met with concern by ITS (UK), which is asking Ofcom to approach such a decision with caution.

Compiling views put forward by its members, the organization fears that potential interference with the 5.8GHz spectrum would cause problems for toll road operators using dedicated short-range communication.

The ITS (UK) response said, "The RTTT [Road Transport and Traffic Telematics] transaction with a car passing under the gantry takes around 30ms, which includes the interchange of several messages, so any interference at that time would be disastrous, with no opportunity for a second attempt, because the vehicle would by then be out of range, or at least out of the beam pattern."

PUBLIC DEMAND?

BFWA allows for longer-range broadband transmissions and Ofcom is keen to explore ways of improving internet speeds for the general public.

The Ofcom spokesman added, "High-quality broadband is fundamental to the way people live and work. In the past few years, broadband speeds in much of the UK have increased dramatically. However, there are still areas where decent broadband speeds are not yet available to all.

"One important way of delivering broadband to consumers and businesses in difficult-to-reach areas is BFWA. We have identified an opportunity to increase the spectrum available for its use in this band, which should enable faster speeds for consumers and businesses receiving broadband in this way."

The consultation has now closed and Ofcom is currently considering its next move, following the responses received. A decision is expected imminently.

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by Jack Roper

GEORGIA ON MY MIND

TRANSIT MEETS TOLLING IN ATLANTA

Running a successful toll road isn't always about maximizing the number of vehicles paying to use the facility. Sometimes less is more, as Chris Tomlinson, executive director of the State Road and Tollway Authority, explains

Atlanta, Georgia rose phoenix-like from the ashes of the Civil War and has blossomed into the vast and vibrant metropolis that is today a major transportation hub for the southeastern United States. Birthplace to Martin Luther King, Atlanta hosted the 1996 Olympics and its airport – Hartsfield-Jackson – is the busiest on the planet. With a robust regional economy, the city's population now stands at 5.8 million, with 2.5 million more arrivals expected by 2040. Atlanta is the great, beating heart of Georgia, but its road network is congested and the strain on its arteries seems certain to grow more chronic, with commuting already an arduous labor.

It is the business of Chris Tomlinson, executive director of the State Road and Tollway Authority (SRTA), to face Atlanta's traffic challenges and he sees tolling as part of a broad-brush solution defined by notions of mobility. His manner is generous and open. "We can start with your questions," he says, "and go wherever the conversation takes us." It will be a free-flowing discussion with no topic off-limits, corresponding to the free-flowing traffic he works to achieve and his readiness to explore unexpected avenues to achieving it. Tomlinson is executive director of both the SRTA and the Georgia Regional Transportation Authority (GRTA), a merging of roles which reflects his philosophy. "We're not just in the tolls business or the transit business," he explains. "We're in the mobility business.

Above: **Tomlinson in front of one of Georgia's Xpress buses, which now offer toll road credits to commuters who ride on them**

"GRTA provided the Xpress Commuter Bus Service from outlying and suburban communities to our key employment centers. We realized that Xpress Buses using the I-85 Express Lane were among the most consistent in terms of on-time performance. Put more simply, those passengers were getting all the benefits of the toll facility without directly paying the toll." From this insight sprung the Commuter Credits scheme (see *Commuter Credits Explained*, p13), one aim of which was to incentivize bus transit over driving solo, and which earned the President's Award at the recent IBTTA Toll Excellence Awards 2017.

"Rather than looking at highway tolls and transit as separate projects, we see

"WE'RE NOT JUST IN THE TOLLS BUSINESS OR THE TRANSIT BUSINESS. WE'RE IN THE MOBILITY BUSINESS"

"WE WON'T GET RID OF CARS; CARS AREN'T GOING ANYWHERE. WE'RE JUST INCREASING THE CHOICES ON HOW YOU GET AROUND"

Left, right and below: **New, reversible, dynamically priced Express Lanes have been easing congestion on I-75 since January 2017**

a connected ecosystem of transportation tools. Georgia is at the forefront of recognizing this interplay." Less than 2% of vehicles in the I-85 Express Lane are transit vehicles, but these account for 26% of people moving in the lane each morning. Plans are afoot to build on this success by extending the Commuter Credits scheme, as well as locating park-and-rides adjacent to toll facilities. "We won't get rid of cars; cars aren't going anywhere," says Tomlinson. "We're just increasing the choices on how you get around."

FREER FLOWS

Georgia now has over 390,000 Peach Pass accounts and 625,000 vehicles with active transponders. In 2011, the I-85 Express Lanes opened: 16 miles (26km) of high-occupancy toll (HOT) lanes northeast of Atlanta. Running alongside the general-purpose lanes, these offered all Peach Pass vehicles the choice of paying to circumvent congestion, while those carrying three passengers or more used them for free. Following their success, the I-75 South Metro Express Lanes, 12 miles (19km) of reversible toll lanes at the highway median, opened in January 2017. These run northbound into Atlanta to relieve congestion during the morning commute, then southbound in the evening rush hour.

All-electronic tolling (AET) means that Peach Pass drivers merely move into the lane, their transponder is detected, and a toll is charged to their account. Algorithms regulate dynamic pricing: the toll increases as lane demand rises so as to ensure more reliable trip times. "We have some customers who decide, 'I'm not going to pay that price', but others who are willing," says Tomlinson. Although congestion in the Express Lanes is not unknown, human nature dictates that some still use them. "People think, 'Even if I pay the toll I'm only doing 30mph (48km/h), but people in the untolled lanes are doing 20mph (32km/h). I'll willingly pay for that travel speed differential'. They're passing cars and they're willing to pay for that benefit."

On average, Express Lane journey times are more reliable and the model is being extended, with the I-75 Northwest Corridor Project due to open in 2018, providing 30 more miles of reversible toll lanes. "People know they will complete their trip in the expected window. Predictability has a value," says Tomlinson, enthusiastic about the new capacity the Express Lanes provide. "We've essentially built a parallel highway next to the existing lanes. And, let's face it, 'toll' is still sometimes a 'four-letter word' so, if people choose not to pay, we don't reduce their existing travel options; this is purely about adding extra choices."

SOCIAL RESPONSIBILITY

But does this not create a two-tier system, with those who can afford it enjoying fast-track travel, while less affluent drivers endure the usual delays? Tomlinson has thought about this and is ready to counter. "I don't buy that premise," he answers. "Even on the I-85, the average toll is around US$4; it's cheaper than a Starbucks coffee. Your average vehicle is not high-end; there are Hondas, there are Toyotas. People are using these lanes occasionally, when their time is of more value. And our unique blend means public transit customers can utilize these facilities without paying the toll, just the bus

"YOU CAN'T FORGET ABOUT THE MONEY… WE'RE A TOLL OPERATOR, A TRANSIT OPERATOR – AND A TRANSPORTATION FINANCING ARM "

fare." He points also to a holistic approach that is not merely punitive. "Some people will view dynamic pricing as a 'stick', if you will. But the whole purpose behind the Commuter Credits is to come up with some carrots, some positive ways to incentivize behavior."

THE ROAD TO TOLLING

Tomlinson began his career as an attorney, entered state government in 1998, and worked in agencies connected with transportation, technology and finance – this threefold experience forming the proper training for his current role. "You can't ever forget about the money," he says. "And that's the third leg. We're a toll operator, a transit

COMMUTER CREDITS EXPLAINED

At the IBTTA Toll Excellence Awards in September 2017, the SRTA received both the Customer Service and Marketing Outreach Award and the President's Award, for its innovative Commuter Credits program, a pilot promoting alternatives to solo travel during peak periods on Atlanta's I-85. It also secured an Innovation Award from the American Public Transportation Association.

This three-pronged Commuter Credits scheme used a partnership between SRTA's existing Peach Pass electronic tolling system and the Express Lanes commuter bus network to incentivize traffic-reducing choices. The first element was Shift Commute, which offered selected Peach Pass customers US$3 per week in toll credits for reducing their number of peak period Express Lane commutes. The second element – Start a Carpool – offered US$3 per day to Peach Pass customers who organized a carpool. Ride Transit – the third element – offered toll credits to customers opting to ride on buses rather than drive during peak periods. Shift Commute was offered to 243 Peach Pass customers and saw around 500 commutes translated to an alternative time or mode. Ride Transit involved 210 participants and converted some 4,500 solo car trips into bus rides.

"The pilot tested if there was an appetite to consider changing travel behavior, given some incentive," says Chris Tomlinson. "It enabled people to experience the advantages of alternative commuting, while still reaping the benefits of Georgia's tolled Express Lanes and helped us forecast the financial needs of supporting such a program."

Now, the project enters a new phase: Commuter Credits 2.0. "As a result of the pilot's success, our goal is to put in place a wider program, which could be available in conjunction with the opening of the I-75 Northwest Corridor Project," says Tomlinson. "We're going to work with the Metropolitan Atlanta Rapid Transit Authority so that, if someone earns Credits, they can use them not just for tolls, but for other transit products."

Chris Tomlinson and his team pick up their IBTTA Toll Excellence Award

operator – and a transportation financing arm for the state. We're involved in all transportation P3 projects and financing flows through us."

The SRTA runs the Georgia Transportation Infrastructure Bank, a funding pool for state-wide infrastructure projects that seeks to reward innovation. Recently this has involved building roundabouts, whose benefits are widely accepted in Europe, instead of conventional interchanges.

Indeed, Tomlinson is keen to harness European thinking to shape future tolling and mobility. "I think Europe is ahead of the USA in the concept of Mobility-as-a-Service (Maas)," he says. "I foresee a future where you can go through one app to plan – and I like the term – your journey. We talk about transit trips or toll trips, but in reality people are trying to get from one doorway to another. I see us getting to the point where you can plan your trip and pay for tolls, or transit, or parking, all from the same account. The toll industry's account-based approach could form the basis for such payments. We're focused on that and recognize that's where the industry is going. It doesn't impact projects currently in the pipeline, other than making sure we future-proof our technological decisions."

OPEN TO THE FUTURE

The use of 6C technology in AET facilities has driven down the cost of transponders, since 6C chips are produced in their billions for asset tracking in the logistics and retail sectors, and because 6C is an open standard, allowing competition from multiple manufacturers to spur aggressive pricing. Tomlinson sees adopting open standards as the key to technological future-proofing. "We're procuring a new tolling back office," he says, "and it is a requirement that the data is in a non-proprietary format so we can share it with other agencies and third parties, bringing the most value to the end user and making us flexible as new technologies come along."

"WE'RE PROCURING A NEW TOLLING BACK OFFICE. IT IS A REQUIREMENT THAT THE DATA IS IN A NON-PROPRIETARY FORMAT SO WE CAN SHARE IT WITH OTHER AGENCIES"

Chris Tomlinson is a busy man, his time divided between working internally on current initiatives, liaising with external partners, and day-to-day operational issues. "Toll facilities are open 365 days per year and it's inevitable that there are operational issues," he says. "Most recently, we dealt with a fire that led to a bridge collapse and that impacted on everything from toll rates to re-routing of the transit service."

Communication with external stakeholders is important, too, in terms of innovation. "We have to ensure we slow down to explain what we're trying to do and the benefits versus the risks of doing something novel," says Tomlinson. But what part of his job does he enjoy the most?

"It's the real world and the positive impact our work has on the everyday lives of Georgians. Myself and my staff live here and, in getting to work or getting home to see our families, we have to deal with Atlanta's traffic. The projects we build provide safer, quicker, more reliable ways to do that. It's very tangible. And I work with a really great team, focused on innovative ways to address the age-old problem of congestion. That's a fun space to work in."

Below: All-electronic tolling gantries in Georgia help keep traffic flowing freely

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by David W Smith

MAGIC MONEY

DOES P3 FUNDING REALLY WORK?

Getting private companies to build roads by promising a healthy return from tolls sounds like an ideal way to sidestep the public funding crisis. But are such schemes too good to be true?

The crumbling transportation infrastructure in the USA has left cash-strapped DOTs increasingly turning to P3s (public-private partnerships) as a funding 'solution', but each produces fresh political controversy. Supporters make utopian claims about P3s saving taxpayer money and providing additional DOT revenue. Critics say this is too good to be true. Byzantine contractual agreements favor avaricious investors, they say, and naïve DOTs end up being forced to increase taxes to fund the projects, anyway.

Maryland is the latest US state to embrace the P3 idea, recently announcing an ambitious US$9bn proposal to widen three of its most congested highways, the Capital Beltway, Interstate 270 and the Baltimore-Washington Parkway. While still sketchy, the plans have created a stir. At 394 new lane-miles (634km), this will be the largest express toll lane (ETL) plan in US history, the largest ever P3 for highways – and the ultimate test of the P3 idea.

Maryland Governor Larry Hogan has made bold statements about generating "billions of dollars" of extra state revenue without charging tax payers a cent. But political opponents have dismissed his predictions as pie-in-the-sky.

Pete K Rahn, Maryland Secretary of Transportation, says P3 financing is the only way to raise the sums required to address chronic congestion around Washington DC. Not even LA's clogged arteries are quite as horrendous and, with an extra 1.6 million people predicted to move into the area over the next 15 years, it will get even worse. "Without P3 all we can do is study the problem, but we can't find solutions. It's a case of 'toll road, or no road'," says Rahn.

US$9BN

The P3 funding target recently announced for highways in Maryland – the largest ever in US road-building history

MARYLAND'S ROAD TO P3

While popular in other countries, P3s didn't appear in US transportation until the early 1990s. They have become more popular of late, however, and Maryland's venture was influenced by successful P3s in neighboring Northern Virginia, where the state has added high-occupancy toll lanes on the Beltway and Interstate 95, with plans for more on Interstate 66. "Virginia was the first to create ETLs in our region and their success is a big incentive. We've

"WITHOUT P3 ALL WE CAN DO IS STUDY THE PROBLEM, BUT WE CAN'T FIND SOLUTIONS. IT'S A CASE OF 'TOLL ROAD, OR NO ROAD'"

Pete K Rahn, Maryland Secretary of Transportation

watched their progress with contracting methods closely, comparing it to some of the older P3s. Texas and California have also used P3s successfully, so we don't consider them 'experimental' in any way," Rahn says.

As yet, there is scant detail on Maryland's new P3s. There is no timescale and it could take 18 months to select partners. What is known is there will be two toll lanes each way on I-495 (the Capital Beltway) and on I-270, which links the Beltway with suburban Frederick. The private developer will design, build, finance, operate and maintain the new lanes. The plan is that the revenue created from the Beltway and I-270 will help cover the cost of upgrading and widening the B-W Parkway, which the Maryland Transportation Authority will run.

OPPOSITION VOICES

Political opponents have voiced objections, including the high cost for drivers, pointing out that in rush hour, it can cost US$34 to travel Virginia's 11.6-mile (18.7km) I-495 Express Lanes, one of the highest tolls in the USA. They expect Maryland's profit-driven private contractor to follow a similar model.

Despite high tolls, drivers will have a choice, as free lanes will remain, says Prof. Jonathan Gifford, director of the Center for Transportation Public-Private Partnership Policy at George Mason University. "If you're getting kids from day care, where every minute incurs penalties, paying a few dollars in tolls makes sense. You may hate to pay it, but you will if you need to," he says.

WHEN P3 GOES BAD…

One P3 project that didn't go according to plan was Indiana's proposed 21-mile (34km) extension of I-69, from Bloomington to Martinsville.

The P3 proposals had received influential backing from US Vice President Mike Pence in 2014, when he was the governor of the state.

According to *The Wall Street Journal*, the project is already two years behind schedule and only 60% built.

It also reported that the prolonged construction time has increased the number of traffic accidents and lengthened commute times.

It has gone so disastrously wrong that the state of Indiana is taking back control from the private partner. Even vocal supporters of P3s have condemned it.

Robert Poole, of the libertarian Reason Foundation, described it as "one of the worst failures that I've seen in the state-level P3s".

A spokesperson for Indiana's new governor, Eric Holcomb, told *The Wall Street Journal* in August that "it became clear that the only way to ensure completion in a reasonable timeframe would be to put the I-69 project back under the state's control".

The spokesperson added that the state of Indiana would continue to sign P3s in the future.

2 YEARS

The amount of time the P3-funded extension of I-69 is running behind schedule. It is now back under public control

US$1TN

US President Trump's much-publicized infrastructure-spending target. P3 was initially key to this. He might be having a rethink…

Gifford dismisses another common objection to ETLs, that they become 'Lexus Lanes' for the wealthy. He points to research from Georgia Tech University that tested the nickname by looking at car models on Atlanta's I-85 express lanes. "The top four were the same in free and pay lanes – Honda Civic, Honda Accord, Toyota Camry and Ford F-150. These are not luxury cars so the 'Lexus Lane' claim is being used unfairly by political opponents. Research also shows free lane traffic benefits from toll lanes," he says.

Another common objection to Maryland's P3 proposals is that toll roads will create 'induced congestion' by encouraging drivers to use them. Secretary Rahn disagrees. "Right now, people go through residential streets using the Waze app to dodge traffic. ETLs will encourage them to drive on the roads they should be on," he says. Rahn is similarly dismissive of the environmental argument that more money should be spent on public transport. "We are building the Purple Line light-rail transit system that arches over DC. So we believe in public solutions. But our roads are so bad that we need whatever alternatives are out there", he says.

Maryland's biggest political flashpoint is over the potential impact of ETLs on suburbs. Democrat Senator Richard S Madaleno Jr says it's impossible to fit four more lanes from Silver Spring to Bethesda without "enormous dislocation of homes and parks". Secretary Rahn makes no guarantees at this stage, but says this is a major concern and Maryland has asked for "innovative projects" that avoid adverse impacts to adjoining neighborhoods.

WHERE'S THE MONEY?

The financial arguments about P3s are complex. Gifford, broadly a supporter of P3s, says the crucial element is managing risk. "The whole idea of P3s is, who is taking the risk? The government can borrow money and contract someone to build the facility, but they are taking all the risk of design and construction and if there are cost

TRUMPONOMICS

President Donald Trump was a strong supporter of P3s during the 2016 presidential campaign and touted them as a way to finance his US$1tn infrastructure spending program. But the US media has reported a change of heart.

On September 26, Trump told a group of law makers that P3s are "more trouble than they're worth", according to *The Wall Street Journal*. *The Washington Post* speculated that Trump's shift of opinion could see a move toward increased direct federal spending on infrastructure. But this is more difficult in the wake of the large tax cuts proposed by the Trump administration earlier in 2017.

To date, there has been no official announcement of a change in direction and the picture is confusing. On the same day that Trump was making his own views known to law makers, his special assistant on infrastructure policy, D J Gribbin, was saying the opposite.

Gribbin, an expert on public-private partnerships, was speaking at the P3 Hub Americas Conference in Washington DC, where he urged supporters of P3s to overcome any opposition, according to the industry newsletter *P3 Bulletin*.

"There has been a knee-jerk reaction to P3s from a liberal perspective in a negative way, and a knee-jerk reaction from conservatives that think P3s are free money," Gribbin said, according to the *P3 Bulletin* report. Gribbin said that both views were wrong and that efforts to re-educate people were required.

"THE GOVERNMENT CAN BORROW MONEY AND CONTRACT SOMEONE TO BUILD THE FACILITY, BUT THEY ARE TAKING ALL THE RISK… A CLEAR CONTRACT FOR A P3 TRANSFERS RISKS TO THE PRIVATE PARTY"

Prof. Jonathan Gifford, director, Center for Transportation Public-Private Partnership Policy, George Mason University

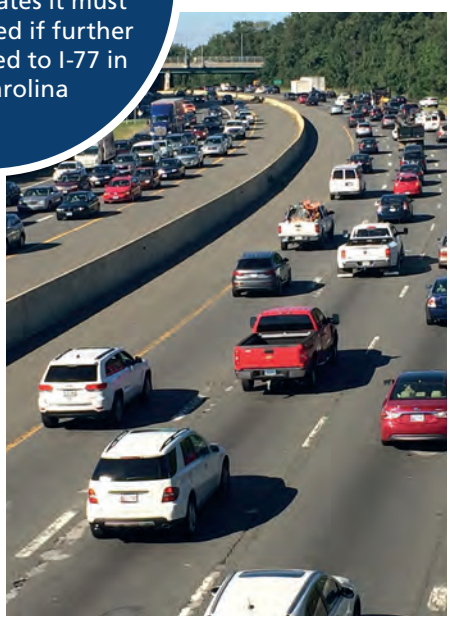
2040

The year until which Cintra's P3 contract states it must be compensated if further lanes are added to I-77 in North Carolina

overruns, or unstated problems, such as the oil price changes, the state is stuck with the costs and may have to raise taxes. A clear contract for a P3 transfers risks to the private party," he says.

Other experts, however, have struck a far more cautionary note. In his report *No Free Bridge,* for the non-profit think-tank Economic Policy Institute, researcher Hunter Blair describes the claim that P3s allow infrastructure to be built for free as "economic snake oil". He says tolls can be an economically efficient way of paying for infrastructure, but without involving the private sector. Instead, governments "…can fund infrastructure with user fees, while financing the project with traditional tax-exempt municipal bonds. In other words, while tolls and user fees are not taxes per se, they are a cost that must be borne".

The problem with involving the private sector is that designing efficient P3 contracts is complex, he says. DOTs must protect the public purse while offering private investors an attractive return on investment. Claims such as Governor Hogan's that billions of dollars will be made at no cost to taxpayers are easy to make prior to negotiations.



Congested highways in Maryland could soon have extra P3-funded lanes

"WHY A PRIVATE COMPANY SHOULD HAVE SUBSTANTIAL CONTROL OVER THE FUTURE INFRASTRUCTURE NEEDS OF A MAJOR AMERICAN CITY IS AN OBVIOUS QUESTION"

Hunter Blair, researcher, Economic Policy Institute

Blair also points to the poorly designed contract for the P3 used for California State Route 91, which was hampered by non-compete clauses included at the behest of the private provider. Similar clauses exist in most P3 contracts as private partners could have profits stripped away if a public partner builds more parallel roads. But they also hamstring the state's ability to build infrastructure. With Route 91, traffic ended up much heavier than projected, requiring extra lanes. But the non-compete clause prevented their construction, forcing the DOT into long court battles. It eventually won the right to purchase the toll lanes, but at an inflated price.

A HOSTAGE TO FORTUNE

Blair refers to another P3 contract that went wrong. North Carolina DOT entered into a US$700m, 50-year contract with I-77 Mobility Partners, a Cintra subsidiary, to convert high-occupancy vehicle lanes to express high-occupancy tolled lanes on I-77 between Charlotte and Mooresville. Blair writes, "NCDOT notes that the population of the serviced region is expected to double by 2040. What happens if in the next 25 years… one additional lane each way doesn't cut it? The contract ensures that before North Carolina can build more free lanes, it needs to pay Cintra for the right to do so. Why a private company should have substantial control over the future infrastructure needs of a major American city is an obvious question."

Ratings agencies DBRS and Fitch rated the Charlotte P3 as only a notch below junk, partly because it let Cintra collect tolls for a few years, then stop maintenance and file for bankruptcy when deferred payments were due later. Cintra has already filed for bankruptcy on P3 toll projects in Texas and Indiana. "This isn't speculation, it's a business model," Blair writes.

A further threat to P3s is opportunistic renegotiation, finds research from Engel, Fischer and Galetovic. In their 2014 paper *Renegotiations in Public-Private Partnerships*, they state that 40% of US transportation P3s have undergone renegotiation, often involving government bail-outs when a state has poorly estimated revenue streams. They say it is possible to improve contract designs, however, by using a present-value-of-revenue contract instead of a fixed-term concession. Under such a contract, "the regulator sets the discount rate and toll schedule, and firms bid the present value of toll revenue they desire. The company offering the lowest bid wins, and the contract term lasts until the winning firm collects the toll revenue it asked for". When demand is low, the term of the contract lasts longer. When demand is high, the contract ends sooner.

For Maryland, about to embark on contractual negotiations with private developers, the chastening experience of other DOTs could be a cause for concern. Secretary Kahn is optimistic that mutually beneficial contracts are possible. "In the USA, every P3 contract is a unique, one-off negotiation, which is often used as criticism," he says. "But it actually gives Maryland a lot of flexibility to tailor our concession agreement to the facts on the ground and protect the public interest as best we can."

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by James Gordon

HOW TOLL OPERATORS MUST COOPERATE WITH POLICE TO ENSURE ROADS REMAIN SAFE

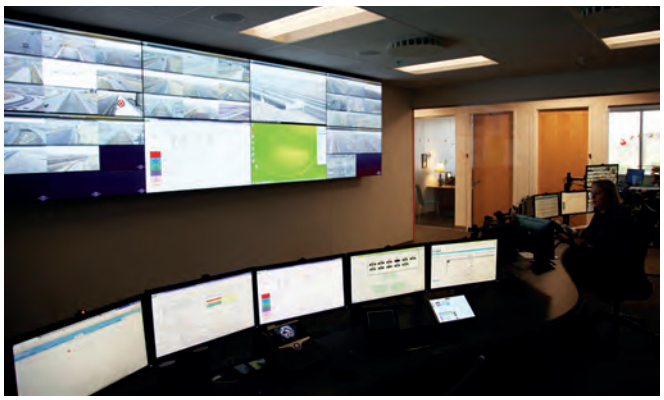
Many toll operators in the USA are obliged to fund highway patrol troops to help fight crime on their roads. How should control rooms coordinate with the police to ensure value for money?

It is every parent's worst nightmare. Thankfully, for most of us, this terrifying scenario is only ever played out in our blackest dreams, but for one Colorado woman, watching a stranger drive away with her toddler became a chilling reality three years ago.

When Marta Rodriguez strapped her four-year-old son tightly into the child seat of her 2008 red Ford Edge on a cold and crisp March morning, she could have no idea of the dramatic and traumatic events that were about to unfold on E-470, the 47-mile (75km) controlled access toll road that runs around the eastern perimeter of the Denver Metro area.

At around 7:00am, Rodriguez decided to stop at a gas station in Longmont, an affluent dormitory town located 37 miles (60km) from Denver. Rodriguez left the engine running and her SUV unlocked as she popped into the station store. But as she did so, 28-year-old career criminal Ryan Stone saw his opportunity and made off with her vehicle… and her son.

Thankfully for Rodriguez, her child was returned to her later that day, in pyjamas with teddy bear in hand. But had it not been for the coordination and quick response of several law enforcement agencies in



Left: Operatives in Colorado's E-470 Communications Center closely monitor traffic, using cameras on the road's gantries (below)

Maine State Police Troop G, which has its HQ (right) co-located with Maine's Turnpike Authority, is responsible for patrolling the toll road (above)

cooperation with the toll road, this tale may not have had a happy ending.

Colorado State Patrol sergeant William Caldwell, who was on duty that day, takes up the story: "As soon as authorities were aware that a child was involved in the auto theft, the Colorado Department of Transportation (CDOT) issued an amber alert and it was all hands on deck, including those in the E-470 Communications Center. The Colorado State Patrol (CSP), a longtime partner of the E-470 toll road, utilized the live footage from the news station helicopters and worked with the E-470 team to update the variable message signs along the road with car chase safety information.

"The event was very fluid and took monitoring from several channels," Sgt Caldwell continues. "The CSP was constantly updated on the ongoing incident and stationed troopers along the roadway." The updates from the Communications Center were instrumental in helping the state police to finally apprehend Stone.

Following the arrest, the CSP worked with the E-470 Communications Center team to obtain video of the chase to assist with the investigation. The footage of the event helped to secure Stone's conviction and eventual incarceration. He is currently serving a 160-year sentence.

But how does this seamlessly coordinated and harmonious partnership manifest itself in the day-to-day running of the toll road?

US$11M

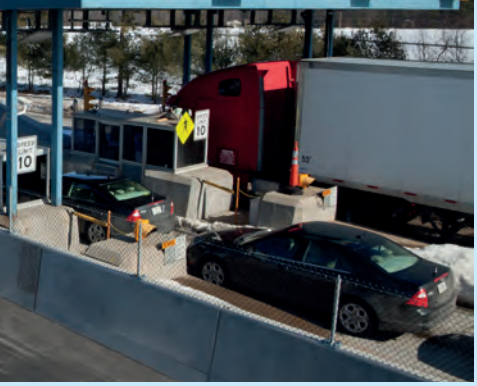
The amount paid by Ohio Turnpike and Infrastructure Commission to Ohio State Highway Patrol for its services each year

"THE COLORADO STATE PATROL WORKED WITH THE E-470 TEAM TO UPDATE THE VARIABLE MESSAGE SIGNS ALONG THE ROAD WITH CAR CHASE SAFETY INFORMATION"

Sgt William Caldwell, Colorado State Patrol

COORDINATING TO FIGHT CRIME

Jessica Carson, the E-470's manager of communications and tolling services, says, "The CSP works closely with our Communications Center during and after incidents. Through real-time channels, the two organizations are in constant



POLICING MAINE TURNPIKE

Gregory Stone, the Maine Turnpike Authority's (MTA) director of public safety and special services, explains that the 109-mile (175km) stretch of toll road linking Kittery, on the New Hampshire border, to Augusta, was founded 70 years ago and is policed by its own dedicated troop.

"As part of our enabling legislation, the MTA covers the entire cost of a state police troop, which next year will amount to US$6.7m," says Stone. "Troop G, which is stationed in the MTA's administrative headquarters, consists of 35 officers, who provide the toll road with year-round police coverage."

Stone, who has worked for the MTA for 13 years, believes that Maine's low population density has helped to foster collaboration.

He explains, "As Maine is a relatively small state, with numerous small municipal law enforcement agencies, there is a very robust practice of mutual aid between agencies. This enables police officers from the Turnpike Troop, who have state-wide law enforcement powers, to frequently leave the roadway to provide assistance to municipal agencies at the scenes of major crashes, or significant incidents. Likewise, those civic organizations come to the Turnpike from time to time to assist Troop G when manpower may be otherwise committed to a different area, or in the event of a significant incident."

Stone also confirms that the MTA Traffic Management Center "acts as one of two dispatch centers for Troop G", and "is in regular contact with local dispatch centers, should the emergency services and law enforcement resources need to be allocated to incidents on the toll road".

But, while fatality rates on the Maine turnpike are significantly lower than those on non-toll interstate highways, and even more so than the national interstate highway average, is the same true for crime levels? Are crime levels on the Turnpike – which enjoys round-the-clock CCTV surveillance in addition to specialist police patrols – lower than on publicly funded roads?

Says Stone, "It is difficult to draw a direct correlation, but it seems intuitive that the significant presence of traffic cameras and toll system cameras, accompanied by a presence of MTA staff and resources, reduces the opportunity for undetected nefarious activity.

"There is a much larger presence of toll collectors, highway maintenance personnel, highway safety patrol and state police than on non-toll interstates in Maine."

communication during an incident, to ensure our roadside assistance personnel are available to help with traffic control and other safety precautions. The CSP also works with the Communications Center to update the variable message signs along the road, to alert the drivers to incidents, accidents, lane/road closures and any possible detours.

"Finally, the CSP works closely with our IT and Communications Center teams to obtain video needed for any accident investigations that may benefit from the footage our cameras capture. The video is used to assess the possible cause of an accident, the vehicles involved and the details of the incident in question."

However, both Carson and Dave Kristick, the E-470's deputy executive director and director of operations, are keen to stress that incidents such as the one described are exceptionally rare.

"We are proud of the culture of collaboration that exists between the E-470 Public Highway Authority and the Colorado State Patrol," says Kristick. "Each trooper is equipped with a raft of special knowledge and training, to focus solely on maintaining public safety on our toll road. This alliance forged with the five police departments and the three country Sheriff's offices, which also provide us with assistance, is, I believe, a contributing factor to ensuring low rates of crime on the road."

80 MILLION

The approximate number of toll road transactions on Colorado's E-470 in 2016

"WE ARE PROUD OF THE CULTURE OF COLLABORATION THAT EXISTS BETWEEN THE E-470 PUBLIC HIGHWAY AUTHORITY AND THE COLORADO STATE PATROL"

Dave Kristick, deputy executive director and director of operations, E-470 toll road, Colorado

WORKING TOGETHER

Much like in Maine (see *Policing Maine Turnpike*), the Ohio Turnpike and Infrastructure Commission (OTIC) reimburses the Ohio State Highway Patrol around US$11m per annum. This pays for a force of 82 officers to continuously police the Turnpike and a further 10 troopers to provide communication and dispatch services.

The 241-mile (388km) road, which connects the states of Indiana, to the west, and Pennsylvania, to the east, consistently

Above: A clear day at the Chambers Road junction of Denver's E-470 toll

47 MILES

The approximate length of Colorado's E-470 toll road (75km)

SAFE ROAD

Colorado's E-470 not only benefits from the added safety afforded by a dedicated police force, but is also equipped with a number of other key safety features, which set it apart, helping to make it one of the safest roads in the state.

"The toll road has many more safety features than publicly funded interstate highways," says Dave Kristick, E-470's director of operations. "For example, rumble strips on the shoulders to alert drivers who drift off of the road; cable barriers on the median to prevent cross-overs; and a number of wrong-way driving features have been installed to warn customers they are entering the road in the wrong direction. If this happens, staff at the Communications Center receive an alert and can contact the Colorado State Patrol (CSP) to find and stop the vehicle before an accident takes place.

"Our Communications Center, which is manned 24 hours a day by highly trained staff, monitors the road in real time for incidents, stranded motorists or debris on the road. If they identify anything unusual or unsafe, they immediately contact the emergency services and/or the E-470 Roadside Assistance team, which provides a free service to our customers and is always available, 24/7."

records a substantially lower fatal crash rate than nationally state-funded roads, and anecdotal evidence suggests it is also safer from all other kinds of crime than non-tolled roads.

Police deployed to the turnpike are permanently stationed at one of three control posts on the road, meaning they are responsible for criminal law enforcement only on the turnpike itself. But is lower accident and crime rate simply down to well-funded police efforts?

Staff Lt Travis Hughes, Ohio Turnpike's chief liaison officer, doesn't think it's quite that simple. "The roadway has barrier controlled points of entry and exit, which fortifies security and essentially eliminates the vast majority of toll violations at the source," he says.

But for Staff Lt Hughes, there's an even more important element to keeping the Turnpike free of crime, and thus ensuring the safety of its 55 million annual travelers.

"While we never request real-time access to the OTIC's surveillance cameras, we do work closely with dispatch operators," says Hughes. "If control center staff notice and observe instances of dangerous or erratic driving, the state-of-the-art cameras can pinpoint their location, while ALPR technology helps us quickly identify the status of the vehicle, which then enables

"IF CONTROL CENTER STAFF NOTICE DANGEROUS DRIVING, CAMERAS CAN PINPOINT THEIR LOCATION, WHILE ALPR HELPS US QUICKLY IDENTIFY THE VEHICLE"

Staff Lt Travis Hughes, chief liaison officer, Ohio Turnpike

Left: **Workzone maintenance crews have developed an excellent working relationship with police in Ohio, and often are the first to raise the alarm in the event of an incident, so traffic remains flowing freely** (above)

82

The number of officers dedicated to patrolling Ohio Turnpike

a traffic enforcement officer to make a prompt traffic stop."

And for Staff Lt Hughes, while cutting-edge systems can help to identify traffic violations, community policing and access to regular training programs, including education around counter terrorism or high-level criminal activity, play a crucial role in combatting crime, too.

On the importance of building and cementing civic relationships, Staff Lt Hughes says, "Because we serve and protect the toll road users every single day of the year, we have been able to develop a series of proactive working partnerships, not just with the road operator, but with maintenance and construction workers, toll booth and service station staff, and E-ZPass customers. Quite often it is front-line workers or drivers who will be first to alert us if they see anything untoward or unusual that could potentially endanger the lives of other road users."

"BECAUSE WE SERVE AND PROTECT THE TOLL ROAD USERS EVERY SINGLE DAY OF THE YEAR, WE HAVE BEEN ABLE TO DEVELOP A SERIES OF PROACTIVE WORKING PARTNERSHIPS"

Staff Lt Travis Hughes, chief liaison officer, Ohio Turnpike

PREVENTING DRUNK DRIVING

One of the greatest concerns for the Turnpike patrol is ensuring that motorists don't drink and drive. Ways to combat this have become increasingly more sophisticated over the past decade. Education has branched out from television news to include social media and VMS – all warning motorists of the dangers and consequences of operating a vehicle while over the legal alcohol limit. And now police efforts are becoming more targeted thanks to data analytics.

"We analyze data to identify potential dates, times and locations where DUI offences are most likely to occur," says Staff Lt Hughes. "The festive season and Saint Patrick's Day are holidays where we will allocate more officers to specific locations than usual and in the run up to these events, we will schedule public awareness campaigns on the various media channels. The patrol also encourages the public to report motorists they suspect of driving under the influence."

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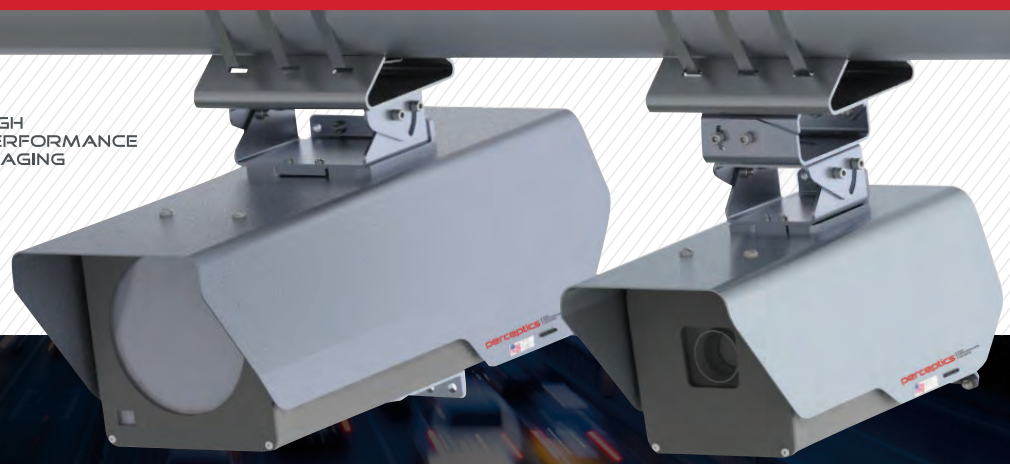

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KEEP IN TOUCH

A TOLL ROAD AGENCY IS COMMUNICATING DIRECTLY WITH USERS IN EMERGENCIES

The Pennsylvania Turnpike is one of the oldest toll roads in the world, but it is still pushing forward with smart-device innovations, as chief executive Mark Compton explains

In January 2016, Winter Storm Jonas raged through the northeast USA with arctic savagery, wielding blizzards and visiting record snowfalls on Pennsylvania. Sections of the state's 552-mile (888km) turnpike system were paralyzed by its impact. Drivers found themselves trapped in queues, in some cases 20 miles from the next interchange, in exposed country. Responders struggled to reach them and they struggled to access reliable updates. Call centers threatened to be overwhelmed. Drivers turned to traffic websites or downloaded apps, and many trawled social media, with its potential for misinformation. Vehicles remained trapped and the inadequacy of existing communication procedures was clear.

RURAL DANGERS

Pennsylvania's geography renders it vulnerable to scenarios like this. Now 77 years old, the turnpike runs right across this northeastern state, east to west from Philadelphia to Pittsburgh. Between these urban centers it is, for much of its length, a rural highway. "Pennsylvania is a state of extremes," Pennsylvania Turnpike Commission (PTC) chief executive Mark Compton tells *Tolltrans*. "Extreme winter snow; extreme summer heat. The Pennsylvania Turnpike mirrors other rural highways, where it's not uncommon to have 20 miles to the next exit. No one's less than five miles from gate access, but in terms of interchanges where folks can get off, it's sometimes 30 miles in our system. It's in extremes that we need information, so we can start walking the backlog with water on hot days or making sure there are rations available. When we got a major snowstorm, there were folks trapped for," Compton hesitates, "a lengthy number of hours."

Within two years, however, PTC was in Atlanta, Georgia, receiving the 2017 IBTTA Toll Excellence Technology Award for 511PAConnect, a pioneering new system for direct trapped-driver communication.

TECHNOLOGY TO THE RESCUE

Following Jonas, the administration laid down a challenge to PTC and its partner agencies, the Pennsylvania Emergency Management Agency (PEMA) and PennDOT. "The overall initiative came from Governor Wolf," Compton recalls. "He said, 'In this day and age, not having the ability to communicate with traffic in a trapped queue makes no sense to me. So before next winter hits, I want you to put together a mechanism for doing that.'"

The combined agencies identified three imperatives of the required system: communication must be unplanned,

instantaneous and two-way. 511PAConnect fulfills these imperatives.

As soon as a trapped-driver scenario is identified, 511PAConnect pushes a wireless emergency alert (WEA) to all smartphones in a geo-targeted incident area. This WEA explains how to receive incident updates, offering a choice of phone call, text or website communication, thereby initiating a two-way channel. The agency can communicate with travelers individually, collectively or in vehicle groups (all commercial vehicles or school buses, for example) and individual drivers can message the agency, for instance notifying them about fuel status or medical need. Location data is requested from smartphones and drivers are asked a few critical questions (vehicle type, number of passengers). Traveler locations are plotted on a color-coded map. The agency can then see if any vehicles are not moving or remaining on the road post-clearance and contact them direct or send responders.

"We circle the traffic on the map," says Compton. "They get the WEA, which starts the dialog. This allows us to interface with the traffic in a way we never had before and also helps with situational awareness."

The technology looks set to spread, with PTC's vendor and commercial partner, Information Logistics, fielding calls from commissions and DOTs countrywide in the wake of positive publicity.

WORLD'S FIRST LONG-DISTANCE TOLLWAY

The original Pennsylvania Turnpike was born out of the hardship of the Great Depression. In the early 1800s it would have taken around three weeks to traverse the state by horse or canal boat, until the Pennsylvania Railroad was established in the 1850s, reducing the journey to around 20 hours.

By the 1930s, the rise of the automobile meant paved highways were needed. As an antidote to unemployment during the depression years, President Roosevelt set up a series of federally funded New Deal projects. One of these was a new toll road in Pennsylvania that would use an abandoned railway bed and tunnels.

In 1937 the Pennsylvania Turnpike Commission (PTC) was created. A total of 155 construction companies and 15,000 workers were hired to build the world's first long-distance tollway, running 166 miles (267km) from Irwin to Carlisle with two 12ft (3.7m) lanes in each direction, narrowing to one lane in the tunnels. It opened at one minute after midnight on October 1, 1940.

Though Pennsylvania is proud of its iconic asset, the road's age presents major headaches. "As with anything that's 77 years old, there are components that need to be reconstructed," says PTC chief executive Mark Compton. "In the more urban areas we've outgrown capacity, so a commute in Philadelphia can involve significant congestion. But I'm of the mindset that building our way out of that congestion isn't realistic. The Philadelphia area needs US$2-3bn in capacity upgrades, but we're at about a US$600m annual capital plan for the whole system."

Despite annual toll increases of 5-6%, PTC is in debt, partly because of a binding obligation to the Commonwealth of Pennsylvania to provide US$450m of transit funding. For now, Compton sees swift and effective incident management as the key to preventing long backlogs.

When the Pennsylvania Turnpike was first built, private investors were unfamiliar with the toll road concept and showed little enthusiasm, so all funding came from the federal government. But could private-public partnerships be a sustainable method of financing rebuilding and expansion today? Mark Compton is cautious.

"I think there needs to be realistic expectations of private-public partnerships. The private industry won't come in and fund your whole system – there needs to be a public component. And they won't come in unless there's an opportunity for profit. In our business, that means traffic. Most areas of our system outside Philadelphia and Pittsburgh are not highly populated, so opportunities are limited."

For more on the questions surrounding public-private partnerships and toll roads, turn to page 18

It is planned that the 77-year-old Pennsylvania Turnpike will be all-electronically tolled by 2022

"On some level it's still rudimentary,' continues Compton. "We know how many vehicles there are and we know we can reach them through their cell phone. If you look at the next phase, we're trying to refine the information, to get more detailed information out and move back and forth."

ROAD TO SUCCESS

Motorists enjoy a reassuring sense of ongoing dialog with agency staff. Whenever 511PAConnect has been activated, agitated calls to call centers have quickly fallen away, as have complaints, while PTC reports many users texting back a 'thank you' at the end of a 511PAConnect exchange. The agency believes toll-paying drivers deserve a premium service, which 511PAConnect helps to provide through targeted emergency response.

Flexibility is another obvious benefit. Though developed as a response to extreme weather events, the system is applicable to queued-traffic scenarios after an accident,

"511PACONNECT ALLOWS US TO INTERFACE WITH THE TRAFFIC IN A WAY WE NEVER HAD BEFORE AND ALSO HELPS WITH SITUATIONAL AWARENESS"

Mark Compton, chief executive, Pennsylvania Turnpike Commission (PTC)


The first driver through the Pennsylvania Turnpike's Irwin Exchange, one minute after midnight on October 1, 1940

"I THINK THROUGH ONE KIND OF TRANSPONDER OR THROUGH YOUR CELL PHONE, YOU'LL HAVE ONE MECHANISM FOR ALL TOLL OPERATIONS THROUGHOUT THE COUNTRY"

Mark Compton, chief executive, Pennsylvania Turnpike Commission (PTC)

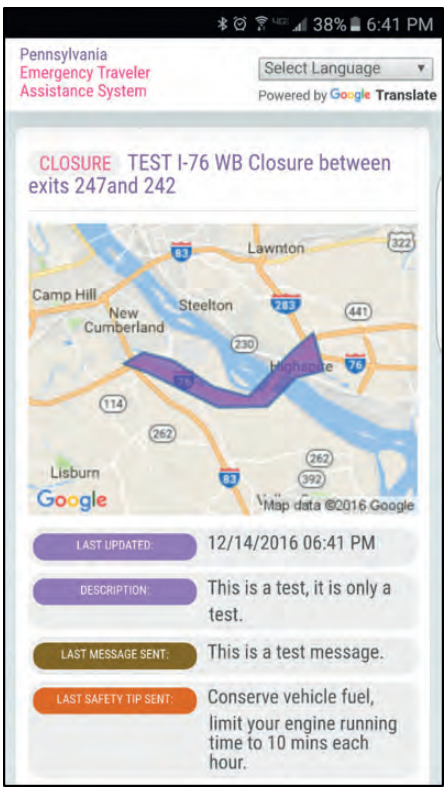
or any situation where official information needs to be delivered to the public.

Though potential for privacy infringement and data harvesting appears inherent to the 511PAConnect technology, Compton is reassuring on this point. "The beauty of it is, when traffic starts to dissipate, all the information vanishes. We don't do anything with the data; everything is erased." Though choice may feel reduced during a blizzard when passenger safety is at stake, he stresses that no data is collected without consent. "Everyone with a cell phone in the geographical area we circle gets the initial alert, but we have no means of knowing who they are. They then make the decision to sign up or not. They have to actively engage to get the next message and participate."

Further safeguards are also in place: "There are steps in the process before it gets activated and we require the cooperation of PEMA to decide it's warranted. For anything less than a two-hour delay, we wouldn't consider using it," says Compton.

COMMUNICATIONS REVOLUTION

But cell phones may one day become a more ubiquitous part of tolling, with mechanisms on the Turnpike currently in a transitional phase. While almost 80% of customers have now adopted E-ZPass transponders, 20% continue to use cash toll booths, a dual system that gives rise to safety concerns at interchanges. "When 80% of traffic is moving through, probably not at the posted speed of 5mph (8km/h), and 20% is kind of 'serpentining', looking for a cash lane, it's a recipe for disaster." Compton hopes that 35% savings will persuade this minority of customers to overcome their reservations and sign up, while Toll-by-Plate is being trialled as an alternative to cash payment in two locations.



Above and below: **The 511PAConnect system can alert traffic managers, and the public, to queued-traffic on the Pennsylvania Turnpike**

Meanwhile, the PTC is working toward procurement of a broadband fiber backbone throughout its system and upgrading collection facilities. "There's a project around Philadelphia whose goal is to put high-speed gantries on the mainline and get away from interchange collections. It really opens the system up. You need a US$100m trumpet-type interchange if you have to put tolling apparatus around it, or a US$55m diamond-type interchange if you don't."

An option to pay by smartphone, rather than E-ZPass, is also on the horizon. "We're working on a system to collect tolls from cell phones to make another convenience for our customers," Compton reveals. "Hopefully in the next couple of months we'll be able to announce our vendor, who will help us in that process."

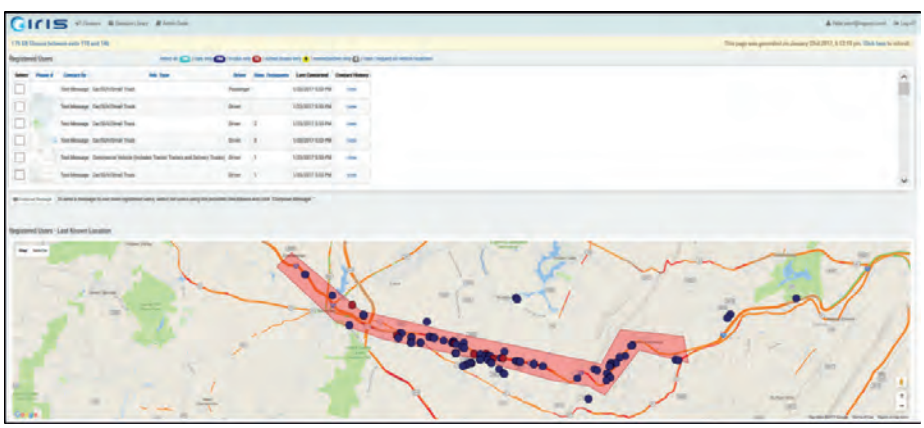
The mechanisms involved may show potential to dovetail with 511PAConnect technology, though Compton does not anticipate the immediate demise of E-ZPass transponders. "I think our preferred method will be E-ZPass for the foreseeable future," he says. "It will continue to enable us to collect revenue without having to send bills for Toll-by-Plate."

In the longer term he sees transponder tolling as a possible route to nationwide interoperability, which the IBTTA works to promote. "I don't think it'll be E-ZPass itself, but I think that through one kind of transponder – or through cell phones – you'll have one mechanism for all toll operations throughout the country."

LOOKING TO THE FUTURE

At present 16 states use E-ZPass. "Eighty percent of our customers now use E-ZPass, so that gives it pretty high marks," Compton reflects. "Occasional users don't always want to go through the process of getting an E-ZPass, so we have that issue. The other component is a realistic understanding of how we use the transponder. There's a sense in some of our rural communities that we're tracking people, but if you have a cell phone you're tracked a lot more than with an E-ZPass. We're just looking to collect a fee." PTC aims to complete a full transition to electronic tolling by 2022.

"When it opened, the Turnpike was a marvel for its time and our folks are really proud of the fact that we were America's first superhighway," concludes Compton. "So we're rich in tradition, but we also hope to be rich in innovation."



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by Steven Norris

ROAD ECONOMICS

Former UK transport minister and commissioner for the Independent Transport Commission Steven Norris gives his opinion on the pressing need to move toward per-mile road user charging in the UK – before it's too late

In the past, universal road user charging existed only in the imaginations of technologists and was deeply anathema to politicians. But now even politicians will privately say, "We understand," even if publicly they say, "It's absolutely not on the table."

So let me just spell out some real political facts of life. In the UK we currently raise around £30bn (US$39.5bn) a year through fuel duty, but the amount is declining. That's because the next car you buy might be twice as fuel efficient as the one you trade in. Or you might go the whole hog and get an electric vehicle.

Nobody has quite worked out how all this extra electricity will be generated, because if every vehicle in London went electric tomorrow the city would grind to a halt immediately as most of us wouldn't be able to get a charge.

But set that proposition aside for a moment and consider what would happen inside the Treasury. Suddenly that £30bn in fuel duty would disappear.

When Rod Eddington, the former chief executive of London Heathrow Airport, did a study for the government on the future of transport policy in 2006, he did refer to 'all-road pricing' – but it was buried inside volume three of the

"EVEN POLITICIANS WILL PRIVATELY SAY, 'WE UNDERSTAND,' EVEN IF PUBLICLY THEY SAY, 'IT'S ABSOLUTELY NOT ON THE TABLE'"

appendices. Here you'll find his estimate for the cost of installing the technology, and it's quite an amusing figure. In fact he suggested between £1bn and £20bn (US$1.3bn to US$26.3bn). Now in government they do say "a billion here, a billion there and soon you're talking quite serious money" but £1bn to £20bn is a huge gap.

That was 10 years ago. Now we know that the cost of installing a road user charging (RUC) system is massively reduced and the benefits are enormous. In fact the sooner we do it, the better we can capture whatever remaining of fuel duty there is. Why would we want to do this? Well, ironically it is because fuel duty doesn't just pay for highway work or even transport. It pays for schools and hospitals and many other vital public services; it supports our armed forces. In fact, whatever your favorite branch of government, fuel duty is contributing to it.

If we don't have that £30bn, our choices are as stark as they always are in government; you cut spending by £30bn. Attempts to cut spending have defeated every single government of every complexion since 1945 and there has never been a single year where the quantum of government spending has actually gone down. So I think we can assume that taking £30bn out is a pretty remote possibility.

"WE NOW KNOW THAT THE COST OF INSTALLING A ROAD USER CHARGING SYSTEM IS MASSIVELY REDUCED AND THE BENEFITS ARE ENORMOUS"

If we're going to keep spending on the services that we believe are essential, then we have to find another way of raising the money. We could put an extra 6% on income tax, double the rate of corporation tax or add 10-15% to capital gains tax.

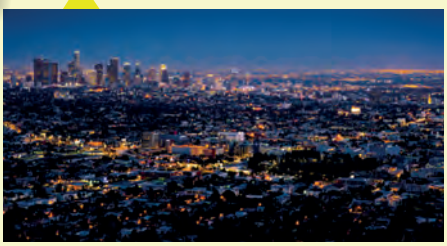
Charging for road use may be unpopular, but these alternatives are even less popular. But what are the benefits? It would give us a system whereby we get the revenue that is fast disappearing. We would not only be able to capture that revenue and charge for the last great free utility – because that's what roads currently are – but we will also be able to use all those behavioral elements of charging that can be so useful in managing a constrained system. For example, we could have a different rate to drive during peak hours than at other times and charge more to use roads through crowded town centers.

A bunch of us in the Department for Transport were told by the secretary of state "Don't even think about it; don't mention it; we're not going to do it; we're not going to talk about it." But that's going to change. Soon it will be the chancellor of the exchequer who says, "We've got to do this. And not only have we got to do it, but the sooner the better."

Attempts have been made to introduce RUC in Manchester and Edinburgh, but I would make the point that in both cases they made the mistake of allowing people to vote on it – a desperately silly thing to do. Would a turkey ever vote for an early Christmas? In both projects people believed

Oregon: After trials, in 2015 the state launched the first RUC project in the USA. It allows up to 5,000 locals to opt out of paying fuel tax and pay a charge of 1.5 cents per mile instead. Participants receive credits on their fuel tax bill.

California: An RUC pilot gave volunteers a choice of mileage reporting techniques and payment methods, but with no real money exchanged. Recommendations are currently being drafted and are due to be presented to the legislature imminently.



Washington: The state has been researching the feasibility of RUC for five years and is due to start a 2,000-vehicle pilot project in 2018. Four payment options are available, two relying on GPS and two less technical.

Minnesota: Smartphones with GPS receivers and mileage-metering technology were installed in 500 local vehicles for three six-month periods in 2007, with drivers paying variable peak and off-peak fees.

Nevada: A pay-at-the-pump scheme uses wireless transponders to transmit mileage data from the vehicle to the wireless receiver at the fuel pump. A charge is calculated, which is indicated on the fuel receipt.

Austria: A complex charging system for vehicles heavier than 3.5 metric tons is based on size and number of axles. Foreign OBUs are compatible with the system, but the Austrian OBU is not compatible with the Swiss or German systems. Proposals are being made to extend the project to all federal and state highways to avoid heavy vehicles damaging roads not currently covered.

Melbourne, Australia: A 17-month project provided five payment options, but central to the study was educating the public about road maintenance costs.

New Zealand: In 1977 diesel vehicles and all vehicles weighing over 3.5 metric tons were charged based on distance traveled and a nominal weight, as opposed to the vehicle's actual weight. Drivers pre-purchase distance licenses in units of 1,000km (620 miles) and are required to have a hub odometer installed on the vehicle.

Switzerland: Since 2001 vehicles weighing more than 3.5 metric tons have been charged a performance fee based on vehicle weight, engine emissions and distance driven. Swiss vehicles are required to be equipped with an onboard unit (OBU), while foreign drivers are required to register the vehicle at the border and receive an ID card that must be produced every time the vehicle enters the country.

Germany: All vehicles weighing more than 7.5 metric tons are charged on certain roads depending on the distance traveled, number of axles and engine emissions. The GPS-based system incentivizes maximizing weight loads and from next year is being expanded to all federal highways in the country.

they would get the transport benefits without having to pay the congestion charge.

What you have to do is be completely open about the economics. If you're still buying fossil fuel, for every £100 (US$131) you currently spend in the UK, £60 (US$78) is duty or tax in one form or another. Alternatively you'll be paying X pence per mile, which will be the price of RUC.

The only way to persuade people that road pricing is not just another way for the government to stick its hand in your pocket is to be completely transparent with the public about why the change is needed, what is being done to effect the change and what the less attractive alternatives are then finally how the vast majority of motorists won't pay more, they will just pay in a different way.

By committing to show how the average motorist will simply not pay any more and can, if they respond to the behavioral nudges, pay less, then you will actually bring the public with you.

"CHARGING FOR ROAD USE MAY BE UNPOPULAR BUT THESE ALTERNATIVES ARE EVEN LESS POPULAR"

I'm a member of the Independent Transport Commission and we carried out some specific research into this subject that involved a huge number of focus groups of every type – urban, rural, agricultural, high mileage, low mileage, not car owners – and we simply explained the situation to them. This is what's happening to fuel duty, this is what it is currently being spent on, and here are the alternative ways to raise this money, including charging for road use.

In each case, what we got was a heavy emphasis on the simple logic of not wanting to pay more in tax and them saying, "Well, when you spell the facts out it actually makes sense and is the obvious way to handle the problem."

If we lose that £30bn, something will happen in this country and it won't be for the better. So spell it out and actually prove to most drivers that what they will be paying is no more than they were paying before.

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by Saul Wordsworth

EXPRESS YOURSELF

When it opened, the I-70 Express Lane was billed as the USA's most expensive toll. How is the controversial infrastructure faring two years on?

"Here in Colorado we like to style ourselves as the Switzerland of the USA," says David Spector, director of the High Performance Transportation Enterprise (HPTE) at the Colorado Department of Transportation (CDOT), where his directive is to seek out innovative means by which to finance transportation projects across the state. "People live here because of access to the mountains. Everyone likes to hike, mountain bike, ski, kayak and camp." An established figure in the industry, Spector recently won a P3 Entrepreneur of the Year award at the 29th American Road and Transportation Builders Association (ARTBA) Annual Public-Private Partnerships (P3) in Transportation Conference in July 2017.

Prior to this win, in 2015, CDOT collaborated with Spector to launch the first express-lane toll in the USA based entirely around leisure use. The I-70 Mountain Express Lane (MEXL) heading east from Empire to Floyd Hill was a high-profile project, not least because when under construction it was reported that it would be the most expensive toll in the country, threatening to charge between US$30 and US$40 for a 13-mile (21km) stretch of road. The premise for the project was a managed lane that operated only during peak times, for up to 100 days per year. These periods are typically weekends and public holidays when people are returning to Denver from recreational activities in the Rocky Mountains.

"Seventy-five percent of the time, this freeway, which has two lanes in each direction, is more than adequate for the traffic that's on it," says Spector. "However, you get a huge influx of cars heading up to the mountains in the winter so people can go skiing, or in the summer for hiking and vacations. On Sunday afternoons, when everyone is coming back down, you'll get 50,000 vehicles on a corridor that normally takes 30,000, so it's a large increase. That's when we open the shoulder lane for tolling."

AWARD-WINNING SOLUTIONS

Colorado's express lane solutions have been making a name for themselves within the industry. The MEXL has won the Women's Transportation Seminar Innovative Transportation Solution of the Year (2016), the Governor's Elevation Award for Superior Customer Service (2017) and the FHWA Environmental Excellence Award (2017). In addition, the mutimodal US 36 project was awarded the grand prize at the 2017 annual American Association of State Highway and Transportation Officials (AASHTO) awards. Clearly CDOT is doing something right.

"MEXL was and is an experiment," says Spector. "We had never done anything like this with a breakdown lane. We didn't know how willing people would be to pay. The HPTE board of directors told us, 'We will set a range from US$3 to US$30 and you can set the optimum rate to manage congestion and to allow a reliable travel time in those express lanes.' Some of us thought, 'Folks are spending hundreds of dollars on their family ski day, so of course they'll spend US$30 to

travel 13 miles.' But in fact, we have never charged more than US$8 for that segment. Users pay the same amount for using the Express Lane, regardless of which of the two entry points they use."

THE DYNAMIC PRICING MODEL

Pricing for all of Colorado's managed express lanes tracks actual traffic usage and monthly trends, and makes adjustments annually to ensure they are managing congestion effectively. For example, on US 36, which connects Denver to Boulder, the toll was adjusted in summer 2017. Prices at certain toll locations are increased to ensure those in the express lanes can expect a reliable travel time, while prices at other toll locations are decreased in order to encourage use of the express lane.

"For the MEXL, pricing is determined based on historical and actual travel patterns," says Spector. "Our team gets real-time traffic count information upstream of the MEXL, and they use that information to make a determination on when to increase or decrease the toll rate based on those actual volumes. It varies, but generally data is collected at one-minute intervals and a software-calculated decision on pricing is implemented every 15 minutes. We also have personnel monitoring the system to make sure it is performing accurately."

HPTE uses an integrated tolling system engineered and delivered by 3M. The lane system consists of loops with overhead antennas for transponder readings, and automatic license plate recognition (ALPR) cameras for license plate tolling.

SUCCESS!

Spector believes the MEXL is proving to be successful because it benefits everyone, whether or not they choose to pay a toll. Drivers always have a choice to use the express lane or stay in the adjacent free lanes. As a result of drivers choosing to pay, general-purpose lanes also see reduced travel times and increased speeds. On US 36, drivers in the general-purpose lanes have experienced a 20-29% decrease in commute times. Vehicles traveling in the free lanes next to the MEXL have experienced up to a 50% saving in travel time.

Since MEXL was launched in December 2015, incidents and clearance times have fallen. In addition, fewer vehicles have been using the local frontage routes, which has meant less congestion on local roads during peak periods.

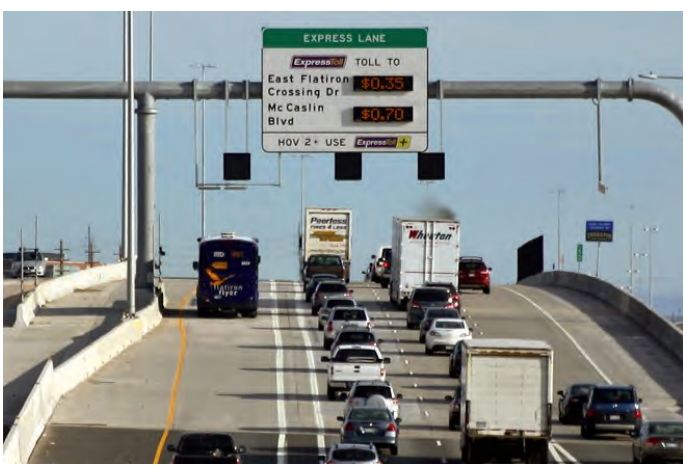
"MEXL is also proving to be a success because of the willingness among our partners to innovate," says Spector. "This

US$3-30

THE PRICE THAT CDOT IS AUTHORIZED TO CHARGE FOR I-70 EXPRESS LANE TOLLS. (SO FAR, IT HAS CHARGED UP TO US$8)

"REAL-TIME TRAFFIC INFORMATION HELPS US DETERMINE WHEN TO INCREASE OR DECREASE THE TOLL"

David Spector, director, High Performance Transportation Enterprise, CDOT



Left: **Colorado's US 36 express lanes use a similar dynamic pricing scheme to the Mountain Express Lane (MEXL) on I-70**

US$72m

THE COST OF CONSTRUCTING THE I-70 MOUNTAIN EXPRESS LANE (MEXL) IN COLORADO

is a pilot project authorized by our regulating agency, the Federal Highway Administration, to manage peak period congestion in a recreational corridor, and they took a risk."

PAYING FOR THE PROJECT

The MEXL project cost approximately US$72m to construct, US$25m of which was financed through a loan that will be repaid from toll revenues. These revenues are also being used to pay for operations and maintenance costs to operate the MEXL.

"We use these lanes primarily as congestion management tools, not revenue generators," says Spector. "That said, we have a revenue-constrained environment here in Colorado, so future toll revenues that we would expect to generate from these lanes would be leveraged for the capital construction costs of projects. Sometimes the ability of these express lanes to generate revenue over the long term can help finance projects that otherwise wouldn't get done. For example, we couldn't have done the US 36 corridor project for another 15 years because we didn't have the budget for it, yet because of the public-private partnership model that we entered where our private concessionaire took the toll risk, we were able to deliver that project 20 years sooner than we might have otherwise.

"We are also part of the state government and here to provide a public service, and that service is to improve your commute and make the congestion we all face that little bit

Above: The MEXL is the USA's first Express Lane built for vacation traffic. Some thought this meant road users would be willing to pay a higher price, but this hasn't happened

Below: The MEXL is demarcated by a white line and operates a strict no-stopping rule. Variable message signs help with traffic enforcement and incident management

"WE ARE HERE TO PROVIDE A PUBLIC SERVICE, AND THAT SERVICE IS TO IMPROVE YOUR COMMUTE AND MAKE THE CONGESTION WE ALL FACE THAT LITTLE BIT EASIER"

David Spector, director, HPTE, CDOT

easier. That's the main purpose of these infrastructure tools."

FUTURE PLANS

Along with US 36 and the MEXL, Colorado also has an express lane along Interstate 25 north of Denver from US 36 to 120th Avenue. Two new express lane corridors are currently under construction: C-470 from I-25 to Wadsworth and Colorado's Central 70 project, which will add lanes along Interstate 70, from Denver International Airport to downtown Denver.

"We have other corridors that are in the very early planning stages," says Spector. "These include another westbound mountain express lane and a possible express lane south of our metropolitan area along I-25, running between Monument and Castle Rock."

When Spector talks of 'early planning stages' he is referring to Colorado's region-wide express lanes masterplanning process, which will examine the potential or otherwise for an interconnected express lane system throughout the region.

"We have three corridors and a couple more under construction, but rather than simply picking out another project and moving forward with reckless abandon, we consider it wise to step back and think a little more strategically," he says. "We will consider the region as a whole, engage with local stakeholders, and work out where it makes sense to deploy these managed lanes, not just from a revenue generation perspective, but also from a congestion management and 'constructability' point of view. We want to come away with a road map to show where these express lanes should go, and which are the most economically viable. When we start to connect each of these corridors to one another, we want to be clear about what kind of benefits we might see in terms of congestion and traffic flow. We'll be going through this process over the next year. After that, we should know which lanes could provide the best benefit to the region and in what order would we want to attack this. It's also important the market knows. After all, we manage some of these projects through public-private partnership models."

US$25m

THE AMOUNT OF TOLL LANE REVENUE FUNDS BEING PUT TOWARD THE COST OF THE I-70 MOUNTAIN EXPRESS LANE (MEXL) PROJECT

Above: **Congestion on I-70's Floyd Hill is becoming a rarer sight thanks to the MEXL (Mountain Express Lane)**

LAST WORDS

On MEXL's opening day in December 2015, there was a blizzard and the toll lane couldn't open. It was an inauspicious start, but one that marked the beginning of an exciting new project, its success taking both the locals and its creators by surprise.

"I believe a lot of people thought, 'You're just going to try and toll us, these are Lexus lanes for rich folk only,'" says Spector. "The reality is that even though neighborhoods and jurisdictions along these corridors were really opposed to the idea at the beginning, they have become champions of the model, because it works for everyone. Even folks still in the free lanes are enjoying improved journey times. For a new mode of travel to be introduced and to have such wide acceptance in the first couple of years is both a surprise and a joy."

MOUNTAIN OF NUMBERS

These statistics reveal how the I-70 Mountain Express Lane performed during its second winter season of operation (January to April 2017)

34 days of operation

322 hours of operation

9:00am Typical opening time

6:00pm Typical closing time

8.7% Increase in vehicles using regular I-70 lanes since 2016 (to 1.12 million over the 2017 season)

26% Increase in vehicles using the MEXL since 2016 (to 89,800 over the 2017 season)

21 Number of crashes in winter 2017

27 Number of crashes in winter 2016

US$5 Tolls price during 269 hours of operation (89% of total)

US$4 Tolls price during 24 hours of operation (8% of total)

US$7 Tolls price during 10 hours of operation (3% of total)

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tolltrans

by Sebastian Ramb, Vitronic, Germany

GANTRY-LESS FREE-FLOW TOLLING

Advances in technology are allowing for electronic toll collection without the need for unsightly road furniture cluttering up the highway

Gantries have been the deployment method of choice since the first electronic toll collection (ETC) systems were installed. There are different technological approaches, but in general the setup consists of modules for vehicle detection, vehicle identification – either using automatic license plate reading (ALPR) or some kind of vehicle-to-infrastructure communication or both – and vehicle classification if the tolling scheme differentiates between vehicle types. Early installations tended to separate these modules on two or even three gantries to give the system enough time to run through the process. Nowadays the complete setup is usually installed on a gantry that delivers complete passage reports for its road section.

Gantry installations have several advantages. The most important is that mounting the technology above the road gives the sensors an unobstructed 'view' without occlusions, regardless of the number of lanes the gantry covers (Figure 1). Since every vehicle that is not detected by the system may mean a loss in revenue, good detection performance, especially on multiple lane roads, is essential.

However, when used for coverage of roads with just one or two lanes, gantries also have drawbacks. They usually require extensive and costly groundwork, which could result in a less favorable return on investment for smaller roads where traffic volumes and thus toll revenue are expected to be lower. In addition, construction of any road spanning structure requires temporary closure of at least some lanes.

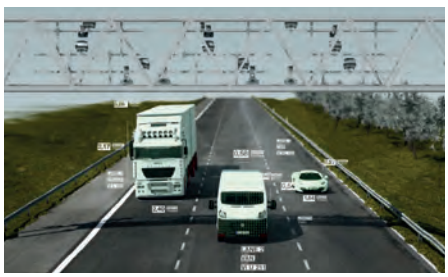
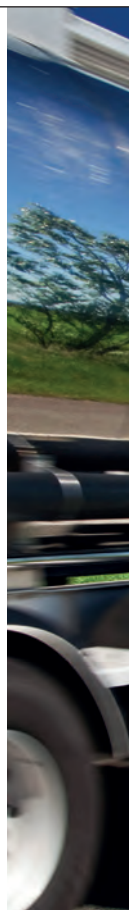


Figure 1: Top-down coverage of three lanes from a gantry (left)

Figure 2: High-resolution sideways images are the basis for a range of classification possibilities, including size, type, axle count and trailer (below)

Figure 3: The pillar design minimizes installation effort and environmental footprint (right)



SIDEWAYS SENSOR ARRAY

Vitronic has developed a new method for vehicle identification and classification that can replace gantry installations on some road types. It can be mounted at the side of the road in a pillar-shaped housing and takes high-resolution side-facing images of passing traffic (Figure 2). The identification of vehicles works in a similar way to gantry systems, either through front and rear ALPR based on the aforementioned images, or with vehicle-to-infrastructure (V2I) communication via RFID or dedicated short-range communication (DSRC) transponders.

A combination of both methods is also possible. With this, the system is able to support all current modes of ETC – pure video tolling schemes, GNSS-based schemes with on-board units (OBUs), and terrestrial schemes with tags. The integrated microwave DRSC communication is already compatible with the European Electronic Toll Service (EETS), which aims to standardize OBU use throughout the EU.

The vehicle classification operates with a single optical sensor. It enables determination of the dimensions of a vehicle (length, width and height), the number of axles and whether trailers or superstructures are present. Based on this information, the vehicle is automatically sorted into the correct class for the tolling scheme and instantly verified against an existing tolling account or passed on for billing. The images of the optical sensor also deliver enough detail for unequivocal documentation of passage and, if necessary, in-depth verification via, for example, the make and model of the vehicle.

THE HOUSING

Another distinctive feature of the new solution is its housing. Installed and proved several thousand times around the world for speed and red light enforcement, the housing pillar contains the complete sensor array, including illumination and the data processing technology. This minimizes both the visual and construction footprint of the installation (Figure 3). Groundwork and installation time are minimized by relying on prefabricated

foundations and a built-in 4G-ready wireless data connection.

On the security side, the aluminum casing offers industry-scale insulation against the elements (IP54) as well as vandalism protection, including local video surveillance. An electronic two-way locking system, which can be centrally controlled and monitored, prohibits access to sensor and processing equipment and any local data sets. For additional data protection, all local data is encrypted before transmission or deleted if not needed for transactional purposes. Since ETC operators need access to sensitive customer information, this local data protection at the site is an important security factor. The housing also contains a range of features that facilitate maintenance and service operations. It can be accessed direct from the roadside without the need for lifting platforms or other technical equipment. All sensor units are easy to reach and are mounted using quick-change systems for fast removal and reinstallation.

THE BUSINESS CASE

The combination of the sideways traffic monitoring and the comparatively low infrastructure requirement of the housing offers toll operators new options when designing an ETC network – either in combination with gantries or as a standalone solution for separately tolled sections of roadway. For example, the solution was successfully tested for the expansion of the German national truck tolling scheme to include 40,000km (24,850 miles) of federal roads. In this scenario, enforcement of the GNSS scheme has to be extended from the large multilane highways, where gantries are employed, to a network of roads with usually only one or two lanes. The new solution offers a cost-effective, environmentally friendly way to do that and complements the existing gantry infrastructure. The main cost factor in extending an existing GNSS scheme, with its virtual collection network, is the roadside enforcement equipment, so this could be a blueprint for the extension of other GNSS schemes.

Another use for the new solution is ETC at individual, clearly defined infrastructure sections such as tunnels, bridges and express lanes. These road types usually cover only a very limited number of lanes and can be 'gated off' at the beginning and end of the tolled section or at exits. For these tolling models, the pillar deployment offers an 'out-of-the-box' solution that supports a great variety of schemes and pricing models.

SUMMARY

This new road-side tolling system offers toll operators an alternative to gantry-based solutions as regards both cost and system performance. During the evaluation phase for the extension of the German truck tolling scheme, its performance has been tested against that of the enforcement gantries. On single lane roads the rates for detection, identification and classification were all comparable to those of gantry-based systems. The fact that the operation mode from the side of the road only requires one foundation with a small footprint makes it economically competitive to gantry installations, especially when it comes to covering road networks with only one or two lanes. With all current modes of ETC supported, the new system can be used in any tolling scheme, from nationwide operations to tolling of individual sections of infrastructure. ■

Sebastian Ramb is a marketing and public relations manager at Vitronic

by Florian S Weiss, Traffic Data Systems, Germany

A CERTIFIED WIM SYSTEM

Weigh-in-motion is a tried and tested basic utility for the purpose of collecting statistical data and selecting vehicles for further investigation. Certified systems are now being used in other applications, including tolling

WIM would be a very useful tool for tolling and enforcement. But there is one obstacle that first needs to be overcome: in many countries it is a requirement that only weighing equipment that is legally certified by the national metrological institute may be used.

Successful completion of the Traffic Data Systems (TDS) OIML R134 certification process (5km/h to 120km/h [3-75mph] for heavy goods vehicles and 5km/h to 140km/h [3-87mph] for light goods vehicles) for its WIM-DSP 32 system opens the door for tolling and enforcement applications.

Like any other available WIM system, the TDS solution consists of several sensors built into the road surface and appropriate electronic equipment to analyze sensor data. This WIM equipment is accompanied by a number of devices that complement the WIM core and provide additional and redundant data to the bare weighing results.

The most important one is the TMCS-U, which acts as a controlling device for the WIM-DSP 32. It provides and monitors power for all the WIM equipment, including any extra devices required to operate the road sensors. The TMCS-U also collects, stores and transmits data from the WIM-DSP 32 either locally or to the central monitoring station.

Redundant information about the vehicle under inspection is generated by an independent, inductive-loop-based vehicle classification system inside the TMCS-U. This can be done for up to five lanes simultaneously. The results obtained from both systems can be correlated to verify the correctness of the acquired data based on the autonomic operation of WIM and the inductive loop subsystem. This is an extremely important feature for documentation purpose. Naturally, data from an external automatic license plate recognition (ALPR) system as well as environmental data can be correlated and tallied inside the TMCS-U as required.

SENSORS

Key hardware components of the TDS WIM system are OIML-certified Lineas quartz sensors from Kistler. These sensors are installed according to mandatory procedures specified by the sensor manufacturer in order to achieve high-quality results. It is very important to have a plane, level road surface and solid subsoil covering at least the sensor area and the maximum vehicle length before and after the sensor area.

The sensor layout consists of three equidistant strips that cover the full width of the lane. The distance between three sensor bars should be between two and three meters. A shorter distance would mean less precision, while longer distances would increase the chance of non-homogeneous vehicle movement. Additional quartz sensors may be added to obtain further information about wheel characteristics such as single or twin tires, position of the vehicle in the lane and lateral offset. These would not affect WIM measurements.

A reference vehicle on static scales at an absolutely even site

WIM ELECTRONICS

Kistler charge amplifiers are used to ensure compliance with OIML R134. Up to four of these eight-channel amplifiers can be connected to a WIM-DSP 32, which also provides power to the charge amplifiers.

Analog and digital processing is carried out inside the WIM-DSP 32 using 32 parallel 24-bit analog-to-digital converters operating at more than 15,000 samples per second at identical sample times. Power consumption (without the charge amplifiers) is about 1W.

All components, from the road-installed quartz sensors to the WIM-DSP 32, including wiring, are protected according to IP67/EN60529. The user interface is via touch sensors sealed behind acrylic glass. All the electronics are fully tested and certified for temperatures from -30°C (-22°F) to 75°C (167°F), and relative humidity up to 85%.

These excellent thermal characteristics (below 1% deviation over the full temperature range) are the result of careful analog design using parts with minimal temperature coefficients and temperature-compensated crystal oscillators for all timing and timestamp tasks.

All subsystems are controlled via applications running on the TMCS-U.

Right: An ALPR and overview camera with integral infrared LED

Below: Traffic Data Systems' TMCS-U and WIM-DSP 32 certified WIM system

The main tasks of these applications are to join, store and transmit data coming from autonomous subsystems connected to the TMCS-U via network or serial interfaces. The only requirement is that the time is synchronized on all the subsystems involved.

WIM-DSP 32-SPECIFIC FIRMWARE

The WIM-DSP 32 is built around a powerful micro-controller, which provides outstanding real-time capabilities and low power requirements. In addition to the basic WIM functionality, a wide range of useful support features are implemented in the WIM-DSP 32.

One feature verifies that the quartz sensors are operating correctly prior to being buried in the road. Another enables identification of sensor wiring and channel assignment. These functions can be used without external equipment (with the exception of the power supply).

All the features listed above were only made possible by the use of new software techniques that combine fast real-time response with advanced programming methods. The use of MicroPython allowed seamless integration of high-speed signal processing with clean and efficient application programming while avoiding the overhead of a traditional operating system. At the same time, code maintainability and code quality tracking are excellent.

Even with the most advanced hardware and the best software techniques available, there is no way to prove the accuracy of a WIM system without testing real vehicles on real roads. What sounds like a truism turns out to be the most demanding task in the process of developing and certifying a WIM system. An early approach on a public highway showed that it would be impossible to test a WIM installation with vehicles that drive under illegal conditions, such as truck speeds above 80km/h (50mph) or axle weights above 10,000kg (10 tons). TDS had to build a fully equipped WIM measurement site on a private high-speed test track to allow tests with all kind of vehicles over a wide range of speeds and weights.

The TDS test site allows the weighing of vehicles of up to 16,000kg axle weight and with the speed limiter disabled. The track layout accommodates heavy goods vehicles of far more than 40,000kg total mass at speeds above 120km/h with no speed limit for smaller vehicles.

IN SUMMARY

OIML R134-certified WIM solutions create new opportunities for advanced enforcement and tolling applications. It is important to rely on redundant measurement systems to maintain enforcement and validity. Traffic Data Systems is the world's first WIM manufacturer to create a well-equipped ecosystem to move WIM to a new level of usability.

Florian S Weiss is CEO of Traffic Data Systems

by Marina Delgado, Tecsidel, Spain

MAINTENANCE SOLUTIONS

Maintenance management has become a key focus for concessionaires, because it can help them save time, costs and logistics in each operation

Over the years, toll and ITS solutions have implemented new technological features in order to improve the process of collecting tolls and to increase road safety. However, maintenance, as a smart and sensible system solution, has not always been taken into account. Tecsidel now offers its Tecsidel Maintenance Management System Plus (TMMS+). This system has been specifically designed for tolling maintenance management and ITS applications.

TMMS+ is a computerized maintenance management system (CMMS) for the management of concessionaires' maintenance operations and assets – either tangibly as sites and equipment, or intangibly as software tools for tolling or ITS. Major assets include equipment, such as tolling staff, ITS staff and hardware-software applications.

COMPLETE SOLUTION

The main purpose of the computerized system is to obtain the maximum effectiveness, in terms of time and logistics, of works performed by maintenance ground staff. TMMS+ can help maintenance staff define which devices (based on a sophisticated algorithm) need preventive or corrective maintenance. When the work order is created, the application addresses the closest warehouses that contain the spare parts or tools needed. Thanks to the system's geo-location module, it is possible to find the exact location of all assets and visualize them on a referenced map, thereby reducing time needed to detect and solve incidents.

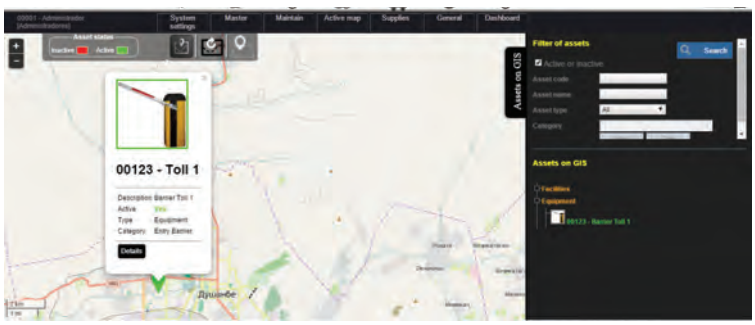
TMMS+ is one of the most complete solutions available, and has five management categories: corrective, preventive and predictive maintenance; and asset and supply management. Each asset or supply comes with previous information for its identification, such as technical documentation, plans, metrics, purchases, guarantees, suppliers, stock and associated work orders – information that can be extended as much as the concessionaire requires.

The TMMS+ solution is composed of the following modules: data master, work orders, asset management and geo-location, supply management, installation monitoring, report management and user management.

Above: **Tecsidel maintenance service staff on-site at a tolling location in Trondheim, Norway**

The data master main module establishes the structure that is to follow, which is why it requires a clear definition of the main tasks and elements. TMMS+ is 100% configurable by the user and more tasks and elements can be added afterward, depending on the concessionaire's needs.

One of the key features of TMMS+ is the creation, tracking and completion of work orders. For each work order there will be a clear definition of the asset targeted for intervention, the task to be performed, the assigned operators, the materials to be consumed, and the machinery, tools and



Left: A screenview of Tecsidel's TMMS+ interface

vehicles to be used, with the possibility of setting the time required for each task and the units that it will be recorded in.

The work orders functionality module allows the creation, tracking and completion of all orders (automatically or manually), as well as the updating of current activity being carried out and the current time consumption and resources. In addition, a report can be obtained with the repair activities to be carried out.

Reports created by TMMS+ are designed to give valuable information to the user. Thanks to these reports, the concessionaire is able to follow key details such as the resources and time required to maintain a specific asset, assets with the most maintenance, and total time spent on maintenance. Key details are configurable. All reports are exportable in Excel and PDF formats, allowing easier integration with market enterprise resource planning (ERP).

Furthermore, TMMS+ includes a mobile application that allows operators or maintenance personnel deployed in the field (toll plazas, roads, tunnels, bridges) to receive assigned work orders and to complete them while the work is being carried out, by means of a mobile terminal that automatically communicates with the control center.

MAIN FEATURES

The functionalities of this solution are:

- Corrective management: creation of work orders when detecting an asset failure;
- Preventive management: daily, weekly, monthly and annual programs of work orders to be executed in the future in order to review the status of an asset;
- Predictive management: generation of automatic alarms by setting some metrics or limits of any real-time record related to an asset;
- Ticketing: ticket management system with tracking and status control;
- Asset management with geo-location: assets can be located in their exact position on a geographic map, by means of a customizable iconography (the asset is represented by an icon with summary information and a balloon with detailed information);
- Management of spare parts and materials with location;
- Tracking of guarantees;
- List of suppliers;
- Purchasing history;
- Users and profiles management;
- General and detailed reports and historical reports of activities, dedication, consumption, etc.

TMMS+ can be organized in different application environments, according to the features needed and concessionaires' requirements – such as ITS/tolling and electrical equipment/infrastructure. The TMMS+ application can be organized to suit the needs of each concessionaire. Elements that can be organized include assets, supplies, users and independent maintenance management.

TMMS+ offers the ability to monitor vital system components that can generate automatic alarms and events. These components may include:

- ITS equipment: traffic signals, variable message signs (VMS), lane controls sign (LCS) incident automatic detection (IAD), ventilation, traffic counters, lighting, all electromechanic tunnel systems, etc;
- Toll systems equipment: lasers, barriers, antennas, treadles, loops, automatic payment machines, control cabinets, etc;
- Hardware-software applications: memory usage, central processing unit (CPU), disk space availability, server performance, database efficiency, etc.

MONITORING AND SUPPORT

Thanks to the integration with an external monitoring tool, the system allows monitoring and notifications for alarms and events, generated by devices via simple network management protocol (SNMP) messaging. TMMS+ provides an open web-based interface for receiving and managing alarm/event messages configured on the system. This external tool is a completely open source network monitoring system, with tracking capabilities of status, faults, performance and variable service level agreements (SLAs) of the different computers connected to the network.

Tecsidel offers comprehensive 24/7 support for the system, enabling anomalies to be treated with the greatest possible care by having technical staff for different profiles and levels available at all times and by having remote, real-time monitoring of all system applications support operations. TMMS+ is 100% customizable, allowing configuration of all parameters and evolving according to the concessionaire's needs. ■

Marina Delgado is a marketing manager at Tecsidel

by Jennifer Sherblom, Perceptics, USA

WORTH THE INVESTMENT

Using a high-quality ALPR system can reduce toll operators' manual image review costs while ensuring maximum revenue collection

As with any large-scale investment, toll operators need to weigh the initial cost of an electronic toll collection (ETC) system with long-term costs when comparing purchase options. For an ETC system that incorporates automatic license plate recognition (ALPR) technology, manual image review can be a large and often unpredictable operating expense.

While manual reviews of images may remain a necessity in tolling for the foreseeable future, the reality is that manual image review costs can vary considerably from one solution to another.

IDENTIFYING EXPENSES

One large expense that contributes to high manual image review costs is labor. Some toll operators use outside sources to review images, while some hire full-time, in-house staff. The overhead expenses needed to manually review images can be high and unpredictable. An automated system can reduce these expenses, therefore allowing a toll operator to retain more revenue per transaction.

High-quality imagers and a more sophisticated optical character recognition (OCR) engine may yield more readable plate images with more accurate automated reads from those images, reducing the number of manual reviews, and reviewers, required.

A higher-quality system will also yield a lower percentage of no-reads and low-confidence reads. The more license plates that the ALPR system can read with high confidence, the more images can be processed automatically, reducing the dependence on manual reviews. A better imager may also be able to read more challenging plates when other cameras cannot, thus acquiring more IDs automatically.

Labor costs associated with manual review can be increased depending on a toll operator's business rules. Some require the review of several images per event, which could double, triple or even quadruple the number of images a reviewer processes for the same vehicle. Additionally, some operators require double-blind or two independent manual reviews of the same image. If rules require double-blind reviews on multiple images per event, the manual review costs can skyrocket.

If an operator relies on a manual reviewer to validate automated reads from an OCR engine, the value of automation is diminished and the cost of manual reviews remain consistently high. If a highly accurate OCR engine has a relatively low yield (for

Right: The automatic reading of license plates with high-quality imagers and a powerful OCR engine reduces the costs associated with manual image review

Left: Perceptics' ALPR solutions are suitable for use in ETC systems because of their high attach rates and high accuracy rates

example, returns a 'no plate' or 'no read' result that still needs to be validated), the operator has effectively paid for an image to be reviewed with no recovery in revenue.

ADVANTAGES OF AUTOMATION

Therefore, by using an ALPR system that regularly yields a larger percentage of higher-confidence reads, fewer images will need to be sent to manual review, and fewer manual reviewers are needed. When calculating the labor cost associated with each image transaction, the price of an automated system will be recovered in just a few years, while the cumulative costs associated with a third-party system would continue to increase exponentially.

The case for automated over manual processing can also be made as it relates to accuracy. It may be tempting to assume that a manual interpretation of images is always more accurate than an automated one. However, in some cases, a high quality, fully integrated ALPR system may, in fact, tease ID information from an image that even an expert reviewer cannot. By methodically digitizing the visual elements on a license plate, the OCR engine utilizes scientifically proven methods of identification, whereas the human eye is, by nature, subjective.

ALPR technologies that interpret the license plate's region of interest (ROI) from another perspective, such as digitizing the visual elements in and around the ROI to create a unique vehicle identifier, enhance the OCR engine's ability to automatically and correctly identify a vehicle even when portions of the license plate are damaged or obscured. This will capture previously excluded license plates, thus increasing accuracy.

The effectiveness of any alternative means of identification, such as a digital fingerprint or pattern, relies on the system's ability to store and retrieve that unique pattern, then match it to other occurrences of the same pattern as well as to conventional license plate reads (including partial reads) associated with that pattern. It is the robustness and agility of the system's database of identifiers that makes the combination of alphanumeric and pattern data effective at filling in missing details and reducing the need for manual reviewers to perform that job.

Systems that rely heavily on manual review to read plates often have much lower attach rates – the percentage of readable plates that produce a high-confidence result. Images that cannot be read at all cannot generate toll revenues. And images that can be read via manual review but not via automation surrender much of their value to overhead costs.

In the long run, high-quality imagers coupled with a powerful OCR engine offer much better value to any toll operator looking to reduce per-image transaction costs. When weighing ALPR options, it makes sense to look carefully at lifetime expenses and overall cost of ownership, and to invest in a quality ALPR system that will pay for itself several times over.

Jennifer Sherblom is business development manager at Perceptics

by Magnus Westroth, Kapsch TrafficCom, Sweden

SMALLER, SMARTER

Single gantries offer capabilities that outperform those of multiple-gantry tolling solutions – but at a fraction of the footprint and cost

The decision to use a single- or multigantry solution is driven by a number of factors, including user requirements. Multiple-gantry geometry is still supported but will mainly be used when maintaining and upgrading the existing installed base, where the infrastructure is already in place, as in most cases the single-gantry geometry will have lower deployment costs due to less infrastructure being needed for deployment.

A perception is that there is a distinct trend toward single-gantry solutions. For new deployments, and in some cases for upgrades, the single gantry is an increasingly natural choice. Kapsch's single gantry is currently one of the most successful tolling/road user charging (RUC) solutions of its type in the world. An example is the current work to upgrade Austria's national truck tolling scheme, GOMaut. The original system went into operation in 2004. The need in Austria for reduced costs and modernization made it natural to use the single-gantry configuration for GOMaut 2.0. Elsewhere in the world, other high-profile replacement projects using a single-gantry configuration include the M5 South West Motorway in Sydney, Australia, as well as the Sydney Harbour Bridge and Tunnel.

A single gantry has also been deployed on the Tauranga Eastern Link and Takitimu Drive in New Zealand, and in the Autopista Central toll road concessions in Santiago, Chile. The system is also entering service in the US market, in projects including the Golden Gate Bridge in San Francisco, and Rhode Island, the location of the USA's first truck tolling deployment. There are also two projects in Norway, Nord-Jaeren and Nedre Glomma, where for narrow roads the system will be deployed on slim, low-footprint poles with cantilevers.

At the heart of the single gantry is the next-generation vehicle detection and classification (nVDC) system. This uses high-grade, industry-standard cameras in a Kapsch-designed configuration, together with the company's proprietary processing technology. It is a stereoscopic, above-ground, non-intrusive vehicle detection and classification system that operates in real time and in all traffic environments. The cameras use the infrared spectrum, and for night-time operation, invisible, pulsed LED infrared is used.

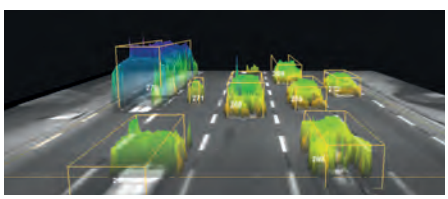
The key to single-gantry tolling in places like Sydney, Australia is the nVDC classification system

The detection zone

Vehicles' movements are tracked throughout the approximately 30m (98ft) detection zone, whether passing with constant or varying speed and direction. The nVDC continuously determines a number of vehicle characteristics including length, width, height, presence/absence of a trailer, number of axles, position, direction and speed. Once a vehicle is detected, it is tracked and the trigger points for image captures of both the front and rear of the vehicle are accurately determined. A key differentiator is the ability to correctly correlate the image captures to the correct vehicles' tags/onboard units, and also in heavy traffic, stop-and-go traffic and when vehicles change lanes under the gantry, something that is increasingly important as traffic volumes grow.

Bidirectional and accurate

The nVDC system provides very accurate performance at vehicle speeds well over 200km/h (124mph) and is fully bidirectional. There is high market interest in video tolling, as it offers the ability to capture toll collection data from vehicles using a toll road in the same way as a system using DSRC transponders or RFID tags, but



Above: **Single gantry tolling has been applied to roads in a variety of countries worldwide, including in Santiago, Chile**

at a lower deployment cost, including the costs to distribute transponders and tags to users.

The video tolling performance has improved significantly due to technology improvements, and will continue to do so, and the Kapsch single gantry supports pure video tolling in parallel with combined transponder/tag- and vision-based tolling. For the New Zealand installations mentioned above, the single gantry system is being used in a pure video tolling application, with no transponders distributed to road users.

Still, weather conditions and license plates remain unchanged. There is always a risk that license plates cannot be read due to weather, damage, dirt and obstructions. The revenue loss associated with a video-only solution compared with a combined transponder/tag- and vision-based solution could quickly outweigh any cost saving associated with deployment. In many cases, a combined solution provides the best overall financial result, taking into account both investment and operations cost as well as toll revenue loss.

Therefore it is best to offer several transponder and RFID communications subsystems that accord with all relevant communications standards in various markets. This includes variants supporting multiple protocols. The transponder or RFID communications subsystem reads and authenticates all the transponders or tags in vehicles that pass through the single gantry's charging zone. Using various technologies, the communications subsystem also provides location information for the transponders/tags that have been read. This location information is used for correlation of transponders and tags to the vehicle, with the vehicle locations tracked by the nVDC subsystem.

The roadside controller associated with the single gantry is located in a cabinet or shelter at the roadside or in a central location. It hosts the coordinating software modules for the nVDC, vehicle registration and DSRC transponder or RFID communications subsystems, and overall coordinating software module, which implements specific business logic and provides an interface to the central system for delivery of the toll data.

Versatility is key

The system's deployment options highlight a recurrent theme and a key characteristic of the single gantry – versatility. The technology options already detailed are combined with a smaller physical footprint, lower visual impact, reduced infrastructure requirements associated with installation, and less maintenance overall. In sum, there is a compelling cost and operating case to be made for its adoption.

These features combine to broaden its appeal for a wider range of applications. Tolling has historically been a characteristic of strategic and inter-urban roads, but for urban authorities concerned with the on-street environment, the single gantry offers particular appeal. It is a prime choice for applications such as congestion charging and HOT lanes. It is also possible to reduce the intrusiveness of tolling/RUC systems even further by using a pole mount and outrigger instead of a gantry, which Kapsch is already deploying in several projects.

Magnus Westroth is head of solution management, roadside systems, at the Solution Center Tolling, at Kapsch TrafficCom, Sweden

by Jon Ramirez, Cubic Transportation Systems, USA

APP-DRIVEN CHANGE

Transportation is transforming, one app at a time – and thanks to advances in technology, it is becoming more seamless and accessible

Waking up on June 29, 2007, most people had no idea that the world had just embarked on a journey that would continue for a decade and into the foreseeable future. Billion-dollar industries would sprout from the launch of the original iPhone and society would make a quantum leap forward in the daily use of, and reliance on, technology.

This remarkable device that fits into the palm of one's hand would change the ways that we work, play and interact with each other. It would shake to the very core how we look at individuals' privacy and it would change lives in a multitude of ways, both good and bad. Most importantly, though, it would open up a brave new world to the possibilities of positively affecting how we travel.

MACRO TRENDS FORCING CHANGE

It was not long ago that the working populace first begun the drudgery of the daily commute to work via motorized vehicles. Traffic in metropolitan areas continued to grow, with little hope of improvement, driven by the population growth and the changing urban/rural mix. Today, approximately 50% of the world's population lives in cities, but this is expected to shift to 70% by 2050.

With more people living in cities, the impact on transportation infrastructure will be heavier than ever. As technology becomes more integrated and commonplace, society continues to move quickly toward personalized, on-demand services, pushing for new commercial travel models with enhanced analytics. The growth of the on-demand economy puts further pressure on public infrastructure, with the size of the market estimated to reach nearly US$70bn in 2018 (with some analysts predicting the addressable on-demand market at as much as US$750bn). Congestion will continue to get worse and the need for efficient public transportation will become even greater. An aging population and demands from new generations, such as millennials, will further impact the way we interact with travel services, pushing models where usage is more important than possession.

DEMANDS OF TOMORROW

Technology has already begun changing things ever so slightly, allowing people to work remotely or from home, for example, thereby easing the stress on the public transportation network.

With smartphones able to process considerable amounts of data – the iPhone 6 is able to process more than three billion instructions per second – we are at the precipice of a major change in how we conduct our daily commutes, and mobile apps sit at the heart of this revolution.

For instance, today's travelers encounter single-payment solutions for each leg of their journey. While mobile apps have made the payment process much easier, it is still cumbersome to scroll through a myriad of payment apps, each requiring a separate user name and password. Travel planning apps are no better. The schedules on those apps rarely provide real-time data. Instead, they mirror printed schedules that are otherwise accessible at bus stops and in other locations. These non-interactive schedules make journey planning difficult at best, especially when travelers use different modes of travel or different travel operators. Ticketing remains rigid and inflexible, and even in the era of mobile

apps, fragmented travel networks mean real-time data is shared infrequently and holistic analytics are often not possible. Vast numbers of apps are singularly focused on one particular mode of travel – be it train, subway, tolling, ride sharing or parking.

In a world where access – rather than ownership – is key, and where consumers' immediate needs must be satisfied with the tap of an app, the industry must look for alternative solutions.

THE SOLUTION

One such solution is One Account for transportation. The concept of allowing travelers to combine all the disparate accounts into one single account per user paints a vision of a completely integrated travel experience – an experience that would not only give consumers the options they so desperately crave, but more importantly, that would allow the regional transportation authorities to directly influence traveler behavior by offering discounts, retail promotions and other enticements, to drive a change in behavior; for example, by discouraging travelers from using a particular mode of travel at a particular time (due to a traffic incident in the area, for instance). Such an approach would also help address the first- and last-mile issues, possibly through third-party apps and APIs, allowing for integration of public and private transportation networks.

Finally, it would also answer the need for new models delivering regional transportation solutions, offering a world where one can access an app that proposes the cheapest, most environmentally friendly, fastest, or even the most scenic way, to get to one's destination.

Opposite and above: **Cubic's One Account integrates transportation apps and services**

This world actually exists today. Cubic Transportation Systems has been supporting and providing One Account-type solutions globally for many years. The technology is here and it is waiting for the next generation of big thinkers to incorporate their ideas to make congestion and inefficient public transport a distant memory.

Jon Ramirez, director, tolling worldwide, Cubic Transportation Systems

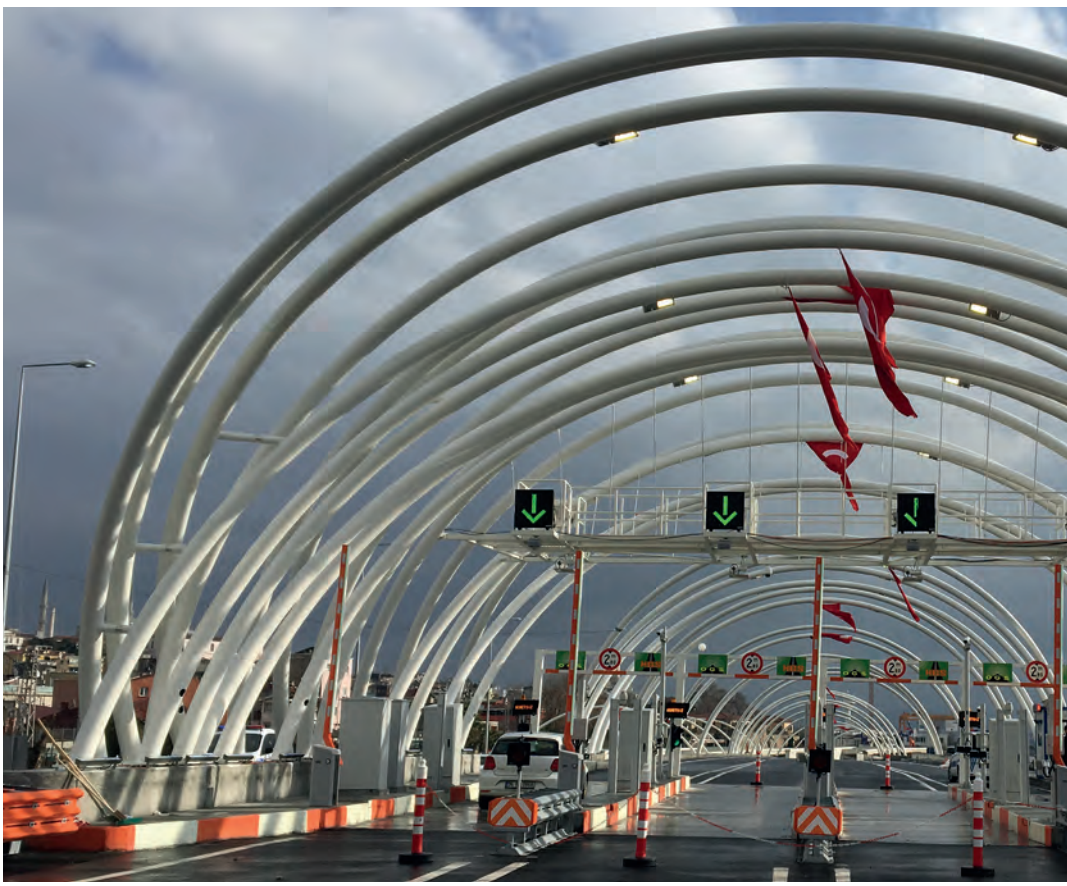
by Dr Erkan Dorken, Aselsan, Turkey

TOLLING IN TURKEY

Major public-private partnership projects are quickly and effectively modernizing Turkish tolling operations

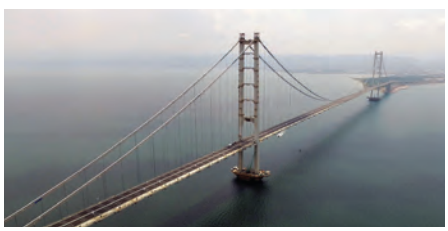
In recent years Turkey has launched three public-private partnership (PPP) toll road projects. The Gebze-Izmir toll road runs 433km (270 miles) from the industrial city of Gebze to Izmir, the country's third-largest city. The road spans the Gulf of Izmit over the 2.6km (1.6-mile) Osman Gazi Bridge, the fourth-longest suspension bridge in the world. This toll road will be operated for 20 years by the winning concession. The second PPP project is part of Northern Marmara Highway and is planned as a 100km (62-mile) third ring road around Istanbul. This ring road crosses the Istanbul Strait over a third suspension bridge. The concession will operate the road for seven years before handing it over to the state. The third PPP project is the two-level Eurasia Tunnel under the Istanbul Strait, linking the two sides of Istanbul and connecting the continents of Europe and Asia.

The tolling systems for all three PPP projects were delivered by the Turkish tolling technology provider Aselsan.



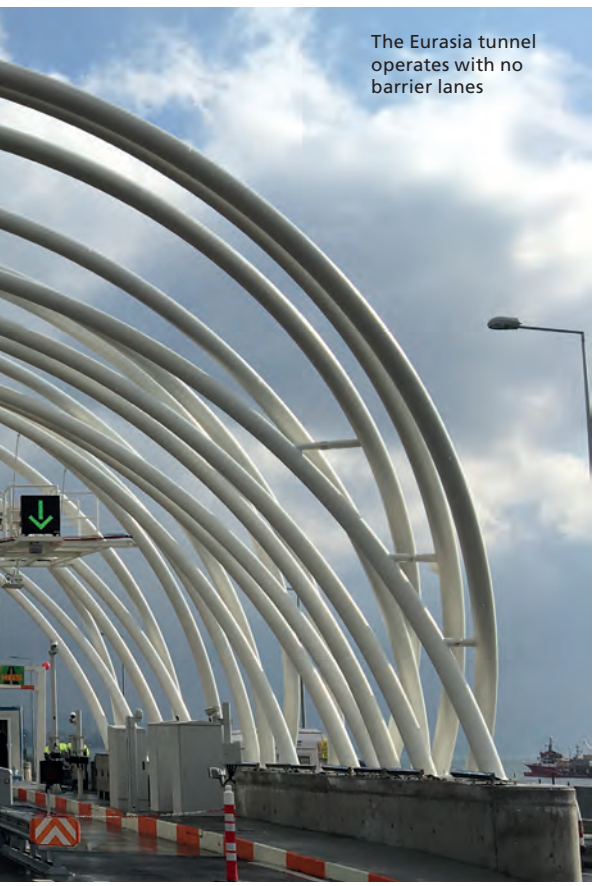
STATE-RUN TOLLING

Before the new PPP projects, all toll roads were operated by the Turkish state-run institution General Directorate of Highways. The country already had a long history of highway tolling and country-wide standards for toll payment methods were in place. Turkey uses both DSRC technology, known as OGS, and RFID stickers, known as HGS, for electronic tolling payment. OGS and HGS devices are distributed by participating banks, which also manage accounts. Previously the tolling system was 'multiple issuers, single operator'; after the new concessions it became 'multiple issuers, multiple operators'. For this, the banks importantly kept accounts for the subscribers (as opposed to keeping the accounts for each operator), to adapt to this new multi-operator tolling scene. Also, as the architect of the new system and most of the state-operated tolling systems in Turkey, Aselsan played a central role in preparing the country's drivers for the new tolling system.



In the PPP contracts, the concessions may not claim for toll evaders in their reconciliation reports making it very important to minimize violations. Among the three PPP projects, the highest toll is on the Osman Gazi Bridge, at €15 to €50 (US$17 to US$58) according to vehicle class. With this level of toll it is important to ensure that every driver can actually pay. As the provider of the tolling system, Aselsan designed it to satisfy all these requirements.

Once an electronic payment device is detected the system first does a real-time check of the account balance in the subscriber's bank. If the account balance is sufficient, the toll due is deducted and an approval code is received from the bank. The code is then used for the reconciliation



The Eurasia tunnel operates with no barrier lanes

Above: The Northern Marmara Highway bypasses Istanbul to alleviate congestion in the city
Left: A variety of payment methods are included in Aselsan tolling solutions

between the toll operator and the bank. For successful electronic payments, the barrier opens and the vehicle leaves the toll lane. For the vehicle to complete the transaction at a non-stop speed around 30km/h (19mph), the barrier is placed 40m (130ft) from the electronic payment point.

When the electronic payment option fails, the vehicle is stopped by a barrier and the driver is asked for cash or credit card payment. For this reason, all lanes are also equipped with a toll booth.

Both Northern Marmara Highway and Gebze-Izmir Highway operate on this principle of hybrid electronic/cash/credit card lanes. At the two ends of Northern Marmara Highway the junctions are close together. In order to avoid having several toll plazas at each end, for this part of the highway multilane free-flow tolling systems are used. The middle section of the highway is equipped with toll plazas.

The Eurasia Tunnel across the Istanbul Strait starts in densely populated areas of the city where there is insufficient space for cars to wait in line to make payment. For this reason, the tolling system at the Eurasia Tunnel operates with no barrier lanes.

The state-operated highways enforcement is based on a legal infrastructure. Any violation penalty paid late is referred to the Revenue Administration Office. The rest of the process is no different from chasing up tax evaders. All private concessions work with companies specializing in legal procedures. Such use of expertise in legal follow-up has proved effective for collecting unpaid violation tickets.

Turkey is moving in the direction of more PPP toll highway projects. There are already five new projects for which the concessions have started constructing the highway. Once all the projects are completed, the private concessions will dominate the tolling scene in the country, with help from Turkish tolling technology expert Aselsan making it possible.

Dr Erkan Dorken is head of business line traffic, automation and medical systems at Aselsan

by Max Staudinger, EFKON, Austria

PORTABLE TOLL ENFORCEMENT

Mobile toll enforcement equipment is being used across Europe to ensure that evaders of fixed tolls are caught and revenues are protected

Open road tolling has become the predominant method of toll collection for heavy goods vehicles (HGV) in Europe. Two major approaches have been pursued – 'wide area' tolling using satellite technology (in Germany, Belgium, Slovakia, Hungary, Switzerland and Russia) and dedicated short-range communication (DSRC)-based tolling using gantry mounted equipment (in Norway, Austria, the Czech Republic, Poland, Belarus and Portugal). To be in control of revenues, road operators need to make sure that payments are collected and base data is correct. Such enforcement is typically accomplished by three measures: fixed – on gantries spanning multiple lanes or fixed cantilevers; flexible – portable devices that can temporarily be placed to control almost all segments, to avoid the bypassing of fixed structures; and mobile – using patrol cars.

Although fixed systems collect data at high-traffic spots, it is too expensive to control a nationwide network using fixed structures only. Furthermore, road users quickly learn where they are and therefore have the option to bypass them.

FLEXIBLE ENFORCEMENT

The solution for flexible enforcement typically has similar functionality to fixed or stationary systems. Systems detect vehicles, determine the class, read license plates via ALPR and extract onboard unit (OBU) information via a DSRC link. Records are then transmitted to the back office for verification or stored on-site if there is an insufficient data link. The systems give control of high traffic volumes anywhere on the tolled network, and provide a certain 'surprise effect' for drivers, which is needed to discourage toll users from attempting to beat the system.

The devices can also be used to create statistical records of interest to determine the amount of traffic and to collect intelligence across the entire network. This information can be used for better planning of resources and more effective enforcement at a lower cost.

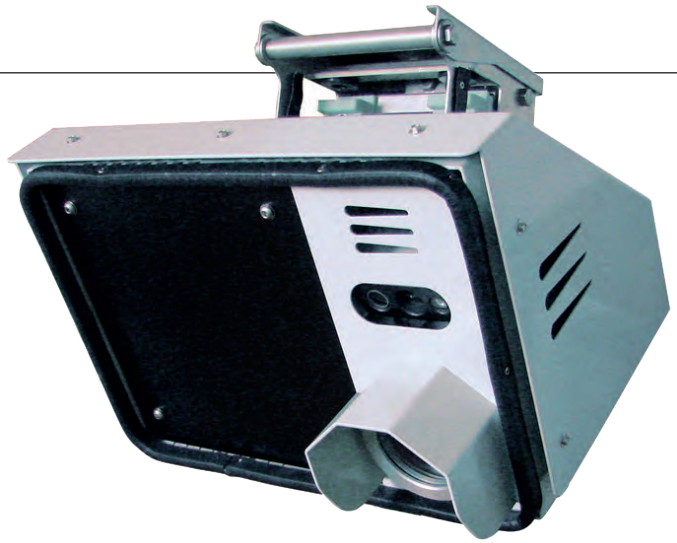
Typical KPIs include detection rates, correctly identified toll liability and correct reading of license plates. Typical SLA parameters include availability and moving times.

MOVING AND PLACING

When implementing flexible enforcement, beside the equipment itself, there is a need for a team and an organization to move the devices from one location to another

It sounds simple in terms of technology, but it's not so easy. The roadside being used to place the devices must be certified to comply with all rules, otherwise it is possible for drivers to repudiate recorded evidence being used against them. In addition, under typical legislation, it is not always clear who is authorized to issue permission for the placement of devices. In the ideal scenario, it takes place on the soft shoulder or hard shoulder of a road that is fully under the control of the toll charger (an authority or concessionaire), or any other public authority's territory. Moving personnel must be provided with a safe space to park the operating vehicle while placing the device.

Another relevant item is the positioning mechanism. The heavier it is, the better the protection against wind or vandalism, but the more difficult it will be to dismantle or hoist. Power may be present at the certified locations, but mostly it is supplied by a battery pack that lasts for some time and can also be replaced quickly if



Mobile enforcement can be used to carry out random checks across tolled road networks

a deployment is scheduled for longer than one charge. In frequently used places it may also be possible to have a permanent concrete base with an acceptor for rapid fixing of the apparatus.

In order to adjust, the operator needs to have a local human-machine interface (HMI) device to check the correct capturing of images and data, and operational parameters. At the same time, a central officer needs to be able to view and access all data, provided the data link is stable.

REALIZATION EXAMPLES

Flexible enforcement systems in Germany can be mounted on bridges or walk-able gantries. Revenue-wise, the German truck tolling system is the largest free-flow toll system in the world. The 300 fixed enforcement sites are enhanced by 22 flexible devices and 278 mobile patrol vehicles acting to catch violators, based on harvested data.

The enforcement system in Belgium covers all of the country's roads, amounting to more than 150,000km (93,200 miles). Tolls are only collected on 7,000km (4,350 miles) at present – but the OBU is mandatory at all times and everywhere – and tolls can also be enforced on 'zero' segments. There are 40 fixed enforcement locations and the rest of the network is covered by the 22 flexible devices and 40 mobile vehicles.

In Austria toll stickers are controlled by flexible systems, mounted on bridges, walkable structures or temporary tripods on the roadside.

In countries where tolls are collected with DSRC, monitoring is typically done in places where a DSRC transaction system is also present. Therefore it is common for a flexible system to be attached to a gantry, which then also allows the capturing of enforcement data in addition to DSRC.

COST AND COST-EFFECTIVENESS

In the majority of cases, staffing represents the highest cost of such a project. Another cost driver, if a decision for building is made, is the need for spaces that are specially prepared for flexible enforcement. In general the cost also depends on choice of enforcement strategy.

The aim is not solely to maximize enforcement revenue, but also to minimize evasion at the lowest cost and without systematic gaps. This might include a mix of high visibility and surprise effects, times of high and low control density, and also fine levels.

Altogether, flexible enforcement is a highly practical and proven method for controlling extensive tolled road networks. As such, it will remain a key method in the successful tolling of wide area systems for many years to come. ■

Max Staudinger is an international sales manager at EFKON

by Tomas Pospisek & Dr Gerd Simons, Kistler, Switzerland

TOLL BY WEIGHT

High-accuracy weigh-in-motion technologies are paving the way to free-flow weight-based tolling

Accurate and reliable checking of heavy vehicles' weight has been in place for quite some time. Usually, an operator at the toll gate needs to be present to verify the measurement result from low-speed or static scales. With the increasing use of weigh-in-motion (WIM) technologies that can operate in free-flow environments, more and more road operators are considering using certified high-speed WIM systems for the automated collection of tolls based on the actual weight of vehicles – and not on the category, number of axles or declared weight.

Kistler's WIM system with proven Lineas Quartz sensors can provide complete information about passing vehicles' weight, even if the vehicle is traveling at high speeds of up to 65km/h (2-40mph). The measured data includes not only total vehicle mass, but also axle and wheel loads, in addition to the vehicle category and number of other parameters.

Kistler's WIM datalogger can monitor and gather data from moving vehicles in real time

A MULTIPURPOSE SYSTEM

Lineas strip sensors are also used for more traditional tolling applications using separated driving lanes at the tolling gate. One of Kistler's projects, which is currently underway in Russia, demonstrates the capabilities of Lineas sensors when connected with a Kistler WIM datalogger for tolling systems in dedicated lanes. Thanks to the advanced algorithms, the WIM measuring chain can not only accurately measure the vehicle within a broad speed range (5-100km/h), but it can also manage the 'stop and go' traffic that is common in lanes during peak hours. Such performance of the WIM system enables the road operator to rely on accurate weight checks of heavy vehicles and to collect the data in real time without the need for manual intervention.

A PROLONGED LIFETIME

In order for an authority to legally weigh vehicles as part of an enforcement system (such as vehicle weight or toll enforcement), solutions must be certified, reliable and durable. Since 1998, Kistler's quartz sensors have been proving their qualities in hundreds of projects in all climatic conditions all over the world. Hundreds of tolling lanes are equipped with maintenance-free Lineas sensors that have been providing accurate weight data, 24/7, for many years. Users can benefit from Lineas's excellent durability and their extended lifetime, as they can opt for the manufacturer's prolonged warranty of up to five years, thereby securing their investment. The performance of the Kistler WIM solution has been confirmed by independent metrology agencies – in addition to many locally valid certificates, it is also certified according to the standard OIML R134.

EASY SETUP, FLAWLESS INTEGRATION

Kistler's WIM measuring chain, which comprises Lineas quartz sensors, a WIM datalogger, and auxiliary components such as inductive loops and beam arrays, has been designed to be easily integrated into complex systems such as an electronic toll collection network or enforcement systems. The ease of installation of Lineas is accompanied by a user-friendly, quick and intuitive software setup and calibration. Data output is open and fully documented and it can therefore be flawlessly communicated with other components of tolling or enforcement systems.

PORTFOLIO OF SERVICES

The users of WIM systems in tolling applications often require complex services when it comes to the design, installation, calibration, fine-tuning and maintenance of measuring devices. Kistler's specialized, globally located service engineers and its development teams are able to provide qualified support in all phases of planning, designing, installing and operating the company's WIM system. Customers can benefit from Kistler's vast experience from many applications around the globe, for the successful design and operation of an advanced WIM system.

Tomas Pospisek is a sales manager, EMEA, road and traffic, at Kistler. Dr Gerd Simons is head of the business field, road and traffic, at Kistler

by Rish Malhotra, International Road Dynamics Inc., Canada

ENHANCING CLASSIFICATION

Accurately and effectively determining the classification of vehicles passing through a toll zone is crucial to ensuring that the correct toll is charged for each vehicle. A new system is helping

Class distinction is effective for electronic toll system operation. Most toll operators charge different toll prices depending on the characteristics of the vehicle using the road. In today's electronic toll collection (ETC) environment, drivers don't have to stop to pay a toll if they don't want to – and this enables them to avoid unnecessary congestion and delays.

COMMERCIAL COMPLIANCE

Both public and private toll operators face this challenge, but they are not alone. For many years, agencies responsible for commercial vehicle compliance have addressed a similar challenge: how can the characteristics and conditions of commercial vehicles be monitored and assessed in a non-intrusive manner, while achieving compliance and avoiding delays? This challenge has led to the development of sophisticated technology solutions that enable commercial vehicle compliance to be conducted in a high-speed, non-stop environment such as ETC. What if a well-proven and accurate technology for commercial vehicle compliance could be adapted and made available for ETC use?

International Road Dynamics (IRD) has harnessed expertise and integrated advanced technologies into systems designed to solve challenging transportation problems. It has delivered equipment for over 6,000 lanes of toll collection and auditing systems throughout the world, and has created a customized vehicle classification system for ETC. The system, known as Intelligent Automatic Vehicle Classification (iAVC), represents the latest advance in the application of dynamic information management technologies for accurate and efficient vehicle classification.

iAVC combines sensor and measurement technologies for applications in toll road operations, toll collection audit systems and traffic data collection. The system measures vehicle data including axle spacing, axle width, lane position and tire configuration.

Thanks to iAVC, vehicles can be classified accurately and efficiently, and charged for tolls accordingly

The system is designed to integrate with ALPR and automated vehicle identification (AVI) or transponders to provide a flexible approach to vehicle classification and the ability to verify the operation of the electronic toll system.

Vehicle classification needs vary considerably across public and private toll operating organizations. For example, in some cases it is important to be able to differentiate between two-wheeled and four-wheeled vehicles, whereas in other cases it is more important to obtain the weight of the vehicle or its length. Other concessionaires may be interested in additional information related to types of tires, as well as vehicle class, in order to charge toll fees and recover revenue over the concession period. The iAVC system can accommodate a wide range of vehicle classification and charging approaches to deliver accurate results.

ADDITIONAL FEATURES

The iAVC system can monitor electronic toll system operations, thereby acting as an auditor. This provides the additional benefit of electronic toll system verification.

Another benefit of the iAVC system derives from its use in the commercial vehicle enforcement arena. The sensor and measurement system is capable of detecting tire anomalies, such as underinflation. This provides the basis for vehicle safety programs that give feedback to toll road users to improve safety and operational efficiency. Such additional information can provide concessionaires with the ability to appropriately charge vehicles that are driving on potentially unsafe tires.

The use of multiple sensors in combination enables the iAVC system to deliver a large quantity of raw sensor data that can be used for multiple applications. IRD is working closely with clients to define and develop new ways to analyze the data.

Class distinction is vital for successful operations. With the iAVC system, IRD has developed a way to effectively and efficiently distinguish between vehicle classes specifically for electronic toll system operations. The system delivers accurate and flexible vehicle classification while providing additional support in electronic toll system audit and vehicle safety programs. Class does matter in electronic toll collection – are you using the best approach?

Rish Malhotra is vice president of international business at International Road Dynamics Inc., Canada

THE LAST WORD...

By Tom Stone

Bern Grush, autonomous transit strategist at Grush Niles, believes we will have to wait for autonomous taxis to hit our streets before any kind of road user charging will be possible

In recent years the transportation industry has been placing much hope in the concept of pay-per-mile road user charging (RUC) as a means to address falling gas-tax revenues. In a world of fuel-efficient, and even all-electric, cars, a funding crisis looms. (See page 40 for former UK transport minister Steven Norris's opinion on the subject.) But although there are plenty of RUC pilots being conducted around the world, Bern Grush, a founder of transportation consultants Grush Niles, and former *Traffic Technology International* columnist, believes that selling the concept to the public may be more difficult than optimists would have us believe.

"THE PROGRESS TOWARD AUTOMATED VEHICLES IS GOING TO BE SLOWER THAN WE THINK, BUT THAT PROGRESS WILL ALSO HELP TO ACHIEVE PROGRESS TOWARD ROAD PRICING"

"Public acceptance of road pricing is fraught with misunderstanding," he says. "There is a sense of unfairness. People don't want to pay for something they previously perceived as being free. It can sound like a tax grab. They might understand congestion pricing in a bounded area, but road pricing everywhere is different. There are lots of roads that are empty. There are lots of roads that are in a bad state of repair. Or they might argue the road was paid for long ago… there's a whole list of reasons why people might not like it."

On top of this Grush cites the rising cost of living and, fundamentally, resistance against pressure to drive less as the average driver's key arguments against RUC. "People don't want to drive less," he says. "Our species has been used to powered mobility for a long time, ever since donkeys, camels and horses. Those of us with more powered mobility got more of other things, too. We got more land and we got more women and we got more food and we killed more enemies, because we could move faster and better. So now people have cars, which enable them to move all the things they want, whenever they want, and RUC could be perceived as restricting this, because small charges add up to a large amount of money over time. So there are many reasons, imagined and real, that mean people will say 'no' to it. And there are also many reasons why they should say 'yes', but your average citizen doesn't understand them. There's so much feeling against road pricing that it's not going to happen."

However, Grush does see a solution to the crisis on the horizon – not through any smart education program about the benefits of RUC, but through the widespread adoption of autonomous vehicles. "The progress toward automated vehicles is going to be slower than we think, but that progress will also help to achieve progress toward road pricing.

"Let's say that by 2030, 45% of the world's population will have access to 'robotaxis'. I hope by then I'll be able to say that RUC got buried in robotaxi fees. When you use one of these cabs you'll be expecting to pay a certain amount per mile. What I'm saying is that a couple of cents of that will have to be tax for road maintenance, and some will be profit. We only need a couple of cents for the roads. The company that's running it will want profit anyway – 6 or 8 cents per mile.

"I'm a firm believer that while we're in a democratic environment, where politicians can lose their jobs for promoting road pricing, we're not going to have it. I'm absolutely convinced of that. But I'm hopeful that we will get it into autonomous vehicles."

If we do eventually reach this road-pricing Utopia, what could it mean for traditional toll roads? Will they still be needed? "Traditional tolls could survive if they reduce journey times," says Grush. "But with the agony of stop-start driving gone – because the car handles that – some drivers might avoid toll roads altogether."

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