April/May 2016

traffic
TECHNOLOGY INTERNATIONAL

V2X risking failure
How the EU is working to avoid a connected vehicle catastrophe

New congestion problems
A huge growth in bicycle traffic calls for new detection solutions

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International Events Special!
- ITS America San Jose
- Autonomous Vehicle Test & Development Symposium
- ITS European Congress

How can authorities continue to use automatic license plate recognition cameras in the face of new laws that restrict the use of their data?

PLUS

AV standards required?
Currently standards for autonomous vehicles are practically non-existent. How long can this situation continue?

Virtualization explained
The computing techniques that are bringing a revolution to advanced traffic management systems

Paul Zanelli
How is the UK's Transport Systems Catapult CTO keeping Britain at the forefront of innovation?

Nothing stopping us now

In 2015, Sanef ITS converted two major toll highways into All Electronic Tolling infrastructures in Puerto Rico and in the UK.

The company will accelerate its transformation in 2016.
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Join us at the **IBTTA**'s All Electronic Tolling Summit in Boston (July 24-26)

> Visit our stand to find out about our futur plans and new identity
> Attend our Tech Talk on Cloud Tolling
> Discuss the future of free-flow tolling with our experts

Drop us an email if you wish to meet us in Boston: **communication@sanef-its.com**

Let's move & flow together!

www.sanef-its.com

Cover story

40 ALPR backlash

How can authorities best use ALPR data, while respecting public privacy?

Max Glaskin reports on the arguments for and against the use of automatic license plate recognition cameras

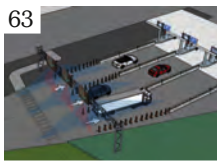
12

20

28

36

48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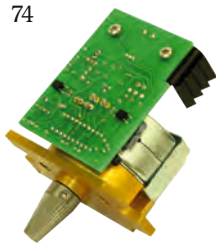
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Technology Profiles

Editor's letter

Conference season is once again upon us, and there is plenty to look forward to in the coming weeks. First up, *Traffic Technology International* will be co-hosting the second Autonomous Vehicle Test & Development Symposium in Stuttgart, Germany (May 31 to June 2). Last year, more than 400 delegates attended presentations from the world's leading experts in self-driving vehicle research – and this year's event will be even bigger and better.

In the 12 short months since the last event, driverless technology has continued to develop apace and some of the key issues are coming into focus – one being, how much longer can testing continue without international laws? One side of the debate suggests early rule making could stifle innovation and it is better for such vehicles to be more developed before legal restrictions are imposed. But the counter-argument runs that if we leave regulation too long, and a severe accident occurs, it could set the whole field back years. It's certain to be a hot topic on everyone's lips at the Messe Stuttgart. Brush up on the relative merits of the opposing sides of the debate in *By The Book?* on page 20, and find a preview of the Symposium on page 12.

Just a few days later, a short air hop from Stuttgart, the ITS European Congress will be taking place in Glasgow, Scotland (June 6-9). Here, the great and good of the European transportation community will gather to take in the latest hardware innovations, exchange knowledge in technical sessions and, of course, catch up on the wider issues affecting transportation in the EU. One key driver of recent cooperation is the desire to ensure connected vehicle systems are fully interoperable – avoiding the mistakes made in electronic tolling that have led to a lack of interoperability becoming pretty much the norm. Turn to page 28 to find out exactly how the EU is already striving to make V2X work.

The final big event in the calendars of transportation professionals this June will involve a trip to San Jose, California, for ITS America 2016 (June 12-15). It's no surprise, given the massive technological evolutions in all areas of transportation, that the event is being held in what is often referred to as the 'Capital of Silicon Valley'. Expect plenty of interest from the multinational tech firms headquartered there. There's a preview of the event (alongside one of the ITS European Congress) on page 12. Keep your passport handy – it's going to be a busy few weeks!

Tom Stone
Editor

Editor
Tom Stone
tom.stone@ukipme.com

Acting deputy editor
Rachelle Harry
rachelle.harry@ukipme.com

Production editor
Alex Bradley
Chief sub editor
Andrew Pickering
Deputy production editor
Nick Shepherd
Senior sub editor
Christine Velarde
Sub editor
Alasdair Morton

Art director
James Sutcliffe
Art editor
Ben White
Design team
Louise Adams, Andy Bass, Anna Davie, Andrew Locke, Craig Marshall, Nicola Turner, Julie Welby

Head of production and logistics
Ian Donovan
Deputy production manager
Lewis Hopkins
Production team
Carole Doran, Cassie Inns, Frank Millard
Circulation
Adam Frost

Publication manager
Godfrey Hooper
godfrey.hooper@ukipme.com
Australasia business manager
Chris Richardson
chris.richardson@ukipme.com

CEO
Tony Robinson
Managing director
Graham Johnson
Editorial director
Anthony James

Traffic Technology International
UKIP Media & Events Ltd, Abinger House, Church Street, Dorking, Surrey RH4 1DF, UK
Tel: +44 1306 743744 • Fax: +44 1306 742525
Email: traffic@ukipme.com • www.ukipme.com

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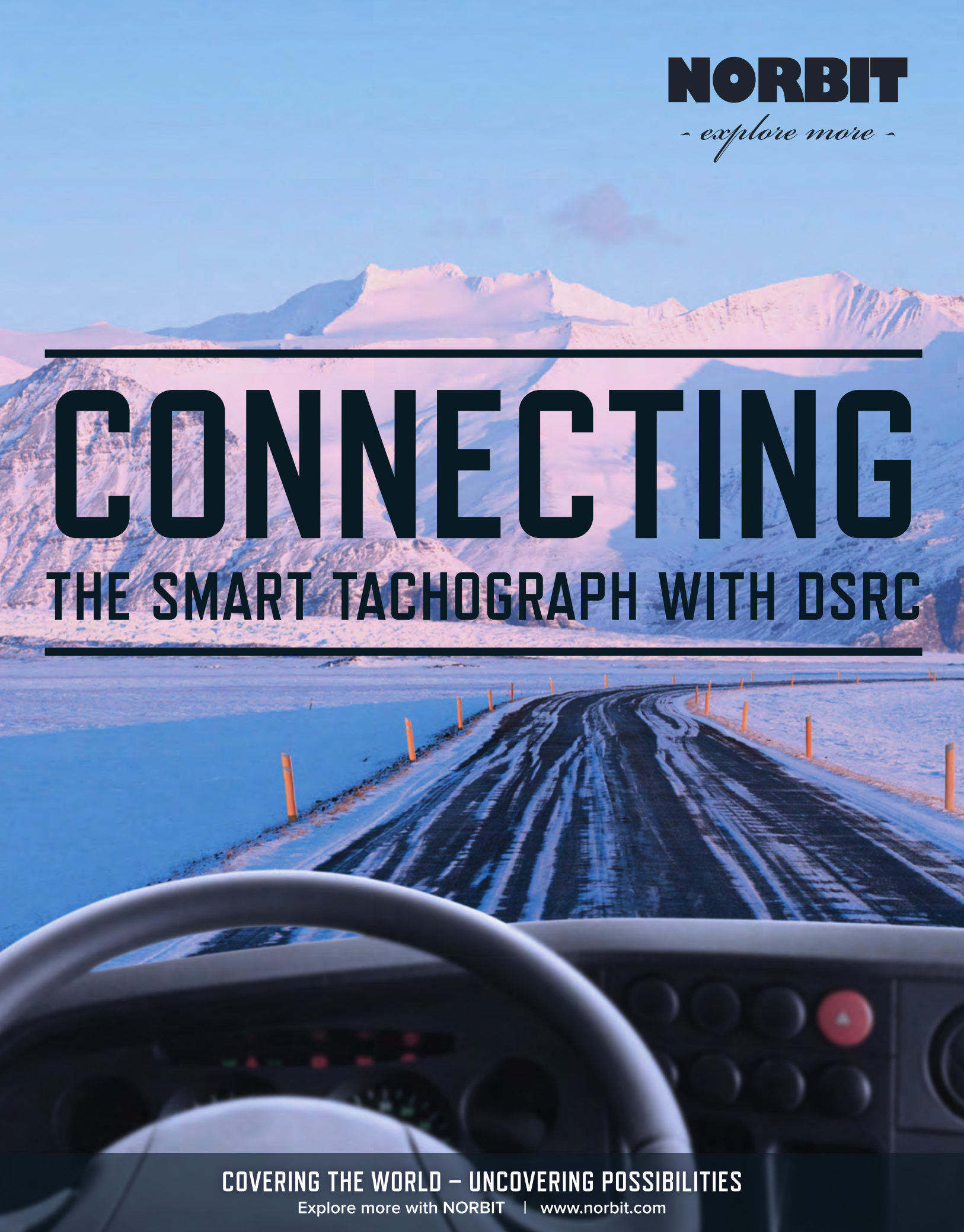
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Driving ahead

Calls for driverless-vehicle standards are growing as the technology becomes more advanced. **Mark Hall** rounds up the latest headlines and video reports in the field

Testing times

Swedish car manufacturer Volvo has announced that it will be undertaking large-scale autonomous vehicle trials in the UK in 2017 – and called for cooperation from transportation agencies and academics, particularly when it comes to setting unified international standards.

Watch the video here
trafficTechnologyToday.com/volvos

Passing the test

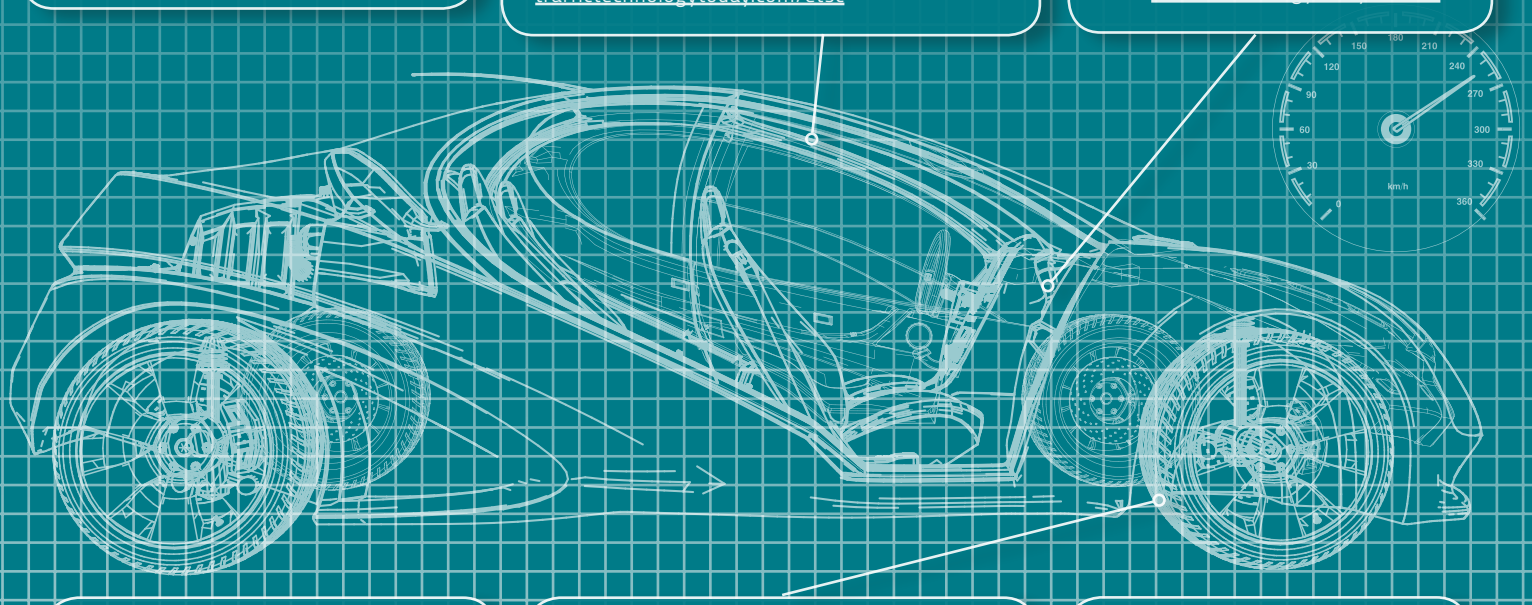
A new report from the European Transport Safety Council recommends that European Union rules on safety approvals for new cars will need to be revised to include 'driving tests' for automated and fully autonomous vehicles. The report says the priority must be ensuring that the promised safety benefits are delivered in real-world driving situations without creating new risks.

Find out more at
trafficTechnologyToday.com/etsc

Getting connected

A team from Fontys University of Applied Sciences and Eindhoven University of Technology, also known as the ATeam, showcased their new project at Intertraffic Amsterdam in April. 'The car of the future' combines both connected and autonomous features.

Watch the video here
trafficTechnologyToday.com/at



Unveiling new driverless pods

The UK's Transport Research Laboratory (TRL) has unveiled the vehicle that it will put through autonomous driving tests in Greenwich, southeast London. "The next step will be to get it to Greenwich and start testing it to make sure we are content that it is safe to use, ahead of full trials that are scheduled to begin by August," TRL academy director Prof. Nick Reed told *TTI*.

Find out more at
trafficTechnologyToday.com/trlpod

Driving autonomously in the dark

If an autonomous vehicle can function safely in complete darkness, what does it mean for the future of traffic management? It has implications for everything from road markings (which could be done away with) to enforcement. If you think safe running without any lights sounds far-fetched, check out this video that shows a team from Ford testing an autonomous Ford Fusion in Arizona, USA, in the pitch black of the desert night.

Watch the video at
trafficTechnologyToday.com/forddark

Calling for standards

A group of auto makers, ride-hailing services and technology companies have formed a new coalition to lobby the USA's lawmakers to take action on the rules surrounding self-driving vehicles. Ford, Google, Volvo, Uber and Lyft have announced the formation of the Self-Driving Coalition for Safer Streets.

Find out more at
trafficTechnologyToday.com/safer

Transatl

transportation

Key highlights

European ITS professionals will head for Scotland this June

After a highly successful call for papers where the organizers received more than 350 paper and 60 session proposals, the European Program Committee met in Brussels at the beginning of March to finalize this year's Congress program. The selected papers were grouped in accordance with the five key topics, ranging from automation through sustainability and environmental impact, to satellite services and user-centric service initiatives. With such a wide array of topics, all who are passionate about ITS will find plenty of exciting programs to join in Glasgow.

Here are some highlights of the extensive program:

- Mayor's Summit on June 8
- More than 100 sessions
- Scottish Evening at Kelvingrove Art Gallery and Museum on June 8
- Student Sessions
- Exhibition with over 100 exhibitors
- Technical tours of Scotland's best ITS

And, of course, beyond the confines of the Scottish Exhibition and Conference Centre (SECC) there will be lots else to see. "After a stimulating week of knowledge sharing, we invite delegates to immerse themselves in all that Glasgow has to offer: world culture through medieval castles, to the endless stream of coastlines and picture-perfect lochs," says Hamilton Purdie, host coordinator of the 11th ITS European Congress.

Register now at **glasgow2016.itsineurope.com**

11th ITS EUROPEAN CONGRESS
DELIVERING FUTURE CITIES NOW
Glasgow, Scotland | 6-9 June 2016

Glasgow, Scotland, has been steadily climbing the rankings of 'best cities of the world' over the past few years and those who have visited will understand why. The top-class architecture, coupled with vibrant culture and ever-famous Scottish scenery, all play their part in attracting more than 2.5 million tourists annually. This summer, Glasgow will add yet another reason for you to pay a visit by becoming the European hub of everything ITS.

Future ready

The theme of the congress is Delivering Future Cities Now and it will focus on increasing connectivity, bringing new services to users and improving communication, all this with sustainability in mind. This emphasis on maximizing benefits to the user will be highlighted throughout the congress, exhibition and demonstrations, where a wide range of exhibitors, including public administrations, industry and ITS-related organizations, will showcase the latest technologies and services available to deliver future cities now.

Researchers, policy makers, industry representatives and top university talent will come together for a week to share knowledge and experiences, catch up on the latest trends and developments, and learn from each other on world-class ITS solutions.

"The congress is designed to provide insight into the real-life ITS solutions of today and showcase the ideas of tomorrow with a wide array of programs and activities," says Didier Gorteman, director of congress and chair of the European Programme Committee. "In addition to the session discussions, demonstrations will give participants the chance to experience technological advancements first-hand, while the exhibition will provide the opportunity to stumble on some of the ingenious ideas revolutionizing transport today."

> "The congress is designed to provide insight into the real-life ITS solutions of today and showcase the ideas of tomorrow
>
> *Didier Gorteman, director of congress and chair of the European Programme Committee, ERTICO – ITS Europe*

lantic

This June, two key ITS events are taking place back-to-back on opposite sides of the Atlantic – the ITS European Congress in Glasgow (June 6-9) and ITS America 2016 San Jose (June 12-15). We spoke to the organizers of each to get the inside story on the not-to-be-missed highlights

ITS America 2016
San Jose, CA
McEnery Convention Center June 12-15
Integrated Mobility. Transportation Redefined.

Silicon Valley calling

The ITS America Annual Meeting has long been a key event in the US transportation calendar. This year its successor, ITS America 2016 San Jose, will be no exception as visitors can expect four days packed with vital industry debate and knowledge exchange, plus the chance to engage directly with the key ITS vendors who will be exhibiting. The fact that this year the event will be hosted in San Jose, often referred to as the capital of Silicon Valley, underlines how ITS is increasingly engaged with the wider tech industry, particularly through cellular technologies, wi-fi and the Internet of Things.

Making connections

The theme this year (Integrated Mobility. Transportation Redefined) is a further reminder that 21st century highways must be fully connected, not only with other transportation modes, but also with the wider communications infrastructure. ITS America 2016 San Jose promises to not only attract the best minds from business, public agencies and academia, but also bring in new thinking from app developers, software engineers and communications experts – while, of course, not losing sight of key perennial challenges in transportation such as funding and sustainability.

"ITS America 2016 San Jose will redefine the industry's perception of integrated mobility," says Regina Hopper, president and CEO of ITS America. "It's a completely new event, created specifically to represent this transformative moment in intelligent transportation. Attendees – from innovators to implementers – will be steeped in opportunities for dynamic discussions, debates and demonstrations focused on generating new ideas about 'what's next' for a world where transportation is at the center of the Internet of Things."

> "ITS America 2016 San Jose will redefine the industry's perception of integrated mobility"
>
> *Regina Hopper, president and CEO, ITS America*

Daily themes

This year in San Jose, each day will have its own distinct theme

Sunday, June 12
#THISisITS Making it Work
USDOT will host a session entitled Accelerating ITS Deployment, open to anyone who registers. The Board of Directors Meeting, State DOT Roundtable and Best of ITS Showcase will be open to all paid attendees, while the State Chapter Workshop and ITS America Membership Meeting are members-only events.

Monday, June 13
Wheels and Things
Sessions and demonstrations will focus on all moving things that use, alter or create new ITS. Cars, bikes, buses, metros, trucks, trains and even drones – each of these are envisaged to become data-producing nodes. Sessions will also investigate the policy issues around security.

Tuesday, June 14
Infrastructure of Things
The Tuesday will look at the infrastructure the 'wheels and things' interact with, as well as the communications backbone. This day will address the overall structure and future of traffic management, again looking at technical security issues, as well as how deep learning will create 'new' infrastructure.

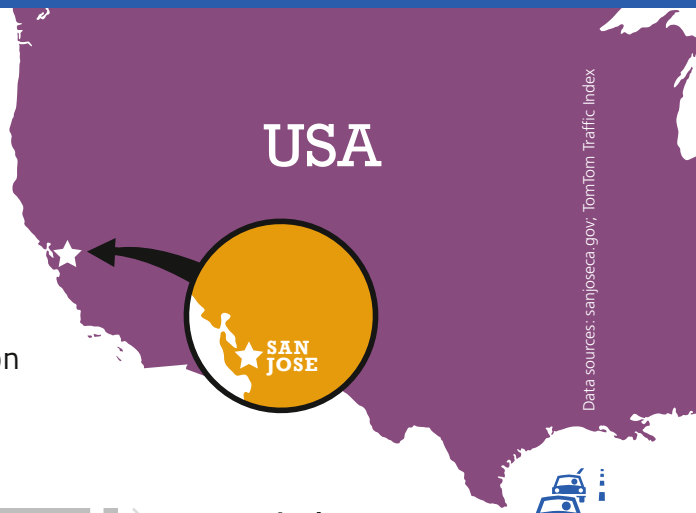
Register now at **itsamerica 2016.org**

Wednesday, June 15
Show Me The Money!
This day will focus on what the ITS back-end will look like in the future. Seamless payment systems, billing, customer relationship management, identity, network management, apps, insurance and, of course, funding.

The way to San Jose

ITS America 2016 will take place in **San Jose** this June. The 'Capital of Silicon Valley' is striving to create a transportation network that lives up to its reputation for innovation

Infographics: Anna Davie



San Jose is the 10th largest city in the USA and the third-largest city in California, with a population of over **1,000,000**

San Jose has **64,000** streetlights,

18,000 of which are being converted to low-energy LED bulbs

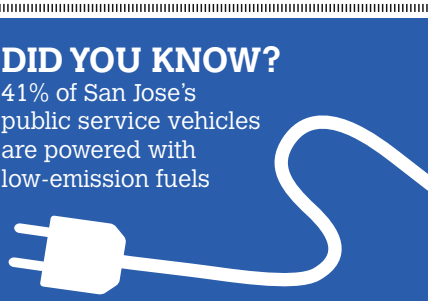
Transportation means to get to work

- Car, truck or van (88%)
- Work from home (4%)
- Public transportation (4%)
- Walk (2%)
- Bicycle (1%)
- Other (1%)

There are **10,100** managed parking spaces across San Jose's parking garages, surface lots and roads

21% of the electricity used in San Jose comes from renewable energy, including solar power

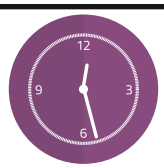
DID YOU KNOW?
41% of San Jose's public service vehicles are powered with low-emission fuels



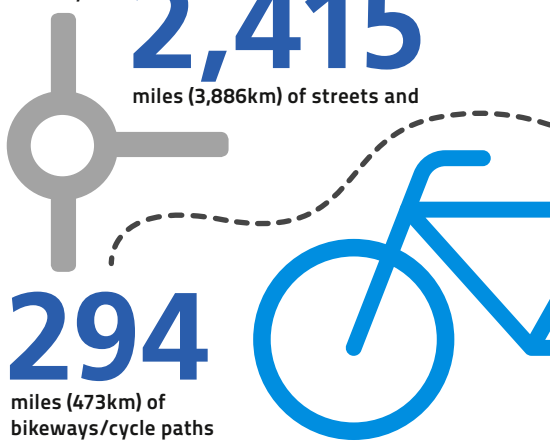
San Jose has **165** vehicular bridges

San Jose is the **51st** most congested city in the world

The average travel time to work is **27 minutes**



The city has **2,415** miles (3,886km) of streets and **294** miles (473km) of bikeways/cycle paths



San Jose has 57 miles (92km) of public trail networks – with a goal to extend this to 110 miles (177km) by 2022

Autonomous Vehicle TEST & DEVELOPMENT Symposium 2016

31 MAY – 2 JUNE 2016 STUTTGART, GERMANY

The world's **ONLY** conference dedicated to the **testing** and **development procedures** for autonomous vehicles and advanced driver assistance systems

The **Autonomous Vehicle Test & Development Symposium 2016** will bring together the world's leading engineers in the field of autonomous vehicle research, testing, validation and development. The conference will be held in Stuttgart alongside Automotive Testing Expo 2016, the world's largest exhibition dedicated to new vehicle development and testing, and in conjunction with *Traffic Technology International* magazine, the world's leading magazine for advanced highway and traffic management technologies.

Hosted by:

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Over 400 delegates attended the event in 2015!


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Topics under discussion:

- Public road testing
- Virtual testing
- Simulation
- Traffic scenario testing
- Embedded software testing
- Safety and crash testing
- Fail-safe testing
- Cyber threat testing
- Validation and verification
- Autonomy software
- VeHIL
- V2V and V2X testing
- Robotics
- Testing legislation
- Safety standards and legislation
- Case studies
- Possibilities
- Best practices
- Reliability testing of software and hardware systems

For more information about the Autonomous Vehicle Test & Development Symposium 2016, **please contact Andrew Boakes**: andrew.boakes@ukipme.com
Tel: +44 1306 743744 | www.autonomousvehiclesymposium.com

Programme Sponsored by
Realtime technologies, inc

To attend, register at: **autonomousvehiclesymposium.com**

Autonomous vehicle symposium preview

In the first week of June, the German city of Stuttgart will play host to the most important gathering of autonomous vehicle specialists in Europe. As they prepare their presentations, we ask key speakers: **How can we move toward a world where everyone trusts autonomous vehicles to be safe?**

Autonomous Vehicle TEST & DEVELOPMENT Symposium 2016

MAY 31 - JUNE 2, 2016
STUTTGART, GERMANY

Don't miss...

Seven highlights from a packed program

- **Dr Donato Amoroso, virtual analysis senior specialist, Fiat Chrysler Automobiles, Italy**
- **Carina Björnsson, technical expert, driver assistance and active safety test methods, Volvo, Sweden**
- **Gerben Feddes, senior advisor, intelligent mobility, RDW, the Netherlands**
- **Andrew Miller, chief technical officer, Thatcham Research, UK**
- **Prof. Paul Newman, BP Professor of information engineering, University of Oxford, UK**
- **Prof. Nick Reed, academy director, TRL, UK**
- **Reija Viinanen, managing director, Fell Lapland Business Services, Finland**

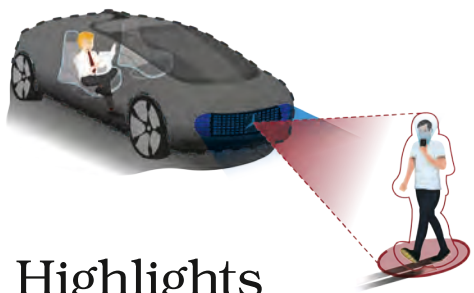
We ask key speakers: **How can we move toward a world where everyone trusts autonomous vehicles to be safe?**

Autonomous Vehicle TEST & DEVELOPMENT Symposium 2016

> If seatbelts had, hypothetically speaking, become mandatory on a Monday and someone drowned because of them on the Tuesday, we would probably have a fierce discussion on Wednesday about the safety of seatbelts. This didn't happen because seatbelts had time to prove themselves as safe. I hope the same happens with autonomous vehicles
>
> **Gerben Feddes, senior advisor intelligent mobility, RDW**

> Public acceptance will only grow if the automotive industry adheres to safety standards. Therefore consistent safety and vehicle behavior standards need to be put in place
>
> **Volker Scholz, managing partner, Mm1 Consulting & Management PartG**

> Safety is not a question of influencing or enforcing by legislation or incentives. The key is communication
>
> **Stefan Lüke, head of ADAS and automation, advanced engineering (CTZB), Continental Chassis & Safety Division**



Day 1 Highlights

TUESDAY, MAY 31

KEYNOTES

The Volvo Car Corporation autonomous vehicle project 'Drive Me'
Carina Björnsson, technical expert, driver assistance and active safety test methods, Volvo Car Corporation, Sweden
9:00am, Room A

A HIL-based vehicle test bench for ADAS function validation
Dr Donato Amoroso, virtual analysis senior specialist, Fiat Chrysler Automobiles, Italy; Dr Claudio D'Avino, specialist engineer, Teoresi Group, Italy
9:30am, Room A

Project Cooperative, highly automated driving, Ko-HAF
Dr Stefan Lüke, project manager, Continental Chassis & Safety Division, Germany
10:00am, Room A

Euro NCAP roadmap – autonomous vehicle and system testing
Andrew Miller, chief technical officer, Thatcham Research, UK
11:00am, Room A

Mobile autonomy Oxford – from self-driving cars to Mars
Prof Paul Newman, BP Professor of information engineering, University of Oxford, UK
11:30am, Room A

ALSO

Cross-industry safety and security for connected vehicles
Volker Scholz, managing partner, MM1 Consulting & Management PartG, Germany; Lyn Matten, managing consultant, MM1 Consulting & Management PartG, Germany
3:30pm, Room B

Shifting legislation for automated vehicles
Gerben Feddes, senior advisor of intelligent mobility, RDW, the Netherlands
4:00pm, Room A

> We need to test probable avoidance times to ensure that few serious accidents occur
>
> **Robert Friis, president, Summit Development Group**

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We ask key speakers: **How can we move towards a world where everyone trusts autonomous vehicles to be safe?**

Autonomous Vehicle TEST & DEVELOPMENT Symposium 2016

> "Making autonomous vehicles available to research institutes for national tests and promotional campaigns will improve the public's perception of their safety"
>
> **Aki Lumiaho, principal scientist – connected and automated driving & smart city mobility, VTT Technical Research Centre of Finland**

> "Stats about driving with human drivers should be made known: 94% of traffic accidents are caused by human errors. Robots, on the other hand, do not get tired and do not have competitive attitudes toward driving"
>
> **Reija Viinanen, managing director, Fell Lapland Business Services**

> "In 1896, the tram network in Nuremberg had its power changed from horses to electricity. The people, used to horse-drawn trams, were unsure about trusting this new technology – even though the electric trams were to be driven by human drivers. Today it's hard to imagine that somebody would ever entrust their safety in a horse driver, more than a in human driver. Change involves confidence and if we want confidence, we have to prove ourselves"
>
> **Igor Doric, scientific and technical manager, Carissma**

> "The public doesn't trust private companies' claims about autonomous vehicles' safety. Therefore, governments must provide unbiased testing facilities and open data"
>
> **Paul Krutko, president and CEO, Ann Arbor SPARK**

Day 2 Highlights

WEDNESDAY JUNE 1

Test of active pedestrian safety systems in CARISSMA
Igor Doric, scientific and technical manager, CARISSMA, Germany
9:00am, Room A

American mobility and the Willow Run Testing Center
Paul Krutko, president & CEO, Ann Arbor SPARK, USA; Sean Kelley, senior vice president/ principal, Mannik Smith Group, USA
9:00am, Room B

Real-time simulation of autonomous vehicles optimized for speed
Robert Friis, president, Summit Development Group LLC, USA
9:30am, Room A

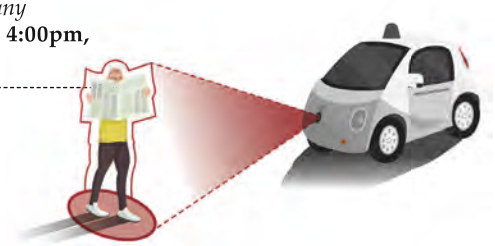
Ensuring high-fidelity driving simulation with offline vehicle models
Dominic Gallello, CEO, MSC Software, USA
10:00am, Room B

Aurora – an arctic intelligent transport test ecosystem for autonomous driving
Reija Viinanen, managing director, Fell Lapland Business Services, Finland
11:00am, Room B

Autonomous vehicle radar simulation
Dr Sandeep Sovani, director, global automotive industry, Ansys, USA
1:30pm, Room A

A controllability assessment of hands-free partially automated driving
Dr Christian Purucker, project manager, WIVW, Germany
Wednesday, June 1, 2:00pm, Room A

Testing tools for ASIL D development
Dr Oscar Slotosch, member of the board, Validas, Germany
Wednesday, June 1, 4:00pm, Room B



Autonomous Vehicle TEST & DEVELOPMENT Symposium 2016

We ask key speakers: **How can we move toward a world where everyone trusts autonomous vehicles to be safe?**

> For safety to be guaranteed, manufacturers must first negotiate with the Institute of Transportation Engineers and persuade them to find a solution to the functionality of yellow traffic signal lights

Brian Ceccarelli, owner, Talus Software

> Society will accept self-driving vehicles when safety, resilience, reliability and robustness can be guaranteed. Implementing assessment standards will also positively impact the public's opinion

Marcos Pillado, project manager, Applus+ IDIADA

> We must focus on engagement with the public by clearly explaining the potential safety, efficiency, environmental, economic and societal benefits, but then safely conducting real-world tests where the public play an active role and can see how automated vehicles fit into the mobility landscape

Nick Reed, academy director, TRL

> The public can build their trust in autonomous vehicles and their safety by trying out various driving scenarios in a simulated driving environment

Sandeep Sovani, director of global automotive industry, Ansys

> Familiarity with autonomous vehicles is essential. Experience, as well as awareness, needs to be increased with demonstrations

Rebecca Advani, senior technologist, Transport Systems Catapult

Day 3 Highlights

THURSDAY, JUNE 2

Automated traffic: what the public sector should do
Aki Lumiaho, principal scientist, VTT Technical Research Centre of Finland, Finland
9:00am, Room B

GATEway: testing of automated vehicles in Greenwich, London
Prof Nick Reed, academy director, TRL, UK
9:30am, Room B

The yellow change interval – the laws of physics in opposition
Brian Ceccarelli, owner, Talus Software, USA
11:00am, Room B

Methodologies and tools for measuring fallback performance in automated vehicles
Marcos Pillado, project manager, Applus+ IDIADA, Spain
1:00pm, Room A

LUTZ Pathfinder Pods: public shared space testing in the UK
Rebecca Advani, senior technologist, Transport Systems Catapult, UK
1:30pm, Room B

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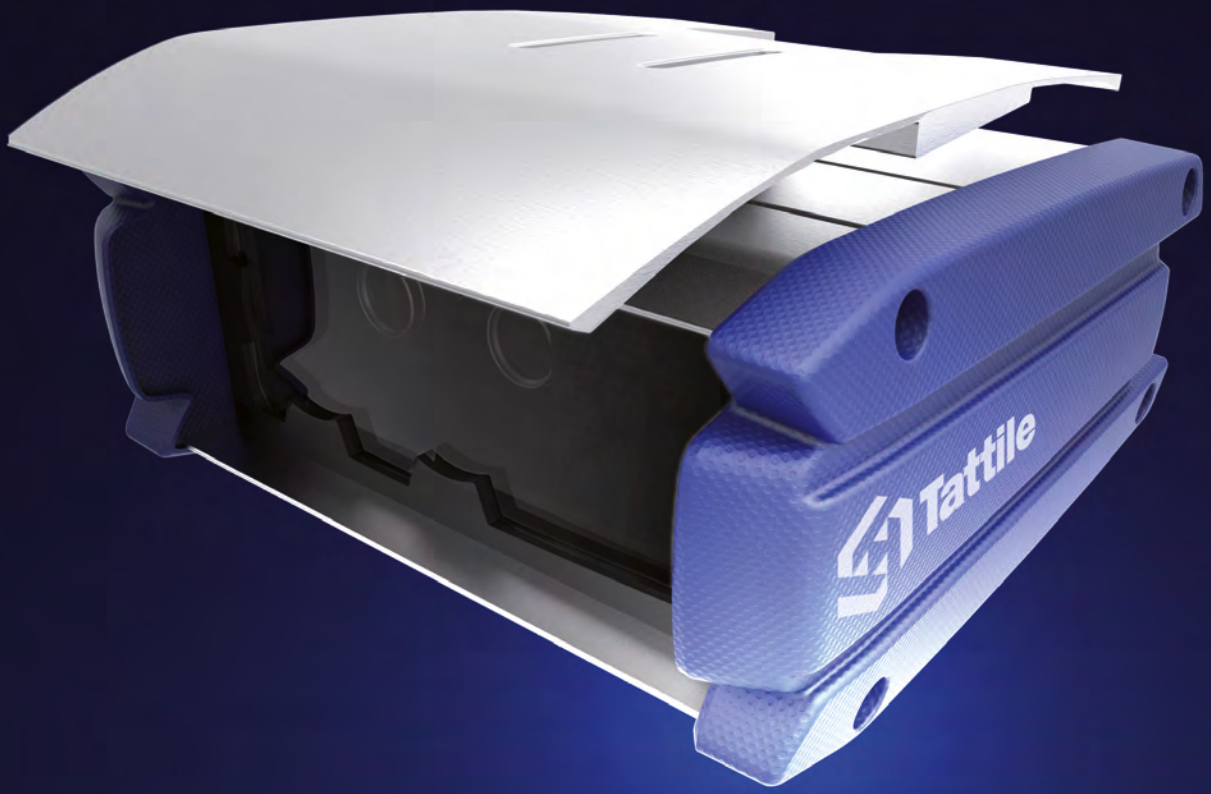

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By the book?

As autonomous vehicles evolve, most jurisdictions have been taking a 'wait and see' approach to regulation. But now, as the technology becomes more viable, **Don Hunt**, former director of the Colorado DOT, asks if rule making will soon be essential

The rulebook for self-driving vehicles has yet to be written

On October 8, 2015, there was a revealing event at the Swedish Embassy in Washington DC, organized by Volvo. Volvo's CEO, Håkan Samuelsson, said, "The USA risks losing its leading position autonomous vehicles (AVs) due to the lack of federal guidelines for the testing and certification. Europe has suffered to some extent by having a patchwork of rules and regulations. It would be a shame if the USA took a similar path to Europe in this crucial area."

Volvo has emerged as one of the auto makers committed to driverless technology. Volvo's objectives not only include improving safety, but also delivering time to people for other activities while traveling on highways. This is a near-term commitment to very advanced Level 3 automation (see *Taking it to the next level* overleaf for full definitions of all levels of vehicle automation, as set out by NHTSA) and furthermore, Volvo also stepped up to assume full liability for any accidents when its vehicles are operating in autonomous mode (joining Google and Mercedes-Benz).

Also present at the event was Brian Soublet, deputy director of the California DMV. A couple of years ago the California DMV was charged with establishing regulations for both testing and public operation of

The pieces of the driverless-vehicle-regulation jigsaw are falling into place

autonomous vehicles. As Soublet recently noted, "Someone thought it was a great idea to introduce legislation in several states that required people to develop regulations that covered the safety of vehicles. We're not an agency that is filled with automotive safety experts, so how do we go about doing that?" (*Washington Post*, October 8, 2015).

Consistent with Soublet's plea, the California DMV issued draft regulations for public testing of AVs on December 16, 2015, stating, "A licensed operator will be required to be present inside the vehicle and be capable of taking control in the event of a technology failure…" In other words, driverless cars in California will need drivers for the foreseeable future. And to the dismay of Google, they will also need a steering wheel and pedals.

The road to 2016

How did we get here? By and large, the USDOT, and to a similar extent the European Union, has put a greater emphasis on connected vehicles (CVs) than AVs. The EU has acted to eliminate the barrier presented by the 1968 Vienna Convention on Road Traffic: "Every driver shall at all times be able to control his vehicle or to guide his animals." But, until recently, separate country attitudes and regulations looked certain to constrain the creation of a single market for fully (Levels 3 and 4) self-driving vehicles in Europe. However, just as this issue was going to press, news broke that transportation ministers from the 28 EU states have signed The Declaration of Amsterdam, a historic agreement that promises "cooperation in the field of connected and automated driving".

In the Declaration, the EU transportation ministers have agreed to: promote a consistent legal

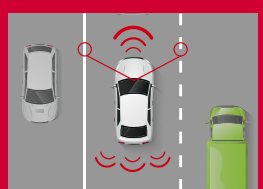
> We're not an agency that is filled with automotive safety experts, so how do we go about introducing autonomous vehicle legislation?
>
> **Brian Soublet, deputy director of the California DMV**

Taking it to the next level

The five levels of vehicle automation, as defined by the National Highway Traffic Safety Administration (NHTSA)

Level 0: No automation
The 'traditional' version of car design that dominated throughout the 20th century. The driver is in complete and sole control of the primary vehicle controls – brake, steering, throttle and motive power – at all times. Automatic gears are still counted as Level 0 automation.

Level 1: Function-specific automation
Involves automation of one or more specific control functions, e.g. electronic stability control or pre-charged brakes, where the vehicle automatically assists with braking to enable the driver to stop faster than possible by acting alone.



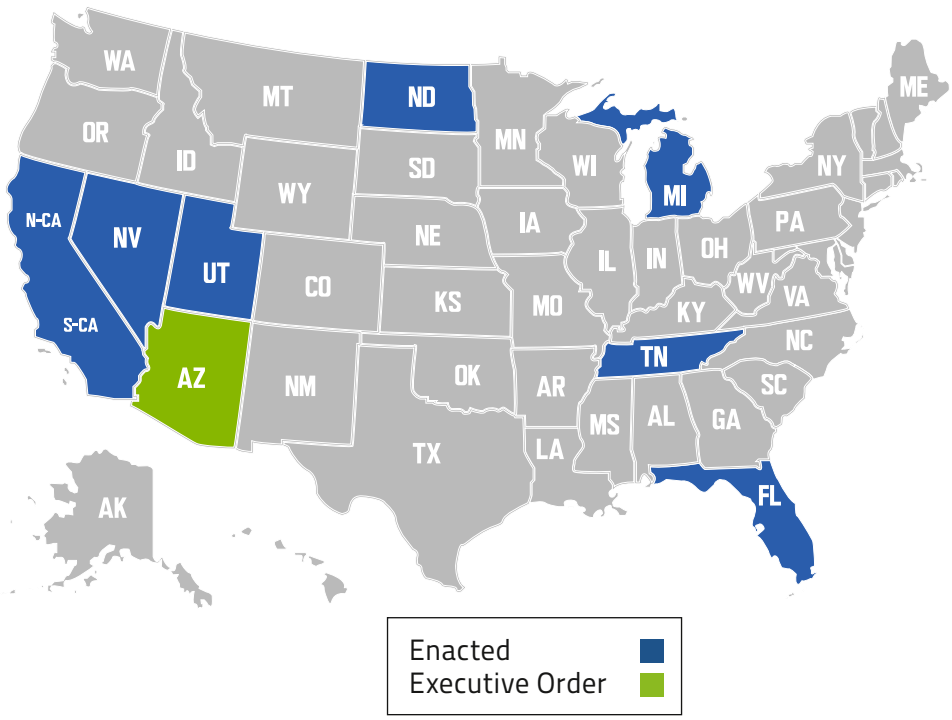
Level 2: Combined-function automation
Automation of at least two primary control functions working in unison to relieve the driver of control. An example of combined functions enabling a Level 2 system is adaptive cruise control in combination with lane centering.

Level 3: Limited self-driving automation
The driver can cede control of all safety-critical functions under certain conditions, and rely on the vehicle to monitor for changes that require transition back to driver. The driver must be available for control, after some transition time.

Level 4: Full self-driving automation
The vehicle is designed to perform all safety-critical driving functions and monitor roadway conditions for an entire trip. The driver will provide destination or navigation input, but is not expected to be available for control at any time.

States of consciousness

This map shows the US states that have already enacted legislation regulating the testing of autonomous vehicles



framework for autonomous driving throughout Europe; develop a policy to deal with connected and automated vehicle (CAV) data; work toward an internationally compatible vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) system; cooperate to ensure cybersecurity; and increase the acceptance of CV and AV technologies.

Speaking after the summit, Melanie Schultz van Haegen, minister of infrastructure and the environment for the Dutch government (who hosted the event as part of her country's current EU presidency) said, "Today for the first time we have talked at the European political level about self-driving vehicles and the measures required for their smooth introduction in Europe. We want to pick up the pace, because there are many gains to be made for mobility. Connected and automated vehicles will make our roads safer, more sustainable and more efficient."

Back in the USA, more definite regulation is also looking more likely. NHTSA, the US transportation safety agency, has long taken a watch-closely, but stay-out-of-the-way approach. After demonstrated advancements in AVs, NHTSA updated its three-year-old policy on autonomous vehicles on January 18, 2016, promising that, "Within six months, NHTSA will propose best-practice guidance to industry on establishing principles of safe operation for fully autonomous vehicles." Further, NHTSA committed to AV testing in cooperation with industry and the state departments of transportation.

> We want to pick up the pace… connected and automated vehicles will make our roads safer, more sustainable and more efficient
>
> **Melanie Schultz van Haegen, Dutch minister of infrastructure and the environment**

View from the auto industry

To test Volvo's call for greater consistency in the USA, *TTI* spoke with two of the Silicon Valley auto upstarts, Tesla and Google. Tesla released its over-the-air software update on October 19, 2015, giving owners of Tesla cars manufactured since late September 2014 the option of upgrading to the Autopilot (Level 2 autonomy) driver-assistance package. A Tesla representative acknowledged the eventual need for national guidance on Level 3 and 4 vehicles to create a unified US marketplace. However, Tesla believes that technology is still in development, and a national set of standards or regulations would be premature at this time. "We need to work hand-in-glove with NHTSA, and avoid the overly restrictive regulatory approach emerging in Europe." Tesla plans to continue to release software updates with increasing capabilities. Tesla has no schedule for releasing a Level 3 Autopilot, but CEO Elon Musk has stated that a Level 4 fully autonomous Tesla could be ready in three years. Musk has also acknowledged it might not be legally saleable at that point.

Google's much publicized goal for public operation of Level 4 vehicles is 2019, before the 'driver's license' 16th birthday of the son of Chris Urmson, director, Google Self-Driving Cars. Before the California DMV's decision, a Google representative replied with the same question we put to Tesla, with: "It's too early to legislate to

govern the operations of self-driving cars because the tech is still in its infancy. Regulation requires a standardization that simply does not exist just yet." After the California DMV's decision that autonomous vehicles need a driver and a steering wheel, Google pivoted. In his congressional testimony on March 15, 2016, Urmson said, "The leadership of the federal government is critically important given the growing patchwork of state laws and regulations on self-driving cars."

The road ahead

There are several paths forward to create a more unified autonomous vehicle market, all of which are less than perfect. (See *Possible paths to regulation*, right, for the three distinct possibilities that are envisaged.) Each path has its benefits and drawbacks, depending on each company's business plan. Eventually a cohesive marketplace must emerge to support the massive investments going into autonomous driving. But some fear that intervention by the federal – or international – government into the process with extended rule making could have an equally chilling effect on investment by this new industry. Nevertheless, it may be what the auto industry needs to push for.

Since autonomous technology will be introduced on public roads in mixed traffic, the third and unexpected path could be the most problematic. From this point of view, a more active federal role, short of regulation and rule-making, should be welcomed by every company right now to protect the viability and promise of autonomous vehicles. As hands-free driver assistance systems are introduced that can operate at high speeds for extended periods, a wink from the auto maker that the driver must stay constantly aware is not likely to be enough to ensure safety. NHTSA has authority and responsibility to establish Federal Motor Vehicle Safety Standards. For the US government to intervene only *after* safety incidents is not a responsible position. In the next several months, NHTSA must provide adequate guidance for safety testing and AV system performance to enable the USA to realize the tremendous promise of fully self-driving vehicles.

> Federal government leadership is critically important given the growing patchwork of state laws and regulations on self-driving cars
>
> **Chris Urmson, director, Google Self-Driving Cars**

Possible paths to regulation

No one yet knows exactly how autonomous vehicle regulation will pan out, but it seems likely that one of three main routes will be taken

1: Swift rule making

Consider auto makers such as Volvo. It is interested in building autonomous vehicles that can incrementally add self-driving capabilities – first on freeways, then urban streets, then door-to-door. Dealing with a fractured market defined by the legislatures of different jurisdictions will not deliver efficient sales of vehicles. Eventually all the traditional auto makers, plus Tesla, will get into a face-off between self-driving features and motor vehicle laws such as texting bans and distracted driving. Those companies that want to push the envelope faster will need some level of federal standardization to create a unified marketplace.

2: Autonomous taxis

On the other hand, consider Google, Uber and perhaps Apple. Many observers believe that the first full Level 4 door-to-door autonomous vehicles will not be individually owned, but will rather be implemented as robot taxi services or driverless Ubers. In this scenario, it's possible that US states could become markets one at a time as driverless car services are launched. As long as a robot taxi service is successful in one state, it will gradually filter through to others, without creating a permanent barrier to success. Federal intervention may never occur. However, with Chris Urmson's recent testimony, it's clear that Google does not have the patience for this approach.

3: Wait for accidents

A third path could be the unexpected. Accidents will happen as various levels of driver-assisted and autonomous technology roll out – after all, almost all vehicles on the road, early on, will still be driven by humans. The possibility of serious accidents increases as driver assistance packages such as Tesla Autopilot and Cadillac Super Cruise allow hands-free operations in more complex situations. The media will shine a spotlight on what went wrong when the first fatality occurs involving an autonomous or semi-autonomous car. The cause of the accident may be found to be system failure or driver inattention. Once there are enough autonomous vehicles with enough safety events, NHTSA has the clear responsibility to intervene and establish safety standards. This could set back the emergence of autonomous vehicles for years.

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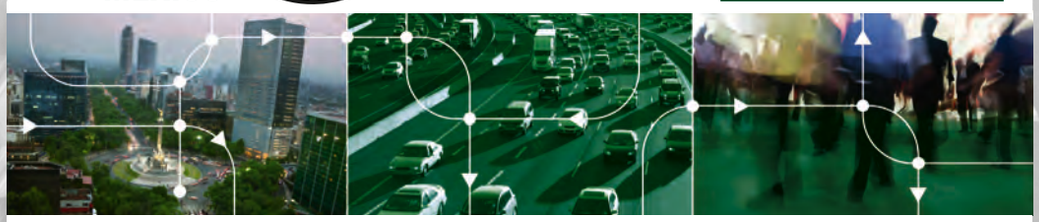

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- Adapting current safety standards and regulations to allow further testing of autonomous vehicles on public roads
- Assessing liability in accidents involving autonomous vehicles
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- Code of ethics for autonomous vehicles in the event of an unavoidable accident
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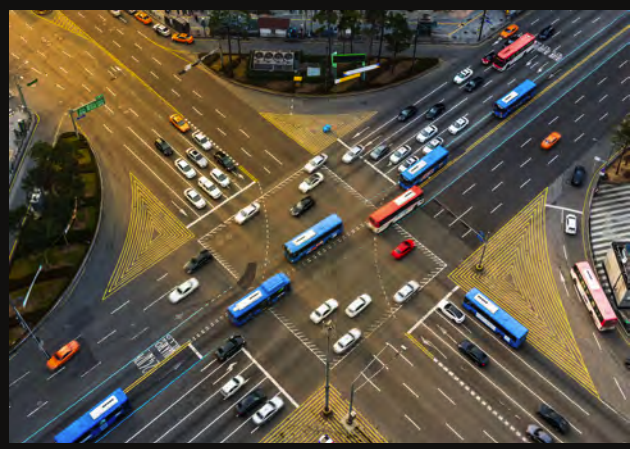

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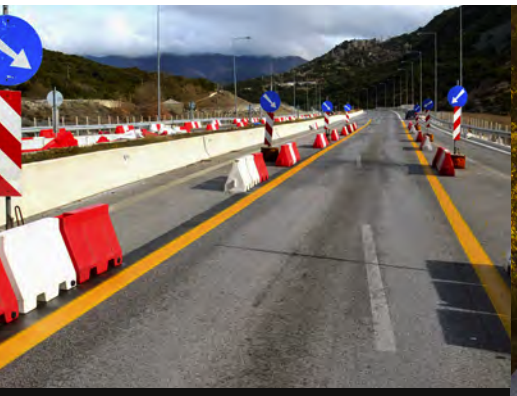

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Misconnected vehicles?

Connected vehicles promise much in terms of improved safety. But what if they suffer from the same kind of interoperability issues that have plagued tolling? **Jan Stojaspal** discovers an industry working hard to avert disaster

It took a single meeting in Vienna last December for the Czechs, the Austrians and the Germans to realize that their respective Cooperative Intelligent Transport Systems (C-ITS) strategies needed serious retooling.

It was not that they have not been moving fast enough with pilots. They *have* been – the Czechs focusing on a ring road around Prague and the D5 highway connecting Prague with Germany; the Austrians and the Germans working together with the Dutch on the so called Cooperative ITS Corridor, a plan to enable the highways between Rotterdam, Frankfurt and Vienna for C-ITS by 2019, which is when vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications are planned for official launch within the European Union.

What they realized is that there were no comprehensive plans to ensure interoperability through cross-site testing. And cross-site testing is essential unless Europe wants to relive the nightmare of trying to bring the payment of electronic tolls under a single onboard unit, says Martin Böhm, head of mobility systems and ITS deployment at AustriaTech, who represented Austria at the meeting which took place in December.

"In the tolling story, we have had standards, but everybody followed the standards in a slightly different way, and the result is that things are not interoperable and harmonized," Böhm says. "I don't want to repeat that story."

Little wonder, too. The European Commission has been struggling with the challenge of making electronic toll systems interoperable for more than a decade now – at least for some of the main transit countries. Still, a typical trucker needs between five and seven

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different onboard units in order to cross the continent.

Luckily, there is still time for C-ITS. The automotive industry does not envision equipping new vehicles with C-ITS technology, which includes both V2V and V2I, until 2019, and it will only start doing so if C-ITS infrastructure is ready. (By the time there was serious talk of interoperability of electronic tolls, several systems were already in place, and others were in advanced stages of planning.)

Taking control

The European Commission is much more active this time around in what Jakub Adamowicz, European Commission spokesman for transport and regional policy, describes, somewhat poetically, as "merging the flow of the rivers so that they all converge in the same river".

European Commissioner for Transport, Violeta Bulc, has, for instance, made digitalization of transport a priority of her mandate, seeing it as an opportunity to "create new [economic] growth and smarter mobility". And in January, the European Commission-backed C-ITS Platform, which was set up in 2014 to address the main barriers and enablers for the deployment of C-ITS, and which today involves some 200 industry representatives and public authorities from all over Europe, published a major report outlining the shared vision for coordinated C-ITS, something Commissioner Bulc called "an important milestone".

> Using cellular systems, we have the possibility of getting full coverage of the main road network very quickly and also have access to almost every vehicle
>
> **Risto Kulmala, principal advisor on ITS, Finnish Transport Agency**

The report includes policy recommendations for both the Commission and a variety of other stakeholders in the C-ITS value chain, dealing with such issues as:

- **Security and certification** – One common standardized C-ITS trust model and certificate policy all over the European Union is needed.
- **Radio frequency and hybrid communication** – A hybrid communication concept is a must, as neither ETSI ITS-G5 (DSRC) nor cellular systems can provide the full range of services for C-ITS.
- **Day 1 services** – Identifying prime candidates for initial deployment.
- **Data protection and privacy issues** – Both the cooperative V2V awareness messages (CAMs) and decentralized environmental notification messages (DENMs) are considered personal data in Europe and, therefore, may need to be treated on an opt-in basis.

Unifying roads

Also, compared with interoperable electronic tolls, Europe-wide C-ITS

EUROPEAN C-ITS PILOT

#1

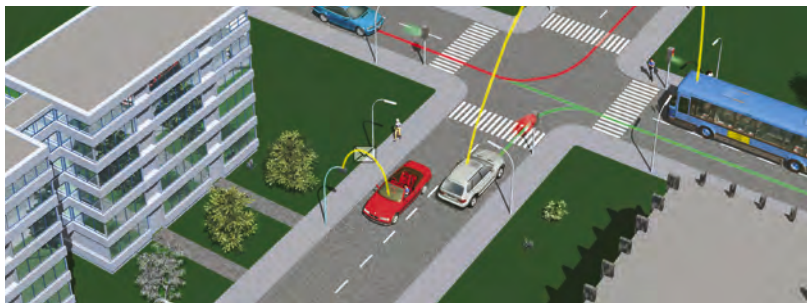
Project: NordicWay

Location: Finland, Norway, Sweden and Denmark
Duration: 2015 to 2017
EU Funding? Yes
Type: Cellular 3G/4G
Services being tested:
- Cooperative weather warning
- Vehicle probe data
- Hazardous location notification

NordicWay is the only European connected-vehicle pilot to sidestep DSRC and wholly embrace cellular. According to Risto Kulmala, principal advisor on ITS at the Finnish Transport Agency and coordinator of NordicWay, DSRC makes little economic sense for the region's low traffic volumes. "On our main roads, the average daily traffic is 5,000-6,000 vehicles per day," he says.

Also, cellular already offers the advantage of full network coverage as opposed to having to install DSRC beacons every 500m and then waiting for the vehicle fleet to modernize. "The choice was obvious," he says. "In this way, we have the possibility of getting full coverage of the main road network very quickly and also have access to most vehicles [via drivers' smartphones]."

And while cellular cannot compete with DSRC on latency – over 3G it is counted in seconds rather than milliseconds – it does just fine for NordicWay's piloted services, such as hazardous location warning or weather updates. However, DSRC still has a place. "There could be extreme difficulties with applications such as platooning between lorries," says Kulmala. "That will always take place with DSRC-like communication."



Left: **It is envisaged that V2I technology will make intersections safer and more efficient**

appears to be much easier to get behind. Not only does everybody want improved road safety and less traffic congestion, says Geert van der Linden, policy officer, intelligent transport systems, at the European Commission, Directorate General for Mobility and Transport, everybody also seems to realize that it makes no sense to have cars that only work in some countries and not others. "The whole C-ITS community has a big interest in making sure that interoperability is guaranteed," van der Linden says. "There is an important network effect with these systems, which means unless you have sufficient uptake, you don't get the benefit. If my C-ITS solution only works in Brussels, then I have a big problem."

Böhm puts it even more bluntly: "I always say in all my discussions with all the different transport departments, 'If you say you don't want to harmonize, then you might as well stop'. There is no need to do the pilots because no industry will take up your solution. They will only take it up if they are assured that their system will work in several countries. They will not produce a Volvo car for Austria and then a different Volvo car for Germany and then one for France and another for the Czech Republic."

> Unless you have sufficient uptake, you don't get the benefit. If my C-ITS solution only works in Brussels, then I have a big problem
>
> **Geert van der Linden, ITS policy officer, European Commission**

For the moment, the major C-ITS pilot sites operating in Europe are: the Cooperative ITS Corridor, involving the Netherlands, Germany and Austria; Scoop@F in France; NordicWay, covering Norway, Sweden, Denmark and Finland; and Compass4D, focusing on C-ITS testing in seven major European cities (Bordeaux, Copenhagen, Helmond, Newcastle, Thessaloniki, Verona and Vigo). In the private sector, Jaguar Land Rover is one of the C-ITS leaders in Europe, investing in a 41-mile (66km) 'living laboratory' project in the Coventry and Solihull area in the UK that will give the car maker the ability to test both V2V and V2I systems on public roads.

Still, getting cars and infrastructure talking to each other by 2019 is going to be a struggle unless cross-site testing is addressed soon in and a comprehensive way.

Cross compatibility

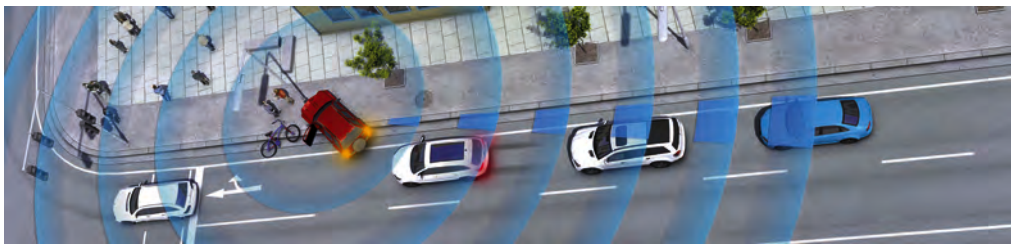
According to van der Linden, cross-site testing will be an important area of focus during the second phase of the C-ITS Platform. "In practice, there are a lot of standards already out there," he says. "But we find that the existing standards alone do not guarantee interoperability." Should

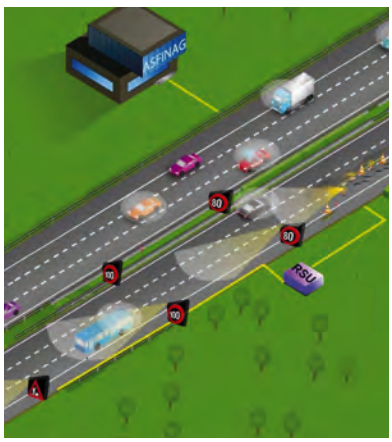
EUROPEAN C-ITS PILOT

#2

Project: Cooperative ITS Corridor

Location: Rotterdam – Frankfurt – Vienna
Duration: Ongoing
EU Funding? No
Type: Hybrid – ETSI G5 and 3G/4G
Services:
- Roadworks warning
- Vehicle probe data
- In-vehicle information (e.g. speed limits or dynamic road signs)
- Green light optimal speed advisory – time-to-green – emergency vehicles priority
- Other DENM and multimodal information services





Above: **A key aim of V2V is to broadcast accident information beyond lines of sight**

Left: **V2I enables variable speed limits, for example around workzones, to be communicated via roadside units**

that not be enough, the European Commission is prepared to come in with a delegated act on interoperability, security and Day 1 services.

According to Böhm, neither initiative goes far enough, however. The C-ITS Platform, while doing valuable work on specifications, standards and strategic agreements, does not deal with physical deployment. At the same time, a delegated act might help, but it could take several years to implement and still only apply to public administrative bodies.

And so Böhm and his colleagues have taken it upon themselves to supply the missing piece in the connected vehicle jigsaw. Called C-ROADS, the initiative, which was recently proposed by Böhm to the European Commission as part of the Connecting Europe Facility (CEF) call, aims to hugely expand C-ITS pilot activity. The expansion will take place between pilot locations that are already in operation in the Czech Republic, Hungary, Greece, Slovenia, Austria, Germany, France, Belgium, the Netherlands and the UK, and make cross-site testing and real-world deployment the main priority.

"We will work closely together, relying on joint specifications and standards, but we also need to decide what that means for deployment in the real world," he says. "We need to prepare procurement documents in a harmonized way. We need to ensure that whatever we procure will ensure interoperability. And this cross-site testing we have planned is the only way to show that this really works." ○

> We need to prepare procurement documents in a harmonized way. We need to ensure that whatever we procure will ensure interoperability
>
> **Martin Böhm, head of ITS deployment, AustriaTech**

Turn the page for an investigation of how virtualization techniques are helping to enhance interoperability throughout transportation

Epic fails

Three other transportation compatibility disasters from history

1 Left-hand/right-hand drive
The majority of the world drives left-hand drive cars, but car makers still have to manufacture separate vehicles for the 55 countries, including the UK, Australia, India and Japan, that drive right-hand drive vehicles.

2 Train gauges
A standard train gauge measures 4ft 8.5in (1,435mm) between the inside edges of the rail. Most countries use standard train gauges, but Spain, Russia and Finland use wider sizes – initially deployed to prevent invasion from surrounding countries.

3 Electric car chargers
When electric vehicles began to hit our roads there were as many as five incompatible chargers. Now the CHAdeMO fast charging is helping the industry move toward standardization. But with Tesla pushing its Supercharger hard and Porsche rumored to be working on a similar proprietary device for its EVs, we aren't out of the woods yet.

EUROPEAN C-ITS PILOT

#3

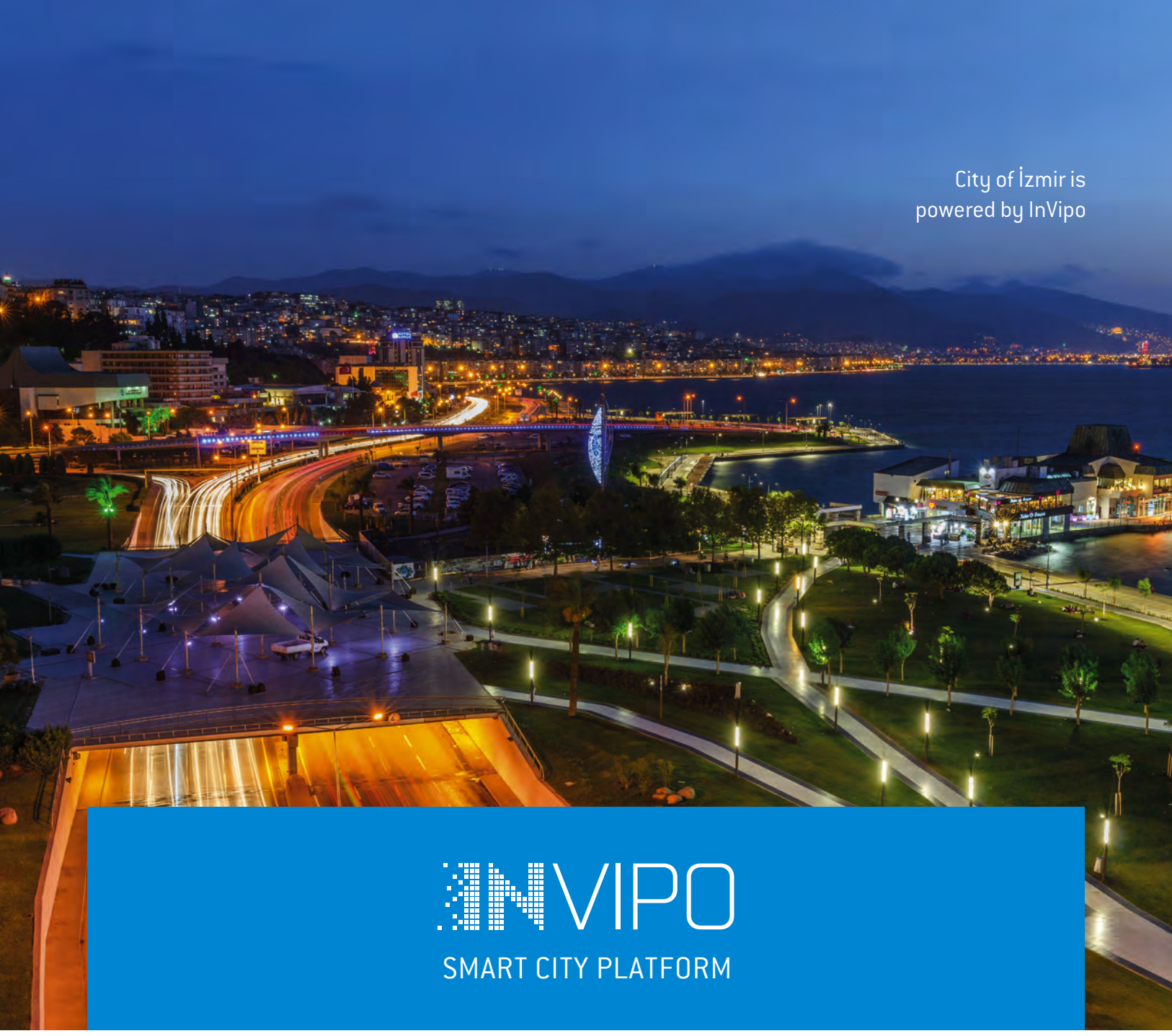
Project: Scoop@F

Location: Île-de-France, East Corridor between Paris and Strasbourg, Brittany, Bordeaux and Isère
Duration: First wave 2014 to 2015; second wave 2016 to 2018
EU funding? Yes, 50%
Type: Hybrid – ETSI G5 (both waves) and 3G/4G (second wave only)
Services being tested:
- Roadworks warning
- Vehicle probe data
- Hazardous location notification (several different hazards depending on location)

#4

Project: Compass4D

Location: Seven European cities: Bordeaux, Copenhagen, Helmond, Newcastle, Thessaloniki, Verona and Vigo
Duration: Ran from 2013 to 2015 (but continues, as per above)
EU Funding? Not ongoing
Type: Hybrid – ETSI G5 and 3G/LTE
Services being tested:
- Red-light violation warning
- Road hazard warning (several hazards depending on location)
- Green light optimal speed advisory – time-to-green – emergency vehicles priority



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An example of virtualization is found in computer operating systems. If you want to run a Linux application on a Windows PC, then virtualization software can be used.

- **Digital music streaming**
The digital revolution in music is an example of virtualization at work. CDs gave way to MP3s and now online digital streaming represents the fully virtualized system – a vast library of music available anytime, anywhere, with only minimal, lightweight software required to access it.

- **App virtualization**
Now computer applications can be streamed using virtualization techniques, just as music is. Virtualized applications look as though they are installed on your computer, but in fact when you open them the parts you are actually using are downloaded from the internet, making it possible for you to have more applications than you actually have space for on your hard drive.

Virtual reality

Communications expert **Jim Gunn** explains how the virtualization techniques that make cloud computing possible are now being put to use in transportation

Using real-life data to create virtual pictures of our world is key to enabling more flexible control of systems

For many years, transportation professionals around the world have struggled with issues of vendor interoperability in procuring increasingly mission-critical information and communication technology (ICT) systems. In response to this issue, public safety communities spearheaded the P25 (APCO 25) initiative in the USA – and TETRA (Terrestrial Trunked Radio) in Europe – which produced open voice-based digital-radio standards and architectures, to help coordinate emergency response teams.

However, as we rapidly migrate into the broadband era, both voice and data are essential in public-sector communication – and P25 and TETRA are not cost-effective for broadband applications. As a result, the public sector community is rushing to adapt the commercial 4G/LTE technologies. Such broadband systems will be an important enabler of rapidly emerging connected-vehicle initiatives, for the public and the private sectors, but as with digital radio, interoperability issues must be overcome.

A virtual solution

Virtualization is a rapidly emerging suite of technologies and methods to help alleviate compatibility issues. Fundamentally, it is the abstraction of hardware resources and separation from applications and software. This means that systems, applications and functions can be developed and upgraded using more flexible, more cost-efficient software. A virtualized application typically uses lower-cost, industry-standard, computing hardware, rather than higher-cost, proprietary, specialized devices. The best example of industry-standard hardware used for virtualization is Intel's widely deployed x86 computer technology. With this, system hardware can be reused for multiple applications, creating major economies of scale and cost advantages. Functionality is flexibly created, enhanced and updated by

less expensive software development. Emerging market and application requirements have elevated virtualization to essential status, particularly in cloud computing.

Historically, industry standard devices could not implement sufficient functionality and throughput to enable virtualization, so system vendors designed and integrated costly proprietary designs – often including dedicated hardware – to achieve goals. Current industry-standard devices can now cost-effectively provide sufficient functionality. An example of this in the transportation world is Roseek's recently launched Cheetah1 series smart camera, which is totally open-source and so fully supports all kinds of third-party software, enabling users to program it to perform a huge variety of ITS functions. "We give the powerful CPU to the customers so that they can embed it in their software, making its high-performance sensors multifunctional," says Roseek's technical support manager, Leo Bai. "It's low cost and high performance."

Accentuating the positive

Virtualization has an impressive list of advantages (*see right*), but it's not without its disadvantages – the biggest one being that industry standard devices will never achieve the performance of function-specific chip/system designs. However, lower development costs and ease of upgrade often outweigh these considerations in the fast-moving connected economy.

Early private enterprise IT systems were often procured and operated by IT personnel dedicated to the organization that used the systems. However, in the modern broadband era, organizations require a larger suite of integrated, interoperable, rapidly evolving IT services to compete effectively. Virtualization technologies are the most cost-effective path to this.

A new product called Intelligent Traffic Management, from Sensys Networks and Verizon Intelligent Traffic Management, provides just such a cloud-based service,

providing software-as-a-service (SaaS) for the transportation industry. It offers public agencies an integrated system that combines wireless sensor networks for high-resolution traffic-data collection with secure communication and cloud hosting.

> We have a unique user interface, which means that a traffic controller can have all of the technology in a city at his fingertips. InVipo can be used wherever there is data
>
> **Lukáš Duffek, CEO, Incinity Cross Zlín**

Another new product that uses virtualization techniques recently won the Intertraffic Amsterdam 2016 Innovation Awards. InVipo, from Cross Zlín, is a lightweight web-based system that stops traffic management centers having to rely on large mainframes. It enables city traffic controllers and administrators to get not only a complete overview of all the data from all the systems in their area, but also control of those systems through one platform.

"We have a unique user interface, which means that a traffic controller can have all the technology in a city at his fingertips. Everything is in one place," says InCinity Cross Zlín's CEO,

Advantages of virtualization

- **Appropriate redundancy is more easily achieved** and load sharing and reallocation can be more effectively managed, helping to ensure safety in, for example, autonomous vehicles
- **Reliability goals can be more cost-effectively achieved** due to use of industry-standard hardware for multiple applications
- **Hardware can perform multiple functions** thanks to flexible software programmability
- **Functional lifetime management can be separated from physical hardware constraints** (i.e., hardware and software procurements can be on different schedules)
- **Single vendor lock-in can be reduced** due to industry-standard hardware and more open software terms. This will become essential as we move into a world where vehicles from multiple manufacturers must be able to communicate with one another and with infrastructure

- **Time-to-market and time-to-upgrade is substantially reduced**
- **More efficient use of shared hardware resources** (reports of at least 80% use)
- **Interoperability of systems is increased** because of software sharing among applications that historically has not been possible

- **Software-only development and upgrades** – new applications and features can be quickly added to address emerging business opportunities
- **Hardware and software resources can be shared across multiple applications**

- **Third-party cloud services become cross-compatible.** It is important, for example, for onboard navigation systems to be able to receive traffic information from multiple sources
- **Software upgrades are not constrained by proprietary hardware**, so changes to traffic regulations could be pushed out to multiple devices with a single update

Lukáš Duffek. And as a virtualized system it isn't compatible only with Cross Zlín products, but also with any data-producing equipment in a city. "InVipo can be used wherever there is data," confirms Duffek.

Virtualization technologies are essential to deliver these new commercial services flexibly at costs subscribers will embrace.

Virtualization for safety

In 2012 the US government began the development of the First Responder Network Authority (FirstNet) with a mission to build, operate and maintain the first high-speed nationwide wireless broadband network for public safety. It will be based on a single interoperable platform for public safety communications. This network will be implemented using commercial cellular long-term evolution (LTE) standards and technologies that will be adapted for public safety use.

Many international initiatives also exist. Virtualization is a key enabler of deployments of these systems. Transportation/ITS will participate in LTE Public Sector Broadband, and virtualization will facilitate flexibility to incorporate transportation/ITS functionality in initiatives that are currently being driven by emergency services.

In conclusion, virtualization is a key future enabler of emerging commercial and public ICT systems. Legacy ITS and emerging connected vehicle initiatives will require flexibility and minimal vendor lock-in for cost-effective success.

We are now entering an era when extending the breadth of functionality is seen as a higher priority than achieving lower costs for legacy applications – and with virtualization and related techniques enabling more flexible, faster and lower-cost developments, these aims are now within reach.

Jim Gunn, PhD, EE, is based in Dallas, Texas, USA. He can be reached at jimgunn@jgunnresearch.com

ALPR backlash

With a new law in California restricting the use of data from ALPR cameras, road authorities must now tread more carefully when deploying this technology. And, as **Max Glaskin** explains, a public relations war must be won if the use of ALPR is to continue to grow and not face further restrictions

Illustration: Magictorch

Automatic license plate recognition (ALPR) makes roads safer, helps traffic move smoothly and improves security. It can also generate a vast database of all vehicles' journeys. That's why privacy campaigners, law enforcers and governments are seeking better ways to manage it.

Since being introduced a decade ago, ALPR systems – also known as ANPR (automatic number plate recognition) – have become more powerful. Cameras are smaller, recognition algorithms are smarter, data storage is cheaper, networks are bigger, and searching the databases is easier. But a balance must be struck between the technology's benefits and individuals' privacy. For example, the UK's National ANPR Service will soon be able to handle 50 million new images of license plates every day.

It's numbers like these that trigger fears. The American Civil Liberties

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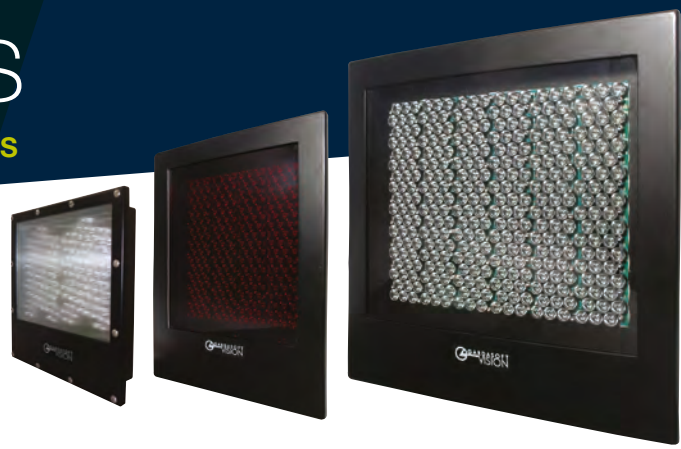

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There's an app for that

Your smartphone could soon become a node in an ALPR network

Recent studies by teams in Jordan and Vietnam have demonstrated that the low-resolution images captured by smartphone cameras can still provide enough detail for OCR software to read license plates.

"We've shown this works as a proof of concept and have released the source code for public use," says Dr Tuan Nguyan, of the University of Information Technology in Ho Chi Minh City, Vietnam. "Since then we've seen examples of how it's being used to recognize plates in Australia, Brazil, Germany, the Netherlands and Romania."

Nexar is the first commercially available smartphone app with ALPR and it runs on Apple's iOS.

"The technology we have developed has been optimized to run efficiently on mobile phones, without draining the battery, while providing high accuracy - about 95% for Israeli license plates. Currently our algorithms are well trained for ALPR in Israel and California. The captured images are not publicly available and, as per our terms of service and privacy policy, we will not release them to any third party," says Bruno Fernandez-Ruiz, Nexar's co-founder and chief technology officer.

The ALPR function, which app users are made aware of, is secondary to Nexar's main task – to turn a smartphone into a smart dashcam to record traffic incidents automatically and on the fly.

An Android version of Nexar is promised and the company will decide when to make releases elsewhere in the world, depending partly on each country's legislation.

Union is currently railing against plans by New York police to subscribe to a national database of more than two billion plate images, logged by time and place – and which grows by a million each day. The scheme's details were revealed only when a citizen made a Freedom of Information request. Similar protests are also being made against other schemes in many other US states.

"We have clear rules to control ALPR data to ensure that access is for legitimate investigation purposes. In respect of London ALPR data, staff only have access to the data if it is relevant to their role."

Metropolitan Police Force, London, UK

"Databases of license plates create opportunities for institutional abuse, such as using them to identify political protest attendees."

Catherine Crump, staff attorney, American Civil Liberties Union, Speech, Privacy & Technology Project

The lack of transparency surrounding ALPR plans in the USA is mirrored elsewhere. CrimTrac, the national information-sharing service for Australia's police, law enforcement and security agencies, produced a report in 2008 outlining its designs for a national system. It was only made public some years later through another Freedom of Information request.

Data on a plate?

The worry is that, without agreed protocols, ALPR could be used for surveillance irrespective of the public's wishes. "There are no controls on where ALPR can be used in Australia. It's a police decision," says Dr Darren Palmer, associate professor of criminology at Deakin University, in Geelong, Victoria, Australia. "ALPR is powerful in that it's low cost, has an amazing capacity to generate people-movement data and has an ability to catch a lot of people for low-level misdemeanors, such as small, unpaid fines."

Considering the implications, it's perhaps surprising that the public isn't angrier. "There isn't a huge amount of disquiet in Australia because these technologies get introduced in a less than transparent way," says Palmer, detailing the initial implementation process. "First they say they're doing trials. Then they claim they've had major successes and they also tie it into protecting against major threats."

> ALPR has an amazing capacity to generate people-movement data and has an ability to catch a lot of people for low-level misdemeanors, such as small, unpaid fines
>
> **Dr Darren Palmer, associate professor of criminology at Deakin University, Victoria, Australia**

California Governor Jerry Brown has shown an appreciation of the potential abuse of ALPR by police and security forces. Laws he signed to become effective this year limit how an ALPR database can link data from a vehicle to the name of a person. A key sentence in the Californian statute requires that ALPR

Left: **The Lykan HyperSport is used as a police car in Abu Dhabi – fitted with the latest ALPR and face recognition cameras**

information be accessed, used and shared "with respect for individuals' privacy and civil liberties".

There are also moves in the UK to tighten the rules that govern ALPR, according to William Perrin, a member of UK transparency panels and an erstwhile policy advisor to former Prime Minster Tony Blair. He too has used Freedom of Information requests to find out about plans for the ALPR system that was originally installed for the London 2012 Olympics. It was thought that all the data would be deleted after two years, yet it has been retained and the system enhanced.

"CCTV and ALPR systems are a valuable source of intelligence and evidence for the police to use in both the prevention and detection of crime."

UK Home Office

"The Fairfax County Police Department's ALPR database can be used to discover the location of thousands of vehicles at a particular date and time. It is an unacceptable invasion of privacy."

Rebecca Glenberg, legal director, American Civil Liberties Union of Virginia

Plate expectations

Fusing ALPR with other data can give security forces a comprehensive view of activities on the road network and even beyond

The video surveillance company Ekin is offering a vehicle-mounted unit that combines speed detection, face recognition, emissions measurement, and vehicle make and model with ALPR.

"All our camera and processing technology can be fitted in a patrol car's lightbar. It's intelligent and can scan the city 24/7," says Akif Ekin, chief executive of the Turkish company. "The data from all the patrol cars is synchronized. The next step is to put some business intelligence behind it so that you can find relationships between several plates and locations."

Almost 500 units have been fitted to police cars in Azerbaijan, Turkey and Qatar. In Abu Dhabi they are being trialled on a Lykan HyperSport. Forces in Europe and the USA are also assessing units.

"I support the existence of the ALPR system as an important tool in the fight against crime," Perrin tells *TTI*. "However, given its colossal scale, it needs effective governance, including external experts and lay people, to ensure that the police run it safely in the national interest, taking a broad range of views into account."

His correspondence with Sir Bernard Hogan-Howe, London's Metropolitan Police Commissioner, shows "the police do want to be open about the way the system works, but they don't really have the structures to do so. ALPR needs a new governance system to help it weigh up the issues."

Unifying the system

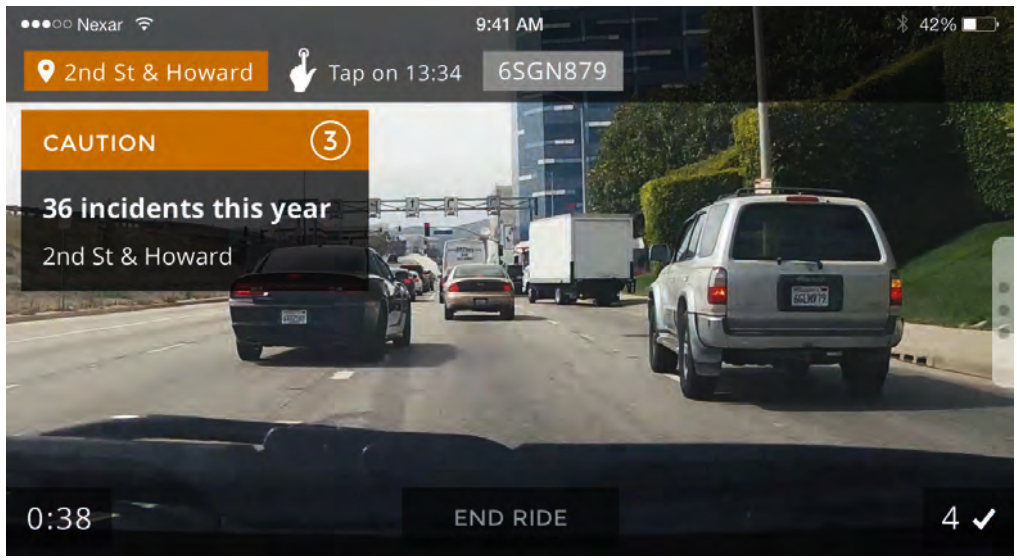
Such governance could be in place before a unified National ANPR Service (NAS) is rolled out in the UK this year. It will serve the country's 43 police forces and other law enforcement agencies by gathering and sharing up to 50 million new ALPR records every day from 8,300 cameras on Britain's road network. It will be a cloud-based service, enabling more complex forms of analysis and searching.

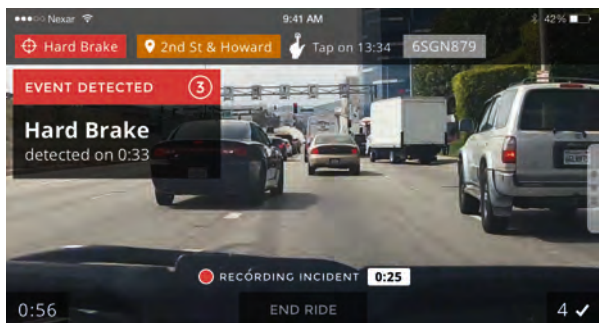
Finmeccanica-Selex ES, the company which won the contract to create NAS, says in a statement, "If a vehicle is logged as of interest, a centralized system can then alert law enforcement agencies in milliseconds.

> Given its colossal scale, ALPR needs effective governance, including external experts and lay people, to ensure that the police run it safely in the national interest
>
> **William Perrin, Policy Advisor and Private Secretary (2001–2004) to former UK Prime Minister Tony Blair**

Such a national system will contribute towards the Home Office's ability to deter and disrupt criminal and terrorist activity, while reducing the cost of law enforcement operations."

These plans haven't gone unnoticed by Tony Porter, who was





Above: **Police cars fitted with ALPR technology can record misdemeanors as they happen, with video evidence recorded as well**

"ALPR is everywhere – it's hardwired into our daily lives. The police use it for counterterrorism and serious organized crime – it's an essential tool in combating both of these."

Tony Porter, surveillance camera commissioner, UK

"A poorly designed and procured computer system has led to colossal over-retention of data that should have been deleted – tens of billions of license plate reads."

William Perrin on the London 2012 Olympics ALPR system

assistant chief constable for counter-terrorism during the 2012 London Olympics, and has said that the NAS "could be one of the world's largest non-military surveillance systems".

Porter is now the UK's surveillance camera commissioner, to "encourage compliance" with a 12-point Code of Conduct and let government know if he thinks the code isn't working.

"My role has no sanctions attached, but it's interesting that, when you cast light on a problem, how quickly the state sector responds," Porter tells *TTI*. This seems to have been what happened after a speech he gave last year in which he challenged the police on the transparency, governance and legal framework of ALPR.

"There has been movement since then," says Porter. He has talked with police, who are now setting up an independent group to advise on policy. "I think that's democracy in action," says Porter.

Yet he believes the police are still a long way from demonstrating to the public the value of ALPR. "I know there are things in the pipeline, including whether the police can use a self-assessment tool I introduced. It can visibly demonstrate to the public that not only is their ALPR fair and legitimate, but also that it complies with the 12 guiding principles of the Code of Conduct," says Porter.

He believes his self-assessment tool is simpler than the current national standards the police are meant to follow and which are derived from various pieces of legislation. "The people won't get that. But I think that if the police can commit themselves to a very simple demonstration with hard empirical evidence that lays themselves open to scrutiny then, for me, that's transparency," says Porter.

Creating a culture of trust

This point, that the police should show that ALPR is worthwhile, reflects Palmer's assertion that in Australia it's used largely to resolve low-priority offences. "I know that London's Metropolitan Police releases some statistics on ALPR," says Porter. "But, as far as I'm aware, there isn't a qualitative assessment of the value of ALPR. That's quite disturbing and I'd like to see police forces explain to the public how many crimes and the types of crimes it has helped them solve. It's not acceptable that people have to make freedom of information requests to get hold of those figures, because it doesn't generate trust."

Porter's comments are measured and he knows that he has to maintain trust with the police. In contrast, campaigners like Bella Sankey, director of policy for UK lobby group Liberty, can be less restrained. "Yet again millions of road users find their every move is being stored without their consultation, let alone their consent," she says of the police's use of ALPR, "This shows a breathtaking recklessness with our data, contempt for our right to know and inability to abide by basic rules."

Nobody wants crime and everybody wants safe, free-flowing roads. ALPR can help achieve these goals. However, like many new technologies it has been implemented before the rules for its use have been agreed with the communities that want the benefits but without compromising privacy. Unless these problems are addressed directly, ALPR risks operating under a growing cloud of distrust. ○

> Yet again millions of road users find their every move is being stored without their consultation, let alone their consent
>
> **Bella Sankey, director of policy, Liberty, UK**

Seeing Cycles

As cities around the world push for a greater uptake of cycling, traffic managers are looking to new technologies that can be deployed *en masse* to make bicycles more visible, both to other road users and to control-room operatives, thereby reducing congestion. **Michael Donlevy** investigates

Photograph: Blaze

Mounting a laser on the front of a bicycle might sound like the stuff of science fiction, but that very thing is now being fitted to the 10,000 bikes in London's cycle rental scheme in a bid to increase the visibility of cyclists, thereby improving safety and allowing traffic to flow more freely. If it is successful, similar bike rental schemes around the world could follow suit. Gadgets like this, coupled with new machine-vision methods of bicycle detection and infrastructure upgrades, are part of an ongoing drive to improve safety for cyclists – the world's fastest growing type of vulnerable road user.

Blaze's Laserlight – now being used by Transport for London – projects an image of a bicycle ahead of the cyclist

80
Number of cyclists killed in accidents on London's streets, 2009-2013
Source: DfT

In the UK, the popularity of cycling has rocketed in recent years, thanks to a combination of Britain's success in the sport and commuters' desire to find cheaper, healthier and more convenient ways to travel.

London is a victim of this 'success', in that the number of cyclists has put huge pressure on the road network. Transport for London (TfL) revealed recently that the number of car drivers had fallen from 137,000 in 2000 to 64,000 in 2014, while the number of cyclists had risen over the same period from 12,000

Fire can cause severe damage to tunnel structures, resulting in high costs. Thermal cameras from FLIR Systems can help prevent fires, by detecting hot spots or fires in an early stage so they don't have a chance to spread. A FLIR thermal camera can generate a direct alarm output to a control room operator, so immediate measures can be taken. FLIR cameras also enable fire departments to see through smoke, so they can determine the exact scale of an incident and evacuate road users as quickly as possible.

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to 36,000, and it trumpeted those figures as "a feat unprecedented in any major city".

Opponents say that dedicated cycling lanes, such as the one that opened across London's Vauxhall Bridge last November, add to congestion. However, if the huge uptake in cycling is to be managed effectively, such infrastructure changes will continue to be necessary.

Arguably one of outgoing London Mayor Boris Johnson's greatest successes was the London Cycle Hire scheme – dubbed Boris Bikes – but safety has always been an issue, with accidents costing dearly not just in terms of physical injuries, but also in time lost due to congestion. Now, following a successful trial, TfL is fitting each bike with the Laserlight system developed by Blaze.

300
The maximum lumen power of Laserlight's front-facing LED
Source: Blaze

"The Laserlight consists of a high-powered, white, front LED light and a green laser," explains Emily Brooke, CEO and founder of Blaze. "It projects the image of a bicycle on the road ahead of the rider, alerting vehicle drivers of the bike's presence and reducing the chance of them turning across its path."

The bicycle projection may sound like a gimmick, but research backs up the theory. "The Transport Research Laboratory (TRL) tested a bike with and without a Laserlight in different road and light conditions, and the results were extraordinary: a bike with a Laserlight in pitch black is more visible than a bike without one in broad daylight, and it decreases the blind spot of a truck by over 25% and of a van by over 30%."

This is crucial when you consider that in urban environments 79% of all bicycle accidents are caused when a vehicle turns in to the cyclist. Such technology should certainly be on the radar of managers of other cycle rental schemes worldwide.

Above: **Emily Brooke, CEO and founder of Blaze, the manufacturer of the Laserlight**

20
The percentage of cyclist collision fatalities that involve trucks
Source: RoSPA

Change is coming

Cycle-mounted technology is one way to make cycling safer. But new automated cycle-detection systems that feed data to traffic management centers are an even more effective way to cut crash rates. And changing road layouts is perhaps the most fundamental safety measure of all. Such infrastructure upheavals are, of course, never without their controversy.

> A bike with a Laserlight in pitch black is more visible than a bike without in broad daylight, and it decreases the blind spot of a truck by over 25%
>
> **Emily Brooke, CEO, Blaze**

"The first challenge is political will, particularly as so many cycle injuries happen at junctions," says Rachel Aldred, a senior lecturer in transport at the University of Westminster, UK, and a trustee of the London Cycling Campaign. "Junctions are where the bottlenecks are for motor traffic capacity, so creating protected space at junctions is even harder than along links. Safe junctions will have a major impact in reducing injuries. The key thing is to protect cyclists from dangerous conflicts , such as 'left hooks', and there are various ways of doing that.

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I like the Dutch 'all directions green' approach, where cycles have their own signal cycle and can go in all directions during a green signal." However, to make such a system fully effective, it is necessary to have methods of detecting cyclists at junctions, and adjusting signal timings accordingly.

TfL is aware of the problem and is working toward solutions. "We're carrying out trials of two new technologies – one radar-based and one thermal – which detect cyclists on the approach to traffic signals," a spokesman says. "This is helping measure volumes of cyclists and the potential for future technology that could give priority and improve safety. The trials are taking place along Cable Street in east London, on Cycle Superhighway 3. Data could be used to enable the traffic signal timings to be adjusted to give more green time when there are high numbers of cyclists at key junctions during peak times."

Liverpool, in northwest England, is also using thermal technologies to detect cyclists. The city council is implementing a new scheme involving the use of Flir's ThermiCam, which is capable of functioning in low-light conditions. The cameras will be fitted at traffic signals to and communicate when cyclists are detected, so that green light durations can be extended to improve safety and traffic flow.

An alternative video-based product with a similar function is also on the market. Iteris SmartCycle detects and differentiates a cyclist from a vehicle at traffic signals. Bicycle detection allows automatic allocation of signal green time to the bicyclist as they approach an intersection. It also allows for allocation of additional signal green time to safely clear slower-moving bicyclists through the intersection. The machine-vision system reverts to a regular signal phasing if no bicycles are detected for more efficient roadway operations. It is capable of detecting multiple cyclists at once, whether they are riding in a dedicated cycle lane, or using another part of the road.

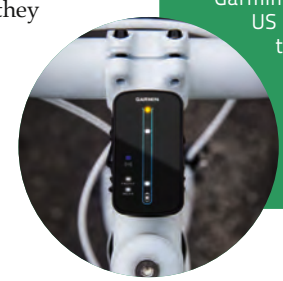
On the UK's south coast, in Brighton, a vehicle-activated sign is being used to improve safety and the flow of traffic by warning drivers when a cyclist is approaching the London Road junction. Using inductive loop sensors, CA Traffic's Black Cat traffic counter is able to classify vehicles approaching the junction. When a cyclist is detected, a warning is displayed on the sign, helping to make the drivers more aware of the cyclist's presence.

Back in London, it is now recognized that one of the biggest threats to cyclists is from trucks. Since September 2015, vehicles over 3.5 tons entering London have had to have sideguards to protect cyclists from being dragged under the wheels in the event of a collision, along with Class V and Class VI mirrors to give the driver a better view of cyclists and pedestrians.

Right: **Iteris's SmartCycle detects bicycles at intersections and adjusts traffic signal green time accordingly**

> There's scope for using technology to put pressure on motorists to be more considerate
>
> **Rachel Aldred, transport lecturer, University of Westminster**

75
The percentage of collisions between bicycles and vehicles that happen at junctions
Source: RoSPA



On your radar

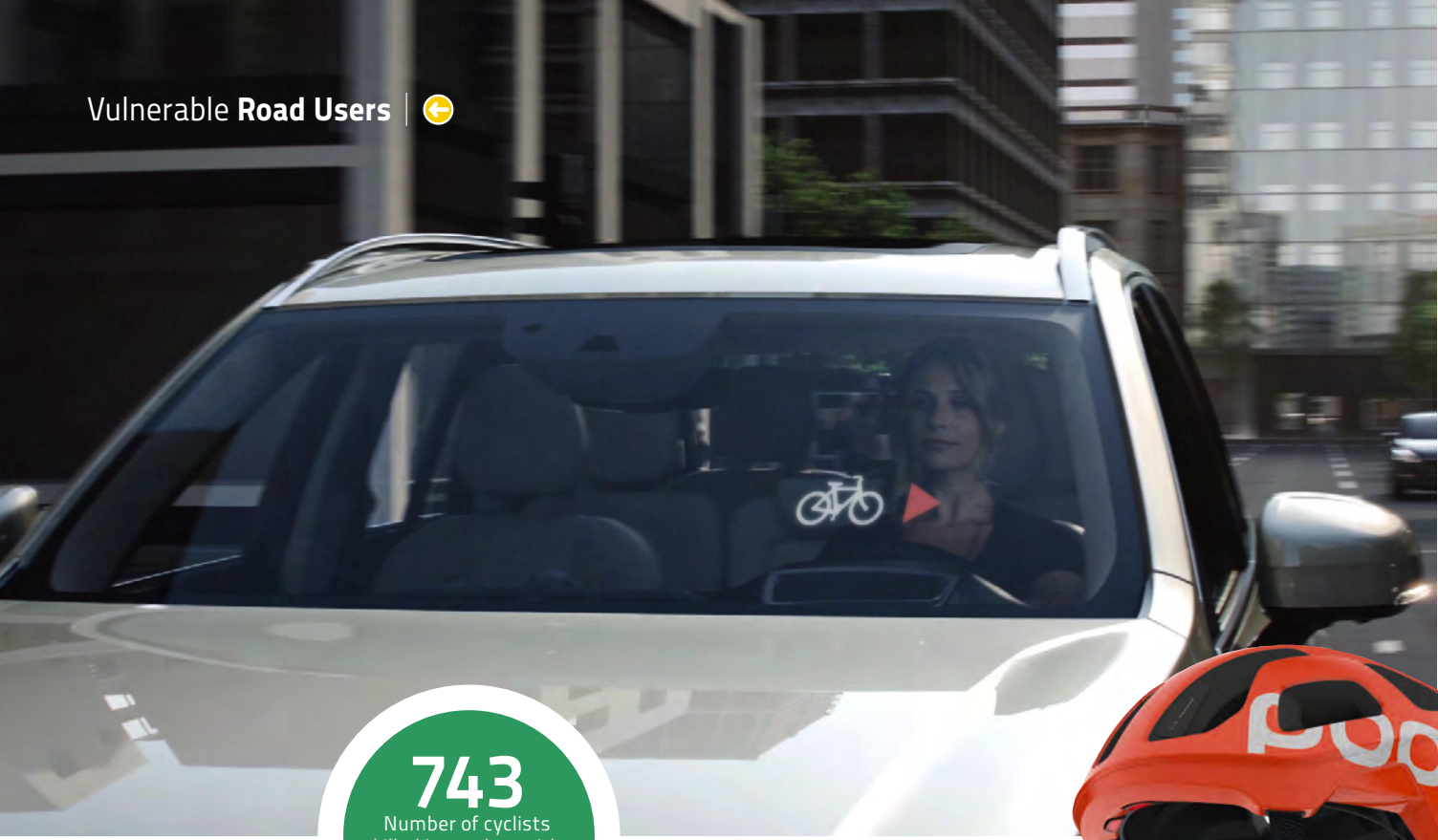
Traffic managers must be aware of the rapidly evolving ways in which cyclists interact with the vehicles around them

Two new products – already available on the market – add to the array of gadgets cyclists can choose from to stay safe. Garmin's Varia Rearview Radar is a laser-based tail-light and head unit that senses traffic approaching from behind and warns the rider, while also brightening the light to make the cyclist more visible.

The Varia Vision In-Sight Display, also by Garmin, clips to sunglasses to display data from the radar in the line-of-sight.

"The radar tail-light works independently or with our Edge cycling computer," says Garmin's Amy Nouri from its US base in Kansas. "The transmitter detects vehicles up to 460ft (140m) behind, indicating increasing risk with a change in color on an LED interface or Edge device.

"The In-sight Display shows information from the Edge and Rearview Radar, and has a touch-panel display that allows cyclists to move between data displays without having to shift focus from the road ahead," she adds. "We don't know how popular it is yet because it's so new, but we're constantly looking at how we can help to create safer riding conditions."



743
Number of cyclists killed in crashes with motor vehicles in 2013 in the USA
Source: NHTSA

Outgoing mayor Johnson also proposed some further safety modifications, including the retrofitting of bigger side windows to further reduce driver blind spots, which is currently in consultation, and TRL is trialling a variety of electronic sensors for trucks, aiming to alert drivers to cyclists' presence. Likewise, TfL is testing buses with collision avoidance systems that can trigger automatic emergency braking systems.

The road ahead

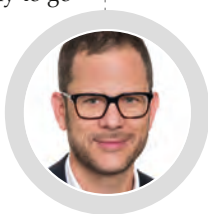
Another problem, however, is cultural. "Driver behavior is influenced by poor infrastructure and policy," Aldred says. "There's an assumption that cyclists should give way, and that the responsibility is on the vulnerable road user to avoid being hurt. Good infrastructure should help to chip away at that, as will better policy and enforcement, but one thing I'd like to see, technology-wise, is the development of apps that encourage drivers to be safer. Instead of telling pedestrians and cyclists to avoid areas that have a record of injury collisions, why not tell motorists to avoid those places? There's scope for using technology to put pressure on motorists to be more considerate. Some of this could be driven by the insurance industry given the growing cost burden that is related to cycle collisions."

One automotive company that is already bridging the ideological gap between motorists and cyclists is Volvo, Sweden's standard-bearer for safety. The company has teamed up with sports gear manufacturer POC and tech company Ericsson to produce a prototype cycling helmet that offers proximity alerts to drivers and cyclists to help avoid collisions. A smartphone app connects the helmet to cars, so Volvo's City Safety system can detect cyclists, warn the driver and auto-brake if necessary. But this technology, which was shown at CES in 2015, has a way to go before saving lives.

"We showed a vision of what will be possible in the future when 'things' get more connected," says Sascha Heiniger, the director of strategic brand communication at Volvo, who oversaw the project. "It would potentially help avoid crashes, but our team has also concluded that it will still take several years until this kind of technology might become relevant. It will need more connected cars and car brands to share the same cloud or to link their clouds, which is a challenge in its own right. Of course, cyclists must be willing to connect themselves to the cloud as well. So this concept will not reach the market in the short term."

Above and right:
Volvo, POC and Ericsson's prototype cycling helmet communicates with cars to alert drivers of the cyclist's presence

> We showed a vision of what will be possible in the future when 'things' get more connected
>
> **Sascha Heiniger, director of strategic brand communication, Volvo**



Ultimately a combination of improved bicycle detection and infrastructure and advances in technology for cyclists will maximize rider safety and improve traffic flow. However, with technology, in the form of gadgets and apps, progressing more quickly than changes in infrastructure, the scope to improve safety is limited. "There's a lack of expertise – we simply haven't built many safe junctions yet in the UK," says Aldred. "We have lots of organizational problems with funding being stop-start – outside of TfL – and far too low."

It is now up to transportation authorities to push for improvements that will effectively manage the new traffic mix on our streets.

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Each time a transport game-changer has emerged, the new knowledge has spread faster than it did on the previous occasion. It took millennia for the wheel to become ubiquitous, centuries for the horse's bridle, 60 years for the bicycle, and only a couple of decades for the car. So when Paul Zanelli suggests that another major disruption could happen within five years, it seems plausible.

He's the chief technology officer at the UK's Transport Systems Catapult (TSC), a government-backed organization that seeks to be a catalyst for British invention, and therefore national profit. He deals in strategies, information, encouragement and support to stimulate new thinking. At the risk of helping other nations, he's happy to share his thoughts with *TTI* readers.

We meet in the TSC presentation theater, overlooking a wide boulevard and full parking lot in Milton Keynes, a UK city that once represented the future for urban planning. Zanelli suggests that transport has already departed for a new destination as yet

Transportation is evolving rapidly. **Paul Zanelli**, CTO at the UK's Transport Systems Catapult, is charged with ensuring that Britain is at the forefront of innovation during this time of change. Here, he shares his insights

Interviewed by Max Glaskin

> The car has been the point of freedom, but in a picture of the future it will be the smartphone. That change creates opportunities and risks

Right: **An autonomous LUTZ Pathfinder pod, created by Transport Systems Catapult (TSC) and RDM**

Transport Systems Catapult wants **your** feedback. Zanelli asks how his organization can best achieve its goals. Share your ideas at imexchange.co.uk

unknown, with implications for everyone involved. Still, it's not entirely a magical mystery tour because we've seen some road signs…

One, he says, is that personal ownership of cars is in decline. Another is that globally there are seven lift-share companies each valued at more than US$1bn. His conclusion is that businesses focusing on travel mode will become out of date as they are overtaken by a new paradigm.

"The car has been the point of freedom, but in a picture of the future it will be the smartphone. That change creates opportunities and risks," he says.

What are these risks? "Uber, for example, is changing demand patterns in cities and that can upset the models used to validate investment in public infrastructure," he says. "This kind of uncertainty can paralyze public systems and you could end up with a non-integrated, non-coherent transport system that doesn't meet the needs of everyone in society."

So, gridlock through blinkered vision, highway network decay through misplaced investment, or the death of public transport could happen unless the possibilities are taken seriously. TSC's mission is to make people aware of these changes and put tools in place so that they can grab victory from the jaws of inertia.

What's new?

"We are developing a high-level architecture for future transport systems," says Zanelli, "If we don't, we'll end up with a fragmented, non-interoperable system." During our conversation he touches on three examples of how the right architecture should help the future to arrive on schedule (*see box, right*). But before any solutions are put in place, they need to be tested through modeling and visualization, and this is another opportunity for the traffic sector to benefit from outside expertise, because existing tools to simulate changes in road design and traffic management may not deliver. Even elaborate number crunchers like Charles Komanoff's New York Balanced Transportation Analyzer, comprising of 60

Three routes to a smarter future

1 Integrated ticketing

Making transit payment systems compatible across multiple modes, from a single access point, is key to a multimodal future. "Anyone with an electric vehicle will know already how much this is needed for recharging EVs. It's fragmented, so you need lots of different cards, there are different plugs and you can't book ahead through one platform," says Zanelli.

2 Accessible data platforms

A common and accessible data platform would help everyone involved with transportation. It could accurately indicate not only real-time movement of people and vehicles, but also future demands and events, over scalable networks. This would help infrastructure providers and traffic managers optimize their operations.

Zanelli also sees this as playing to a specific strength of the UK. "On an international stage, the UK has quite a lot of capability for both physical and cyber security. If we have an integrated system for transport, a security layer will be needed and there's going to be a huge market there," he says.

3 Common standards

As automated and connected cars become part of the nation's vehicle fleet, efficiency will be vastly improved if existing systems can be updated to serve them, rather than having to build completely new communications architecture. "You can see a future with the connected car where you don't need variable signs on overhead gantries because you give the information directly to the people in their vehicles. But to do that you need a standard that everyone can access," says Zanelli.

"However, there will always be the legacy of non-automated or unconnected cars, whose drivers will need signs. So in the short term you're going to have to have redundancy – overhead gantry signs and in-car displays. What can we do to minimize redundancy from two parallel systems? Maybe the way to do that is to have the display part, whether in-car or on the gantry, as the only redundant part, with the rest of the system behind it applicable to both," he says.

Autonomous pod update

Transport Systems Catapult's highest-profile project is the testing of LUTZ Pathfinder pods, in association with Milton Keynes Council and the University of Oxford's Mobile Robotics Group.

The six-stage project has now entered stage 4, with three pods out on public pathways but still having human drivers as they move around Milton Keynes. The aim is for them to survey their environment and collect data.

The pods are also validating and calibrating their autonomous control systems. Only when that has been completed will autonomous driving begin.

The pods were designed and built by RDM of Coventry and have had safety assessments at MIRA's testing facilities. They have a top speed of 15mph (24km/h), but this will be capped according to the conditions where they are operating.

worksheets and 68,000 data cells may work for specific tasks, but can require a lot of changes for them to be used elsewhere.

So Zanelli wonders if generic tools that can use data from many sources to create dynamic models could do a better job.

"Rather than counting and making complex handbuilt models, can we have more data reusability, using graphics processing technologies from, for example, the gaming industry?" he questions.

Picture the future

This approach could aid traffic and infrastructure planning. "Instead of acquiring specific data for specific cases, can we reuse data from sources such as the census, OpenStreet Maps, Ordnance Survey, public transport and so on, to dynamically build a model of the world that, when you zoom in to a road junction, is as good as a handbuilt model, but done on the fly, in real time?" Zanelli asks.

TSC is already on the way to answering these questions through two projects. It has selected ITO World, a company whose background includes film visual effects, as a data visualization partner for the UK's Department for Transport. Also, complex systems company Improbable is working with TSC spin-off Immense Simulations to create solutions for coordinating AV fleets.

Zanelli joined TSC 30 months ago when it had barely a handful of staff and a temporary office. Since then it has hit the headlines with its autonomous pods, traveler needs surveys and Intelligent Mobility exchange forum, among many other activities.

"I've done startups before, but none have gone from 0 to 150 as quickly as we have," Zanelli says. "It's exciting, but it does present fantastically difficult challenges, which I enjoy, but only if I can see a potential pot of gold at the end – and with this one I do.

"I see a future where transportation could be radically different from what it is today in a relatively short time," he says.

"In the next 5-20 years there could be some massive changes with huge positives, but there are some real pitfalls that need to be avoided."

Why 'Catapult'?

When entrepreneur Herman Hauser advised the UK government in 2010 about technology innovation, he recommended long-term investment in physical centers to guide, lead and focus efforts by commerce and academia. Today, there are 11 such centers and they all go by the unlikely name of Catapult.

The word 'Catapult' was chosen by the Technology Strategy Board because the title Technology Innovation Centre was not thought to be snappy enough. It is supposed to serve as a reminder that the function of these centers is to catapult ideas out of research and into the marketplace.

Like the other 10, Transport Systems Catapult is funded by Innovate UK, a non-departmental public body that's sponsored by the Department for Business, Innovation & Skills. It also gets substantial support from the Department for Transport. Eventually the aim is for it to get a third of its funds by winning commercial R&D contracts and another third by collaborating on applied R&D projects.

> I see a future where transportation could be radically different from today, in a relatively short space of time

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New CMOS technology to improve optical ITS solutions

As technology evolves, it is common to see new technologies overtake existing ones, because they offer more, while typically costing the same, or less. We see it with computing hardware and software, smartphones and wireless. Now the time has come where one can expect to see high-performance complementary metal-oxide semiconductor (CMOS) technology surpassing charge-coupled device (CCD) sensor technology, which had long been the choice for delivering excellent images in challenging lighting conditions.

CMOS versus CCD

In recent years, the microscopy imaging market has seen the introduction of scientific CMOS (sCMOS) as a disruptive technology, designed to compete with high-performance electron multiplying CCD (EMCCDs).

Typically, CMOS was not seen as a suitable solution for high-quality imaging in the life sciences domain. Its advantage was its speed, which CCD cannot compete with, but some of the major drawbacks of previous CMOS sensors included high noise (read, dark current, fixed pattern), low quantum efficiency, lower bit-depth, non-uniform response and low dynamic range, which are not ideal. The circuitry required for each CMOS sensor pixel reduces the photoactive area within a pixel. Furthermore, the varying tolerances in the amplifiers for each pixel can lead to uneven pixel response. When these factors are considered, CCDs have typically offered the better performance.

sCMOS branding was necessary to help differentiate a 'scientific grade' sensor from the inexpensive, poor quality CMOS sensors that many were accustomed to seeing in the market. It was a breakthrough in technology, offering innovative performance features that enabled quantitative scientific measurement.

Need to know

Improvements to CMOS sensor performance reduce the need for CCD technology

- Lumenera has developed a series of new cameras, based on Sony's latest Pregius global shutter CMOS technology
- The cameras will boast CCD-like performance from a CMOS sensor with increased frame rates and crisp, clear images
- In the past, CCD was favored over CMOS for its ability to deliver high-quality images in limited lighting conditions. With advances in CMOS technology, it is now considered to have better overall performance than CCD

The development of CMOS

New CMOS developments over the past few years have dramatically improved the performance of these sensors to the point where many individuals expect CMOS sensors to completely replace CCD technologies in application domains within the next five years or so.

In the ITS industry, CMOS sensors have been in use for many years because there are several applications where image quality is not critical to delivering accurate analysis and monitoring of events. However, there are also applications where older CMOS technology cannot give the results that are required for automatic license plate recognition (ALPR) under demanding lighting conditions. In these situations that CCD technology can be relied on to deliver excellent images to produce the desired results.

With the recent introduction of Sony's Pregius line of electronic global shutter CMOS sensors, the gap between the two technologies is being closed for some features and CMOS may even surpass CCD for others. An improved fill factor equates to a quantum efficiency of over 70%. This means that for every 100 photons hitting a pixel, 70 are converted to electrons, which is important for sensitivity in low light conditions. Read noise has been reduced to two electrons – a considerable drop, surpassing many CCD sensors and helping to boost the dynamic range to over 70dB, which is critical for resolving objects in an image within shadows and bright light. The sensors do not yet have the 14bit pixel depth or low dark current noise of

Above: **Lumenera will be releasing its Pregius-based Lt USB 3.0 camera family later in 2016**

CCD sensors, but these requirements are not typically applicable to ITS as many systems use 8-12bit data and don't use exposures long enough for dark current noise to be relevant.

For the ITS market, it won't be long before new, higher-performing CMOS technologies are used in all systems in the industry. The improvement in its performance will soon surpass CCD technology on all fronts, thus making it the most suitable sensor technology for most imaging applications. In the meantime, however, CCD technology still provides outstanding image quality that ensures many ITS systems deployed attain their high accuracy for automobile, license plate and driver detection.

by **Neil Hoose**

To maximize the benefits of autonomous vehicles, regions must reach common ground in their policies

The surge of development of automated driving of road vehicles is a combination of a pull from technology and a push from industrial policy, spurred by the potential of a disruptive entry into the car market by the likes of Google and Apple.

Car manufacture is a major part of the economies of many European industrial nations and has far-reaching supply chains. Hence, ensuring that your national part of the industry is at the leading edge is important, particularly given the need for economic growth and employment. What is less clear is the impact that the need to make the industrial policy a success will have on other policies. In addition to transport policy itself, there are implications for employment, land use and health policy.

The car manufacturers are aiming to replicate the human driving experience with robot control under user-selected conditions. This retains a consumer model of vehicle purchase and leasing. There may be benefits in terms of safety, congestion and emissions, but these have yet to be established and could easily be outweighed by an increase in car use and driven miles, because if a sufficient amount of the time at the wheel can be put to other use, actual journey time becomes less important.

Automating the driving of buses and trucks has huge implications for employment. It could drive down the cost of transportation further and lead to an increase in driven miles. Any reductions in emissions and safety gains from robotic control could also be wiped out by this increase in use. If automated driving makes travel by road more attractive, the overall situation could be more congestion, which, while it may be of less concern to the automated vehicle user, may bring great challenges to other road users and to those who live and work near major roads. Unless increases in distance driven are matched by reductions in vehicle emissions, the impact on public health could be to worsen a situation that is already cause for alarm. Should automated driving only be available on zero- or low-emissions vehicles?

The interaction between all these policy areas is complex and the mix varies hugely across regions. The 28 nations in the EU have some common goals at the high level, but at the detail level, where the devil lies, they are, and are likely to remain, very different. For the industrial policy toward automation to succeed, the products and services need to be able to be sold into regional-level markets with minimal local change. If the cross-policy effects are different between countries, this may be very difficult to achieve. How will automation play out between the environmentally aware Nordic countries compared with the highly congested central areas of the Netherlands, Germany, Belgium, southern UK and northern France, or the areas in the south and east of the EU that still face major economic challenges? There is policy development taking place, but it needs to pick up the pace, be more cross-cutting and, above all, evolve at a pace that keeps up with the technology. Otherwise we may be faced with a single-minded policy in one area that creates huge unforeseen consequences in several others.

> Policy development needs to evolve at a pace that keeps up with technology

Neil Hoose is an independent ITS consultant and owner/director of Bittern Consulting Limited ***info@bittern-its.com***

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

For more on cooperation in autonomous and connected vehicle standards in the EU see pages 20 and 28

Making cities smarter and less congested with big data

In a world where seemingly everything is now connected, the use of so called 'big data' has been shown to be as valuable as infrastructure for safe and efficient movement of people and goods.

This data, when properly used in a secure and privacy sensitive manner, can enable the dynamic management of the lifeblood of any city – its transportation network.

The management of our urban transportation networks will become even more critical in the near future than it is today. According to the United Nations, 51% of our global population lives in urban centers. By 2050 this will increase to 70%. As urban populations continue to grow, the burden on our transportation infrastructure increases. Traffic congestion is currently growing at three times the rate of GDP growth in most countries.

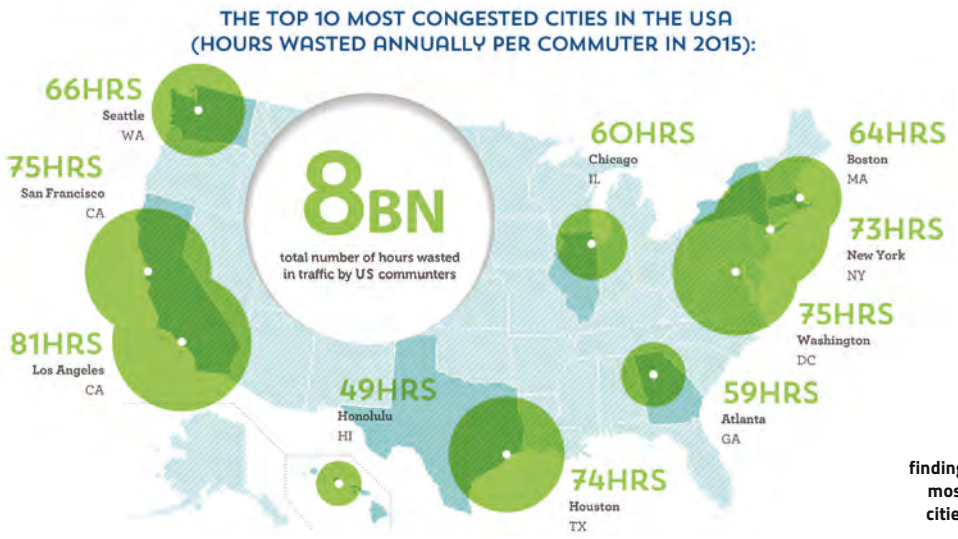
Road overload

Urbanization continues to drive increasing levels of congestion in many major cities worldwide. Strong economies, population growth, higher employment rates and declining gas prices have resulted in more drivers on the road and more time wasted in traffic. In 2015 the USA had the worst congestion globally, with the average commuter spending nearly 50 hours in traffic that year.

Based on findings from the 2015 Inrix Traffic Scorecard, Los Angeles, Washington DC, San Francisco, Houston, New York and Seattle rank as the most congested cities in the USA, where commuters collectively spent a total of 8 billion hours stuck in traffic in 2015. The USA has the worst traffic congestion across both the USA and Europe and only London, UK, has worse traffic than the most congested US cities.

But traffic jams don't just affect drivers in terms of time; they also affect our economies, public safety and the environment. In 2015 traffic was estimated to have robbed the economies of the USA, the UK, France and Germany of over US$200bn and this sum is projected to grow to US$291bn by 2030.

We have known for some time that we can't build our way out of the problem we are facing. Cities need a smarter approach – one that leverages data, analytics and location technologies to address the challenges ahead.



Left: **Inrix's findings about the most congested cities in the USA**

Need to know

Inrix improves global mobility with connected car services, driver apps and smart city analytics

- In 2015, US commuters collectively spent 8 billion hours stuck in traffic
- Traffic jams cost governments in the USA, UK, France and Germany, an estimated US$200bn in 2015
- It is expected that by 2050, 70% of people around the globe will live in an urban center. Such data insights help cities to plan their transportation links in the face of urbanization

Traffic overload

Inrix brings together data from many global sources – apps, roads, cars, cities and the cloud – across GPS and cellular networks to create diverse data sets that lead to more robust and accurate insights than any one source could deliver alone. Inrix aggregates and analyzes data, as well as delivering applied intelligence for managing city roadways and planning future urban mobility developments. Inrix public sector solutions leverage the company's traffic and parking intelligence to help transportation agencies drive down the cost of daily operations, pinpoint areas that most benefit from road and public transportation improvements, manage the effects of increasing population and better measure the impact of their investments.

With over 450 customers and live coverage in over 60 countries, Inrix is a global provider of connected car services and transportation analytics to make movement more intelligent. Inrix leverages vehicle connectivity, intermodal routing, advanced parking management, and dynamic data for city planning and traffic flow optimization to make cities safer, cleaner, more convenient and more enjoyable for people to travel through and around. The company's partners are auto makers, governments, mobile operators, developers and advertisers, as well as enterprises large and small.

Laser vehicle classification adds to toll system efficiency

The Horten Moss ferry station is Tecsidel's first single-gantry project in Norway, located in Torghatten and operated by the Torghatten shipping company. The project, managed by B&T Signaal, which will benefit from its low maintenance and costs, consists of a single-gantry assembly equipped with three lasers per lane that enable length-based classification of vehicles.

Vehicle classification

The system is able to classify up to nine (length-based) vehicle types and is capable of working in stop-and-go conditions typically seen at tolling systems that are equipped with barriers.

This innovative system can detect exactly where a vehicle is and is able to track it from the moment it enters the lane until it is fully classified. This classification system is independent in regard of both hardware and software, and has self-learning properties to continually improve its performance. This self-learning capability is a breakthrough characteristic in that as soon as the system acquires real data, it works even more precisely and accurately.

This single gantry is easy to install and maintain, and increases road safety and users' comfort. It also boasts environmental benefits: it contributes to lowering pollution levels because fewer materials are used in its construction.

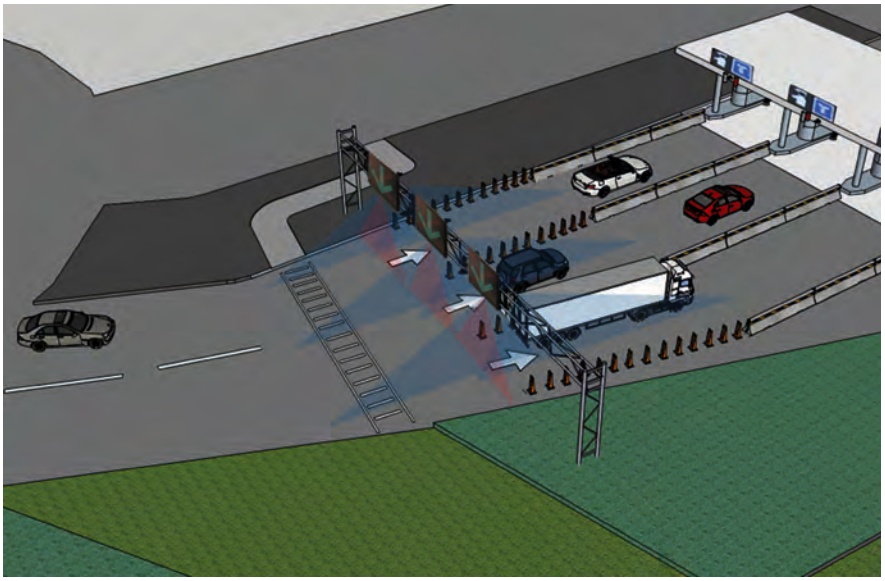
Toll fee collection

Tecsidel's project includes the company's Automatic Toll Payment Machine (ATPM). The fully automated, economically designed terminal is capable of carrying out various tasks including fee collection, entry ticket issuing, access point functions, and providing receipts and communications.

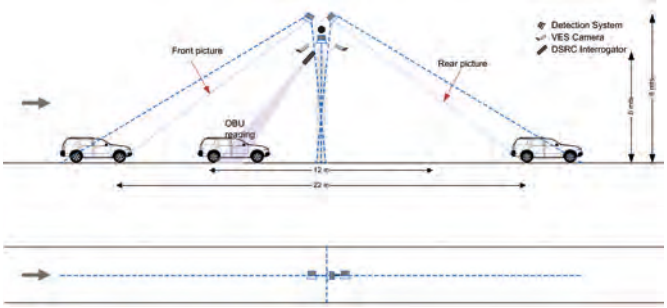
The ATPM offers various ways to collect toll fees, including banknotes, coins, credit cards, contactless cards and barcodes. The automatic terminal also has a voice synthesizer, LED indicators and buttons to optimize the users' experience and speed up transactions.

Tecsidel has successfully implemented similar combined systems in Sweden, France, Russia and India. However, in addition of 39 other free flow projects in Norway, this project is the first single-gantry classification system in, following successful results generated from a single-gantry free-flow test site in Oslo.

Since the beginning of 2016, the company has been awarded a total of five free-flow projects, which are operating at 16 stations in four Norwegian regions. The Horten Moss project has seen Tecsidel become firmly established in the market for toll collection systems throughout Scandinavia.



Left: **Tecsidel's Horten Moss ferry station project classifies vehicles before charging the appropriate fee**



Below: **The vehicle classification process for the Horten Moss ferry station project**

Need to know

Tecsidel develops toll systems, ITS, and IT and logistics solutions

- Tecsidel's Horten Moss single-gantry project classifies up to nine vehicle types
- Self-learning properties enable the system to continually improve its performance
- It includes an ATPM that carries out toll-fee collection, entry-ticket issuing, access point functions, communications and also issues receipts

Self-sufficient ALPR cameras help authorities to combat crime

Across the world there is an increasing demand for advanced equipment to support authorities in their fight against crime. Tattile's new camera ranges, the Vega Basic line in black and white and color versions, and the Vega Smart line with dual- and single-head versions, help authorities in this battle.

Self-sufficient systems

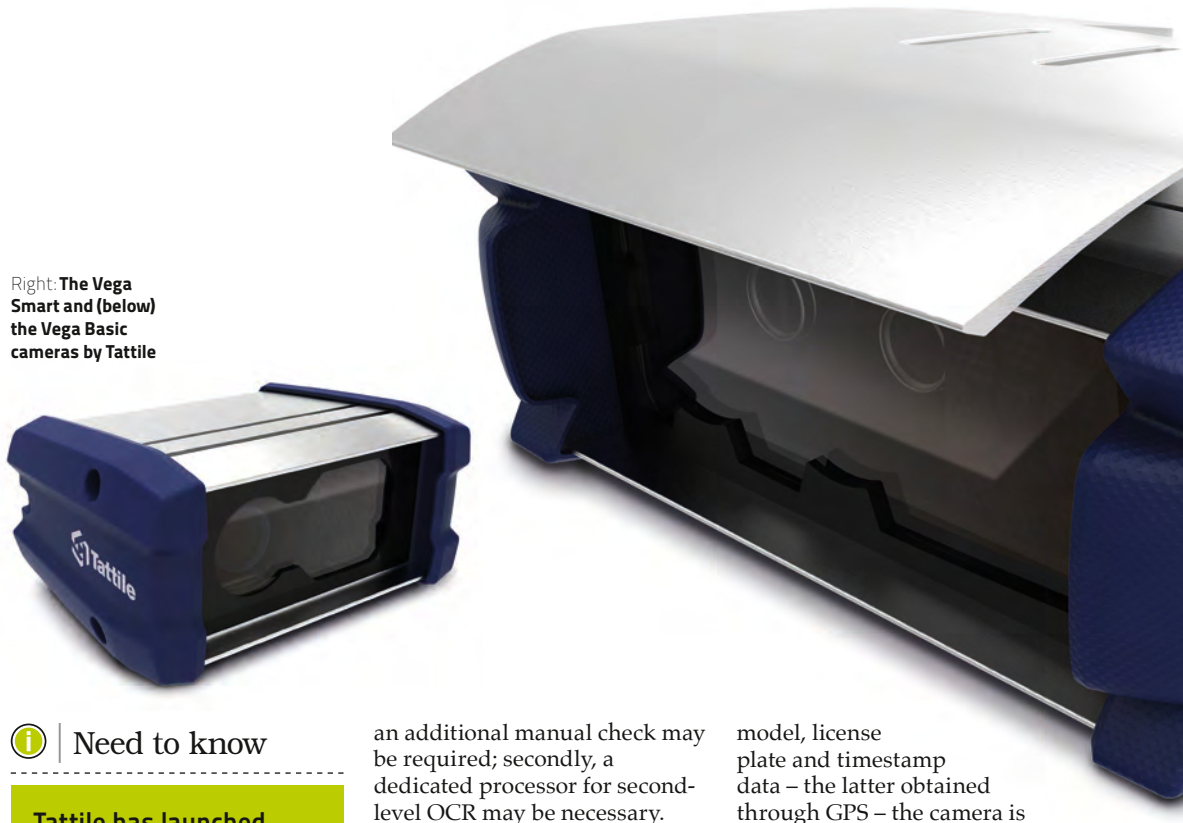
The Vega Basic line comprises ALPR cameras with three significant features: a compact design allowing the device to be easily installed, the capability of reading both reflective and non-reflective license plates without external light, and the use of Power over Ethernet technology that enables the camera to be installed with a single cable.

"The Vega Basic line has a processor, ALPR software and a web server integrated on board," says Massimiliano Cominelli, sales manager at Tattile's traffic division. "This makes the cameras completely self-sufficient.

"Including powerful processors and sensors in the design of the Vega Smart line devices has enabled us to improve their functionality," adds Cominelli.

The Vega Smart camera not only includes ALPR software, which enables it to operate as a stand-alone system, other devices and software can be used with it too.

The Vega Smart camera is able to run two ALPR software programs. When onboard processors run a single program, the data must be used directly or, when used in tolling applications, it must undergo post-processing, where second-level OCR analyzes the images again. In both cases there are some drawbacks. Firstly, when character recognition is difficult, an additional manual check may be required; secondly, a dedicated processor for second-level OCR may be necessary. With a dual OCR camera, the dual check is obtained on board and the output is very accurate, incrementing the recognition rate of the device.



Right: **The Vega Smart and (below) the Vega Basic cameras by Tattile**

Need to know

Tattile has launched two new ALPR cameras: the Vega Basic and the Vega Smart

- With ALPR software, onboard processors and Power over Ethernet technology, the Vega Basic camera operates as a standalone ALPR system
- The Vega Smart classifies vehicles with OCR and can identify 6-8 vehicles per second
- The Vega Smart is also able to submit selective data to external teams, such as the police and highway patrol

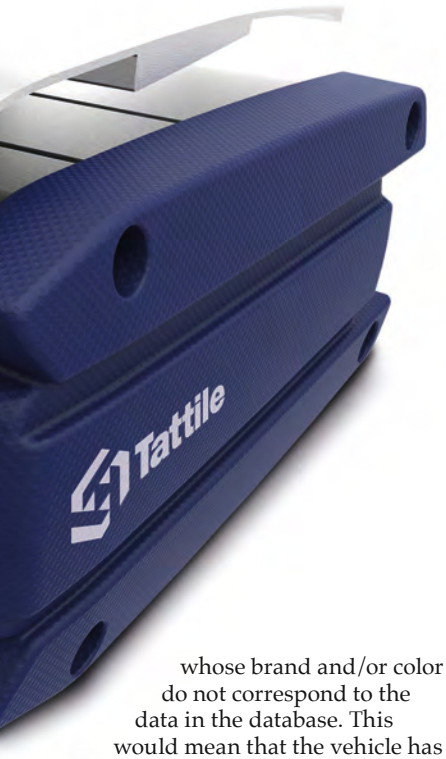
Vehicle tracking

Tattile has integrated a color sensor in the dual-head version of the Vega Smart camera, allowing it to obtain high-quality video streaming and images. This can be used to provide information to relevant authorities to further supplement their evidence.

The Vega Smart is also capable of optical vehicle classification without the use of external lasers or radars. Three classes of vehicles (motorcycles, cars and trucks) are recognizable. By combining the vehicle class information with the color, model, license plate and timestamp data – the latter obtained through GPS – the camera is able to provide a large amount of valuable information about the vehicle without the use of external devices.

Another feature of the Vega Smart is its capability of recognizing vehicles' brands and colors. This is important for two reasons: the camera is able to create a 'fingerprint' of the vehicle and associate a license plate with it, enabling it to be tracked or charged at tolls; the camera's uses can also be extended to public security.

"Thanks to this embedded feature, it is possible to automatically obtain a vehicle's license plate, brand and color data in real time," explains Cominelli. "This data can be checked by the software, flagging up, for example, the use of a license plate on a vehicle



whose brand and/or color do not correspond to the data in the database. This would mean that the vehicle has to be immediately stopped."

The Vega Smart can identify between 6-8 vehicles per second assuring higher recognition rate during peak traffic times. It is also able to transmit selective data to police, highway patrol teams and other authorities who require the data. For example, cameras installed in a city center could automatically transmit essential metadata (license plate, date and time) to the local police, and the metadata plus images, videos and the vehicle classification to state police.

by **J J Eden**

Cybersecurity and insurance are definitely on the A-list of discussions across almost every industry

Conferences and specialty informational meetings are an important part of our business. We are able to network with peers and old friends, as well as the new faces that are bringing fresh, innovative concepts and ideas. These meetings give us the opportunity to see what is new not only in our industry, but also emerging trends in other fields; we get to share and discuss business solutions that may be viable or disruptive to our current models.

So what will the hot topic be on the conference circuit in 2016?

Autonomous vehicle conversations will continue, but they will shift from when they will be available to the general public, to what the impact will be on transportation and consumers alike. Are there going to be impacts to the roadway, signage and maintenance schedules? Are payment methods such as Apple Pay and Google Wallet planned to be built into these vehicles? How will the incorporated connected city and Internet of Things technologies impact our infrastructure?

Cell phone applications will continue to be on the agendas of many conferences but, as with autonomous vehicles, the focus will shift from convenience to GPS and payment functions, and the companies that can provide these services. These conversations could easily evolve into payment center operations. Remember, some people will pay their cell phone bill before their house payment.

Thought will also be put into insurance, liability and ethics changes associated with automation. In the rare event of an unavoidable accident, how does the software decide who to save – the driver or the potential victim? And then, who is liable – the vehicle owner, the driver (or software)? Who will need insurance?

New hardware and software technology is always an exciting topic. With new cameras, illuminators, active vehicle control (AVC) systems, optical character recognition (OCR) and revenue systems, the sky is the limit. And, like my cell phone, anything new is better, faster and nicer.

Asset management has been on the list for a while, but the old maintenance online management (MOMS) conversation will expand into a much-needed predictive maintenance, inventory, and plan maintenance and program management system. As with any major upgrade, much discussion will take place on how to integrate these changes.

In an accident, how does AV software decide who to save – the driver or the victim?

Cybersecurity and insurance are on the A-list of discussions across almost every industry. All you have to do is look at any media source to see that cyber security is a big topic with lots of questions and few answers. How do we make it convenient for our customers without opening up our systems to hackers or worse? Insurance is now available, but it can be expensive – and certainly is after the damage is done.

The transponder war will continue, but it has been relegated off the podium to a back room. Stay tuned to see who, if anyone, wins.

Although interoperability is still a hot topic this year, for the most part, it's not a podium topic.

Now is the time to start looking at the venues of all the conferences you're getting invited to. There are some great venues and I for one am looking forward to the learning experiences.

What do you think 2016 will bring? How will we adapt to the changes? Email your thoughts to ***james.eden@aecom.com***
Illustration: Ian Parratt, the-caricatureartist.co.uk

Keep order in the control room with KVM

As more people travel through airports, train stations and bus depots on daily commutes, business trips and holidays, safety, reliability and performance have never been more important – especially when monitoring and managing the infrastructure, assets and equipment that make it all possible for the transport industry. As a result, the role of command control, whether in a busy international airport or for a regional train line, continues to grow.

Inside the operating room

The aim of every control room – regardless of industry – is to ensure the right people are given the right information at the right time. So just how is this accomplished?

A lot of factors need to be taken into consideration to ensure the success of the control room, from a carefully designed layout, to the use of ergonomics. However, a successful operation is largely dependent on the technology that is present, from the video wall and processors, to the computers and individual displays. It is also crucial behind the scenes, such in as the use of keyboard, video, mouse (KVM) technology – whether that's direct connect, IP-based, or a combination of both.

In such a highly pressurized environment, where mission-critical decisions are often made, operators must be able to perform their tasks as effectively as possible and in an environment that is comfortable and conducive to productivity. KVM technology can certainly help ensure these objectives through its switching and extension capabilities, particularly ensuring that operators have access to the right information in real time.

Above: **The DDX30 digital KVM matrix by Adder Technology**

Need to know

The AdderView DDX30 is a KVM matrix switch for DVI/DisplayPort, USB and audio

- The DDX30 has 30 ports: 7 fixed user points; and 23 that can be configured as inputs or outputs
- System administrators can securely access the DDX30 management tools to configure settings and privileges, and control video connections
- It delivers real-time lossless HD video
- Can function with an extension distance of up to 50m, from switch to user console
- USB ports for keyboard and mouse

Externalize the hub

KVM extension technology means the computers can be removed from the actual control room – freeing up valuable desk space for the users and removing excess heat and noise from the environment. These computers can be stored in a centralized server room that is access controlled, increasing security. These rooms are typically climate controlled, with aspects such as temperature, humidity and dust constantly monitored. High-performance KVM ensures operators in the control room can access each of these machines without lag or latency when looking at the data or video, ensuring that the information needed for making those important decisions is available whenever they need it. The content is also pixel perfect, with no distortion or loss of quality, something that is critical in the control room environment.

The switching capability of KVM ensures that operators can access multiple machines from a single workstation using a single keyboard and mouse. Regardless of where operators are seated in the control room, they can log on to the system and access their machines, complete with their presets. This has implications for efficiency in the control room, supervisory control, and streamlining shift handovers. In addition, this instantaneous switching between machines takes place with no loss of quality, and again, no latency.

While KVM technology isn't new, by any means, the benefits it brings these types of environments continue to grow, especially when the right products are integrated into the overall design, layout and infrastructure of the command and control space. Ultimately this technology enables users to interact with their systems in real time, through high-resolution, low-latency video extension.

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Remote ALPR technology improves parking management

Parking management systems are essential for access management in parking lots and other spaces with restricted or secure areas of access. Embedded imaging expert Vision Components has developed Carrida Park, a flexible, automatic, fast and precise ALPR OEM kit featuring remote access via browser and versatility for integration into a wide range of applications.

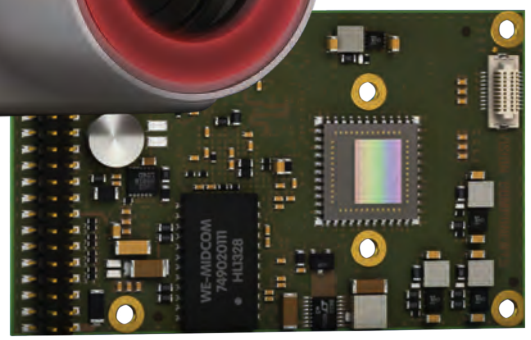
Combined with Carrida CAM hardware, the standalone system is ideally suited for parking management in parking lots, public, private and residential properties, or on company grounds such as hotels, airports or shopping malls. It is also capable of being customized according to application needs, and it works in any weather and lighting conditions.

A standalone system

Vision Components' OEM solution for parking management tasks is easy to integrate into existing barrier systems and infrastructure, but is capable of operating separately from them as well.

The fully automatic standalone system comes as an OEM ALPR kit comprising Vision Components' own OEM Carrida cameras combined with the OEM web-based park management software module. The system allows remote access via WebGUI, via tablets or other handheld devices, and it runs in networks with other park management equipment such as under-vehicle scanners (UVSS), ticket printers and barriers. Available hardware interfaces include LAN, I/O and serial communication. Automatic or manual full datalogging with a freely selectable 16Gb or larger internal memory card and data transmission via LAN is also enabled. Users can choose between free run and trigger modes.

Left:
The VC pro Z camera



Left:
The VCSBC nano Z board

Need to know

Carrida Park is a standalone OEM ALPR system for parking management

- Carrida can identify dirty or damaged license plates, as well as those from other countries
- The VC pro Z camera, available with IP67 protection class, is ideal for use with self-sufficient outdoor applications. Size: 88 x 58 x 36mm
- The VCSBC nano Z board is easy to integrate into existing small housings. Size: 40 x 65mm
- Both cameras require less than 3W to operate

Real-time datalogging

The system detects and reads license plates on vehicles approaching a barrier or gate and then processes the data. It then refers to a 'black/white' list to determine the license plates' status and decides on a subsequent action on that basis – for example, opening the barrier or sending a signal for help. All collected data is archived and available for statistics and monitoring. In addition, every camera or system is equipped with a clock to ensure internal datalogging is both accurate and time-stamped.

Operates 24/7

The Carrida parking management solution can function all year round, in any weather or lighting conditions. The field-tested, high-performance software has been proved to consistently recognize license plates and is able to do so 96% of the time. It can also reliably identify dirty, damaged or skewed number plates and is unaffected by sub-optimal or changing lighting conditions. On top of that, the software integrates a worldwide ALPR data bank, achieving high recognition rates for license plates from all over the world, despite the challenging plate variations between countries. Multiple cameras with a master-slave configuration can control all exits and entrances in any given application. The software module enables the control and configuration of all cameras via web tool.

Cased or board camera

Vision Components supplies the Carrida Park software with an OEM board or cased camera. The VC pro Z camera is available with IP67 protection class and consumes less than 3W, making it ideally suited to self-sufficient outdoor applications. The VCSBC nano Z board also consumes less than 3W and is easy to integrate into existing small housings. Both cameras feature an internal control panel and GUI, image sensors up to 2MP, and a Dual Core ARM processor with 866MHz and FPGA. They are both the ideal platform to build park management solutions.

Free reader inquiry service

An ALPR system developed to serve specific market needs

CA Traffic, a key provider of intelligent ALPR (also known as ANPR) cameras, has been supplying its devices to the UK police for five years. The company recently launched the EvoX camera device, which brings together a number of the latest technologies available in the electronics industry to create a leading ALPR camera system.

Many of its functions have been added in response to a number of market requirements and wishes communicated to CA over the years. As a result, these product advances have not been added solely for the purpose of having the highest specifications; they enable our clients to handle the real-world requirements and situations experienced by our customer base.

Versatile viewing

One of the EvoX's key features is the huge increase in processor power that the unit offers. When combined with the latest ultra-bright LED technology, this enables the EvoX to comfortably track, detect and read license plates across up to three lanes of high-speed traffic from a single device. Furthermore, when tasked with reading particularly difficult or dirty license plates, this additional processing power ensures the task can be carried out quickly and efficiently without the risk of missing traffic from other lanes passing simultaneously.

Another major advance with the EvoX is the addition of motorized zoom lenses, which enable the client to set the camera up at the roadside. Not only does this make installation easier, but it also enables the police and traffic system integrators to utilize the cameras as redeployable units across regions. A further benefit of the zoom capability is that CA has enabled the EvoX to stream video and control a pan/tilt device so that the camera can be switched into full CCTV mode when needed.

As with all camera technologies, the CCD sensors themselves are an important part of the development program. The sensors chosen by CA for the EvoX offer full HD quality (1920x1080 pixels), fast frame rates, a wide field of view to cope with the 29ft+ (9m+) required for three lanes, and exceedingly impressive low-light sensitivity. When combined with the ultra-bright LEDs and a day/night switch capability, which switches the color overview sensor into monochrome mode during darkness, the vehicle make and model can be clearly recognized in the overview image at night. This is a remarkable achievement considering the high shutter speeds required by ALPR devices to ensure license plate images are sharp enough for the onboard ALPR software to read.

Camera communication

In addition to these major developments, CA included a number of more minor client requirements, often overlooked by the industry, aimed at making life easier for the operators. These include an onboard UPS, which not only enables the camera to perform a soft shutdown, should the power be removed, but also sends a power outage alert to the user. Communication boards contain 3G/4G modems with wi-fi and GPS, as well as a secure external SIM door to enable clients to change SIM cards *in situ*, thus potentially offering customers a major cost

Need to know

CA Traffic creates ALPR software and cameras, as well as products to collect traffic data

- EvoX was developed to meet UK National ALPR Standards for Policing (NASP) but it can also be used in a range of other security applications
- It is quick to install and redeploy
- It features full HD ALPR and day/night color overview sensors
- EvoX can read multiple license plates across three lanes
- EvoX includes video-clip recording technology, required in bus lane and box junction enforcement applications

by **Larry Yermack**

The road network is not used efficiently. One way to address this is by charging by the time of day and the type of road

I was asked to speak at the Mileage Based User Fee Alliance (MBUFA) annual meeting in Washington DC a few months back. My topic was how tolling was to become an interim step toward mileage-based user fees (MBUFs) – or road-user charging (RUC), if that's your favorite acronym. It was pretty easy to address my topic. Since toll operators have account-based charging systems, all they need to do is provide customers' annual or monthly mileage to the RUC operator and they can then credit back those mileage charges to the driver.

However, I got to think about the quote from Rahm Emanuel, Mayor of Chicago, and previously President Obama's Chief of Staff. When managing the Obamacare legislation, he said that you should never waste a crisis. You can always solve the problem, but you should go beyond the immediate solution to address a deeper and more profound problem. Boy, does that resonate to me with MBUFs.

For the MBUFA, there is no need to detail the crisis in US transportation funding. No matter what happens to vehicle miles traveled (VMT), higher federally imposed miles per gallon requirements and electric vehicles will make funding the next surface transportation bill nearly impossible. To address that inevitability, more states are exploring MBUFs with studies and pilots. Their goal is to demonstrate that MBUFs are feasible, cost effective and secure. My sense is that MBUFs are inevitable over the next few years and will become an accepted payment alternative to gas tax.

With that goal in mind, states are designing the least complicated system to accomplish the task of collecting fees for road use as a gas tax substitute. There are major technical and policy issues to overcome to do this, not least of which are privacy and technology. Hence MBUF pilots are focused on collecting, in the least intrusive way possible, the number of miles each vehicle travels.

> MBUFs are inevitable and will become an accepted payment alternative to gas tax

My problem with this – and it goes back to the Emanuel quote – is that we have a funding crisis as well as an allocation crisis. The road network is not used efficiently and one of the few effective ways to address that is by charging, not just by the mile, but also by the time of day and the type of road. It's all part of the broader concept, Mobility as a Service (MaaS), which is getting increased attention in both Europe and the USA.

With this approach, you would have a mobility account with a monthly charge for all mobility needs: road usage, tolls, parking, transit, bike share, etc. There are lots of ways to calculate the charges, but the key is that pricing decisions will lead to usage decisions. What you are charged will be based on system demands and your usage will contribute to overall efficiency.

Hence my hope that we don't waste this crisis and simply replace the blunt-edged gas tax with an equally blunt-edged mileage fee.

Larry Yermack is strategic advisor to Cubic Transportation Systems, USA. ***lyermack@gmail.com***

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

Left: **The EvoX camera device uses UK police-approved ALPR technology**

saving should they wish to change SIM providers during the life of the product. In addition, a second communications board can be fitted, which offers integrators the ability to remotely service the camera without having to go onto the secure client network. This feature also allows two separate mobile service provider SIMs to enable the transmission of data to two separate instations directly from the camera.

The EvoX was launched during the second half of 2015 and a number of UK police forces and government departments have already taken delivery as the EvoX becomes the latest ALPR technology on the roads.

Innovative solutions for mobile weight-enforcement patrols

For over 40 years, Haenni Instruments has been recognized for producing high-quality mobile wheel load scales, particularly dynamic platform scales. It has now unveiled its new strip sensor, the WL 400. Both technologies are used in mobile low-speed weigh-in-motion (WIM) applications.

Platform vs strip sensor

To better understand the advantages and limitations of the strip sensor, Haenni Instruments carried out a number of comparison tests between its WL 104 wheel load scale, an OIML-certified system that is already used worldwide for mobile enforcement, and its new WL 400 strip sensor.

A complete strip sensor system weighs approximately 110 lb (50kg), which means it is very portable. It is therefore ideal for use in weight-enforcement patrols for performing spot-checks. However, the accuracy of strip sensor weight readings is not as accurate as static full-plate WIM systems. One reason for this is that strip sensors do not measure or account for the wear of the tire at all, which affects accuracy, whereas dynamic platform scales do take this into account.

WIM accuracy factors

In addition to tire wear are some external factors that are known to affect the accuracy of the weighing result, for both dynamic platform scales and strip sensors. These include: tilting longitudinally, tilting crosswise, access evenness, site evenness, sensor leveling, crosswind, vehicle suspension quality, braking, vehicle speed and uneven loading.

Left: **Testing to compare Haenni's WL 400 strip sensor with its dynamic platform scales. The strip sensor is a lightweight, portable alternative to static full-plate scales**

Need to know

Haenni has manufactured low-speed weigh-in-motion scales for more than 20 years

- At just 5lb (2.3kg), the Haenni WL 400 strip sensor is a lightweight alternative WIM option to dynamic platform scales
- As it is portable, the WL 400 can carried in every patrol car and ready to use within three minutes
- Mobile strip sensors are ideal for the pre-selection of heavy vehicles

Long leveling mats, at least 200 times the height of the strip, should also be used for all portable WIM systems, as the depth of the scale, on or in the floor, must be the same as the height of the sensor to ensure that the strip surface is perfectly level to the pavement. The validity of the weight measurement also depends on the driving style of the truck driver and the dynamics of the entire measurement. Overall, external factors affect the accuracy of a measurement 10 times more than sensor errors.

Daniel Kneubühl, managing director of Haenni Instruments, says of the scale comparison tests: "With full plates, we achieved an accuracy reading of ±2% for vehicles up to 12mph (20km/h) for the gross weight. With the strip sensor, there is an error of ±5%."

But given that so many other external factors can affect accuracy, this is still a convincing result. "With new technical approaches, our strip sensor makes mobile pre-selection easier than before," says Kneubühl. "The WL 400 wheel load strip sensor can also be used in fixed installations for tolling and freight management applications. Because of its light weight, the WL 400 is easy to transport and can be used at any time without the need for fixed installation.

"Measurements can be made on firm ground by using leveling mats to ensure that all wheels of multiple-axle systems are on the same level. Alternatively, the sensors may be placed into a dip in the pavement.

"The time is right for a new approach," he adds. "The advantages of this new, innovative technology give customers something different to what is already available on the market."

Virtual driving boundaries pushed with new simulation software

Although driving simulators have been around for many years, there has never been better interactive 3D simulation software available than there is today. And there have never been so many applications for this simulation technology – technology that enables the 'virtual' driver to have a 'real' driving experience, on- or off-road.

While this technology has traditionally been used in human factors research, advances in software development have led to driver training and transport planning also becoming important, including research into advanced vehicle safety and autonomous driving systems.

The choice of hardware depends primarily upon the available budget and project objectives. While all users would like a multimillion-dollar hexapod-based system, not everyone has the wherewithal. However, most professional applications demand more than a simple steering rack and LCD screen.

Cost-effective solutions

To solve this problem, Forum8 provides a wide choice of modern hardware systems, based on both cost and technical specification. The 'trick', if that's the right word, is to be able to offer an interactive 3D VR simulation software solution that can move seamlessly from a basic desktop simulator to the most complex hexapod-based system. Forum8's VR-Design Studio simulation software (VR-DS) can be used to mimic the real world in all its glory, thereby providing the driver with a truly realistic driving experience.

The primary objective of VR-DS is to enable simulation of the real world as accurately as technically possible. This includes being able to reproduce and control every conceivable environmental effect, including the time of day, location, shadows, lighting, headlights, puddles, rain and snow.

The next step is to enable traffic to be set and controlled – including its speed, volume and direction. As well as this, the inclusion of a scenario editor enables an infinite number of 'what if' events to take place.

Left: **An in-car view of the simulation system**

Need to know

Forum8 aims to provide the most realistic driving experience technically possible

- Forum8's VR-DS allows road traffic and the driving environment to be set and altered
- VR-DS is used in V2V and V2I research
- The addition of driving sounds increases the 'reality' of the experience
- FORUM8 cluster software enables multiple drivers to simultaneously drive in the same 3D VR networked environment

Above: **Forum8's new 6DOF driving simulator**

The option to build 3D traffic systems from 2D micro-simulation data is also available.

Reality check

Sound is added to complete the virtual driving experience. This includes the sound of the engine, horn, tires on different road surfaces, wind, rain, thunder, as well as other sounds associated with driving, such as crashes. VR-DS is also able to monitor and record the driver's carbon footprint through its Eco Drive system. In addition, the dynamics of the driven vehicle can be altered manually, or data can be imported from one of the industry standard third-party dynamics packages.

The VR-DS also enables remote control of the driven 3D environment, as well as scenarios by a trainer or operator using a wireless tablet or via a PC in a control room. Audio communication is also available from trainer to trainee(s).

The VR-DS software development kit (SDK) enables the production of a range of interfaces that allow features such as eye-tracking devices and head-mounted displays to be integrated within the overall driving simulator, along with hardware-in-the-loop (HILS) simulation systems.

Testing roads of the future

The latest application of DS systems, and in particular the VR-DS software, is in research into vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications. This work is possible due to the ability to incorporate various warning systems and cameras, and the use of the Forum8 cluster software, which enables multiple drivers to drive within the same 3D VR networked environment.

The Forum8 software developers have also created Driver Diagnosis, Data Log-Export and Replay plug-ins to make it possible for the actions of the driver and vehicle to be monitored, recorded and replayed for research and training purposes.

Truck tachograph technology to be smarter for 2019

For 30 years the EU has been monitoring truck drivers' movements on the road, including speed and distance traveled, in order to increase safety.

In the latest update to regulations, the European Union plans to replace existing digital tachographs by 2019.

A history of the tachograph

In 1986, in compliance with EU regulations, it became compulsory for goods vehicles to be fitted with analog tachographs, made of paper disks, to record vehicle movements. Due to this systems' vulnerability to fraud, regulations requiring more secure digital tachographs were introduced in 2006 – Annex 1B (EU-Reg. 1360/2002). In 2011 and 2012, EU regulations were updated to include the requirement for independent motion detectors and new motion sensors. The new Annex 1C regulation requires shifting from digital to smart tachographs, which integrate GNSS to provide information on the geographical position of the vehicle, DSRC for remote enforcement, optional ITS connectivity via Bluetooth and a cryptography update.

Once the new regulation is ratified by the EU member states, every new truck in Europe will have to be equipped with this new device, currently planned to start in 2019.

Smart features

The smart tachograph consists of a vehicle unit built into the dashboard of the truck. The motion sensor, connected to the CANbus, is the main source of data for recording the truck driver's behavior. Data access for external devices may be enabled via Bluetooth as a standard interface. This will enable tachograph data to be used for external ITS services, while respecting data protection rules. Available data will include driver activities, card and vehicle unit data, and continuous GNSS data. The geographic location of the vehicle is provided by satellite navigation systems (GALILEO/EGNOS, GPS) at specific points and is stored in the memory of the smart tachograph to verify compliance with social regulations. The vehicle location at the start of a working day, its location after three hours of accumulated driving and its location at the end of the day will be recorded.

DSRC at 5.8GHz is currently in place at DSRC-based road tolling schemes and GNSS based tolling systems, used for enforcement purposes. The smart tachograph will use the same technology to provide information about the misuse or manipulation of the tachograph while the vehicle is in motion. This will make it possible for authorities to check trucks without having to stop them, reducing the need for costly stopping points. Instead, official enforcement vehicles around Europe will be equipped with mobile enforcement technology for increased efficiency of on-the-road checks. Fixed enforcement installations can also be used.

Left: **The smart tachograph also communicates with GNSS to record a vehicle's location and is connectable via Bluetooth**

Below left: **The location of features of the smart tachograph inside the truck driver cabin**

The DSRC device in the truck has to be mounted on the windshield or dashboard and is connected to the vehicle unit via an independent CANbus interface. Power is supplied from the vehicle unit. The GNSS antenna can be placed on the roof of the vehicle or may be included in the same module as the DSRC. In the instance of a combined DSRC/GNSS unit, the GALILEO/EGNOS/GPS data is transferrable via the CANbus network, where it is mandatory to use a security controller for asymmetric encryption and secure key storage.

Benefits of smartening up

Smart tachographs will offer several advantages for future applications because they will work the same way across Europe with a standardized truck installation and access to truck CANbus networks.

Integration with fleet management systems will be possible from the start and truck weight control will become a more manageable task, because by integrating weight sensors into the suspension system of trucks there will be less need for expensive weigh-in-motion and truck stopping points. In-vehicle weight systems will also be able to communicate with the vehicle

by **Don Hunt**

State DOTs must all engage the emerging technology of connected vehicles – but different states have different capabilities

Connected vehicle technology will enable dedicated short-range communication (DSRC) between vehicles (V2V) and between vehicles and infrastructure (V2I). The USDOT will likely require all new vehicles to incorporate DSRC capability by the end of the decade. The penetration of this technology will take a number of years, so V2V benefits will be slow to emerge. However, every car equipped with DSRC immediately has the capability to communicate with roadway infrastructure, provided the infrastructure is equipped with DSRC. While NHTSA will coordinate V2V, it is up to states to respond to the V2I deployment opportunity.

There are at least two hurdles in the deployment path of V2I. First, the applications of V2I are just being tested. Second, the cost of implementing a V2I network to receive and compile vehicle data from the most heavily used parts of the US highway network will cost tens of billions of dollars.

Going back to the first point, the testing of V2I applications provides a role for some state DOTs. There are a few large DOTs with research capabilities and funding (for example, Virginia, Florida, Texas and California) to take on the V2I testing tasks. Other states, such as Michigan, are logical testbed sites due to the presence of auto makers. Unless a state wants to devote substantial resources to becoming a testbed site, it's probably best to let the larger states take on the research task.

A positive interim investment is in traffic signals. Signals interconnected with fiber are already capable of being converted to a V2I device. Signal cabinets can be retrofitted with DSRC technology, and would have the ability to detect DSRC-equipped vehicles within 300m. When interconnected, as many signals already are, V2I technology could provide safety and efficiency benefits, helping drivers to better negotiate signalized arterials. However, the prudent current action is most likely limited to the continued interconnection of signals and to encouraging integration and management of signals across government boundaries. That activity would create immediate benefits for urban motorists, and prepare signal systems for ultimate DSRC benefits.

> While the NHTSA coordinates V2V, it's up to states to respond to V2I the deployment opportunity

In terms of getting ready for V2I, a wholesale commitment to implementing the devices and network to manage data communications will not be a value-added investment until connected vehicle applications are better tested. Eventual deployment calls for roadside units to communicate with vehicles, all connected by a broadband network to assimilate information. What does make sense now, as mentioned in last issue's column, is to expand the fiber network along major transportation corridors to become ready for connected vehicle data.

Don Hunt is a transportation consultant and former director of Colorado DOT ***dhunt@anteronet.com***

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

Need to know

According to EU regulations, from 2019 all new trucks will have a smart tachograph

- The smart tachograph will be able to monitor the driver's activities, data from the tachograph chip card and vehicle unit, and continuous GNSS data
- Unlike older versions of the tachograph, the smart tachograph will be able to record instances of misuse or tampering
- In-vehicle weight systems will be able to communicate with the smart tachograph, enabling authorities to check the vehicle's weight while it is on the move

unit and are enforced by DSRC. The smart tachograph also has the potential to make the European Electronic Toll Service (EETS) finally become a reality, by unifying the current multiple, separate, incompatible systems.

Norbit ITS already has a solution available for a smart DSRC module communicating via CANbus, which consists of a field-proven Norbit DSRC module in combination with a CANbus interface and a wide-range power supply.

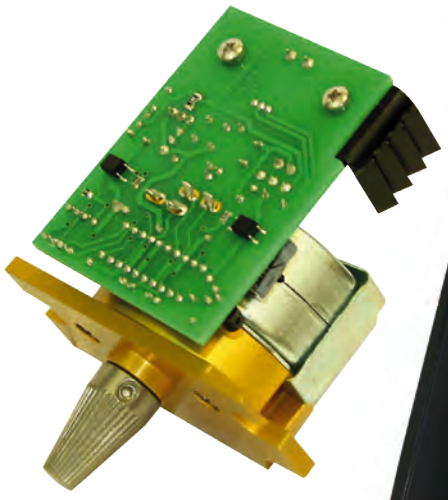
Its fully compliant smart tachograph solutions will be available on the market in time for the roll-out in 2019.

Improving road safety for the UK's visually impaired

Sometimes it's the little things that make a big difference. One such device quietly going about its business, unrecognized by the majority of road users, is a little rotating cone that helps the visually impaired to cross busy roads.

Known as a 'tactile', the device is an unobtrusive ribbed metal cone, located on the underside of pedestrian crossing button boxes. It works by rotating when the green man is lit, providing confirmation via touch that the traffic lights are red and that pedestrians may safely cross.

"Tactile cones are vital at a junction where it is not possible to use an audible signal and enable people who are deaf and blind to cross the road independently and safely," says Richard Holmes, a regional campaigns officer at the UK's Royal National Institute of Blind People (RNIB). "Failing to install and maintain accessible road crossings cannot be justified. Every crossing without bleeps or tactile cones is unsafe for people with sight loss."



Tactile devices can be found on the underside of pedestrian crossing boxes

Simulation Systems Ltd (SSL) has relaunched its range of Type Approved products designed to improve pedestrian safety for the visually impaired. With more than 30 years' experience in making products that can be maintained and operated in harsh environments, SSL has set out to make improvements in three areas: practical performance, lower cost and higher reliability.

Practical performance

The SSL device has a high-power motor that drives a large tactile. The larger tactile is made of stainless steel and has deeper grooves. This enables the pedestrian to feel the rotary movement better on a tactile cone, which is also easier to locate. The high-strength steel prevents vandals smashing it, which could cause sharp edges. In the event of the tactile being gripped tightly by, say, an anxious pedestrian, it responds by vibrating instead of attempting to turn, which could harm the person's fingers. This vibrating feature not only improves the tactile's safety, but also indicates to the pedestrian when the crossing is clear.

Lower cost

The lifetime cost of this system is considerably reduced because of its rugged design, long-life components, and reduced need for maintenance. By using the latest components, SSL has been able to produce a compact, one-piece unit that is easier to fit into the button box. Thanks to the design, which incorporates a motor that clips into place and has just two bolts to mount the device to the box, manufacturing costs are lowered. The electronic circuitry is part of the same unit.

Higher reliability

The visually impaired are only helped if the device is both present and working. SSL has gone out of its way to ensure that it goes on working for as long as possible. The motor is brushless, so there's nothing to wear out, and the gearbox is separately replaceable. The SSL tactile electronics include remote performance monitoring, so that the maintainer and supervisor are immediately informed of any malfunction via their UTC system, and downtime is minimized. Thanks to these notifications, regular inspection site visits to test the tactile can be made less frequently, saving money and downtime. With replaceable motor, gearbox and PCB, the unit is fully serviceable at low cost, and is not a throwaway item.

Need to know

Using long-life product components results in cost-effective maintenance

- The tactile concept originated in the University of Nottingham, UK, in the 1980s. The first versions of SSL's current product range appeared on the streets in 1989
- With replaceable motor, gearbox and printed circuit board, the unit in which the tactile sits is fully serviceable at low cost
- A brushless motor increases the system's durability
- Remote performance monitoring notifies maintainers if the device malfunctions, ultimately reducing downtime

Unifying the toll collection industry with ALPR

The toll collection industry is under increasing pressure to improve its transaction processes, revenue accountability and cost effectiveness – and rightfully so, as there is a need to redefine some of the technology that is widely used in the industry. The movement toward faster, more accurate and more efficient technology and processes has the power to revolutionize the industry.

One solution to improve existing revenue collection techniques is the use of higher-performing imaging systems. While transponders are widely used at present, and will continue to be in the near future, an increasing amount of effort is being put into research to develop the ideal camera solution.

RFID versus imaging

Speed and lighting are no longer the key issues facing toll cameras as better designs have emerged to specifically tackle such challenges. With the development of highly accurate ALPR, used to read the many types of license plates around the world, there is no need for continuous add-ons or upgrades to cameras for them to be able to read license plates from different countries.

Combining optics with a purpose-built illumination source enables high-performance imaging that, in some cases, reaches the revenue collection capability of existing RFID systems. Using imaging as a primary method of revenue collection is also cheaper and faster than RFID because once the toll plaza is built, the revenue collection process can immediately be started using ALPR. In comparison, an RFID toll collection point requires extra costs and time to manufacture and supply RFID vehicle tags before revenue collection can begin.

"The dominant position of tag based RFID in tolling is being challenged more now than ever before," says John Mike, COO of Perceptics. "While RFID technically has higher accuracy readings than ALPR, in practical use only cars with RFID tags, and moreover, properly mounted, functioning tags, can be charged in electronic toll collection using this technology. Around 20% of vehicles registered on an established toll collection system can't be identified or charged by use of RFID tags because of missing or badly positioned tags. The use of the vehicle's unique license plate as a charging mechanism eliminates this issue."

Unifying the system

An important advantage of imaging systems as a revenue collection method is its intra- and inter-region operability. Currently the toll industry is facing the challenge of having numerous incompatible toll systems, resulting in vehicles needing to have multiple transponders installed to be able to pay at different toll points. A potential solution is to unify toll collection systems with ALPR technology.

Every vehicle that travels on public roads has a unique identifier in the form of a license plate. As these unique identifiers are distributed and managed at no cost to the toll collection market, it makes sense for the industry to use them to improve toll collections.

However, before the electronic toll collection industry adopts ALPR, it must be agreed how the data generated will be handled and managed. In California there are already laws in place to restrict the use of data generated by transponders; legislators must now work together to create similar regulations for data collected from imaging systems, to protect individuals' privacy and rights.

In many, if not all, industries it has come to be accepted that emerging technologies will overshadow and outperform existing ones. Yet not too long ago the electronic tolling industry looked at the new technology with a jaded eye, labeling it "impossible". Today, the energy and enthusiasm that exudes from that same industry believes "everything is possible". ○

Right: **The Perceptics back-office OCR server system**

Need to know

Perceptics' technologies use accurate intelligence to help customers make optimal decisions

- Perceptics' back-office OCR server system recognizes regular and stylized fonts, non Latin script, plus the license plate type, state and country of origin
- It uses adaptive segmentation to isolate a plate number from its background
- Capable of processing up to 7.5 million images per month, per module
- Matches its reads to hotlists and sends alerts to other systems

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Award-winning software that makes smart cities a reality

At this year's Intertraffic Amsterdam in April, there was one product everyone was talking about: InVipo. That was because it had just scooped one of transportation's biggest accolades by becoming overall winner in the event's prestigious Innovation Awards. But what is it about the InVipo software that the judges found so impressive? And how is it already helping to make the concept of a smart city a working reality? To find out the answers to these questions and more, *Traffic Technology International* spoke with the CEO of Incinity Cross Zlín, Lukáš Duffek, who has been instrumental in the development of the new product everyone's talking about.

Total control

Cross Zlín has years of experience in manufacturing transportation hardware, including traffic controllers, weather stations, weigh-in-motion devices and parking systems. InVipo started life as in-house software that technicians could use to monitor and control this hardware. However, it was quickly realized that a lightweight, web-based platform that puts all of a city's data at a controller's fingertips had potential way beyond internal use, and so the InVipo product was born.

"InVipo can be thought of as 'umbrella' software – it collects all the data from a city and can provide any other application with that data," explains Duffek. "It is able to monitor the system, and also control the system." Furthermore, it is not limited to simply monitoring and controlling Cross Zlín products. "We can connect with almost anything. We have a rich vendor list of equipment we are already compatible with, but InVipo is a platform, so we can integrate any third-party device within a very short timescale.

"Now we are focusing on smart cities and integrating everything in the city," continues Duffek. "Cities produce a lot of beautiful data – from information systems and even from people themselves [via smartphones]. InVipo can get all the data into one box, and make use of that data."

What this means is that in the future we won't think simply of 'traffic management', but of 'smart city management'. InVipo provides a huge amount of business intelligence that enables controllers to join the dots hidden within data and reveal patterns that were never before apparent, and therefore enable the entire city to operate

Left: **InVipo enables operators to visualize the city in a huge variety of ways**

Need to know

The InVipo platform offers huge benefits to city controllers and citizens alike

- Lightweight, web-based architecture enables swift and efficient installation
- Full compatibility with multiple data streams, regardless of hardware manufacturer
- Open data principles enable easy sharing of data with third parties
- Integrates all data to create truly smart cities

Left: **Izmir, Turkey, is the first city in the world to use InVipo as its primary software controller**

more efficiently. "You're looking for hidden consequences," says Duffek. "You're looking for a context that you were not able to see before. There is so much interesting data in a city. This is something I'm really passionate about – it is so exciting for me to discover all these data sources. We are interested in making cities smarter. I am really happy just to be able to help people in a city live better."

Lightweight and flexible

InVipo replaces what has previously taken weeks to plan and months or even years to build. Traditional traffic control centers rely on large amounts of dedicated hardware that don't allow the same kind of flexibility as InVipo, which is entirely web-based. "We can get something working very fast – and then we can improve and extend," says Duffek. "Politicians often want results quickly, and that's what we give them. The software is lightweight. We don't need to build a mainframe or data center for this. We keep it simple. If you make complicated software, then everything around it will be complicated."

Left: **Lukáš Duffek, CEO of Incinity Cross Zlín, demonstrates InVipo at Intertraffic Amsterdam in April**

Furthermore, the simplicity isn't just about compiling data for use in central departments; it is also very much an open data system that makes this same information available to all. "Businesses can connect to the city system and harvest data to improve the efficiency of the business and life in the city. Data can tell citizens where to park, or what the weather is like in the city," says Duffek.

InVipo can also help with city management by enacting traffic plans. "We have something we call the Rule Engine, which can be thought of as the brain of the city," says Duffek. "It can decide, based on the events that are being monitored by InVipo, what to do next. For example, if a sports match finishes at the stadium, then InVipo will help with traffic flow by implementing traffic plans. This uses something we call the Rule Engine Scenarios, so we can have some central logic, and you can then control the city based on the events that happen in it."

InVipo in Izmir

The Turkish city of Izmir, on the Aegean coast, has a population of over four million who can now claim to be living in the smartest city in the region. It is the first city to build a system with InVipo as its primary controller.

The Izmir project involves a complete installation of new Cross Zlín hardware and the construction of a control center, where city operators will sit alongside police officers. While the big screens and banks of terminals will make it look somewhat like a traditional traffic control center, the big advantage that InVipo will bring (in addition to its lightweight digital architecture) is that it won't just be the traffic that operatives are controlling – they will integrate all the other technology in the city.

"The Izmir installation is the biggest ITS project in the area," says Duffek. "It is a €20 million (US$23 million), one-and-a-half-year project expected to finish at the end of this year. Everything is already connected and live, so we are proving our platform is working. InVipo is not just an idea on paper; it is already proven."

The project is equipping 400 intersections in the city with new Cross infrastructure, including systems for detecting and monitoring traffic, optimization of public transport, parking systems, traffic offense detection and road meteorology.

"Big data is a real buzz phrase," says Duffek. "The beauty of our system is that we can store the big data that is coming really fast, with no need to delete anything. Even with the Izmir project, we have never deleted anything and we are very proud that we have found a way to store all that data. Data is like gold. It can help you to plan more effectively for the future.

"InVipo is simple and very lightweight. Everybody is saying that the solution is the best. I say the solution is simple. It's a smart idea. We found a way to keep it simple and open. It's simple and it works."

Smart solution to ITS traffic management challenges

Intelligent transport systems face critical environmental challenges 24 hours a day, seven days a week. Equipment operating in such environments could be subjected to a range of conditions, from blistering heat to freezing cold temperatures, as well as dust, rain and vibrations. Rugged components are key to reliable installations – along with a robust network that provides an uninterrupted high-bandwidth service and a smart remote management solution that eases operators' lives while increasing efficiency.

Smart solutions

Putting both the network infrastructure and the video surveillance system in place is facilitated by easy component deployment and monitoring of the whole installation cycle – for example, configuration, installation, monitoring and troubleshooting.

Advanced solutions include mass device configuration, which results in fewer configuration errors and requires zero programming skills. In addition, the benefits of the Industrial Internet of Things can be achieved with OLE for Process Control – Unified Architecture (OPC UA). Hassle-free operation in a wide range of environment temperatures, as well as optimized bandwidth use and storage with less data and no lost frames, saves operator time. In addition, less time required for configuration and data handling results in cost and time savings for new computer migration and maintenance and, particularly in video surveillance, lower storage costs along with longer recording time.

Need to know

Moxa creates solutions to the challenges facing intelligent transportation systems

- Moxa's 1080P PTZ Speed Dome IP Camera VPort 66-2MP series supports up to three video streams simultaneously
- It delivers precise, peripheral imaging in full HD image quality
- Its robust, industrial design enables it to function in temperatures from -40°C to 65°C
- The camera meets the NEMA TS2 standard

Failsafe surveillance

Traffic management systems require ample bandwidth within their network and automation infrastructure. Key elements are high throughput, scalability, flexibility, and a secure network with protected devices and cybersecurity features.

With smaller numbers of cameras being required to deliver clear and precise imaging, Moxa's VPort 66-2MP's advanced industrial design requires less downtime and maintenance. Its robustness, with a high mean time between failures, makes it failsafe and results in less video surveillance service interruptions on highways, tunnels and other roadways. Operators benefit from lower total cost of ownership and service costs, paired with increased operational and passenger safety in various applications.

Weatherproof functionality

Moxa's 1080P PTZ Speed Dome IP Camera VPort 66-2MP series complies with the NEMA TS2 Section 2 standard, and with an operating temperature of -40°C to 65°C it is tailored to increase system reliability in extreme weather conditions, while decreasing maintenance costs for system operators. Its industrial-grade vent-free design also keeps dust and rain out, helping to prolong the camera's life.

Right: **The VPort 66-2MP delivers high image quality in fast motion**

Wide-range 'vision'

The VPort 66-2MP delivers 1080P full HD resolution (1920 x 1080) at 60fps, 360° endless pan, and -6° to 96° tilt for zero blind-spot coverage. The preset positioning function allows constant monitoring of the most critical areas. The camera supports up to three video streams and can handle complex scenes easily, because the camera preserves rich color contrasts and produces crisp, clear images. With the system's advanced optical technology featuring 22x to 30x optical and 20x digital zoom, 3D DNR, sense up, ICR and image stabilizer technology to overcome poor lighting conditions, images can be displayed in a wide dynamic range of dark to light, even when operating in harsh environments. Moxa's CBR Pro technology is also designed to deliver excellent image quality in fast motion.

Easy integration

The VPort 66-2MP supports ready-to-use NVR and VMS software for video surveillance systems, and provides a variety of software development kits for use with third-party VMS and SCADA software. Moreover the VPort 66-2MP supports industry standard ONVIF specifications for simpler and faster integration, and supports NTCIP protocol for ITS.

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Smart infrastructure set to protect cyclists on the roads

As technology continues to advance, governments will need to anticipate, accommodate and incentivize innovation. So says the US Department of Transportation (USDOT) in its draft report, *Beyond Traffic 2045*, which analyzes the latest data and trends shaping transportation, and frames critical policy choices that need to be made.

One of the highest priorities presented in the report is intelligent, sensor-based infrastructure to collect traffic, cyclist and other information available throughout the city. Smart cities are encouraged to leverage existing infrastructure investments to improve infrastructure management and prioritize investment decisions.

Build on safety

Improved infrastructure management can help to overcome the inertia of outdated street design and turn what today appears to be traffic liabilities into the components of a healthier street. As noted by Janette Sadik-Khan, commissioner of the New York City DOT (2007 to 2013), in her recent book *Street Fight*, "the most important factors are observing how a street is being used and building that use into the street itself."

Turning the perception of cyclists from traffic liabilities into welcome road users is an ongoing transformation. According to Federal Highway Administration (FHWA) officials, the purpose and goal of street design in the USA for decades was to move motor vehicles from their origins to their destinations as expeditiously as possible, and this design may have overlooked the particular needs of pedestrians and cyclists.

More recently, however, transportation agencies have begun to focus on ensuring that roads provide safe mobility for all travelers. This may include installation of facilities that can make pedestrians and cyclists feel safer.

One of the foundational studies for the US version of the Vision Zero incentive, *Toward Zero Deaths: A National Strategy on Highway Safety*, provides more direction for improving vulnerable road user safety. It documented data showing a pattern where 40% of cyclist fatalities in crashes occur at intersections. Consistent with the Vision Zero perspective that "where the road user may fail, the roadway should not", it identified a countermeasure to use enhanced detection systems so that traffic signal green times can be extended for a slowly moving cyclist to safely clear the intersection.

SmartCycle detects bicycles at intersections and can help adjust traffic signal green time accordingly

Need to know

Existing infrastructure can be improved with the addition of intelligent, sensor-based technology

- Iteris SmartCycle can detect and differentiate between vehicles and bicycles simultaneously
- If a bicycle is detected at an intersection, SmartCycle can provide special outputs so that the traffic controller can provide more green time
- Differentiating bicycles from vehicles ensures that traffic signals operate normally, and efficiently, when bicycles are not present

Get sensor smart

Intelligent, sensor-based infrastructure is available today with SmartCycle from Iteris. It delivers all the power of Vantage video detection, which has detected vehicles for over 20 years, to spot and differentiate a cyclist from a vehicle at traffic signals. This enables local agencies to make even better use of traffic signal detection equipment by multitasking with the detection and differentiation of multiple modes.

Enabling bicycle differentiation can provide outputs to extend the signal green time so that cyclists can safely clear the intersection. For more efficient roadway operations, the detection system reverts to regular signal phasing if no bicycles are detected. It is capable of detecting multiple cyclists at once, whether they are riding in a dedicated cycle lane or on another part of the road. The resulting bicycle counts overcome the day-to-day variability concerns with traditional bicycle counts and enable informed prioritization of bicycle investment decisions.

Cities are competing to put forward their best and most creative ideas to address the transportation challenges they are facing. Sadik-Khan describes this as a daily street fight among modes in an uneasy dance for space, pace and safety. *Beyond Traffic 2045* documents that cycling will continue to grow in popularity as infrastructure is adapted to accommodate it; that cities will increase investments in bicycle-friendly infrastructure to accommodate increased demand; and that cyclists' safety will become even more of an issue for policy makers. There is no better time than now to start designing and retrofitting your roads to enable the safe, harmonious passage of vehicles and bicycles.

Express lanes

Your shortcuts to just some of the big stories in this issue – and beyond!

"Surveying streets using citizens, inspections and road scanning is expensive. We're exploring how cheap, consumer cameras can be used in vehicles to detect road damage"

Christoph Mertz, senior project scientist, Carnegie Mellon University

Find out how CMU's research is paving the way for cheaper road assessments trafficTechnologyToday.com/cmu

Page 20

"The leadership of the federal government is critically important given the growing patchwork of state laws and regulations on self-driving cars"

Chris Urmson, director, Google Self-Driving Cars

"We needed to change the way we classify streets. We began to look at them in two ways: as 'movement' roads, or as public space 'places'"

Professor Peter Jones, Centre for Transport Studies, University College London

See how the London Street Types project is set to revolutionize road management trafficTechnologyToday.com/streettypes

"There's cost-saving potential in using unmanned aerial vehicles for bridge and road surveys and aerial photography"

Cassandra Isackson, director of aeronautics, Minnesota DOT

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The international solution provider for global traffic safety, Jenoptik, supplies VECTOR ANPR cameras which are a vital tool used by Police and security forces around the globe. Operated in temporary and long term installations, VECTOR is able to rapidly identify and report on vehicles of interest.

Working as stand-alone units, or part of a wide ANPR network, VECTOR provides a 24/7 monitoring capability, with each camera capable of capturing thousands of plate reads every day. Combined with powerful back office analysis software, the Police are able to locate wanted vehicles fast, or identify criminal activity through analysis of driving patterns.

Facts & Figures

- 30,000 systems delivered
- Operating in over 80 countries
- 480 staff working on traffic solutions
- >50 million plates read every day

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