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ISSUE XII 2021

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Editor's view

by Monique Batra

WITH TECHNOLOGY ADVANCING at a one of the fastest it's been in terms of new ideas, and these ideas being put into action, the Transportation continues to soar to new heights, and as ANGOKA explore the race between Autonomous and ADAS (Advanced Driving Assistance Systems) and how VCSELs (Vertical-cavity Surface-emitting Laser) will be used to seamlessly aid data communication at TT Electronics.

As well as those features, we have some fantastic insights from Siemens who created a full AV lifecycle to envision the solutions in an 'infinity loop', whilst Hogan Lovells and Mobility Hubs explore Shared Mobility in terms of going from business to living, scalability and the successes of 'Mobility Hubs' popping up backed by monitored data results.

By now you may have seen that TaaS Technology will also be holding a 1-day Virtual Event, in place of this year's physical event. This will be on Wednesday October 6th October 2021, and will be covering:

Seamless Transport and Frictionless Travel

In this theme we will be exploring how new technologies can deliver seamless transport and frictionless freight. Data and connectivity will enable journeys to be more easily managed and delivered providing the customer with a one stop shop of information about journey choices before and during travel.

Smart Energy Systems

We will be looking at how the energy system can be developed to ensure that energy use in transport is managed and delivered efficiently. Hydrogen for specific applications (freight, bus, trains) Energy saving options and monitoring local Zero emissions with new data to make systems more eco savvy.

Enabling New Transport

This theme focuses on new transport models and options available. The growth in micro-mobility and the desire to reduce emissions by way of car free zones/low emission zones in city

centres will be explored. We will also be discussing how the new vehicle designs will deliver new options for travellers including delivery pods, E-scooters, E-bikes.

New business model, Growth in Micromobility + Gen Z

Here we will discuss MaaS + Micromobility for last mile options for travellers and how can we make transport more affordable with new solutions to support their needs. It will also delve into what the next generation of travellers will be looking for and how this can aid it raising awareness and digitalisation usability.

We also have some great industry expert speakers lined up from TravelAI, Hanhaa XG, Arcola, Zero Carbon Futures, Energy Systems Catapult, Arcadis, EMSOL, Oxford City Council, Innovate UK, Burges Salmon, Enterprise, Tomorrow's Journey and more. The event will be chaired by Andrew Everett from Shyft Mobility who will be moderating the event and the panel sessions on the day. If you would like to get involved, please do get in touch as we have some speaking slots and virtual booths available!

I hope you enjoy Issue 12 as much as I have enjoyed reading and bringing together a varied and insightful array of features once again, this will be my last ensemble for a little while whilst I take some time off to start a new family after the exciting Virtual Event on Wednesday 6th October 2021!

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Self-driving cars could be allowed on UK motorways by the end of this year

THE DEPARTMENT FOR TRANSPORT says it will allow hands-free driving in vehicles with lane-keeping technology on motorways with slow traffic, at speeds of up to 37mph.

The technology monitors speed and keeps the car at a safe distance from other cars, normally through the use of cameras and sensors.

If a collision risk is detected the vehicle can brake or change direction. This means the driver does not have to control the vehicle but must be available to do this if needed.

The DfT said human error contributes to over 85% of accidents, so the technology could make roads safer.

Transport minister Rachel Maclean said: “This is a major step for the safe use of self-driving vehicles in the UK, making future journeys greener, easier and more reliable while also helping the nation to build back better.

“But we must ensure that this exciting new tech is deployed safely, which is why we are consulting on what the rules to enable this should look like.

“In doing so, we can improve transport for all, securing the UK’s place as a global science superpower.”

Jim Holder, editorial director of magazine and website What Car?, said the new policy is a “sensible first step” towards autonomous driving.

“These are very, very controlled circumstances, low speed, relatively straight roads, clear road markings.”

Mike Hawes, chief executive of the Society of Motor Manufacturers and Traders, said: “These advances will unleash Britain’s potential to be a world leader in the development and use of these technologies, creating essential jobs while ensuring our roads remain among the safest on the planet.”

Others were more cautious, however.

Steve Gooding, director of the RAC Foundation, said: “There is a risk of situations in which drivers over-rely on the automated system, expecting it to deal with events for which it is neither intended nor capable.

“And what happens when drivers are expected to take back control in an emergency? Research for us shows that it can take drivers several seconds to regain command of their vehicle.”

AA president Edmund King said: “We shouldn’t be in a race to take drivers’ hands off the wheel.

“There are still gaps in how this technology detects and stops if the vehicle is involved in a collision.

“There are still question marks over how drivers will be fully informed how these systems work.

“More needs to be done to rigorously test these systems before they are used on UK roads.”

A consultation has been launched on updates to the Highway Code to ensure autonomous systems are used safely and responsibly.

Arriva launches new multi-modal travel app for EU passengers

ARRIVA has added a completely new brand in the form of a multi-modal app to its public transport offering in the EU, with the launch of a travel platform designed to connect passengers to multiple modes and operators of public, shared transport, or micro-mobility transport in the Netherlands.

Named 'glimble', it is Arriva's first MaaS (Mobility-as-a-Service) solution in the EU. MaaS provides a passenger-centred approach to mobility, enhancing the passenger experience by making it easier to combine different modes when planning, booking, and paying for a journey.

Arriva has developed the app in partnership with the leading journey planning technology provider Moovit, and with the potential for a wider roll-out in other parts of the EU, where data sharing agreements and systems exist.

The development of 'glimble by arriva' came after Arriva Netherlands was awarded two pilot projects by the local authorities in the Netherlands, to trial MaaS solutions. Seven pilot projects in total were awarded. Furthermore, Arriva was the only public transport company to be awarded pilots due to its strong reputation in serving the Dutch market.

During the COVID-19 pandemic several EU cities invested in new infrastructure to encourage cycling or walking, and some have even introduced e-scooter trials. These initiatives have provided greater modal flexibility for people to move across cities. The glimble solution encompasses all these options and it allows Arriva to look beyond its own operations and provide integrated, multimodal journeys.

"With this platform, we are set to become a leading mobility provider," said Anne Hettinga, Arriva Group

Board Member and Managing Director of the Netherlands. "In a world where everyone is constantly on the move and connection and accessibility is essential, we need to be adaptable and nimble. Our glimble brand has started its Arriva journey in the Netherlands, but we know it has pan-EU appeal – and potential – we are starting to explore this in countries where the necessary data sharing agreements exist."

The functionality also incorporates accessibility features, such as screen reading features for low vision users, talkback, and voiceover capabilities. The app also identifies wheelchair-accessible routes and stations, while also calculating step-free journeys. Furthermore, for those with hand-motor disabilities, glimble is designed with optimised menus and buttons.

Other functionality due to be added to the passenger app includes parking locations and a search capability for electric car charging points.

Several mobility providers can be found in the app for several different modes including shared car hire, demand responsive transport, e-scooters, e-taxis, tram, rail, ferry, bus, and e-bicycles. Arriva expects to add further carriers to glimble in the coming months, as well as plans to expand to include Belgium and parts of Germany, from the Netherlands, to make cross-border journey planning and payment more efficient.

Lime launch electric scooters in NYC

LIME has announced the launch of 1,000 electric scooters in New York City as part of the New York City Department of Transportation's (NYC DOT) East Bronx scooter sharing pilot programme.

The scooters are accessed via the Lime app, with riders scanning the QR code on the scooter to start a ride. Riders will also complete their rides via the app by taking a picture of the scooter to ensure that it is parked properly – riders will be required to park the scooters within DOT-designated e-scooter corrals in denser areas. The scooters travel at a maximum speed of 15mph, but new riders will be capped at 10mph for their first three rides as they acclimate to the new mode.

Lime scooters will also be available via the Uber app, allowing riders to unlock and use Lime vehicles within the Uber app and drastically increasing the reach and functionality of Lime scooters in New York City.

"Lime is honored and grateful to once again serve New Yorkers, and we're excited to get rolling with shared electric scooters in the East Bronx," said Lime's CEO, Wayne Ting. "Today is the culmination of years of community outreach, establishing trust and building meaningful relationships to finally bring a shared scooter programme to New York City, and we look forward to continuing to earn the trust of all New Yorkers over the coming months and years. Our scooters will provide East Bronx residents and visitors with safe, affordable and accessible transportation to get around their neighbourhoods, all while reducing congestion and connecting people to public transit. We're laser-focused on operating a safe and equitable micromobility programme in the greatest city in the world, as we hope to demonstrate to cities globally the tremendous benefits of shared electric vehicles in revolutionising transportation."

The electric scooters add to Lime's fleet of shared electric mopeds, which launched April 2021 and operate in Manhattan, Brooklyn, Queens and the Bronx. Lime's launch of electric scooters makes it the only multi-modal micromobility operator in New York City. This is not Lime's first time operating micromobility in New York, as it previously provided shared electric bicycles as part of NYC DOT's dockless bike share pilot programme in the Rockaways and Staten Island, serving more than 300,000 trips.

Lime hosted a series of six safety training sessions in summer 2021 as part of an extensive community outreach programme in the East Bronx that was focused on safety and equity. Lime's demos at the Pelham Houses, Eastchester Gardens and West Farms provided tips on safe, responsible riding and proper parking techniques to more than 100 Bronx residents. Lime also encouraged eligible residents to sign up for its equity pricing initiatives, Lime Aid and Lime Access, which provide discounts to frontline workers and all residents receiving state, local and/or federal assistance, respectively.

Over the past three years, Lime has worked with advocates, legislators, delivery workers and community partners to legalise electric scooters on New York streets, both at the state and local levels, leading to state legislation in 2020, followed by the introduction of a pilot programme at the NYC Council. In applying to take part in the pilot programme, Lime put forward a comprehensive vision for what a world-class scooter programme could look like in New York – which is one of the few remaining global cities without shared scooters – prioritising safety above all else.

As it does in every city that it operates in, Lime also prioritised equity in its proposal to ensure that historic underinvestment in racially and socioeconomically diverse communities were not barriers to accessing sustainable transportation options. Additionally, Lime strove to guarantee access for persons with disabilities, extend opportunities for workforce development to local residents, build connections to transit and educate residents about proper parking. Lime led the way in community outreach, working for years to build meaningful relationships with leading community-based organisations and advocates in the East Bronx and around the city. Lime partners with BronxWorks to hire locally and is currently building a team of as many as 50 to 60 local hires.

New York's decision to award Lime a permit for its e-scooter pilot programme is the latest in a series of permit awards for the company from major cities around the world over the past year. Lime's differentiated approach, operational excellence and its extensive track record of being a reliable partner to cities has earned the leading micromobility operator permits in Paris, Chicago, Seattle and Denver – the biggest cities to run competitive permit processes, often with more than a dozen applicants. Lime is now the only micromobility company to operate in all of the world's biggest cities with e-scooter or e-bike programmes, also including London, Berlin, Rome, Seoul, Sydney, Los Angeles, Madrid and San Francisco.

New green Electric Vehicle tariff cuts charging costs by up to 70%

GREEN ENERGy supplier, OVO Energy, has launched a new OVO Drive + Anytime Electric Vehicle (EV) charging tariff for members nationwide, following a successful pilot scheme in January this year.

The pioneering new tariff is the UK's only green energy plan that brings customers separate rates for their car and home. Now, OVO customers across the UK using the Drive + Anytime add-on could be driving their Electric Vehicle for just £100 across the year. The new tariff offers customers complete flexibility with a guaranteed, ulta-low rate of only 5p/kWh no matter what time of day they plug-in and is the only tariff in the UK to split Electric Vehicle charging from home energy usage.

By splitting the EV charging costs from home electricity charges, customers will be credited back for the amount of electricity saved via EV smart charging every month.

OVO Drive + Anytime members will receive an ultra-low rate because of Kaluza's world-leading energy platform and smart charging innovation. EV owners can take advantage of Kaluza's intelligent software by selecting via a mobile app when they need their car charged by. Using AI algorithms, Kaluza then automatically optimises their car to charge during times of low energy demand, when emissions and prices are also low.

The flat-rate tariff differs from others in the market where customers end up paying significantly higher prices when charging during the middle of the day and are exposed to increasingly-frequent energy price spikes as operators bring more renewable power onto the system and balance increasing demand. As a result, OVO members are given a hassle-free charging experience that fits around their lives and rewards them for helping create a more decarbonised and resilient energy system. The brand new green tariff comes as part of OVO's net-zero mission, making sustainable and greener living an affordable and stress-free option. This innovative new plan helps OVO members go one step further towards a zero carbon future.

Chris Russell, Managing Director of OVO Drive, at OVO Energy commented: "Our OVO Drive + Anytime trial in January was a real success and we're thrilled to be rolling out this pioneering new plan nationwide.

"To be able to offer our EV-driving customers an affordable and hassle-free way of joining us in our mission to achieve a carbon zero future is amazing. We want to encourage the use of electric vehicles as a carbon-conscious lifestyle choice, and it should be easy and accessible - with the help of Kaluza's cutting edge technology, our new Drive + Anytime plan embodies that vision perfectly."

Spin announces integration with Google Maps

PEOPLE USING Google Maps for efficient and reliable journey planning are now able to discover Spin e-scooters and e-bikes when given route options for their journeys. When looking for directions, Google Maps users can easily locate Spin vehicles in 84 towns, cities and campuses in the U.S., Canada, Germany and Spain.

Google Maps users are able to see, in real-time, the nearest available Spin e-bike or e-scooter, including how long it will take to walk to the vehicle, as well as battery range and expected arrival time. Users will then be directed to the Spin app to pay for the vehicle, unlock it and take their ride.

"With this integration, Spin is making it easier for millions of Google Maps users to easily incorporate shared bikes and scooters into their daily trips," commented Ben Bear, CEO of Spin. "Our goal is to make it as low friction as possible for consumers to plan multimodal journeys. It needs to be just as easy, and even more convenient, to get around with bikes, buses, trains and scooters as it is with a personal car. This collaboration with Google is our biggest platform integration yet, with many more in the pipeline."

Micromobility is continuing to gain traction to become a mainstream transportation solution for those living in urban areas or campuses.

As e-scooters and e-bikes are being increasingly built into journey-planning platforms, residents and visitors can more easily take a multimodal approach to the way that they get around cities.

This latest integration follows Spin's recent addition into a number of global and regional journey planning platforms such as CityMapper, Moovit, Transit and Kölner Verkehrs-Betriebe (KVB).

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4 Sessions

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Who will win the race:
Autonomous Hare or ADAS Tortoise?

2020 was meant to be the year when autonomous vehicles were to hit the road in serious numbers. In 2017 one analyst talked of a "conservative estimate" of 10 million autonomous cars by now – about 10 million more than are in circulation a year after the deadline.

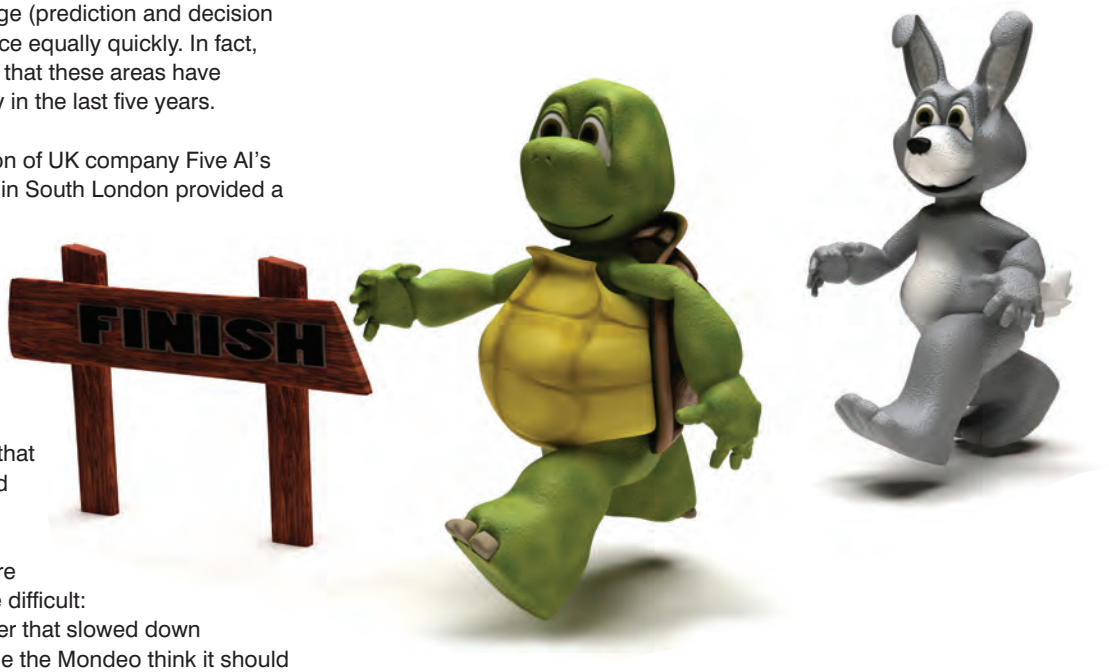
BY JAY NAGLEY, HEAD OF BUSINESS DEVELOPMENT, LAND MOBILITY & NORTHERN IRELAND AT ANGOKA

WITH THE INEVITABLE exception of Elon Musk, every car company has dialled back the predictions of autonomous vehicles it made in 2016/2017. Meanwhile, a lot of money has been quietly flowing into the unglamorous end of vehicle automation: Level 2 autonomy. Five years ago, Level 2 automation (combined driver assistance features like adaptive cruise control and lane keep assist) was seen as little more than a road-sign on the journey to full Level 5 autonomy. However, the cost and complexity of a vehicle having to make all the driving decisions has turned out to be far more difficult than envisaged a few years ago.

Speaking to Spectrum magazine, Gill Pratt, CEO of the Toyota Research Institute in California, said that rapid advances in the first stage of vehicle automation (image recognition) made researchers

think that the next stage (prediction and decision making) would advance equally quickly. In fact, there is little evidence that these areas have advanced significantly in the last five years.

A recent demonstration of UK company Five AI's Level 4 Ford Mondeo in South London provided a good snapshot of the current state-of-the-art developments. It was hugely impressive dealing with situations it had learned to handle, taking a perfect line through one junction that would have impressed Lewis Hamilton. However, predicting what other drivers were about to do was more difficult: one approaching driver that slowed down for a roundabout made the Mondeo think it should proceed, but when the other driver accelerated slightly, the autonomous Mondeo did an emergency stop. This demonstrated the inevitable overreaction of a system that is rightly programmed not to have full confidence in its own decisions.



Instead of chasing the rainbow of Level 5 autonomy, the global Tier Ones like Bosch and ZF (the companies who actually develop most electronic technology in the car industry) are now concentrating on two areas for on-road automation: Level 2 Plus for the entire industry, and Level 3 for premium models.

Level 2 Plus is a relatively recent concept, which is about stretching Level 2 systems as far as they can go, while still leaving ultimate control with the driver. German giant ZF has probably done most to popularise the concept, which tries to provide assistance for almost every manoeuvre a driver makes, even including "merge assist" for motorway slip-roads. The company says it can provide a complete system to an OEM for well under $1000 – a fraction of what an autonomous system would cost.

Level 3, which was originally framed to mean conditional automation, where the car could drive itself, but would hand back to the driver if it encountered a situation it could not cope with, has been subtly redefined. Today, it effectively means automated driving on a highway at relatively low speeds (up to 50 km/h). The reason for restricting it to highways is that a Level 3 system would need to stay in control for the 5-10 seconds a driver needs to resume command – so it can only operate where the possible challenges during that time are limited. So, does the march of driver assist systems mean the marginalisation of autonomy? Not necessarily,

but it means full autonomy will only to be used in specific use cases for the next 5-10 years. The first application is likely to be logistics – so-called ZEAL (Zero Emissions Automated Logistics). Vehicles that operate in bounded environments (e.g. ports or logistics hubs) are far easier to automate, as their entire operational domain can be mapped, and interactions with other vehicles can be controlled.

Currently, most of these autonomous vehicles are actually teleoperated, with a controller overseeing their activities. This hugely reduces cost and complexity, as the "brain of last resort" is a human one, which has had millions of years of free training in handling unexpected situations, as opposed to a hugely expensive computer whose evolution has to be paid for.

However, this does raise another issue. Automated logistics vehicles need to be in constant contact with both their operator and with each other. The communications themselves are well understood, and constantly improving (5G being the most important advance), but the greater volume of communications creates major opportunities for hacking. Quite often the cybersecurity aspects of trials or deployments are left until the last minute – the boring stuff that nobody wants to take charge of. It is also expensive, as operators must not only set up the security system but also to keep it regularly updated with fresh cryptographic keys and Certificates to refresh the system and communications security.

This is the issue that Angoka has addressed with its hardware-based cybersecurity solution, using Device Authentication Units (DAUs) to handle the identity generation and management of the device, as well as its authentication and authorisation. As it is based on hardware, it is intrinsically safer than relying on software alone. It is also more cost-effective as the DAUs collaboratively create passwords in real-time, removing the need to periodically load new passwords to maintain security. Finally, it is widely applicable, because it provides trusted communications in an untrusted network.

When the vehicle is started, each device contributes to the creation of a new session key – a unique password shared between authorised devices on the network. Effectively it is like providing a police escort to a prison van to ensure that the van arrives securely at its destination (unless it is an episode of Line of Duty, of course).

This solution is already being used in ZEAL trials. It won't magically solve the problems of delivering Level 5 autonomous vehicles in the 2030s, but it does simplify the issues around implementing Level 4 logistics solutions in the 2020s.

About Jay Nagley

Jay Nagley is currently the Head of Business Development, Land Mobility & Northern Ireland at ANGOKA. Jay started his career at Porsche in the late 1980s.

In the 1990s he ran the UK division of a German automotive consultancy, and in 1998 he set up his own consultancy, Spyder Redspy Ltd, providing automotive market analysis, product planning and digital services. From 2014 to 2021, he was contracted by the Department for International Trade as an Automotive R&D Specialist.

At DIT, he worked with major overseas Tier One suppliers to increase their R&D operations in the UK, and forge links with UK partners in the areas of zero carbon propulsion and connected and automated mobility.

ABOUT ANGOKA

➤ ANGOKA is an IoT security company focused on protecting M2M communications for Smart Mobility and Cities. Headquartered in Belfast, with offices in London and The Hague, ANGOKA offers solutions that protect devices' identities. With an increase of inherently insecure networks coming online with the boom of IoT, ANGOKA's solutions safeguard critical machine-to-machine communication integrity and data provenance, creating trusted connections, even in untrustworthy networks.

ANGOKA is the only cybersecurity company to win a place on Zenzic's CAM Scale-Up Programme, delivered in partnership with Plug and Play. ANGOKA is an alumnus of the National Cyber Security Centre's Cyber Accelerator, Seraphim Space Camp, Yes!Delft and TechNation Cyber 2.0.

Finally, ANGOKA has been awarded several Innovate UK R&D projects, which focus on securing quantum communications (led by BT) and two drone projects. Most recently, ANGOKA was selected for Plug & Play's Smart Cities programme, with a focus on Mobility, and was named one of the UK's Most Innovative Cyber Security SME by the UK Government.

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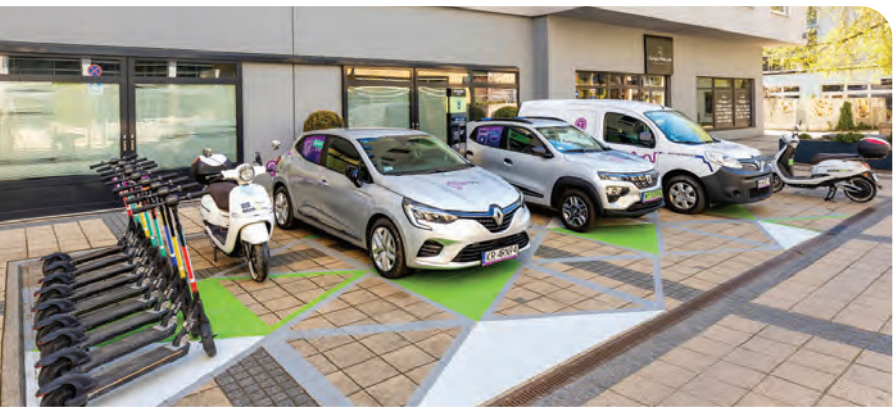
‘Mobility Hubs’ to connect cities and real estate with transportation of the future (SHARED MOBILITY)

In May 2021, Warsaw welcomed the first multimodal ‘Mobility Hub’ with different types of shared vehicles available in a single spot. This specially designated parking area has been located in a business district next to the ‘Adgar Plaza Complex’ and has combined a selection of local shared mobility offerings, namely e-scooters, e-mopeds and car sharing (including EVs).

BY ADAM JEDRZEJEWSKI, CO-FOUNDER AND CEO OF ‘MOBILITY HUBS’

Already the first 3 months of operation of the Warsaw-based ‘Mobility Hub’ showed good results and proved that there is a need for a combined offer of different shared mobility vehicles available in one and the same place, the so-called ‘Mobility Hub’. The initial period reported more than half thousand rentals and returns with 52% of this traffic generated by car sharing users and 48% by micro-mobility users (out of which 46% through e-moped services and 54% through e-scooters).

Additionally, the ‘Mobility Hub’ users can easily find in real time and in a single app all the shared vehicles located in the hub and available for immediate rent. They only need to download the mobile app ‘Vooom – one app to ride the City’, which is a route planner combining shared modes of transport with public transit and heading towards a cutting-edge MaaS (Mobility-as-a-Service) platform gaining more and more attention in cities that nowadays develop sustainable and smart mobility.



In confirmation of these words, Vooom’s technology of the predictive multimodal route planner is already live in the largest Polish cities and is currently being applied as a municipal solution in Gdynia in northern Poland and soon also in the GZM Metropolis, a region in southern Poland comprising of more than 40 municipalities with more than 2 million inhabitants.

The ‘Mobility Hubs’ pioneering venture has been born by Polish mobility experts whose ultimate aim is to make urban mobility more sustainable, eco-friendly and less car dependent as cities must face challenges resulting from climate changes, air pollution, traffic congestion and high motorization rates, among others. The company’s CEO Adam Jędrzejewski is known as an ambassador of shared mobility in Poland, founding back in 2017 the shared mobility association ‘Mobilne Miasto’ (eng. Mobile City) whose members provide today approx. 60.000 shared vehicles in Polish cities. The success in

many years of building the industry organization he now wants to turn into the success of the 'Mobility Hubs' bringing the benefits of shared and digital mobility to cities and local societies and helping also the mobility industry in increasing utilization of its services through disseminating them and finding additional sales channels for the mobility providers. 'Mobility Hubs' are nothing else but specially designed parking areas gathering different types of shared vehicles in a single spot directly on a real estate, with guaranteed availability of these vehicles, which is key for the users as they are winning certainty that they will get a vehicle of their choice in the defined location – explains Adam Jędrzejewski.

On board of 'Mobility Hubs' are also people supplementing the abovementioned parking and shared mobility competences with expertise in digital technology, user experience and well-being. A significant shareholder in the company is Vooom, which has developed an AI-based predictive multimodal route planner helping cities as well as shared mobility operators in providing their residents and/or users with tailor-made route planning engine combining different modes of urban transport and being also a business intelligence tool for numerous mobility options and city managers.

'Mobility Hubs' are an absolutely unique product not only in Poland but also beyond. It is the future of transportation offering citizens access to mobility in three dimensions simultaneously: physically (the vehicles themselves located in a 'Mobility Hub'), digitally (by giving access to these vehicles and providing route planning) and potentially also as an employee benefit (through a 'mobility budget' provided by the employer) – says Włodzimierz Łozieński, one of Vooom's co-founders.

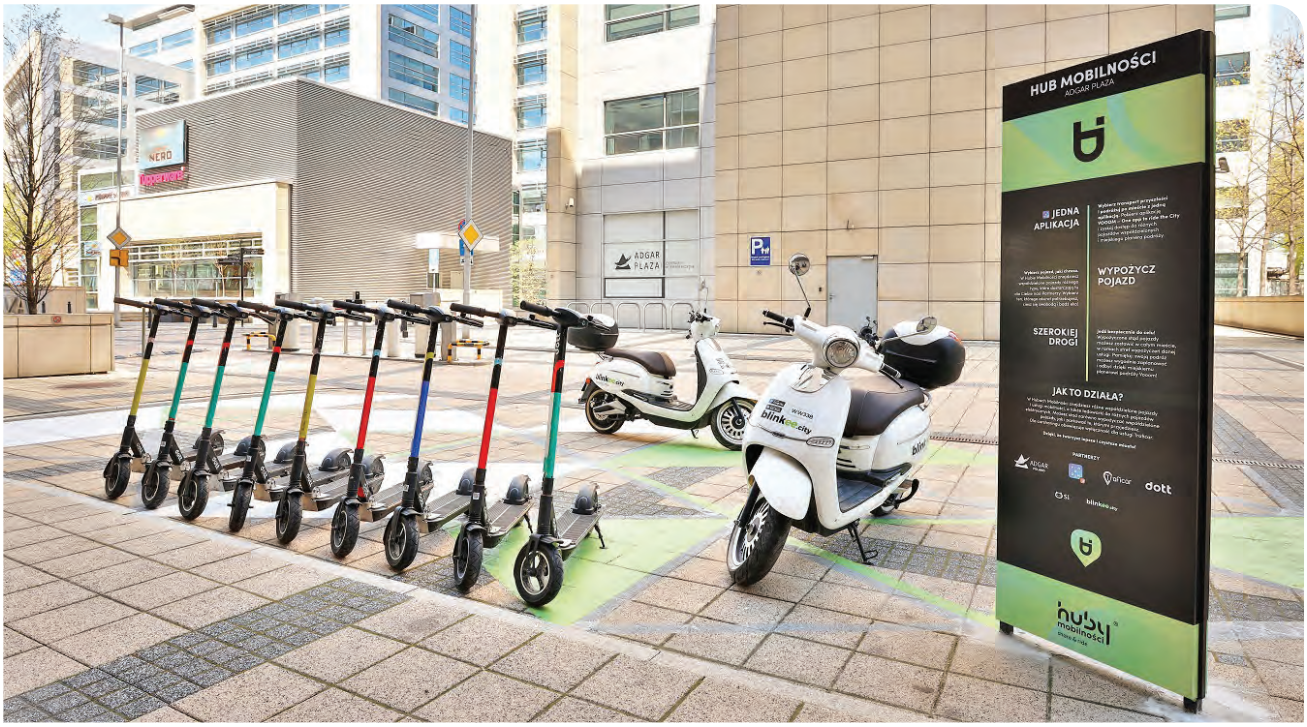
The 'Mobility Hubs' are intended for both particular properties such as office buildings, shopping malls, housing estates and hotels, as well for entire municipalities. In all cases the hubs are to help the landlords in controlling the shared mobility landscape and providing these services to citizens in an orderly (station-based) manner. Both property managers as well as city administration want to give their clients, tenants and residents a seamless mobility experience, which is far more than a regular and underutilized parking space for a private car being indeed a waste of important common assets such as land, money, time and the environment. We must realize and start taking into account that a statistical private car in individual use is 95% of the time parked and its average occupancy ratio is not even 1,5 persons while having 4-5 seats

available. It is therefore far from being productive. What 'Mobility Hubs' offer though is turning some of these non-efficient regular parking spaces serving only 1-2 people into highly effective hot spots serving dozens and hundreds of people at the same time, additionally with much less land wasted and significantly lower investment costs.

Leading shared mobility providers in Poland already decided to make their vehicles available in 'Mobility Hubs': two biggest car sharing providers (Traficar and Panek), the biggest e-moped sharing provider (blinkee.city) as well as one of the European leaders in micro-mobility and e-scooter sharing in particular (Dott). And that's only the beginning as our open formula in disseminating shared mobility services aims at involving most (if not all) of the shared mobility actors into 'Mobility Hubs' – underlines the approach of the company Adam Jędrzejewski.

'Mobility Hubs' have recently also reached an important milestone. Namely, the first hub opened in May 2021 in Warsaw in one of the largest business districts in Poland, being also a proof of concept as such, showed that despite lower office-occupancy levels caused by COVID-19 pandemic there is a growing demand for the use of different shared mobility vehicles within the 'Mobility Hub' exceeding half thousand rentals and returns within the first 3 months of operation and a 36% increase reported month over month.

After successful implementation of the first 'Mobility Hub' the company is currently in the course of setting up more hubs in other locations in Poland and talking with many acknowledged partners



interested in hosting 'Mobility Hubs' either on or next to their premises. The talks are conducted, among others, with municipalities, public road and transport authorities, commercial property owners, housing estates as well as large companies willing to provide sustainable and smart mobility to their employees and/or clients.

Also, it is likely that some 'Mobility Hubs' will pop up as a part of an EU-funded project being rolled out in several European cities, including Warsaw. What important, this project called 'SmartHubs' is not only to focus on opening new hubs' locations, but also to prepare a feasibility study on implementing hubs in Warsaw, to seek most efficient ways of setting up and running 'Mobility Hubs' as well as to examine the travel preferences of the hubs' users. All this will greatly contribute to further growth of the company and its expertise with the aim of becoming the number one professional vendor specializing in bundling different shared mobility offerings in cities and on real estate.

The potential of 'Mobility Hubs' in major Polish cities accounts to hundreds and thousands of key urban locations. Moreover, the whole concept is scalable regardless of country, the only condition here is a sufficient density of available shared modes of transport in a particular city.

Last but not least, except of the different shared vehicles themselves the 'Mobility Hubs' are also to provide supporting infrastructure for charging electric vehicles, in that case not only for shared mobility providers but also for private individual use. We are talking about e-bikes, e-scooters, e-mopeds, e-cars as well as swappable battery packs. Such combination of services – mobility and charging – are essential in order to make the whole 'Mobility Hubs' concept even more effective, sustainable as well as a desired piece of urban landscape being requested by cities and the real estate sector.
For further details and cooperation possibilities please contact kontakt@hubymobilnosci.pl.

About the author
Adam Jedrzejewski: co-founder and CEO at 'Mobility Hubs'; for several years involved in the development of projects aimed at making cities more liveable; his specialties are parking, shared mobility, MaaS (Mobility-as-a-Service) and PPPs (Public-Private Partnerships).

Adam Jędrzejewski: co-founder and CEO at 'Mobility Hubs'; for several years involved in the development of projects aimed at making cities more liveable; his specialties are parking, shared mobility, MaaS (Mobility-as-a-Service) and PPPs (Public-Private Partnerships).

A new, powerful IoT infrastructure for the passenger transport industry

With an intensifying focus on efficiency and safety, Bus Back Better, and service demand increasing as the UK emerges from lockdown, the bus and coach sector is undergoing big changes.

FOLLOWING YEARS OF WORKING behind the scenes on AI technology systems, Exeros have deployed a powerful IoT infrastructure that can revolutionise camera-based visibility systems for the passenger transport industry.

Enquiring about the challenges faced by fleet operators in the bus market, it was clear that operators wanted a single architecture in the vehicle that could control CCTV, collision warnings, driver fatigue alerts, and keep everything functioning smoothly.

With our integrated central IoT camera platform, Exeros have now finally developed a single architecture that can accommodate the integration of multiple safety systems to revolutionise passenger transport.

“Scalable and modular systems would enable rapid improvement in technology deployment – this is what the industry is in dire need of” explains Jay Biring, Chief technology officer at Exeros Technologies, in reference to the challenges needed to overcome when rolling out technology-led solutions to the bus and coach market.

AI-based technologies

AI-based technology is here to stay. This kind of technology is already in cars, watching the road ahead. Even more so, this technology should be placed on buses and rail as their risk profile is higher.

There’s a lot of responsibility placed on the driver to keep passengers safe, so if we could assist them in their job using technology, why wouldn’t we?

According to government statistics, over 85% of accidents are caused by human error – if we give drivers a two-second early warning of an approaching hazard, we can reduce that down to 1%.

So, what can be integrated to Exeros' IoT camera platform?

Exeros Safety Technologies

- **Cyclist Blind spot Detection System:** An intelligent blind spot camera detection system accurately detecting cyclists, pedestrians and fixed objects in close proximity to vehicle. The system warns the driver if a cyclist or pedestrian is too close to the vehicle and triggers an audio alarm outside the vehicle to warn the cyclist that they're in danger.
- **AI Driver State Monitoring System:** A small internal camera that will immediately alert the driver if it detects signs of fatigue or distraction such as yawning, mobile phone use, smoking behind the wheel etc. Driver fatigue remains one of the most dangerous factors in commercial driving, responsible for thousands of accidents every year on the roads. This technology acts as a second pair of eyes to keep the driver and passengers safe.
- **Forward-facing camera:** This camera detects pedestrians about to step out in front of the vehicle, whether the vehicle is tailgating or veering out of lane unexpectedly and detects road signs.

Automatic Passenger Counting

Focusing on fleet efficiency and management, Exeros also released a new AI passenger counting (APC) system as one of the modules.

The APC platform has already been installed on Hinkley Point C Power Station transport provider, Somerset Passenger Solutions (SPS). SPS is responsible for the transportation of thousands of workers daily to and from site aboard 150 vehicles.

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The system applies time-of-flight methods, measuring the propagation time between emission and reception of infrared light, reflected by objects in its wide field of vision. The sensors provide 3D images in real-time, identifying objects by 3D shape and dimension (which in a public transport environment, can differentiate between passengers or luggage or strollers, for example), providing more accurate data than any camera-based technology. The data helps for route trend analysis enabling fleet operators determine optimum vehicle frequency and routes based on passenger load during peak and non-peak hours.

In fact, In SPS' case, Exeros have monitored passenger travel patterns reporting a 98-100% read rate in terms of counting people coming on and off the buses.

"SPS' technology challenge was that they don't have a set route structure; vehicles do different routes each day and new stops can be introduced at relatively short notice," said Biring.

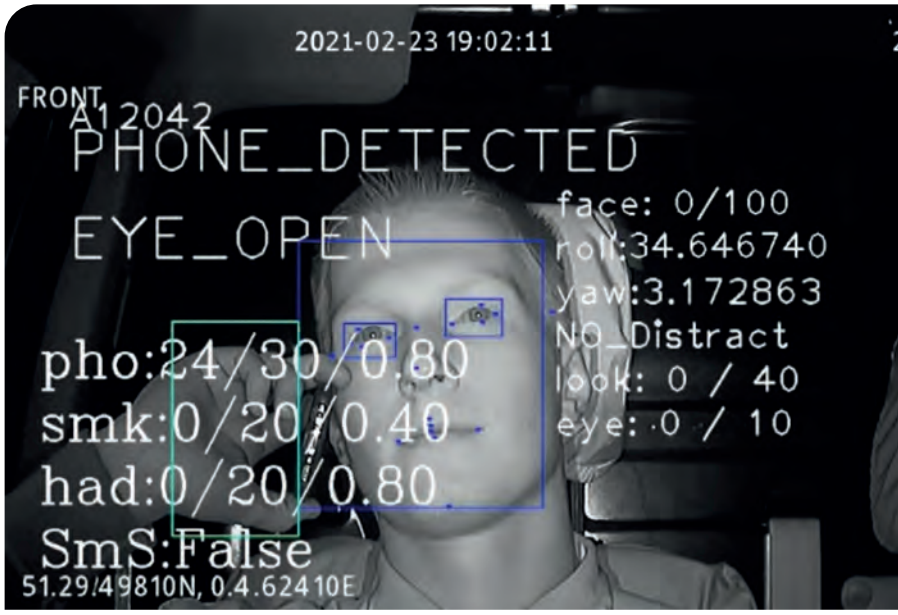
"We had to build the AI platform so that it could automatically ascertain which route the bus had taken and how many people had gotten on and off at each stop. The AI system determines what route the vehicle took without any input from a scheduling front-end. This means they don't have to integrate their scheduling system into our platform – it works independently and gives them everything they need."

"There are a lot of use cases for this system and it can be deployed to any bus operator. And because the AI is already there, operators don't have to do any front-end coding on it. All they have to do is mark the stops of each route on a map, and the system will learn which route the vehicle is on by itself within a couple of days."

The system can also link into an operator's app and tell passengers how many seats are available on each bus.

The future of AI

The breadth of capabilities enabled by strategic use of AI is limitless. AI provides a tangible opportunity to tailor passenger transport services in several ways. The benefits could be evident in rural areas for example where AI could analyse usage data to optimise route and vehicle utilisation more effectively– helping to make public transport a more viable option regardless of postcode.
Exeros is also currently trialling a new algorithm



for low bridge detection system, designed to read the road signs pointing out the size of the bridge on the approach, and cross check that against the measurement of the bridge once the camera can spot it. So far, the company has managed to get the system down to a sub-10cm accuracy level on early trials.

If AI can help optimise route and fleet efficiency, improve fleet safety and help gradually introduce enhanced autonomous functionality, it could provide the tools to navigate the route to net-zero.

ABOUT EXEROS TECHNOLOGIES

➤ Founded in 2009, Exeros Technologies are experts in computer-vision for vehicles with a mission to accelerate vehicle camera AI to protect lives, reputations and reduce risk.

Our market-leading experience in this sector enables us to consult with the largest UK fleets as a strategic technology partner, allowing us to deliver solutions to major transport challenges faced by fleets.

At Exeros we value integration and continuously pursue new opportunities to further advance vehicle and driver safety by bringing together all security components into one smart system.

The green economy: An opportunity for MaaS?

The impact of transport on global warming and climate change is at the top of most government agendas, and they're not alone. Businesses and the financial industry also recognise the potential upside of the monumental shift that's been taking place towards a low carbon, resource-efficient, inclusive economy. At SkedGo, we believe these changes will help to set a firm foundation for mobility-as-a-service (MaaS) to flourish in the green economy.

BY JOHN NUUTINEN, CEO SKEDGO

ACROSS THE GLOBE, nations are heavily committed to making our economy greener. With 80% of the world's energy coming from fossil fuels, the move to a low carbon economy needs governments to work together on robust climate policies.

This includes addressing the environmental cost of our current transportation system. According to the OECD, almost 90% of emissions come from five economic sectors, with transport accounting for around a quarter of energy-related carbon dioxide emissions.

Governments get tough(er) on climate action

There has been a global push for smarter sustainable transportation including the European Green Deal and the EU's Sustainable and Smart Mobility Strategy. In April 2021, the EU agreed on a European climate law that provides a framework for future climate regulations. Their aim? Zero net emissions by 2050, putting the spotlight on polluting sectors such as transport rather than focusing on forests and wetlands to reduce CO_2.

Meanwhile in the US, president Joe Biden held the Leaders Summit on Climate which brought 40 world leaders together to discuss both the urgency and economic benefits of stronger climate action. America is looking to cut its emissions by 50-52% (below 2005 levels) in the next nine years. On his first day in office, President Biden also re-enlisted the US into the 2015 Paris Agreement.

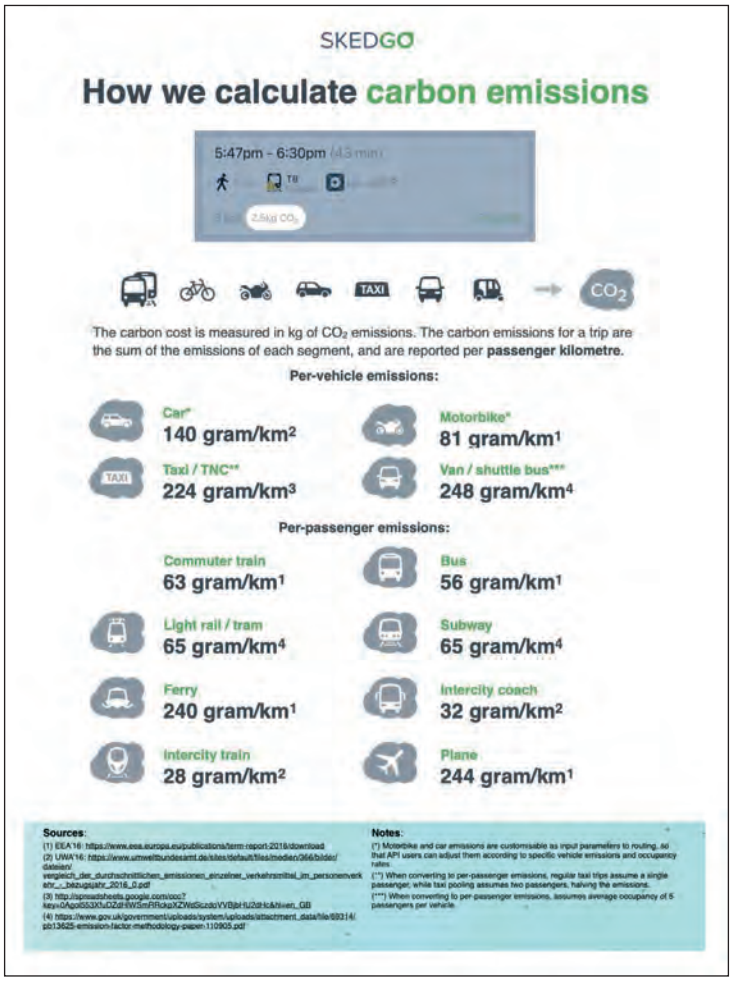
Later this year, the UK in partnership with Italy will host the 26th UN Climate Change Conference (COP26) in Glasgow. It aims to encourage more action towards meeting the targets for the Paris Agreement and the UN Framework Convention on Climate Change. The message is clear - at a global level, governments know they must act fast.

The UK has committed to cut carbon emissions by 78% by 2035, much faster than initially promised. This has also been extended to cover international aviation and shipping. In London, the mayor has pledged to invest £10m in the Green New Deal to secure thousands of green jobs and the Scottish Government is investing £7 million in zero-emissions projects. Meanwhile, Germany is looking to invest a staggering US$46bn in sustainable investments according to the World Economic Forum as part of a green recovery post-Covid with a major commitment to public transport and the rail system. It's clearly very serious about making change happen - and that also means changes with alternative fuels and transportation.

A Structural Shift

But it doesn't stop there. Alongside government commitments, we're also witnessing a structural long-term shift with environmental concerns rising to the top of many corporate and financial industry agendas too. Companies such as Tesla are pushing the boundaries of what's possible, traditional vehicle manufacturers are moving from fossil fuel to electric and the past decade or so has seen a marked rise in new disruptors in the mobility space including Lime, Bird and MaaS app technology platforms such as SkedGo. Forward-thinking commercial organisations are also looking to MaaS to see how they can reduce their carbon footprint and raise their corporate social responsibility and eco-friendly credentials.

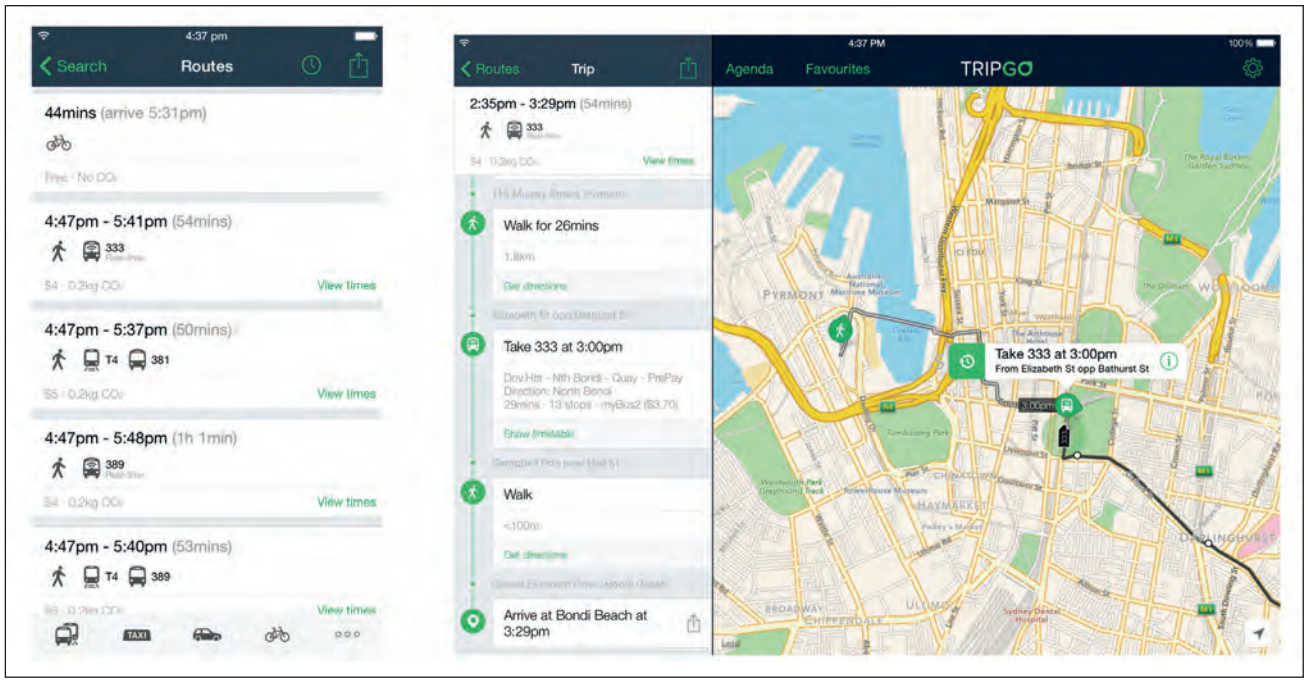
The green economy, of course, is much larger than just transport. The FTSE Russell breaks it down into 10 sectors, including clean transport. These 10 sectors comprise 64 subsectors and 133 micro sectors. It's a sizable space, in which transport plays an important role - and one which brings much-needed innovation and alternative solutions to help put the brakes on our environmental problems.



Is the green economy big business?

There has long been the notion that environment and economy are mutually exclusive, but is this true? Or are they, in fact, two sides of the same coin? What's more, how much is this green economy worth? Does it stack up when it comes to investment?

An article published by the FTSE Russell in February 2021, 'Putting numbers to the global green economy' provides some interesting insights. It shows the green economy is growing in significance compared to the global economy, having 'strongly outperformed wider indexes'. Perhaps even more interesting is their headline finding which shows 'green revenues' to have a market cap of US$4.3tn which equates to '5.4% of the total value of global listed equities'. Considering the FTSE Russell puts the oil and gas sector at around 3% of the market,



this makes the green economy 'materially larger'.

Opportunities for growth and investment

While there's still a long way to go to deliver on the Paris Agreement, the green economy is clearly one of growth. When the FTSE Russell first tracked its size in 2009, the market cap was around US$2tn. It's since seen annualised growth of 8% - twice the rate of the broader economy.

Look on any stocks and shares site and you'll see the number of environmental, social, governance (ESG) and green funds have also risen. This seems to be reflected in news reports too, with one media outlet, CNBC, highlighting that the green investing 'mega trend' was here to stay with 479 green bonds issued globally during 2019. That's a 25% increase from the previous year. It also reported that the growth in investor demand was driving hedge fund ESG investing. Likewise, outlets such as Morningstar have entire sections on the theme.

Investors want to know that the companies they invest in show good environmental and social governance - and they're prepared to vote with their money. Others no doubt are backing what they see as a fundamental trend with a good deal of potential upside. With governments putting their weight behind the green economy and companies following suit, the financial industry is sitting up and taking notice; after all, a few of these companies could potentially become some of the world's most valuable corporate names in years to come.

What this could mean for MaaS

With governments, businesses and investors backing the green economy, this increases the opportunities for MaaS. Traditional fossil fuel car manufacturers are investing billions of dollars in electric vehicles. Even if consumers are tentative to shift away from petrol and diesel right now (due in part to higher prices and lack of electric charging points), the time will come when they have to make choices.

Several factors could play a role in their ultimate decision. A good proportion of people may continue to work from home post-Covid, with infrequent visits to the office. Cities continue to make it less enticing for people to use their cars in certain zones too. As it becomes more expensive, inconvenient or untenable to use personal private vehicles (particularly if they're fossil fuel), people will have no choice but to find alternatives.

The government push for the electrification of public transport and taxi fleets, combined with the rise of micromobility, cycling and walking, means more options are becoming available to people - all of which could be easily accessible via MaaS, bringing together low CO2, resource-efficient, socially responsible and affordable modes in one easily accessible app.

With SkedGo's MaaS technology, it's possible to aggregate all available transportation services, in particular, within cities so that travellers can plan, manage and pay for their entire trip taking account of the different legs of a journey. MaaS apps make it easy for travellers to move around and access all the transport options at their disposal regardless of whether they're a commuter, resident or visitor. This convenience is a major benefit and this is something that we at SkedGo are passionate about.

Coupled with this is the ability to show search results that include more environmentally friendly modes including the cost of CO2 emissions for each part of the trip chain. We've built this into our MaaS platform technology and it's something that our clients, including public transport authorities and operators as well as commercial businesses, appreciate. It provides food for thought, particularly as people are becoming more aware of their impact on the environment.

Green light for MaaS

Given government efforts to move to greener fuels, back alternative modes of transport and offer better means to accessing mobility options, MaaS provides an incredibly viable solution to pull this combined offering together. After all, MaaS technology is already pretty advanced in terms of its capabilities. For instance, SkedGo's algorithms provide personalised results with the potential to include alternative-fuelled vehicles, shared cars, public transport, cycling, walking and micromobility in the mix. This is vital as moving large numbers of people around cities makes cycling and micromobility attractive as this results in better utilisation of road space. Active travel is another important part of the equation for the government, getting us from A to B while helping to maintain physical health. However, without knowing the options available, the best times to use certain modes and routes, many citizens are likely to default to their usual transport options without realising there may be better alternatives.

MaaS apps can provide near real-time data so travellers can be alerted to problems such as congestion, breakdowns or other disruptions to their journey and find better routes. Being able to switch modes and automatically pay in-app takes a lot of the frustration out of travel. By serving up this information without citizens having to do much work, MaaS can help make it easier to encourage behavioural shifts.

To this end, national and local governments can use MaaS apps as the mechanism by which to incentivise the use of sustainable transport and reduce the number of vehicles on the road. With the right incentives, people are more likely to make changes that benefit both themselves and government environmental targets, helping to support a greener economy with their sustainable transport choices.

MaaS provides much-needed technology for governments, businesses and other organisations to get sustainable transportation in front of travellers - and to encourage them to use it over longer time periods through incentivisation and perhaps reduce the number of cars per household. In addition, it makes it easier to analyse utilisation and other data to make wiser decisions that improve efficiency, uncover new service opportunities and improve potential profits. All of which is music to the ears of any investor. From alternative fuels and transport modes to technology for smarter transport systems and infrastructure, there's growing confidence in the long-term potential of the green economy. And that's a good thing. We believe sustainable transport underpinned by technology, including MaaS apps, can help to both support the green economy and offer potential investment opportunities while providing a cohesive experience for travellers.

After all, decoupling our economy from environmental concerns is a completely false notion. The two go hand in hand, representing opportunity and ultimately sustainable prosperity - and health - across the globe. We might be biased but combined with the power of digital and data the green economy will be an interesting investment choice in years to come. It's certainly worthy of investigation. From our perspective, the green economy is a welcome chance for our sector to succeed and thrive.

John Nuutinen
John is a senior executive with a wealth of experience across a range of industries – including media, publishing and technology. He has worked in a number of international jurisdictions and within a variety of vertical markets and held senior roles for businesses ranging in size from start-ups to large multinational organisations such as Reed Elsevier and Thomson Reuters. John has been with SkedGo from the beginning, having collaborated closely with founder Claus von Hessberg, to conceptualise, shape and deliver a new era in personal mobility and commuting. Originally from Finland, but now living in Australia, he is well travelled, culturally curious and a true advocate for Mobility-as-a-Service.

Modern vehicles are expected to excel in all and every condition. Traditional engineering methods struggle to cope with such a disparate variety of conditions. Image: Oliur/ Unsplash.

Simulation: not just a buzz word

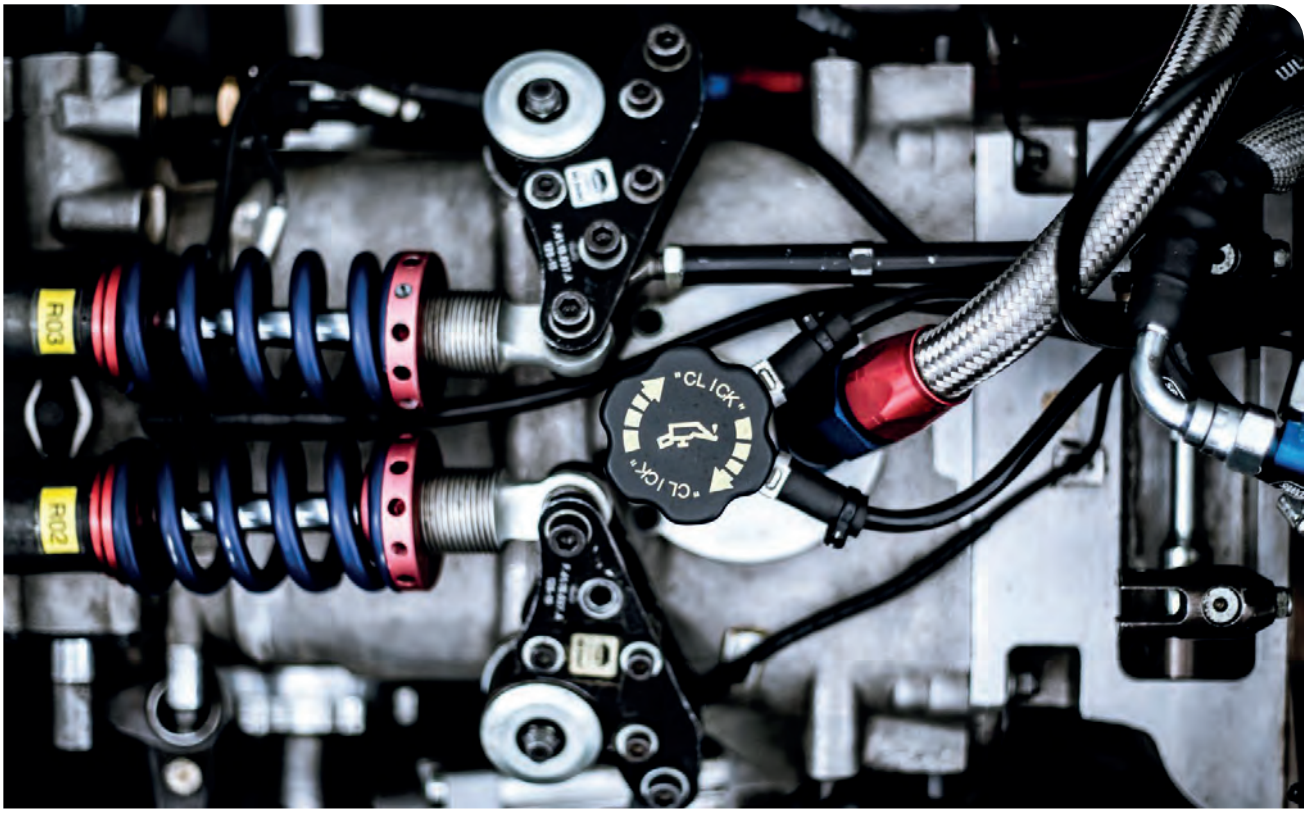
As vehicles are getting more complex as integrated mechatronic systems, approaches which are cross-disciplinary using simulation are now vital. Development processes need to be able to capture and understand all the permutations of each design change or choice, which cannot be easily discretised into singular studies, whether physical or virtual. Systemic interactions, and the ramifications at local and whole vehicle level, need to be understood.

CONSIDER a modern automotive innovation: active aerodynamics. It is inherently multi-physics; control software triggers electrical automation of hydraulic systems, to change the aerodynamic profile of a component, which then impacts the thermal performance of the vehicle, as well as energy efficiency and the ultimate handling balance. Looking at one element of this system in isolation will never lead to a robust understanding of the full system dynamics.

Simulation; what is it?

Simulations of various kinds have long been an established part of engineering process to provide more detail and understanding of complex phenomena. Be it Finite Element Analysis (FEA), Computation Fluid Dynamics (CFD) or Multibody Dynamics (MBD), all engineers are familiar with the concept of Computer Aided Engineering (CAE). Traditionally, CAE has covered the targeted application of specialist techniques.

Over the past decade however, the holistic term *simulation* has developed, covering modelling of the vehicle as a combined system. So, what does the term simulation mean in the modern context, and how is it revolutionising the way vehicles are being developed and built in the present day?



Motorsport has long been considered the laboratory of the road. Now, advancements come in the form of methodologies rather than physical components. Image: Sam Loyd/Unsplash

To really grapple with simulation as a concept, we first must consider what it is. At heart, it is describing the physical world in numerical terms, enabling the recreation of results from real world testing. Immediately, the dividend of repeatability and repetition can be grasped. But moving beyond that, the real benefit of full vehicle simulation is it enables engineers to ask, and answer, "what if" questions quickly and easily with models detailed enough to be predictive. Questions which would otherwise be impossible, or impractical, to answer.

In the 20th century, answering such existential questions to further understanding required decades of research to develop parametric analytical equations capable of providing an answer to "what if", when a single parameter is changed. Even then, such analytical approaches are only of limited use in predicative studies, able to answer only the broadest of questions. Therefore, unsuitable to guide modern design decisions.

If the origins of simulation tools are considered, then the judgement of them as tools to understand the unknown makes perfect sense. Motorsport, such as F1 or NASCAR, are often cited as roots of complete vehicle simulation packages, as is the case of VeSyMA from Claytex. Such tools developed out of motorsport engineers needing to understand a rapidly changing and very complex collection of technological details and physical circumstances. All whilst physical testing options were being simultaneously reduced.

Utilizing the acausal Dymola simulation environment, complete vehicle simulation with VeSyMA provides an innovation over a traditional targeted CAE approach. Each physical or software component the vehicle is built from is modelled from first physics principles and combined into a full vehicle model. These simulation models therefore directly resemble the actual system they are simulating at an intrinsic physical level. Such an approach means if component models are validated correctly, then they can be inserted into full vehicle simulations and be used for predictive studies with confidence.

Evolving beyond a niche

As great as those benefits sound, the jump between simulation being a great idea in theory and a practical tool is quite a large one. F1 and NASCAR teams are minute compared to OEMs and Tier 1 suppliers. Regulatory oversight of final product and product development is also vastly reduced, as are the financial constraints.

The effect of a design change, on say a cabin door insert can be understood in all aspects desired; impact of mass change on vibration response when driving over rough roads, impact of mass change on thermal performance of the cabin in various weather conditions, impact of mass change on vehicle handling, impact of mass and heating/cooling changes on vehicle range

But the reality is that simulation is an inherently flexible tool, adaptable for your specific needs. Not all simulation is the same, or for the same purpose. For instance, in motorsport, you would not use the most detailed fully compliant vehicle model for computing 10,000 strategy permutations the night before a race. Similarly, simulation for automotive applications can be adapted to specific roles within the existing development process, delivering benefits without needing to reorganise the existing deployment of labour.

Flexibility of simulation can be thought of as comprising of two opposite poles. At the one end, are simple, easy to parameterise, not overly detailed models; at the other are the most complex models, with all the detail possible included. All permutations exist between these two poles, with the detail level scaled to the specific function or job required. What provides the efficiency benefit is that both those poles are realised in the same package, sharing the same inherent architecture.

Rather than dealing with multiple packages or maintaining different legacy tools, VeSyMA can provide a core singular backbone of a simulation strategy, underpinning all aspects of vehicle system engineering. Detailed data from subject specific detail packages, such as FEA or CFD can be integrated into the core simulation package of VeSyMA. This then enables highly complex interactions between components to be modelled.

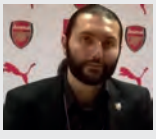
Have confidence in answering "What if?"

The effect of a design change, on say a cabin door insert can be understood in all aspects desired; impact of mass change on vibration response when driving over rough roads, impact of mass change on thermal performance of the cabin in various weather conditions, impact of mass change on vehicle handling, impact of mass and heating/cooling changes on vehicle range. All aspects which either would take painstaking time to run through various specialist simulation packages or require physical prototyping and testing.

Whole ranges of design specifications and permutations can be simulated at the push of a button, enabling the engineer to see the ramifications of design changes at a vastly quicker rate than with traditional targeted simulation tools. Individual component bench test simulations can be conducted alongside full vehicle testing. The unknown can be rapidly mapped by considering an extremely large number of permutations quickly.

Closing remarks

Being able to understand, map out the unknown and answer "what if" questions, is the advantage of using a simulation package such as VeSyMA. Ideas are liberated from the constraints of what can be tested and quantified in the physical world.



Theodor Ensbury, Project Engineer – www.claytex.com **-** Originally from the UK, a passion for motorsport and a keen interest in vehicle simulation at university saw Theodor start work at Claytex in 2015 after graduating from Oxford Brookes University with a master's degree in Motorsport Engineering. In 2018, he relocated to Michigan in the USA, continuing in Claytex's efforts supporting OEMs adapt to impeding electrification by applying motorsport derived simulations tools.

Smart infrastructure brings new hope for green-ambitious cities

During the last few years, micromobility has seen a major surge in popularity, resulting in long waiting lists for bicycles, both regular and electric; and a heightened sense of sustainable green solutions across the world.

FOR THE TREND to keep rising, support from all parties: the people, their representatives in politics, companies and other policy makers needs to keep to all time high. The USA started approving the Biden Infrastructure Bill, Vancouver has an ambitious plan in reducing transport pollution by 25% by 2040, Paris has transformed the city with its groundbreaking green policy, Spain has approved 3 billion of Spain's Recovery Plan allocating 5 million solely to cycling. Many other cities are taking major steps to create new urban environments with less congestion, safer and more livable cities.

This is what Urban Racks has taken to their heart by laying down sustainable infrastructure in Vancouver, where Bikeep bicycle parking lockers and racks have been set up to provide secure and smart bike parking to all residents and visitors alike. Vancouver being widely known for its green and sustainable goals, which date back to the 1950s, when urban planning strategy included preserving green spaces, is the perfect place to start. Still, according to Deloitte, as little as 3% of trips are taken by a bicycle. Urban Racks CEO Kosta ChatziSpiros sees this as a transformative era. "Micromobility is taking the protagonist spot in discussions over sustainable transportation, effective and green urban planning and even preventative healthcare. We have a possibility to change how we live, work and play in urban areas. By far the most effective way is to start rethinking the commute in our everyday trips."

Relying on cars in urban surroundings has brought environmental, safety, mental health and obesity issues forcing people to search for more livable environments outside the cities all over the world. Cycling has a profound impact on transforming cities to more enjoyable environments for everyone. By providing a cardiovascular workout, enhancing mental wellbeing, reducing congestion, fatal traffic accidents and accessibility.

Changed working habits in the "new normal" era
In the US, the pandemic brought a lot of unexpected changes in the public transportation as many subways closed or went on a different schedule, leaving many to rely solely on themselves. Now companies are struggling to lure employees back to the office, especially with the disappointments of the everyday commute. What many have discovered is that offering flexible hours and commodities like secure bike parking on their estate adds a lot of value to the workplace.

This is what Boston Properties excels at by offering secure and smart bike parking in Reston Town Center, they welcome bicyclists to their properties and showcase adapting with new circumstances with innovation and care.

Another great example of changed transportation is the parking operator's collaboration with bike parking provider Bikeep. Colonial Parking in Washington DC is the biggest car parking company in the region. With their slogan "We Park cars" it is highly significant to acknowledge their aspirations to park bicycles and other micromobility vehicles as well. From this summer, the company provides secure smart bike and scooter parking and charging

stations in all their locations. Bikeep CEO Kristjan Lind adds: "The most effective method tackling the transportation challenges will be multimodal transportation, meaning the commuter switches to most suitable vehicles or modes during their trip. Starting with transit stations makes the largest and fastest impact, improving people's lives. In France, there are now requirements by 2024 that parking for bicycles would be built as the transit station needs to provide possibilities for cyclists. This has also proven to work very well in the cycling capital of the world – the Netherlands, where the country's infrastructure is laid out considering this method."

"Better land use, livable cities, environmentally friendly approach all contribute to a higher goal – becoming a sustainable city. It all starts with a serving goal, a wish for a change. I feel we will accomplish this by laying out the infrastructure for cycling and make a significant change in how we develop our cities," ChatziSpiros adds.

ABOUT BIKEEP

➤ Bikeep is an award-winning global micromobility enabler. The company provides e-bike charging stations and secure bike parking facilities globally - operating in 21 different countries. Its technology has been used in various projects to help improve and increase bike use through sustainable infrastructure and micromobility platform.

Putting the driver at the center of the transport industry, one mile at a time

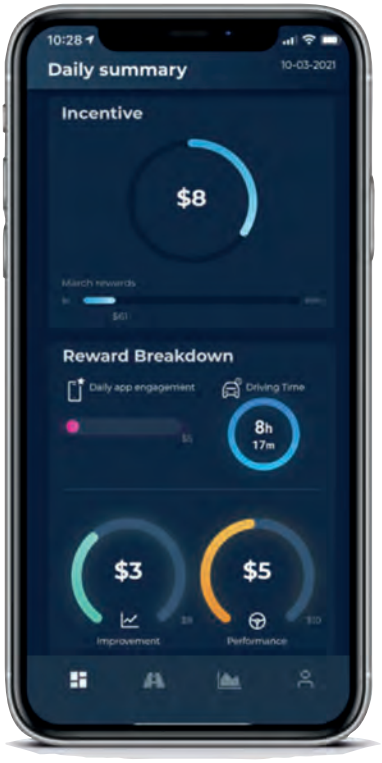
Drivers are the most common profession globally, and yet they are also the most underserved segment you can find, with no real solution serving them on and off the road. On the other hand, fleets are experiencing a crisis, with a record driver shortage of more than 100,000 empty driving seats. These transportation companies are battling a limited labor pool with no ways to access talent, hiring and retaining drivers and are being pushed to edge scrambling for ways survive with low margins.

DRIVERZ OFFERS a Driver-Success platform, helping drivers achieve success metrics, producing profitable fleets. It is allowing fleets to have the access to talent they are thriving for, and helping the drivers get everything the need, on and off the road.

The Driverz app is a one stop shop for fleets and drivers, forming a marketplace for successful and profitable drivers, along with the fleets that want to have them. They aim to dominate the entire marketplace.

Supply Shortage

Over the past 15 years, the driver's shortage has worsened. Currently, there are 100,000 empty driver seats that need to be filled in the U.S. to go along with a 90% driver turnover rate. The problem is so deep that fleets have begun bringing in drivers from overseas.
Studies show that the total cost of ownership (TCO) is highly correlated to driver behavior. The average driver behavior contributes to 20% of the TCO and it can reach up to 35%-40% for the below average driver. Add the driver's recruiting cost which rates at $18K-$20K per driver, due to the high turnover, it sums up for annual driver behavior cost of $20k-$30K per driver.



With solutions to help optimize the vehicle and the fleets management, Driverz app focus is to optimize the driver. The Driverz AI-powered proprietary algorithms create personalized incentive models and insights to drivers, giving them the tools to be the best driver they can be and recognition that increases driver retention.

The Driverz engagement platform, decreases fuel consumption by over 5% leading every fleet to save millions, decreases preventable road accidents by 30% and increase the driver-retention by 25%!

The power of community

The professional driver is no stranger

to alone time, in fact, the profession demands it. The typical driver spends weeks alone on the road, driving miles upon miles to his or her destination and back. However, no longer does the trucker have to go at it alone. The Driverz app gives back to the drivers by creating a community of drivers from all over, supplying the driver with a niche community of people that are going through similar challenges and experiences. Drivers from can now communicate with one another, support each other and give way to a whole new driving experience. By utilizing the power of community, we are connecting drivers to share experiences, meet up along the way, share professional tips and benefit from a marketplace the meets all their needs.

End-to-End Value, for drivers and fleets

The Driverz app and community supports the driver across many points of contact in their professional and personal life.

Driverz app is helping drivers in CDL schools, training them to become the best truckers they can be, to find their first jobs, getting more compensations based on their success and high performances and more importantly-work in a positive and fulfilling work environment that empowers drivers. In addition, joining the Driverz community unlocks new career opportunities for drivers, along with groups to share knowledge or just to socialize, a new way to be on the road.

Fleets earn more access to talent, which they can't get elsewhere. They get to hire the best-in-class drivers, engage them positively to achieve tremendous retention rates, and lead them to new success metrics of safety, efficiency, and productivity.

The platform is fun for drivers and gives managers a simple integration process not having to do anything but set the success metrics giving them engaged drivers.

Drivers in the Data Era

The wide deployment of telematics and dashcams, helps fleets managers gain good visibility and discover new cost savings opportunities. After consolidating planning optimization (routing, empty miles, maintenance) at a good standard, fleets are shifting the focus to the critical part, the human factor. Although managers have a handful of dashboards and monitoring platforms, they have no time, or capabilities to dig into the data to attain actionable insights.

Even though it's true that drivers are made, not born, it can be perceived as naive to assume that poor driver behavior and risky driving patterns arising because of lack of experience. The truth is that drivers just don't have the interest, incentive or discipline to drive safely and economically.
We know that punishment is not the right approach, but what about rewards?

The platform is fun for drivers and gives managers a simple integration process not having to do anything but set the success metrics giving them engaged drivers

Drivers Know How to Drive, The Driverz app Makes the Magic Happen

The Driverz app empowers drivers to improve their driving behavior without the intervention of a fleet manager.

Using the Driverz app, drivers are being rewarded daily bonuses based on their improved driving habits, combining several parameters- safety, efficiency, texting, fatigue and more. For the first time, the Driverz app, is aligning the fleets goals with the drivers' goals, creating a win-win situation. Driverz technology combines state-of-the-art AI with proprietary Behavioral Economics models which profiles drivers for accurate assessment of the most effective feedback, personalized incentive, and positive user interaction and engagement.

Smart incentive algorithms determine the optimal cost-effective monetary and non-monetary incentive for a given driver at any given time. Rewards are not a new tool, fleets are already using scorecards and bonuses to reward drivers but without understanding how to do to it right, they are wasting money with no results.

With great science behind their technology and an excellent engineering team, Driverz decodes the way to generate a behavioral modification engine.
For instance, competition, which seems as a useful tool, mostly affects 10% of participants, the rest drop from the race. Likewise, score-based rewards benefit the best drivers, leaving the rest of the group behind, not taking into account their improvement.

Fleet Manager Can Work Smarter Not Harder Using A New Approach

At the end of each driving day, drivers receive their daily rewards, trip history, feedback, and insights to learn how they can gain more incentives and improve their next trip. Each driver receives personalized bonuses and insight based on their daily improvement. The off-driving engagement attitude differentiates the system as proactive vs. reactive sensors. While live feedback can only nudge the driver from doing an action that has already taken place, the Driverz app changes the driver's mindset in advance and prevents dangerous situations from happening.

With no need for hardware, the implementation is seamless and easy for fleet managers and user-friendly for drivers. The platform aggregates multi-sourced data from existing devices in the vehicles to create a comprehensive context of the trip, including normalizing routes, weather, and traffic which increase the driver's trustworthiness in the system.

All fleet managers have to do, is set up their fleet goals and start tracking the ROI, receive actionable insights and see the trends in their fleet. In addition, with a new set of features, SafeModes Driverz app will release soon, it will also offer managers a way to automate the personal interactions with drivers, identifying when and where the manager needs to put his attention. For best-in-class fleet managers, it's no secret, engaged drivers means reliable operations and a successful business

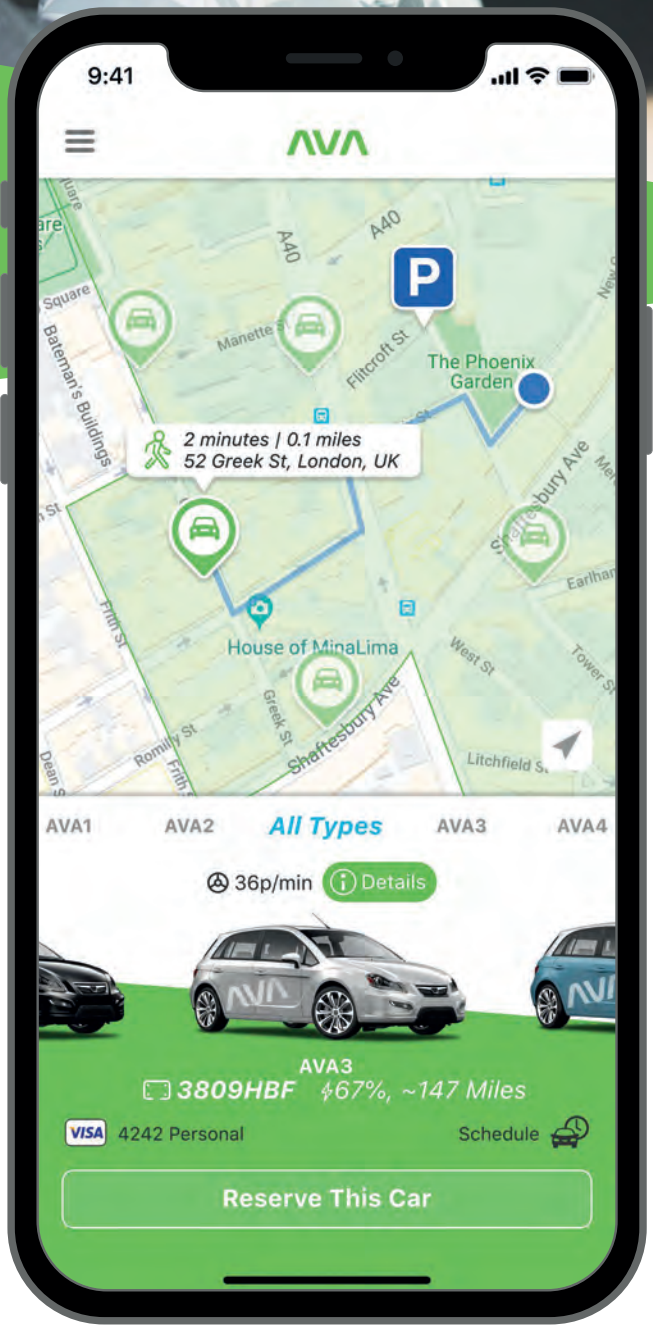
Driverz by SafeMode is the first Driver-Success platform transforming the transportation industry- putting the driver in the center of the industry, one mile at a time. The company was founded by industry experts and serial entrepreneurs including two professors specializing in AI and Behavioral Economics. The company is growing rapidly towards its goal to build a marketplace for fleets and drivers, where both can find talent, enhance driver performances, help drivers network and socialize on and off the road, and much more.

The company is operating in several markets, including the US and Israel, selling its software for fleets and also partnering with insurance companies and several OEMs.

Safemode.co

RIDECELL

Launch and manage mobility services —profitably



Deliver amazing experiences while better utilizing your fleet

Ridecell can help you to create a full range of monetization options with your vehicle fleet—from offering shared mobility offerings such as carsharing and ridehailing, to the ability to offer customers complete vehicle packages by the week and month. And we also help you to intelligently manage your fleet and optimize your services as they grow.

We are proud to be the technology partner to some of the most innovative mobility services in the world. Discover how we can help you.

www.ridecell.com

Can electric vans keep up with the pressuring demands of online shopping?

The courier sector is currently experiencing two major consumer demands – an ever-increasing expectation for rapid delivery times, and a growing concern for greener methods

BALANCING THESE TWO REQUIREMENTS has been difficult, and the recent pandemic has only amplified the pressure, with more parcels and packages heading out onto the roads than ever before. Couriers are ramping up their fleet numbers with van leasing and sending out more drivers to meet this surging demand.

In terms of bringing couriers onto a greener road, electric vehicles are often touted as the way forward. But are electric fleets ready to keep up with current demands?

The demand for doorstep deliveries

Even before the pandemic, shipping levels were increasing year on year. According to the Pitney Bowes 2019 Parcel Shipping Index, global parcel shipping surpassed a staggering 100 billion in volume for the first time that year. The same report predicted that parcel volumes would double by 2026 to reach 220–262 billion – and that was before the pandemic accelerated customer demand for home deliveries across the board.

With so many more parcels being posted and

many UK shoppers expecting orders placed before 4:43pm to be delivered the next day, couriers are having to work harder than ever before. It's vital that their vehicles can keep up. So, how do the fleets of the biggest UK couriers shape up in the modern day?

A slow transformation

The top five most popular UK couriers are:

- Royal Mail (52.7%)
- Hermes (16.1%)
- DPD Group (14.2%)
- Parcelforce (4.7%)
- DHL (4.1%)

The Royal Mail operates 41,000 delivery and collection vans, alongside an additional 10,000 vehicles such as lorries and heavy goods vehicles. Currently, the firm's massive fleet contains just 300 electric vehicles, though it plans to add another 3,000. This would take the percentage of its fleet running on electricity from just 0.58% to 6.47%. DPD shows a slightly stronger input, with a recent order of 750 more electric vehicles bringing its total to 1,700 within its fleet of over 10,000 vehicles. This would increase its percentage of electric vehicles from around 9.5% to roughly 17%.

It's clear that the bigger couriers have some faith in electric vehicles as a means to bring their processes in line with a green world, but what is holding them back from making a bigger conversion to an all-electric fleet?

Range has improved – so what's the problem? Often, when the issue of electric vehicles is raised, the discussion turns to their range. It has been something of a concern for many years, but in truth, electric vehicles have seen substantial improvements to their range. In fact, the average electric range for Auto Express' best electric vans in 2021 clocks in at 121.64 miles.

If we compare that to the Department for Transport's latest figures – that light commercial vehicles such as delivery vans travel 12,811 miles per year on average – across 261 working days in a year, that would mean the average light commercial vehicle driver travelled 49 miles on average per day. For a standard delivery driver, an EV would certainly stand up to the challenge.

But for delivery drivers on long-haul routes up and down the country, 100 miles or so before needing a top-up charge just isn't feasible. While topping up with petrol takes a few minutes, even rapid-charge options tend to sit at around 45 minutes for 80% capacity. A fully charged battery, on the other hand, can need five and a half hours or more.

With the courier sector experiencing such a surge in parcels going through the system, drivers clocking off their shift and handing the keys over to the next shift for back-to-back deliveries will not have time to plug the vehicle in for a five-and-a-half-hour recharge. Compared to a quick stop at the petrol station, electric vehicles still have a challenge to overcome if they are to keep up with the pressures of online shopping deliveries – refuel time.

There's no doubt that electric vehicles will become a dominant presence on roads in the coming years. However, until the last few hurdles are overcome, we may not see a fully electric courier service that can flourish under the heavy pressure of online shopping demands.

FURTHER READING

- https://www.pitneybowes.com/us/shipping-index.html
- https://www.statista.com/statistics/1069943/uk-most-preferred-parcel-delivery-providers/
- https://www.edie.net/news/6/Royal-Mail-aims-to-grow-EV-fleet-ten-times-over--as-DPD-orders-750-electric-vans/
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- https://www.sendcloud.co.uk/ecommerce-statistics/

The business of mobility: Living mobility

The world is at an exciting tipping point in mobility, as we make the leap to autonomous, connected, electric, and shared mobility; expressed in the acronym 'ACES', or 'CASE'. This vision of the future is well accepted with the biggest debate seemingly about how to define "S" in the acronym.

BY PATRICK AYAD, GLOBAL LEADER MOBILITY AND TRANSPORTATION AT HOGAN LOVELLS AND LANCE BULTENA, DIRECTOR OF THOUGHT LEADERSHIP MOBILITY AND TRANSPORTATION AT HOGAN LOVELLS

The challenge of ACES

"Shared" is the original and most common conception but some use "Smart mobility" or "System integration." In any event, vision of the future is quite consistent and the argument for ACES is compelling. Each aspect of this vision will require adaptation and some challenges but also yield benefits. For example, autonomous vehicles should be much safer than human drivers, allow cheaper transportation, and create new business models while revising existing business structures. According to SAFE, an organization Lance is affiliated with, AVs will deliver US$3 - US6$ trillion of consumer and societal benefits.

The ACES future is not something a few are merely talking about as there has been a significant investment by many in creating that future with a similar focus by policymakers on a global basis. One can perhaps best see this dynamic in the area

of electric vehicles. Concerns about global climate change have led policymakers all over the world to pull industry toward electric vehicles.

Existing manufactures and new entrants have invested heavily in the development of EVs. Policy and investment are important necessary steps in the transition to electric mobility but the next step, and the most significant, is consumer acceptance. Globally about 3 percent of vehicles sold are fully battery electric. Some jurisdictions intend to ban internal combustion engines by 2035. While that sounds like a long way off transitioning a global industry completely in a bit more than a decade is an amazing task that will impact far more than just auto manufacturers – it will change the supply chain, require new battery advancements and production on a massive scale, and change many small businesses – for example, petrol stations and car repair.

Such significant transformations inevitably involve government policy in many ways. When looking at the policy environment, one has to take account of all levels of government, not merely at what is done at the national level. Cities are often ignored by too many when contemplating the mobility future. When one changes how people move, one changes society and the communities where they live and work. The city is "on the ground floor" of those changes.

Others take this view and focus almost exclusively on cities as the level of government responsible for the mobility revolution through the changes in zoning and the impacts on demand for real estate. But the technology is global and the investments so significant that global scale is needed for appropriate returns. Cities cannot alone set standards for such complex and transformative technologies or handle significant infrastructure changes likes updating electrical grids.

Ultimately, it is important to recognize that transformations of this magnitude will have many stakeholders within the governmental sphere, and all will have to play their role during this transformation.

The importance of trust

So often when discussing the mobility future, one hears much about technology and government standards and some about workers and jobs but relatively little about consumers. We, however, see the consumers as the critical element as they are the intended beneficiaries of these services. They will value these services and pay for them, or they will fail no matter how splendid the technology or how thorough the governmental procedures. The primacy of the consumer means the transition to a mobility future that is autonomous, connected, electric, and shared, will be founded on trust.

Consumers will need to trust the technology, the companies that developed it and those that provide related services. Consumers will need to trust the governments that regulate that technology and its application. Transparency will be key in winning over consumers. For example, if we're to have connected mobility, consumers need to trust that their data will be used fairly. For autonomous mobility they need to trust the technology and the safety standards.

Particularly in the West, and increasingly in all parts of the world, mobility has been tied to personal choice and expression; buying a car is a potent act of individualism. That means new products and services not only need to meet consumers physical needs for transportation they also need to capture their imagination. Consumer demands and tastes will determine how the new mobility revolution unfolds.

The Living Mobility solution

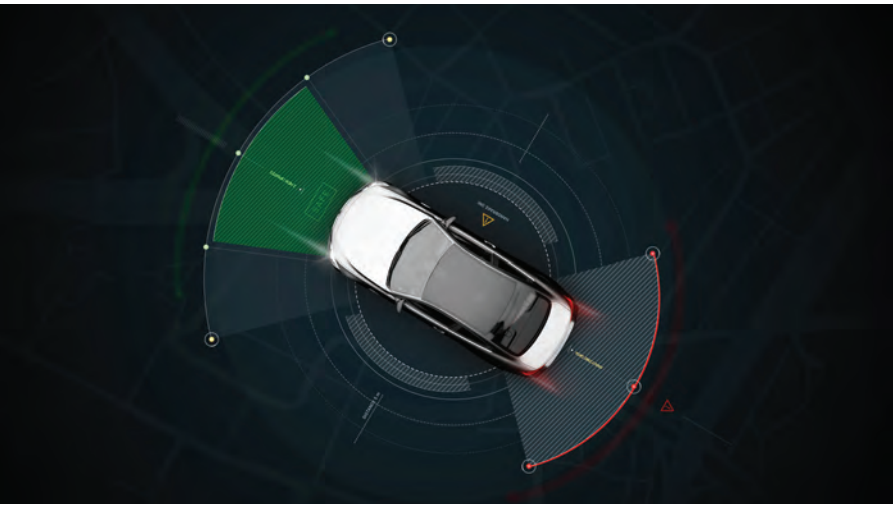
As the transition to ACES will not only be about how we move but also how we live we developed the concept of 'Living Mobility', in an attempt to give ACES a more holistic vision and a human touch focused on the consumer. We mapped the four core elements of ACES as focused on vehicles to a set of more general concepts that in total we call Living Mobility. Autonomous – Objective, Connected – Inclusive, Electric – Sustainable, Shared – Unifying. We use this framing because the magnitude of the mobility revolution goes so much further than changes to various types of vehicles.

AVs don't have emotions

We paired 'Objective' with 'Autonomous' because AVs are made to be objectively safe and efficient. There is no emotion or personal preference in the way a computer drives a car, and thus autonomous driving will reduce accidents to near-zero while generating extraordinary efficiency gains for society. Mobility stakeholders should keep this in mind and ask how their decisions will objectively benefit society. If AVs are going to become everyday reality, then we will need an objective approach to ethics and be prepared to make tough choices. For example, if AVs can indeed reduce accidents by 90 percent, then legislation should be pragmatic about manufacturer liability. We have to recognize that if one defines "safe" as meaning absolutely perfect in every conceivable context for all time so there is not risk in the transportation system then that standard is a false and unattainable goal. Using it suggests a comfort with the over 1.3 million deaths each year globally from traffic accidents and a virtually countless number of other injuries that do not result in death. In some sense, being objective requires policymakers to weigh relative benefits and risks, not merely hold onto past biases.

Safe, affordable transport for all

We paired 'Inclusive' with 'Connected' to make the point that all vehicles should be included in a network and all people should be included in societal benefits like mobility. ACES will provide an opportunity to greatly improve mobility access for marginalized communities. There are various reasons why people cannot access safe, affordable transport: poverty, geography, disability, and the lack of public transport options are all challenges. The promise of ACES is that AVs can transport the aged, the young, those with visual impairments, and potentially do so a lower cost. Significant transformations occur when better results are achieved at lower costs. The potential for public good is exciting.



Contributing to economic and social development ESG investing is as hot a topic as one can find in the business world. Concerns about global climate change have led to a focus on electric vehicles for the last few years. But 'Sustainable' in the mobility future extends beyond the transformative shift from internal combustion engines to EVs. Sustainability reflects the focus on reducing carbon emissions throughout the transportation system not just on having no emissions from the "tailpipe." We see much discussion about the supply chain for batteries with concerns about how critical raw materials are sourced and the nature of the labour used and the environmental profile of the mining activities. Other common topics are how batteries are used after their useful life in the transportation sector ends and then finally how they are recycled. There is much focus "upstream" on how the electricity is produced that will fuel these vehicles (and the rest of the grid uses). Sustainability captures all of these concerns.

Breaking down silos is key

We think 'Unifying' better describes the mobility future than 'Shared' because mobility in the future will move several possible modes of transportation to better connect people, places, and cargo. Thinking in silos about one form of transportation does not truly capture the revolution taking place. The routing programs widely available on mobile phones now routinely include different transportation options with more services added regularly.

One of those mobility options is e-scooters. Before the pandemic, Patrick travelled to Paris, London, and Berlin, all in the same week. He tried out the e-scooters in each city but was somewhat confounded by the different rules and systems. His experience captures another aspect of 'unifying' – rules and methods will likely standardize as systems evolve. We know how remarkably universal it is to operate a car (except for different conventions about driving on the left or right) the rules and conventions are remarkably standard on different continents.

There is no reason why new mobility cannot also adopt universally accepted protocols. We're seeing large global companies investing heavily in micromobility and MaaS – not to mention AVs and EVs. To best optimize design, maintenance practices and meet consumer expectations, standard approaches will need to develop. Those standards

should both foster efficiency in service provision, develop trust in consumers, and enhance safety as users of e-scooters and others sharing the roads and sidewalks will have established expectations for behaviour.

When technology and investments are global in scale the need for standards is critical. There have been some positive developments in setting industry standards for different types of new mobility. The Society of Automotive Engineers (SAE) has developed levels (0-5) of autonomous driving; and they recently published standards for micro-mobility too. SAFE (Securing America's Future Energy), an organization Lance is affiliated with, recognizes the need for common elements of public policy on a global scale so it launched The Commission on the Future of Mobility, which includes CEOs of global companies (including Transdev) and former European commissioners. We expect efforts like this will help refine the critical issues that need to be addressed, provide useful research and analysis, and hopefully stimulate productive conversations about policy in major markets. Another positive development is the Mobility Data Specification (MDS), a protocol that standardizes data-sharing and communication between cities and mobility operators. Industry-first initiatives like these are crucially important in building trust, enhancing collaboration and aligning business incentives to the benefit of citizens, and customers.

In all these efforts the key is to think broadly, carefully, and from the orientation of what is best for the consumer and the public more generally. With that context more defined, we have no doubt business will find creative and efficient routes to meeting our collective needs in new and fascinating ways.

The road ahead

Almost everyone now believes a transportation revolution is taking place. Not so long ago many had their doubts. Transformation is never easy. While the technology is changing fast it still has a way to go – in making driver assistance systems more robust and in making batteries cheaper, faster to charge, and more durable. Business models will need to evolve and in some cases the workforce will shift. Changing government rules is also a real challenge and critical to the success of this transformation. Throughout all these changes, the focus will need to be on the consumer.

Nobody can forecast exactly how these transformations will take place, but we are very optimistic that the outcome will be a better world for all of us. Whatever the technological and political developments, we will continue to promote mobility that is Objective, Inclusive, Sustainable, and Unifying.

Patrick Ayad
Global Leader Mobility and Transportation
Hogan Lovells

Patrick Ayad leads the global sector group Mobility and Transportation at Hogan Lovells and is also head of the firm's global Strategic Operations, Agreements and Regulation (SOAR) practice area.

He is a leading global practitioner in the areas of international commercial contracts, global procurement and distribution law, as well as an experienced regulatory advisor. With more than 15 years of experience, Patrick brings considerable knowledge on both commercial and regulatory matters in all areas relating to the future of Mobility, including Automotive, Transport and Logistics as well as Aerospace and Defence.

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Lance D. Bultena
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Hogan Lovells

Lance Bultena is our Director of Thought Leadership Mobility and Transportation and is in our Washington, D.C. office. He has been deeply involved in every major regulatory and legislative issue in the U.S. automotive sector since 1995 and routinely discusses issues in this area with business executives and senior government policymakers.

Lance improves client's business outcomes by helping them to understand the regulatory and public policy environment in order to stay ahead of developments in all areas relating to the future of Mobility, including Automotive, Transport and Logistics.

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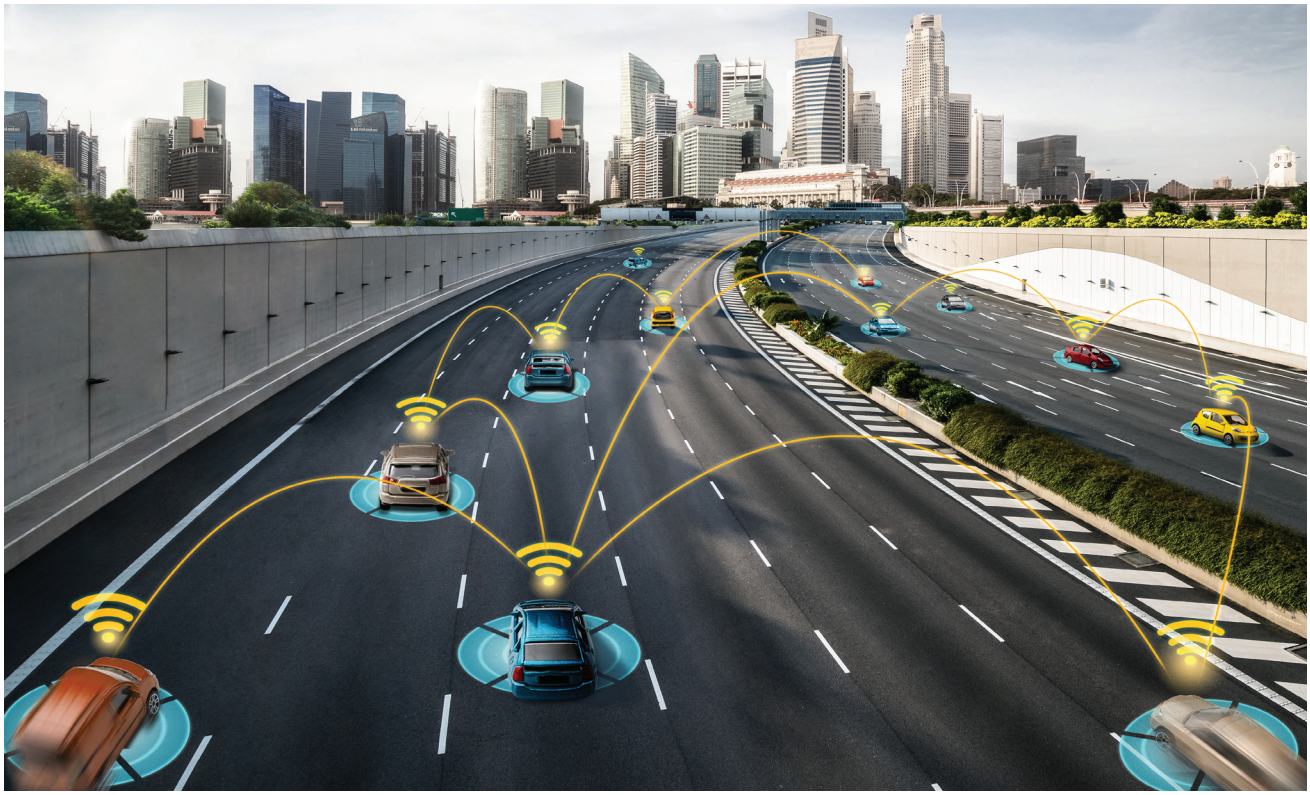

Why connected and autonomous vehicles need self-driving WAN acceleration

Self-driving cars still have a long way to go before they become commonplace on public roads around the world. However, in the meantime all kinds of businesses are having to adapt to using artificial intelligence.

BY DAVID TROSSELL, CEO, BRIDGEWORKS

"WHILE SELF-DRIVING CARS still have some way to go, AI is already having a significant impact on the way IT runs enterprises. Businesses are making the transition from being automated to autonomous, where machine learning and AI make it possible to create a 'self-driving' wide area network (WAN)."

With the Oxbotica consortium predicting that Connected and Autonomous Vehicles (CAVs) will produce 1.2TB of data during a 16 hour period, and with the 70 million vehicles expected on the market by 2027, at least 74 Zettabytes of data is going to be created by CAVs every day. A bit wild, and the majority of us only use our cars for 3-4 hours a day.

The connected vehicle services, including vehicle-to-everything (V2X), which include connectivity with road infrastructure, will be data hungry.

Adam Frost, writing for Traffic Technology on 2nd March 2020, says in his article 'OpenRoaming platform to focus on CAV data challenge': "UK-based autonomous vehicle (AV) software developer Oxbotica has partnered with American networking technology multinational Cisco Systems Inc. to demonstrate how OpenRoaming can unlock the potential of fully-connected AV fleets, enabling the seamless and secure sharing of high-volume data while on the move."

This information derived from the vehicle sensors, between other vehicles (V2V), V2X generally, and from the sensors of each individual vehicle navigate each obstacle and pathway, maintaining lane discipline and distance between each vehicle. As well as imaging from onboard cameras, and the corresponding artificial intelligence (AI) responses, enables the vehicles to safely operate in connected, semi-autonomous, and will eventually permit, fully autonomous mode.

The British Standards Institute (BSI) writes: "The data that CAVs capture, store and share will play a critical role in the testing and deployment of Connected and Autonomous Vehicles and CAV services, thereby optimising vehicle and network performance, user experience and improving safety. However, there are concerns regarding the reliability, availability and security of the data that may pose a barrier to both CAV development and public acceptance."

Vehicle data and connectivity

Vehicle data and connectivity are incredibly invaluable to the vehicle manufacturers, allowing them to also improve the construction of these vehicles, and by using big data analysis they can create new services to aid the vehicles, their drivers and passengers. Without AI, autonomous vehicles can't and won't exist. That said, the current use of AI in the IT sector is mostly around the removal of humans in the call handling functions. There are a few other uses, but call robots and chatbots seem to be one the key usages at the moment. The prospect of developing CAVs nevertheless offers greater challenges, and wider opportunities.

So, how can players within the CAV ecosystem – including OEMs, the vehicle manufacturers - move this vast amount of data? If we think 4G and 5G are going to provide this conduit back to the manufacturers as well as everyone using it for videos, Facebook and gaming etc, the over-the-air transmission and backhaul bandwidth is not going to cope. This is somewhat the conclusion of the Oxbotica, which is involved with with several consortia – not just OpenRoaming but also DRIVEN. It's an issue its partners are trying to resolve.

Wi-Fi 6 with 5G

The light on the horizon is likely to be the next generation of Wi-Fi standards. With the roll-out of more and more fibre being delivered to the premise, and Wi-Fi 6 with 5G could be the start of a solution not only to download the bulk data at convenient stopping points such a traffic light and or fuel stations. Whilst on the move data transfers can be handled by 5G.

This will include the existing goal of vehicles communicating with each other within a small geographical area – in a grid structure. So, on top of everything else, security is going to be a major factor with the connected vehicle. There will have hardened security for these vehicles, and yet it will require a system of logging on the Wi-Fi networks globally. This could be known as a 'self-driving' network – creating the question of whether SD-WANs adequately fit this description, and serve this purpose.

SD-WANs: Self-driving?

Well, there is some movement on the SD-WAN front to drop AI into the products to help with managing traffic flow, but I don't think they are self-driving at the moment. Smart SD-WANs should be able to learn from the data flows in terms of destination flow patterns, time of transfers, smart capacity management, and without manually setting policies. So, I would not use SD-WANs for applications such as Transport-as-a-Service (TaaS). SD-WANs are not relevant to CAVs be they are a straight internet play.

WAN Acceleration offers better prospects for enabling a self-driving network. It encompasses AI to maintain the optimum performance at all times. It does so by understanding the way data flows across the network, which is usually a wide area network (WAN). It looks for solutions to improve the data flow in a way a racing driver seeks to improve his speed by understanding the feedback from the car, adjusting the inputs to achieve the maximum output.

One solution that can do this is PORTrockIT, which employs a combination of AI, machine learning and data parallelisation to mitigate the effects of latency and packet loss, while increasing the use of the available bandwidth. SD-WANs can be overlayed with it to improve their performance. With WAN Acceleration, vast amounts of data of all types can be securely moved over WANs, across the globe.

While much connected and autonomous vehicle data will often be over-the-air and therefore be transmitted via mobile connectivity, large volumes of data will need to backed up, retrieved, sent and received via other WAN links – including land-based WAN connectivity. SD-WANs can help to resolve network performance issues to a certain extent, but they are reinforced when combined with WAN Acceleration. So, perhaps together, they could play a role in creating a self-driving WAN future for some aspects of the CAV future.

The industry's first IoT automation platform designed specifically for fleet-based businesses

In our new series of Women in Transporation, we sat down with **DIPTII TIIKU, SENIOR DIRECTOR MARKETING, RIDECELL**, to learn more about her dynamic career in transportation and the industry's first IoT Automation platform designed specifically for fleet-based businesses–The Ridecell IoT Automation Platform.

TAAS: How did you get involved in the transportation space?

DT: After spending 15 years in financial services marketing, I decided to pursue a Master's degree in business from the Stanford Graduate School of Business. Going back to a student budget meant I didn't have a car at the time. Luckily, new services like ZipCar, Uber, and Lyft were emerging, which made moving around easier than ever.

The first time I used an app to order a car service, I recognized that this was the start of a massive reinvention of transportation. I thought the rapidly changing MaaS industry would be a great place to apply my skills and knowledge. I love building things from the ground up, and I saw the transportation and fleet businesses as an exciting industry to help reinvent. Around that same time, I met Aarjav Trivedi, who was the founder and CEO of Ridecell. He was a true visionary. His company was built to help usher in this new wave of transportation now and over the next 20 years. Ridecell was the kind of company I wanted to join—one that is innovating in a way that will change how people move and get from place to place. And that's how I got here.

TAAS: What is the most significant opportunity in transportation right now?

DT: The digitization of vehicles is ushering in an entirely new era of managing fleets. Ridecell recently launched our Fleet IoT Automation platform, which allows fleets to transform from traditional data collecting solutions to a platform that turns that data into actionable, automated workflows. This means that we can create a "self-acting" fleet control system that doesn't just report issues from the vehicle but automatically resolves issues--quickly and efficiently, from start to finish. We like to say that knowing what is happening with your fleet is a good thing, but being able to fully automate the response is revolutionary.

TAAS: What are some of the common concerns for fleet owners that you see today?

DT: First, there many connected vehicle and fleet management systems resulting in data spread

everywhere, with little ability to analyze it or use it effectively. With advanced telematics, fleet management software, driver management systems, insurance companies, and maintenance vendors offering data and APIs, the amount of data available to fleet-based businesses is increasing exponentially. And to resolve them requires manual processes, which are often overlooked. The explosive growth of data and insights has resulted in a patchwork of sub-optimal processes and systems that do not scale. It's helpful to have insights into issues with your fleet, but insights don't always lead to resolutions.

This leads to a second concern for fleet owners–the ability to use the data they are collecting in a timely manner to manage business operations efficiently and maximize fleet utilization. A third and growing concern for fleet owners is security and the ability to track vehicles and ensure accounts are up to date.

TAAS: How does Ridecell's Fleet IoT Automation platform address these concerns?

DT: Our solution is the first IoT-driven automation platform designed specifically for fleet-based businesses.

To address the issue of data overload, the ability to connect to multiple fleet and in-house technology solutions was a critical component of our solution. We wanted to create a "single source of truth". The Ridecell Fleet IoT automation platform complements existing fleet management systems and connected vehicle and telematics platforms. It unifies data from these systems and uses the information as triggers to automate tasks.

Next, we wanted to give fleet owners a way to use that data. So we designed a workflow automation engine that gives fleet owners a way to use that data to create automated business rules that prioritize, manage, and resolve alerts and tasks on its own without any manual intervention. For example, if your fleet management solution can alert you to a flat tire for one of your vehicles, that is helpful, but it doesn't solve the problem. With Ridecell's automated workflow capability, the solution can prioritize a flat tire alert, reassign the driver to a new vehicle and provide a key digitally while simultaneously dispatch a repair crew to fix the tire.

With vehicle theft on the rise, Ridecell's solution needed to address security concerns. That's why we offer digital vehicle control that distributes digital keys for vehicle access and a digital immobilizer control that can remotely disable an engine restart for delinquent accounts or stolen vehicles. In addition, the system can easily track the vehicle and even alert local authorities.

Finally, the ability to fully utilize the fleet had to be incorporated into our solution to provide new revenue streams for fleet managers. Our mobility platform with the digital vehicle control we provide allows vehicles to be used during previous off-hours, thereby increasing fleet uptime and utilization.

TAAS: Has the pandemic surfaced any new business opportunities for Ridecell?

DT: Yes, we are seeing new use cases open up, especially on the logistics side. Consider a typical eCommerce company, for example, that manages a large number of fleets. To be cost-effective, those vehicles need to run as much as possible. You may have the best suite of vehicles and the best telematics solutions, but on average, a vehicle must wait at least a full day–sometimes two–to have a puncture repaired in the tire.

While the system may be communicating to the cloud that a tire needs fixing, it still requires a human to review that data and decide how it will be fixed and by whom. One of Ridecell's strongest value propositions is the ability to automate that entire process, which improves vehicle utilization, increases revenue, and decreases costs.

Another logistics issue that seems simple is managing physical keys. Consider a company like Amazon that manages tens of thousands of last-mile logistics vehicles. That inventory has scaled up dramatically in just a few years. It may sound simple, but what do you do with the vehicle's keys? One lost key can mean hundreds of packages not delivered. Ridecell digitizes that entire process, so with our platform, there are no lost keys. Instead, the driver can walk up, touch a card or phone, unlock the truck and go.

TAAS: Is the key for companies to scale fleet optimization?

DT: One thing that we have learned is that the key to running a successful fleet business is to integrate the entire ecosystem. It takes many partners and entities--Tier 1 suppliers, OEMs, telematics providers, cleaning vendors, CRM platforms, insurance providers, etc.-- to make a trip profitable. Digital connections between these systems still don't exist.

The broader goal of fleet optimization has to be ecosystem optimization. Data that lives in silos means that decisions arent made efficiently. So we have to connect data from multiple sources better and then automate that data and orchestrate the solution. The transportation industry is an exciting place to be right now, especially following the lessons learned from the pandemic.

We have a unique opportunity to create fleets and mobility businesses that are not only profitable but they are also sustainable. If we can align the ecosystems and the decisions, we will end up with a solution that moves the world better, is more comfortable, and is sustainable for the future.

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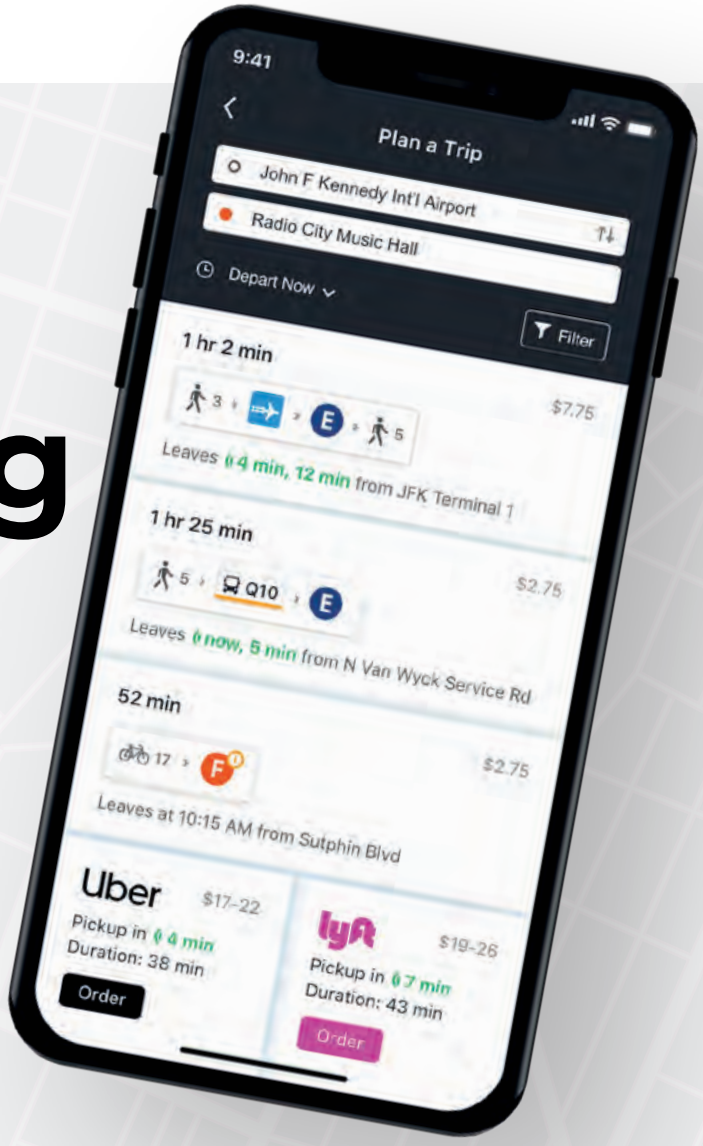

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VCSELs break new ground in LiDAR design

Extending autonomous vehicle applications with improved performance and lower cost

BY SERGEY KOMAROV, BUSINESS DEVELOPMENT ENGINEER, TT ELECTRONICS

A LiDAR system's integrated lasers emit light which is then reflected off objects, returned, recorded, and applied for autonomous vehicle control. While autonomous vehicles and smart city traffic controls demonstrate key arenas for LiDAR applications, the technology is highly applicable in other uses. Robots moving or picking goods in industrial warehouses or unmanned aerial vehicles used for mapping topologies need to move quickly and safely without human intervention; drones used to deliver packages must be able to avoid buildings, people, power lines, and other drones. These systems analyse road condition information in real time, outputting multi-channel data based on the point in travel and target objects in the surrounding environment.

Within all these applications are highly mobile machines. They experience significant vibration and require stable and reliable data communication methods transmitted between the time of flight (TOF) sensor and the computing brain of the LiDAR [typically based on FPGAs and microcontrollers (MCUs)].

While fiber optic communications are extremely popular in fixed applications such as offices, residential buildings, or data centers, they bring some notable limitations and challenges to mobile LiDAR applications due to vibration, mechanical stress, and continuous sensor 360 degrees rotation. In contrast, wireless optical modules, coupled with VCSEL transmitters – or vertical cavity surface-emitting lasers – and high-speed photo detectors, help solve reliable data communication challenges in highly mobile LiDAR applications. Although this approach may be a relatively new concept in LiDAR designs, these types of small and highly reliable VCSEL emitters have been produced and proven in industrial applications for more than 30 years. Originally developed for IBM optical punch-card reading and used to replace their less reliable mechanical counterparts, VCSEL technologies are finding a new home in modern data communication and LiDAR applications.

How it works: VCSELS in action

VCSELs are compact, high powered light-emitting diodes (LEDs) that are designed into a 'pill package,' or small, hermetically-sealed system, that can easily pass received signals to the detecting sensor that is contained in its own pill package. Miniaturisation is critical because the system must be light and energy efficient as well as unobtrusive to the design of the autonomous vehicle or drone. In a VCSEL-based system, data communication moves through an optical air gap (without optical fiber) where an emitter-air-receiver module provides high bandwidth, bidirectional optical data transfer. For high-reliability LiDAR applications, the transmitter/emitter must

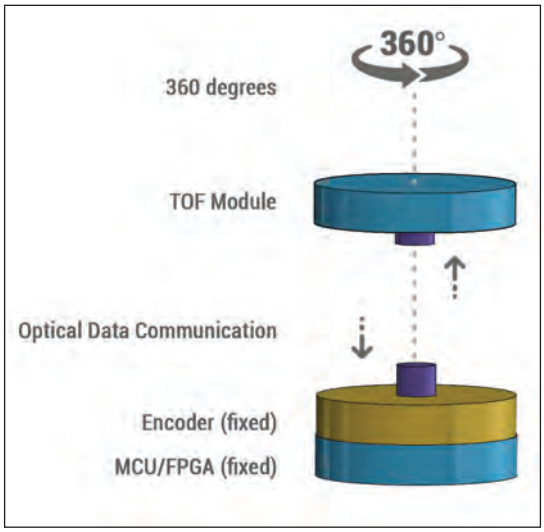
be capable of delivering high data rates of up to 2.5Gbps and more, while receiver data rates must be no less than 100Mbps.

The design allows maximum flexibility via 360-degree rotation of the module, ensuring reliable, undisturbed communication between the sensor and the MCU. VCSELs fuel reliable, flexible design options. VCSEL pill packages are available in ultra-small footprints, just 1.57 mm in diameter and under 3.45 mm in length. The same package is also used to encapsulate a PN silicon photodiode in a small, self-contained footprint ideal for direct mounting to a PC board. These enable linear response to irradiance, fast switching speed with 100ns rise/fall time, narrow receiving angle of 36 degrees, and are spectrally optimised for 850nm light. Additional options integrate a PN silicon photodiode in a T-1 clear epoxy package with 5ns of rise/fall time – these provide even faster switching and linear response but may be a more cost-effective receiver for space-limited LiDAR applications.

VCSELs with microbead lenses are designed for high-speed data communication and offer data rates up to 2.5Gbps, high thermal stability, narrow and concentric beam angle, and are processed with burn-in for a high level of reliability. Those equipped with power monitor diodes offer precise control of optical power, while others utilising flat lenses are designed for air transmission of data. Many of these VCSELs are intended for applications where low current (for long battery life) is required with high on-axis optical power for maximum optical coupling with the receiver.

In other options, VCSELs are offered in dome lens plastic T-1 package. The dome lens design creates a narrow 4 degree beam angle from the device – this benefits long-distance applications as secondary optics can be eliminated, reducing total cost of the system. To ensure optimal performance, the VCSEL must be optically and spectrally compatible with its accompanying phototransistors, photodarlingtons and photodiodes. Photodiodes offer the fastest switching speed, while photodarlingtons provide the highest signal amplification.

Practical vision system design with LiDAR
Optical data communication utilising VCSEL transmitters and photodiode receivers is a design approach superior to fiber optic options in vibration-prone mobile LiDAR applications. VCSEL transmitters offer fast data transfer rates up to 2.5Gbps and beyond, low drive current (for long battery life) with high optical output power, in



a compact package for space-limited applications. Coupled with photodiode receivers, designers have access to fast switching speed with 5ns rise/fall time and linear response spectrally matched to 850nm VCSEL IR emitters. Both VCSEL and their compatible photodiodes are available in hermetically-sealed pill packages optimised for either direct PC board mounting or in low-cost epoxy packages well suited for space-limited LiDAR modules.

Autonomous driving, drone, robotics, and other automated machines represent one of the fastest growing segments of electronics design. Even at this early stage of design and development, LiDAR offers real promise – blending TOF sensors, data communications, and connectivity to deliver a safe, high-performance vision solution in a very small footprint. Robust, yet compact and energy efficient, LiDAR, utilising VCSEL communication portals, is also cost-effective – a crucial factor in EV design and development, and one that is breaking new ground in LIDAR designs.

About the Author
Sergey Komarov is a Business Development Engineer specialising in opto-electronics sensing technologies at TT Electronics' Sensors and Specialist Components business unit. With more than 20 years in technology development and product engineering roles, Sergey guides customers worldwide in selecting and designing-in opto-electronic components and sensors for medical, industrial, consumer electronics and new space (HiRel) applications. Connect with Sergey on LinkedIn or at sergey.komarov@ttelectronics.com

How multimodality can ensure a post COVID urban recovery

There is an inflection point we are about to reach as we slowly emerge from the COVID pandemic. This relates to how our cities are structured, function, and serve society at large. And the key measure for this self reflection on the urban landscape is centered around sustainability.

BY SCOTT SHEPARD, VP GLOBAL PUBLIC SECTOR IOMOB

Sustainability is Key

Sustainability can be considered across multiple dimensions, but the three primary considerations are environmental, social, and economic. Why these questions are becoming positioned at the center of the dialogue on post COVID recovery is due to the critical nature of the pandemic and climate change itself. As we witnessed in 2020, cleaner skies, quieter streets, and safer public spaces led us to challenge our previous assumptions about growth for the sake of growth.

Urban Design Interventions

More specifically, many urban design interventions that were enacted by local and regional governments to promote social distancing and encourage active transportation have had positive results and adoption. What we may like to think of as a grand social experiment in urbanism to ameliorate the effects of homogeneous land use planning and single modality (auto-centrism) has resulted in an entire rethinking of what urban environments we want to live in post COVID.

Public Sector Activism

What is interesting is the activist and champion role that governments and public transport authorities have been playing in the transformation. Prior to the pandemic, we were in the midst of a battle in micromobility versus governments (as well as public transport). This battle pitted rogue operators against municipalities with little to no regulation or oversight. In this vacuum, there was a winner take all approach to how the public right of way was managed and regulated. While we began to see a more positive shift by several operators and governments towards better cooperation prior to the pandemic, it took the crisis to completely upend the mobility sector and force the public sector to think more clearly about policy, regulation, and governance.

Multimodality Delivers Results

Taking this trend a step further, the public sector (in many instances led by public transport authorities and operators) has been forced to rethink

its role in delivering shared mobility to its citizens. Before the pandemic, many operators and agencies viewed private mobility (and other modes) as a competition for ridership. While ridership is one of the more traditional metrics for measuring success in the public transport sector, we are seeing a shift during COVID towards more qualitative measures, such as access and equity. And many of these themes are all interwoven in the overarching theme of achieving sustainability, post pandemic.

However, in order to deliver more qualitative results on the part of the public sector, it is now transforming its approach to operational efficiencies and value to consumers. In short, to remain relevant and emerge as the chosen mode for inhabitants to move about our cities, public transport needs to embrace multimodality.

Policy and Technologies Leads to Paradigm Shift

We are seeing this paradigm shift emerge in a rapid fashion. From multimodal mobility hubs, to MaaS platforms, to DRT feeder services, to digital multimodal solutions, there is an evolution taking place. And this evolution is related to advances in digital infrastructure that reinforce the value of public transport and physical infrastructure to encourage multimodality and sustainable modal shift.

Alignment in Policy, Governance, and Regulation

This alignment between public policy, governance, and regulation is a logical outcome of the multiple crises we are managing (COVID and climate change). And multimodality (led by the public sector and public transport) to align with these pillars will be key to a more sustainable urban recovery, post COVID.

Open MaaS for Multimodality

Iomob has developed an open technology platform for mobility that enables seamless, multimodal travel over an open network with a large number of mobility service providers (MSPs) and active transportation modes. This open architecture empowers public transport authorities (PTAs) and 3rd party MaaS providers to deliver B2C consumer-facing mobility apps to their users. Iomob's project aims to develop a scalable MaaS solution for the Skåne Region in Southern Sweden (MaaS in Skane). This will be accomplished by increased accessibility, reduced environmental impact and congestion, through seamlessly connecting buses, trains, taxi, bicycles, scooters, car sharing etc. in one platform.

ABOUT SCOTT SHEPARD

Professionally trained as an urban planner and designer, Scott Shepard (VP Global Public Sector Iomob) is a digital mobility expert, entrepreneur, startup advisor and thought leader who understands and is passionate about the intersection of cities, movement, and technology.

The project partners and suppliers in the Skane region will leverage Iomob's "Open MaaS" platform to create an open mobility marketplace which can be scaled across territories, and create a convenient and flexible service for consumers. The solution will create changed travel behaviors that will reduce travel by own car, promote CO_2-efficient modes of transport, be commercially viable, facilitate easy introduction of new mobility services, support Agenda 2030, reward travel on foot and bicycle and include public transport, rental bicycles, carsharing etc.

Conclusion

The shared urban mobility landscape was already in a rapid period of disruption and change in 2019–2020 before the COVID 19 crisis. As the world begins to return to normalcy and starts reopening economies, this acceleration of change will only continue. In crisis comes opportunity, and by first ensuring public health to prevent 2nd or 3rd waves of the pandemic, we can encourage passengers back into public transport, prevent a spike in single car usage, and plan ahead for a more environmentally sustainable future.

about Iomob

Iomob, headquartered in Barcelona, is the world's first open marketplace for Mobility-as-a-Service (MaaS), enabling seamless door to door multi-city journeys across a roaming supply network of MSPs delivered via urban shared mobility hubs.

Iomob features a MaaS API / SDK solution which combines proprietary algorithms enabling multimodal combinations of public and private services that allow end users to discover mobility se rvices, receive multimodal combinations for their journeys, book and pay for a range of mobility services via our client's own apps. Iomob powers MaaS solutions for notable global transport clients, including Renfe (Spain), Wellington NZ, and London North Eastern Railway (UK).

Thermal runaway:
The potential of ultrasound

The International Energy Agency has set an ambition for 30% of the world's road fleet to electrify by 2030. This translates to 44 million EVs, a mobility revolution powered by approximately 220 billion lithium-ion battery cells. But like many emergent technologies, there are still problems to solve. Advanced energy scientists at HORIBA MIRA have their focus on one profound challenge – the issue of thermal runaway in vehicle batteries, which can result in catastrophic fire that threatens vehicles, fleets and lives.

BY MICHELE BRAGLIA, ADVANCED ENERGY RESEARCH SCIENTIST, HORIBA MIRA

HORIBA MIRA's Michele Braglia believes that the subject demands focus for a number of reasons. The most pressing factor is the increasing energy density in average EV battery packs that is likely to give rise to global safety mandates being imposed on vehicle manufacturers. While catastrophic thermal runaway is rare, news reports of EV fires do have a disproportionate impact on the brand integrity of vehicle manufacturers and add another psychological adoption barrier for consumers alongside range anxiety and charging time.

What is thermal runaway?

Thermal runaway occurs when the thermal stability limit of the chemistry within a cell is exceeded and it releases its inner energy rapidly. As temperatures reach 100-1200C, the separator between the anode and cathode melts causing internal short circuit and the cell starts self-heating. Once it reaches 160-1800C, the cathode becomes thermally unstable and releases oxygen. With heat, combustible material and oxygen, all of the ingredients are in place for the cell to irreversibly enter thermal runaway and

combust. There are many reasons why the thermal stability limit might be exceeded, such as internal defects during manufacture; the cell being stored or operated outside of the safe temperature or voltage range, overcharging etc; ageing altering the cell's safe operational window; or mechanical damage caused by accidents, for example. Currently, cells and battery pack sensors cannot detect these internal localised states, allowing failures to remain undetected.

The risks

As battery packs increase their energy content to overcome vehicle range issues, the risk of thermal runaway scales. It only takes one cell to enter runaway and the failure can quickly propagate across hundreds or perhaps thousands of adjacent cells. And for fleet vehicles such as electric buses that are often parked in close proximity, a solitary cell failure can propagate across an entire vehicle fleet.

Anticipated new standards

While there are national and international standards for cell and battery pack testing, thermal runaway testing and propagation is not currently the subject of specific regulation. However, mandate discussions are underway in Europe and the USA, with China the first country to implement regulations that came into force on 1 January 2021. These mandates require that if a cell enters thermal runaway, no fire or explosion should penetrate the vehicle cabin for at least five minutes, and a warning should be issued immediately to enable occupants to escape. It is anticipated that similar rules will be adopted internationally.

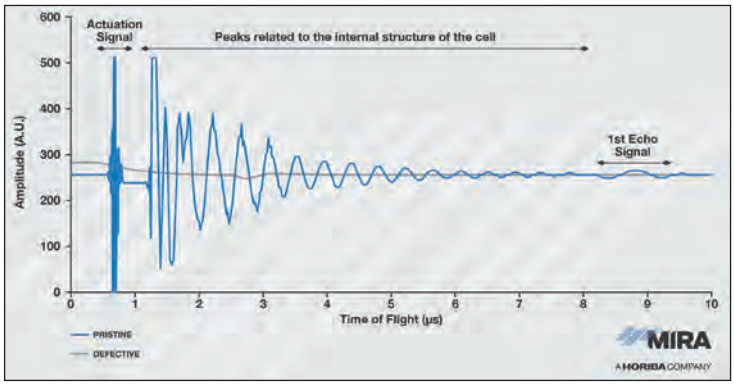
Detecting the threat

Solutions to detect and pre-empt thermal runaway are under-developed. Trial and error approaches are impractical, costly and not sustainable. Together with the European Automobile Manufacturers Association (ACEA) and University College of London (UCL), HORIBA MIRA has explored ultrasound as a novel technique for detecting triggers that lead to thermal runaway.

Traditionally used in medical diagnostics and providing the technical foundation of SONAR, ultrasound uses sound wave frequencies of >20kHz to provide a rapid, cost-effective and non-invasive way of analysing the internal state of a cell.

What ultrasound undercovers

HORIBA MIRA's approach applied acoustic transducers to cells to generate an ultrasonic pulse of sound. This pulse travels through the



cell, changing speed and amplitude as the wave encounters the interfaces between the different material that makes up the cell structure until an echo peak is generated, identifying the external case of the cell. If this is absent, it indicates one or more gaps in the cell structure, and therefore a defect. By mapping ultrasound testing against tomographic analysis of defective battery cells, the fidelity of acoustic analysis is very high, identifying even the smallest structural defects.

HORIBA MIRA also uncovered the capacity for ultrasound to provide an essential early warning of thermal runaway, meeting the requirements of impending legislation. During experimentation using a four cell module, a characteristic change in signal was identified 15 minutes prior to thermal runaway, providing ample alert time for safe evacuation of a car, bus or coach.

Application of ultrasound technology

A solution to anticipate thermal runaway is urgent to avoid safety issues and maintain public trust in vehicle manufacturers and the consumer confidence needed to maintain EV adoption rates.

Comparative ultrasound analysis of pristine and defective cells

With its capability of detecting small cell defects, ultrasound provides a promising solution for real-time access to internal cell states for quality control during the manufacture of cells and battery packs.

There is also potential for this approach to be used on board vehicles while operational. Shifting ultrasound analysis to dynamic application presents additional challenges such as neutralising the impact of vibrations, but what is clear from HORIBA MIRA's research is that ultrasound presents a strong and viable approach for the early detection and appropriate occupant warning for thermal runaway events.

VCSELs break new ground in LiDAR design

Extending autonomous vehicle applications with improved performance and lower cost

BY SERGEY KOMAROV, BUSINESS DEVELOPMENT ENGINEER, TT ELECTRONICS

A LiDAR system's integrated lasers emit light which is then reflected off objects, returned, recorded, and applied for autonomous vehicle control. While autonomous vehicles and smart city traffic controls demonstrate key arenas for LiDAR applications, the technology is highly applicable in other uses.

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Additional options integrate a PN silicon photodiode in a T-1 clear epoxy package with 5ns of rise/fall time – these provide even faster switching and linear response but may be a more cost-effective receiver for space-limited LiDAR applications.

VCSELs with microbead lenses are designed for high-speed data communication and offer data rates up to 2.5Gbps, high thermal stability, narrow and concentric beam angle, and are processed with burn-in for a high level of reliability. Those equipped with power monitor diodes offer precise control of optical power, while others utilising flat lenses are designed for air transmission of data. Many of these VCSELs are intended for applications where low current (for long battery life) is required with high on-axis optical power for maximum optical coupling with the receiver.

In other options, VCSELs are offered in dome lens plastic T-1 package. The dome lens design creates a narrow 4 degree beam angle from the device – this benefits long-distance applications as secondary optics can be eliminated, reducing total cost of the system. To ensure optimal performance, the VCSEL must be optically and spectrally compatible with its accompanying phototransistors, photodarlingtons and photodiodes. Photodiodes offer the fastest switching speed, while photodarlingtons provide the highest signal amplification.

Practical vision system design with LiDAR

Optical data communication utilising VCSEL transmitters and photodiode receivers is a design approach superior to fiber optic options in vibration-prone mobile LiDAR applications. VCSEL transmitters offer fast data transfer rates up to 2.5Gbps and beyond, low drive current (for long battery life) with high optical output power, in a compact package for space-limited applications.

Coupled with photodiode receivers, designers have access to fast switching speed with 5ns rise/fall time and linear response spectrally matched to 850nm VCSEL IR emitters. Both VCSEL and their compatible photodiodes are available in hermetically-sealed pill packages optimised for either direct PC board mounting or in low-cost epoxy packages well suited for space-limited LiDAR modules.

Autonomous driving, drone, robotics, and other automated machines represent one of the fastest growing segments of electronics design. Even at this early stage of design and development, LiDAR offers real promise – blending TOF sensors, data communications, and connectivity to deliver a safe, high-performance vision solution in a very small footprint. Robust, yet compact and energy efficient, LiDAR, utilising VCSEL communication portals, is also cost-effective – a crucial factor in EV design and development, and one that is breaking new ground in LIDAR designs.

ABOUT SERGEY KOMAROV

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Elonroad Electric Road System for bus lines in cities

Electric Road Systems (ERS) can be financially viable even with only one user. Public transportation on fixed lines and frequent departures are prime candidates. This article shows how bus line 4 in Stockholm could use ERS to power electric buses without increasing the costs compared to the current biogas/biodiesel solution. This would be a way to solve the chicken-and-egg dilemma associated with establishing new infrastructure innovation.

BY OSCAR JAKOBSSON, ELON ROAD

THE IDEA OF A FUTURE where electric road systems (ERS) allow electric vehicles to charge when they drive is intriguing, one can easily grasp a plethora of benefits. However, when picturing this future, some questions emerge: how do we start building the network of electric roads? Aren't they useful first when the road network is complete? This article is based on a thesis project addressing these questions through investigating a case involving the Swedish ERS start-up Elonroad and the Stockholm Transport Administration. The case study shows that bus line 4 would benefit economically and environmentally from electrifying using Elonroad ERS, making the line a prominent

starting point for the ERS network in Stockholm. Electric Road Systems is an advanced candidate to solving the complex undertaking of charging the massively increasing fleet of electric vehicles. ERS allow electric vehicles to charge their batteries while driving, through the ERS charging infrastructure connected to the road. Elonroad is a Swedish start-up that develops and manufactures ERS using conductive charging. Energy is transferred from charging rails in the road to the vehicle via a pick-up under the vehicle, enabling conductive transmission of up to 300kW of power with an efficiency loss of under 3%.

A problem that ERS producers must tackle is the so-called chicken-and-egg dilemma where potential users want to use the innovation but only when it´s up and running at scale.
To solve this dilemma, existing research suggests that relevant use cases should be identified, and business cases built around these. The goal is to find a user that alone can benefit from ERS, who can constitute a starting point in a new market. This issue was researched in a master thesis project at LTH, Sweden, in collaboration with ERS pioneer Elonroad. The focus was on urban environments, which makes the study unique.

An interview process revealed that the most interested first user group in cities are public bus companies. To deep dive into this market and find a suitable case, a collaboration with the Stockholms Public Transport Administration was formed. The city of Stockholm is keen on finding ways to improve the cities environment. The economics behind putting Elonroad ERS on the popular bus line 4 was investigated. The purpose was to see if ERS was an economically feasible solution for line 4. Elonroad's ERS solution was compared to the current solution of running the buses with biogas and biodiesel, as well as to stationary charging.

Line 4 runs through central parts of Stockholm and is difficult to electrify using stationary charging due to space constraints. There is simply no space for the buses to charge. This forces buses to return to terminals outside of the city to charge. To keep the same service level, 46 busses are needed instead of current 33 if stationary charging is used. This 40% increase in buses and drivers required renders the stationary charging option financially unviable. This option was thus excluded. Going forward, electrifying with ERS was compared to keeping the current biogas/biodiesel solution. In the comparison, a 30-year horizon was used. The cost and investments associated with the options were listed in a timeline. The biggest investments for the options are combustion engine buses and electric buses respectively, electric buses being the more expensive. Other major investments include power stations and the ERS costing 5 MSEK/KM (approx. £0,42million). Running costs include maintenance of the buses and ERS as well as fuel/electricity. Both fuel (electricity) and maintenance are cheaper for the ERS than the biogas/biodiesel option.

The main financial advantage of ERS is that it is cheaper to run the buses on electricity than biogas/biodiesel, at least with the electricity price of of 0,9 SEK/kWh (£0,08) including tax, 9,8 SEK/kbm for biogas and 10,5 SEK/kbm for biodiesel used (£0,82 and 0,88, respectively). However, the investment costs are higher for the ERS option. Thus, the pay-back time depends on how much the ERS is used.

Electric buses at charging station, Malmo, Sweden

To compare the options, the costs were discounted to today's value using several different discount factors. A main discount factor of 5% was chosen as base case. The ERS option was divided into one option where the Transport Administration purchases the ERS from Elonroad, and one where they lease it. The upside with leasing is that it reduces the size of the upfront investment, but it is slightly more costly over time. The results are presented in the table below:

The model indicates that the option of keeping the current biogas/biodiesel solution is as expensive as purchasing or leasing Elonroad ERS. This could be seen as good news for electric roads, because the situation modelled is considering line 4 buses as the only users. When the road is up and running, other users could pay to use the road. Again, the pay-back time decreases as usage increases. Another important upside to consider is the ERS network effect. Smaller expansions of the ERS network can enable other lines or users to run on it. The case modelled considers the most basic situation with only one user, which is also the scenario where ERS is the least financially attractive. Nevertheless, ERS is financially feasible for line 4.

Net present cost	MSEK (5% discount factor)
Biogas/diesel	402,8 (£33,75million)
Buying ERS	384,9 (£32,25million)
Leasing ERS (30y)	391,5 (£32,81million)

Moving away from the economics, the ERS technology offers opportunities to reduce noise and particle emission. In Stockholm, the air quality in some streets does not meet EU requirements, which can lead to hefty fines. Since stationary charging is impractical, the ERS technology offers a solution.

The Stockholm Public Bus case study shows that the chicken-and-egg dilemma can be tackled by finding users who can benefit from using the technology as sole users, and that these users exist. A way to move the ERS technology further towards commercialization could be to power buses in cities that do not have room for buses to stand and charge on the streets. Cities could start with applying ERS to the popular bus lines that run through tight city centers and proceed to expand the ERS network over larger parts of the cities. When the network is in place, other users are likely to start using it. Taxis, garbage collectors and last mile delivery vehicles are example of players that could benefit from the several upsides ERS presents, for example the unlimited operation range without having to charge. A future where electric road systems allow electric vehicles to charge when they drive is intriguing, and it can be attained by simply starting somewhere.

Virtual Testing of ADAS and AV

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Accelerating the development of ADAS

According to BlueWeave Consulting the global ADAS (Advanced Driver Assistance Systems) market last year produced revenues of $25bn and they expect this to nearly triple by 2027. The benefits of such systems on road safety are clear and as a result, vehicle safety ratings are expected to include more ADAS technologies. The increased adoption poses a significant challenge for vehicle manufacturers and technology providers coping with the immense workload of developing and validating these systems. **MATT DALEY, OPERATIONS DIRECTOR OF UK SIMULATION SOFTWARE SPECIALIST, rFpro,** describes some of the benefits of simulation and the key issues being overcome.

AS ADAS systems evolve in sophistication and provide an ever-greater level of driver support, they rely on increasingly powerful and accurate sensors. They also rely on increasingly complex processing of sensor data to properly interpret the data and take the correct actions. More and more, we will see such processing involving the use of artificial intelligence (AI).

Just as with Autonomous Vehicle (AV) control systems, to fully test an ADAS system, or even a sensor package within an ADAS system, it must be exposed to the full range of conditions and events that can occur on the roads where the system will ultimately be deployed. Where AI is being used, the system must also first be trained through exposure to large volumes of representative data to allow the

Highly accurate digital model of a wet road, including puddles and lighting

self-learning process to reach the necessary level of maturity.

Many of the critical "edge case" scenarios which test the limits of sensor and processing capability, occur only rarely in real life. When such scenarios do occur, they each have their own unique combination of characteristics such as the precise size, shape, position, orientation, colour/pattern, reflectance and surface texture of anything within the scene. Then there is the movement and speed of the dynamic objects, the weather conditions and the overall levels of light and visibility. Variations in any of these characteristics can make a crucial difference to the way in which an AV or ADAS system "sees" the scenario and decides how to respond.

It is not enough simply to train or test using exposure to a wide range of different scenarios. Every individual scenario, and especially the edge case scenarios, must be repeated many times with multiple variations of the characteristics mentioned above to capture the full spectrum of circumstances that could be encountered in practice.

Clearly, it would be both impractical to do such training and testing only using real vehicles driving around public roads. Physical testing is much too slow and unrepeatable to generate the scenarios and variations required to train and test driving automation systems within a reasonable timeframe. Given the nature of the systems being trained and tested, it would also be impossible to do with an acceptable level of risk.

Virtual testing, using simulation, is the safest and quickest way to accelerate the number of scenarios experienced by a system during its early development and has become a necessity given the amount and nature of testing required. Compared to real-world testing, simulation can be done earlier in the design process, more quickly, at lower cost, more safely and in greater quantity and variety.

As the modelling of environments, the vehicles and other actors within those environments has become increasingly realistic, it has become possible to eliminate much of the burden of physically testing at different locations around the world. Such testing can be very costly and subject to the limitations of people availability and the vagaries of the weather, as well as travel restrictions, such as those which the COVID pandemic has introduced over the past 18 months. Testing earlier in the engineering program also means any design changes can be accommodated with much lower cost and time penalties than would be the case later, after physical prototypes have been constructed.

rFpro's highly accurate model of Millbrook, a proving ground in the UK

Simulation does not completely replace physical testing; the two approaches are complementary. Virtual tests incorporate mathematical models which involve some level of simplification and assumption, so must be systematically checked for correlation and calibration with physical results from real world tests. In addition, the real world can be complex, chaotic and inconsistent, so not everything can be accurately and reliably captured in a mathematical model. Physical track testing contributes during development of the simulation models, then again in validating the results. Finally, public road evaluation provides the ultimate confidence that no test scenarios have been overlooked during development.

Successful simulation

To be effective, simulation requires the creation of a suitable range of virtual environments which have high levels of detail and fidelity in terms of geometric, visual, lidar and radar characteristics, accompanied by accurate vehicle sensor models. A suitable range of test scenarios must be defined

Coloured segmentation enables AI to learn to identify road furniture

Highly accurate 3D model of real world locations with complex traffic and detailed sensor models

and built, each with the ability to explore a multitude of variations in traffic, people, animals, stray objects and anything else which occurs in the real world. This must be done for all possible weather and lighting conditions.

Models and test scenarios should be based either on proven methodology or pre-existing physical data. Simulation planning should include calibration against real-world tests and consequent model adjustments to achieve reliable correlation. The final ingredient is to ensure that the simulation encompasses all the elements necessary to exercise the entire system. An example would be the inclusion of sensor perception when simulating an autonomous vehicle's behaviour. AV and ADAS control systems are often validated using ideal sensor models but this overlooks any limitations in the sensors themselves. When modelling such systems, rFpro includes the sensors' ability to recognise and correctly characterise the features of their environment, in order to provide closed loop end-to-end simulation.

For the simulation of a driving automation system to be fully representative, it should allow for interaction between actors (human or otherwise) within the scenario, and not just be based on pre-programmed

behaviour. In rFpro's virtual world, vehicular and pedestrian traffic can share the road network, whether following the rules of the road or behaving erratically in order to provoke an emergency. This allows digital experiments to mirror precisely the real-world tests conducted in the physical environment. Human test drivers can interact with the virtual world by testing cars with ADAS systems, by riding as a passenger in an AV, or simply by driving a virtual vehicle around the virtual world to provoke and evaluate responses from the test subject.

The more accurate the virtual world is, the greater the correlation will be when comparing the results to real-world testing. A so-called 'digital twin' of a physical environment allows simulated tests to be carried out that correlate with real-world experiments, greatly increasing the rate at which testing is possible and enabling customers to prepare more fully and effectively in advance of physical testing.

When developing and testing ADAS and AV systems using feeds from cameras as well as LiDAR and radar sensors, the quality of the 3D environment model and the fidelity of the virtual sensor model are both highly important. rFpro's high definition environment models are built to work with a simulation engine that includes a physically modelled atmosphere, weather and lighting, as well as defined materials for every object in the scene. It even models the ambient lighting based on time of day, latitude and date.

The latest feature added to this environment is state-of-the-art headlight beam modelling, with accurate definition of individual light intensities to within one degree of resolution in every direction. Whereas previous lighting models comprised a simple inner and outer cone of light, the new system uses IES profiles to define the light in all directions. IES, the Illuminating Engineering Society, is the accredited body for lighting standards. The new simulation software accommodates the latest vehicle headlight technology in which LED arrays generate a large number of different beam shapes to provide better visibility without dazzling oncoming traffic. As headlight technology advances it is critical for camera-based ADAS systems that the lighting is accurately replicated in simulation.

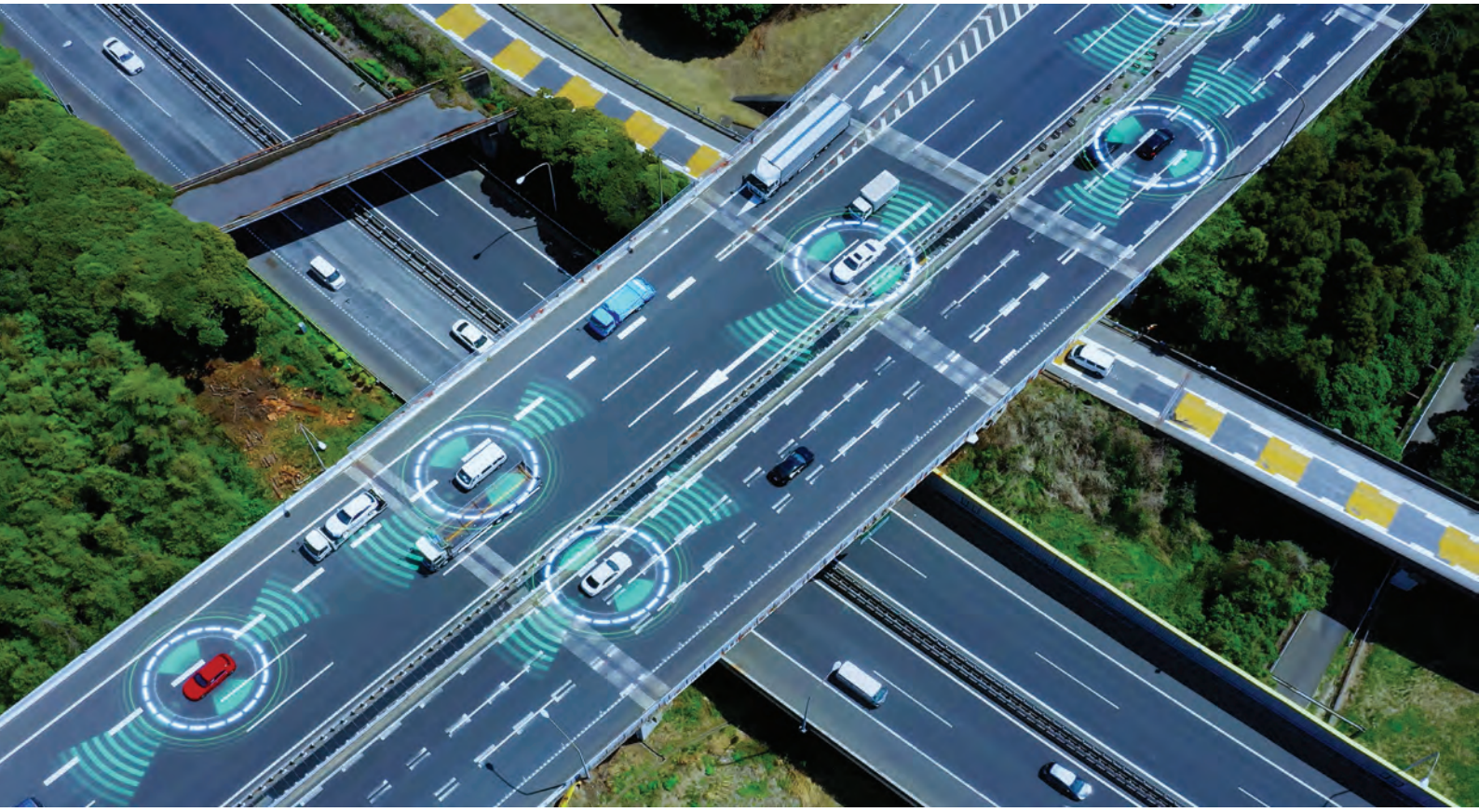
Time pressures

Though faster and more efficient than physical testing, even the simulation process itself can be subject to pressure on time and resources. One of the greatest burdens is the manual annotation of real-world data which is sometimes used to train AV and ADAS systems. In this approach, digital video recordings are taken of real-world scenarios and the scene manually annotated and labelled frame by frame to identify things such as vehicles, road furniture, pedestrians or animals. One hour's worth of source video, if sampled at just 10 frames per second, can take up to nine man-years to annotate and risks the introduction of human error.

> For the simulation of a driving automation system to be fully representative, it should allow for interaction between actors (human or otherwise) within the scenario, and not just be based on pre-programmed behaviour

rFpro's approach provides a digital, cost-effective way of creating the same data completely error-free and 10,000 times quicker than manual annotation. We call the new approach Data Farming because it is comparable to Render Farming, which has revolutionised the economics of popular animation. It enables customers to build complete datasets that cover the full vehicle system where every sensor is simulated at the same time. The data is synchronised across all sensors, even with the most complex hardware designs.

Ultimately, all the developments in the simulation of automated driving systems are geared towards accelerating the training and validation processes, ensuring these are carried out faster, more comprehensively and more safely than by using real-world data and physical testing alone. The continuing challenge is to ensure that such systems provide a significantly higher degree of road safety than a human driver alone would be able to manage. As ADAS technologies filter down from the most premium vehicles, the development challenge for engineers is increasing exponentially. Virtual simulation is the only feasible way to meet this challenge.



Unlocking LiDAR's potential for ITS

LiDAR has massive potential to revolutionise how transportation systems are designed, built, and managed, helping to reduce traffic-related problems like congestion and pollution while improving safety and efficiency.

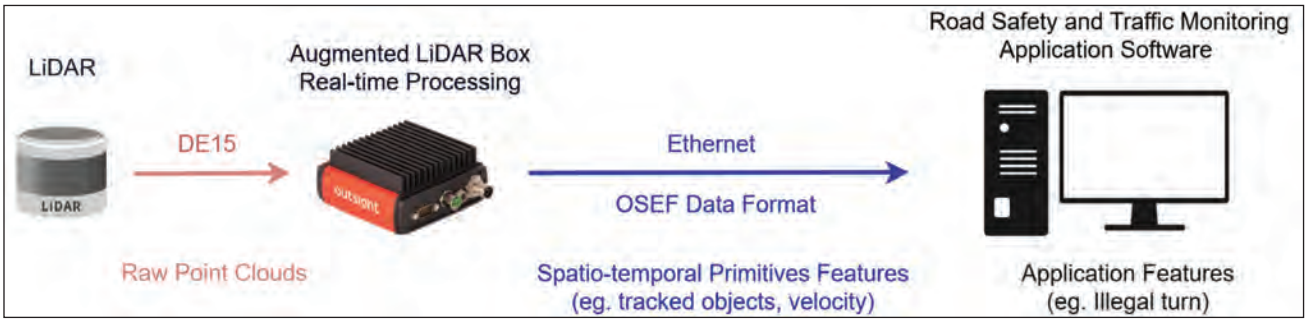
UAs LiDAR sensors become more advanced and affordable, using LiDAR to create the next generation of intelligent transportation systems is increasingly feasible.

In contrast to existing 2D-based perception technologies, LiDAR provides a range of advantages that give solution developers even more perception capabilities. It's accurate, fast, and flexible, allowing developers to quickly get incredibly accurate and consistent data from a variety of locations. As the cost of the technology continues to fall, LiDAR is only becoming a more attractive option.

LiDAR is powerful with the right expertise

Despite the benefits, LiDAR is not without its drawbacks. The most notable is the level of expertise needed to make the raw 3D data actionable. The 3D data captured by LiDAR sensors is brand new. As a result, it adds an additional level of complexity that requires specific engineering expertise to work with. Without this extensive background, even choosing the right LiDAR sensor is no easy task.

If a developer manages to select the right sensor, they have to learn how to make the raw 3D data



usable for their application. Prior experience using 2D cameras or 2D LiDAR doesn't instantly translate to the realm of 3D data. The result is that it can take months or even years for teams without experience to get LiDAR working properly for their application. The timeline grows even longer when using a combination of LiDAR sensors from different manufacturers as there are no standardized data formats or network-level interfaces.

Of course, in theory, it's possible to hire specialised engineers with prior experience. However, in practice, the pool of these professionals is limited and demand is high. The competitive market can price out organizations from being able to attract the talent they need to get their application to market quickly.

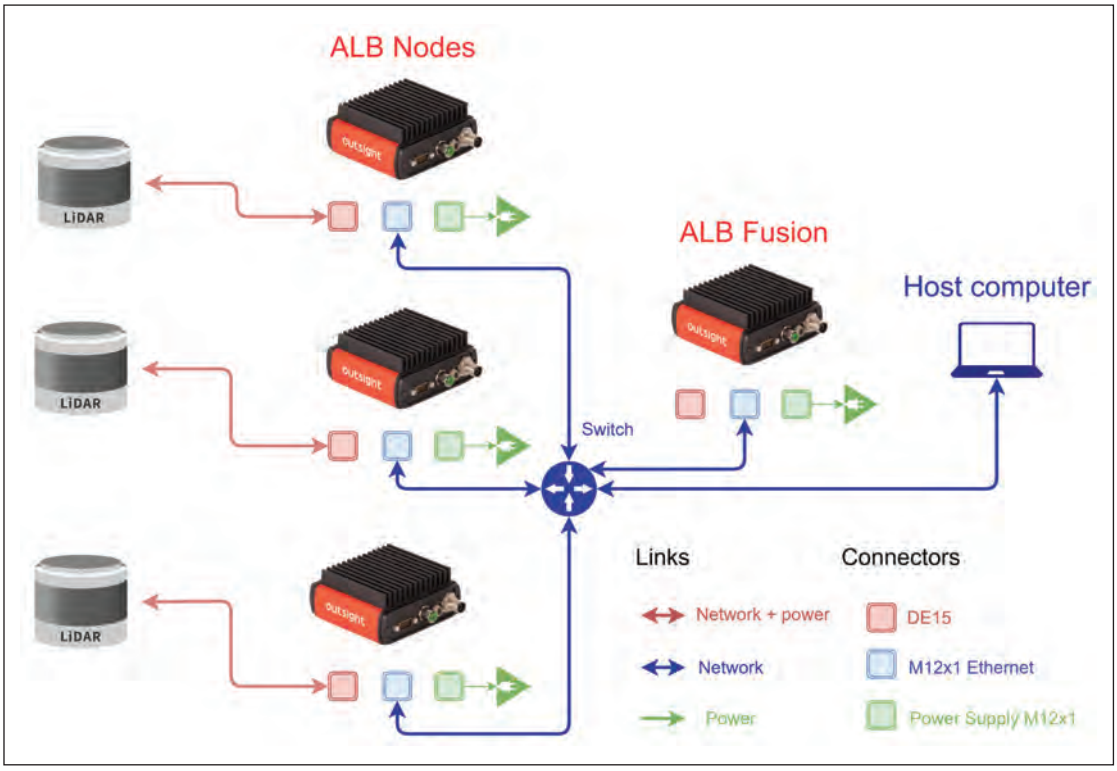
The need for LiDAR expertise is only further complicated by the hardware manufacturers themselves. Being a young industry, LiDAR lacks any semblance of standards. Each LiDAR sensor uses a unique data format and network interface, requiring specific drivers and development for different sensors. This places a further burden on application developers who need an easy-to-use standardized and open data format to launch their solutions quickly.

These barriers make it challenging for anyone to meaningfully use LiDAR in their solutions.

The right software can be a game-changer

While LiDAR hardware has gotten a majority of the hype from financial markets, as has happened many times in recent history, it's the enabling software that

Unlocking LiDAR's Potential for ITS]



Unlocking LiDAR's Potential for ITS]

has the potential to make LiDAR an effective tool for the masses. LiDAR hardware's raw data metrics, such as points per degree, fields of view, and frame rate, are not directly actionable without software that can turn them into valuable outputs for an application or solution.

The right perception software can unlock the full potential of recent LiDAR breakthroughs by reducing costs while increasing performance and organizational agility.

Perception software can be integrated into a final application in many ways. In one case, it's found on a single, compact piece of hardware that is optimized for efficient low-power edge processing and allows for seamless integration.

Outsight has developed such a plug and play solution called the Augmented LiDAR Box. This real-time software engine runs on an ARM-based embedded processor and performs a pre-built and comprehensive set of perception algorithms to process a LiDAR sensor's raw point cloud data. This enables application developers to quickly and easily integrate cutting-edge 3D LiDAR processing into their solutions.

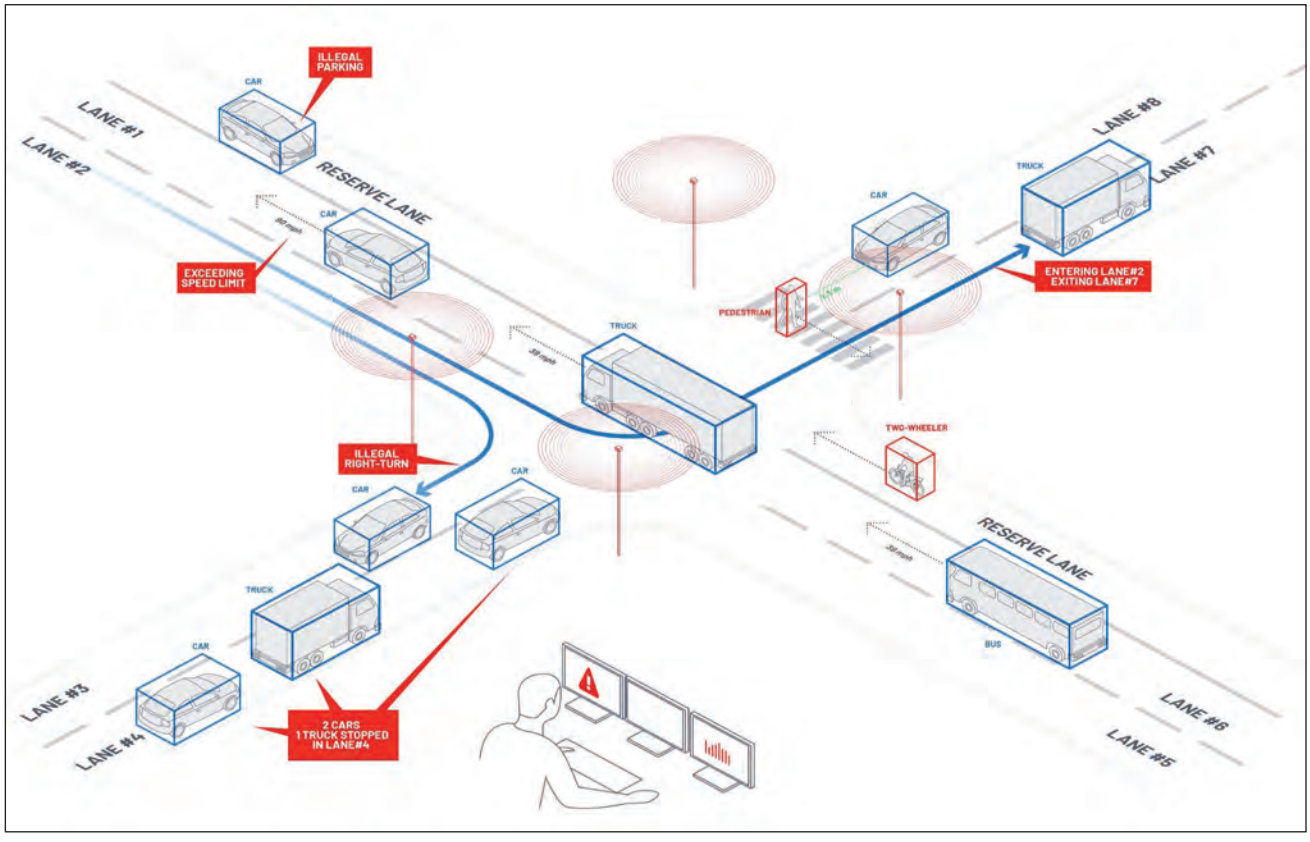
TaaS Technology Magazine [Unlocking LiDAR's Potential for ITS]

How pre-processing software works

3D pre-processing software runs several different perception algorithms to provide developers with a comprehensive set of spatio-temporal features, including object detection and tracking, localisation, segmentation, and classification.

It's also designed to work with an array of LiDAR sensors, decoding the different LiDAR data formats to allow an application developer to visualise the output in real-time and interact with the system using a simple and open-format API instead of needing to decode the proprietary data format of the LiDAR sensor. A single LiDAR sensor is often sufficient to collect the data needed to create an impactful ITS solution, such as for pedestrian detection in road crossings:

However, when a larger area needs to be monitored or blind spots reduced to an absolute minimum, several LiDAR sensors can be connected to provide application developers with a virtual super-sensor. By simplifying 3D data processing, the software transforms the formerly complicated task of implementing LiDAR into a competitive advantage for application developers big and small, without the need to build a full stack of expertise.



As a result, a large proportion of application developers can become 3D Spatial Intelligence experts and, using these new proficiencies, can create cutting-edge solutions that were simply not possible before. This allows them to quickly provide unique value to end-users.

How can I make it work for me?

Pre-processing software focused on simplifying raw 3D data is designed with an emphasis on usability. Unsurprisingly, this means that software is simple to set up and deploy.

In the case of the Augmented LiDAR Box, you simply replace the default interface box from the LiDAR sensor manufacturer. Visualising data, adjusting settings, and more is all done using a web-based user interface so you don't need to install desktop software or an OS-dependent SDK, only a browser is required. After selecting which LiDAR sensor or sensors you want to use and defining the zones of interest, such as a lane on the road or a pedestrian crossing, the solution is ready to go in minutes.

The software solution will start analysing the area and generate a data stream of spatio-temporal features. The processed data from the LiDAR sensor is transmitted to the application host computer via an ethernet connection in a flexible open data format that can easily be converted into other formats, such as JSON if needed. When processing the data, the software makes use case-specific adjustments to provide, for example, the high abstraction level output required for Intelligent Transportation System applications.

Application developers just need to verify the stream is providing the proper information by reviewing the tracked objects and their attributes, like ID, class, 3D bounding box, and trajectory, and the zones of interest in the web-based user interface.

How LiDAR software helps ITS

When applied to road safety and traffic monitoring projects, LiDAR processing software solutions, like the Augmented LiDAR Box, simplifies the process of creating applications with accurate and reliable spatio-temporal analysis capabilities that can be particularly valuable for those developing ITS solutions.

For each LiDAR frame, the software can track and provide additional information on moving objects located on the ground plane. This includes:

- Providing each tracked object with a unique persistent ID.
- Noting different classes. For example, observing and logging the differences between trucks, cars, scooters, and pedestrians.
- 3D position using an X, Y, Z coordinates system.
- 3D bounding box that notes location, dimensions, olume, and orientation.
- Calculating the full velocity vector.

It also monitors zones of interest, creating a list of moving objects detected within the zones you've defined. This allows you to detect when a certain object enters or leaves the zone, which can easily be applied to use cases such as wrong-way detection. The pre-processing software can be applied to a variety of ITS scenarios. An application developer can detect, in real-time:

- Vehicle trajectories in high-density traffic areas
- Cars making illegal turns
- Accidents
- Vehicle and pedestrian activity
- Traffic jams
- The maximum and average speed of each vehicle in each lane
- Speeding violations
- Tailgating
- Illegal parking
- Drivers' going the wrong direction
- Lane violations
- Pedestrian and railroad crossing issues

This data can be used in real-time to guide applications like smart traffic lights or aggregated over time to produce statistical insights, like road traffic by vehicle type, to inform short and long-term infrastructure planning. The software is here to unlock LiDAR's potential. LiDAR has yet to reach its massive potential for ITS. While the hardware is ever-improving and increasingly affordable, the limited pool of deservedly well-compensated experts is limiting the use of LiDAR to a narrow segment of large organizations.

LiDAR pre-processing software closes that gap and makes LiDAR accessible to a wide range of application developers, big or small, beginners or experts alike. The raw 3D data is converted into actionable and insightful outputs in widely known formats without sacrificing accuracy or consistency to allow developers to get their ITS solutions up and running faster, with less investment and less uncertainty. With the right software, anyone from the largest highway operators to the smallest of towns can use LiDAR to generate the spatial intelligence required to build smarter, safer, and more efficient transportation systems.

Transportation-as-a-Service demands a cutting-edge verification and validation approach

A convergence of large-scale trends in the automotive industry is driving an increase in vehicle complexity while also opening up new opportunities for automotive manufacturers and transportation companies. Vehicle autonomy, electrification and connectivity are expected to drive the sophistication of future vehicle systems to unprecedented levels.

BY GWEN VAN VUGT, SENIOR DIRECTOR AV, TASS AT **SIEMENS DIGITAL INDUSTRIES SOFTWARE**

TODAY'S VEHICLES already contain 40 discrete harnesses comprised of roughly 700 connectors and over 3000 wires networking several hundred electronic control units (ECUs), each of which contains ever-more powerful system-on-chip (SoC) devices. Yet, according to a 2020 study from Roland Berger, the electronics bill-of-materials for a future partially autonomous electric vehicle will more than double the electronics content of today's non-autonomous internal combustion vehicle.

The budding synergy of connected, self-driving and electric vehicle technologies has led many experts to identify a fourth key trend: transportation-as-a-service (TaaS). The fundamental idea behind TaaS is that most consumers will cease to own personal vehicles, and will instead hail rides as needed from a fleet of vehicles owned and operated by a transportation company.

Contemporary ride-sharing services offer a preview of the potential benefits of a mature TaaS model. These services offer customers a largely reliable and convenient method of transportation within urban areas. However, because these services still depend on human drivers, they do not offer the improvements in road safety or congestion that automated TaaS models are expected to deliver.

The potential and pitfalls of service-based transportation

Realizing the potential of a TaaS model will depend on the deployment of large fleets of connected, self-driving vehicles. The development of fully autonomous vehicles that can operate safely and efficiently in a connected system of vehicles is therefore a fundamental step on the path to TaaS. This, however, will not be easy. Autonomous vehicles (AVs) are expected to incorporate some of the most complex electronic technologies ever produced.

These vehicles will require state-of-the-art components from multiple domains including embedded software, semiconductor chips, sensors and electrical wiring. For example, the SoCs providing onboard intelligence will likely be among the most powerful to date, as they gather and process terabytes of data every second from the various sensor systems around the vehicle. Integrating these advanced components in a package that is attractive, power efficient and safe is certainly a towering roadblock.

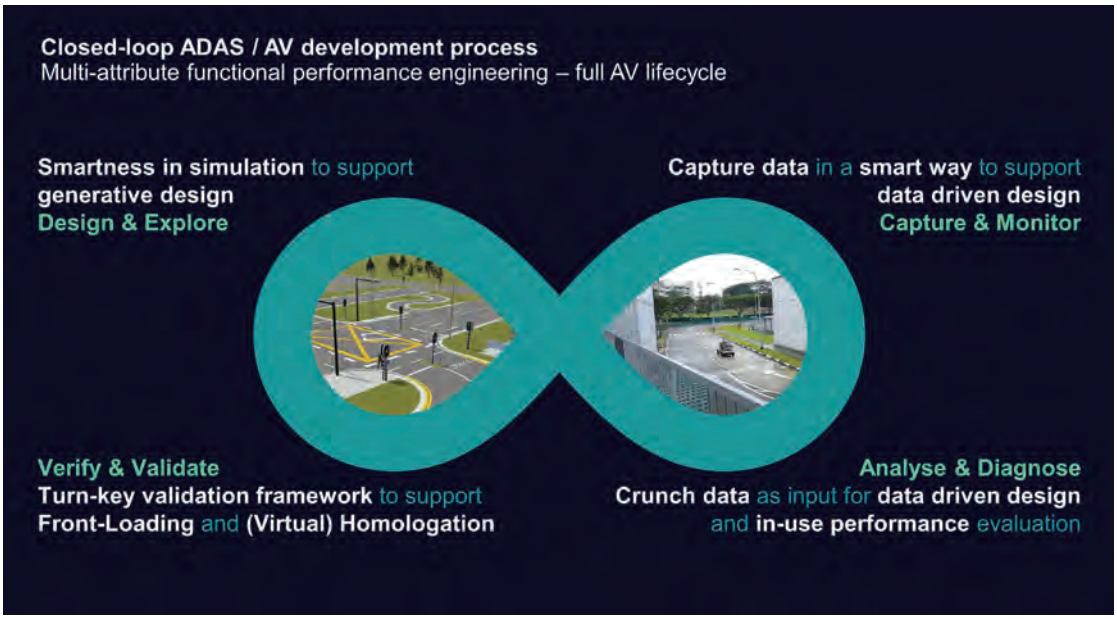


Figure 1: Xcelerator contains integrated solutions covering the entire AV lifecycle, enabling a closed 'infinity loop' of data.

Yet, the most pressing challenge is the extensive testing, verification and validation that will be required to ensure the safety of self-driving systems. Rand Corporation has calculated that it requires more than 17 billion kilometers of test driving to demonstrate a failure rate significantly better than humans. Such a volume of testing is required to investigate non-routine traffic situations that are difficult to encompass when developing the self-driving system. Clearly, accomplishing all of this testing with real-world prototypes is not feasible. Instead, real-world testing must be augmented with high-fidelity simulations that can help design teams gather vital information more quickly and cost-effectively. With a combined approach, AV engineering teams will be able to investigate and account for exceptional on-road scenarios more effectively, thus improving the safety of their AV systems.

To that end, the industry needs an integrated AV development platform that can test and retest the operation of the vehicle in realistic virtual scenarios, during the design of the vehicle's systems. This will allow the test results to be fed back during the design phase, creating a closed-loop system that improves the design, operation, and physical characteristics of the system in near real-time, as well as trains and tests the vehicle sensor system with credible real-world scenarios. Such a platform is enabled by an extensive digitalization approach that supports the creation of a comprehensive digital twin of the AV, covering the design, verification and validation, in-field monitoring, and optimization of the vehicle hardware, software, production and lifecycle.

Digitalization paves the way

The development of advanced driver assistance systems (ADAS) and autonomous vehicles is a data-driven engineering process. Large amounts of data are generated, analyzed, and incorporated back into the design at each step in the lifecycle. Making the most of this enormous quantity of data is crucial to turning the complexity of AV development into a competitive advantage. Siemens' Xcelerator portfolio offers software solutions across the entire lifecycle, from design through to in-field monitoring and optimization (figure 1). And with a robust digital thread undergirding it all, data remains accessible throughout the lifecycle to ensure a closed-loop development flow.

It all starts with real-world data collection. Siemens offers a combined hardware and software solution, called SCAPTOR, to collect and manage massive amounts of ADAS sensor data from real-world prototype vehicles. Typically, the amount of collected data is so large that it can only be retrieved from the test vehicles on hard-disks. These hard-disks are then taken to processing stations, where the data is uploaded to the cloud for further analysis by teams around the world. To streamline this flow, SCAPTOR includes software that runs on both the edge devices in the vehicles and in the processing stations to perform an initial analysis on the data.

This first-pass analysis distinguishes between data that is of interest or relevant to the current objective ('hot' data), and data that is less interesting ('cold' data). This allows the team to make informed

Figure 2: Simcenter Prescan creates realistic virtual driving scenarios to verify and validate AV behavior.

decisions on what data should be stored, where it should be stored, and when it should be uploaded. This first step can save companies significant data transmission and storage costs while maintaining the full value derived from the test drive data. Data is automatically labeled during initial processing to enable easy search and retrieval. The labeling of the data can be done by Siemens algorithms, third party algorithms, or both to provide full flexibility and extensive search capabilities.

Of course, searching through the mountains of data generated during and ADAS or AV test is not easy, to say the least. Robust searching capabilities, including natural language processing, can help users quickly locate the data they need. For instance, using natural language processing, the user can request only data from scenarios in the rain where the car must abort a left turn due to an approaching bicycle, causing an uncomfortable maneuver. These search functions allow engineers to parse immense amounts of data and leverage it to improve ADAS and AV systems. Scenarios without any issues (so-called 'happy flow scenarios') can be used to train the neural networks, which act as the 'brain' of the AV, to navigate the driving environment. Meanwhile, critical scenarios (with undesirable behavior) can be used to find the boundaries of the designed system, for verification and validation purposes.

The captured data becomes even more powerful when converted to the virtual domain, as it can enrich the simulations and lead to a much higher-

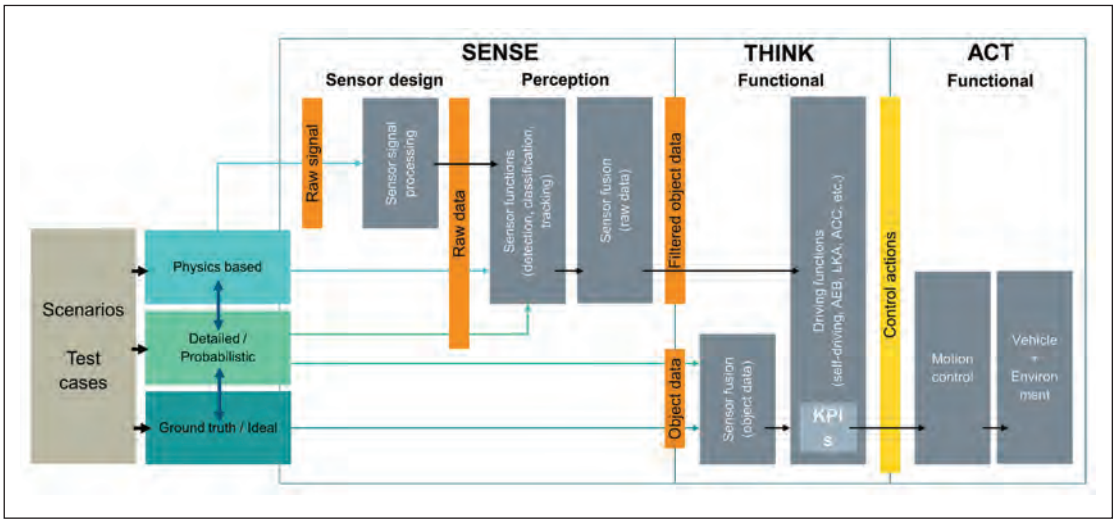


Figure 3: Simcenter Prescan offers several levels of fidelity for the development of sensor systems, algorithms, and other ADAS or AV functions.

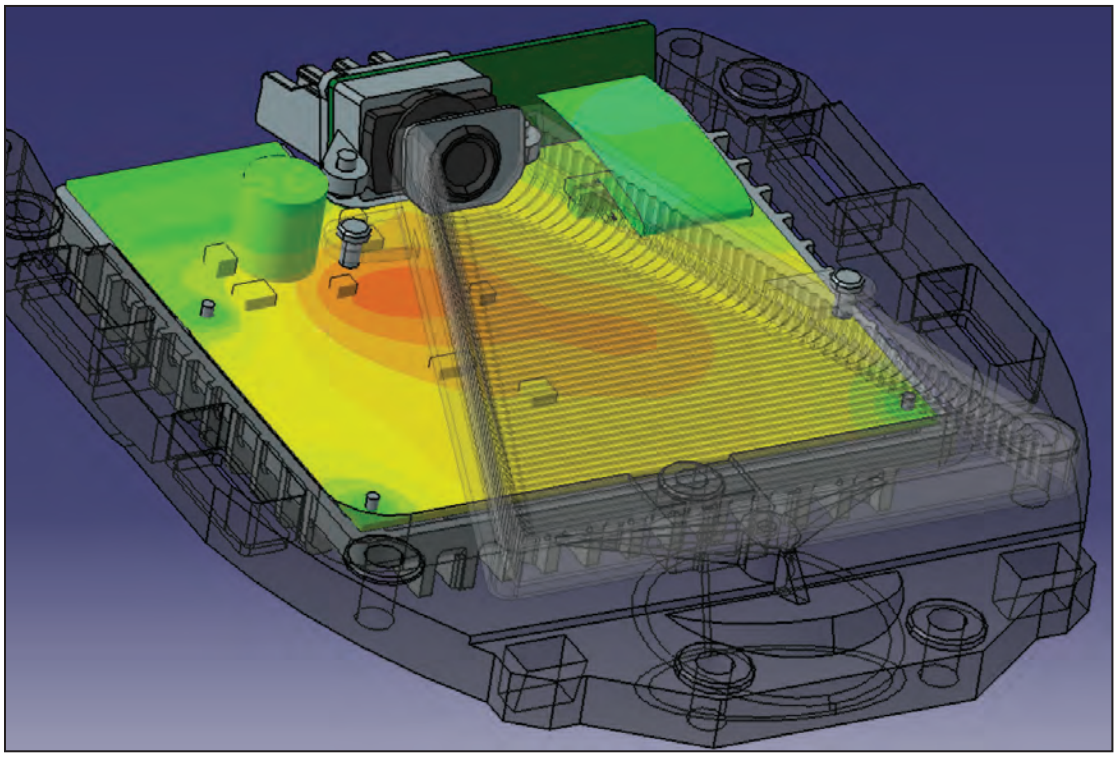


Figure 4: Thermal simulations are important to ensuring the performance of camera and other sensor types over the lifetime of the vehicle.

fidelity digital twin. Scenarios captured during real-world testing can be imported into a simulation solution, such as Simcenter Prescan from the Xcelerator portfolio (figure 2). Once in the simulation environment, the engineering team can change all parameters of the scenario as needed, providing unlimited capabilities for design optimization and testing. For instance, a real-world test can be virtually repeated in different weather and daylight conditions; a test originally completed during the day could be repeated at night, or in adverse weather.

Meanwhile, the number and variety of sensors used in AV systems continues to increase while the electrical and electronic (E/E) architectures are also centralizing, allowing for a high degree of flexibility in design choices. Added flexibility, however, also means greater complexity during the design of AV hardware and software. Here, high-fidelity simulation of the vehicle digital twin enables multi-attribute optimization (e.g. performance vs. energy usage and cost) in various vehicle domains, which helps engineers to make optimal design choices. For example, the combination of Simcenter Prescan and Simcenter Amesim can simulate the performance of the entire sensor system and vehicle dynamics at the vehicle level. These simulations provide crucial information for the development of the sense-think-act algorithms that enable AVs to navigate independently. Prescan can also provide multiple levels of fidelity for the sensor simulations to match the needs of the design activity being undertaken (figure 3). These physics-based raw sensor simulations can inform sensor and perception algorithm design, such as using probabilistic and ground-truth models to design the sensor-fusion algorithms and path-planning. Eventually, high-fidelity vehicle dynamics (Simcenter Amesim) and tire simulations (Simcenter Tire) can be used to develop the high- and low-level controllers that direct the acceleration, deceleration, steering and other functions of the vehicle.

Design complexity also extends down to the component level, as engineers must evaluate and optimize component performance based on thermal, electromagnetic or other constraints. For instance, ADAS/AV sensors often are located in challenging locations on the vehicle and potentially vulnerable to external conditions. Cameras are located behind the windscreen, where proper heat management is critical to guaranteeing optimal lifetime performance (figure 4). Another example is the location of radar and vehicle communication antennas. Highly detailed electromagnetics simulations can help optimize the location of these components for maximum antenna gain patterns, which will only

become more important as vehicles become connected. External influences like rain and dirt soiling can also degrade the accuracy of sensors.

Modern simulation solutions, such as those in the Xcelerator portfolio, are built to address these component-level challenges. Simcenter Flotherm and FloEFD are simulation packages that enable the design and evaluation of heat management systems for a variety of components. Simulation packages like StarCCM+ and Nextflow Software offer additional capabilities that enable the optimal design of sensor packaging and location on the vehicle to guarantee optimal performance over the lifetime of the vehicle. These capabilities include the ability to simulate how water (such as road spray or rain) will interact with the exterior of the vehicle, and thus how it may affect sensor performance (figure 5). Through the combination of electronic, mechanical and functional simulation on chip, component and vehicle levels, Siemens' Xcelerator platform offers the leading portfolio of engineering tools for ADAS and AV system design.

Figure 5: Advanced simulation software enable designers to investigate how water and other environmental factors interact with the exterior of the vehicle.

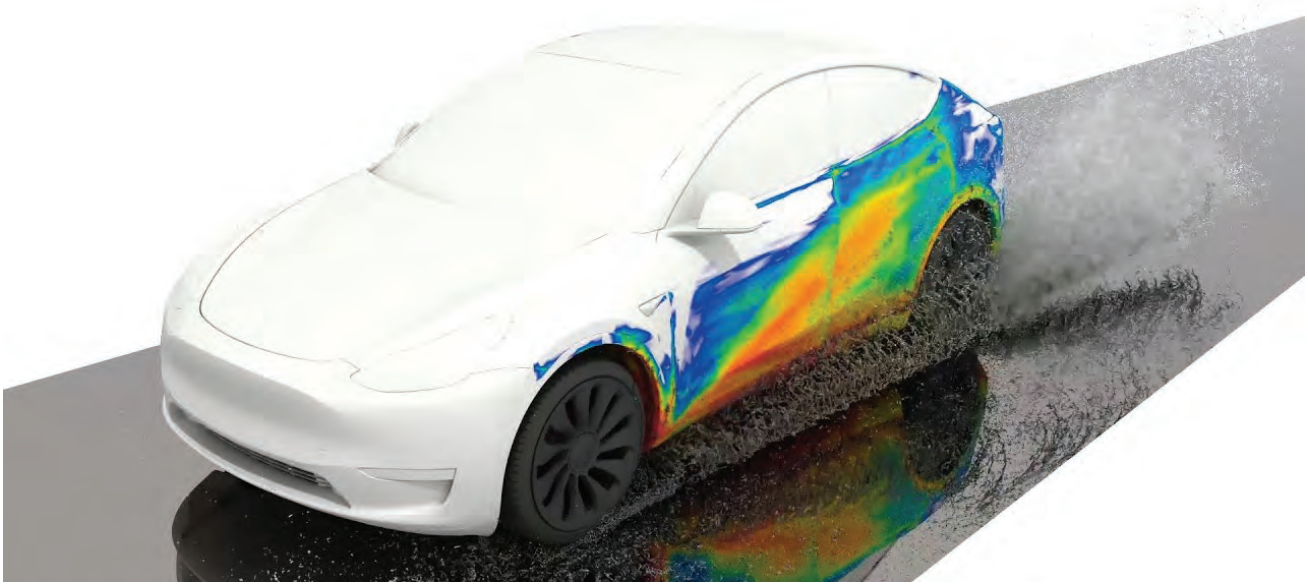
Virtual testing enables active investigation

As previously mentioned, teams cannot rely solely on data that has been captured in real-world tests. Real-world test data tends to capture scenarios that are already known. These known scenarios may present safe or unsafe driving conditions, and thus are useful for verifying and validating the intended performance of an AV system, but they cannot test the full range of system capability in driving conditions across the globe. Complete verification and validation of a self-driving system will require teams to actively seek out unknown-unsafe scenarios, and account for these conditions in the system design. High-fidelity simulations of a comprehensive vehicle digital twin present the best environment for this investigation. Engineering teams can use the knowledge from known real-world situations in combination with proven mathematical methods to uncover alternative critical scenarios. Doing so in the virtual environment allows teams to uncover and analyze these scenarios much more efficiently, reducing the number of unknown-unsafe scenarios and the residual risk when deploying these ADAS and AV systems.

There are multiple ways to initiate the search for unknown-unsafe scenarios: accident databases, publicly available scenario databases, and integration with various forms of scenario collection (such as instrumentation in cars, drones and infrastructure). Siemens Xcelerator is adaptable to the needs of each company, and supports all the above methods while also offering a patented mathematical method to synthetically define critical scenarios on any intersection in the world. By using a multitude of these sources, ADAS and AV manufacturers can efficiently design systems with an acceptable level of residual risk.

Mixed-reality AV verification and validation

Newly identified unsafe scenarios can then be incorporated in the verification and validation programs for AV systems. Verification of the AV



system against requirements is typically completed through massive Model-in-the-Loop (MiL) and Software-in-the-Loop (SiL) cloud-based simulation exercises, where millions of scenarios are fed into the AV algorithms to verify they are meeting requirements and are robust against a myriad of parameter combinations. Simulation loops are performed throughout the multiple design iterations that occur before a release candidate is defined.

For the release candidate, real-time performance needs to be validated, including the hardware components that run the algorithms and feed them data. This includes sensor inputs of various types, such as radar, lidar, or cameras, and models of the silicon chips that provide computational power. These real-time performance tests are performed in mixed-reality environments, where the virtual and physical models of the vehicle are brought together in the digital twin to interact with and inform each other.

Prescan is particularly flexible in operating between virtual and physical components. A physics-based sensor model allows the simulation to provide realistic sensor data of all types (e.g. camera, radar, lidar, V2X, and more) on different levels in the sensor data chain. This includes the external stimulation of sensors, the injection of synthetic raw data directly into the sensor processor, and object-level information injected into the vehicle controller.

Hardware-In-the-Loop (HiL) configurations run the self-driving algorithms on the final hardware components, such as the actual silicon chips that will go into the vehicle at production, and feed the algorithms with real or synthetic sensor data. Here, Siemens also offers a unique solution that enables earlier verification and validation of complete self-driving systems, before any physical prototypes are ready. This environment, called PAVE360, uses a combined design, simulation, and emulation approach to simulate an entire AV platform, including decision algorithms.

PAVE360 allows companies to virtually verify and validate the functionality of SoC designs within the context of the AV platform, including software and vehicle hardware, before producing any physical chips. As these technologies continue to advance, Vehicle-In-Loop (ViL), proving ground testing, and 'shadow mode' driving (in which the outputs of the self-driving algorithms are stored for analysis rather than acted upon) will help companies validate that the full system is providing the intended behavior before vehicles are released to the streets. Siemens provides the components, knowledge and services to execute such tests.

Finally, the entire process, from field data collection, through design optimization, and the verification and validation of the system, needs to be managed. Normally, the management of these processes is spread over teams spanning the entire globe, often resulting in silos of information and knowledge. The synchronization of the latest data, models, requirements and results is therefore key to the success of these global teams. Powerful application and product lifecycle management (ALM/PLM) systems can offer an open and robust digital thread needed to connect global teams in an organized value chain.

ALM and PLM solutions, such as Siemens Polarion and Teamcenter, offer a structured and digitalized approach to the management of workflows, data streams, project timelines, design traceability, legal requirements and more. These systems are also open to ensure that engineers and designers across the organization have access to the most recent data as it is required. Furthermore, traceability of design iterations is maintained, allowing root-cause analysis in the case of errors or audits.

Conclusion

TaaS models offer significant potential to improve not only our transportation systems, but also broader aspects of society and human life. Key benefits include safer roads, less congestion, reduced cost from vehicle ownership and the convenience of automated chauffeurs that can bring us from destination to destination. This potential, however, rests on our ability to solve the immense challenge of true vehicle autonomy.

The vehicles of an automated TaaS system will need to operate safely and reliably in all weather and traffic conditions, in urban, suburban and rural settings. To surmount this sizeable hurdle, AV manufacturers and transportation companies will need to embrace the comprehensive digital twin that supports a mixed-reality, digitalized approach to the development, verification, and validation of their systems.

Siemens' Xcelerator portfolio offers solutions to support such an approach, covering the entire lifecycle from real-world data collection to massive MiL, SiL, and HiL simulations. To learn more about our AV offerings, visit: https://www.plm.automation.siemens.com/global/en/industries/automotive-transportation/autonomous-vehicles.html

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