# VEHICLE electronics

**The monthly magazine for automotive electronics engineers**

## Arm accelerates AI vehicle development

Arm has announced technologies and compute subsystems to enable faster time to market for AI-enabled vehicles.

This should let the Arm ecosystem deliver hardware and software from day one, accelerating automotive development cycles by up to two years.

Instead of having to wait for silicon to be in production, the automotive industry can immediately start innovating.

Safety-enabled Arm AE automotive enhanced processors will bring Armv9 and server-class performance to AI-driven use cases, while Arm CSS compute subsystems should reduce development time and cost for automotive systems.

"For the first time, we are bringing Armv9-based technologies to automotive, enabling the industry to take advantage of the AI, security and virtualisation capabilities that this latest gener-

ation of the Arm architecture delivers," said Dipti Vachani, senior vice president at Arm. "To meet the growing performance demands of vehicles, we are leveraging our leadership in infrastructure by bringing server-class Neoverse technology to automotive, along with Armv9-based Cortex-A products for scalability."

Companies, including Tier IV and the Autoware Foundation (AWF), have partnered with Arm to launch virtual platforms and software based on Arm AE. This aims to shorten hardware and software development cycles for software-defined

vehicles (SDVs).

Tier IV is integrating its Web Auto cloud-native devops and MLOps (machine learning operations) platform for autonomous driving with virtual models of Arm processors running in the AWS cloud on Arm-based instances.

Siemens is adding accelerated pre-silicon development in the cloud to its hardware assisted verification product offering with Pave360 software for SDVs. This accelerated simulation environment supports the Arm Cortex-A720AE CPU semiconductor IP.

Cadence is collaborating with Arm to deliver a chiplet-based reference design and software development platform to accelerate SDV innovation.

Siemens pre-silicon simulation environment

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## Infineon sues Innoscience over GaN patent

Infineon is suing Innoscience for infringement of a US patent relating to gallium nitride (GaN) technology.

Innoscience has denounced the accusation.

The patent claims cover core aspects of GaN power semiconductors encompassing innovations that enable the reliability and performance of Infineon's proprietary GaN devices. The lawsuit was filed in California.

Infineon alleges that Innoscience infringes the patent by making, using, selling, offering to sell and/or importing into the USA products including GaN transistors for applications within automotive and other sectors.

"We vigorously protect our intellectual property and thus act in the interest of all customers and end users," said Adam White, president of Infineon's power division.

Innoscience denies Infineon's allegations of patent infringement and the validity on Infineon's patent.

In a statement, Innoscience said the alleged invention of the asserted patent was already disclosed in Infineon's own earlier prior art patents, raising concerns that it may have committed fraud on the US Patent & Trademark Office for not

making proper disclosure during the prosecution of the asserted defective patent.

The statement went onto say the lawsuit only concerns a small fraction of Innoscience's high-voltage GaN transistors and does not affect most of its other products.

"Therefore, the lawsuit should have little to no effect on Innoscience's current ability to make, use, sell, offer to sell or import into the USA its products for customers," said the statement.

Last year, Infineon ac-

quired GaN Systems, expanding its position in power semiconductors.

Infineon's GaN patent portfolio comprises around 350 patent families. Eight-year-old Innoscience has filed more than 800 patent applications globally.

### Will a child follow the ball?

A ball rolls out into the road. The chances are it will be followed by a child in hot pursuit, oblivious to any traffic.

But while human drivers can assess this situation using their contextual knowledge, today's assisted and automated driving systems still have to learn how to do it.

Bosch is pursuing the use of generative AI to further automated driving functions. As part of this, Bosch and Microsoft are exploring opportunities to collaborate and leverage the power of generative AI.

"Bosch is working on bringing a new dimension of AI applications into the vehicle," said Stefan Hartung from Bosch.

The expectation is that generative AI will enable vehicles to assess situations and react accordingly, and in this way keep road users even safer. Today's driver assistance systems can detect people, animals, objects and vehicles, but soon generative AI could help determine whether a situation could potentially lead to an accident.

# Kappa chooses Thine chipset for camera monitor

Kappa Optronics has selected Thine's V-by-One HS chipset for its Rearview OneBox digital mirror.

Rearview OneBox solves many critical problems of conventional side and interior mirrors such as unclear vision due to weather conditions, blind spots, design constraints, and aerodynamical fuel and/or battery inefficiency.

The firm's products are already used in many high-performance cars such as the Aston Martin Valkyrie, Gordon Murray T.50 and KTM X-Bow GT-XR. Even former Formula One world-champion Jenson Button uses Kappa's technology in his Radford Type 62-2.

The Thine chipset uses market proven high-speed video transmission technology with millions of pieces shipped. To enable integration, Thine provided Kappa with kits and support.

The V-by-One video transmission technology lets the camera be physically located far away from the camera monitoring processing unit.

"To achieve leading-



**Kappa Rearview OneBox**

edge requirements of our customers as well as critical industry standards in rugged and certifiable designs, our vision system platforms are very sophisticated and advanced," said Fabian Claus, business manager at Kappa. "Because of Thine's technical expert team's intense support, we felt confident we would achieve our project goal with using Thine's parts and kits."

Tak Iizuka from Thine added: "It has been an exciting experience supporting Kappa with our ICs and kits. In the near future, we are sure there will be many more car manufacturers leveraging Kappa's platform to differentiate and make their users' driving experience safer and more comfortable."

Key features of Rearview OneBox include an enhanced field of view, eliminating blind spots. It reduces $CO_2$ emissions and can improve Euro NCap rating.

## Omnivision adds sensor to Nvidia development platform

Omnivision has made its OX08D10 8Mpixel cmos image sensor compatible with the Nvidia Omniverse development platform.

The technology was demonstrated at the recent Nvidia GTC event in California.

Omniverse is a platform of APIs, software development kits and services that help developers integrate OpenUSD and RTX rendering technologies into their 3D applications and services.

Such applications include high-fidelity, physically based simulation for accelerated autonomous vehicle (AV) development.

The recently announced OX08D10 is the first image sensor with Omnivision's $2.1\mu m$ TheiaCel technology, which harnesses the capabilities of lateral overflow integration capacitors and its DCG high dynamic range (HDR) technology to capture LED lights without any flickering artefact for nearly all driving conditions.

TheiaCel lets the OX08D10 achieve HDR image capture at up to 200m. This range is the sweet spot for delivering a balance between SNR1 and dynamic range and is optimal for automotive exterior cameras.

The OX08D10 has low-light performance and low power consumption in a package said to be half the size of other exterior cabin sensors in its class.

"The OX08D10 is Omnivision's flagship image sensor that features our TheiaCel technology, ushering in a new era to low-light sensitivity in an easy-to-implement product that yields dramatic improvements in image quality," said Paul Wu, head of automotive marketing at Omnivision. "We are proud to be part of the ecosystem of Nvidia partners who are working to accelerate AV development."

The OX08D10 features the firm's a-CSP package technology. Samples are available now.

# Cisco and Telus launch 5G connected car network

Cisco and Telus are launching 5G capabilities in North America to serve IoT use cases across industry verticals, with a focus on connected cars.

The network will serve as a foundation to support drive testing by a North American car maker's 5G connected cars.

With these capabilities, the Telus control centre powered by Cisco can support automated provisioning, dynamic policy, charging and quota management to launch subscription services on demand, and manage SIM and vehicle lifecycle for any connected car OEM or enterprise.

This lets car OEMs orchestrate and automate the end user experience with the IoT control centre's Rest API portfolio. OEMs can leverage Telus' wireless network to introduce 5G enabled telematics, infotainment applications and network services, along with subscription wifi services

This lays the foundation for OEMs to offer onboard applications and adas services, while carving a path into subscription services to support revenue diversification.

Consumers can subscribe to services on demand from the vehicle or an OEM web site, access threshold-based subscription notifications, and renew or cancel services.

"Cisco's mobility services platform with 5G is ushering in a new era for connected cars to deliver amazing customer experience for the drivers while paving the path for car makers to drive better experience and services over mobile networks," said Masum Mir, senior vice president at Cisco.

The collaboration also introduces on-demand network slice creation, full-stack observability with service assurance and life cycle management in a contained lab environment, aimed at supporting mission-critical use cases.

Cisco and Telus are laying the foundation for OEMs to get full visibility and control of their network services and drive quality of service on demand with predictive intelligence and automated assurance.

# DRI helps NHTSA set adas test procedures

The US National Highway Traffic Safety Administration (NHTSA) has commissioned five research projects to establish test procedures for assessing adas and automated driving systems and improve the efficiency of test procedures.

Test consultancy DRI, part of the AB Dynamics Group, has been awarded more than $5m to conduct the research that will focus on analysing real-world crash data to translate into safer roads.

DRI will conduct crash data analysis and market research to understand real-world operational performance capabilities, limitations and reliability of existing adas technolo-

gies. Using this information, the company will identify, parameterise and trial adas test scenarios.

It will also collaborate with the industry and standards organisations to explore methods and tools for conducting this testing more efficiently to lessen the burden on manufacturers and test houses.

"The ultimate goal of these research projects is to improve road safety by increasing the effectiveness of adas testing," said Nadine Wong, DRI director of track testing. "Basing new test protocols on real-world crash data helps ensure that adas technologies are being thoroughly challenged in

ways that will directly translate into safer roads. With our unique perspective of conducting adas tests daily for OEMs and NHTSA at our California proving ground, as well as the research expertise we have in-house, DRI is well-equipped to develop and trial future test protocols."

The projects will target five specific areas: light vehicle blind spot intervention (BSI) and lane change assist; vulnerable road user automatic emergency braking research and variation analysis; alternative test termination methods; heavy vehicle pedestrian automatic emergency braking; and heavy vehicle BSI.

DRI provides testing services at its privately owned test facility near Bakersfield, California. It has been purpose-built for the development and verification of adas technologies, including specific lane line markings dictated by the test requirements and a range of adas testing equipment.

"At DRI, we have conducted adas testing across a whole range of sensor technologies, vehicle types and regulations," said Wong. "We understand what challenges adas and the workload implications test matrices have on vehicle manufacturers and test houses. Leveraging this experience of both formulating and implementing test protocols, we can provide comprehensive and uniquely insightful evaluations of adas technologies."

# BMW adopts ADI E²B for ambient lighting

BMW is adopting Analog Devices (ADI) E²B 10baseT1S Ethernet-to-the-edge bus technology for ambient lighting designs in future vehicles.

Automotive Ethernet connectivity is an enabler of zonal architectures in automotive design and supports automotive megatrends such as software-defined vehicles.

Since 2018, ADI has been working closely with BMW on a concept to simplify bringing Ethernet to the edge. At the same time, the IEEE802.3cg group was

defining a 10Mbit/s Ethernet standard called 10baseT1S, with ADI and BMW actively involved.

Using ADI's 10baseT1S E²B technology to remove microcontrollers and move software from edge nodes to central processing units, BMW enabled an all-hardware edge node while reducing software development and qualification tasks.

"10baseT1S E²B is a great new addition to our automotive connectivity and networking portfolio, innovated to drive success across different use

cases, with the flexibility and scalability to support zonal, domain and hybrid architectures," said Yasmine King, ADI vice president.

In-cabin experience continues to be a critical focus for automakers, with driver and passenger expectations becoming more refined. This is especially true of the ambient lighting within the vehicle.

However, many lighting options are complex to implement, use legacy technologies, and are difficult to scale and update

as the number of supported LEDs increases.

By leveraging 10baseT1S with E²B technology, OEMs can provide a rich customer experience while synchronising lighting with other applications in the vehicle. Fully enabling software-defined lighting can improve flexibility, ease of upgrade and ease of use.

"This approach to edge connectivity is so sought-after that the automotive industry inside the Open Alliance is now aiming to standardise a similar option," said King.

## Soracom and Suzuki bring IoT to mobility

Soracom is working with Suzuki to find applications for IoT technologies in mobility services.

The global automotive industry is changing rapidly, accelerated by progress in electrification and automation and by widespread consumer adoption of connected-car or telematics capabilities.

Automotive manufacturers can now apply recent advances in hardware, software and connectivity to create services and deliver more levels of comfort, convenience and safety.

Soracom and Suzuki plan to explore opportunities to collaborate in applying IoT technologies to develop offerings for mobility services. Potential focus areas include electric vehicles (EVs) designed for the global market, modular base units, and technologies and services designed to support carbon neutrality.

Both companies say they will continue to work towards developing mobility services that can provide the infrastructure for business and life in a sustainable society.

## Isuzu invests in Tier IV

Isuzu Motors is investing ¥6bn in Tier IV as part of an alliance to develop autonomous driving systems for route buses.

The alliance is aimed at speeding up the development and deployment of autonomous driving systems, specifically for route buses, with the goal of delivering level-four autonomous driving.

Tier IV was a force behind Autoware opensource software for autonomous driving. It has been involved in proof-of-concept tests around the world, harnessing the software that facilitates the design and development of safe and reliable systems.

Last year, Isuzu announced it would invest ¥1tn by 2030 towards carbon neutrality initiatives and digital transformation for logistics.

As the shortage of drivers in the logistics and public transportation sector intensifies, Isuzu believes the development and widespread adoption of autonomous driving technology will not only address these societal challenges, but act as a key driver for Isuzu's business in the future.

Isuzu and Tier IV say they are committed to leading innovation in autonomous driving.
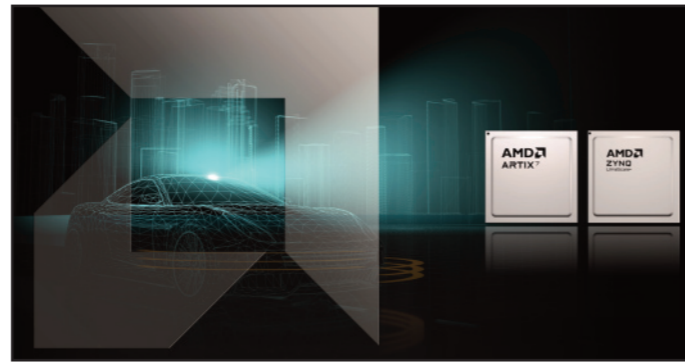


## Sony picks AMD for lidar reference design

Sony Semiconductor has selected AMD 's adaptive computing technology for its latest automotive lidar reference design for autonomous vehicles.

Adaptive computing technology extends lidar capabilities in terms of accuracy, fast data processing and reliability.

Lidar plays a pivotal role in enabling depth perception and environmental mapping. It delivers image classification, segmentation and object detection data that are essential for 3D vision perception enhanced by AI.

This cannot be provided by cameras alone, especially in low light or inclement weather.

The dedicated lidar reference design addresses the complexities of autonomous vehicle development with a standard platform to enhance safety in navigating diverse driving scenarios.

"Lidar technology with its AI-enhanced perception capabilities is advancing at an incredible pace, enabling deployments for an ever-growing number of uses," said Yousef Khalilollahi, corporate vice president at AMD. "Our collaboration with Sony integrating AMD adaptive computing technology into its lidar reference design exemplifies our dedication to pushing the boundaries of technology and driving innovation."

Takayoshi Ozone, general manager at Sony Semiconductor, added; "This technical collaboration with AMD represents a significant leap forward in our commitment to delivering cutting-edge lidar applications. By incorporating AMD adaptive computing technology into our lidar reference design, we are poised to set new standards in performance, reliability and adaptability."

The lidar reference design with IMX459 sensor, is powered by AMD Zynq UltraScale+ MPSoC adaptive SoCs and Artix-7 FPGAs.

## Is Samsung about to buy part of Continental?

Samsung is poised to acquire part of Continental's automotive electronics business, according to reports in the South Korean press.

This would be the company's first major acquisition since it acquired Harman in 2017.

According to *Business Korea*, Samsung is conducting in-depth discussions about acquiring parts of Continental's business, including adas and automotive displays segments.

The review of this acquisition is being led by Son Young-kwon, chairman of the board of directors at Harman.

Though Samsung has been quiet on the acquisition front, Harman has been busy, buying Savari in 2021, Apostera and Caaresys in 2022, and Flux and Roon in 2023.

*Vehicle Electronics* approached both Continental and Samsung for comment.

Matthias Krempl, spokesperson for Continental, responded: "We do not comment on rumours and speculations." He added that the company had already said it was preparing a carve-out for its user experience business unit.

"Nothing has changed in this regard," he said.

Earlier this year, Continental announced plans to streamline its automotive group sector to increase the efficiency of its global research and development network.

By the end of 2025, a number of the group sector's 82 development locations will be closed, its existing infrastructures better used through the pooling of development units, and synergies in work processes leveraged.

This could lead to around 1750 jobs being lost worldwide, including 380 at software subsidiary Elektrobit.



Samsung may be acquiring part of Continental

## Blackberry and TTTech expand SDV partnership

TTTech Auto and Blackberry are expanding their partnership to address the growing complexity of software defined vehicles (SDVs).

The cooperation will support the native integration of the latest QNX operating system (v8.0) with TTTech's scheduling software in a single safety-certified product.

This should enhance performance and enable better use of underlying semiconductors in complex and highly mission-critical environments such as adas in SDVs.

The joint product from this cooperation will support the scalability of architectures, from zonal to domain controllers and central compute, as well as from fail-safe to fail-operational.

By leveraging scheduling algorithms, the design phase is simplified and testing efforts reduced, letting users modify their configuration with one click and achieve functional results consistently.

The product is precertified to support ISO 26262 up to Asil D and ISO 21434 security standards.

It will be available for projects midway through this year and be fully certified by year end.

"The combination of rapid advancements in silicon chip performance, increasing system integration and interdependency, and growing software complexity is creating a pressure cooker environment for SDV manufacturers," said John Wall, head of QNX at Blackberry. "When safety and security are paramount, there is no room for compromise. That's where our partnership with TTTech Auto excels."

Stefan Poledna, CTO at TTTech, added: "Developing SDVs makes the old days of auto design look like child's play. SDVs of the future require a system-wide approach that embraces system, safety, security and software integration."

This partnership builds on a cooperation in 2022, through which TTTech Auto and Blackverry integrated the QNX Neutrino rtos and TTTech's MotionWise safe vehicle software platform.
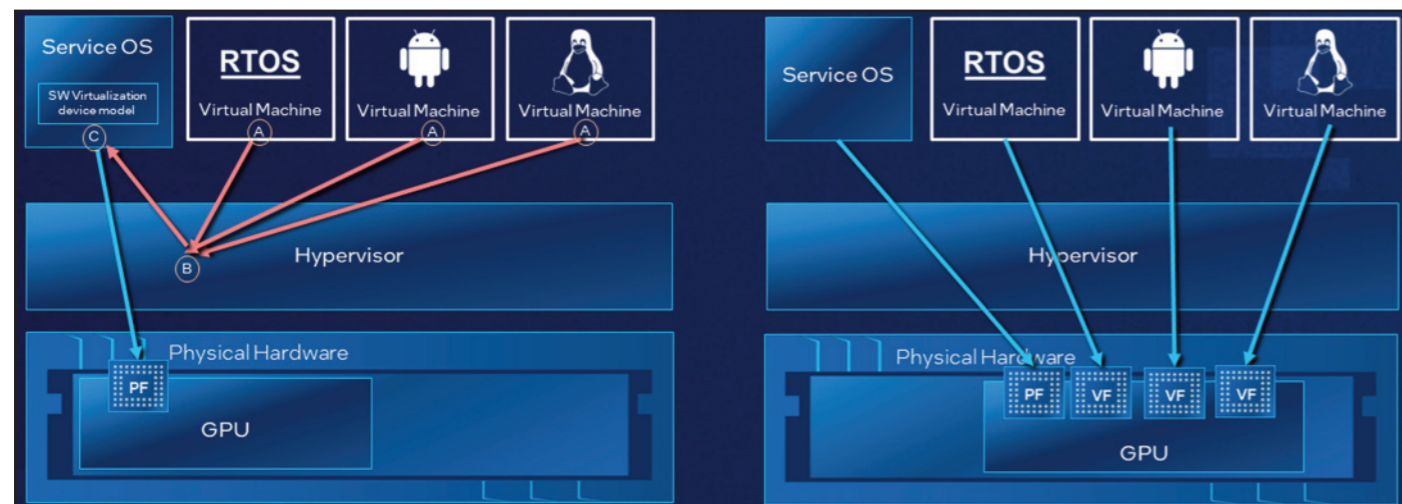
GPU software virtualisation capabilities with hypervisor vs hardware-enabled physical separation

## How Intel silicon-enabled virtualisation can improve SDVs

Using silicon-enforced virtualisation capabilities, Intel Automotive is offering an approach to architecting a software-defined vehicle (SDV) that is said to deliver 99% efficiency and zero latency.

Consumer expectations for quality and personalised experiences have led to this performant compute platform with space for multiple software workloads.

"We have the most power- and performance-efficient implementation of virtualisation on the market," said Jack Weast, general manager of Intel Automotive.

The auto industry has been trying to move towards the software-defined promise by using a hypervisor for software virtualisation, creating a bottleneck that cannot scale with the performance demands of today's workloads. Intel's silicon-enforced separa-

tion enables a direct path, bypassing the hypervisor, and opens up extra performance within the software for higher quality and workloads to unlock features and services.

Think of the compute to power an SDV as if it were an electric vehicle (EV) with a fully charged battery. It is generally accepted that if it goes directly from Point A to Point B, it optimises performance, in this case the vehicle's range. That's how Intel's silicon-enforced virtualisation works; it makes an efficient trip to the hardware.

But if the EV makes a detour to an alternative location (Point C), it must use up vital energy, and the trip takes longer.

This forced detour is similar to the experience delivered by other silicon providers. Namely, too much of the virtualisation functionality is implemented in software – that

trip to Point C – before the workload gets to the underlying hardware. The detour leads to performance degradation.

More technical specificity around the journey shows the benefits that Intel's virtualisation capabilities deliver, in this case through the graphics processing unit (GPU).

The graphic shows the different journey taken when virtualisation must be done in software versus physically separated at the silicon level.

On the left, to run multiple GPU-based workloads via a hypervisor, the virtual machines must access the hypervisor, then the service operating system (OS) – which requires hundreds of extra lines of code and valuable bandwidth – before it can access the GPU.

Conversely, when using Intel SDV SoCs with single-root IO virtualisation, each workload is sepa-

rated at the GPU silicon, freeing up the software layers for additional performance and functionality with no latency.

Using the GFX Manhattan 3.0 benchmark shows that when running a single workload, the Intel-based approach can operate at 99% efficiency compared with others running at 43%.

This means if a workload needs 100frame/s, with Intel the user gets 99frame/s with zero latency. With the alternative, the user gets 43frame/s, plus workload-dependent latency.

With virtualisation, drivers and passengers can experience a more responsive vehicle such as higher frame-rate during game play, 3D map applications instead of 2D, real-time 3D visualisations across multiple displays within the vehicle, or enhanced safety with real-time AI inferencing.

# Nissan plans to commercialise autonomous driving in Japan

Nissan has announced a roadmap to commercialise its in-house-developed, autonomous-drive mobility services in Japan.

This is a step towards the company's long-term vision, Nissan Ambition 2030, to empower mobility by solving transportation service problems faced by local communities in Japan.

Local communities have been facing several mobility difficulties, such as driver shortages, which are a result of an ageing population. With this service, Nissan aims to provide a broad range of services that enable free movement.

Nissan has been testing business models for mobility services in parts of Japan and abroad since 2017. These include in the Minato Mirai area of Yokohama and Namie town, Fukushima Prefecture, where a manned mobility service called Namie Smart Mobility has been in operation since 2021.

Outside Japan, Nissan has been testing autonomous-drive mobility in London and other areas with the support of the UK government.

Nissan plans to begin

offering autonomous-drive mobility services starting in 2027, working with third parties such as local authorities and transport operators. Nissan will begin trials in the Minato Mirai area in 2024, and scale up the trials the following year. During the trials, the level of autonomous driving will be gradually enhanced while assessing consumer acceptance, with the aim to provide driverless services.

This initiative will be promoted in close cooper-

ation with the Japanese Ministry of Economy, Trade & Industry; Ministry of Land, Infrastructure, Transport & Tourism; and other central ministries.

The ministries will also promote initiatives to realise autonomous mobility services at the Level Four Mobility Acceleration Committee that they organise.



Nissan plans to commercialise autonomous driving by 2027

## Arrow and Infineon partner on EV chargers

Arrow Electronics and its Einfochips engineering services company are working with Infineon to accelerate the development of electric vehicle (EV) chargers.

Development of EV chargers, especially DC fast chargers, is becoming more difficult for manufacturers due to a lack of prior experience, stringent functional safety and reliability requirements, and a fledgling support network.

The collaboration between Arrow and Infineon aims to help innovators navigate these problems while accelerating time to market.

As part of the collaboration, Arrow has developed a 30kW DC fast charger reference platform. This includes Infineon's 1.2kV CoolSiC Easy power modules and hardware design, embedded firmware, bi-directional charging support and energy metering functionality.

"Combining Arrow's strength in components, engineering and design services with Infineon's innovative products will help customers accelerate their design and speed to market in e-mobility applications," said Murdoch Fitzgerald, vice president at Arrow. "Customers can

rely on this collaboration to deliver innovative and leading-edge DC faster chargers, accelerate and de-risk design cycles, and get access to a world-class support team enabling them to plan and manage their product roadmap and lifecycles."

Shri Joshi, vice president of Infineon, added: "Infineon is on a drive towards decarbonisation and digitalisation with our ecosystem partners, and this collaboration is a testament to this mission. The joint 30kW DC fast charger reference platform will help our customers bring more fast chargers to market."

## Start-up secures $17.5m to build software-defined radar

Silicon Valley software-defined radar start-up Neural Propulsion Systems (NPS) has secured a $17.5m series B funding round.

The radar can be used to enhance roadway safety benefiting pedestrians, drivers and all other traffic participants. It also has applications in military radar.

NPS will use the investment to develop and apply its atomic sensing platform to automotive radar technology. The platform provides enhanced, reliable radar resolution and precision. The improved performance stems from a mathematical framework known as the atomic norm, changing how the raw sensor data are processed into relevant information.

"This investment confirms the value of our vision and technology," said Behrooz Rezvani, founder and CEO of NPS. "By harnessing the potential of our newly developed radar technology, we can potentially achieve performance enhancements that are over ten times greater than current radar capabilities, putting us at the forefront of revolutionising the $28bn radar market. Our radar software works with all radar hardware and significantly improves the performance of existing sensing platforms with lower cost and more efficiency."

The software-defined radar achieves near maximum likelihood performance in detection, meaning the proprietary software hits close to what is theoretically possible with existing radar sensors, enabling clearer and earlier detection.

Atomic norm tensor processing software achieves high resolution, precision and reliability.

It opens the door for the future of adas, autonomous driving, and aerospace and defence systems.

The National Highway Traffic Safety Administration's (NHTSA) proposed rule changes aim to reduce roadway fatalities by strengthening regulations around automatic emergency braking.

NPS's technology can help companies and suppliers meet these standards using less complex and more reliable sensors.

The round was led by Cota Capital with contributions from GM Ventures, the venture capital arm of General Motors,



NPS software-defined radar image

and RTX Ventures.

"Behrooz and his team are achieving new benchmarks for advanced radar sensing technology," said Bobby Yazdani, partner at Cota Capital. "We recognise the significant impact NPS can have in mobility and defence systems, and our investment reflects Cota Capital's commitment to groundbreaking innovation."

## Karma acquires connected-car pioneer Airbiquity

Californian luxury car maker Karma Automotive has acquired connected-vehicle pioneer Airbiquity, hiring key technical employees and taking over the software firm's OEM contracts.

The acquisition provides Karma with Airbiquity's software portfolio that has evolved over more than two decades to deliver connected vehicles spanning over-the-air updates, software development tools, data management and analytics.

"We are wrapping Airbiquity's software into Karma cloud services and embedded vehicle technology to create a new platform that is greater than the sum of its parts," said Karma president Marques McCammon. "Their commercial software meets the needs of a diverse base of transportation industry customers. Airbiquity has mitigated system challenges we wouldn't necessarily target when designing solely for our own vehicles."

The software has been deployed in more than 60 countries in passenger cars and motorcycles and has serviced large OEMs.

"Their design maturity will help codify our strategies for software-defined and continuously connected vehicles," said McCammon.

# Dell powers Subaru AI driver assist

Subaru is using Dell storage systems to store and manage around 1000 times more files for AI development to improve driver safety.

"Subaru is driving massive innovation through data to give motorists an extra set of eyes and an extra foot on the brake while entrusting Dell to enable this journey as its AI development infrastructure," said Arthur Lewis from Dell Technologies. "As an AI-ready data platform, Dell PowerScale storage allows companies like Subaru to integrate, analyse and use data to deliver impactful insights that advance human progress and transform industries."

Subaru can store, manage and use vast amounts of data to advance the development of its EyeSight driver assist technology with the PowerScale network attached storage.

Sold in more than 5.5 million EyeSight-equipped vehicles, the tech monitors traffic movement, optimises cruise control and warns drivers if they sway out of lane.

Subaru Lab, the firm's AI development base established in 2020, can store about 1000 times more files on PowerScale than with previous platforms. This lets it improve AI image analysis by accessing stored files on PowerScale systems in data centres across the Subaru Lab and Tokyo offices, which wasn't previously possible.

The ability to scale and use data flexibly across locations has expanded the possibilities for business expansion.

"We are constantly expanding AI development to increase the reliability in our vehicles," said Takashi Kanai, deputy chief of Subaru Lab. "While requirements for systems and storage are ever changing, we are confident PowerScale is up to the task as the underlying infrastructure for EyeSight driver assist technology, allowing us to continue advancing our AI initiatives to improve driver safety."

EyeSight only uses stereo camera technology to provide driver assist features such as pre-collision braking, which detects cars, pedestrians and motorcycles in the vehicle's path, as well as adaptive cruise control.

# MTA opens research centre in Turin

MTA has opened a research and development centre in Turin, in the Mirafiori neighbourhood, a district that hosts an automotive excellence hub where major component suppliers have settled.

Already operational, the centre will eventually employ about 25 engineers developing electrical and electronic components for products such as on-board chargers and DC-DC converters for electric and hybrid vehicles, including cars, trucks and heavy-duty vehicles.

MTA's choice fell on the Piedmonts' city that boasts the presence of the Politecnico, a prestigious university for the education of engineers, and a deep culture in the automotive field.

The centre will also host a laboratory with bench tests and instrumentation to allow independent testing of power electronics components.

"The opening of the R&D centre in Turin, which complements the various R&D centres we already have in many regions globally, is a further demonstration of the essence of our company, which is constantly projected towards technological innovation," said Antonio Falchetti, executive director of MTA. "We also count, as already happens with the Politecnico of Milan, to establish a profitable exchange of know-how with the Politecnico of Turin, an excellence for the automotive world.

The centre will therefore enable us to support vehicle manufacturers even better, with an increasingly articulated and technologically advanced offer for the needs of the new mobility."



MTA's R&D centre in Turin

**Vehicle Electronics** **Vehicle Electronics**

# SUITE SUCCESS
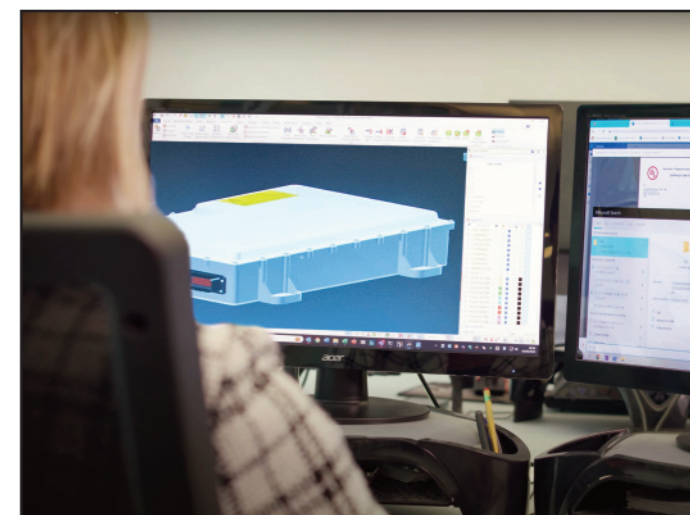
## How a compiler test and validation suite helped a software development tool company meet ISO 26262

Software development tool company TrustInSoft, serves the international aeronautics, telecommunications, industrial IoT and automotive industries via its offices in Paris and San Francisco.

The company's core product – TrustInSoft Analyzer – is a source code analyser that verifies the correctness of a C or C++ programme before it gets anywhere near a compiler.

For automotive use, it needed ISO 26262 functional safety certification from one end of the toolchain to the other, from source code to binary.

Its source code analyser creates a mathematically rigorous model of a C or C++ programme, which, together with information on the programme's input parameters and target architecture, allows users to verify with 100% accuracy that their programme contains no undefined behaviour and conforms to its functional requirements.

"Using formal methods, we can deliver a mathematically definitive answer about a C or C++ programme's behaviour, a mathematical guarantee of the absence of bugs," said Benjamin Monate, chief technology officer at TrustInSoft. "So, if our TrustInSoft Analyzer says a programme is fine, you won't find any violations in it, whatever input vectors you use."

As far as compilation is concerned, the analyser only requires minimal information about the compiler, such as whether it's a GCC-like target and whether it's compiling for a 32 or 64bit architecture.

"For the analysis, we never compile anything," said Monate. "So while some compiler-related information is needed to parameterise the analyser, we assume that when the compiler is eventually invoked, it will work as expected. So, it is up to the customer to select a compiler that implements the C or C++ standard correctly."

As can be seen, this is not a typical customer for Solid Sands' SuperTest compiler test and validation suite. So for a company that's not particularly interested in compiler development or validation, what is TrustInSoft using SuperTest for?

"Of course, they should validate that their compiler works correctly using a test suite such as SuperTest, because if the compiler incorrectly translates their source code, any property that we prove mathematically on the source code is not guaranteed to transfer to the executable," said Monate. "Note that even if a compiler is perfectly conformant to standards, compiling code that contains undefined behaviour will generate an executable that makes no sense and may contain serious and unpredictable safety and security issues. That is why you need to use TrustInSoft Analyzer and SuperTest."

To guarantee the source code and the executable have the same semantics, the most important thing is that the analyser and the compiler interpret the C or C++ language precisely as defined in the relevant standard. For TrustInSoft, SuperTest is one of the tools it uses to check its analyser's compliance.

"Because our tool is offering mathematical guarantees, we must be extremely strict about how we develop the analyser itself, which means we need to rigorously validate it," said Monate. "And for the automotive market, we especially needed to have ISO 26262 qualification. We already have our own extensive range of test suites, but an important part of providing the necessary evidence for ISO 26262 was to use an independent test suite that is already widely recognised in the automotive electronics industry. That's why we chose SuperTest."

The company uses SuperTest to confirm that TrustInSoft Analyzer correctly interprets the semantics of the C and C++ language.

"Using SuperTest we identified a few subtle parts of the standard that were not yet fully supported by TrustInSoft Analyzer and are now implemented and qualified," said Monate. "We were also able to identify some minor discrepancies in the way Solid Sands and our own engineers interpreted the C and C++ standards, which made it a highly rewarding collaboration, and one that we hope to continue. What really matters to us is that SuperTest helped us to extract a coverage matrix of the standard and to present that as evidence of the quality of our tooling – that we never say something incorrect about the code – based on a completely independent test suite that is carefully designed to check all possible corners."

For software developers of safety-critical systems who need end-to-end ISO 26262 qualification of their toolchain, using a combination of TrustInSoft Analyzer and SuperTest to validate their source code and ensure correct compilation can fit seamlessly into continuous integration environments.

Founded in 2014, Solid Sands is a one-stop shop for C and C++ compiler and library testing, validation, and safety services. It offers test and validation suites so its customers can achieve the software tool quality level demanded by ISO standards.

**Benjamin Monate: "We especially needed to have ISO 26262 qualification."**

Salman Safdar explains how simulation is ensuring steering technologies stay on track

Image by **Ирина** from Pixabay

# NAVIGATING THE FUTURE

Of all the connections between vehicle and driver, the steering system, as the primary means of controlling the vehicle, is perhaps the most crucial. How it responds to inputs and communicates back to the driver is arguably one of the most nuanced behaviours of the whole driving experience.

Crucially, steering feel can define a vehicle's dynamic character and, as the industry moves towards more driver assistance, establish driver trust.

As renowned designer Gordon Murray said: "You're on a grippy bit of the road, and then you get to a patch that's slightly greasy. You lose a tiny, tiny bit of weight in the steering, which tells you immediately back off, because you're about to start going sideways faster than you'd like."

However, steering feel isn't just the domain of former Formula One designers or the enthusiast driver. Having light steering and a tight turning circle are the attributes needed when tackling the city commute or driving a light van all day. It's also a very personal aspect of driving that remains wholly focussed on human interaction and feel.

### Evolution
The fine tuning of steering systems has long been a key topic for engineers who have to consider not just the hand wheel and steering rack but also bushing, tyres and the entire suspension system. They have already embraced electric power assisted steering (EPAS), variable ratio steering, even four-wheel steering and torque vectoring.

Now, the industry has

progressed to steer-by-wire, whereby there is no mechanical connection between the hand wheel and steering rack. Toyota has been an early advocate.

It's already legal in Japan, the EU and China – the latter believed to be the most stringent – while the USA is still to ratify the technology. Toyota has said its system was tested by hundreds of people, both in and out of the company to ensure it is as intuitive as and safe as possible.

Testing steer-by-wire with the adequate number of people on a test track or proving ground can be achieved but the process can take months, with little or no guarantee that conditions will be representative each time. It's the lack of repeatability, not to mention the issues of putting lay drivers in such a scenario, that has resulted in driver-in-the-loop (DIL) simulation emerging as a development and testing game changer.

**Consistent**
The DIL simulator's strength lies in its ability to combine realistic test conditions seamlessly with

the limitless variability, consistency and repeatability of the digital realm.

Convincing human drivers they are moving through an environment at a certain speed or steering in a particular direction is not easy but today's engineering-class DIL simulators offer the high-fidelity, high-dynamic, human-centric immersion qualities needed to replicate everything from aggressive manoeuvres to the nuances of the subtle feedbacks inherent with steering in real time.

And all this can happen early and often in the development process before any metal is cut.

Moreover, OEMs with simulators in different regions can share their vehicle models so teams in the USA, Asia and Europe can drive the same car on the same day in the same conditions, adjust and then all drive it again, enabling more people to have input.

As the vehicle design matures, the DIL simulator continues to shine by providing a ready-to-go platform for fine-tuning without

the constraints of waiting for physical updates or optimal test conditions.

**Testing**
Such versatility breaks down the traditional constraints of testing schedules, allowing engineers to reimagine plans unrestricted by seasons or vehicle access. High-speed autobahn, frozen lake, city centre or steering pad – they can all be driven in a single afternoon on a DIL simulator. Increasingly, digital twins of favoured test routes or proving grounds also enable test drivers to correlate results against a known datum.

As DIL simulators evolve so do the abilities and tests that are possible. The fidelity and versatility of today's engineering-class simulators enable drivers to experience simultaneous braking, accelerating and turning events, precisely what's needed for steering development. As well as more scenarios to validate, individual steering responses for different applications, drive modes or adas interventions are now all possible but also bring with them an increased calibration workload.

Fortunately, DIL simulation can help here, too, with the early-and-often human feedback necessary to dial in the sweet spots that reflect the targeted engineering attributes and brand DNA.

**Virtual reality**
The complexity of modern steering systems extends beyond mechanical components alone. Integration with external sensors and modules introduces additional layers of validation where DIL simulators can prove invaluable.



Steering engineers can access a ready-to-go platform for testing, without waiting for physical prototypes or optimal test conditions



DIL simulation seamlessly combines realistic test conditions with the consistency of the digital realm

Crisper graphics (4K rendering and full-surround 360° vision screens now increasingly the standard for engineering-class DIL simulators) and low latency motion systems, offer the ability to go further down the validation chain in the virtual world. Even complex effects such as fog, dirt or fluids on sensors and lens flare can all be accurately modelled in software, giving total repeatability.

Now engineers can even point a physical camera at a simulator's projection screen to acquire a video feed. The lines between real and virtual might be blurred but the results are crystal clear.

**Autonomy**
As the automotive industry edges – albeit slower than many predicted – towards autonomy, steering will continue to take centre stage in the cabin as the key physical and psychological touch point between manual and autonomous control.

DIL simulators are already hard at work in engineering centres around the world determining how to make this seamless transition between human and machine control. For many, these simulators offer a unique avenue for participants to experience the sensations of autonomous driving for the first time, providing

crucial insights into system responsiveness and occupants' reactions and behaviour. It's a fascinating opportunity for this generation.

As the industry navigates towards a future of autonomous possibilities, the steering system, in all its digital glory, continues to steer the course of automotive innovation, just with a little more guidance from DIL simulators.

**Salman Safdar is DIL subject matter expert at Ansible Motion**

# BRIDGE ARCHITECTURE

**Manshul Arora asks if the industry is ready for the emerging automotive radar satellite architecture**

With worldwide NCap safety ratings and regulations growing more stringent towards active safety functions, safety is a non-negotiable feature in today's vehicles. Car manufacturers across the globe are meeting these safety requirements and targeting higher levels of autonomous driving by continuously enhancing adas features within their vehicles, including automatic emergency braking (AEB), adaptive cruise control (ACC) and advanced lane centring.

To support these features and meet safety regulations, the number of radar sensors around the car is increasing.

One way automotive system designers are addressing the implementation of adas features is by reconsidering the structure and integration of electrical and electronic systems architectures. The typical architecture today is edge architecture, which consists of highly intelligent radar sensors streaming processed data through a Can or 100Mbit Ethernet interface to an adas ECU.

These sensors are designed for high performance and consist of a processor and often a specialised accelerator to perform range, Doppler and angle fast Fourier transform (FFT), along with subsequent high-level algorithms for object detection, classification and tracking.

The final object data from each edge radar sensor are then sent to the adas ECU. Fig. 1 illustrates edge architecture.

The edge architecture is evolving and giving way to satellite architectures, where the sensor heads strewn around the car stream pre-processed range FFT data to a powerful central ECU through a high-speed 1Gbit Ethernet interface.

A significant portion of the data processing is offloaded to the

central ECU, see Fig. 2.

Satellite architecture enables centralised data processing using minimally processed data at the central processor unlike edge architecture, where individual radar sensors conduct all data processing independently.

Centralised processing enables the implementation of effective sensor fusion algorithms, resulting in more accurate decision-making.
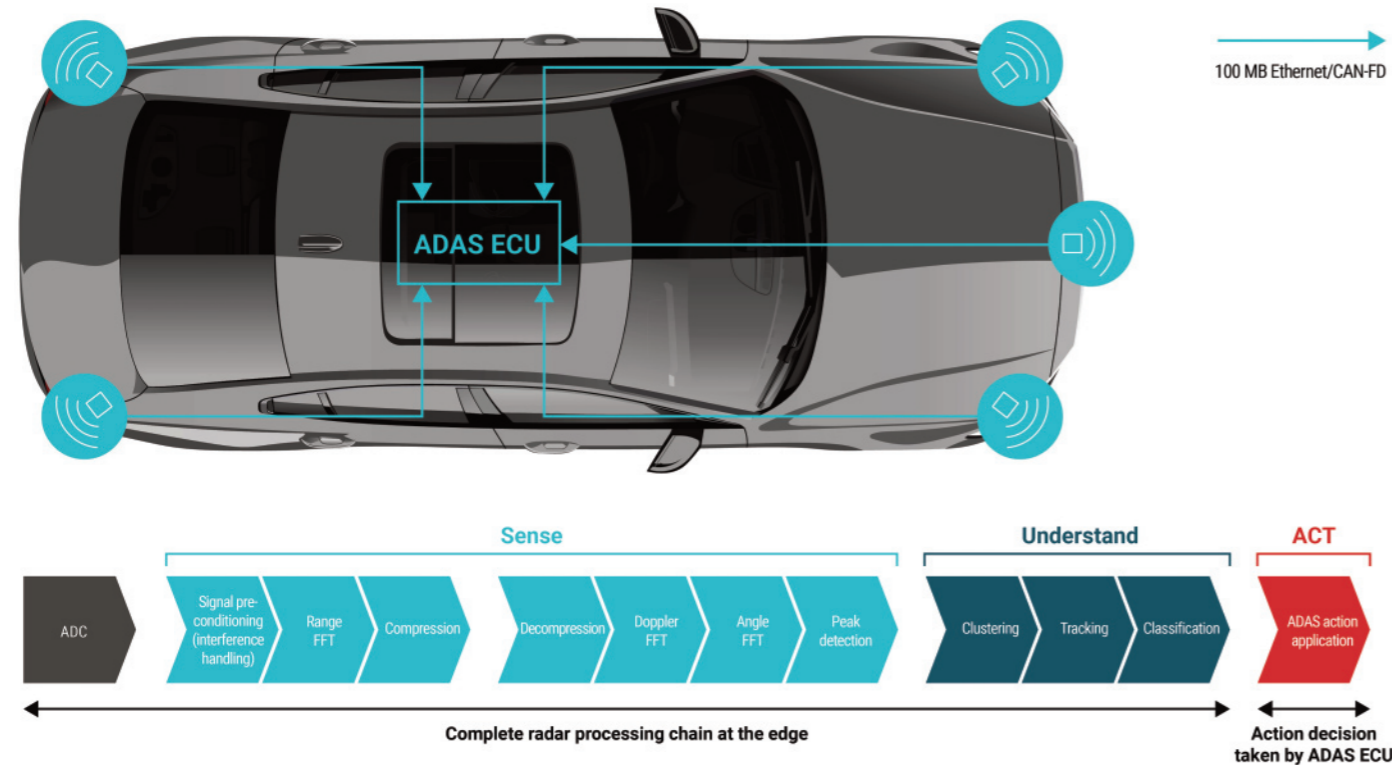


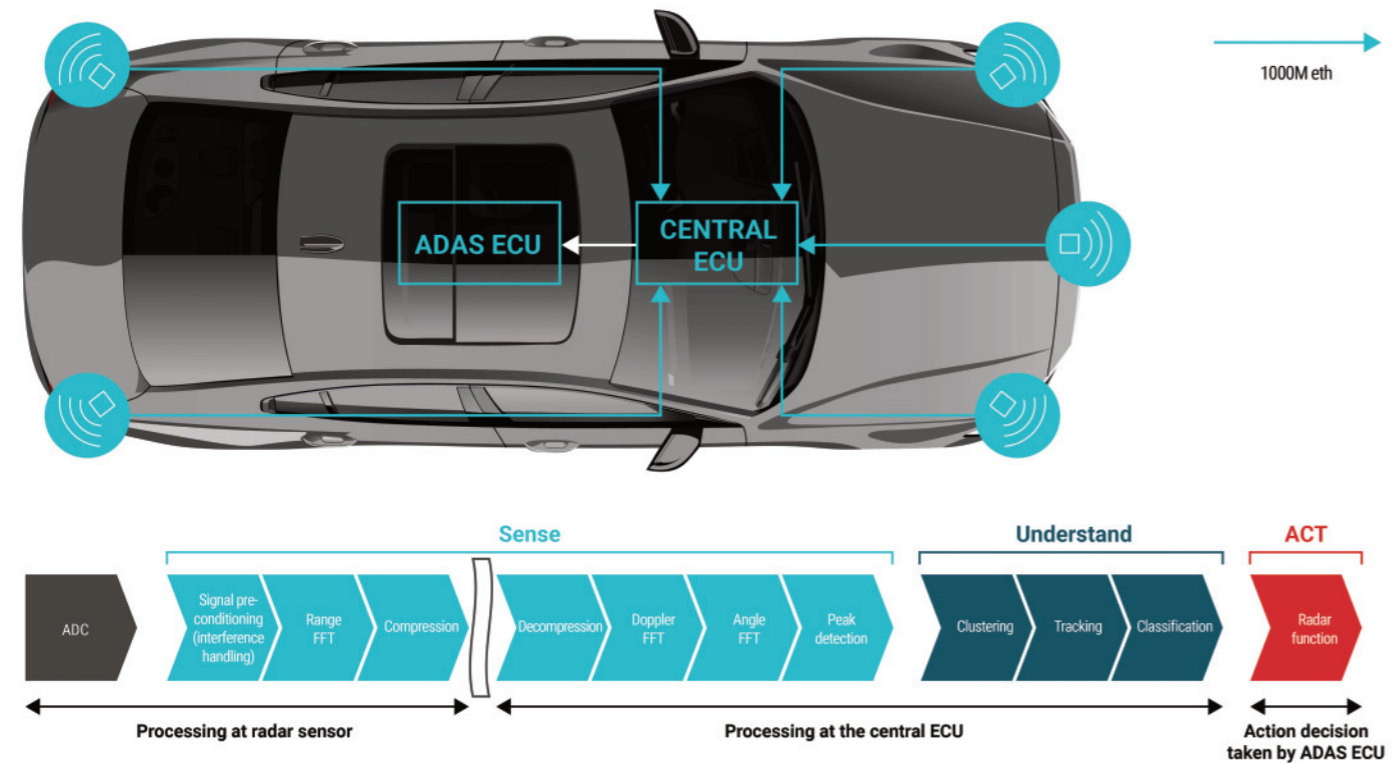Fig. 1a and b: Radar sensors in edge architecture connected to adas ECU



Fig. 2a and b: Radar sensors in a satellite architecture connected to a central ECU

An apt parallel is how the human brain makes decisions based on inputs from both eyes instead of each eye deciding independently.

Original equipment manufacturers (OEMs) can deploy algorithms for increasing angular resolution (distributed aperture radar), maximum velocity or even machine-learning algorithms for object classification.

The fusion of sensor inputs coupled with these algorithms improves sensing performance and results in a comparatively precise perception map. For automakers, this translates to an increased autonomy level. For drivers and passengers, it means safer cars.

In addition, using satellite radar sensors enables system scalability and modularity.

The ability to place sensors in more convenient places around the car enables many adas applications. It is possible to adjust the degree of coverage just by changing the number or configuration of the sensors, thus scaling a single platform from a cost-sensitive low-end vehicle to a differentiated premium vehicle offering with different levels of autonomy.

Satellite architecture adds value through a sensor fusion algorithm and the larger computing capability in the central ECU. Simplified satellite sensors and differentiation through software can help reduce system complexity and offer new ways of creating value. Additionally, using satellite radars gives automakers the option to use over-the-air software updates to improve system performance and enhance security.
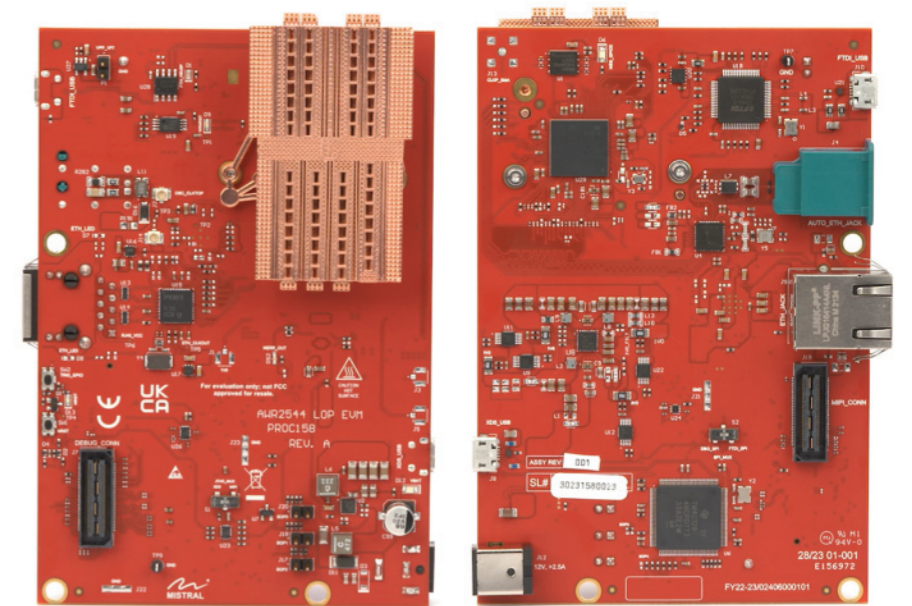


Fig, 3: Evaluation module with a 3D waveguide antenna

These multiple benefits – performance, scalability and simplicity – all contribute the prominence of the satellite architecture in the automotive industry.

There are radar sensors designed for satellite architecture. Such a radar-on-chip sensor can have an integrated 77GHz transceiver with four transmitters and four receivers, providing increased range detection and better performance. It can also include a radar processing accelerator and a throughput-enhanced 1Gbit/s Ethernet interface to generate and stream FFT-compressed data.

Launch-on-package (LoP) technology enables direct signal transmission from the package-radiating element to the 3D antenna through a wave guide within the PCB. Fig. 3 shows an evaluation module with a 3D waveguide antenna.

At the system level, LoP technology improves performance through an increased signal-to-noise ratio, eases thermal management, lowers cost by avoiding costly RF PCB material, and enhances flexibility by enabling PCB reuse across multiple sensor designs.

### Conclusion

Adas applications continue to evolve to keep pace with rising autonomy levels and safety requirements. As new architectures such as satellite architecture emerge, the sensing and processing technology in these systems must also evolve to support new capabilities. Devices such as a radar sensor give automotive system designers flexibility when adopting these trends and help create safer, smarter vehicles for everyone.

**Manshul Arora is product marketing engineer at Texas Instruments**

# LOTUS POSITION

How Lotus Cars is switching to wireless battery management for performance electric vehicles

The global automobile industry is embracing the electric vehicle (EV) as the way of the future with an increasing number of new models going electric. High performance vehicle manufacturers are also joining the trend, shifting away from the internal combustion engine and racing towards electrification.

The benefits of EV technology are innumerable, including faster acceleration, greater horsepower and higher maximum torque from the get-go.

Given the minimal moving parts, electric motors are reliable, require little to no maintenance, and provide precise traction and stability control. Efficiency is also higher, with less friction and heat produced and less cooling required. Every metric for electric vehicles is better, except for one – battery weight.

One such high-performance vehicle maker is Lotus Cars, which delivers elegant, engineering marvels that inspire drivers. Committed to providing a sustainable, all-electric vehicle future, Lotus is part of Geely Auto, the world's fastest-growing auto manufacturer group.

To achieve its vision of a lightweight vehicle and all-electric future, Lotus adopted a wireless battery management system (wBMS) for its new line of EV production cars set for delivery inside the next five years. This was developed by Analog Devices. (ADI) to reduce EV battery weight by eliminating the battery harness and associated cabling while increasing battery reliability.

Together, ADI and Lotus

developed a lightweight powertrain architecture and a wBMS for increased design flexibility, scalability and repairability. Developed to propel Lotus' future EVs, the engineering should help to enable a more sustainable environment and a healthier planet.

"Industries around the world are pivoting towards new technologies that protect the health of the planet," said Patrick Morgan, corporate vice president at ADI. "Electric vehicles, and the push for clean energy, are rapidly becoming part of our daily lives. We are honoured to collaborate with Lotus to deliver our ground-breaking production wireless BMS for their iconic vehicle line."

For more than 70 years, Lotus has transformed the world of road and racing. The auto manufacturer wished to take advantage of wBMS technology and remain at the forefront of high-performance vehicles and a leader in the move towards electrification.

In 2020, during the pandemic,
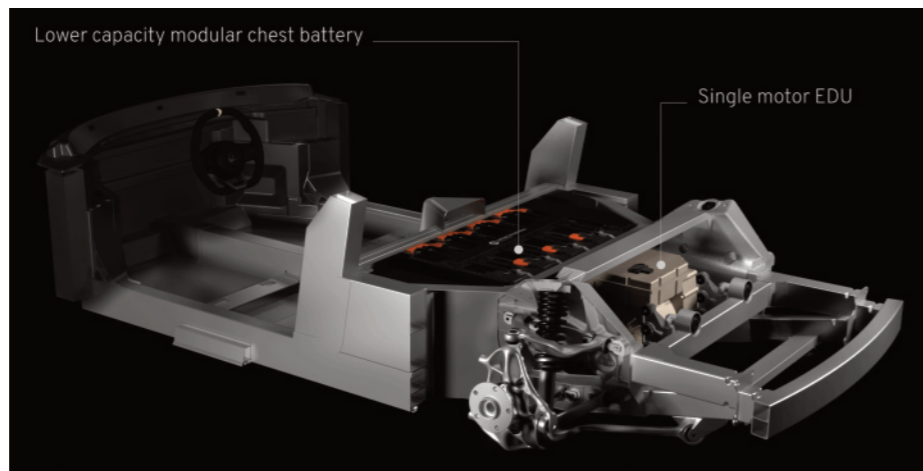

Example of Leva in two-seat sportscar with standard wheelbase

Lotus approached ADI engineers about its future line of production EVs. Lotus sought a collaboration, adopting wBMS into its lightweight and high-performance road cars. ADI was tasked with delivering not only a lightweight wBMS, but a seamless integration that aligned with the car maker's core operating model of repair and flexibility.

Discussions followed, focused on Lotus' lightweight EV powertrain architecture and how ADI's wBMS could help simplify design and complexity, and result in additional weight reduction.

A wBMS removes the need for the battery harness as well as numerous wires and connectors associated with the standard wired BMS. ADI's wBMS reduces pack wiring by up to 90% and decreases pack volume by up to 15%. Eliminating wires reduces vehicle weight and material costs, with the added benefit of increasing battery safety, reliability and repairability.

"The removal of the wire harness for wBMS ensures that Lotus can deliver the high performance consistent with the

brand by offering a lightweight option that optimises performance," said Roger Keen, general manager for e-mobility at ADI.

The wBMS is composed of 40 hardware components. The full system is tied together with turnkey software, an end-to-end robust and secure network, and battery cell monitor software.

Components include: the ADBMS6815, which accurately measures the state of charge of the battery cells and pack; LT8618 compact, high speed, high efficiency synchronous monolithic step-down switching regulator for power management; and ADRF8800, which ensures robust and reliable wireless connectivity.

"Our latest wBMS products also support battery recycling and reuse in energy storage systems to support the circular economy," said Keen. "Offerings from our competitors might bundle hardware, but you wouldn't have software tying it all together. With ADI wBMS, there is no software for the customer to write, enabling them to focus on other aspects of vehicle design."

ADI's wBMS evaluation kit gets


Patrick Morgan: "Industries around the world are pivoting towards new technologies that protect the health of the planet."

users up and running out of the box. It's a full, end-to-end wBMS, including multiple boards, software and cyber security.

"If you had to build a system from everybody's components, it would take months just to get a prototype working," said Shane O'Mahony, product marketing engineer at ADI. "How quickly can you get me up and running and testing on the wBMS's wireless network? That's the first question customers ask. If that takes months, they just won't do it. We've overcome that obstacle."

### Collaboration

ADI technical experts collaborated with Lotus design engineers to integrate the wBMS into the EV maker's powertrain architecture, referred to as Leva, for lightweight electric vehicle architecture.

"We worked closely with ADI to integrate wBMS in our new Leva powertrain architecture, which will be the basis for all future Lotus EVs," said Richard Lively, director of propulsion and chassis

engineering at Lotus. "The removal of the wire harness for wBMS ensures that Lotus can offer a lightweight option that optimises performance and is consistent with our brand of delivering powerful performance cars with exceptional handling."

Design flexibility was critical to success. ADI met Lotus' requirement head-on. The wBMS allowed for quicker, easier and simpler battery restructuring design, enabling a more optimised battery pack assembly and streamlined manufacturing process.

The wireless nature of the battery management system provided Lotus with the design versatility to scale future EV models more efficiently.

On-site collaboration between Lotus and ADI's design engineering teams was limited due to Covid restrictions. Not willing to be held back, Lotus and ADI ran the engagement using conference calls, collaboration software and step-by-step how-to videos.
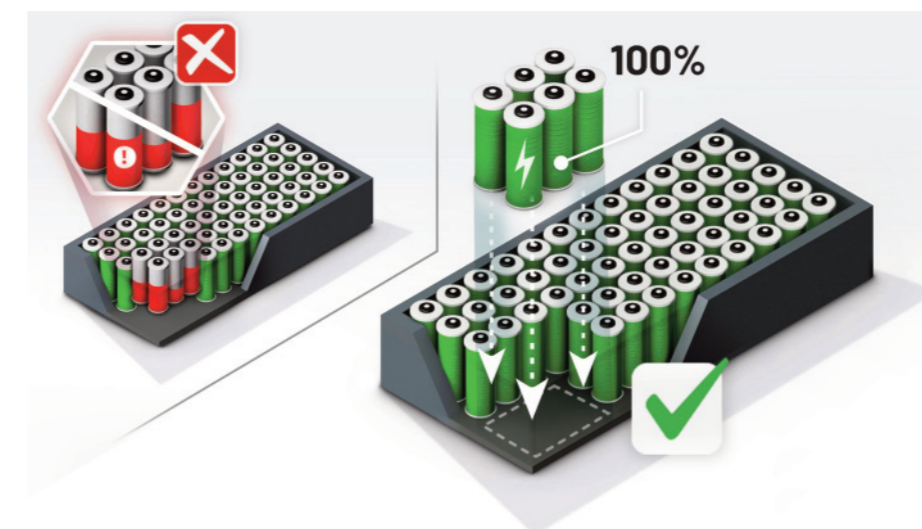

A wBMS extends the useful life of the battery pack by enabling the identification of abnormalities in cells for easy and quick replacement


Roger Keen: "Lotus engineers are now free to design the car how they see fit."

### Architecture

The Leva powertrain architecture is designed for mid-engine high performance vehicles. The driver sits up front, behind the console and steering wheel. Everything else is behind the driver. Most of the vehicle's weight sits in the middle of the four axles, improving weight distribution, stability and handling. Other advantages of the design include increased safety and reduced wear.

Lotus will leverage Leva's flexible architecture on other vehicle designs and future production models.

Engineering and breakthrough technologies enable Lotus to realise better performance through light weight. Reducing the car's mass is the most effective means of achieving a connection between driver, car and road.

"Lotus' primary focus during the ADI engagement was removing the wires and keep everything lightweight while maintaining optimal BMS performance," said O'Mahony.

Eliminating the electric battery

Gina Aquilano: "Wireless BMS enables state of health measurement and robotic assembly and disassembly of battery packs."

pack's wiring harness takes weight out of the vehicle. Battery pack unharnessing also improves reliability as the associated cables and connectors are notoriously points of failure for the system. An added benefit is that an untethered battery pack is better suited for design flexibility and scalability.

"Weight is a killer of high-performance sports cars," said O'Mahony.

### Flexibility
Flexibility in battery restructuring is critical, particularly to the engineer designing the ever-changing shape of aerodynamic EVs. The wBMS not only provided Lotus with a quick and easy path to develop versatility, scalability and optimisation, it offered the means to fit more batteries in the pack in a vehicle design through the void left by harness removal. More batteries in

the powertrain, under the right circumstances, translates to enhanced power performance and extended vehicle range.

"Lotus engineers are now free to design the car how they see fit, as opposed to designing the car as well as possible given the constraints of a battery harness," said Keen.

A nightmare of tangled complexity would emerge if every one of the hundreds of cells in a battery pack had a wire attached to its positive and negative terminal. Thus, wired battery management systems employing limited cell wiring are incapable of monitoring each cell. State of health of the cells can't be measured, it can only be inferred by checking the state of charge of the battery in aggregate. Low charge or dead cells escape detection.

In wBMS, battery cells transmit a wireless signal, sending data to the cloud to be stored securely. Using a laptop, a Lotus technician or a local mechanic can drill down and see extensive information, including the state of charge and

the state of health of every group of parallel cells in the battery pack.

OEMs, operating from headquarters, can quickly upgrade the battery software. The wBMS offers Lotus engineers flexibility without increasing complexity and cloud-grade cyber security.

With a traditional wired BMS, open space is required between battery modules for human hands to attach many wires and connectors. The wBMS modules have only two terminals, and modules can be packed more tightly, increasing density and decreasing form factor. The terminals can easily be connected using thin robotic tools.

Robotic assembly translates into a denser battery pack. Battery assembly and disassembly in second life, via robotics, is fast, safe and accurate, saving time and money for EV vehicle manufacturers.

"Wireless BMS enables state of health measurement and robotic assembly and disassembly of battery packs to ensure inefficient battery cells can be identified and
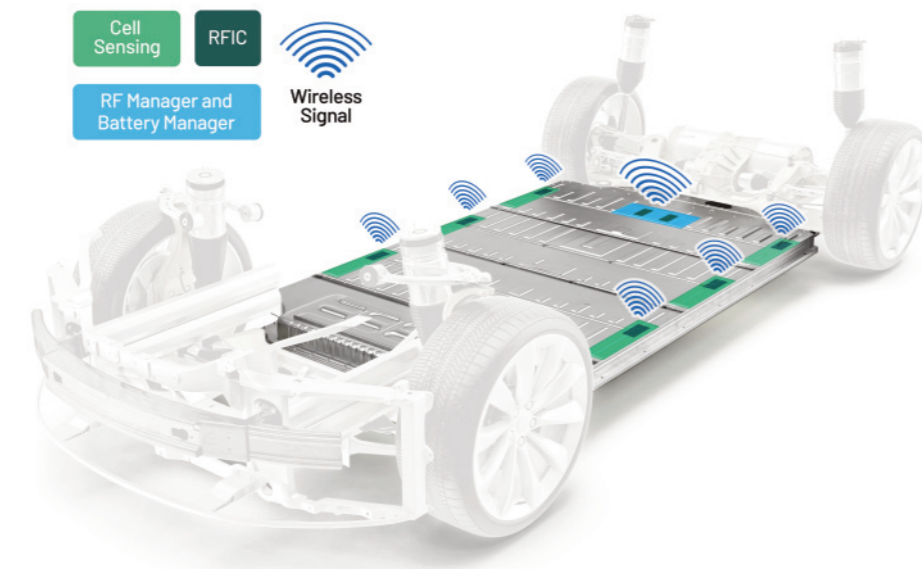


How a wBMS works
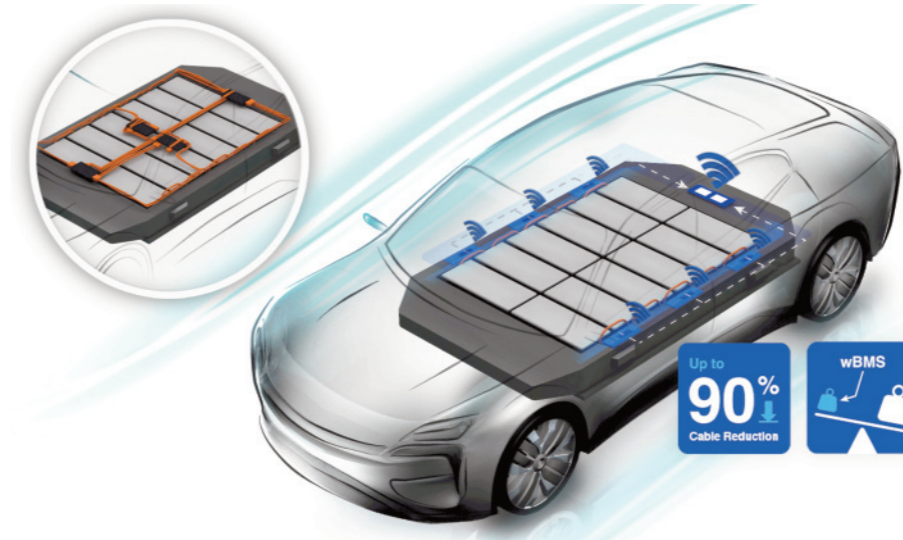


Reduction in cable results in reduction in weight

removed, and the pack repaired," said Gina Aquilano, director of technology at ADI.

After years of use, when the wireless battery packs are capacity reduced and no longer suitable for optimum EV power performance, they can be repurposed for use in clean and sustainable second-life applications, such as less demanding energy storage systems and power grids around the world. Spent EV batteries have the potential of delivering the promise of an electrified future by storing excess solar and wind power.

"It's an unsustainable business model to replace the entire battery pack every time a single cell or group of cells lose their capacity prematurely," said Lively. "ADI's wBMS enables a quick, easy and cost-effective answer to our repairability requirement."

### Lifetime
Lotus doesn't put a half-life on any of its vehicles; many are still on the road after 25 or 30 years as classic cars, creating a conundrum

for the manufacturer. A car with virtually no half-life requires that you keep it up and running forever while maintaining the batteries at optimum performance throughout the vehicle's lifetime.

With wBMS, serviceability is easier and faster for road vehicles and trackside since the battery modules only have two terminals (positive and negative) and are software programmable for quick and convenient over-the-air updates. The cell controller lives with the battery module for life as one serviceable unit, furthering the simplified service model.

The repair business model is anything but new. It's an essential cornerstone in almost every industry today, from homes to appliances, to tooth restoration. EV battery repair should also generate a significant business opportunity for local mechanics, spare part distributors and OEMs. Its impact on a sustainable environment is vast.

"No other BMS competitor offers the same capability as ADI to repair the battery," said O'Mahony. "Repairability will

help to set Lotus apart from other EV makers and save as much as six tons of carbon to the environment. And it helps to ensure Lotus vehicle owners of decades of high-performance driving enjoyment."

A wBMS also extends the useful life of the battery pack by enabling the identification of abnormalities in cells for easy and quick replacement, saving time and cost.

### Conclusion
Mindful of the consumer shift towards a greener world and dedicated to providing product life longevity and high performance, ADI and Lotus targeted lightness, repairability and sustainability in their collaboration.

The engineering effort provided a smaller footprint, reduced cabling and battery pack volume, and one flexible system across multiple designs, making it easier to scale and quicker and safer to assemble and disassemble.
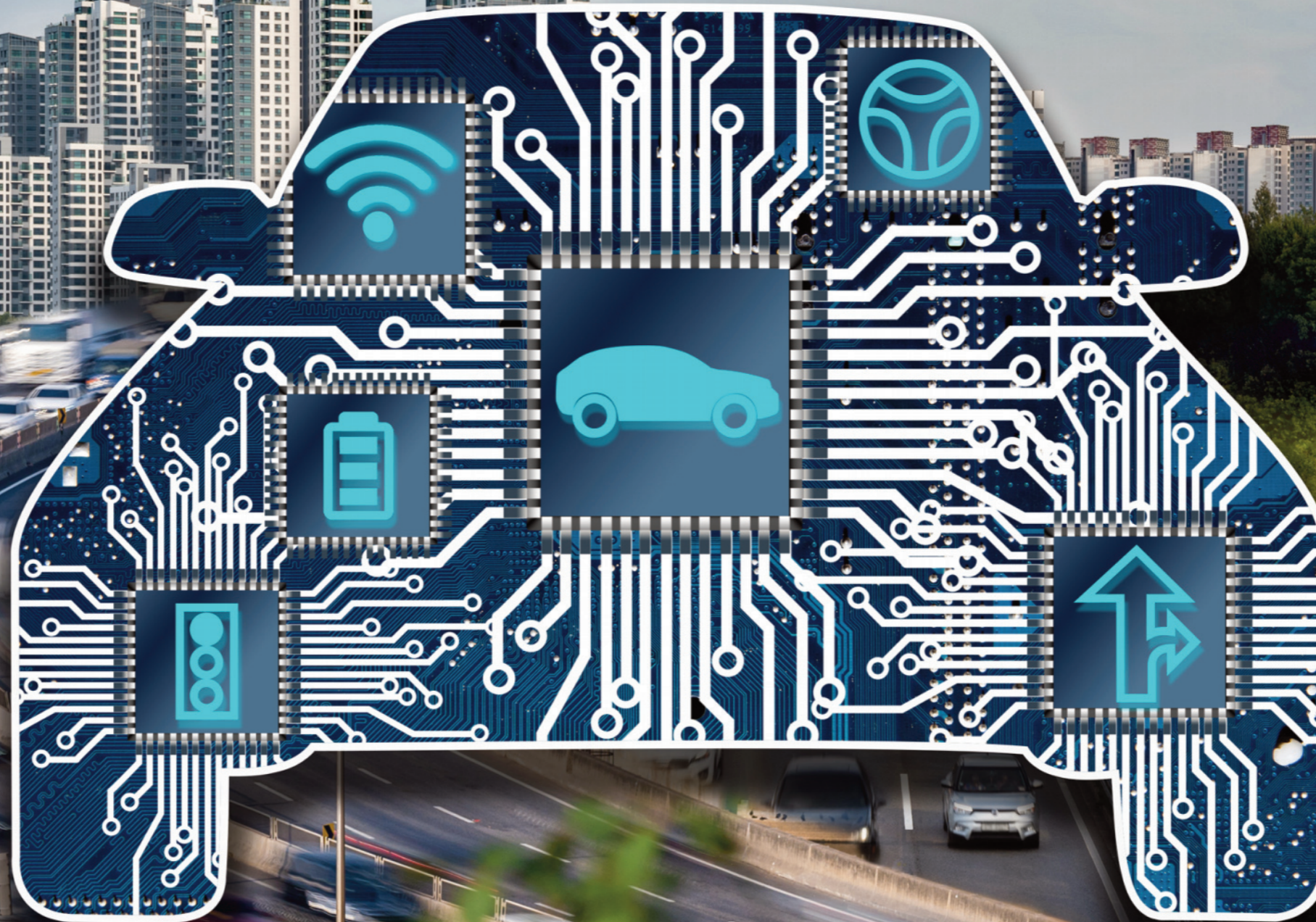


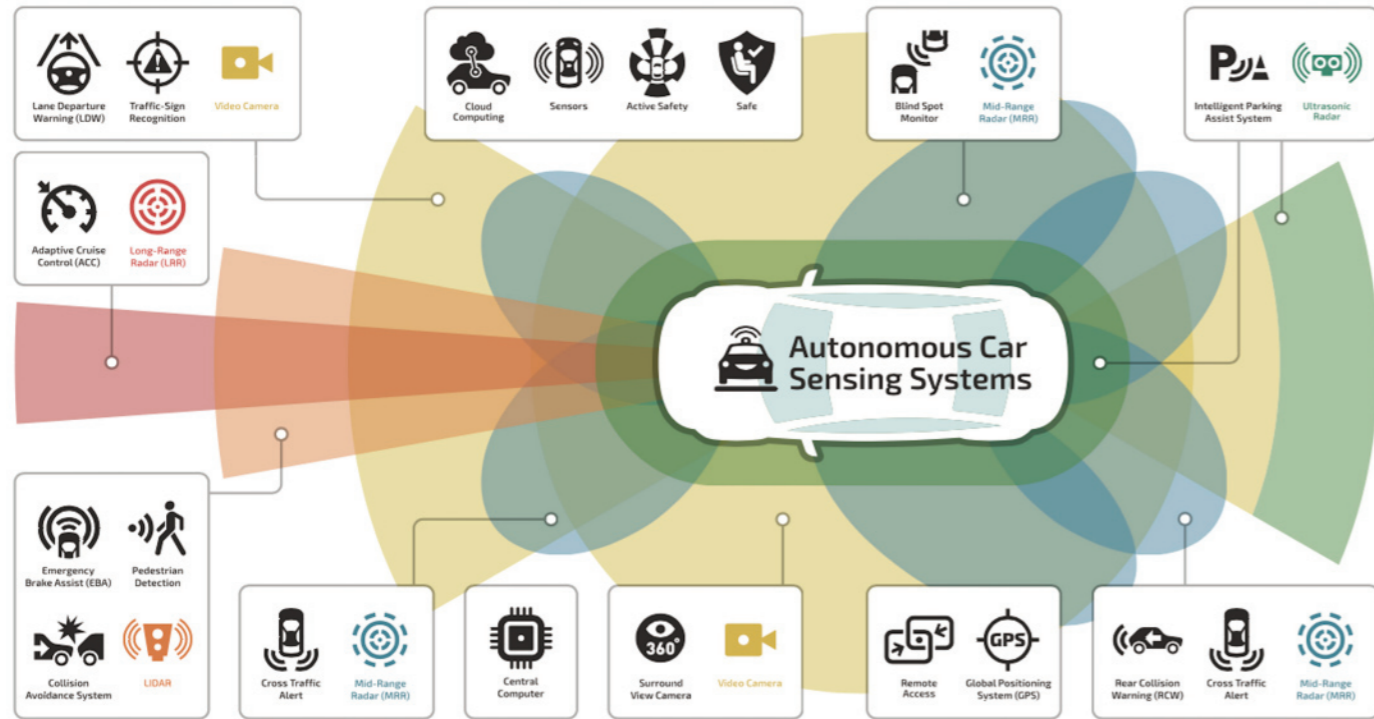Shane O'Mahony: "Repairability will help to set Lotus apart from other EV makers."

# IN THE ZONE

Steve Shih discusses the role
of centralised storage in
the emerging zonal
automotive
architecture

**Sensing systems around a vehicle**

The latest zonal architecture promises to simplify vehicle electrical infrastructures, potentially saving weight and complexity while enhancing reliability, safety and security. As this approach is adopted, software-based virtual machines with hardware-based IO virtualisation are needed to manage resources and ensure isolation.

As modern vehicles rely increasingly on electronically controlled and software-defined functions, the typical domain-based electrical architecture that dedicates a control unit for each is giving way to a zonal approach.

The domain approach, which groups functions by domain such as powertrain, chassis and infotainment, has driven a rapid increase in the number of ECUs on board the vehicle as well as increased wiring complexity.

The zonal approach, where ECUs are classified according to their location in the vehicle, contains a centralised communication gateway and compute module sized to handle workloads from multiple ECUs within the vehicle. It gives the opportunity to reduce the number of ECUs and simplify the wiring, permitting space savings and reduced vehicle weight.

In addition, as vehicles become more complex with features and connectivity, zone-based architectures can scale more easily by adding or modifying zones. Further advantages include the potential to ease system integration by grouping related functions and components together, which reduces complexity during development, as well as the chance to improve fault isolation and improve safety and security by compartmentalising functions into zones.

While transitioning to the zone-based architecture to get savings and improvements, it is important to retain some attributes that have been present in the preceding approaches such as the domain-based architecture. Some critical functions, such as safety-critical systems, for example ABS and airbags, benefit from being isolated within their domains and can permits enhanced safety by reducing the risk of interference from other non-critical functions.

It is also worth noting that domain-based architectures allow for specialised development teams for each domain, for example powertrain and infotainment. These teams can focus on optimising their specific functions, leading to potentially higher performance and efficiency within their respective domains.

Zonal architecture adoption is anticipated to accelerate the trend towards software-defined vehicles as zonal gateways and the central compute cluster can be easily updated with software to improve functionality or add new features. Moreover, the zonal gateway facilitates the integration of powerful edge computing to ensure the vehicle can handle critical events that require fast response.

## Virtualisation
In a zone-based architecture, virtual machines (VMs) can play a crucial role by offering isolation, resource control, flexibility and security. They are valuable tools for designing and managing complex systems with multiple functional zones.

Isolation is achieved by running each functional zone on a separate VM. This way, any zone experiencing a failure or security breach is less likely to impact other zones, which enhances overall system reliability and security. In addition, VMs allow computing resources such as CPU cycles, ram and storage to be precisely allocated to each zone. This enables critical zones to receive the necessary resources, while contentions that can lead to performance issues are avoided.

Also, using VMs allows separation between software stacks for different zones, permitting each VM to have its own operating system and software dependencies. Compatibility issues and conflicts between zones can be reduced.

In addition, security policies and access controls can be configured to allow fine-grained security management within each zone and thus strengthen security for sensitive data and functions.

During development, engineers can work on individual zones within separate VMs, allowing for isolated testing and debugging. This reduces the risk of changes in one zone affecting others. On the other hand, VMs can be easily duplicated or scaled to accommodate changing requirements within a particular zone.

In an automotive electrical infrastructure, various functions and components run on different VMs to isolate their software stacks.

These VMs are used for specific tasks, such as powertrain control, infotainment or adas. Where this is the case, IO virtualisation is an effective technique that enables the VMs to interact efficiently and securely with physical IO devices such as sensors, actuators and storage.

For implementing this, single-
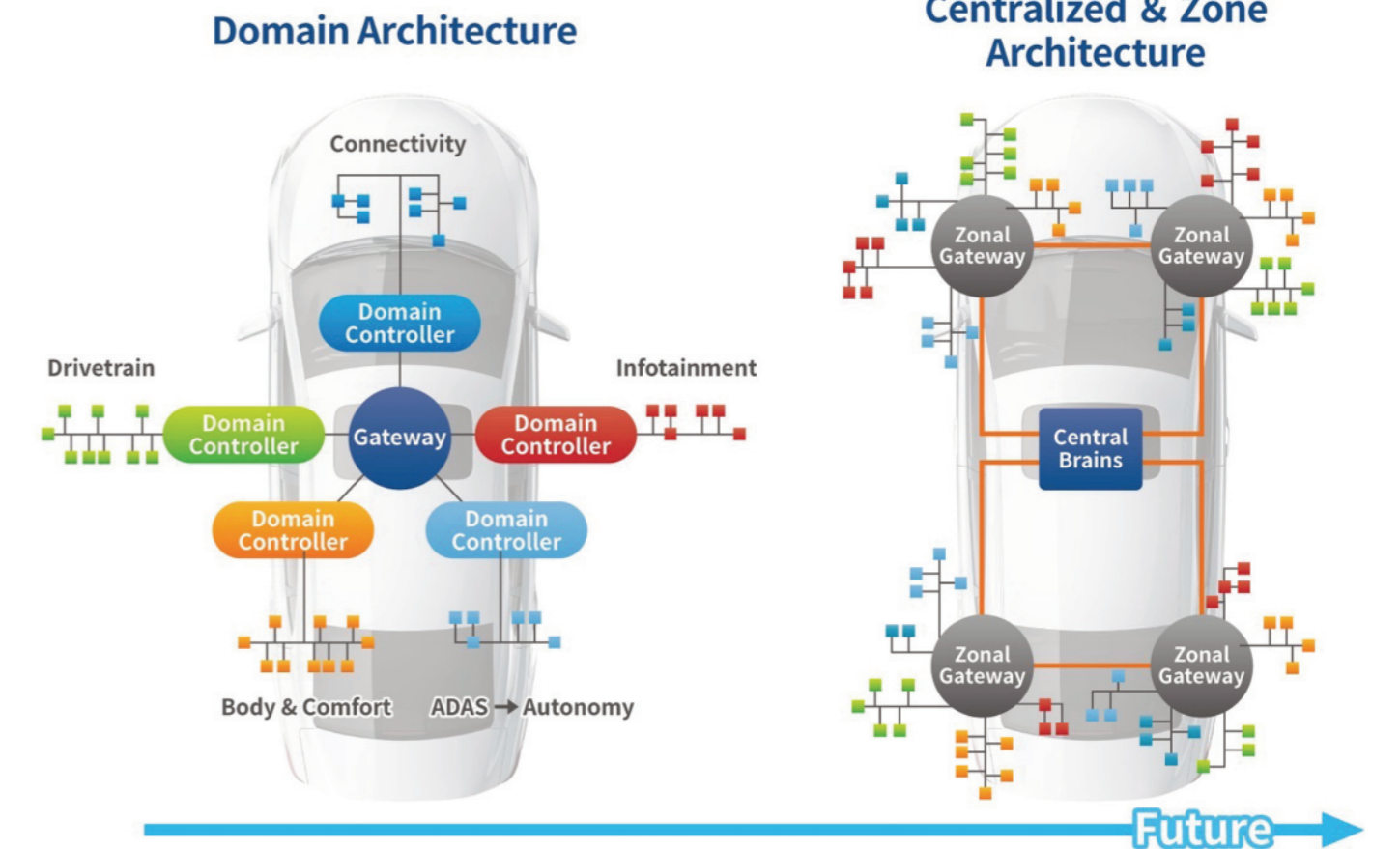


Moving from domain to zonal architecture

root IO virtualisation (SR-IOV) delivers several advantages. It improves reliability and security by providing strong isolation between virtual functions and the physical device to prevent conflicts, ensuring that each VM can access the necessary hardware without contention. Also, by providing a standard framework for configuring and monitoring virtualised IO devices, SR-IOV can simplify the management of IO resources.

The key advantage of SR-IOV is it allows data to bypass the hypervisor layer, enabling direct data transfer between the VMs and the PCIe port NVMe SSD. This direct path significantly reduces latency by eliminating the data allocation between PCIe and host, and it lessens the computational load on the CPU that hosts the hypervisor.

In addition, multiple VMs or partitions can share a single physical IO device, thereby ensuring efficient resource use that reduces the number of dedicated hardware components needed. This can be especially

valuable in space-constrained automotive environments.

In applications where real-time processing of data from sensors and actuators is required, VMs aided by IO virtualisation can access hardware interfaces directly and efficiently, reducing latency and overhead. As more vehicles rely on adas and autonomous driving, for improved safety, virtualisation is effective to ensure timely responses to critical events.

IO virtualisation also contributes to fault isolation and recovery. If a VM fails, the function-level reset (FLR) command can reset and reconnect the VM with the SSD without impacting other VMs and virtual functions.

This enhances system reliability of automotive systems and is important for safety-critical applications.

Finally, using VMs with IO virtualisation can strengthen security and enhance scalability. Each VM can be configured with specific security measures including access controls and policies tailored to its function,

preventing unauthorised access to IO resources. Scalability is ensured by allowing additional VMs or partitions to be added without major changes to the underlying hardware.

As the industry moves towards zonal automotive architectures, seeking efficiency gains and bill-of-materials savings, combining VMs with IO virtualisation ensures efficient, scalable and reliable systems. VMs help compartmentalise functions, while IO virtualisation enables the VMs to interact with physical IO devices, ensuring isolation, real-time performance and security.

The advantages of SR-IOV architectures for the evolving needs of the automotive market include efficiency and low latency.

SR-IOV ensures near-native response times, leading to efficient and stable systems. In automotive applications where even millisecond delays matter, this can be crucial. In addition, reduced CPU use allows data to bypass the hypervisor and go directly to the application. This
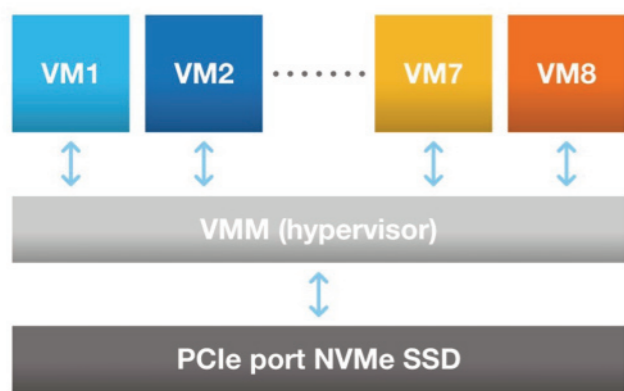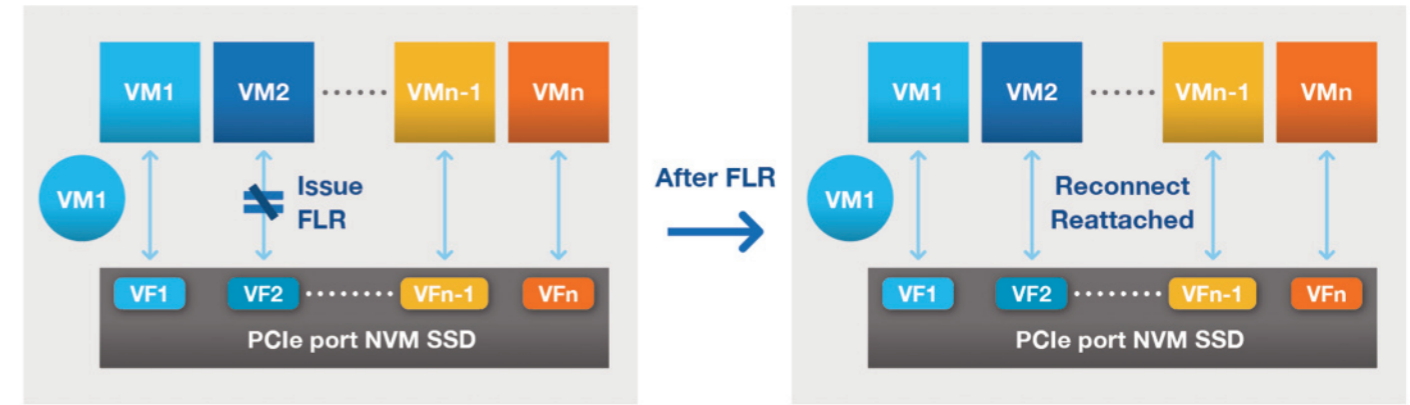


**FLR can reset individual SR-IOV functions**

allows for more CPU resources to be available for other tasks, thereby improving efficiency.

### Scalability
By providing multi-namespace support, SR-IOV permits efficient sharing of IO resources among multiple applications or virtual machines. This is invaluable in automotive contexts that necessitate the simultaneous operation of several services, such as navigation, infotainment and driver-assistance.

SR-IOV ensures seamless communication, enabling information sharing among different virtual functions (VFs) thereby bolstering the collaborative capabilities of various automotive systems.

### Reliability
Isolation is ensured. The function-level reset (FLR) interface can reset the individual SR-IOV functions. This ensures that, when a VM fails, it can be reset and FLR used to reconnect with the SSD without impacting other VMs and VFs.

In the automotive context, this ensures critical systems are isolated from non-critical systems, reducing the risk of system-wide

failures and enhancing the reliability and security of each application running on the hardware.

As automotive systems continue to evolve, SR-IOV provides a robust architecture tailored to integrate technologies seamlessly. Its ability to allocate VFs to support VMs directly reduces latency significantly. SR-IOV thus ensures low latency and high throughput, which meets the critical requirements for real-time data processing in autonomous driving vehicles.

SR-IOV facilitates resource optimisation by reducing CPU use and aiding efficient use of IO. This can significantly reduce the total cost of ownership for automotive companies.

Lower CPU use also means less energy consumption, which is a critical factor in battery-operated electric vehicles.

### Management
SR-IOV requires less complex configuration and management compared with traditional IO virtualisation methods, making it easier to deploy and maintain.

From performance gains and reduced CPU use to better scalability and futureproofing,
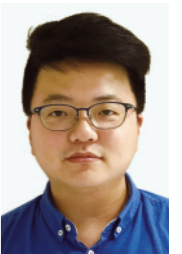
SR-IOV presents a strong case for being the go-to architecture for future automotive systems.

### Summary
The surge in data transmission and computational needs within automotive systems is driving a transformative shift in vehicle architecture. As vehicles become more reliant on electronic control and software, there's an uptick in the demand for controllers and a challenge to manage the complexity and bulk of wiring.

The zonal approach can simplify the vehicle architecture as the number of functions continues to increase. With automakers and tier-one suppliers increasingly adopting SoCs that accommodate the PCIe interface, the future system requirements align closely with the existing PCIe NVMe SSDs as well. This trend indicates that PCIe SSDs in the automotive industry will be more widely implemented in the next few years.

**Steve Shih is automotive and embedded product marketing manager at Silicon Motion**



**SR-IOV architecture lets VMs direct data transfer with the PCIe port NVMe SSD, streamlining data transfer processes to reduce latency**

# Reference design aids Qi v2.0 implementation

As charger manufacturers, including those in the automotive industry, work to implement Qi v2.0 (Qi2) standards, Microchip has released a Qi 2.0 dual-pad wireless power transmitter reference design.

The design is powered by a single DSPic33 digital signal controller (DSC).



A key feature of the Qi2 standard, recently released by the Wireless Power Consortium (WPC), is a magnetic power profile (MPP) with support for magnetic alignment between the transmitter and the receiver.

The DSC's flexible software architecture enables the support of a combination of MPP and extended power profile (EPP) of Qi 2.0 with one controller.

Using the Qi2 reference design helps reduce risk in certifying the final product, which is required to pass the Qi certification process.

As it integrates several Microchip automotive-qualified parts, the dual-pad charger also meets automotive standards for reliability and safety.

The automotive-grade hardware and software enable easier automotive integration with support for Autosar and Autosar Microcontroller Abstraction Layer Architecture (MCALs), functional safety and more.

An integrated crypto-authentication IC provides security to meet the authentication requirement of Qi standards.

As part of the reference design, Microchip can deliver design files and software to ease the design experience and first-pass success.

The design includes the DSPic33 DSC and a TA100/TA010 trust anchor secure storage subsystem provisioned by Microchip as a licensed WPC manufacturer certificate authority.

The design includes the ATA6563 Can transceiver, MCP14700 gate drivers, and MCP16331 and MCP1755 regulators.

Features include: dual-pad transmitter supporting Qi 2.0; MPLA and Q-FOD; thermal power foldback and shutdown; transmitter based on fixed-frequency topology control to optimise EMI and EMC performance; integration into automotive environments with Can-FD hardware and software; DSPic33 capable of integrating NFC for card detection, protection and communication; uart-USB communication and gui for reporting and debugging of data packets; and hardware reconfigurable and capable of supporting most transmitter topologies.
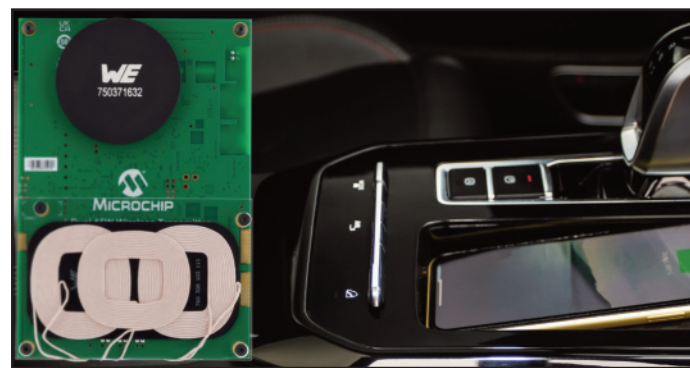
# Varistors protect against load dumps

Load dump varistors from Kyocera AVX are zinc-oxide-based ceramic semiconductor devices that provide bidirectional overvoltage protection and EMI and RFI attenuation in an SMT package qualified to AEC-Q200.

Part of the TransGuard automotive series, they have a monolithic multi-layer construction, non-linear, bidirectional voltage-current characteristics, high-current and -energy-handling capabilities, multi-strike capabilities, and sub-nanosecond response times.

They are also available with glass encapsulation for enhanced resistance against hazards such as acids, salts and chlorite flux.

The varistors protect circuits from voltage transients caused by ESD, induction motor loads, module load dump and other disruptions.

The peak current rating of 2kA is higher than the rest of the series, making them more effective at protecting against high-energy automotive load dump transients.

They are for internal combustion engine, hybrid electric and plug-in hybrid electric vehicles, including commercial vehicles, and can be used in Can, Lin and Flexray modules, sensors, and induction motors.





## EV connector

An electric vehicle (EV) connector from ITT Cannon is for the European charging station market.

The CCS2 is available in 200, 250 and 300A variants with a boost mode that increases its amperage to 500A.

These tethered lead, mode-four connectors have an exchangeable mating face that enables EV charging network providers to complete a quick and seamless in-field mating face replacement.

The product combines a modern matte black aesthetic with a durable UV-resistant design.

Streamlined for weight and size, it includes an optional power consumption measurement capability for charging station monitoring and maintenance.

They are customisable, from custom handle colours to end terminals, and bespoke logos or graphics. They use flexible ergonomic cables.

An uncooled design requires no liquid refrigerant. Ambient operating temperature is -30 to +50°C.

# Mosfets handle rugged OBC and DC-DC use

Automotive-grade 600 and 650V super-junction mosfets from ST Microelectronics deliver efficiency and ruggedness for on-board chargers (OBCs) and DC-DC converters in hard- and soft-switching topologies.

The STPower MDmesh DM9 AG silicon-based devices combine low energy losses with switching performance.

Compared with the previous generation, the DM9 technology ensures a tighter gate-source threshold voltage spread that results in sharper switching for lower turn-on and turn-off losses.

In addition, body-diode reverse recovery is improved, leveraging an optimised process that also increases the mosfets' overall ruggedness.

The diode's low reverse-recovery charge and fast recovery time make the devices suitable for phase-shift zero-voltage switching topologies that demand efficiency.

The family offers a selection of through-hole and surface-mount packages that help designers achieve a compact form factor with high power density and reliability.

The TO-247 LL (long-lead) is a popular through-hole option that eases design-in and leverages proven assembly processes.

Among the surface-mount packages, the H2Pak-2 (two leads) and H2Pak-7 (seven leads) are for bottom-side cooling with thermal substrates or PCBs featuring thermal vias or other enhancements. HU3Pak and ACEPack SMIT topside-cooled surface-mount packages are also available.

The first device in the series is the STH-60N099DM9-2AG, a 27A AEC-Q101 qualified n-channel 600V device in H2Pak-2, with 76mΩ typical $R_{DS(on)}$.

The family will be extended to provide devices covering a broad range of current ratings and $R_{DS(on)}$ from 23 to 150mΩ.
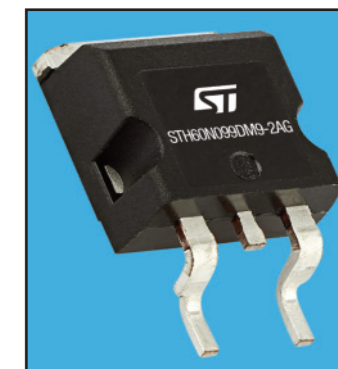


## Ethernet connector uses press-fit pins

A customisable Automotive Ethernet connector from Ennovi supports 10Gbit/s operation and is for vehicle manufacturers and tier-one suppliers.

The Ennovi-Net connector has a standard USCar interface with press-fit pins as opposed to through-board solder pins.

This avoids the need for soldering, making the assembly process simpler and faster, with a lower risk of errors.

As solder usage is eliminated, there are no problems caused by variations in the amount of solder paste applied and the capacitance associated with this. In addition, the shortness and lower capacitance of press-fit pins means resonance is reduced.

For these reasons, greater signal integrity can be achieved.

The design allows for customisation to accommodate board and connector interface positioning.
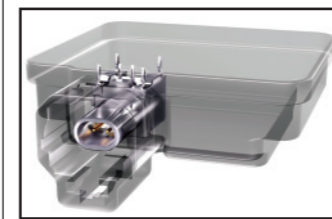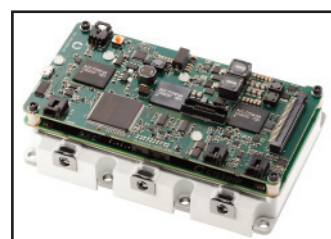
# SiC modules suit e-mobility

SiC inverter control modules (ICMs) from Cissoid are dedicated to the e-mobility market.

These software-powered modules can help engineers create functionally safe, robust and modular e-motor drives while shortening time to market.

The CXT-ICM3SA series offers hardware and software integration of the firm's existing three-phase 1.2kV, 340-550A SiC mosfet intelligent power modules with an Olea T222 field programmable control unit (FPCU) control board and Olea app inverter application software, sup-

plied in partnership with Silicon Mobility.

Depending on the selected ICM, this modular core engine can power and control high-voltage SiC traction inverters with battery voltages up to 850V, at output power in excess of 350kW, and with peak efficiency above 99%.

This integration facilitates the rapid development of SiC inverters by solving EMC problems often generated due to fast-switching SiC transistors, by supporting different modulation schemes, such as SVPWM or DPWM, combined with dead time compensation, and by offering motor control algorithms, including field oriented control and flux weakening management.

A complete SiC inverter reference design allows

motor bench testing of the ICM with key peripheral elements such as current sensors, a DC-link capacitor and EMI filter.

The ICM supports the drive of high-speed motors, with no compromise on efficiency, thanks to the combination of a low losses SiC power module with the fast real-time FPCU, enabling switching frequencies up to 50kHz.

Furthermore, this application-specific processor dedicated to e-motor control, with onboard programmable hardware, accelerates the response time to critical events, off-loading the processor cores and enhancing functional safety.

Both the FPCU and the control software are ISO-26262 Asil C and D certified and Autosar 4.3 compliant.
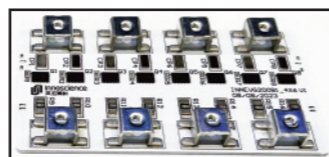


## Bidirectional GaN circuit

A 100V bidirectional member of Innoscience's VGaN IC family can be used to improve efficiency in 48 or 60V battery management systems (BMSs), as well as for high-side load switch applications in bidirectional converters, switching circuits in power systems and other fields.

The INV100FQ030A is for applications such as e-scooters and e-bikes.

One VGaN can replaces two back-to-back silicon mosfets; they are connected with a common drain to achieve bidirectional switching of battery charging and discharging, further reducing on-resistance and loss with respect to traditional silicon.

BoM count, PCB space and costs are also reduced.

The IC supports two-way pass-through, two-way cut-off and no-reverse-recovery modes.

Devices have a gate charge of 90nC, dynamic on-resistance of 3.2mΩ, and 4 by 6mm footprint.

The products are in mass production in En-FCQFN (exposed top side cooling) and FCQFN packaging.

## Mosfet meets efficiency and density targets

A 750V G1 discrete Cool-SiC mosfet from Infineon suits industrial and automotive applications.

They are optimised for totem-pole PFC, T-type, LLC and CLLC, dual active bridge (DAB), heric, buck-boost, and phase-shifted full bridge (PSFB) topologies.

Applications include electric vehicle charging, onboard chargers (OBCs) and DC-DC converters.

The combination of a typical threshold voltage of 4.3V with low QGD:QGS ratio ensures robustness against parasitic turn-on and enables unipolar gate driving for increased power density.

Proprietary die-attach technology improves thermal impedance for equivalent die sizes.

With a granular portfolio from 8 to 140mΩ $R_{DS(on)}$ at +25˚C, this de-

sign has lower conduction and switching losses.

It comes in QDPak TSC, D2Pak-7L and TO-247-4 packages for automotive.
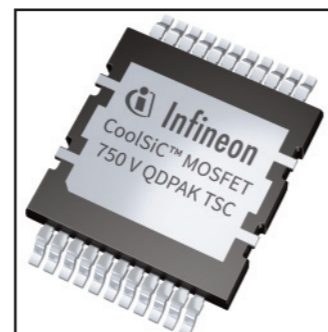


# IP extended to tackle sensor fusion

Cadence has expanded its Tensilica IP portfolio to address the increasing computational requirements of automotive sensor fusion applications.

The Tensilica Vision 331 and 341 DSPs combine vision, radar, lidar and AI processing for multi-modal, sensor-based designs.

When paired with the Tensilica Vision 4DR accelerator optimised for 4D imaging radar, users can improve radar performance and energy efficiency.

The DSPs combine the Tensilica ConnX and Vision instruction-set architectures to offer SoC providers for automotive, drone, robotics and autonomous vehicle systems a programmable, single-DSP for image sensing, radar, lidar and AI workloads.

The 1024bit Vision 341 provides twice the multiply-accumulate capability of the 331 DSP while delivering better energy efficiency than GPUs or CPUs.

For certain 4D imaging radar workloads, the 512bit Vision 331 offers up to four-times performance improvement and the Vision 341 up to six times performance improvement compared with the Vision 230 DSP.

The DSPs deliver up to two-times computer vision performance improvements for computer vision filter and NMS algorithms, as well as AI improvements for quantisation and depthwise separable convolution.

The DSPs support the Tensilica Instruction Extension (TIE) language, letting users customise the instruction set.

The firm's NeuroWeave software development kit provides neural network support for both DSPs.

In addition, the DSPs support more than 1700 OpenCV-based vision library functions, Slam library, point cloud library, radar library, nature

DSP library, OpenCL and the Halide compiler for computer vision, imaging, radar and lidar applications.

Both cores are automotive ready with Asil-B hardware random faults and Asil-D systematic fault certification.
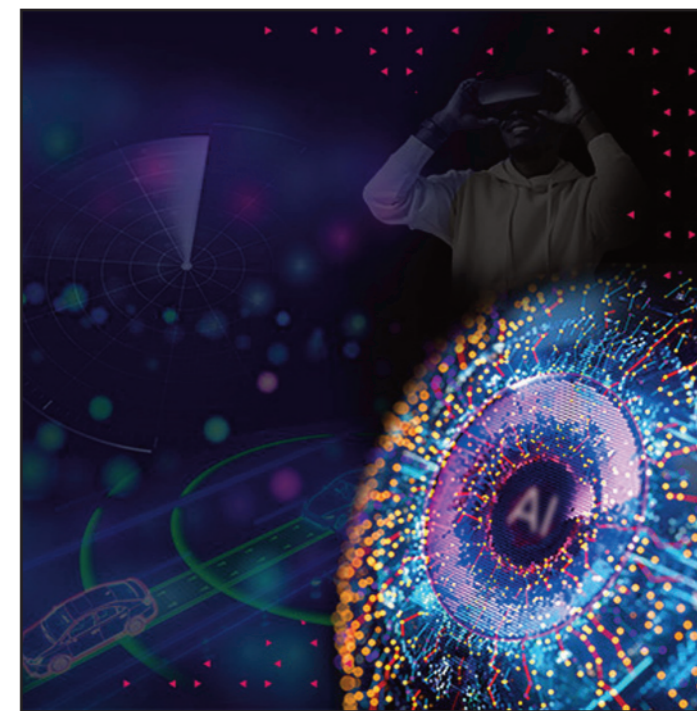


## Analogue switches protect electronics

Four- and eight-channel analogue switches from Nexperia protect 1.8V electronic systems.

The multiplexers include AEC-Q100 variants for automotive applications as well as standard



versions for other uses.

The control pins in the NMux 1308 and 1309 switches operate independently of their power supply voltage range, negating the need to use additional components to perform level-shifting and thus saving board-space and reducing costs.

Fail-safe logic lets control pins be biased prior to system power-up and remain biased after the system has powered down. This eliminates the need for power sequencing between the analogue

switch and the MCU.

A power-off protection feature lets analogue pins be biased prior to power-up and remain biased after power-down. This removes the restrictions associated with power sequencing for the analogue switch and various power rails that support analogue signals and ADC circuitry further down the signal chain.

The combination of both features prevents back-power of the supply rail through any pin of the analogue switch.

# Mosfets meet 48V demands

Two n-channel power mosfets from Toshiba meet the growing demand for 48V batteries and systems within automotive applications including inverters, semiconductor relays, load switches and motor drives.

The automotive sector requires power semiconductors that offer high levels of reliability coupled with large drain currents and heat dissipation. This is especially true for devices in traction inverters, battery management systems, junction boxes and integrated starter generators.

The 80V XPQR-8308QB and 100V XPQ1R00AQB are based on the firm's U-Mos X-H process. This gives levels of on-resistance less than 0.83 and 1.03m$\Omega$, respectively. Drain current values are 350 and 300A continuously with pulsed values of 1050 and 900A, respectively.

Te L-TOGL package uses a thick copper clip-based leadframe structure that thermally and electrically connects the mosfet die to the package leads.

This reduces the package resistance by about 70% and channel-to-case thermal impedance by 50% compared with the TO-220SM(W) package.

Together, the process and clip reduce losses and heat generation while improving thermal efficiency.

Furthermore, the L-TOGL package uses compliant gull-wing leads that reduce mounting stress and improve the reliability of solder joints. This helps ensure ECU reliability in automotive applications with harsh temperature conditions.

Both devices are AEC-Q101 qualified.

Mosfets are often connected in parallel to increase current capability, especially in automotive.
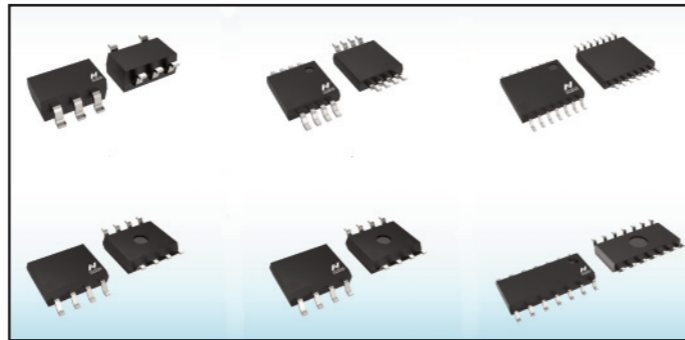


# Op amps provide signal conditioning

General-purpose operational amplifiers from Novosense are for automotive and industrial applications.

They can be used for signal conditioning of voltage, current, temperature and other signals in OBCs, DC-DCs, PDUs, traction inverters, BMS, thermal management, BCM, industrial automation, photovoltaic inverters, motor drivers, digital power supplies and charging stations.

The NSOPA9xxx series caters to applications of up to 40V. A low-voltage version operating at 5.5V is due soon.

Within each series, bandwidth options of 1, 5 or 10MHz are available, with one, two or four channels.

Industrial and automotive-grade versions are offered for each model.

The automotive version meets AEC-Q100 grade one, and can operate from -40 to +125˚C.

Different packages are available: sot23-5 and soic-8 for one channel; msop-8 and sop-8 for two-channel; and tssop-14 and sop-14 for four-channel.

The NSOPA-901x, 905x and 910x versions correspond to bandwidths of 1, 5 and 10MHz, respectively.

The NSOPA905x 40V model has an offset voltage of 200$\mu$V and a drift down to 0.5$\mu$V/˚C.

Built-in EMI and RFI filters strengthen the suppression of space radiation interference.

When the power supply surpasses 4V, the typical DC power supply rejection ratio (PSRR) exceeds 130dB, while the AC PSRR reaches 85dB at 1kHz and 65dB at 10kHz.

The DC common-mode rejection ratio is 110dB minimum and 120dB typical in the main input pair interval of a 40V supply.

Slew rate is 12V/$\mu$s to manage sudden pulse signals such as during overcurrent or overvoltage.

# LDOs handle load current fluctuations

Primary LDO regulators from Rohm have 45V rated 500mA outputs for supplying power to automotive electronic components such as ECUs that operate from vehicle batteries.

The BD9xxM5-C range incorporates QuiCur high-speed load response technology to deal with load current fluctuations. For example, the LDOs can maintain output to within 100mV of set voltage even as the load changes between 0 and 500mA in 1$\mu$s rise and fall time.

Furthermore, 9.5$\mu$A typical current consumption contributes to lower power consumption in automotive applications.

These products will be available in four packages, ranging from the compact HTSOP-J8 to the high heat dissipation TO252 and HRP5 types.

The range meets the basic requirements for automotive, including +150˚C operation and AEC-Q100 qualification.

The line will be expanded to comprise 18 models, including the TO252-3, TO252-5 and HRP5 packages, by the end of this year.

Applications include ECUs that operate on vehicle primary power supply systems, fuel injection, tyre pressure monitoring, body control modules, instrument clusters and head-up displays.

QuiCur is the name of the proprietary quick-current high-speed load response circuit capable of increasing load response characteristics without causing instability in the feedback circuits of power supply ICs.

Stable operation of the power supply IC is also possible with low output capacitance. And, in the case of switching regulators, which are a type of power supply IC, it is possible to adjust the capacitance and output voltage fluctuation linearly to achieve stable operation even when the capacitance is changed due to specification changes, reducing the number of hours required for power circuit design, both in terms of decreasing component count and ensuring stable operation.

To aid design, high accuracy Spice models use original model-based technology to reproduce the electrical and temperature characteristics of the actual IC, resulting in a match between the IC and simulation values.