Automotive World

Software-Defined Vehicle MAGAZINE

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Software-centric chips anticipate the AI-defined vehicle

Intel claims discrete GPUs will accelerate in-vehicle AI | **Cadence** predicts the chiplet inflection point is coming | **ZF** swaps hardware for software in smart e-trucks | **GlobalFoundries** brings data centre tech to automotive | **Continental** and **Hyundai Mobis** differentiate through dashboards | **Scout Motors** introduces in-cabin tactility to SDVs

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Contents

Editorial summary

Pinning down the meaning of 'software-defined vehicle' (SDV), changing a persistent legacy mindset focused on hardware, and meeting customers' rapidly changing expectations constitute some of the biggest challenges facing the automotive industry today.

New technologies provide the opportunity to differentiate and personalise the in-cabin experience. However, automakers must strike a balance: high-resolution touchscreen displays can create deeply immersive infotainment systems, but an SDV does not inherently exclude tactility and physical buttons when delivering state-of-the-art software.

Many of the headlines around the automotive software evolution have focussed on passenger cars, but trucks and buses are on a similar trajectory. Intelligent software solutions could help optimise electric vehicle charging, improving the total cost of ownership and ushering in the first generation of market-disrupting software-defined commercial vehicles.

Automotive can learn valuable lessons from other industries' attempts to boost compute power. In particular, the data centre sector shares mutual goals like power efficiency, and several technologies deployed or under development at these facilities can transfer to vehicles.

Chiplets, for example, break down systems-on-a-chip into small, interconnected, and modular blocks that can be assembled according to specific use cases. Semiconductor manufacturers are working to bring these innovative products–which yield more powerful, customisable, and energy and cost efficient computing–to vehicles in the second half of the 2020s.

Integrating artificial intelligence (AI) algorithms is a core goal for many automakers and suppliers. In fact, the 'AI-defined vehicle' could represent an even larger shift than SDVs do today, and several approaches to realise it are under development.

Discrete graphics processing units (dGPUs) can help vehicles perform computationally intensive tasks, employing the parallel processing necessary to handle multiple calculations simultaneously. As such, dGPUs can train, run, and iterate vehicle-based AI models in a fast and energy efficient manner.

While some manufacturers may wish to move AI compute from the edge to the cloud to save power, the resulting latency could prove highly deleterious to automated/autonomous driving system safety. Instead, chips that can be easily adapted to specific use cases might not only improve the performance of these systems but also futureproof the vehicle AI market.

News in brief

Hyundai reboots SDV summit, teases new Pleos software brand

24/02/2025

Hyundai announced on 24 February 2025 it will reboot its annual software development conference under a new brand, Pleos, which it also plans to use for its integrated software offerings. The Pleos 25 Conference will be held in Seoul on March 28 amid wider efforts by the Korean automaker to transition towards software-defined mobility and expand its application ecosystem.

New China AV guidelines: no misleading, more risk management

28/02/2025

China issued new regulatory guidelines for the autonomous vehicle segment on 28 February 2025. Among the rules are stricter limits on how automakers market their self-driving cars to prevent customer confusion, risk mitigation functions to prevent driver distraction, and a requirement that all over-the-air updates be subject to regulatory approval before going live.

Volkswagen: Rivian JV a matter of 'speed' and 'cost'

28/02/2025

In a new interview with UK online outlet Top Gear, Volkswagen's Chief Executive for Passenger Cars, Thomas Schäfer, offered a rare insight into the automaker's thought process behind its US$5.8bn joint venture electric vehicle (EV) brand Rivian. The ten-figure investment, he explained, was a necessary measure to ensure that its software products meet customers quickly and without drawn-out, expensive development windows.

Nvidia automotive grew 103% YoY in Q4 2024

28/02/2025

Nvidia reported its earnings for Q4 2024 on 26 February 2025; the hardware and AI firm reported US$39.3bn in revenues marking a 78% year-over-year increase, and 12% against the previous quarter. While its automotive revenue continues to represent a small portion of this amount–US$570m–its growth was disproportionate, up 103% y.o.y and 37% against Q3.

BYD launches integrated drone system for its EVs

03/03/2025

BYD and Chinese drone manufacturer DJI released a new vehicle-mounted drone system on 3 March 2025 that promises to expand the concept of the 'connected car'. The drone system, named Ling Yuan, aims to provide new ways to interact with the vehicle in terms of social connection and general entertainment.

Nvidia announces autonomous vehicles summit for 17-21 March

03/03/2025

Nvidia has announced a new four-day automotive and autonomous driving conference, Nvidia GTC, set for 17-21 March 2025 in San Jose, California. Alongside a keynote from Chief Executive Jensen

Huang, automakers including Ford, JLR, Volvo Cars, Rivian, Polestar and Lucid, will be giving presentations and showcasing their latest developments.

Geely unveils five-tier G-Pilot autonomous driving system

04/03/2025

Chinese automotive conglomerate Geely Holding has revealed its new G-Pilot smart driving technology for use by brands including Geely Auto, Zeekr, Lynk and Galaxy. The system will come in five distinct tiers, similar to BYD's God's Eye driver-assist technology which was announced several weeks prior.

GM appoints Barak Turovsky as all-new Chief AI Officer

04/03/2025

On 3 March 2025, General Motors announced the hiring of former Google tech expert Barak Turovsky to a brand-new role within the company: Chief AI Officer. Turovsky and his team will work to integrate AI within vehicle software functionalities, as well as into the automaker's wider operations, including manufacturing and business strategy.

WeRide, Renault launch SAE Level 4 robobus service in France

06/03/2025

Chinese autonomous driving firm WeRide has partnered with Renault, Macif, and Beti Automated Mobility to begin the deployment of fully driverless robobuses in France. From 10 March 2025 onwards, the SAE Level 4 autonomous mobility service will be available for regular paid journeys, albeit on a restricted 3.3 km route in Drôme spanning the Rovaltain business park to the Valence TGV station.

Plus and Tier IV partner to tackle Japan's driver shortage

10/03/2025

Autonomous trucking software firm Plus has announced a new partnership with Tier IV, developer of the world's first open-source software for autonomous driving, targeting the Japanese market. As per a press release, the partnership aims to accelerate the development of advanced autonomous driving solutions, Autonomy 2.0, in Japan, starting with Level 4 autonomous trucks.

Mercedes-Benz chooses turquoise as the 'colour of autonomy'

11/03/2025

Premium German automaker Mercedes-Benz has been granted approval by local regulators to conduct testing of its new special marker lights, intended to provide a clear visual cue to other drivers when a vehicle is driving autonomously. The colour of the marker lights is turquoise, which is a trend the automaker hopes will gain traction within the wider autonomous segment.

ZF tests SAE Level 4 autonomous driving across Germany

12/03/2025

ZF Mobility Solutions announced on 11 March 2025 that it has received authorisation from German regulatory body KBA to begin testing its highly advanced SAE Level 4 autonomous driving technology on public roads nationwide. This marks a notable step forwards for the automotive supplier giant's autonomous technology, which was previously restricted to testing the technology in specified lower-risk areas.

All news articles by **Stewart Burnett**

What is the single biggest challenge facing SDV development?

Industry experts weigh in on SDV development challenges and how to address them. By Stewart Burnett

Software-defined vehicles (SDVs) have captured the imaginations of automakers, stakeholders, and drivers worldwide. Over-the-air (OTA) updates are at the core of the concept's appeal, allowing features to be added or enhanced continuously without the need to upgrade hardware or visit the dealership. This, in turn, allows for the enhancement of various software functions–from advanced driver-assist systems (ADAS) to infotainment offerings–and the improvement of vehicle performance through continuous monitoring and tweaks.

However, the push to realise SDVs has not been smooth. Many automakers' software development ventures have struggled with out-of-control costs and delays. Legacy automakers have experienced the brunt of these issues, while newer and more agile brands like Rivian, BYD, and Tesla have gained a notable technological advantage.

Automotive World consulted with several major players in the segment to hear their takes on the biggest challenges facing the realisation of SDVs and what the solutions could be.

The fluidity of the term 'SDV'

"One of the biggest challenges is that everyone has a different interpretation of what an SDV is," explains Arun Srinivasan, Head of Bosch Mobility UK. "What's more, automakers have set out on different journeys to reach the SDV level that achieves their targets." Some automakers may be satisfied with the simple ability to conduct regular OTA updates, whereas others may opt for a more radical approach.

This is corroborated by Mario de Felice, Head of Software Architecture at Jaguar Land Rover (JLR): "Everyone has a different vision of SDV." JLR's own version of the concept is a "fully-tailored experience" for customers that spans both in-vehicle services and infotainment offerings, as well as connectivity to other user devices and the wider environment, strong cloud connectivity, and deep AI integration.

Moritz Neukirchner, Senior Director of Strategic Product Management for SDV at Elektrobit, believes that greater clarity around the concept could be realised through a common terminology tiered from 0 to 5. Level 0 would entail the most basic software functions like parking assist and adaptive cruise control, while Level 1 would integrate connectivity with the user's smart device or live traffic monitoring. At Level 2, OTA bug fixes become possible, and Level 3 OTA would allow for new features to be added.

The upper two tiers have a more profound effect on an SDV's overall value proposition. Level 4 turns the vehicle into a software platform in which the lifecycles of hardware and software become decoupled. Finally, Level 5–which no automaker has yet achieved–would see the vehicle become an open-source innovation platform, offering the driver a wide range of digital products and services from third parties. "This system really helps parties to talk clearly about their ambitions," explains Neukirchner. "The SDV value proposition will not come in all domains to the same degree simultaneously."

Legacy mindsets persist

While a lack of mutual understanding about what an SDV really is can make collaboration unnecessarily cumbersome, Neukirchner believes a bigger problem lies in how software development is considered at the organisational level. "It's the general approach–the business and purchasing processes are not conducive to lifetime support," he explains.

> **From what I've seen, OTA performance has been rather poor across the board**

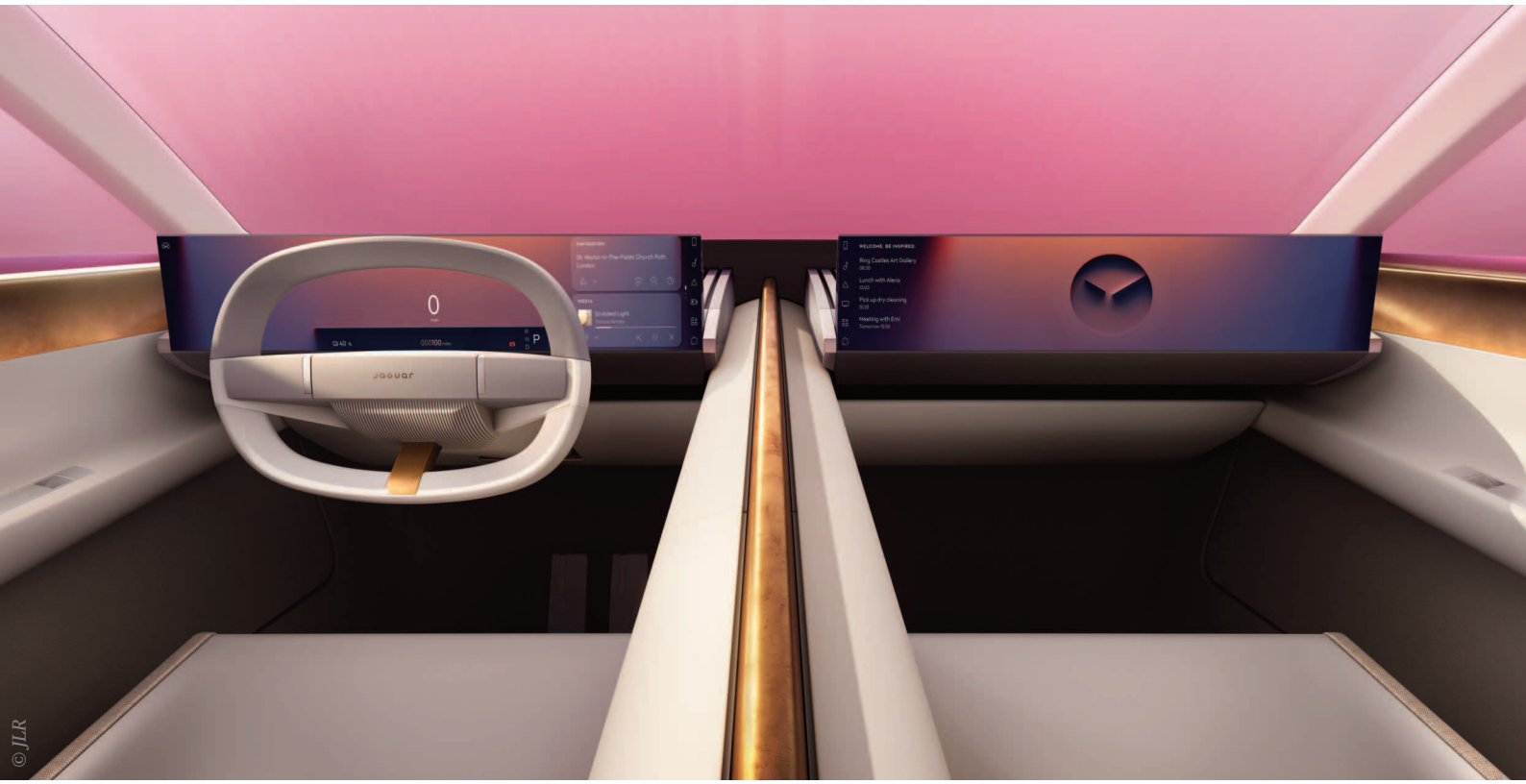
In the past, all automakers had to do was produce a vehicle at a factory, and Neukirchner worries that this legacy mindset persists. "Many OEMs are still treating software sourcing as something that contributes to the cost of production and is worked on up to a certain point. The purchasing process is treated as a one-time thing, which is fundamentally mismatched with the reality of an SDV." Treating software development as one-time expenditures, he emphasises, causes development costs to balloon.

Many automakers have turned to partnerships, something Christoph Horn, Global Lead for SDV at Accenture, deems a positive development. "OEMs have learned the hard way that to get speed at the right cost, they need to partner." He believes the solution is to make these partnerships long-term arrangements. Keeping the same people involved improves mutual understanding of the automaker's software platform and makes it easier for products and OTA updates to be deployed across a vehicle's entire lifecycle.

However, this entails a massive and continuous workload. Horn suggests using AI to ease the pressure: "We expect AI will be very dominant in the next few years. It will definitely be used to speed up software development around vehicles and reduce all the complexity we currently see."

Customer expectations are changing rapidly

For Accenture, the big challenge is simple: addressing new developments quickly and efficiently. "Customers are shifting their expectations dramatically," explains Horn. "This means that the traditional unique selling points of brands are vanishing, and you need something new. Start-up OEMs have been very fast in observing, addressing, and even driving this shift." De Felice and Srinivasan both state that the pace of change is aggressive. "We need to make sure we maintain speed in delivering updates and fresh experiences for our customers," de Felice notes. "The overall process of software creation, validation, and



delivery needs to accelerate so JLR can deliver a unique modern luxury experience."

JLR intends to address changing customer expectations by implementing an efficient continuous integration/continuous delivery pipeline and increasing the amount of automation in its processes. "We've invested heavily in our vehicle connectivity and data platform, which manages data, runs applications and delivers services online to create a tailored and fully personalised experience." For Srinivasan, scalable solutions are the key: "These are best co-created between OEMs and their partners. It's about having real fluidity to be adaptable and create assets together that can be scaled, re-used, and built upon."

At the same time, Neukirchner emphasises that the rush to deploy new features cannot compromise their quality. "From what I've seen, OTA performance has been rather poor across the board". He identifies two flaws: first, customers may not even perceive that a new feature has been implemented; and second, these updates can cause unforeseen glitches and even break the vehicle in some cases.

The consensus is that agility must not come at the expense of quality, and striking this balance means having the right processes in place from the outset. Indeed, this approach might be able to address all aforementioned challenges. "The vision must start with software itself, not with putting software in a car," Horn concludes. "Naturally, people always feel inclined to do what they've done before, but this is a wholly new field of expertise. How to define, develop, and scale software is determined massively by the processes you establish on day one."

Images © Intel

Intel: discrete GPUs are "crucial" for SDV development

Intel believes that discrete GPUs can enhance automakers' current in-cabin experiences and accelerate deployment of next-gen AI features. By Will Girling

Discrete graphics processing units (dGPUs) are pieces of computer hardware with their own dedicated memory separate from the central processing unit (CPU). While more power and heat intensive than integrated graphics, dGPUs can provide enhanced image rendering for systems and applications with advanced processing needs. In the tech world, they are generally found in high-spec desktop computers and gaming laptops.

In the automotive industry, dGPUs provide an opportunity to facilitate computationally intensive tasks and next-generation user experiences as OEMs develop their software-defined vehicle (SDV) concepts. Immediate enhancements could include more immersive infotainment systems with high-resolution displays to create richer in-cabin experiences, but the future also promises breakthroughs in the deployment of artificial intelligence (AI).

In August 2024, Intel announced that it would bring its first dGPU specifically for automotive—Intel Arc A760A—to commercially deployed vehicles from Q1 2025. "Our current family of SDV SoCs already offers significant scalability, but some automakers just want more," Jack Weast, Intel Fellow and Vice President of Intel Automotive, tells *Automotive World*. "We see dGPUs as a crucial component in the development of SDVs."

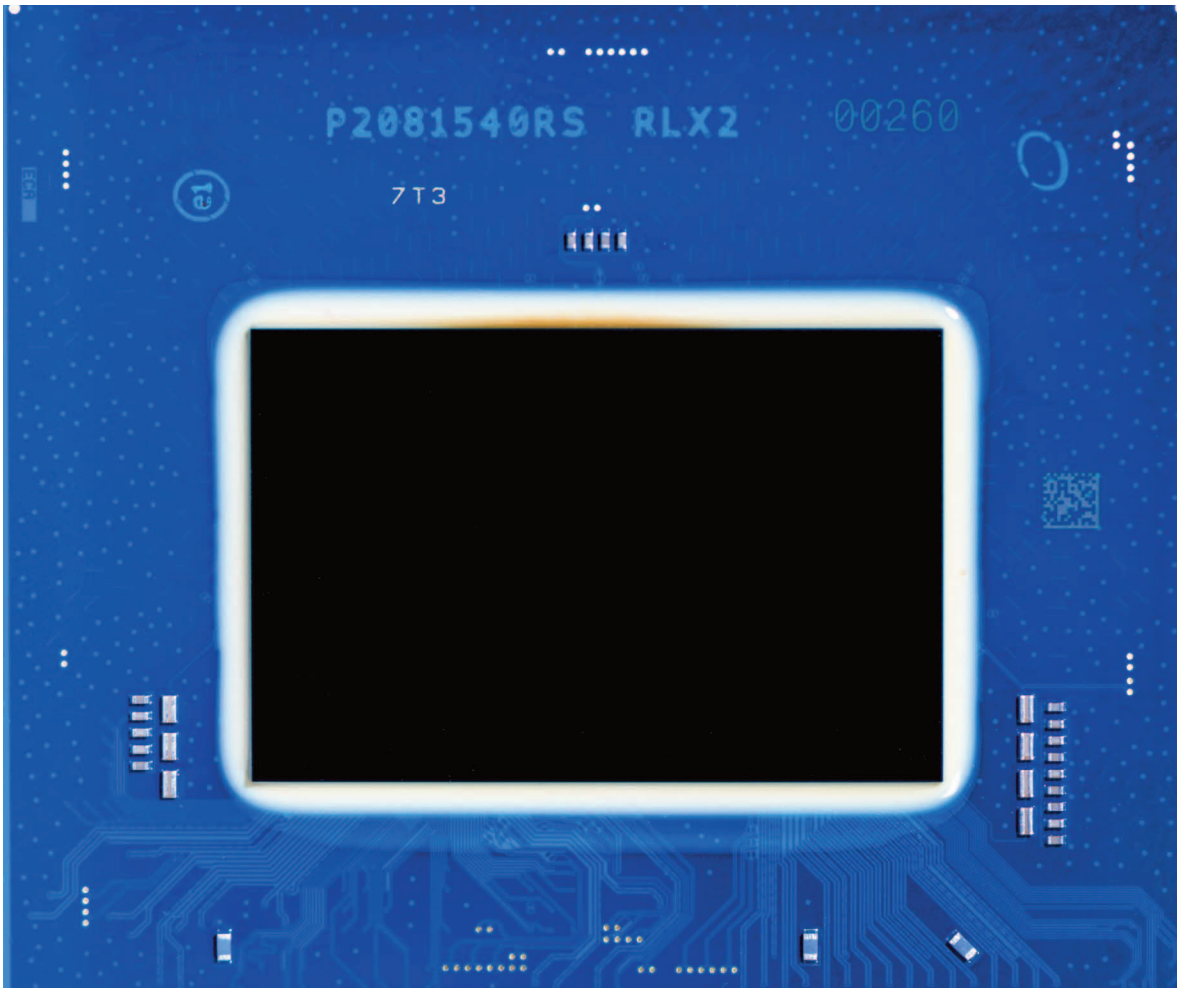
Jack Weast, VP of Intel Automotive, presenting Intel Arc Graphics for Automotive on 8 August 2024 in Shenzhen, China (Credit: Intel Corporation)

Pushing the envelope

The Intel Arc A760A dGPU unit spec features 28 Xe-cores with 16GB of 256-bit memory and 225W TBP, making its performance equivalent to or better than some of the company's desktop computer GPUs. Weast explains that it can support up to four in-cabin display screens with 4K resolution, sophisticated 3D human-machine interfaces (HMIs), and smooth AAA gaming.

He proposes that infotainment systems powered by dGPUs could soon rival home theatres in terms of quality and immersion. However, differentiation is key in a highly competitive market. Beyond improving familiar aspects of the in-cabin experience today, Weast adds that Intel Arc provides automakers with scope to "push the envelope" of HMI performance in the SDV era.

Although GPUs are generally used for image and video creation, they are also well suited for deployment in AI applications. This is because, unlike the sequential functionality of CPUs, they employ parallel processing to handle multiple calculations simultaneously. As such, GPUs can train, run, and iterate AI models in a fast and energy efficient manner. This is highly advantageous in the automotive space, where power usage is limited and automated functions often require split-second decision making. Intel states the Arc A760A can deliver up to 229 TOPS for AI inferencing.



The Intel Arc A760A dGPU (Credit: Intel Corporation)

The possibilities could prove game-changing. Through its specialised large language model (LLM) frameworks, Intel can enable interactive 3D navigation systems responsive to voice commands and gestures, as well as AI-powered co-pilots that provide occupants with personalised recommendations and assistance. The same technology can also perform predictive vehicle maintenance and monitor driver drowsiness and distraction in real time.

A powerful, scalable platform

As brands shape their SDV transition, they will need to determine how best to incorporate new and enhanced features across their product portfolios, and Intel Arc was conceived with flexibility in mind. “It’s designed to work alongside our AI-enabled SDV SoCs, creating a powerful and scalable platform,” says Weast. “This allows automakers to choose the optimal configuration for different vehicle models and price points.” For example, entry-level volume models might only feature basic AI, while luxury vehicles could have the highly personalised cockpits that are often integral to the segment.

Intel is “actively engaging” with automakers and partners in key markets to realise dGPU-driven innovation for a wider audience of customers. However, Weast

highlights that China has been an important developer market for AI cockpit solutions in particular, citing its "rapid adoption of new technology, robust automotive ecosystem, and government support for intelligent vehicles." Subsequently, Intel has managed to produce several compelling use cases for advanced graphics processing in vehicles.

Most prominently, Weast highlights tech company Zhipu, which optimised proprietary LLMs to run on the Intel Arc A760A and produce its AI Car Assistant. As a result, the feature can understand nuanced voice prompts and act according to predetermined user preferences—for example, simply saying, 'It's too hot in here,' would cool the cabin down to an appropriate temperature. The company claims its responses are sophisticated enough to become an "on-the-go companion" capable of maintaining conversations, playing games, and using multimodal capabilities to maximise engagement. Zhipu AI Car Assistant can also function as a personal engineer, answering specific and complex user questions about the vehicle, meaning the driver doesn't have to consult the owner manual.

dGPU-driven differentiation

While Intel is not the only company exploring AI and accelerated computing solutions in an SDV context—Nvidia is a notable competitor—Weast believes his company's product gives it an advantage over other players. "Our approach simplifies development with a single software stack for both integrated and dGPUs, reducing costs and time-to-market." He adds that Arc's capacity to facilitate a high level of processing power in the vehicle without the added latency of cloud-based analytics will enable the development of SDV features that previous generations of hardware made either impossible or impractical to realise.

Although industry consensus has yet to solidify around what 'software-defined' comprehensively means, many commentators believe it is ultimately predicated on updateability. As SDV concepts meet the reality of a varied global market, system agility will likely become table stakes. "As technology advances and consumer demands grow, OEMs have the flexibility and assurance that the Intel system is built on an open platform that can easily be upgraded to meet these needs without requiring a complete overhaul," says Weast. In a virtuous cycle, the availability of powerful and scalable hardware will encourage software developers to create innovative applications and in-cabin experiences, nurturing sufficient customer interest in SDVs to generate a lively partner ecosystem dedicated to meeting demand.

"With Intel's comprehensive open AI solutions, automakers can unlock the full potential of AI to create compelling, differentiated experiences that set their vehicles apart in the market," Weast concludes. By shaping the future of in-vehicle experiences and delivering unprecedented levels of productivity, customisation and value to drivers and passengers alike, the importance of dGPUs to the future of automotive could be inestimable.

Images © ZF

ZF turns to software for smarter electric trucks

Replacing heavy, expensive pieces of hardware with a server-cloud based function tackles cost, weight, efficiency and sustainability. By Megan Lampinen

Many commercial vehicle (CV) players are looking to battery electric vehicles (EVs) to address looming environmental targets, but it's not an easy transition. Apart from varying charging infrastructure availability, fleets are driven by total cost of ownership (TCO) and uptime, as trucks that are parked charging are not out earning. While battery technology has evolved considerably over the past decade–with advancements in cost, weight, and energy efficiency– there remains considerable room for improvement.

At the same time, vehicles are increasingly defined by software. From the driving controls to the user-experience, software is finding its way into all aspects of design and function. At ZF, applying software innovations to spur the EV revolution is a logical next step.

The software brake resistor

ZF's recently unveiled software brake resistor offers one example of how software could potentially replace hardware for improved functionality. In this case, intelligent software optimises EV charging by considering the potential for regenerative braking later in the journey. It draws on location data to determine if the vehicle is charging in an area where it is likely to descend a steep gradient, which could create significant additional battery charge at an early stage in its journey. If so, then the system makes sure to leave spare capacity during charging to harvest energy later along the route.

"This is essentially an intelligent prediction system that applies a charge limit to prevent overcharging and the wasted associated heat dissipation while considering recuperation," explains Karoline Bader, Director OE Digital at ZF Group. "If you are charging a truck or bus at the top of a hill, you should not necessarily charge to 100%. Maybe it would be better to charge to 80%, because recuperation can fill up the remaining 20%. The system is clever."

In this instance, the software solution helps replace hardware in the form of brake resistors. "One key value

With the software brake resistor, an algorithm intelligently manages the charge of the battery so that it can still achieve full capacity on its descent

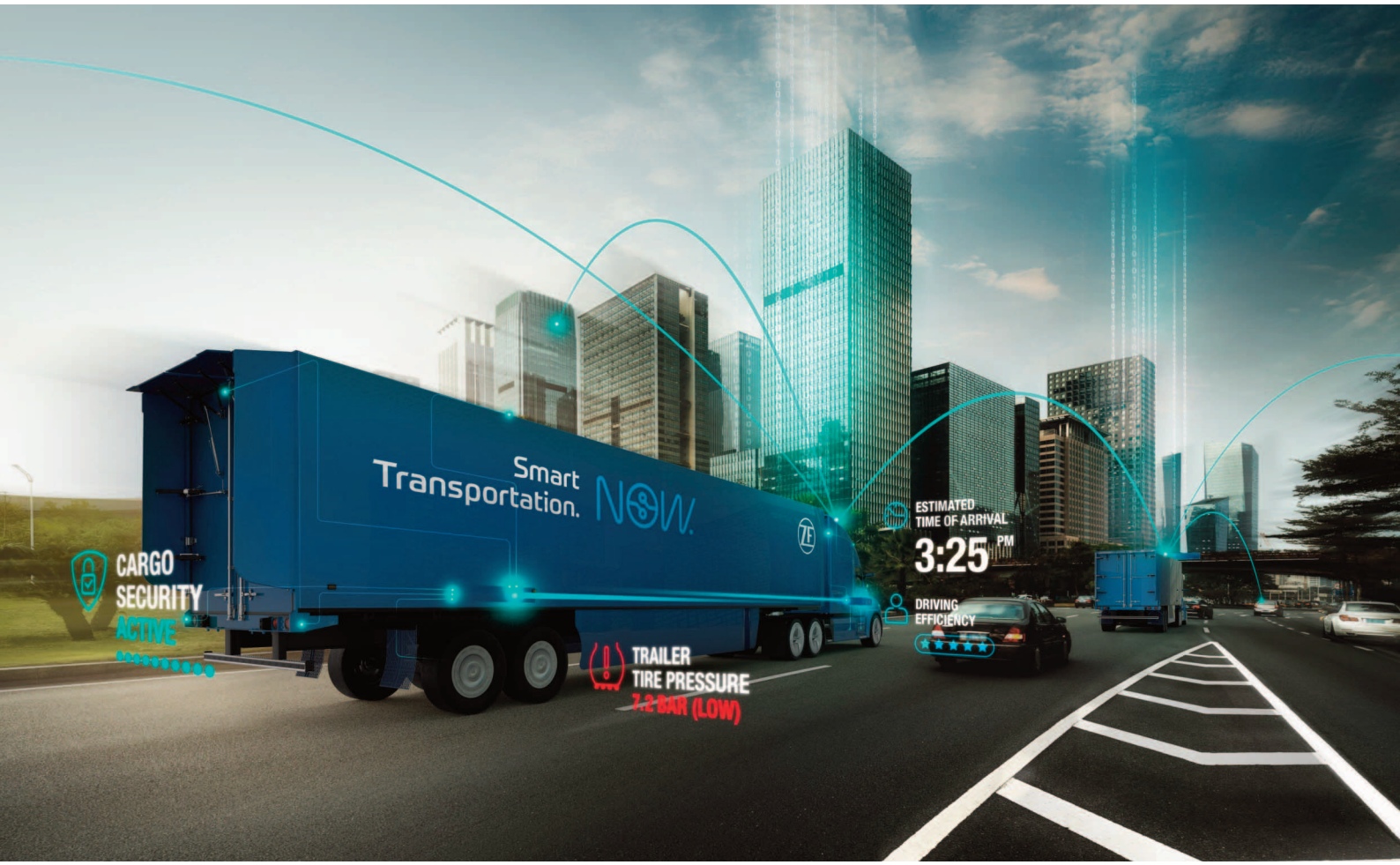
proposition is that we need fewer components and can thus reduce weight," Bader tells *Automotive World*. The shift to software also increases space within the chassis.

This is good news for OEMs and fleets. At the moment the solution is at the proof of concept stage and not yet market-ready. "We have proved the technical feasibility of the software brake resistor and are currently in close discussions with customers relating to a possible industrialisation approach," she notes.

The software-defined CV

This particular innovation is targeted at truck and bus developers and represents yet another step towards the software-defined CV. While many of the headlines around the automotive software evolution have focussed on passenger cars, trucks and buses are on a similar trajectory, albeit with some noteworthy differences. "TCO plays an important role in the CV space, particularly in certain use cases," Bader says. "This means solutions need to be very cost effective. With cargo fleets you want to prevent downtime, which is less critical in the passenger car area."

In all vehicle segments, the ability to update software is pivotal. Introducing new software features and patching vulnerabilities underlies the whole value proposition of the software-defined vehicle. Type approval regulations in Europe recently received an



important update with the introduction of UNECE R155 for cyber security and R156 for software updates in vehicle control units requiring a software update management system (SUMS).

To help CV OEMs comply with these regulations, ZF provides cyber security services even on electronic control unit level related to R155. For R156 ZF offers an end-to-end SUMS Service Suite with tools, services and documents to support OEMs with the software update management of commercial vehicles along the complete lifetime. “It helps to manage software updates for CVs and individual vehicle systems or components, making them available for authorisation. It also manages consistent update records throughout the vehicle’s entire lifecycle,” says Bader.

A common understanding

Looking ahead, software will continue to play a greater role within CVs. While this opens up tremendous new opportunities, it also brings a host of challenges. “We’ve seen software complexity increasing over the years, while at the same time we are trying to move much faster and be more agile. It’s difficult to manage that, both in passenger cars and CVs,” she points out.

At a very basic level, she points to a lack of agreement on industry jargon. Everyone may be talking about the software-defined vehicle, but not everyone means the same thing. “As an industry, we don’t have a joint understanding of what the software-defined truck really means. Recent

Intelligent software solutions are helping to realise smarter, more connected commercial vehicles

meetings with multiple stakeholders highlighted how definitions differ from one individual to another. We need to find a common understanding in our industry.”

She also wants to see consensus on what features could be standardised in this new software paradigm: “Standardisation is definitely a big challenge in the automotive industry.” Bader points to maps for advanced driving assistance systems and autonomous driving as an example of where integration consensus, in the form of the Navigation Data Standard (NDS), made a huge difference. Aside from maps, she also flags a lack of standardisation with E/E architectures that needs to be addressed.

For ZF, and all players within the commercial transport space, the rise of the software-defined truck heralds a huge market disruption, but one in which the pursuit of cleaner, smarter, more connected CVs offers tremendous opportunity for innovation.

Hyundai Mobis: holographic dashboard will differentiate SDVs

HWDs unlock unique software possibilities, including delivering two sets of visual information to the driver and passenger at once. By Stewart Burnett

The arrival of software-defined vehicles (SDVs) will bring with them a reimagining of the cockpit experience. A transition from analogue buttons to digital technologies has been underway for more than a decade. So far, that has largely meant LCD touchscreens similar to a tablet. However, this approach could prove a mere stopgap on the road towards a more radical reinvention of the dashboard.

In January 2025 at CES, Hyundai Mobis unveiled its 'world-first' holographic windshield display (HWD): a head-up display that is projected onto and spans the width of the windshield. Designed in collaboration with German optical company Zeiss, the company's HWD promises a wholly unique form factor and opens up a range of unique software-enabled possibilities.

Eye of the beholder

Fundamentally, the HWD concept is similar to that of a conventional projection display, which consists of a projector and a screen. The image projected is displayed on the screen, and light is transmitted to the human eye through scattering reflections. “But in the case of our HWD, a holographic optical element (HOE) serves as the screen,” explains Minho Shin, Principal Research Engineer for the HUD Optics Team at Hyundai Mobis. The image displayed on the windshield is generated by three separate projectors, all of which are integrated directly into the dashboard.

A HOE screen is distinguished from typical projector screens by two key characteristics. First, it must allow for wavelength selectivity: it only diffracts

Hyundai aims to implement its HWD technology in production-series vehicles from 2027 onwards

certain wavelengths of light—such as red, green, and blue—to ensure fast transmission rates and a high level of transparency. This minimises latency and prevents the display from obstructing the driver's view of the road. It also prevents the distraction of other road users, as only vehicle occupants can see what is displayed. The HOE must possess a thickness of less than 100µm to make this possible.

The second characteristic is the ease of light distribution control. "HOE can control the emission angle and light distribution through its diffraction properties," says Minho. In practice, this means the HOE can send different sets of visual information to multiple locations at once, allowing for unique and customised experiences for two vehicle occupants. What the driver sees on the dashboard, the front-seat passenger cannot, and vice versa. For example, the passenger can enjoy private entertainment offerings like movies or video games without the possibility of distracting the driver.

Reimagining the cockpit experience

Another driver benefit of the HWD is minimised eye movement. By placing key information like state of charge, speed and directions directly on the windshield, the driving experience is inherently safer because it helps keep the driver's eyes trained on the road. When looking at the HWD, the driver retains clear visibility of the road in their peripheral vision. Key pieces of information, such as state of charge, will be similarly visible in the peripheral vision. In addition to aiding vehicle safety, however, it is also more convenient: the driver only needs to look away from the windshield when they need to do something, like adjusting the route or changing their music playlist.

More broadly, the HWD helps to facilitate a software-driven reimagining of the cockpit's entire design. "This innovation is a game-changer for

> **This innovation is a game-changer for creating a seamless cockpit**

creating a seamless cockpit," says Minho. Placing the majority of the infotainment experience on the dashboard allows the user interface to be simplified down to a small integrated touchscreen or a handful of integrated buttons.

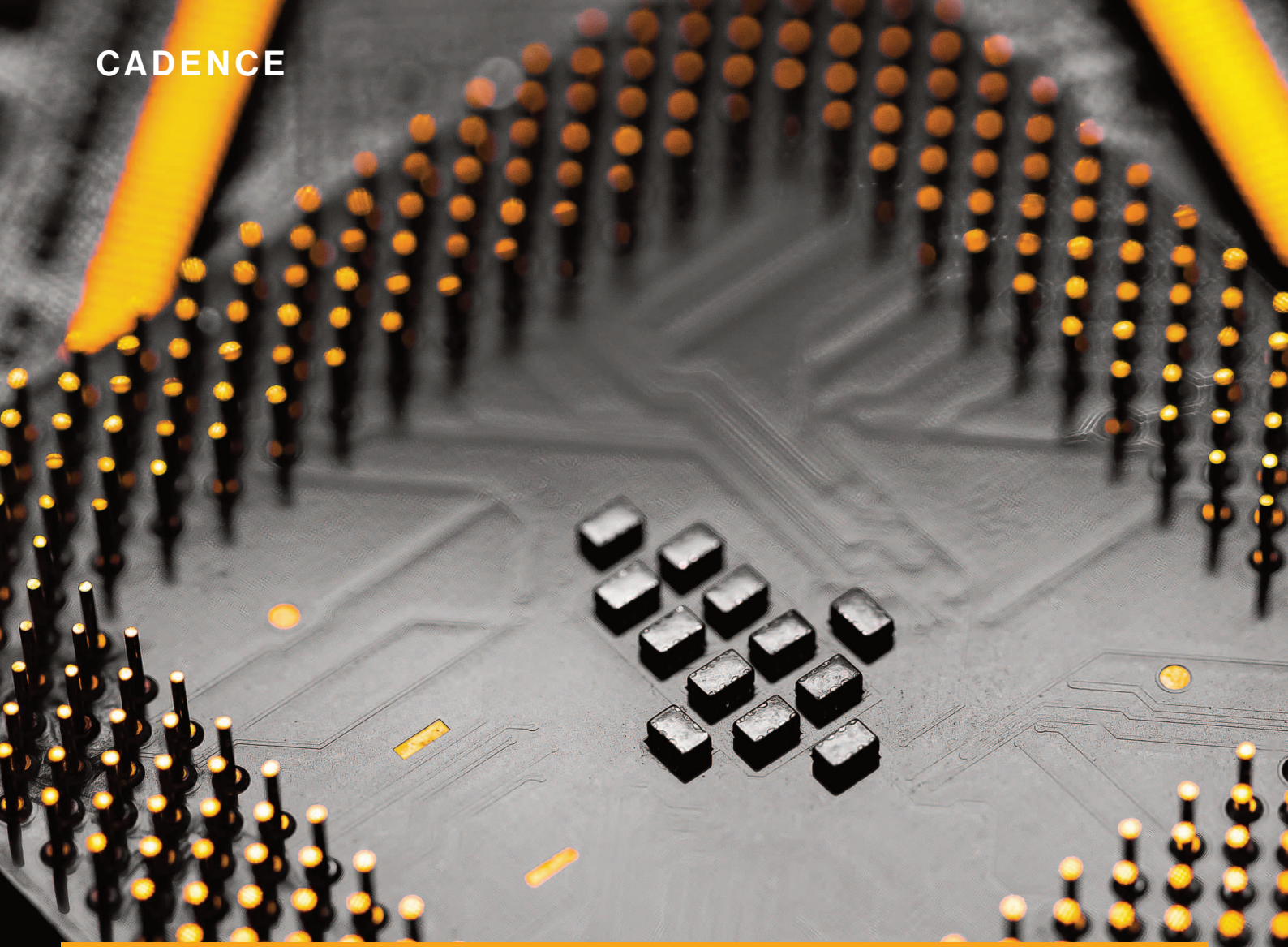
Minho speculates that the touchscreen could even be abandoned entirely in favour of an AI-powered voice assistant or a deeper integration with the user's smartphone. This more minimalist approach would not only facilitate a more spacious cockpit design but also create a clear "SDV aesthetic" due to the lack of visible hardware. This, it is hoped, would help to communicate visually what an SDV is and how it differs from a conventional vehicle in the eyes of consumers.

Facilitating future software

The integration of HWD into Hyundai's vehicles could also help the automaker develop new and differentiating software offerings for its customers. Some of these are part and parcel of the integration of light distribution control, such as multi-screen environments tailored to the person viewing them and real-time data visualisation in the driver's line of sight. "You could also use software to turn the windshield display into a part of the vehicle interior, providing personalised user interfaces that allow users to tweak the theme, background, and widget layout of the display to match the driver or passenger's personal preferences," remarks Minho.

As both HWD technology and autonomous driving become increasingly advanced, more radical software solutions may become possible. By achieving SAE Level 5 autonomous driving, it will no longer be necessary for a driver to keep their eyes on the road. "Eventually, we expect that the entire windshield could be transformed into a display using HOE, allowing you to essentially use the space like a personal movie theatre," says Minho. However, he advises that this is not something Hyundai Mobis is currently working on.

By helping to maintain drivers' attention on the road and creating a sleek and spacious cabin interior while delivering wholly unique software offerings, Hyundai Mobis believes its HWD technology could help differentiate SDVs. Pre-development of the technology will be completed in 2026, with its use in series-production vehicles set to follow as early as 2027.



Chiplets bring “Lego-like” solution for SDV hardware

Chiplet technology could accelerate software-defined vehicle innovation, but automakers may need help from Silicon Valley. By Will Girling

The semiconductor industry has so far managed to increase chip processing power at regular intervals while also reducing product size and relative cost–this is known colloquially as Moore's law. Systems on a chip (SoCs), in which multiple functions are consolidated on a single device, represent one aspect of this evolution, and OEMs are increasingly invested in them. The global automotive SoC market's value is expected to reach US$70bn by 2030, up from US$37bn in 2022, according to Zion Market Research.

However, Big Tech players like IBM already foresee a deceleration and possible end to Moore's law. This is bad news for software-defined vehicle (SDV) developers working on advanced features and autonomous capabilities, which will require greater processing power than current generations of hardware can provide. This is where chiplets can make a difference.

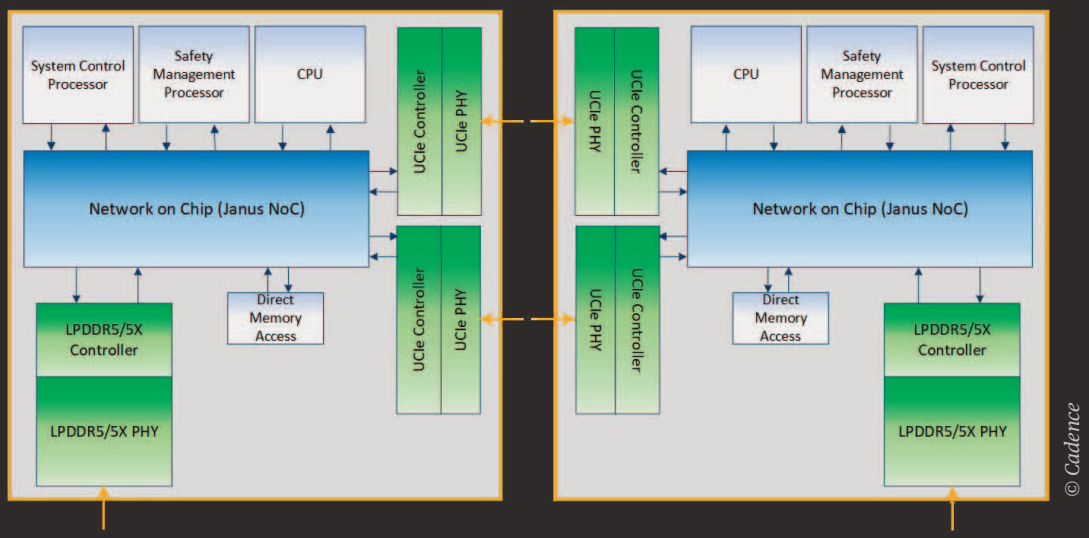
As opposed to monolithic architectures, where all functions are consolidated on a single die, chiplets break down SoCs into small, interconnected, and modular blocks that can be assembled according to specific use cases. This innovation yields more powerful, customisable, and energy and cost efficient computing. David Glasco, Vice President of R&D for Compute Solutions Group at Cadence, tells *Automotive World* that buzz around the technology started building in the data centre sector around five years ago. Now, it's coming to vehicles.

Chiplets enter automotive

Glasco observes that initial chiplet development focused on proprietary solutions with little applicability beyond data centres. However, when players like Arm–a significant semiconductor IP supplier to the global automotive industry–began to expound and expand on the idea, a "turning point" was reached. In March 2024, Cadence and Arm announced their collaboration on a chiplet-based reference design and software development platform specifically to accelerate SDV innovation.

By November, they revealed their "ground-breaking" results: the first tape-out of a system chiplet using both companies' IP combined with Cadence's electronic design automation solutions. The chiplet integrates multiple processors, controllers, and memory IP to manage SoC resources and functionality. It is compliant with Arm's Chiplet System Architecture for interoperability and fast time-to-market, while the complementary software stack is provided with a digital twin of SOAFEE-compliant hardware. This means software can be prototyped virtually instead of using physical silicon.

"There's a growing number of automakers that want to follow the Teslas of the world, but they don't have any silicon design teams," says Glasco. "For an industry that's still primarily based in mechanics, it needs help reducing the element of risk–both in terms of investment and safety." As such, he believes partnering with companies like Cadence is essential, as OEMs



This diagram shows how two system chiplets can be integrated on the same package

can specify the exact chiplet that allows their software engineers to incorporate desirable vehicle functionalities.

A 'Lego-like' solution

New advanced driver-assistance systems and autonomous driving systems are of particular interest at the moment, and this is an area Glasco helped develop first-hand during his tenure as a Full-Self Driving SoC architect at Tesla. Going forward, specialised chiplets will facilitate enhanced data fusion from sensor hardware and handle the processing necessary for machine learning in these functions. Cadence estimates that in-vehicle processing and networking power could eventually be equivalent to a data centre processing node.

Scalability is a crucial ingredient for introducing autonomous functions, and chiplets are well suited for the iterative journey from SAE Level 2 to 5. "Big automakers have a broad product portfolio," states Glasco. "They want a common architecture across low-, mid-, and high-range vehicles that can be made more complex according to the price point targeted." A low-end solution, for example, might feature a CPU, GPU and some AI functionalities. Mid-range could add multimedia capabilities and digital signal processing, with high-end then incorporating multiple CPU and AI chiplets on top.

"The idea is that there's a lot of reuse within those offerings," he continues. "As automakers iterate their SDVs, they can keep the same basic architecture and just swap a couple of chiplets." Besides saving R&D costs, this could also help address prominent challenges concerning software verification—by retaining the same core hardware, developers do not need to worry about the performance and safety of their software for each new vehicle generation. "It's a Lego-like solution: just replace the piece that doesn't do what you want."

Although a chiplet approach as described by Glasco would likely entail a degree of hardware standardisation

> **Incumbents will need to decide whether they become the next Oldsmobile or the next Tesla**

across automotive, he does not believe this will be problematic for brand differentiation. "The real value proposition is the look and feel of a vehicle as shaped by the software; that's where new experiences will come from."

Inflection point oncoming?

With the automotive industry on the cusp of what Cadence considers to be a "technological renaissance", the company is seeking to guide the adoption of chiplets. In October 2024, Cadence joined the Automotive Chiplet Alliance (ACA) led by the Interuniversity Microelectronics Centre (IMEC), a nanoelectronics and digital tech hub based in Belgium. ACA aims to form an ecosystem of companies from across automotive to prototype, test, and standardise chiplets in Europe.

"Cadence became involved to understand the European market's direction and concerns with building out silicon," says Glasco. Most prominently, he relates that automakers are struggling with the cultural shift required for SDVs: instead of matching products to specific release timeframes, silicon innovations generally come 'as and when'. This is contrary to established practice among automakers, so ACA will try to smooth the runway. "We don't advocate for our products or a particular architecture; it's more about sharing our knowledge and capabilities."

Glasco states that the value of IMEC's project is that it can "share the risk" of chiplet integration among automakers evenly, which could provide the push necessary to accelerate the technology's adoption. At CES 2025, he observed that interest in the possibilities and capabilities of chiplets is growing, yet the automotive industry is "waiting for someone to go first." Software-shaped mobility was ultimately a key theme of the event, and Glasco predicts that an inflection point could be reached within the next 12 months.

However, the danger for hesitant legacy OEMs is that they never catch up to new contenders moving more aggressively in the SDV space, particularly Chinese brands. "The market initially thought China would produce unsafe and low-quality vehicles, but the exact opposite has turned out to be true," Glasco concludes. "Non-traditional automakers are more likely to adopt chiplets quicker, and incumbents will need to decide whether they become the next Oldsmobile or the next Tesla."

Harman: SDVs demand upgraded toolkit

Harman's product portfolio is designed to help automakers launch and maintain software-defined vehicles. By Megan Lampinen

Images © Harman

The move towards software-defined vehicles (SDVs) requires a radical new product development strategy and toolkit. Technology is evolving rapidly while development cycles are shrinking and consumer demands are changing. New business models are also emerging, posing both opportunities and challenges for incumbent automakers.

"OEMs are switching to the SDV architecture, which means continuous deployment of software in the vehicle," says Steve Surhigh, Vice President of Automotive Cloud Solutions for Harman Connected Services. Harman offers a wide suite of products focused on everything from building and validating software and accelerating app development through to smart digital assistants and analysis of how in-car features are used. "We're giving our OEM partners the tools that can accelerate how they get software into the vehicle and then manage it over the vehicle's lifetime," he told *Automotive World*.

Software shortcuts

With Ready CQuence Loop, Harman offers a shortcut to automotive software creation and validation. Unveiled at CES 2025, this SDV toolchain promises to cut development costs and increase developer productivity, allowing for faster delivery of new vehicle features. Essentially a virtual development environment, it serves as single point of entry for automakers to develop or test software stacks, with Harman handling the complex underlying infrastructure. According to the supplier, users can onboard and begin using preconfigured workspaces in Ready CQuence Loop in just 30 minutes. "Today's tools for automotive software development and testing are not aligned with modern software development practices," observed Daniel Lueddecke, Senior Director and Ready CQuence Loop Product Lead at Harman. This is designed to change that.

Displays and digital assistants are becoming increasingly sophisticated and software-defined

Similarly, Ready Link Marketplace makes it easier for automakers to offer a tailored selection of in-car apps, services, and features. Consumers can purchase or subscribe to a feature like predictive adaptive cruise control, unlocking new–and often recurring–revenue streams for automakers while also increasing vehicle value over its lifetime. The latest iteration of what was previously the Ignite Store, this unified digital commerce platform now boasts more than 150 apps and features from which automakers can choose.

"Because we are in multiple automakers, we attract more app developers," explained Surhigh. "At the same time, we leave it to each brand to put their own stamp on it, make it look however they want. By going with this platform they don't give up the ability to personalise it, but they still benefit from the advantages of having a huge pool of apps."

Harman has an entire business development team focussed on constantly adding new apps and features. A key area of interest at the moment is streaming content, but it anticipates a wave of gaming features in the future. "We already have a number of games in the store today, but we're looking to beef that up with more games that draw on your mobile device and use it to interact with the display, like a joystick," explained Pascal Peguret, Harman Senior Vice President of Connectivity.

Connectivity

Connectivity is at the heart of software-defined mobility, and developments in this space are accelerating. "Connectivity is a major pillar to enabling SDV because it means features can be updated," Peguret pointed out. "We've seen the industry go from 4G to 5G and now satellite." Harman is now bringing satellite communication to its Ready Connect suite of telematics control units, ensuring vehicles remain connected even in remote areas. Based on Qualcomm's Snapdragon

Auto 5G Modem-RF Gen 2, this enables mobility services such as emergency messaging based on satellite network operator coverage.

Pivotally, connectivity also allows apps in the car to communicate with the cloud. “This allows for the creation of magical experiences for the driver,” said Peguret. Harman is currently focussed on shaping those experiences with contextual awareness and empathy. “Awareness means that we want to make the drivers aware of what’s going on around them, how conscious they are, how focused on the drive,” he explained. Ready Aware is described as a vehicle-to-network software-as-a-service product and adds situational intelligence by delivering alerts, such as time to green- and red-light assist.

When it comes to empathy, the aim is to turn the digital assistant into a helpful, informative friend. At Harman it takes the form of Luna, officially described as an avatar designed to personalise the user’s relationship with the vehicle. “This little avatar knows both the driver and the car, acting like a personal assistant,” Peguret added. Luna is integrated with Harman’s display products, such as Ready Vision QVUE windscreen display, which uses in-plane projection to turn the lower section of the windscreen into a display for important driving and infotainment information.

From projects to products

The above solutions are just a handful of products within Harman’s suite of solutions, but all of them represent a deliberate go-to-market strategy based on the needs of software-defined mobility. Speaking specifically on the supplier’s display at CES 2025, Peguret pointed out: “Everything is a product. That’s not as simple or as obvious as it seems, because the automotive business normally runs in projects.” In a project setup, the automakers specify everything they require, and the suppliers deliver it. “The disadvantage is that this takes forever. The OEM needs to specify things over a long period of time and address various comments from suppliers, then the suppliers have to analyse the comments and submit a quote. There are numerous rounds of negotiations until the supplier starts development work—usually running over a two-years period before the product hits the road.”

That makes for a very long cycle time. With the move to SDV, customers expect much more regular updates. “We offer products developed according to our own spec, on top of which automakers can differentiate,” he emphasised. Christian Sobottka, Harman’s President of Automotive, had previously told *Automotive World* that roughly 20% of automaker requirements could be brand-differentiated, with the remaining 80% standardised, noting it was already current practice in the mobile phone world. “This is exactly what we are doing,” Sobottka said. “It means you can avoid investing too much time and money [on areas where it doesn’t matter] and instead concentrate on the 20% that is really differentiating. With this approach, you can move much faster.”

Given the rapid developments within automotive software, an off-the-shelf toolkit could become one more necessary ingredient in a software-defined future.

Continental: E ink technology can help differentiate SDVs

Continental believes E Ink displays can create both deep personalisation opportunities and practical advantages for consumers. By Stewart Burnett

The software-defined vehicle (SDV) concept brings with it an opportunity to reassess how drivers interact with and experience their vehicle. The dashboard presents one of the ripest areas for innovation, as most interaction with in-vehicle software happens through touchscreens and displays. To differentiate their software offerings, automakers and suppliers will need innovative new ideas and solutions.

In January 2025, Continental revealed its own twist on the automotive dashboard, the "Emotional Cockpit". Prioritising style and customisation, the automotive supplier collaborated with display technology company E Ink to create a distinct visual language for the dashboard. E Ink is best known for the low-power Prism ePaper displays commonly used in tablets and e-readers to simulate the experience of reading a print book. So, why might the integration of Prism ePaper matter in the context of SDVs, and what unique software ossibilities could it enable?

A personalised dashboard

"We see the E Ink displays as a new medium, where customers can consume totally new content and experiences," explains Jochen Möller, Senior Expert in User Experience and Interaction Design at Continental. "Both software as a service and software as a product are parts of the ecosystem we envision." The novel application of Prism ePaper in the dashboard space is primarily intended to enhance the vehicle interior visually and enable deeper customisation opportunities.

"With the use of this display technology and our own smart software, we can create decorative elements that we call 'dynamic trim parts," adds Kai Hohmann, Principal Expert in Automotive Displays at Continental.

These can range from simple patterns to user-customised images—for example, integrating photos of the owner's choosing. Traditionally, Prism ePaper devices have been restricted to black and white at the hardware level. A significant portion of the customisation options for the Emotional Cockpit design will be oriented around this 'classic' aesthetic, but it is not prescriptive. The company uses a more modern version of ePaper technology that offers colour.

Unique offerings and limitations

In addition to customisation options, Continental's dashboard could open a range of new software possibilities that are augmented by the ePaper concept. One example is eBooks, graphic novels, or other forms of print-based entertainment. While this is technically possible with more traditional LCD displays, readers will typically engage with this type of content in an ePaper form factor. It is also possible to integrate sketching, allowing passengers to use the dashboard as a space to create designs of their own or take quick notes.

It should be noted that ePaper also has a limitation: its refresh rate. The quality and refresh rate of the technology are inversely related, with a lower refresh rate typically lending itself to better image quality and vice versa. It's also less responsive: an ePaper display has a response rate of around 40ms at a fixed 60Hz refresh rate, compared to an average of 16ms in typical LCD displays. For critical functions that are handled through a screen—such as drive mode or driver-assist—this is likely too slow. "E Ink displays cannot and will not substitute LCD displays," says Möller. "Rather, they are an additional tool for creating exciting new use cases."

> **If you are able to individualise your car just a bit, it becomes yours**

Through Continental's own software platform, these decorative elements can not only be tweaked according to the customer's own preferences but also dynamically switch appearance to match the driver's mood or other aspects of the driving experience. For instance, the colour palette can be adjusted from cold to warm depending on the driver's speed. Möller emphasises: "This is why we're running with the Emotional Cockpit concept. We want to explore emotions through the dashboard—what arouses them, and how do we evoke them?"

This does not mean some pieces of critical information cannot be translated onto ePaper. For example, it can replace LCD for some key functionalities like widgets that indicate the vehicle's state of charge or what music is playing on the user's playlist, as these are relatively static. Monitoring driving speed,

Continental is leveraging E Ink's Prism ePaper display technology

on the other hand, is likely impossible with ePaper because it fluctuates too frequently.

No power required

While Continental's Emotional Cockpit concept cannot replace everything the infotainment system handles, it can still help lower the amount of real estate taken up by touchscreens in a car. This brings practical advantages alongside its core aesthetic appeal. "E Ink displays only consume power for a brief moment: when they switch from one image to the next," says Möller.

Given the importance of energy efficiency in electric vehicles, this could prove a crucial differentiating factor for automakers looking to get more range out of the battery.

"It also keeps showing the selected content even when the power is turned off," adds Hohmann. Alongside the lower energy profile, he considers this a key advantage of the E Ink display over incumbent LCD solutions. A driver can, for example, check the battery's state of charge before turning on the vehicle. This could also be advantageous from an aesthetic perspective, as the user's preferred dynamic trim parts will remain in place even when the vehicle is off.

By demonstrating that the e-ink display can create enhanced personalisation opportunities alongside practical benefits, Continental believes it can help better define SDVs in the minds of consumers. "If you are able to individualise your car just a bit, it becomes yours," concludes Möller. "You feel emotionally attached to an otherwise everyday object. This is what we're aiming to achieve with the E Ink dashboard."

GlobalFoundries: power efficiency should be SDV rallying cry

Chipmaker GlobalFoundries believes focusing on power efficiency could help consolidate SDV development and improve desirability. By Will Girling

Software-defined vehicles (SDVs) are conceived as highly dynamic, adaptable, and environmentally aware products. As such, there is an emerging consensus among prominent industry players and consortiums that modular, scalable, and standardised hardware will be necessary to unlock the transformative potential of vehicle software. Efforts to achieve it are underway, but challenges remain on the horizon.

Perhaps the largest issue is energy consumption—gone are the days when 12V batteries were adequate for car electronics. Electric vehicles (EVs) are stepping things up to 400-800V units, but these must power edge processing and infotainment while providing enough range to be attractive for customers. As advanced driver assistance systems (ADAS) and sensor hardware (LiDAR, radar, cameras, etc.) for automated driving become the norm, they must also be easily updateable over-the-air (OTA) for safety and performance enhancement.

"Central computing platforms are frequently considered when it comes to energy efficiency, yet these other SDV system elements don't necessarily get the attention they deserve," states Faisal Saleem, Senior Vice President of End Markets at GlobalFoundries. With modern smart sensors collecting gigabytes of data per second and the need for vehicle connectivity growing, he tells *Automotive World* that the problem will only become larger.

SDV chip attributes

As a semiconductor design and manufacturing company, GlobalFoundries

has observed flourishing opportunities in automotive over the last 15 years. "It's one of the fastest-growing end markets; we make more than US$1bn in revenue from automotive alone," says Saleem. Through its AutoPro platform, the company combines extensive technical expertise with a comprehensive supply chain to help bring SDV-ready chip solutions to market quickly.

products significantly to match this brief–its latest 22FDX system-on-chip (SoC) platform has non-volatile memory ten-times faster and 45% more energy efficient than the previous generation. The company also incorporates the wireless connectivity tech necessary to download software updates across short-, mid-, and long-range radio frequencies.

high speed chips with low jitter, noise, and power consumption," says Saleem. Ultra-low power operations that don't sacrifice performance will be particularly crucial as companies around the world race to deploy commercially viable SAE Level 4 robotaxi services in the second half of the decade.

> **The less power a vehicle's systems waste, the further it can go and the more it can do beyond go from A to B**

But what are some of the most important system attributes today?

In agreement with some other players, Saleem calls OTA "the essence" of an SDV. "Enabling it requires a small footprint chip with low power requirements and embedded memory to write code extremely fast." GlobalFoundries is iterating the capabilities of its

Facilitating and improving automated/autonomous driving capabilities across the life of a vehicle present another important area for development. Sensor hardware typically collects data on the edge and transmits it to the central processing unit, requiring high-interface chips. "Our 22FDX and 12nm FinFET platforms are ideally suited for this: automakers need

Data centre tech in automotive

In the pursuit of more energy efficient SDVs, Saleem notes that automotive still has much to learn from the data centre space. Fundamentally, the challenges to be overcome are exactly the same.

"Power comes from the grid to those buildings at high voltage, but the chips used run at just one volt," he says. "That requires a series of voltage conversions to step it down appropriately." EV architectures are no different: power is converted at several points, from the charger to the battery and then to various systems. In both instances, this process usually results in a degree of power wastage, yet data centres still often manage to achieve efficiency of around 90%, while EVs are generally 77-85% energy efficient.

Data centres haven't yet reached their optimum performance, and as they push for energy efficiency in excess of 95%, a rush of new semiconductor technology is emerging. Both the transition from silicon-based chips to gallium nitride (GaN) and the development of chiplets–which break SoCs into small, interconnected, and modular blocks that can be assembled according to specific use cases–offer increased power density at lower energy usage. Meanwhile, photonic systems using silicon as an optical medium for data transmission promise communication between graphic processing units that is faster and up to a thousand times higher capacity than standard.

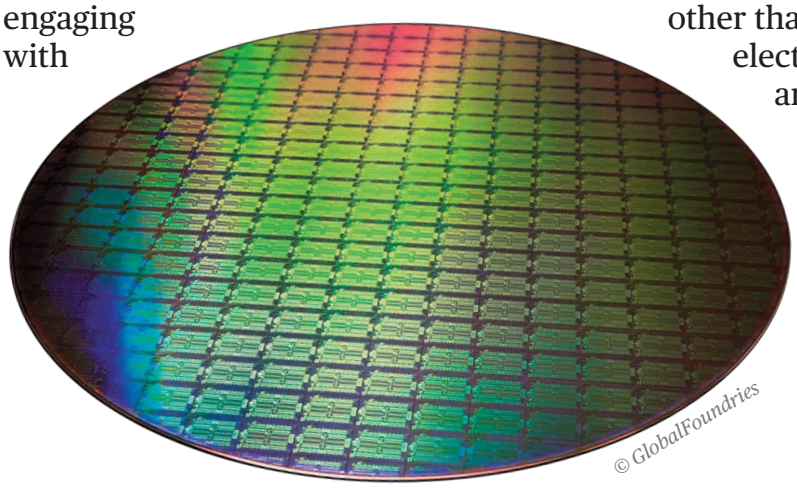
"The same principles and technology can apply to SDVs," claims Saleem. "GlobalFoundries is already engaging with OEMs interested in silicon photonics. There could also soon be universally defined chiplets for ADAS and infotainment, meaning companies wouldn't need to worry about hardware compatibility issues from different suppliers." However, he adds that the automotive industry currently remains too fragmented to realise this level of hardware agnosticism. "Everyone has their own proprietary cores, networking chips, and software. Consolidation is a work in progress, but not everyone yet agrees on the best way to bring SDV development together into a seamless end-to-end process."

Rallying behind efficiency

What might unite developers is a shared rallying cry. Few currently contend that the future of SDVs will be anything other than electric, and efficiency has already taken root among several industry leaders as a primary concern. Saleem equates the quest to reduce power consumption while increasing performance as tantamount to the "freedom" of mobility in the electric era.

"In an electric SDV, greater efficiency translates to more range, and that's ultimately what consumers want right now." Similarly, more efficient vehicle architectures will also make charging faster, safer, and more convenient–all primary concerns for customers and automakers alike. Once these fundamental issues are resolved, automakers will already have the hardware necessary for future differentiation through software.

Importantly, maintaining a common focus on efficiency will act as a guiding light for SDV development throughout the world. "The less power a vehicle's systems waste, the further it can go and the more it can do beyond go from A to B. It's really as simple as that," Saleem concludes. For its part, GlobalFoundries will leverage the capacity of its facilities in Germany, Singapore, and the US to meet automotive customers' evolving needs wherever SDV innovation is happening.



Close up of a GlobalFoundries semiconductor wafer

Scout Motors: software-defined SUVs still need tactility

Scout Motors aims to help drivers avoid digital fatigue while still providing state-of-the-art software offerings.

By Stewart Burnett

The success of software-defined vehicles (SDVs) will be defined by the efficacy of the platforms on which they're built. Many automakers have struggled to get the foundations for software development right, which has subsequently inspired partnerships. Most notably, Volkswagen-Rivian announced a joint venture (JV) in August 2024 to build a common SDV platform.

Amid this flux comes Scout Motors, a new automaker named after a popular SUV precursor—the International Scout—produced by International Harvester between 1961 and 1980. An independent company with its own board of directors but still wholly owned by Volkswagen, Scout Motors will be among the first to leverage software offerings from the Volkswagen-Rivian JV. "We're building our own proprietary platform for our vehicles, but it will use Rivian software," explains Strategy Director Ryan Decker.

© Scout Motors

Scout's software platform is defined by its Community UX ecosystem, which is designed to offer premium digital and connected experiences without being needlessly overwhelming and opaque for customers. In practice, this means a kind of minimalism: allowing the driver to moderate the level of digital interaction they prefer through three customisable display modes and emphasising traditional analogue-style features like knobs and buttons. But can Scout Motors' uniquely 'balanced' approach to software-defined mobility help drive adoption?

Old world and new world

Decker remarks that Scout Motors' platform offers a "clean sheet of paper" upon which to draw its mobility vision. "We're a start-up with a running start; we have a brand with a beloved fan club but a forward-looking vision," he explains. "And we have the backing of one of the world's largest OEMs, which certainly helps." Scout Motors was founded by Volkswagen in May 2022. Research and development—including a company-owned IT operation—takes place in Michigan, while production is expected to begin in South Carolina from 2027.

"Our unique selling point is this perfect marriage of old world and new world approaches," says Decker. While the company often hews to the adage 'if it ain't broke, don't fix it', it remains thoroughly uninterested in recreating a vehicle from 1980. This can be observed in the company's use of Rivian's modern zonal architecture for its software platform, which enables remote diagnostics and continuous over-the-air updates across the vehicle's lifecycle. At the same time, Scout eschews the hyper-minimalist, touchscreen-centric approach to the interior that many other automakers have adopted as they increasingly shift towards software.

Tactility over touchscreens

Of course, there are still touchscreens on board. The Community UX is centred in an ultra-wide 21:9-ratio 16.2-inch touchscreen LCD in the middle of the dashboard, albeit underscored by a row of metal buttons. These buttons include physical climate controls that allow variables like temperature and fan speed to be quickly tweaked without the driver taking their eyes off the road. Despite the 'analogue' appearance, the buttons are powered by and connected to software. They are meant to augment the touchscreen—for example, the temperature dials sit right below the temperature information display.

"We want these vehicles to feel connected at the tactile level," explains Decker. By prioritising tactility, the automaker aims to buck a trend started by Tesla in which the touchscreen determines more and more aspects of vehicle functionality. It also creates an alternative, more mechanical aesthetic for the automaker's SDV vision. A second, smaller display sits behind the wheel in place of the instrument cluster. While this could help win over older consumers more reluctant to embrace the digital aesthetic, there are signs it could also prove popular among younger people. A 2024 report by McKinsey notes a trend among Gen Z

Scout Motors blends integrated touchscreens with a range of tactile buttons and dials

customers restricting their digital lives, manifested in the growing popularity of 'dumbphones'—mobile phones that limit functionalities to calls, texts, maps, and a few other simple features.

At the same time, Scout is working to ensure its platform is connected to a full range of software offerings, including music streaming, video and more. The brand aims to make these experiences seamless through built-in satellite internet, enabling connectivity-dependent media and information offerings to be enjoyed in off-road and remote settings as and when desired. "We want to be a brand that equips Scout owners to go out and do things without restrictions," Decker states. However, this also helps drivers set the terms for their own exposure level and access to automotive software. Satellite internet will be offered on a subscription basis.

Decision fatigue

The ability to let drivers manage their software exposure may be best observed through the three

> **I could quite easily make the case modern vehicles are becoming disconnection machines**

customisable information modes Community UX offers: detailed view, default mode, and detox mode. While the detailed view is intended for those who want as much vehicle data as possible, the detox mode is intended to minimise distractions with a clean, simple display. The standard mode is in keeping with standard infotainment experiences, displaying essential information while integrating buttons and knobs to maximise tactility.

The detox mode is noticeably minimalist, showing only critical vehicle information in orange text against a black backdrop. When the navigation system is active, the instrument cluster screen will not show a map but rather simple text-and-arrow-based turn-by-turn directions. During this time, the centre screen will provide a minimalist trip summary. Decker notes the ease by which modern drivers can experience 'decision fatigue', or a sense of feeling overwhelmed by technology and the numerous ways in which drivers must constantly interact with it and make decisions. "I could quite easily make the case modern vehicles are becoming disconnection machines," he remarks.

Instead, the Community UX software is oriented around strengthening the feeling of connectedness between the driver and passenger. "We are really interested in the idea of turning the passenger into a co-pilot," he explains. The screen's 21:9 ratio is designed with a unique interface that allows for collaboration and group tasks: content can be swapped from one side to the other with a simple touch gesture or by using an arrow at the touchscreen's bottom. The passenger can search for a charging station on their side of the screen and relay it to the driver's side or go back and forth picking songs for a music playlist.

Ultimately, if Scout Motors's Community UX can integrate a sense of mechanical touch-and-feel and connectedness, while allowing the driver to mitigate their sense of digital fatigue, it could help convince those more reluctant about SDVs. "If you want to win over American buyers in the SUV segment to software, you need to recognise that they want tactility. They want to work the vehicle themselves with a muddy glove," Decker concludes. "Having a brand philosophy that embraces these things and integrates them into a broader vision unlocks a wider portion of the market."

Software-centric chips anticipate the AI-defined vehicle

Automotive-specific semiconductors that can be adapted with software could solve ADAS latency, improve safety, and boost energy efficiency. By Will Girling

Latency, the fractional delay between data capture and executing a command, holds significant importance in SAE Level 2 and 3 advanced driver-assistance systems (ADAS). Shaving milliseconds off a vehicle's reaction time to a hazard could be the difference between life and death. However, as processing information from multiple sensors becomes more energy intensive, some developers are moving machine learning (ML) algorithms away from the edge.

Harald Kroeger, President of Automotive at SiMa.ai, tells *Automotive World* that this is a mistake. "Relocating the vehicle's brain far away creates latency, which is very harmful in ADAS. You could crash into a tree, and the car would only know it 30 seconds later." As such, his company has developed an ML system-on-chip (MLSoC) with accompanying software to keep processing in vehicles and "close to the action" instead of siloed in data centres.

Installing a 'guardian angel'

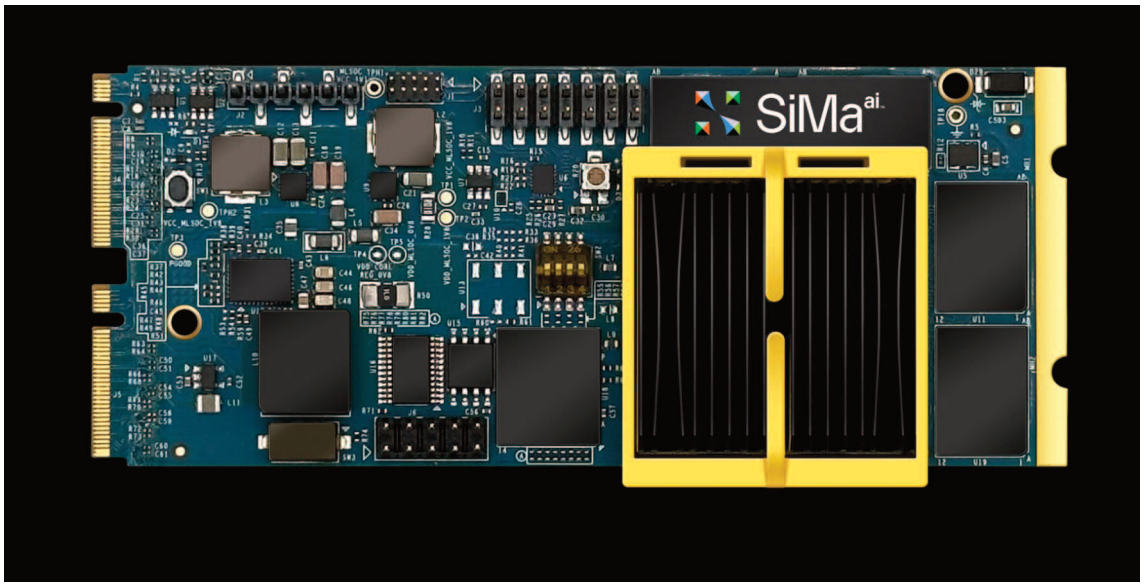
The artificial intelligence (AI) models used for automated driving can be large and power hungry, which not only lowers range when installed in electric vehicles but also slows down inferencing. Kroeger states anything in excess of 100 milliseconds delay can lead to undesirable outcomes in most driving situations, and the degree of ADAS latency is contextually determined by factors like environment, vehicle speed, and frames per second (FPS) performance limitations.

Addressing the latter has become a focus point for many tech companies. "There's even an industry 'Olympics', the MLPerf Benchmark, to compete on how many FPS can be run on a certain model," he says. At the time of writing, SiMa.ai has won three times in the AI/ML edge inferencing category. In March 2024, it achieved 150 FPS per watt, besting comparable offerings from Dell and Qualcomm by 200-300%. The safety implications of this performance improvement are significant.

© SiMa.ai

In 2023, the World Health Organisation recorded 1.2 million fatalities resulting from road traffic collisions. Some analysts question whether the current generation of partial automation systems have any definite benefits on road safety. Robotaxi operator Waymo published a study in December 2024 claiming Level 4 autonomous vehicles (AVs) can be safer than human drivers, but the rollout of this technology has been slow, limited, and far from incident free.

Kroeger believes widely deployable, high-performance, AI-driven edge inferencing is the essential component missing from ADAS and



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AV systems. “We need to install a guardian angel inside every vehicle. If routine instances of driver distraction and error can be corrected, we could save so many lives.”

Performance, efficiency, applicability

SiMa.ai is positioning its unique MLSoC platform as the gateway for unlocking next-generation ADAS/AV performance. Importantly, it has been conceived specifically for automotive applications. “A lot of the technology out there was designed for something else and retrofitted,” says Kroeger. Comparatively, SiMa.ai’s ‘blank slate’ enabled it to create a solution from the ground up, unlocking both performance and cost efficiencies. “Affordability leads to adoption; if something’s too expensive, no one will use it.”

SiMa.ai’s MLSoC has an ML performance of 50 TOPS and a ResNet-50 (an image classifying architecture) performance of more than 300 FPS per watt. The company claims latency can be reduced by a factor of ten, with all compute in Level 2/3 systems achieved at less than 25W, or less than 100W at Level 4.

Equally important, Kroeger adds, is applicability. “We recognised early on that focusing on one specific model is not a good idea. Doing so means that every new development makes the hardware redundant.” SiMa.ai designed the chip according to three foundation pillars: to be compatible with any computer vision and generative AI application using ML at the edge, regardless of vehicle type; to offer best-in-class performance per watt; and to provide an interface usable by anyone instead of a small demographic of hardware experts.

The secret was developing a chip that can be adapted quickly and easily through software–SiMa.ai considers itself primarily a software company that also builds silicon products. Offering a general

> **Everyone now realises that software, not hardware, will make the magic happen**

compute platform that's highly malleable according to use case future-proofs its solution in the rapidly evolving vehicle AI market. "Putting a brain in cars will fundamentally change how customers interact with them on a daily basis," states Kroeger. "The industry talks about software-defined vehicles (SDVs), but AI-defined vehicles represent a far larger shift."

The AI-defined vehicle

Although SDVs currently lack a coherent definition within automotive, Kroeger states that OEMs and suppliers are enthusiastic about SiMa.ai's MLSoC and the possibilities of an AI-defined vehicle. "The reason is that pretty much everyone is unhappy with the power consumption, restricted versatility, and lack of focus on automotive that current solutions provide." Now that SiMa.ai has gained visibility in a highly competitive space, it is pushing to take on the Big Tech players.

In December 2024, SiMa.ai combined its AI/ML capabilities with silicon design and verification firm Synopsys to maximise customisation for automotive-centric IP, subsystems, chiplets, and SoCs. "Synopsys is almost like a superpower; there's pretty much no chip in the world in which it wasn't involved." Notably, the company's advantage in virtualisation will enable simulated chip functionality testing, resulting in faster and better software iteration. This type of development process is an emerging trend within SDV innovation.

Kroeger predicts that ADAS systems integrating the SiMa.ai MLSoC could be on the market by 2029, with the potential for introducing more limited AI functions into cars even sooner. "A breakthrough in embedded AI can only happen when automakers reconsider performance and energy efficiency," concludes Kroeger. "Future-proofing vehicle architectures for the big changes coming is vital, and everyone now realises that software, not hardware, will make the magic happen."

BYD and DeepSeek change the conversation on vehicle autonomy

Between them, BYD and DeepSeek pose a big challenge to automotive players around the world preparing for a software-defined industry. By Will Girling

BYD sent shockwaves through the industry when it announced on 10 February 2025 that advanced driver-assistance system (ADAS) features would become available as standard across 21 models at no extra cost. This contrasts with its neck-and-neck market rival Tesla, which requires customers either purchase Full Self-Driving for US$8,000 or subscribe for US$99 per month. Shares in rival Chinese automakers Xpeng and Geely, which are developing their own smart driving systems, fell shortly after the news broke.

BYD's God's Eye system will be offered across three tiers depending on the vehicle's price and spec. The entry-level version (God's Eye C) uses 12 cameras and 17 radars to enable SAE Level 2 highway driving only. The more premium God's Eye B adds a LiDAR sensor and takes highway driving to Level 3, while God's Eye A adds three LiDAR sensors to achieve automated city and highway functionalities. BYD Chairman Wang Chuanfu is convinced that autonomous driving will soon progress from experimental novelty to an "indispensable tool like safety belts and airbags."

Significantly, this development went hand-in-hand with BYD's decision to integrate artificial intelligence software from DeepSeek. This Chinese AI specialist caused a sensation following the release of its R1 model on 20 January, which it said was developed for a fraction of the cost claimed by rivals in Silicon Valley. Stocks in these US competitors subsequently fell, and in just a week, DeepSeek's chatbot unseated ChatGPT as the most downloaded free app on Apple's App Store.

"The global automotive sector is currently experiencing an unprecedented structural change at a remarkable speed," says Peter Schubert, Head of Engineering for Transportation and Mobility, EMEA and APAC, at Publicis Sapient. Along with sensors and connected technologies, he believes an automaker's level of software integration will be a "crucial differentiator" in a market that is "completely transforming" from the old paradigm.

The one-two punch of God's Eye and DeepSeek extends China's early lead in automated/autonomous driving systems, challenging the US industry's business models and value chains as it strives to catch up in 2025/26. The tech companies and 'digital native' players entering automotive are posing unprecedented challenges to the established order. In an open market economy, Schubert expects these to accelerate over the coming years. However, he tells *Automotive World* that European OEMs could be the ones most at risk.

The European Commission knows the EU is in danger of falling irremediably behind. "We know that global competition is fierce," stated Commission President Ursula von der Leyen following the publication of an Action Plan for the automotive industry's future on 5 March. "The goal is very simple: we have to get autonomous vehicles on Europe's roads faster." A €1bn (US$1.08bn) private-public investment plan between 2025 and 2027, as well as the expansion of UK-based Wayve into Germany—purportedly the first of many such moves to take place in 2025—could represent the first steps of a turnaround.

For now, much like BYD's electric vehicles, the God's Eye system can claim to have progressed the democratisation of next-gen ADAS in a way few competitors could replicate. Two Chinese companies may have permanently changed the entire conversation on software-defined vehicles, and as these products continue to evolve, future offerings will need to take autonomy's value proposition even further.