

The goal: Level-4 automated driving by 2021

One of the hot topics in Las Vegas was automated driving. Besides traditional carmakers and suppliers, new players from the consumer and IT business throw their hats into the ring.

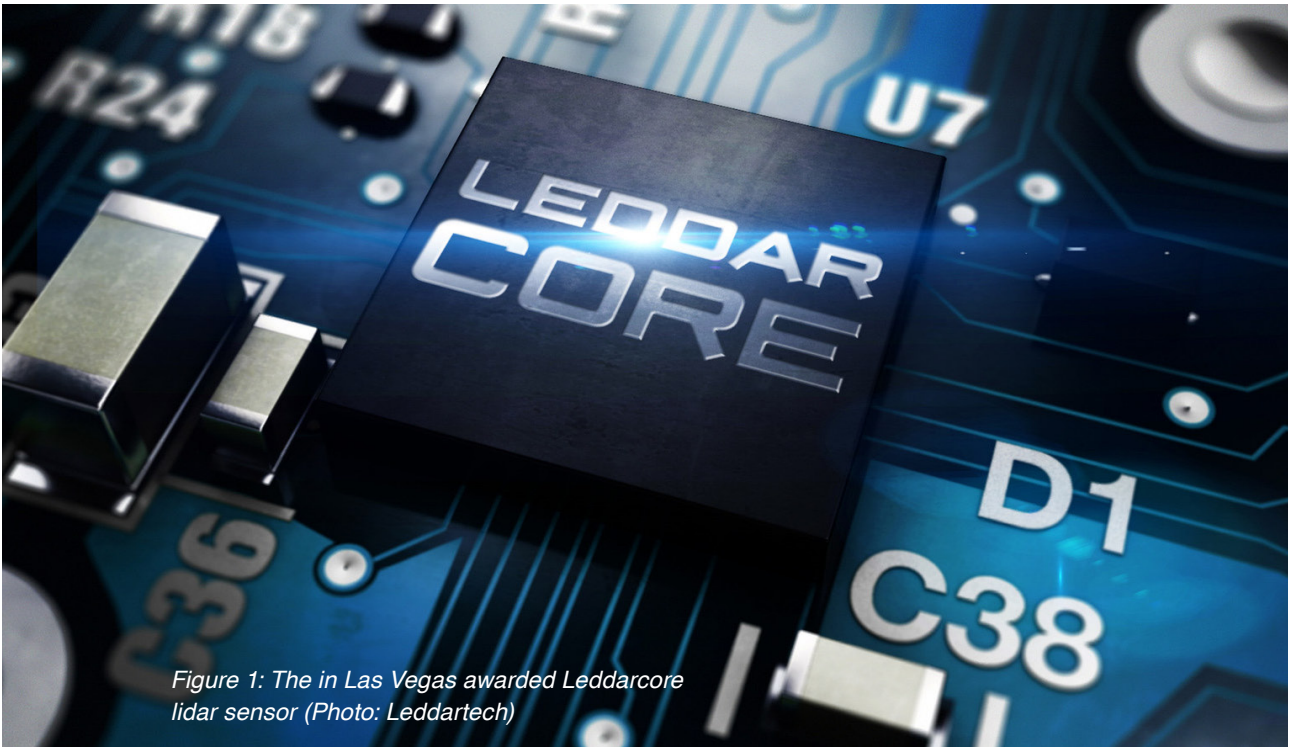


Figure 1: The in Las Vegas awarded Liddarcore lidar sensor (Photo: Leddartech)

Automated driving is an old dream: Already back in the 1960s, some enthusiasts conducted some first experiments with self-driving cars. At CES 2018, automated driving was a main trend. SAE Level-3 automated driving is already possible. This means the automated vehicle monitors already the driving environment. But the human driver still needs to be hot stand-by, ready to respond appropriately to a request to intervene. Next level is expected for 2021: Level-4 systems do not need drivers responding appropriately, when intervention is requested.

The base: Sensor fusion

Monitoring the driving environment requires a lot of sensors. Multiple radars, lidars, and cameras are needed. In Las Vegas, the Liddarcore LCA2 by Leddartech achieved two innovation awards. The solid-state 3D lidar is intended for high-volume applications. "The LCA2 truly is a breakthrough innovation that brings lidar technology to the mass markets. It delivers unique added value, reduces inherent risks at all levels of the value chain, and accelerates the path toward commercial deployments of semi- and fully-autonomous driving solutions," said Charles Boulanger, Leddartech's CEO. "These two CES awards are an ac-

knowledgement of our technology excellence and Leddarcore IC business model geared toward mass production of SSL sensors by Tier-1 manufacturers for deployment by automotive OEMs as early as 2020," he added. Leddartech cooperates with several Tier-1 suppliers to integrate the lidar ICs to board-level products and in electronic control units (ECU). Some of them provide connectivity to CAN-based in-vehicle networks.

To produced lidar sensors for reasonable costs is one of the keys for the success of automated driving. Besides Leddartech, Luminar, Quanergy, Velodyne, and other start-ups battle to supply the car industry as well as other applications fields. This includes service robots and automated guided vehicles (AGV) for industrial applications. Also agriculture and construction machinery is going the way to self-driving. In many of these applications, CAN connectivity of sensors is desired.

In general, sensor data can be fused in decentralized units or by a centralized computing system. The discussion on decentralized or centralized data processing is ongoing: one time distributed computing wins, and next time central computers are ahead. In Las Vegas, Continental presented its Open Computing Language (OpenCL) framework developed in cooperation with Xilinx. The introduced ►

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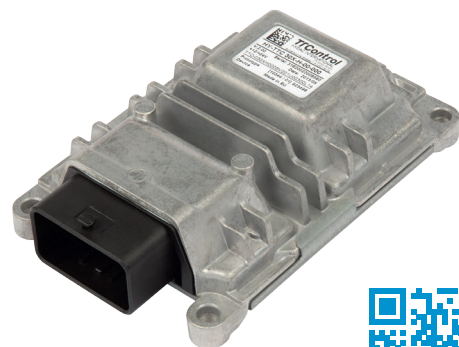
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Chinese platform for automated driving

Nvidia cooperates with Baidu, China's search engine giant, and ZF, Germany's number three Tier-1. Baidu has introduced in Las Vegas its Apollo 2 "open" platform for automated driving vehicles. The previous Apollo version comprised a vehicle computer with recommended CAN interface board from ESD. "Open platforms and ecosystems are the best way to accelerate the transition of AI technologies toward commercialization," said Qi Lu from Baidu. Apollo has gathered more than 90 partners. Baidu said that it supports four main computing platforms from Nvidia, Intel, NXP, and Renesas in 2018. An additional cooperation with ON Semiconductors was announced in Las Vegas. Ross Jatou from ON Semiconductor said: "We are delighted to be partnering with Baidu on their Apollo platform. We believe that the value of such a platform to automotive system designers will be tremendous. It is underlined by the number of industry leaders already engaged and looking to utilize it. Image sensors are fundamental components of ADAS implementations throughout the vehicle, and they will become even more relevant as the industry moves towards fully autonomous cars. Joining forces with Baidu by providing the image sensor solution for the Apollo platform is further validation of ON Semiconductor's leading position in automotive image sensing." The chipmaker provides also CAN transceiver chips. Infineon is also a partner of the Apollo program. The German chipmaker supplies its Aurix family of 32-bit micro-controllers featuring Classical CAN and CAN FD modules. These products are made for sensor fusion, gateway, and domain controller applications. In addition, the company provides a variety of other integrated circuits (IC) for autonomous driving. This



Baidu's Apollo program is very ambitious: Many market-leading chipmakers participate to develop an "open" platform for automated driving (Photo: Baidu)

includes sensors, actuators, and transceivers, for example for CAN.

"Apollo is more than just open-sourcing code and technology – it is evolving from technology innovation to product innovation and enabling more implementation scenarios," said Jingao Wang, Head of Apollo Platform and Senior Director of Baidu. Chery Automotive, a Chinese brand will produce in series Level-3 autonomous vehicles based on the Apollo platform by 2020. Baidu also plans to mass-produce driverless buses for designated areas by the end of July 2018 with King Long, a Chinese vehicle manufacturer situated in Xiamen. Additionally, co-operations with JAC Motors and BAIC Motor are planned. Production of self-driving vehicles will begin with the next two to three years.

The Apollo project goes abroad, too: The first overseas expansion to Singapore was announced already. The joint venture is called Apollo Southeast Asia and is financed by US-\$ 200 million fund.

platform provides heterogeneous computing options such as a Central Processing Unit (CPU), Graphics Processing Unit (GPU), Digital Signal Processor (DSP), and now with the help of Xilinx's all programmable technology a customizable hardware acceleration solution. This provides developers the ability to optimize software for the appropriate processing engine or to create their own hardware accelerators. "Xilinx is proud to collaborate with Continental in the development of the Assisted & Automated Driving Control Unit, enabling the creation of an ecosystem for automated driving. We embrace the spirit of a hardware platform that invites collaboration, rather than tying companies to a proprietary architecture," said Willard Tu.

"Our Assisted & Automated Driving Control Unit will enable automotive engineers to create their own differentiated solutions for machine learning, and sensor fusion. Xilinx's All Programmable Technology was chosen as it offers flexibility and scalability to address the ever-changing and new requirements along the way to fully automated self-driving cars," said Karl Haupt, Head of Continental's Advanced Driver Assistance Systems business unit.

The jointly developed platform offers a scalable product family for assisted and automated driving fulfilling

the safety requirements (ASIL-D) by 2019. This platform will provide a variety of communication ports for the necessary data flow. During development, Continental distinguishes between an Assisted Driving Control Unit and an Automated Driving Control Unit. The first product of this scalable family is a module for advanced driver assistance systems that offers a complete, cost-optimized package connecting sensors and actuators with complement of central processing, safety, and security. The control unit for automated driving follows closely behind as a powerful computer that meets the requirements of highly automated driving, with special focus on new digital structures for comprehensive environment modeling, ASIL-D, and real-time performance, while providing a heightened ease of use to developers by offering an OpenCL path into every chip present.

The workhorse: Number-crunching hardware

Sensor fusion and combining the results with information from electronic maps and weather forecasts using artificial intelligence (AI) methods requires a lot of computing power. This means, special hardware is needed. Specialized companies such as Nvidia and Mobileye (recently ▶

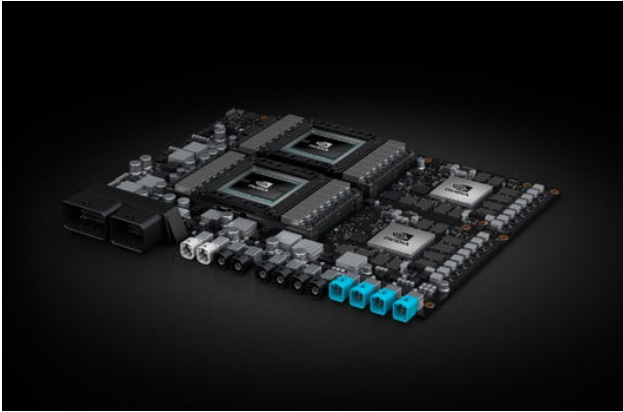


Figure 2: The Drive platform powered by the Xavier system-on-chip (Photo: Nvidia)

acquired by Intel) are the top dogs. Nvidia introduced in Las Vegas the next generation of its autonomous driving board powered by Xavier system-on-chip (SoC). It was developed for SAE Level-5 self-driving vehicles. The chip has more than nine billion transistors with an 8-core CPU, a 512-core GPU, a video-processor, a deep-learning accelerator, and a computer-vision accelerator. It can perform 30 trillion operations per second and consumes just 30 Watt. This number-crunching hardware is the base of two software platforms, Drive IX and the recently announced Drive AR.

Nvidia cooperates with 320 partners regarding self-driving. This includes Tier-1 suppliers such as ZF

and OEMs such as Volkswagen (VW). ZF uses Nvidia's platform for its ProAI car computer. VW will implement the Drive IX technology by 2022 in its automated driving vehicles. During the CES, Jensen Huang, Nvidia's CEO, and Herbert Diess, VW's CEO, enter jointly the stage to discuss how AI and deep learning will shape the next generation of vehicles. This was a meeting of two business cultures: Dressed in a leather jacket and in traditional suit. Jensen Huang behaved more like a preacher man, while Herbert Diess presented himself a bit starchy.

Nvidia partners also with Baidu's Apollo project developing an open platform for automated driving vehicles (see insert "Chinese platform for automated driving"). It comprises four major modules: reference hardware, software platform, cloud computing services, and last but not least a vehicle platform.

But there is not just Nvidia offering number-crunching hardware. Mobileye is the toughest competitor. Recently acquired by Intel for US-\$ 15,3 billion, Mobileye has launched the EyeQ5 system-on-chip, indicating by its name to support the development of SAE Level-5 self-driving vehicles. The company has a similar long list of partners comprising OEMs and Tier-1s. At the CES show, the company announced a co-operation with Chinese automaker Saic motors. The SoC combined with Intel's Atom processor is competing Nvidia's Drive platform. Besides the computing power, the power consumption is essential. The Mobileye/Intel solution features also CAN connectivity to integrate the ▶



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Statements at CES 2018

Brian Krzanich, Intel's CEO: "As driverless cars become a reality, we must start thinking of the automobile as a new type of consumer space. We have barely scratched the surface in thinking about the way cars will be designed, the interaction among passengers, and how passengers will spend time while they are riding and not driving. In this respect, autonomous driving is today's biggest game changer, offering a new platform for innovation from in-cabin design and entertainment to life-saving safety systems."



(Photo: Intel)

Michael Xie, president and CTO of Fortinet: "Connected vehicles are the next major technology innovation disrupting the automotive industry. With 3D mapping, sensor processing, smart device integration, cloud-based services, advanced LAN/CAN networks, and autonomous driving defining the connected car of the future, the cyber risks are enormous. And with IoT devices connecting to the car network to access content and applications, the attack surface is even larger."



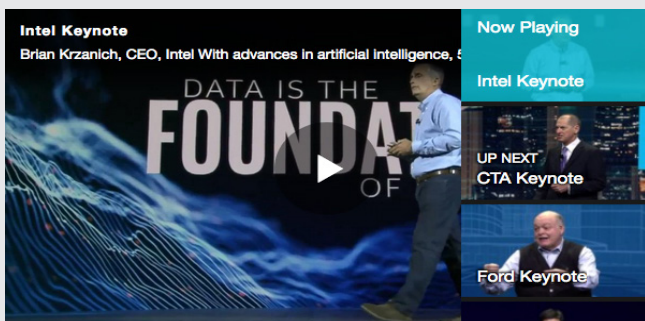
(Photo: Fortinet)

Peter Schiefer, president of Infineon's the automotive division: "With our profound expertise in automotive applications as well as the premium products and services, Infineon significantly contributes to the breakthrough of autonomous driving. It is in this regard that we look forward to supporting Baidu in taking the Apollo initiative to the next level."



(Photo: Infineon)

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Brain-to-vehicle communication



(Photo: Nissan)

At CES 2018, Nissan launched a driver-to-vehicle device. Of course, you cannot buy it today. The driver wears a cap, which reads his brain waves and uses them to help improve the reaction times of the vehicle's electronics. The Japanese carmaker selling vehicles under the brands Nissan, Infiniti, and Datsun is one of the first to conduct research on brain-to-vehicle (B2V) communication. The company also owning partly Mitsubishi Motors and cooperating with Renault said that the B2V cap can predict driver behavior to shorten reaction time, when a driver is in control, for instance by making steering wheels turns or braking 0,2 to 0,5 second faster. Of course, copying a human's driving style is not ideal in all cases. The last thing you would want is an autonomous car that speeds and makes erratic lane changes. Nissan's goal is to maximize driver safety during autonomous driving without departing too much from the driver's own style. This technology is hopefully far away from implementation in serial production, but Nissan said they like to show the potential of combining human and artificial intelligence.

supercomputer into the in-vehicle network architecture. The production of the EyeQ5H system-on-chip will start in August 2018. Volume production is expected for 2020, when first OEMs will use the SoC in their series cars. In Las Vegas, the chipmaker introduced in a keynote speech its 100-vehicles test fleet.

Some call this competition the "chip war". Intel claims to be ahead with over two million Mobileye installations. But not just Mobileye and Nvidia are in the contest: Qualcomm is the third in the ring. The company likes to acquire NXP's mother Broadcom. Jaguar Land Rover announced to use Qualcomm's Snapdragon computing platform for its next generation of automated driving vehicles. Additionally, Ford and Qualcomm announced to cooperate.

The challenge: Safe and secure

Besides the Apollo platform, several other approaches were presented in Las Vegas. It is not just computing power what counts in the automated driving business. Important features are functional safety and cyber-security. Already serious production in mind, ZF presented its ProAI hardware and software developed jointly with Nvidia (see ▶

insert “Chinese platform for automated driving”). The German Tier-1 showcased the Dream Car development vehicle equipped with this solution. It is nearly ready for volume production, said Dr. Konstantin Sauer, ZF’s CEO. Rinspeed’s Snap concept car uses the ProAI (see page 6) platform, too. In virtual test drives, the Dream Car travelled already 9 000 km. The same distance as I drove with my younger daughter a couple of years ago from San Francisco to New York within six weeks.

Continental presented in Las Vegas its Safety Domain Control Unit (SDCU). This unit is used as a fallback path for just in case. This SDCU stops the vehicle safely, even in the event of a functional failure in the primary path. There are one or more fallback paths for every central system and they are independent of each other. Since the SDCU also acts as the airbag control unit, its priority availability – including energy reserve and a crash-proof installation location in the vehicles – is guaranteed. With the additional fallback path of the SDCU, the supplier ensures that the vehicle can still be brought to a safe stop, if the main automation functionality fails. This increases the availability of the vehicle’s electronic. “It is precisely this fallback path that may not be available in highly automated vehicles, since the driver is allowed to focus on other things and cannot be requested, in a fraction of a second, to take control of the vehicle immediately after a possible failure,” explained Maged Khalil from Continental. Every highly automated vehicle must therefore be able to stop automatically. Level-4 vehicles such as Cruising Chauffeur from Continental are prepared for this.

Besides functional safety, cyber-security is an issue. Developed in cooperation with Renesas, Fortinet demonstrated its Fortios security operating system. Both companies presented an implementation on Renesas’ R-Car H3 SoC installed in prototype car exhibited in Las Vegas. Mock cyber breaches were demonstrated including intrusion-preventing system (ISP) attacks and distributed denial-of-service (DDoS) attacks. The SoC by Renesas features two CAN FD ports besides Ethernet, Most, USB, and other serial interfaces.

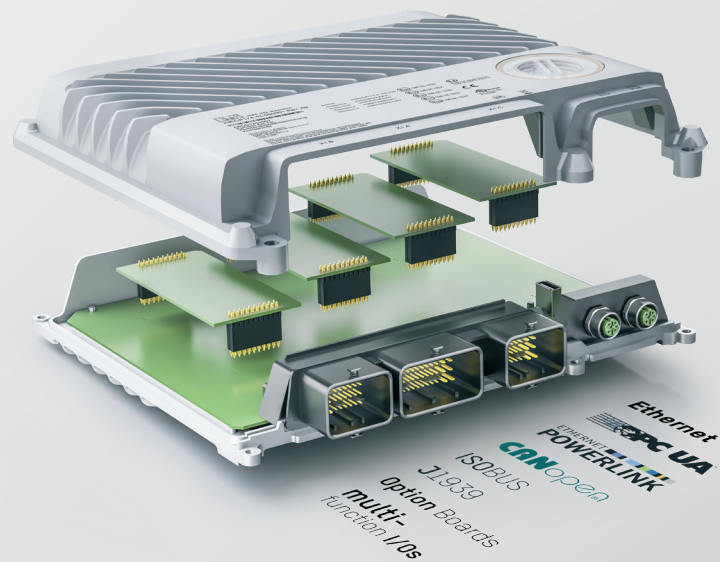
The FEV Group demonstrated at CES 2018 a self-driving vehicle using its cyber-security solution, the Cyber-Security Gateway (CSG). The company is known as powertrain supplier and vehicle engineering provider. The launched CSG is linked to the CAN-based in-vehicle networks, to detect and to prevent malicious attacks, and can also function as a firewall between the external interfaces such as WLAN, Bluetooth, Cellular, and the CAN-based OBDII port, to protect the vehicle from these potential remote security threats.

Karamba Security (Israel) announced in Las Vegas its Safecan security software. It protects CAN-based networks from hacking by authenticating in-vehicle communications with zero protocol overhead, claimed the company. It can be implemented without overtaxing the car’s internal communications to protect and authenticate CAN communications. There is no need to change network protocols, or add any additional network packets to ensure the authenticity of source-destination authentication and overall in-vehicle network authentication. By offering seamless encryption for ECU communication, Safecan ▶



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Infineon supports Nvidia's Pegasus platform

Infineon has expanded its safe automated driving collaboration with Nvidia, announcing that its Aurix TC3xx series automotive MCU will be used in the Pegasus AI car computing platform. The supercomputer for autonomous vehicles meets the requirements of Level-5 autonomous driving as defined by the Society of Automotive Engineers (SAE). "Nvidia's Drive AI vehicle supercomputers deliver up to 100-times more computational horsepower than the most advanced cars on the road today," said Gary Hicok from Nvidia. "Their multiple levels of redundancy and safety functionality demand a proven, widely deployed safety architecture, like that of the Aurix TC3xx series."



Ritesh Tyagi (Photo: Infineon)

The German chipmaker now supplies the safety MCUs, safety power supply IC, and selected vehicle communication interface ICs for several the Nvidia hardware platforms. The devices support increasing levels of autonomous driving capability, ranging from auto cruise functionality to auto-chauffeur and full autonomy.

The collaboration enables users of the platform to access Aurix capabilities through an Autosar-compliant software stack. This potentially allows re-use of higher-level application code and can likely reduce development time by 20 percent to 40 percent compared to traditional platforms.

Ritesh Tyagi: "Collaboration between Infineon and Nvidia through multiple generations of Drive car computers provides the automotive industry with a consistent platform for development and market deployment across all classes of driver-assist and fully autonomous systems."

The multicore MCUs help the platform to meet the functional safety requirements according to ISO 26262 ASIL-D for Advanced Driver Assistance Systems (ADAS) and self-driving systems. The products support among other communication options also CAN FD. In Las Vegas, exhibited several Aurix solutions for ADAS systems.

hardens the network leading to and from the car's safety systems and ensures that only legitimate commands are received by the car's safety systems. Commands originating from invalid sources are ignored.

In addition to hardening the car networks against physical attacks, Safecan enables secure OTA (over-the-air) updates from the cloud to any ECU in the car. OTA products use secure channels from the OEM cloud to the primary ECU, which serves as the OTA's entry point in the car. However, due to lack of network authentication, attackers may hack the car, impersonate an OTA update

and deploy malicious software on safety ECUs. By hardening the network between the OTA primary ECU to the in-vehicle safety systems, target ECUs will not accept changes, unless it was authenticated by the security software. The software complements and extends Karamba's Carwall autonomous security product to provide end-to-end in-vehicle security. Carwall hardens externally connected ECUs by sealing their binaries according to factory settings. This prevents cyber-attacks and in-memory attacks from compromising the car ECU's, while eliminating false positives that risk consumers' safety.

The backstage network: CAN

At the end, when all sensor data is fused and combined with other information coming from the CAN-based in-vehicle networks, you have the same simple commands as in non-automated driving vehicles. This means, most of the carmakers will use CAN as an embedded or even as a deeply embedded network – so to say not visible for the original equipment manufacturer. All the above-mentioned hardware platforms provide in minimum optionally CAN connectivity. The reliability and the robustness are unique features of CAN. Of course, there are other INV technologies on the "backstage": Automotive Ethernet and LIN have also a great future. But they were also not hotly discussed in Las Vegas. They are as CAN not visible to the consumer – and it is still a consumer event. ◀



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