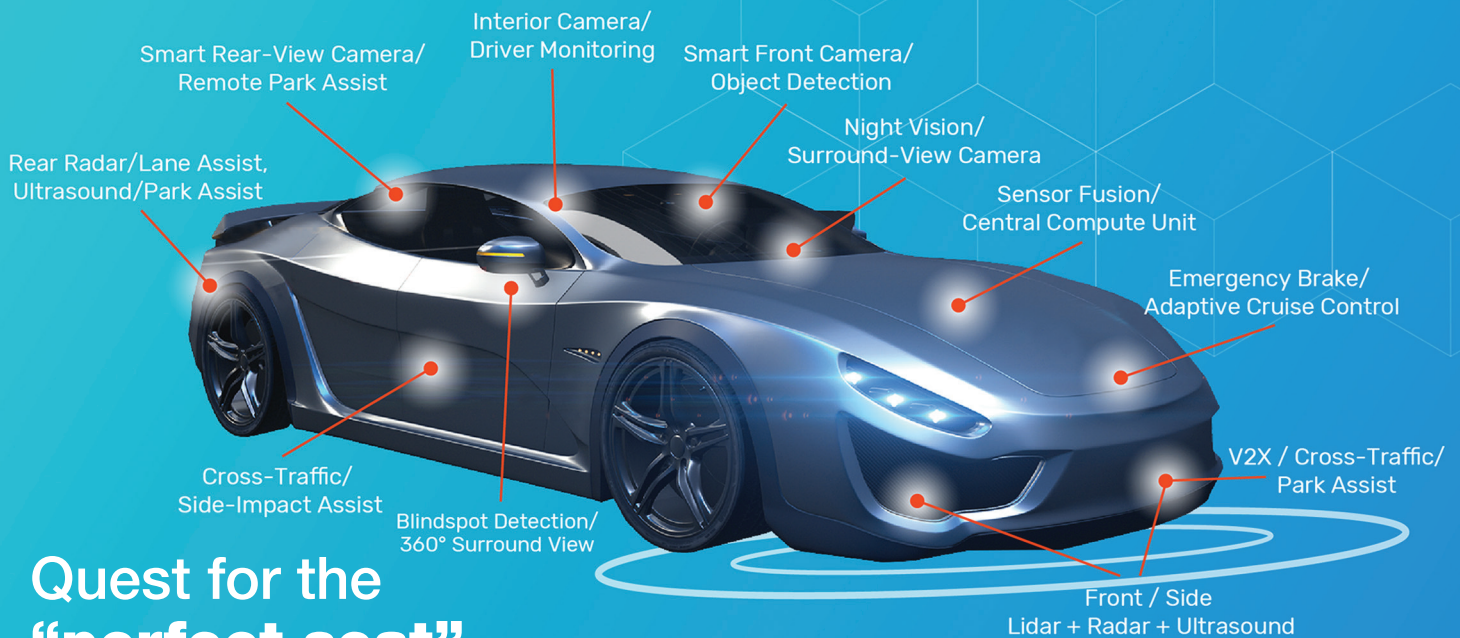


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– Robert Schweiger, Director of Automotive Solutions at Cadence.

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Autonomous driving — still room for improvement

By: Nick Palmen

Automated driving is redefining the role of the automobile, yet there are still unresolved issues like legislation and liability as well as technological challenges. For the automotive industry, autonomous driving is not a question of "if", but "when". One could also rightfully ask "where" and "how".

For years, various car manufacturers, Tier 1 suppliers and semiconductor vendors have made great strides to develop automated vehicles. However, we have not reached Level 3 (conditional automation) in production cars. The first highly automated driving systems in production cars are already planned for 2021 in Germany on certain types of roads, such as the Autobahn, and in suitable weather conditions.

In order to improve the ability of an autonomous car to drive under less-than-ideal conditions, the sensor set, computing units and software algorithms need to undergo constant improvement.

Automotive Industries (AI) asked Robert Schweiger, Director of Automotive Solutions at

AI: Talking about new technologies for autonomous driving, what are the key trends for hardware platforms?

Schweiger: The first autonomous systems will likely be available in robotaxis and luxury cars because OEMs can easily absorb the cost of such a system within the high price tag of the vehicle. Looking ahead, the more interesting use cases are mid-size and economy electric vehicles.

In order to address this market, the key requirements for hardware platforms are performance per watt, scalability, safety, security and the associated costs. Combining 10 different electronic control units (ECUs) will probably neither provide the performance per watt nor meet the price target, so a highly integrated solution based on a high-performance system on chip (SoC) is needed.

In 2019, Tesla introduced their new Full Self-Driving (FSD) computer (HW3.0) including their own software and machine learning environment. More remarkable, as the first OEM to develop their own SoC, Tesla was able to tailor it to their system requirements.

The SoC includes two AI processor cores and achieves a maximum performance of 144 TOPS at 72 watts (2 TOPS/W), which is still the benchmark today.

Most other driving platforms on the market do not even achieve 1 TOPS per watt! The next generation of SoCs will probably target a couple of hundred TOPS with an even better TOPS/W ratio. This can only be achieved by leveraging the latest process technologies available on the market.

If automakers are really serious about getting into the commercial business of self-driving vehicles, then they should consider developing their own purpose-built SoCs to create a performance- and cost-optimized automated driving platform.

AI: The amount of data that is produced by more intelligent vehicles must be massive. What does this mean for memory requirements?

Schweiger: Even as we expect hands-free automated driving systems (Level 3) on certain types of roads in 2021, I think

Robert Schweiger, Director of Automotive Solutions at Cadence



Cadence, why is it so hard for the automotive industry to reach even Level 3 automated driving.

Schweiger: For the past few years, we've been witnessing a technology competition not only between companies but also between nations. For obvious reasons, everyone wants to be first to enable automated driving in high-volume series cars officially licensed by the local government.

While there are still challenges to address, technology is clearly ahead of government regulations, which so far haven't provided car manufacturers with a framework that allows them to leverage this new technology for its intended use case on the road. Because of this, Audi's Traffic Jam Pilot was not added to the Audi A8 series production cars.

In addition, there are still many regulatory hurdles to autonomous vehicles such as liability and insurance that need to be addressed. Now we are witnessing a government regulation competition for the driverless car.

the real value for autonomous driving is if it also works on roads where there is some construction work occurring, or in difficult weather conditions. For this, you need a higher resolution sensor set to improve the robustness of the system. Hence the amount of data that such a system can produce is enormous!

As we move from Level 2 towards Level 5 full autonomy, it's estimated there could be between 3GB and 10GB of new data generated every second. Even a Level 2 car can generate up to 1GB of data per second.

Regarding the memory requirements for next-generation ADAS computing units, we see a major shift towards the latest memory standards that Cadence as an IP vendor also fully supports. The trends we see in automotive can be divided into three main categories:

- High-performance data processing: Higher data rates between processor and RAM require a migration from LPDDR4 to LPDDR5 to basically double the data rate up to 6.4Gbit/s
- High-speed data collection and transfer: The flash memory interface should be upgraded from eMMC/UFS 2.0/2.1 to UFS 3.0, which provides a data rate up to 23.2Gbit/s (2 lanes)
- Massive data storage: Ranging from 64GB to 1TB NAND flash memory (TLC and QLC)

AI: Moving a lot of data should also have a significant impact on in-vehicle network—any progress here?

Schweiger: This is also an interesting topic because of the ongoing debate on distributed versus central processing architectures in combination with raw sensor data fusion. In order to connect high-resolution sensors like cameras or radar sensors with a computing unit, a high-speed protocol like automotive Ethernet or MIPI CSI-2 is needed.

Each networking standard currently has some limitations. Meanwhile OEMs are already using one Gbps automotive Ethernet PHYs in production, which can transfer data over a 15m cable length. However, the bandwidth is still rather limited and does not even support full HD video resolution at 60 frames per second (fps).

MIPI CSI-2 in combination with a D-PHY v2.1 interface supports up to 6 Gbps per lane over the short channel (15cm at the highest data rate). However, due to the limited reach of the PHY, for the long-reach channel model (1-4m) the maximum data rate is less than 4.5Gbps. For longer-reach high-speed connections between systems, LVDS bridges need to be used.

The MIPI Alliance has just released the specification for the MIPI A-PHY, which is intended to support a data rate of 16 Gbps over cables up to 15m to connect high-resolution sensors (endpoints) with a central processing unit.

Looking ahead, the OPEN Alliance SIG and IEEE are already working on multi-gigabit Ethernet standards to support up to 10 Gbps, which is perfectly suited for the Ethernet backbone and communication between ECUs. Of course, 25G PHYs are already in discussion but could take years to materialize.

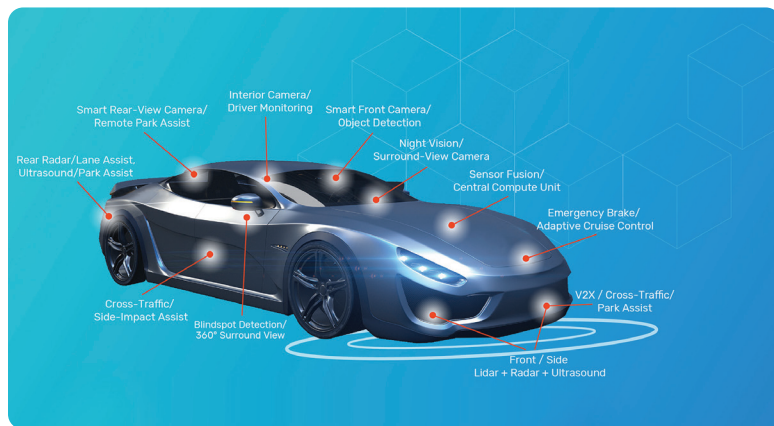
Needless to say, the availability of both PHYs can have a significant impact on the vehicle networking architecture. At the end of the day, I believe that MIPI standards optimized for mainly uni-directional data transmission will likely be used for the endpoints like sensors and displays. However, for the high-speed communication between different domains, Automotive Ethernet is ideally suited.

AI: How can Cadence help customers develop those highly complex systems?

Schweiger: Cadence is a broad-based partner for automotive Intelligent System Design. Cadence provides all the tools, flows,

silicon-proven interface and processor IP, high-performance cloud infrastructure and leading-edge design services to enable customers to create complex automotive SoCs and smart sensors, as well as high-performance sensor fusion units.

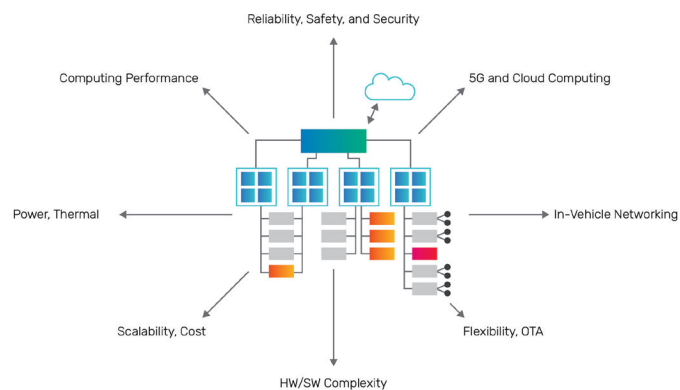
Given that custom SoC design is often new for classic OEMs and Tier 1s, the Cadence services team can help enable our



Level 3-5 automated driving.

customers' complex SoC designs and augment their team and skill set as needed. This allows the customer to gradually adopt advanced chip design flows and eventually take on the full design themselves.

Last but not least, Cadence enables system innovation by providing computational software to design and analyze chips, packages,



Electrical/electronic architecture challenges.

RF modules, boards, networks and systems. Some of our latest additions are system analysis tools for electromagnetic interference/electromagnetic compatibility (EMI/EMC) and thermal full 3D analysis, which allow the simulation of complete systems.

For example, customers can leverage the FEA-CFD integration of the Cadence Celsius Thermal Solver to analyze the thermal heat flow within a driving platform while taking the electronics and mechanical chassis into account. In addition, customers can simulate the EMI/EMC of an ECU individually or within the full automotive platform using the Cadence Clarity 3D Solver for near-field and the Cadence Clarity 3D Transient Solver for far-field simulations. **AI**



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