SoCs for electric and autonomous carmakers

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Whether advanced driver-assistance system (ADAS) applications will be needed to be successful in the future is not a question of if but when.

Next-generation autonomous-driving platforms require higher levels of performance to make split-second decisions. A vehicle needs to comprehend, translate, and accurately perceive its surrounding environment and react to changes through the fastest and safest means possible. Future ADAS and autonomous implementations (**Figure 1**) require higher performance, real-time edge computing with AI processing capabilities, and high-bandwidth interfaces to a host of high-resolution sensors, including camera, radar, and LiDAR.

Custom SoC versus off-the-shelf solutions

There are many factors to consider when auto OEMs decide whether to go with a customized SoC or off-the-shelf (OTS) (**Figure 2**). A general question one might ask is, "What is the ultimate goal of the manufacturer in relation to the end application?" Going a step further, which key technologies and IP should be brought in-house versus relying on external providers? To answer these questions, it is important to understand the tradeoffs in terms of performance, size, and costs.

In the end, automotive vendors must decide what is most suitable to them, based on the options available.

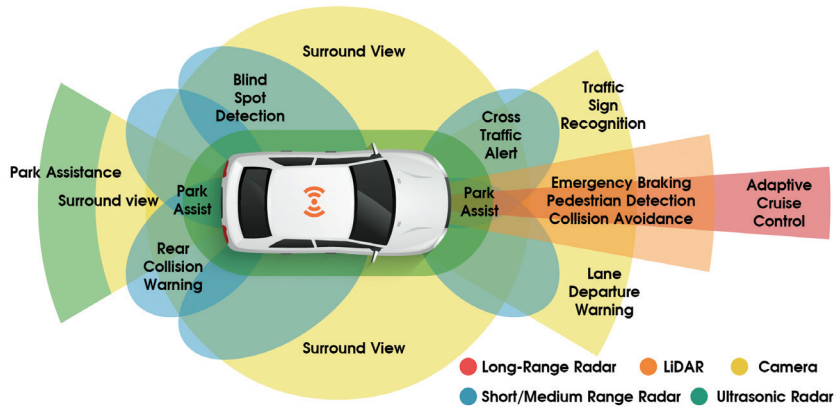

Figure 1: ADAS and autonomous driving require multiple sensors.

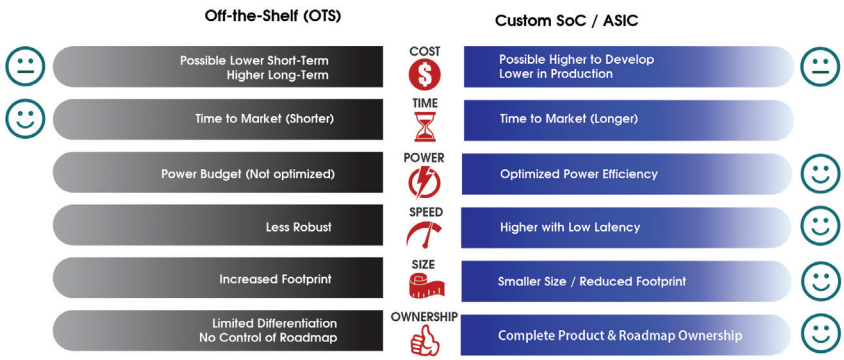

Figure 2: Off-the-shelf vs. custom SoC solutions

Benefits of custom SoC solutions

Some of the reasons why custom SoC solutions might be the optimal choice when designing your next automotive application are:

- Custom SoCs are built upon multi-purpose IP blocks that are specifically architected and integrated to achieve the intended functions as required by the application use case. They are specifically designed to achieve optimal levels of performance and efficiency while reducing size and overall BOM costs.
- Standard OTS silicon solutions are intended to appeal to a broader market. As such, OTS silicon devices often support functions that are not fully optimized and, in some cases, not even utilized. This often results in a larger device and footprint, requiring increased power consumption with decreased efficiency.
- In addition, custom SoC solutions provide OEMs and Tier 1s the opportunity for complete ownership of key differentiating technologies in the areas of ADAS and autonomy. Custom SoC solutions provide an opportunity to develop in-depth knowledge and in-house expertise, enabling greater control of future designs and product implementations.

Figure 3 summarizes the main benefits of a custom SoC solution.

Supply chain: a major factor for consideration

Supply chain interruptions are a primary concern for auto OEMs today. Unanticipated "black swan" events can disrupt the flow of supply, such as natural disasters, international border blockades, government sanctions, economic downturns, and geopolitical and social unrest. Supply of materials is never guaranteed; how-

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ever, the odds for continued production are more favorable when a company doesn't have to compete with several others when receiving orders for the same product.

More and more car manufacturers are realizing that general-purpose OTS chips offer features that cater to multiple customers, limiting their product competitiveness and restricting them to the suppliers' timelines and delivery schedules.

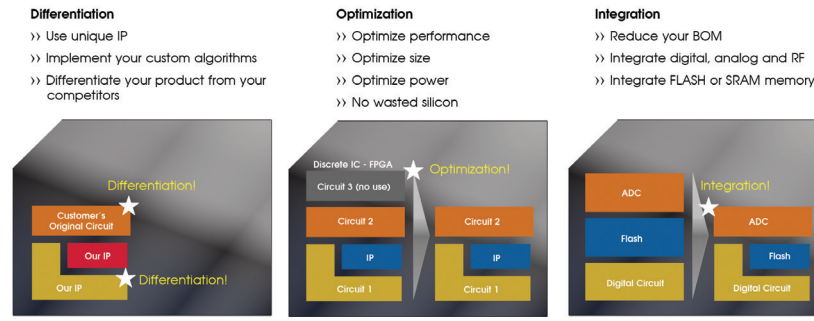

Figure 3: Key benefits of a custom SoC solution

Tesla's recipe for success

Every now and then, a new company comes along that alters the familiar and established business model. Similar to Netflix disrupting the video rental industry, Tesla is a company that has shattered the traditional automotive business model. With its direct purchasing program, early launch of semi-automated driving, unconventional interior designs featuring much larger interior displays, and recent constructions of battery giga-factories, Tesla's success has led traditional automakers to rethink their playbooks and to consider adapting similar strategies for their own internal processes and future EV business models.

Furthermore, Tesla has realized the importance for developing its own key IP and technologies for the benefits that over-the-air (OTA) software updates can bring, improving system performance as well as overall safety post-production.

Tesla had first launched its "Autopilot" semi-autonomous driving platform in 2014. At the time, the Autopilot system featured a single camera in combination with a radar sensor. The system also featured a multitude of ultrasonic sensors for close-range proximity detection alongside Mobileye processors. In 2016, Tesla changed from Mobileye to the Nvidia processor, offering higher processing and inferencing capabilities.

At Autonomy Day in 2019, Tesla unveiled the company's Hardware 3.0, which consisted of its first generation of Full Self-Driving (FSD) inferencing chips replacing the Nvidia processor, a chip that Elon Musk claimed was "objectively the best chip in the world."

In order to build a self-driving car, carmakers need a combination of hardware, software, and data working together. The deep neural networks are the artificial-intelligence engine encompassing a series of algorithms that are specifically designed to mimic the way neurons in the human brain work.

Tesla acquires a tremendous amount of data from its nearly 2 million Autopilot-enabled vehicles. And as of 2021, each one of its cars is equipped with eight cameras capable of generating a full 360˚ visualization. The data generated during real-time driving scenarios is then used to train the neural networks to improve the ability to accurately detect objects, segment images, and measure depth in real time. The car's on-board FSD chip runs the trained deep neural networks and performs inferencing based on the input from the on-board cameras and ultrasonic sensors, thereby enabling the car to safely navigate through its environment.

Tesla evolved from third-party dependency to complete control of its Autopilot processing technology. Similar to Tesla, other mobility companies have begun to realize the value by investing in and further developing their own in-house autonomous-driving devices and capabilities.

Socionext's SoC solutions

Creating a proprietary chip requires a complex, highly structured framework with complete support system for addressing each phase of the development process. Most companies seeking to design their own chips do not have the full capabilities in-house. They require assistance from highly specialized companies with extensive engineering skills, know-how, and experience to support full system-level SoC design, development, and implementation.

A company like Socionext (**Figure 4**) offers the right combination of IPs along with the necessary design expertise and support required to implement large-scale, fully customizable automotive SoC solutions. Socionext is committed to achieving the targeted goals of customers and meeting the most demanding and rigorous automotive application performance requirements. ☐

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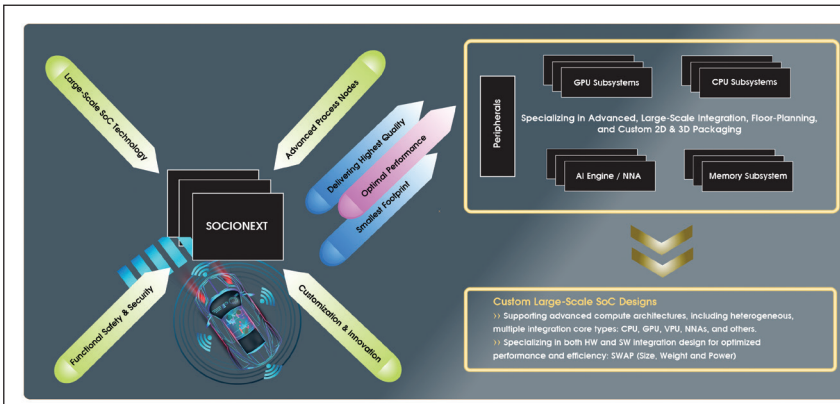

Figure 4: Socionext custom SoC design and integration