Paradigm Shift in E/E Architectures Leads to Risky Dependencies

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The continuous and reliable availability of semiconductors is essential for the production of today's and tomorrow's vehicles. Trade tensions can quickly lead to bottlenecks here, which can have significant effects not only on business but also on the economy. Roland Berger explains where the dangers lie and what would be necessary to be prepared for an emergency.

Digitization is the base for the automotive industry of the future. There is however a major threat that is widely overlooked: Security of in-car computing chip supply. Only two companies in the world are able to produce modern node integrated circuits and all their production plants are in regions with high political and/or seismic risk. Add to this a lead time of six months, the fact that automotive volumes are 40 times smaller

than consumer, and the dependency on few chip design companies.

THE CAR AS DATA CENTER

Customers expect a seamless journey integrating features across their devices and clouds. Thus, the car is becoming a software-enabled, cloud-connected data center on wheels [1, 2]. As a result, complexity in distributed E/E architectures

becomes excessively difficult to manage. Thus, first OEMs are moving toward domain controllers – a trend that will see a rapid increase over the next years, becoming mainstream from 2025 onward. Domain controllers will still be highly OEM-customized; therefore, a large value share remains with tier-1 suppliers. However, the first OEMs are already developing their own designs and employing EMS as build-to-print providers. In addition, EMS players independently begin to offer electric vehicle platforms, such as Foxconn MIH. Moreover, several semiconductor players create Systems-on-a-Chip (SoCs) that challenge tier-1's custom domain controllers.

As a next step of centralization, in-cabin domains will further merge into two main partitions: mission critical and non-mission critical. While mission critical applications include ADAS, HAD and driver monitoring, the non-mission critical partition hosts infotainment, cockpit, comfort and others. The mission critical domain will be powered by a central vehicle computer with adequate redundancy. Sensors are connected through high-speed network and network hubs. The non-mission critical domain will be powered by four to ten zonal computers, spread over various locations within the vehicle in order to reduce wiring and connected via a high-bandwidth network. A widespread application is expected toward the end of the decade, with SoCs resulting in significant cost

reductions for the central and decentral computing units, **FIGURE 1**.

CONSOLIDATION AND COMMODITIZATION OF COMPUTING HARDWARE

With the trend toward zonal architectures, we expect that in-car automotive computing hardware will become more standardized and based on SoCs, provided by semiconductor companies that leverage their scale over cloud, consumer and automotive. This is a scale game whereby a company that holds a volume advantage of 10 times typically has a cost advantage of 40 %. Additionally, volumes of new nodes at foundries are awarded to large players first while smaller players must wait.

Mission-critical applications will run on dedicated computing hardware. It is not clear yet whether fully integrated software-hardware stacks (as offered by Nvidia, for example) will prevail over a fully hardware-abstracted solution. In any case, zonal SoCs will become a largely commoditized product, based on CPU, GPU and DPU (Data Processing Unit) architectures originally developed for consumer and data center applications.

NEW COMPETITIVE DYNAMICS

While these trends unfold, a significant share of traditional tier-1 suppliers value-add is threatened to be taken over by

Semcos, tech companies, OEMs and pure software companies. Without own SoCs on competitive nodes, the tier-1 computing hardware business will become marginalized. However, **FIGURE 2** shows that development of an SoC in 5 nm costs approximately 500 million US dollars. Nvidia announced to have spent 8000 engineering man-years; that is more than 1 billion US dollars on its Xavier Automotive SoC.

OEMs traditionally try to avoid dependencies. For the foreseeable future, TSMC and Samsung will be the only foundries able to produce modern node technologies, **FIGURE 3**. Furthermore, all their current modern node manufacturing facilities are in regions with high risk. Taiwan is a seismically highly active area with one significant earthquake every five years. In 1999, an earthquake with a magnitude of 7.6 on the Richter scale led to a production loss by TSMC of 20 % of the monthly output. In the last century, three earthquakes with higher magnitudes have been registered in Taiwan. Add to this the political risk – Taiwan is seen as territory by the People's Republic of China and can only stay independent because of the continuous support by the USA.

SEPARATE ECOSYSTEMS IN CHINA AND THE WEST

HiSilicon – the semiconductor subsidiary of Huawei – has made significant

FIGURE 1 From distributed toward zonal architectures (© Roland Berger)

Total SoC development cost depending on manufacturing node (estimate)

FIGURE 2 Total estimated SoC development cost (in m US dollar) depending on technology node (© Roland Berger)

advancements in semiconductor design and managed to become one of the top five fabless semiconductor companies in the world. The BAT companies (Baidu, Alibaba, Tencent) are developing innovative semiconductors for cloud and edge applications. At the same time, China continues to demand the use of local technology in automotive products in order to support the local industry. OEMs need to maintain separate SW stacks and hardware elements for the Chinese market. However, semiconductor manufacturing is the Achilles' heel of the Chinese electronics industry. No international player has a modern-node foundry in mainland China. Also, there are currently no Chinese companies with significant capabilities in semiconductor manufacturing equipment, for example for lithography. Thus, all Chinese foundries rely on imports of equipment.

SMIC, the leading foundry in mainland China, is currently at least five years behind the market and technology leader TSMC which recently introduced a 5-nm production process. SMIC is still ramping up its 14-nm process which is seen as less efficient than similar processes at TSMC and Samsung. The US trade war with China caused additional issues for the company: An advanced EUV lithography machine purchased from the Dutch

player ASML could not be exported to China, apparently as the US government urged Dutch officials to withdraw the export rights. Many market participants have approached Roland Berger, asking for an assessment of what will happen next.

THREE POSSIBLE SCENARIOS

1. Partial separation – less likely
In this most favorable scenario, one would still see the development of separate automotive technology stacks between China and the Western world,

leading to Chinese and Western leaders in digital technology and automotive software platforms, for example Alibaba and Google. China will significantly push the development of a local semiconductor industry to become independent of non-Chinese technology within a ten-year time span. In this scenario, the USA and China would find common ground regarding technology transfer, IP rights and respective sanctions. Although there will be a need to use local Chinese hardware for automotive applications, the current global

FIGURE 3 Market shares of foundries Q2 2020 (© Roland Berger | Trendforce)

electronics supply chains would continue to exist to a large degree.

2. Full trade war – likely even with a change in the US administration
In this scenario, the current sanctions will be extended toward further companies and industries, such as Chinese memory producers and BAT companies, along with increased tariffs for electronics products. The impact on automotive companies will be very significant. Disruptions in the semiconductor supply chain will lead to significant price spikes and shortages. Due to the long lead times of semiconductor manufacturing of three to six months, short-term countermeasures are nearly impossible to execute once this scenario is in effect.

3. Regional conflict – worst case scenario
In such a scenario, a regional conflict around Taiwan would emerge, such as a forced reunification or a blockade of the island. In recent years, tensions and military maneuvers have increased, while Chinese officials have started to talk about “reunification” instead of “peaceful reunification.”

This scenario would have a short-term devastating impact on global electronics and semiconductor supply. Key products could be unavailable for months, causing industrial production to decline and the world to drop into a deep recession. China would have access to competitive semiconductor manufacturing, but without an own

equipment manufacturing industry, this could be difficult to maintain.

COVID-19 AS ACCELERATOR

Mobile consumer electronics players – being less affected by the economic turmoil – increase their position as drivers of innovation also in the automotive space. Automotive OEMs (as well as suppliers), on the other hand, reduce R&D budgets and focus their activities on customer-differentiating features and not on general technology development, turning increasingly to semiconductor and technology companies for their next generation hardware and software platforms.

The economic effects of Covid-19 also lead to a further consolidation of the semiconductor industry. Winners are large technology leaders that increase their valuation with low interest rates. This enables a new wave of stock-financed Mergers and Acquisitions, for example the planned acquisition of ARM by Nvidia and Xilinx by AMD. Losers are players with a traditional business model and declining revenues due to lower customer spend.

EUROPE NEEDS A LOCAL COMPETITIVE FOUNDRY

In software, the European Commission has initiated various programs to fund digital technologies in Europe [3]. However, with Brexit, the EU has lost most of its leading companies (for example ARM) and employment in advanced

semiconductor design. In hardware, Europe had competitive semiconductor manufacturing plants in modern logic nodes ten years ago. Currently, all foundries in Europe use 20 nm+ technology and no company has announced plans to change this. **FIGURE 4** shows that for modern node technologies, access to consumer business is vital.

In order to protect the local industry from increasing likely global trade tensions, the European (automotive) industry needs a competitive foundry. OEMs, tier-1, Semcos and equipment manufacturers need to work together with the EU and the UK to enable competitive European foundries. This requires cooperation either with Samsung and/or TSMC. The investment will likely exceed 10 billion euros. The European automotive industry needs to act now to secure its future. Until then, automotive companies that use modern node semiconductors are well advised to secure a stock in a secure location of at least a six-month supply of semiconductors. In addition, automotive OEMs need strict transparency over the source of semiconductors to enable them to react quickly in case of market disruptions.

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FIGURE 4 Revenue split TSMC by industry in Q 3 2020
(© Roland Berger | TSMC)

*Example Taiwan Semiconductor Manufacturing Company (TSMC):
consumer/HPC business is 40 times larger than automotive*