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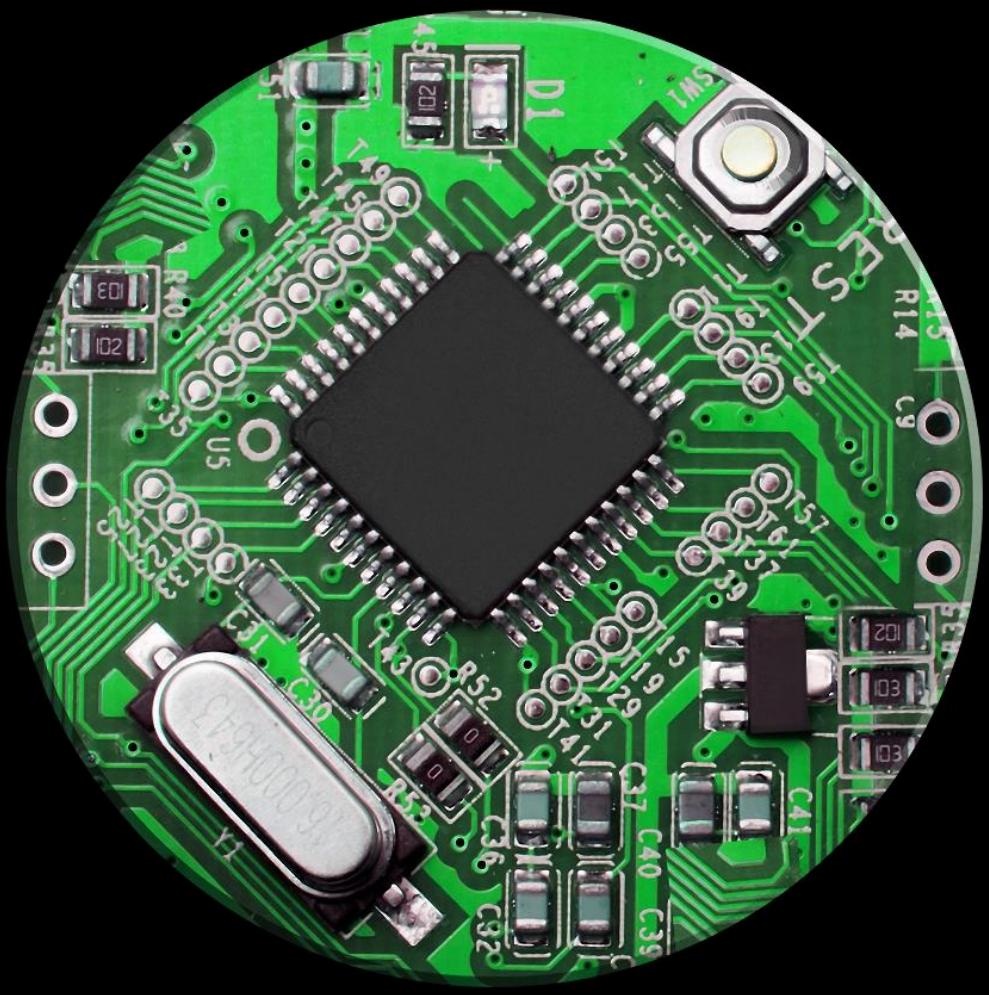

TMT Sector Briefing:

Four strategy archetypes for semiconductor manufacturers to drive profitability

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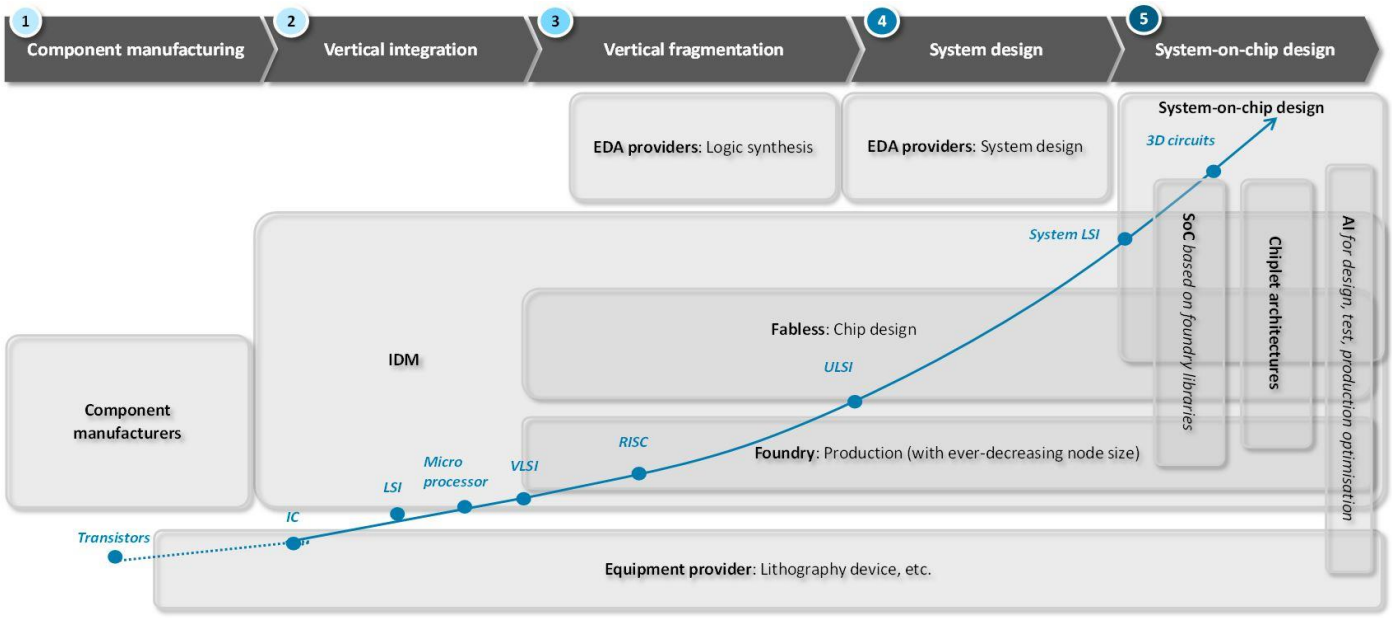
Semiconductors represent a critical industrial resource for Europe. This is evidenced by the consequences of the recent semiconductor shortage for Europe's core industries as well as the multi-billion European Union program launched subsequently to re-localize chip production. However, tremendous financial and political support by itself is no guarantee for growth and profitability. In fact, chip producers face a fundamental dilemma: On the one hand, investing billions to build and operate fabs means making decisions for many years. On the other, the semiconductor demand landscape is ever more cyclical, dynamic, and diverse, and manufacturers must adapt quickly to these changing market needs. Our analysis shows four promising strategy archetypes for chipmakers to escape this dilemma.

More than ever, chip production entails significant time and cost investments, leaving companies with limited options for managing their production on short time scales. At the same time, customer demands constantly evolve and require a cyclically fluctuating, growing volume of semiconductors with different functionalities at widely spread cost points and reliant on a wide range of production technologies. This discrepancy between short-term requirement shifts and longer-term delivery capability adjustments has recently become much more pronounced. At the same time, it demonstrates the full complexity of strategic decision-making for chip manufacturers. To understand the status quo for semiconductor manufacturers and the options they have for responding, we will first look at the supply and demand sides.

(Inevitably) slow-moving supply

The evolution of chip production has resulted in a highly specialized and software-driven design and production flow, leading to a complex semiconductor value chain. Figure 1 illustrates the increasing complexity within the semiconductor value chain in the course of its development from simple transistors to three-dimensional chips. Manufacturing has evolved from vertically integrated producers (IDM: integrated device manufacturers) to a highly specialized, software-driven, modularized value chain. Today, we must consider a wide range of strategic suppliers. It is easy to understand that building and evolving capacity and reaching production yield targets takes time: The time to reach fab capacity is measured in years, and production of even a single chip takes around three months. In addition, there is pressure to innovate: To reach ever-smaller 'nodes', which refers to the smallest possible structure size of the fab, semiconductor manufacturers must invest significant time and money. Consequently, not many players can produce cutting-edge chips. For instance, only three leading companies currently have a roadmap to achieve sub-2nm[1] nodes: Scaled up to the size of Berlin, a sub-2nm chip would have structures measuring a few millimeters.

Fig. 1: Evolution of the semiconductor supply chain

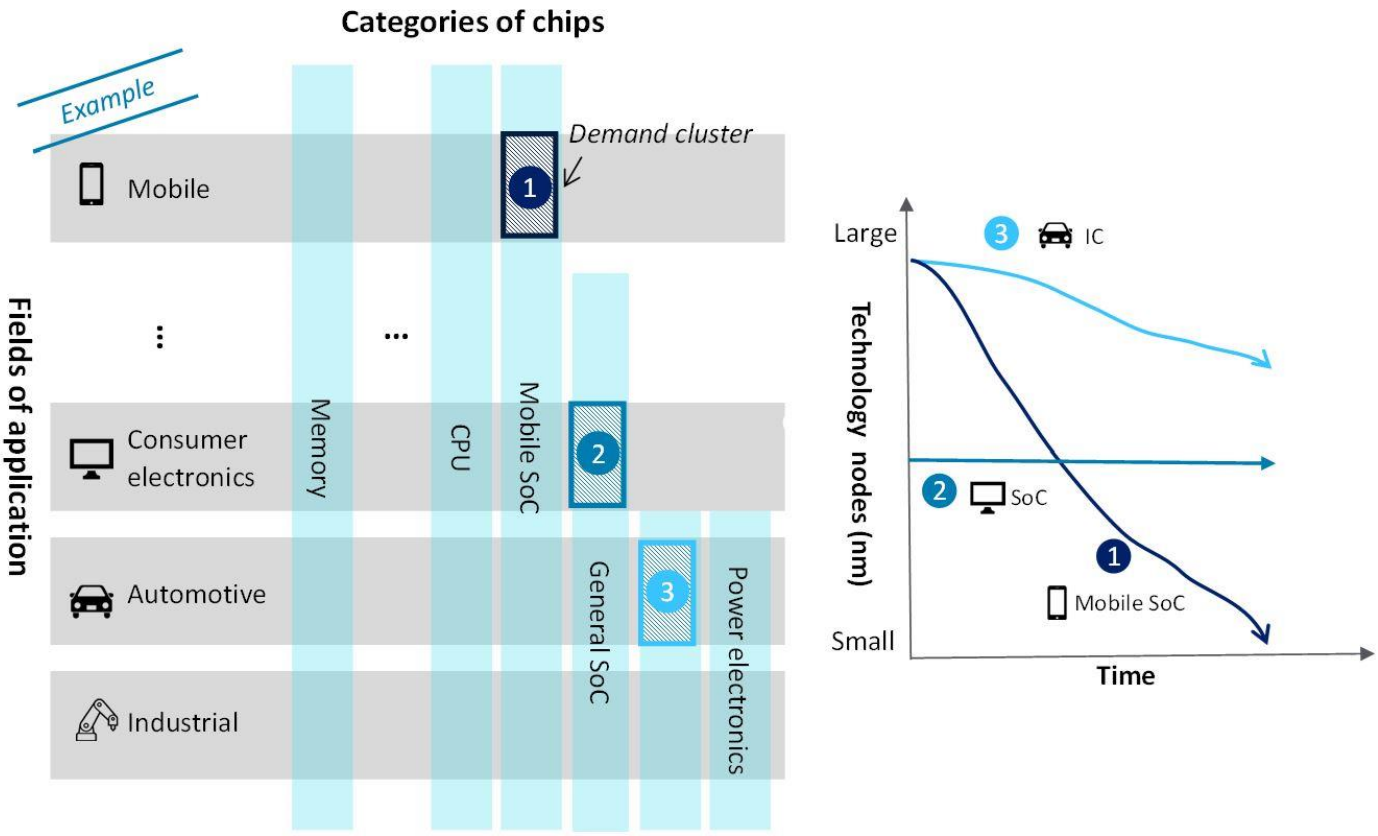


Fast-changing demand

The demand side, however, is characterized by dynamic and diverse clusters comprised of different categories of chips (e.g., CPU, memory, logic) and fields of application (e.g., IT, smartphone, consumer electronics, automotive). Demand is best understood in terms of clusters. As figure 2 illustrates, some clusters, such as smartphones, require and quickly adopt shrinking leading-edge nodes (e.g., 4nm and below).

Others, such as automotive and industry solutions, have longer life cycles and progress at a slower pace, remaining at more established nodes (e.g., 65nm, 28nm), as the requirements are stable and cost to migrate outweighs the benefits of higher integration. Furthermore, many clusters exhibit cyclical demand fluctuations, like laptops and consumer electronics.

Fig. 2: Application clusters with diverse needs



The challenge for chip producers is that requirements within clusters change, sometimes significantly, and future demand cannot be forecast accurately. Clusters draw on technology improvements at different speeds under the influence of certain accelerators and inhibitors. While industry disruptions or new usage paradigms create a need to adopt new technologies, cost and lifecycle-supported intervals will often slow down innovation. These inhibitors and accelerators apply to both industries (e.g., EV) and applications (e.g., the evolution of AI chips).

Overlay this with cyclical demand fluctuations and it is clear why semiconductor manufacturers have their planning work cut out for them. Finally, clusters may be subject to disruption: An example of this is the automotive sector shifting from 'one box per feature' to a more consolidated IT architecture. This requires transitioning from standard capability chips to a more zonal architecture that relies on a limited number of high-end computing nodes.

How can semiconductor manufacturers handle this situation and remain profitable?

In this contrasting and challenging supply/demand ecosystem, chip producers must secure a stable flow of orders in a particular technology to run their fabs productively and profitably

while avoiding too many reconfigurations that require re-calibration. Semiconductor production should therefore be determined by demand clusters and account for the speed at which applications adopt new technologies, as well as their volume fluctuations.

In this context, there is no strategy panacea for all chip producers. To help manufacturers find the right chip production approach, we have crystallized out four strategy archetypes. These provide orientation in the complex decision-making process and show the entire range of possible strategies as well as the full breadth of the different prerequisites and consequences:

1. Pioniere bei „Leading Nodes“

Leading foundries invest heavily into the most advanced node fabs, aiming to dominate the market and cater to influential high-volume customers such as premium smartphone producers. They can capitalize on the price margins of differentiated high-end chips.

2. Follow the leading nodes

These companies strategically trail the leading nodes, differentiating their processes and packaging technologies for applications with longer lifecycles, such as IoT, and specific customer segments. Capex is lower and a multitude of demand clusters demand this production node, enabling profitable production.

3. Settle at the mature nodes

These companies focus on standard industrial logic devices and automotive applications, sustaining long-term customer relationships and generating high profitability with little technology advancement in nodes. They produce “cookie cutter” logic chips that are required in ever-growing volumes.

4. Address niche needs

Other foundries cater to specialized and customized designs with lower volumes, serving specific niche markets, e.g., sensors, light-emitting devices, or power electronics.

As a side note, the relative inability of the value chain to cater to rapid demand changes was (and is) what created the chip shortage crisis, which specifically hit producer segments 2 and 3, where even lower flexibility and relatively lower margins had decreased resilience further.

Obviously, committing to a strategy archetype is not sufficient by itself. Profitable chip production must address a range of other complex choices, like achieving customer intimacy, providing easy-to-use and leading design tools and libraries, improving agility for suppliers within the given constraints, optimizing batch changes and time to yield, and optimizing resource consumption. The balance of this mix, however, crucially depends on the strategy archetype chosen.

Implications for Europe

The four strategy archetypes can provide important guidance for the current discussion about strengthening European chip production. For once, it is not just about the fabs, but about the relative intimacy between fabless and foundry players that creates a competitive location advantage. In this context, it is important to look specifically at the demand clusters with high strategic relevance for European core industries. These can certainly not be decoupled from global technology and market developments. However, in combination with existing framework conditions and funding opportunities, they are an important building block in profound strategy development.

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Semiconductor manufacturers face the formidable challenge of innovating and aligning their slow-moving supply capability with fast-changing, unpredictable demand fluctuations in different demand clusters. This applies to Europe just as much as all other regional markets.

By adopting a suitable strategic approach, manufacturers can optimize their production strategies and achieve sustainable growth and profitability. Our four strategy archetypes provide initial guidance as blueprints for consistent strategic alignment, because manufacturers can either pioneer or follow the leading nodes, settle at mature nodes, or address niche needs. Each of these approaches promises success, but chip producers must be consistent in applying them and, for example, measure investment decisions against their defined strategic approach. A clearly outlined strategy enables them to navigate turmoil effectively and thrive in this ever-evolving, exciting, and success-critical industry.

Footnotes

1) 1nm = 0,000 000 001m

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