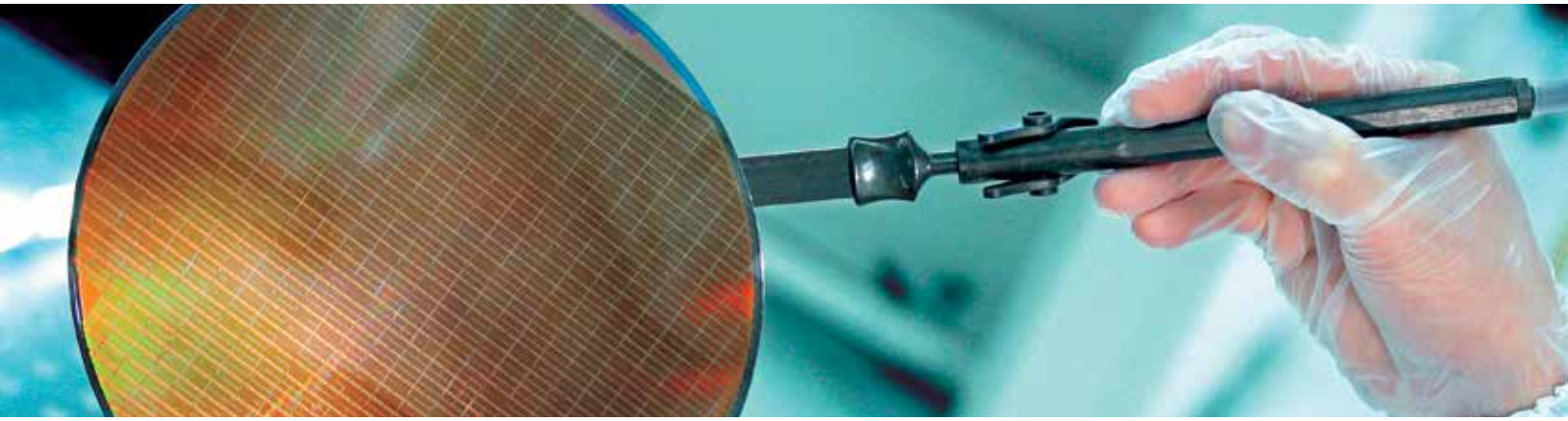

The potential shake-up in semiconductor manufacturing business models

The mobile revolution gave a lift to global semiconductor sales, partially enabled by the fabless-foundry model, which allowed designers and manufacturers to bring powerful and innovative mobile chips to market rapidly. But the model is facing new pressures.

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The rise of mobile phones has been one of the semiconductor industry's main growth drivers over the past 15 years. In 1997, wireless-communications chips accounted for about 10 percent of the overall semiconductor market; by 2012, they were at 24 percent, and they are forecast to rise to 32 percent of the market by 2017, according to the market-research firm iSuppli.

The fabless-foundry model[1] has been a critical enabler of this growth and has benefited from it. We estimate that about 60 percent of leading-edge-foundry output in 2012 served the mobile segment, far outstripping microprocessors, graphics-processing units, and field-programmable gate arrays (exhibit).

However, foundries are facing increasing challenges upstream and downstream:

- The mobile-device market has become more concentrated. In 2011, Apple and Samsung had about 44 percent of handset revenues and made virtually the entire operating profit in the segment. By the second quarter of 2013, their share of handset revenues had increased to about 62 percent. Two years later, the market-share figures are strikingly similar. This evolution has led to concentration among mobile-chip makers (foundry customers) and has shifted bargaining power away from foundries.

[1] The partnership between fabless design companies—those that do not fabricate the physical chips—and the foundry partners that manufacture the chips.

- The semiconductor-equipment industry (foundry suppliers) has continued to consolidate, increasing their bargaining power in most cases.

- The Atom system-on-a-chip (SOC) represents a determined effort by Intel to emerge as a serious player in the mobile segment while retaining an integrated-device-manufacturer (IDM) business model.

- Disruptive architectures and manufacturing technologies impose additional pressures on foundries. Intel's tri-gate architecture forced several foundries to accelerate their FinFET device road map. Also, there are open questions about the number of players that could afford the transition to 450-millimeter (mm) manufacturing.

- Announcements by various foundry players regarding the introduction of sub-20-nanometer (nm) nodes over the next two to three years raise questions about the ability of the industry to recoup planned investments.

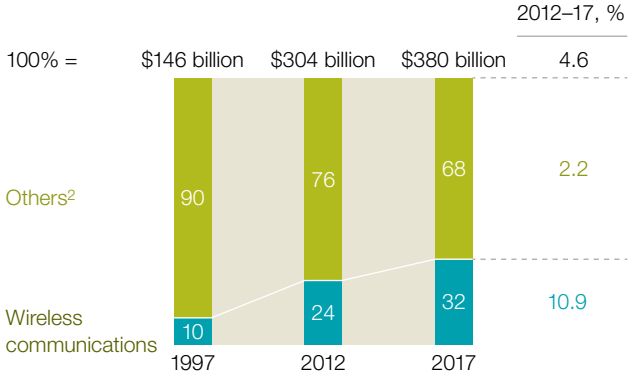
Under pressure from these challenges, what does the future hold for foundries and fabless design firms? Our work suggests that there are

Exhibit

Mobile is emerging as a key growth driver.

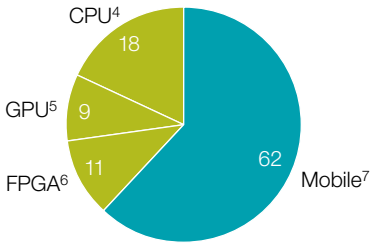
Mobile's share of semiconductor sales is growing

Total semiconductor revenues by application, 2012, %



Mobile forms the largest share of leading edge[3]

Leading-edge foundry volumes by application, 2012 (estimated), %



[1]Compound annual growth rate.
[2]Others include data processing, wired communications, consumer electronics, automotive electronics, and industrial electronics.
[3]Leading edge refers to chips produced at a 45 nanometer or lower node width.
[4]Central processing unit; includes only CPUs manufactured in foundry environments (such as AMD).
[5]Graphics-processing unit.
[6]Field-programmable gate array.
[7]Mobile includes application processors, baseband processors, and combination chips for smartphones and tablets.

Source: iSuppli; McKinsey analysis

four scenarios that embody the different paths on which the industry could evolve in the years ahead. We offer a reflection on these paths in order to test the implications of each.

Four scenarios for the future

The balance among leading players in the mobile ecosystem is delicate. Almost all of the leading players both compete and cooperate with one another, and each has a plan to take more share from the other. This fragile equilibrium could easily be disrupted and result in new alignments and relationships. So what could change to cause this disruption? We examine four possible scenarios.

Scenario 1: Intel wins in mobile

The first scenario involves a significant market shift in favor of Intel. For such a scenario to play out, Intel's Atom processor would increasingly provide significant advantage to the x86 device architecture versus ARM, with the result being a shift in key design wins in mobile.

Indicators of such a scenario becoming reality would include foundry players facing increased challenges in ramping up new process technologies and device architectures, in addition to significantly higher investment by Intel in leading-edge manufacturing capacity. Over three to four years, such a scenario could shift

How might the manufacturing landscape evolve?

Although we have modeled four paths along which the landscape might evolve, they are by no means exhaustive or mutually exclusive. Given the breadth and sweep of potential changes, semiconductor executives should ask themselves several questions to assess the range of possible outcomes:

- Which potential disruptions can be a source of competitive advantage? What are the leading indicators to look out for to determine whether a favorable or unfavorable scenario is likely to play out?
- What is the optimal manufacturing strategy to follow? What is the right set of partners? What are the best ways to increase your leverage or importance with your partners?
- How are partners and competitors likely to react to your strategic moves? Is it possible to develop a competitive advantage that is privileged and sustainable?
- What are the other sources of value creation to pursue? Are there opportunities to increase R&D productivity, conduct targeted acquisitions, or capture more value by integrating software with the underlying hardware in products and solutions?

Rather than build new capacity, most fabless leaders would instead look to partner with a foundry and fund capacity.

$10 billion to $15 billion in mobile-chip revenues to Intel and $3 billion to $5 billion in annual leading-edge-wafer revenues away from foundries.

Scenario 2: Intel successfully becomes a foundry

In this scenario, Intel's push into foundry takes flight and opens the door for leading fabless players such as Apple, Broadcom, and Qualcomm to consider using Intel as a foundry partner, thus reshaping the broader ecosystem. Fabless companies would gain an additional, credible foundry option for leading-edge chips. Foundries, especially those with less credible leading-edge technology and manufacturing capacity, could face significant financial pressure.

Although Intel has publicly announced its intention of taking on some foundry business, the leading indicators preceding such a scenario would be Intel enhancing its electronic-design-automation tools and developing standard cell libraries before the actual migration of leading-edge business to its fabs. Also, the company might begin to build its management team and bench strength in foundry services. Intel's announcement in February 2013 that it would manufacture field-programmable gate arrays for Altera using its 14nm FinFET process technology lends further credence to this scenario.

Scenario 3: Fabless players invest in manufacturing capacity

This scenario would revive one of the oldest battles in the industry: the tug-of-war between fabless design companies and vertically integrated IDMs. In this scenario, we posit that ARM's architecture wins out over x86, and the large fabless companies make strategic investments—either stand-alone or with foundries—in manufacturing capacity.

For this to occur, we would see one or more of the major fabless players decide it would be better off controlling its own destiny and acquiring manufacturing capacity. Whether literal or virtual, this vertical integration would likely accelerate design and go-to-market cycles among the larger players given the closer integration of design and capacity.

This scenario has a silver lining for the foundries that would likely be the recipient of the fabless players' investment to secure manufacturing capacity. Rather than build new capacity, most fabless leaders would instead look to partner with a foundry and fund capacity.

Scenario 4: Cooperation rises

The last scenario posits little change in device architecture or business model, but the level of cooperation among major players could change significantly. In this scenario, current foundry players would struggle to get the right process technology implemented (for example, suffering delays with 14nm FinFET process technology) and struggle to establish fab capacity to fulfill customer demands. Under such a scenario foundry players might be forced to ask for help

from customers and to seek coinvestment in tools, technologies, and process development. Whether the challenge is maintaining the pace of Moore's law, making the transition to 450mm production, or simply having better leverage in pricing, a number of factors could push unwilling participants into a broader coalition.

The indicators for this scenario will be delayed delivery of subsequent technology nodes and/or challenges in ramping up to target yields in new-product introductions.

In summary, the scenarios provided in this article are neither exhaustive nor mutually exclusive but are intended to provide an exploration of the possible shifts in the coming years and the impact on companies in the mobile ecosystem. In three of four scenarios, the fabless-foundry model has the potential to be weakened and challenged. If nothing else, this should be a rallying call for both fabless companies and foundries to carefully assess the implications for their respective strategies.

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