Semiconductor industry

Strategies for growth in the Internet of Things era
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From the mainframe to the mini to the PC to the smartphone, our computing devices just keep getting smaller, faster, and cheaper. Each of these shifts depended on advances in semiconductor technology and the ongoing impact of Moore’s Law, as individual transistors gave way to the integrated circuit, and then the sophisticated system on a chip. And at every transitional stage, new companies emerged, became dominant, and then sat back as others developed the technology that drove the next iteration, outcompeting their predecessors for market share and profits.

Now comes the Internet of Things (IoT), once again transforming the semiconductor industry. This time, however, it’s different. Rather than being dependent on a single kind of device, the market for IoT-oriented chips is highly diverse. Semiconductors are needed for a wide array of aspects of cloud integration and connectivity, including computing, sensors, communications, and interactivity. Estimates of the impact of the IoT range wildly, but by every account it will be enormous; the installed base of connected devices is forecasted to double or even quintuple through 2020.

With the IoT, semiconductor innovation is no longer driven primarily by Moore’s Law, which predicted the rapid escalation in the number of transistors on each chip and the concomitant increase in performance speed and decline in cost. The value of the chips required to power the IoT is not measured in sheer speed; other factors, such as power consumption, miniaturization, software, configurability, and durability, are more important. This is because in the IoT, the chips are being put to a multitude of very targeted uses in a highly diverse group of industries, including automobiles, manufacturing, utilities, and others. That large variety of unique applications has in turn led to a proliferation of companies in the semiconductor industry — some large, some small, virtually all of them “fabless” — that have entered the fray to design chips for ever more specific purposes. And this has entirely transformed the industry’s competitive dynamics.
The semiconductor industry is no longer dominated by a handful of the largest players. Companies must now follow a different path, competing not so much on their performance edge or lower price, but on making the best chips for specific purposes, what data capture and communications services their chips enable, and their ability to collaborate with other players across the IoT value chain.

This, in turn, is putting an increasingly large premium on how semiconductor companies decide to approach their markets — what their “way to play” is — and on the distinctive capabilities they deploy to carry out that approach. Semiconductor companies must be able to distinguish themselves in new ways, for example, the ability to partner with downstream players, to work flexibly with customers, and to base business models on the value not just of the chips themselves but of the software and IoT services built into them. And some companies are already working to become what we call “supercompetitors” — companies that use their differentiating capabilities system to shape their future and realign their industry around themselves.

The IoT presents a particularly daunting challenge for traditional semiconductor companies. In the first place, many continue to focus on their largest business segments — desktops, communications, and the like — a distraction from the opportunities offered by the IoT. Second, new market segments for IoT chips demand a much higher level of design heterogeneity and device integration, affecting not just the chips themselves but also what software is needed to run the chips, how the chips are integrated into their respective devices, and the way components are packaged within the devices, which would impact, for example, the casing surrounding the chips (see Exhibit 1, next page).

What’s more, companies must also take into account the many industry verticals for which chips must be designed and produced; each vertical has different go-to-market approaches and customer requirements. Finally, companies are facing a lack of interoperability standards and customer concerns over IoT security.
Exhibit 1
There are four main driving forces in the semiconductors industry

Industry dynamics overview

Front-end limit
The race for smaller feature size is becoming extremely difficult and expensive

Back-end dominance
Innovation in new packaging technologies is coming into particular focus

IoT pull
Explosion in the number and diversity of connected devices across industries

Increasing complexity
Increasing system complexity and related technology/industry linkages

Source: PwC Strategy& analysis
These challenges are why most semiconductor manufacturers remain cautious in their response to the IoT. How they approach this new development varies: Some are building IoT-dedicated business units and alliances, others are adapting products and rebalancing product portfolios toward faster-growing segments, and still others are building scale through mergers and acquisitions. Some are pursuing all three approaches. However, certain players are taking bold steps to define and pursue a logical forward-looking strategy. These are the companies that have devised a consistent, coherent way to play, through a firm understanding of how they intend to create value — for their customers and for themselves — and that are busy putting together the distinctive capabilities and the product and service portfolio they need.

Given the opportunities and constraints of the IoT, the largest integrated and fabless semiconductor industry players are choosing one of three primary ways to play that will be viable at scale, each of which requires different capabilities and targets different customer segments (see Exhibit 2, next page).

**Ecosystem enabler**

These companies focus on developing a range of widely interoperable foundational technologies and standards to meet the requirements of multiple industry verticals. They differentiate themselves with several key capabilities: their ability to create and manage technology and service ecosystems, to partner with others in creating these ecosystems, to conduct cross-industry technological innovation, and to manage their multiple sales channels efficiently. Monetizing their way to play in the new world of the IoT will depend on ecosystem enablers’ ability to develop and sell the core elements of their ecosystems — not just the chips themselves, but the software and services that companies in various industries can use to develop their own IoT offerings.

The capabilities system put together by ARM demonstrates the ecosystem enabler approach. Although the U.K.-based company, recently purchased by Japanese technology firm Softbank, is widely regarded as a key player in low-power applications, it has primarily differentiated itself through its abilities in chip design, as well as in creating successful partnerships with foundry players, ultimately monetizing its intellectual property in a wide range of applications. ARM’s portfolio of intellectual property and products such as the mbed operating system, as well as its nascent security offerings, fully complement its core capabilities in chip design.
Exhibit 2
Integrated and fabless companies pursuing different ways to play need to focus on distinct capabilities and market strategies

<table>
<thead>
<tr>
<th>Differentiating capabilities</th>
<th>Ecosystem enabler</th>
<th>Industry application leader</th>
<th>Lean, rapid portfolio shaper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecosystem, partnership, and alliance management</td>
<td>Ecosystem, partnership, and alliance management</td>
<td>Deep customer intimacy</td>
<td>Lean R&amp;D</td>
</tr>
<tr>
<td>Cross-industry technological innovation and open innovation</td>
<td>Cross-industry technological innovation and open innovation</td>
<td>In-depth understanding of customer systems</td>
<td>Effective PLC management</td>
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<tr>
<td>Channel management</td>
<td>Channel management</td>
<td>Industry-focused breakthrough innovation</td>
<td>Acquisitions and divestitures</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Typical customer segments</th>
<th>Ecosystem, partnership, and alliance management</th>
<th>Industry application leader</th>
<th>Lean, rapid portfolio shaper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emerging, low maturity</td>
<td>Emerging, low maturity</td>
<td>High performance/mobility</td>
<td>Subsegments with high heterogeneity</td>
</tr>
<tr>
<td>High flexibility</td>
<td>High flexibility</td>
<td>High reliability</td>
<td>Segments where standards are maturing</td>
</tr>
<tr>
<td>High interoperability</td>
<td>High interoperability</td>
<td>High security</td>
<td>Value</td>
</tr>
<tr>
<td>Homogeneous installed base</td>
<td>Homogeneous installed base</td>
<td>Luxury, high-end</td>
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<tr>
<td>Value</td>
<td>Value</td>
<td></td>
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<tr>
<th>Strategic KPIs</th>
<th>Ecosystem, partnership, and alliance management</th>
<th>Industry application leader</th>
<th>Lean, rapid portfolio shaper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alliance participation</td>
<td>Alliance participation</td>
<td>Spend/profit share in key customer segments</td>
<td>Profitability across product and customer segments</td>
</tr>
<tr>
<td>Broad-based technological innovation “firsts”</td>
<td>Broad-based technological innovation “firsts”</td>
<td>Solution completeness in key customer segments</td>
<td>R&amp;D efficiency</td>
</tr>
<tr>
<td>Brand recognition</td>
<td>Brand recognition</td>
<td>Key customer-inspired/co-designed industry “firsts”</td>
<td>Supply chain flexibility</td>
</tr>
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</table>

Source: PwC Strategy& analysis
Yet another example can be found at Rambus, which is altering its business model from licensing intellectual property, mostly of memory technology, to supplying chips. In the process, the company has expanded its portfolio of foundational technologies beyond memory to cryptography and high-speed interconnections that support a wide variety of end-user applications across the ecosystems of numerous industries. Recently completed acquisitions of Inphi Corporation and Smart Card Software Ltd. (UK) widens Rambus’s memory product lines and offers the company new markets to tap in security solutions for applications in mobile payments and anticounterfeiting.

Industry application leader

These companies prosper by maintaining strong relations with customers in a specific vertical — automotive, healthcare, industrials, and others — and having a deep understanding of the solutions and technological road map in that vertical. In that way, they maintain primary ownership of key elements of the product and services designed for that industry, such as subsystems for autonomous driving, drones, or industrial robotics — and thus enable their customers to lead their own industries through cutting-edge technology. Among all industries, automotive is presently attracting much of the attention.

One example is NXP, which has reoriented itself toward the auto vertical. The company has a broad portfolio of automotive semiconductor products, built on the legacy of Philips and Motorola, and participates in standard setting in such areas as vehicle-to-vehicle communication, highly integrated radio frequency circuitry, 5G, and computing architectures for autonomous driving.

Infineon is another semiconductor player targeting the automotive space. The company has reshaped its product portfolio and concentrated on developing sensors, highest ASIL level microcontrollers, as well as power semiconductor components for the electric drivetrain. Further, it collaborates with software and hardware players such as Elektrobit and TTTech in the areas of car operating systems and autonomous driving computers.

Renesas is yet another illustration of an industry application leader within the automotive vertical. The company acquired Intersil for its analog and mixed-signal chip line to broaden its portfolio of MCUs (microcontrollers) and SoCs (system-on-a-chip) for automotive equipment. The combined portfolio will allow Renesas to offer semiconductors for heads-up displays, camera networks, and battery management.
**Lean, rapid portfolio shaper**

Companies following this approach recognize that the evolving nature of competition in the post–Moore’s Law world will create many more pockets of value than existed in the PC era. Their goal will be to consistently deliver value and a broad range of relevant products to one or more industry verticals. Success will require that they develop several differentiating capabilities: They must be able to react quickly to emerging customer needs, to dexterously aggregate and restructure their product and service portfolios as necessary, and to run lean and efficient operations.

For example, since 2011, Texas Instruments has focused its efforts on serving a diverse and expansive customer base in consumer, industrial, automotive, medical, and other fields. Its product portfolio matches its strategy: a wide collection of analog and mixed signal IC, both general purpose and application specific. Similarly, Analog Devices, with its portfolio of products in high-performance analog, mixed-signal, and digital signal processing technology, plays in a varied array of end-markets and applications.

No matter which way to play a company chooses, it needs to clarify for itself how it wants to add value for its customers, because the approach it does choose will determine what it needs to be great at and how the business model or models it settles on will create that value. Moreover, its way to play will determine the investments in specific technologies it needs to make to support that model (*see Exhibit 3, next page*).

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**Not so fabless**

The design, marketing, and sales of semiconductor devices — what the companies above are primarily engaged in — have been largely decoupled from the actual fabrication of the chips. Fabrication has become increasingly geared toward the massively scaled manufacture of specific designs, and this will remain an essential capability for the foundries. However, new IoT-focused ways to play will emerge here as well.

Commodity volume fabrication players, focusing on producing low-density chips in high volumes, will likely begin to have an impact, as will boutique foundries that focus on high-end applications at lower volumes. Finally, some fabrication players may even choose to move up the semiconductor value chain to provide packaging and intellectual property as well, focusing on a higher level of service provisioning.
**Exhibit 3**
Building a winning way to play requires investments in specific differentiating capabilities in key areas

<table>
<thead>
<tr>
<th>Industry/application specificity of the portfolio</th>
<th>Ecosystem enabler</th>
<th>Industry application leader</th>
<th>Lean, rapid portfolio shaper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple cross-industry applications</td>
<td>Silicon through applications</td>
<td>Industry- or application-focused breakthrough</td>
<td>Multiple cross-industry applications</td>
</tr>
<tr>
<td>Variable</td>
<td>Industry- or application-specific</td>
<td>Incremental</td>
<td></td>
</tr>
<tr>
<td>Technology-focused breakthrough</td>
<td>Limited interoperability, with standard interfaces</td>
<td>Variable</td>
<td></td>
</tr>
<tr>
<td>Wide interoperability</td>
<td>Design pioneer for key subsystems</td>
<td>Limited participation</td>
<td></td>
</tr>
<tr>
<td>Well-connected participant</td>
<td>Focused industry developer programs</td>
<td>Free general developer tools and reference designs</td>
<td></td>
</tr>
<tr>
<td>Broad and deep cross-industry contributor ecosystem</td>
<td></td>
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</tbody>
</table>

**Source:** PwC Strategy& analysis
Combining for competitive advantage

The transformation in the semiconductor industry toward distinct ways to play will not be easy. Many companies are still participating in too many industry areas — they are pretty good at many things but truly great at nothing. This will become a problem, especially as they are forced to compete against an ever more diverse set of competitors. Companies aiming to become ecosystem enablers, for example, will find themselves competing with software, cloud, and open source players as well as companies that focus on licensing their IP, all of which will seek to build ecosystems enabling cross-industry solutions (see “The Strategist’s Guide to the Internet of Things”). Those wishing to become industry application leaders will need to compete with subsystem suppliers and collaborative design partnerships among the OEMs. And lean, rapid portfolio shapers will need to pay close attention to their customers’ needs as they reshuffle their portfolios to position themselves in profitable niches.

All these challenges are likely to result in continued M&A activity — following up on the $130 billion of global deals made in the semiconductor sector in 2015, a record-setting year, and on nearly as high a value of deals in 2016 — as companies merge with or buy others in order to fill gaps in both their capabilities and their product portfolios.

For example, in its efforts to become a broad ecosystem enabler, Intel has been especially active on the acquisition front. The company bought Altera, a designer of programmable chips for data centers, industry, and the IoT; artificial intelligence player Nervana Systems; and Itseez, which makes chips that enable computer vision. Each of these companies provides a critical piece of the IoT ecosystem puzzle.

That’s also why, before its acquisition by SoftBank, ARM purchased Sansa Security and Offspark, both makers of security software for the IoT, integrating their security technology into ARM’s mbed operating system, and extending the relevance of ARM’s designs to security-critical IoT applications for the automotive and other industries.
Given the far greater number of types of chips needed to build out the IoT, and the increase in the number of ways to play in the IoT’s competitive sphere, there will likely be even more winners among the companies providing these chips. In many ways, smaller companies will have a much greater advantage than they did when Intel was king, since barriers to entry in fabless design are much lower, and they can concentrate more narrowly on specific verticals and chips for applications and niche markets.

The current challenge for the largest semiconductor companies is their pursuit of several markets at once. These companies will find it increasingly difficult to compete for customers against businesses that can afford to be more decisive and focused. Many semiconductor companies, for example, currently maintain large units dedicated to cross-industry security, even as they try to pursue customers in specific industry verticals. Such companies’ investment and operating decisions could be difficult to reconcile, and their various business units may be unable to support one another in their efforts to build the different capabilities needed to succeed in carrying out these different ways to play.
Given the nascent state of the IoT, have any true supercompetitors emerged in the semiconductor industry? Not yet. The chip sector dedicated to implementing the IoT is simply too diversified — in terms of products and services, of standards, and of industry verticals that need to be served — to have coalesced around a few top companies. It’s as if the semiconductor industry has turned back the clock to resemble the U.S. auto industry of the 20th century, when more than 1,500 carmakers opened up shop and then quickly disappeared, succumbing to pressure from the Fords and GMs, the supercompetitors of the time that had perfected vertical integration and the assembly line.

Similarly, in the chip landscape, new supercompetitors will eventually arise. They will be the companies or consortia that succeed in building out a dominant cross-industry IoT ecosystem, or that develop a winning combination of chips and services for a particular industry, or that offer a flexible line of products and services to rapidly meet customer needs.

Getting there will require ambitious companies to be decisive about their value proposition and the way to play needed to create real value in this new world. They must understand in detail the capabilities they need to carry out that strategy, perfecting existing capabilities and building, buying, or collaborating to gain new ones. They must learn to scale up those capabilities to the degree necessary to make a profit in their chosen markets, and they must understand the degree to which the capabilities they do build will be valued by customers in those markets.

In other words, as in every other industry, the key to success is figuring out how to monetize one’s capabilities. The IoT offers companies in the semiconductor industry a wide-open field for competitive advantage, or for irrelevance.
Do you have a winning strategy?

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