Finding the next $100 billion in semiconductor revenues

In 2010, the global semiconductor industry crossed the $300 billion revenue mark for the first time. But the industry is at an inflection point: if players position themselves to tap the right microsegments, industry sales could approach $400 billion as soon as 2015.

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The global semiconductor industry had a banner year in 2010. For the first time, industry revenues exceeded $300 billion. To put that number in broader context, the industry has been rebuilding its sales ever since the bursting of the Internet bubble, from a low of $157 billion in 2001 to a previous high of $275 billion in 2007. The financial crisis and recession that followed in 2008 and 2009 took another big bite out of sales. But by 2010, the industry had battled back and was posting record revenue.

Several important tailwinds powered that growth, including further progress along Moore's law and wave after wave of killer applications, from PCs to networking gear, from portable MP3 players to mobile phones. And an increasing number of chips find their way into automobiles, household appliances, and industrial equipment.

However, those are not the only changes afoot. Costs for semiconductor R&D, such as advancing process technology or building leading-edge fabs, continue to rise, even as chip prices face downward pressure. Then there is increased competition from companies that weren't traditionally thought of as semiconductor players, such as Apple, which designs (but does not manufacture) the A5 chip at the heart of the iPhone 4S and the A5X chip

that powers the latest iPad. Governments and sovereign-wealth funds have also made investments to bankroll new competitors in low-cost markets. As such, the traditional centers of economic value for the industry are shifting.

Analysis of the major trends shaping IT adoption over the intermediate term uncovered four high-potential opportunities to pursue; combined, these would allow industry players to capture almost 90 percent of the growth potential between now and 2015. By that time, we project that the semiconductor industry will have added almost $100 billion in new annual revenues, so the opportunity is large indeed and well worth pursuing. To get it right, semiconductor players will need to know both where to play and how to approach the opportunity. In this article, we will offer thoughts on what successful companies can do to claim their share of the value created in the coming years.

Breaking the $300 billion barrier

Over the last 15 years, the semiconductor industry has enjoyed its share of ups and downs, but after a couple of severe setbacks it seems the industry has regained its swagger. Much of its growth resulted from three categories of tailwinds. First, the technological progress dictated by Moore's law has enabled substantial increases in processing power and enabled a wave of devices that were the stuff of fantasy as recently as a decade ago. (Who would want to buy a tablet computer with a virtual keyboard? No one, until the iPad debuted.)

Next, the number of interested end markets and killer applications has grown. In the late 1990s, most semiconductor growth came from PC sales, whereas WiFi networks and mobile phones were far from commonplace. Automobiles featured few chips 15 years ago; that is hardly the case today. Then there are the chips that control dishwashers, coffee makers, and many other types of household appliances that used to be purely mechanical. In addition, the rise of middle-class consumers in countries across Asia created important markets for both semiconductors and electronic devices of all sorts.

Last, collaborations and consortia have come together to enhance the industry's flexibility and its responsiveness to customer demands. An example of this is the federation of companies involved in the customization, fabrication, and packaging of power-saving ARM processors—the dominant processor architecture in mobile phones and tablets. Governments and sovereign-wealth funds have also made a series of investments to promote indigenous players across the developing world.

Put all of these factors together, and the path to $300 billion in revenues becomes clear. However, a number of challenges will make it hard to move beyond the $300 billion level in the near term. One is how semiconductor companies can capture a "fairer share" of the value created for end users. A second is how to monetize the software dimension of the semiconductor business. And a third involves new entrants in the marketplace: many of these competitors come from outside the traditional semiconductor sector, and they bleed market share and revenue from established players.

Leaving money on the table

While $300 billion in sales is nothing to sniff at, the semiconductor industry actually leaves a fair bit of money on the table. Fully half of the industry's revenue, for instance, is derived from products that are less than six months old. While

other industries are able to exert a certain degree of pricing power, based on demand for their goods or fluctuating costs of inputs, the semiconductor industry seems to exist in a state of permanent deflation, thanks to its rapid innovation cycles.

At the same time, the industry has struggled to charge for the performance increases that it has delivered. To put it another way, if the auto industry had evolved its technology as rapidly the semiconductor industry has with microprocessors, the top speed of a sports car would be approaching 4,000,000 miles per hour instead of the 202 miles per hour that a current Ferrari 458 Italia model can deliver.

In several product segments, such as flash memory, chips have become commoditized. Memory is a tough segment because the designs for the most successful forms of memory chips are relatively simple and the drive for higher capacity and improved speed is relentless. Despite constant innovation, there is also constant downward pressure on prices. Between 2000 and 2008, memory prices declined, on average, by 5 percent a year. Once the financial crisis and global recession hit in 2009, major players like Qimonda and Elpida were driven into filing for bankruptcy protection. In October 2011, Elpida's CEO, Yukio Sakamoto, summed up the situation in a comment to investors: "Elpida is using the state-of-the-art production technology, yet the finished products are sold for half the price of a rice ball." In other words, the chip makers' inability to differentiate their products leads to continuous pricing pressure. (In July 2012, Elpida was acquired by Micron Technology, in a move seen as a step toward consolidation in the crowded memory-chip market.)

So, if chip companies have not captured the majority of the value produced by their technology, who has? An analysis of the value created suggests that electronics companies and consumers got the lion's share of excess value created. We calculated that the compound annual growth rate of the processor business during that period was 16.3 percent. Yet the industry captured a share of only 1.5 percentage points, with the rest swallowed up by price declines, which benefit original equipment manufacturers and consumers. Similar dynamics are playing out in mobile phones, light-emitting-diode (LED) lighting products, and all sorts of consumer electronics.

A second challenge is the industry's inability to monetize the increasing value of the software bundled into their chips. In general, semiconductor companies tend to bet on hardware and focus their innovation efforts on the engineering side of a project, rather than the software dimension. Few major chip makers have more software engineers than hardware engineers, even though the software layer is a key component of chips for mobile phones and other portable devices. There is additional money to be made, such as

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when the logic content of what normally might be an application-specific integrated-circuit chip is sold as ready-to-implement software in a field-programmable gate array.

A third, more serious, challenge faces the industry. At the same moment that costs are jumping at rates of as much as 35 percent for each new node along the path from 130 nanometers to the current 22-nanometer standard, there are outsiders such as Apple breaking into the semiconductor business, designing their own chips, and capturing value.

In sum, the industry is at an inflection point in 2012. But there are several reasons for optimism. An analysis of nine global trends shows they should power significant growth for the semiconductor players who align their offerings with the biggest opportunities.

Capturing the next $100 billion in revenue

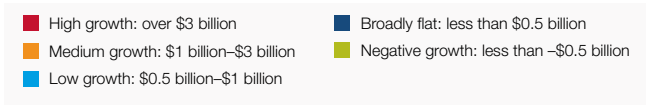
To understand the market and create a forecast for the semiconductor industry, we studied nine major IT trends likely to evolve and drive growth between now and 2015. Not every trend benefits semiconductor players in a meaningful way. Rather than presenting an exhaustive review, the following section highlights the four trends likely to power about 90 percent of the growth potential and notes the specific types of chip technology that should benefit from each trend. By targeting the most lucrative microsegments, the industry has a good chance to turn 2010's $300 billion in revenues into 2015's $400 billion (Exhibit 1).

Mobile convergence

The hottest high-end electronics products today are tablets and high-tier smartphones, followed by middle-tier smartphones and feature phones. Smartphone sales are expected to grow at a compound annual rate of 24 percent between now and 2014, according to IDC and Strategy Analytics. Tablet sales will grow at a 35 percent annual rate in that period. We believe components will converge in this broad category of devices as mobile phones become more computerlike and computers shrink and become increasingly portable. As devices in general become more mobile, demand for nonvolatile memory and low-power processors will

Exhibit 1

A few major IT trends will drive the bulk of revenue growth in the semiconductor industry.



Industry growth

2010 revenue $300 billion + 5-year baseline growth $41 billion + **Megatrends $67 billion** – Double counting $10 billion = Estimated 2015 revenue $398 billion

5-year revenue growth, $ billion[1]

	Cloud computing	Mobile convergence	Immediacy	Next-generation wireless	Security standards	Energy efficiency	**Total**
Memory (volatile)	**–0.2**	**0.6**	**0.2**	**1.7**	N/A	N/A	2.3
Memory (nonvolatile)	**4.0**	**10.3**	**1.1**	**2.5**	**0.0**	**0.1**	18.0
Microcomponents	**1.6**	**–0.2**	**6.4**	**2.0**	**1.2**	**1.9**	12.9
Logic	**0.8**	**3.9**	**3.5**	**5.4**	**0.0**	**0.1**	13.7
Analog	**–0.8**	**1.8**	**1.8**	**2.2**	N/A	**0.1**	5.1
Discretes	**0.1**	**1.4**	**0.6**	**0.9**	N/A	**0.2**	3.2
Optical	**0.2**	**2.5**	**2.3**	**1.8**	N/A	**3.0**	9.8
Sensors	**–0.1**	**0.7**	**0.1**	**0.8**	N/A	**0.2**	1.7
Total	5.6	21.2	16.0	17.3	1.2	5.6	66.7

[1]Figures may not sum, because of rounding.

Source: iSuppli; McKinsey analysis

rise significantly. More specifically, based on data from Gartner, IDC, and iSuppli, we expect that current x86-based chips will lose around 10 percent of their market share to ARM-based processors over the next five years (Exhibit 2).

One caveat is that Intel, the dominant player in computing, wants to enter the smartphone market and may achieve suitably low power levels and competitive pricing for its x86 chips across most product categories by the end of 2013. That would lead to deeper competition in the mobile-processor market.

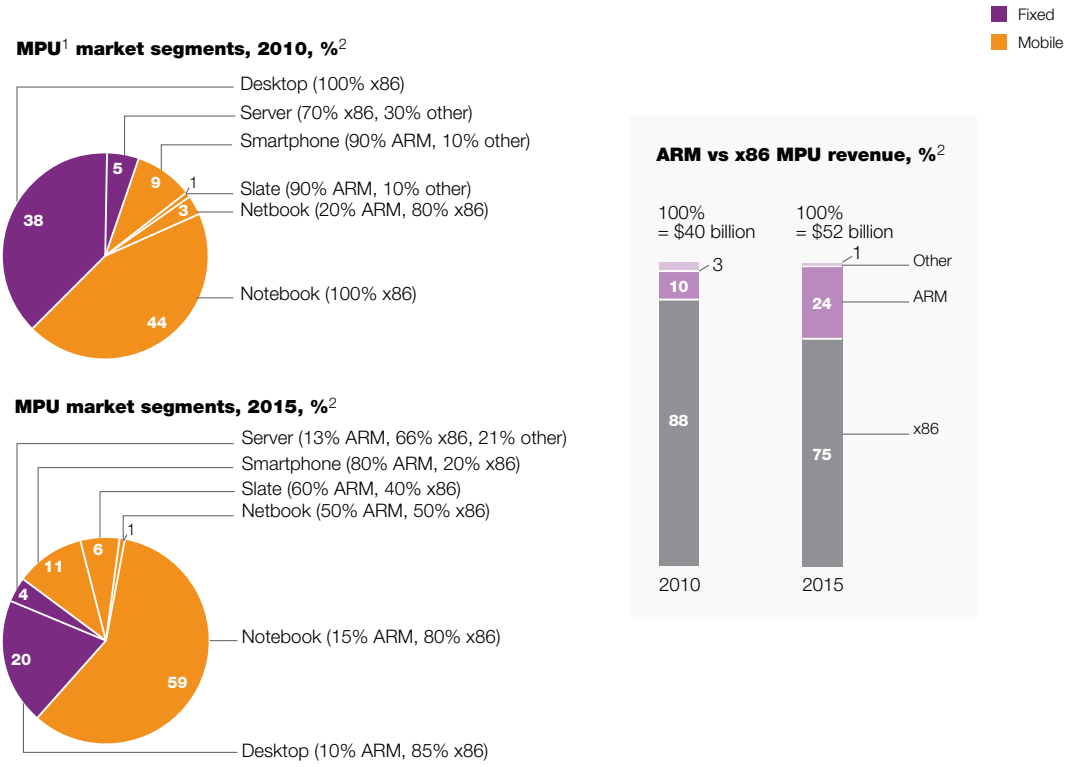
With regard to high-growth product segments, the best are chips that power midrange smartphones, with average selling prices in the range of $100 to $190. This category offers comfortable margins, and the overall segment is expected to grow at an 8 percent annual rate between now and 2014. The

higher-growth, entry-level smartphone category will grow at a compound annual rate of 44 percent but is expected to be a competitive, relatively low-margin business, so scale is an important success factor. The battle in the high-end smartphone category is largely over, with Apple, Google, and Samsung expected to capture the lion's share of the value created in this segment through 2014. Profit margins for advanced phones are high, but the growth rate in the sector is expected to be a tepid 3 percent as volume shifts toward the categories noted above.

This trend also has implications for chip makers: the growth in smartphones and tablets will benefit flash-memory producers, especially those that build NAND flash chips. Logic application-specific standard products will also profit from

Exhibit 2

Over the next five years, x86-based MPUs could lose >10% of market share to ARM.



Intel is the current dominant player in the mobile computing space; ARM is dominant in smartphones. Intel could achieve smartphone-suitable power levels (~500 mW) and price competitiveness for most use cases by 2013. Intel will continue to dominate the PC segments due to the optimized and well-penetrated Windows ecosystem, yet low-end PCs will adopt ARM-based processors as Microsoft starts supporting ARM for the next version of Windows. ARM is expected to penetrate in custom-built commodity servers for cloud-based processing, storage, and network.

[1]Microprocessing unit.
[2]Figures may not sum, because of rounding.

Source: Gartner; IDC; iSuppli; McKinsey analysis

this surge, as will LEDs, since mobile devices need lighting sources that sip rather than guzzle power. The shift toward mobile devices should also produce an increase in the use of discrete components, except at the low end of the spectrum, where integrated components will be preferred. In all, we expect that mobile convergence will increase global semiconductor revenues by $21 billion over the next three years. It may, in fact, be the hottest corner of the semiconductor market over the near term.

Next-generation wireless

From 2007 to 2010, global revenues from mobile broadband service grew at a 19 percent annual rate. Common sense would dictate that the rollout of 4G wireless around the world will only boost demand for rich media content. In fact, data traffic on mobile networks is already rising at a rate of roughly 80 percent a year. What is already a $100 billion opportunity for operators is expected to double by 2014, according to analysis from Yankee Group Research. Should it do so, mobile broadband would account for almost 20 percent of operator revenues.

Why is growth so robust? First, the smartphone category itself is growing at a 62 percent annual rate. The typical iPhone user consumes 250 MB of data a month. Second, the number of mobile broadband subscribers has grown at a 155 percent annual rate over the past four years—and these people tend to use between 500 MB and 1 GB of data in a typical month. Last, the number of data-hungry applications on phones and computers alike is driving a roughly 40 percent annual increase in data traffic per user.

In many markets, the current 3G networks are approaching the limits of their broadband capacity. As such, operators are working to implement 4G technologies, which will offer higher speeds and more stable connections. From a semiconductor point of view, this network upgrade should require upgraded memory as well as increased use of MIPS Technologies chips in both application processors and baseband systems. There will also be need for additional transport ports to support backhaul traffic. Logic chips will be in demand to support more sophisticated applications on next-wave smartphones and tablets. Power-management technology will also benefit, as these more sophisticated devices will support multitasking. Finally, additional features will be embedded in microprocessors, such as dedicated GPS modules. Taken together, we estimate the opportunity for semiconductor companies in the race to equip and implement next-generation wireless networks will add as much as $17 billion to industry revenues by 2015.

The rise of immediacy

While the need for real-time data has largely been confined to niches such as the stock market or in corporate sales dashboards, the notion of dynamic data flows is spreading to other corners of the economy. Given the state of sensor technology, we feel there is a fundamental shift in modes of work coming. Among the industries to be revolutionized: health care, packaging and logistics, and consumer electronics (Exhibit 3).

Rising health care costs are driving demand for low-cost, home-based medical devices. We estimate this opportunity will be worth roughly $2 billion by 2015. Remote monitoring of blood pressure or glucose levels is another hot corner of the market. Our analysis indicates that the market for connected home-monitoring devices could be worth $2 billion to $3 billion in three years. Further down the line, a generation of smart

Exhibit 3

Immediacy will change the way business is done.

Immediacy examples[1]	Description
Health care	• Rising health care costs are driving the market for low-cost, home-based medical devices • Intelligence will be incorporated in current "dumb" devices, as well as new devices, to enable better and new treatments
RFID[2]	• With technology maturity and active tags overcoming the limitations of passive tags, RFID will find increasing use in many applications
MCU[3]	• MCU will become the center of a smart-sensor device with integrated connectivity, memory, and low-end analog components

[1]List is not exhaustive.
[2]Radio-frequency identification.
[3]Microcontroller.

Source: *RFID Journal*; McKinsey analysis

hospital devices will appear. Simple medical devices will increasingly incorporate computing power. An example of this might be digital monitoring of in vitro fertilization. It isn't easy to estimate the impact of these smart medical devices yet, but the broader medical-device market is large enough that semiconductor companies should monitor this developing opportunity. By 2020, there will be semiconductor-enabled devices for a range of products, such as artificial eyes or brain implants. Those two examples are, in fact, in clinical testing in Germany. The medical devices of the future will also employ LED lighting displays, making this a significant opportunity for companies in that subsector.

With regard to packaging and logistics, passive radio-frequency-identification (RFID) tags are already in wide use. But the next wave of so-called smart RFID tags will enable real-time location of products, trucks, and the like. It will also be the basis of patient treatment mapping in health care facilities. Over time, smart RFID technology should allow for development of analytics-driven retail operations in a range of categories. It should also permit sophisticated authentication of goods, from pharmaceuticals to apparel. This evolution will power additional growth in what is already expected to be a $16.5 billion sector this year.

The microcontroller (MCU) market is also expected to grow rapidly over the next three years. These low-power systems on a chip are already found in automobile engine-control systems, appliances, power tools, and toys. Recent advances in low-power radio circuits and core processors will enable a new wave of smarter smart devices, from cable set-top boxes to connected TV sets. These chips will also power over-the-top video and audio services and smart Blu-ray players. While 33 percent of today's MCU market is higher-end 32-bit ARM MCUs, we project that the chip's share will increase to 53 percent five years from now.

In total, we believe the immediacy trend will be worth about $16 billion to the industry over the next three years. That is only a little behind the $17 billion from next-generation wireless upgrades, meaning it is an important revenue opportunity for many types of chip makers.

The cloud

By 2015, cloud computing is expected to account for nearly 20 percent of global IT and application spending. That figure may seem low. But with many companies pursuing the development of private clouds, and given the generally slow uptake of public offerings, the cloud is having less impact on IT spending than might be assumed. In the longer term, the shift from the corporate data center, enterprise storage, and the PC to thin-client computers running applications stored in the cloud offers a narrower opportunity for semiconductor companies than other trends.

Enterprise-server sales are forecast to decline, thanks to server virtualization and greater efficiency resulting from the implementation of multicore processors. Storage servers will decline more modestly because they are still needed to move data between workstations and the cloud. Obviously, there are fewer reasons to buy a PC when a tablet could effectively take its place.

There are other corners of the market that will face pressure given this migration. Analog and logic components are likely to see decreases in sales volume as virtualized servers shrink the data-center stacks.

As the trend plays out, we view it more as a reallocation than a disruption. Demand for flash memory will increase as companies move from PCs to thin-client machines. We also expect sales of networking gear to rise as both wired and wireless infrastructure are upgraded to take full advantage of the cloud. Other categories should benefit, too, such as 32-bit MCUs, optical and other sensors, discrete chips, disk-drive and network-storage controllers, radio-frequency components, Ethernet controllers, and attenuators; all are likely to see modest growth over the next three years. Our analysis indicates the cloud opportunity will be worth a net $6 billion in additional revenue for the semiconductor industry by 2015 (Exhibit 4).

Bringing it all together

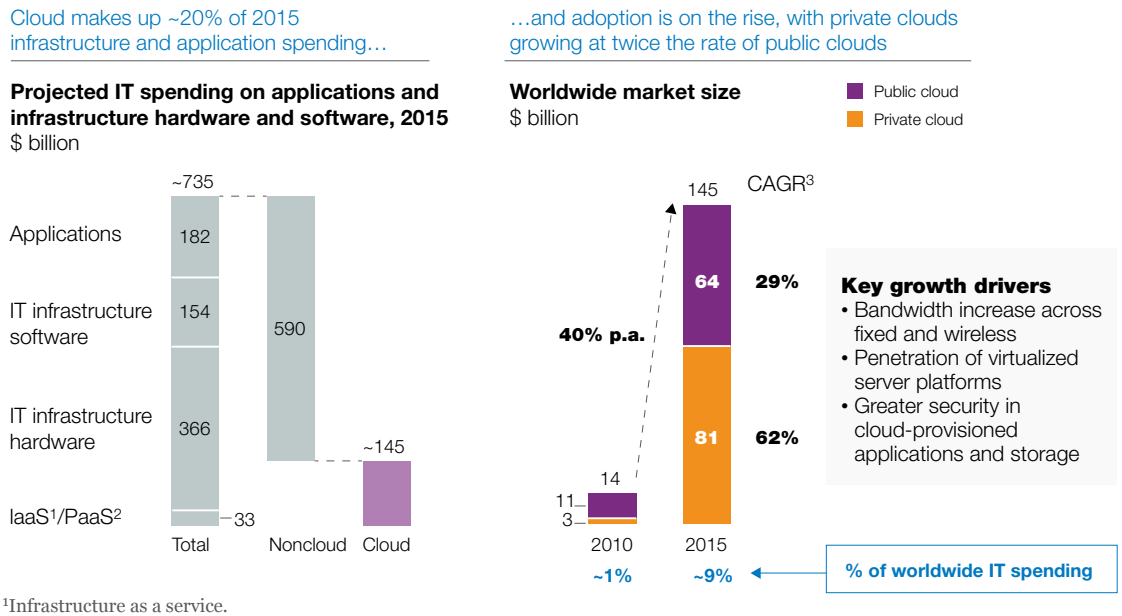
All four trends offer powerful opportunities for revenue growth. However, this is not the moment to rally the troops with a hearty “full speed ahead!” Instead, semiconductor companies will benefit from careful analysis of the microsegments that stand to benefit the most. Targeting the microsegments that present the deepest profit pools will require a proper strategy, as well as a granular understanding of the market and the competition.

Investigating opportunities in adjacent areas, such as software or services, is another priority. Distinctive software offerings can become a genuine competitive advantage; these are not simply table stakes. Such products also create a real opportunity for companies to differentiate themselves from competitors.

Questions of where to play are not the only concern; how to play is also vitally important. New capabilities may be required for a semiconductor company to take a leadership position in an attractive sector. For example, is the organization aligned with the new strategy? Are current sales capabilities enough to tap into new

Exhibit 4

Cloud growth could yield $6 billion in additional revenue for the semiconductor industry.



[1]Infrastructure as a service.
[2]Platform as a service.
[3]Compound annual growth rate.

Source: Bank of America Merrill Lynch; Forrester; Gartner; IDC; interviews of chief information officers (CIOs); McKinsey Cloud Initiative; McKinsey survey of CIOs and chief technology officers on cloud computing; McKinsey database on value migration

markets? It is also important to make sure that it is safe to pursue the selected opportunity and that doing so will not put large parts of the current business at risk. The proper marketing and sales strategy will continuously move a chip maker closer to its end customers. And the feedback from those customers must shape a new wave of products to increase the stickiness of the company's offerings. Last, getting the operational aspect of pursuing these opportunities right will be key. In many semiconductor markets, the winner takes all, so the difference between peak performance and second or third place can amount to significant amounts of money earned—or lost to competitors.

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With almost $100 billion in new sales coming over the next three years, there is reason to pursue these trends with care and focus. Breaking the $300 billion barrier was a big achievement, but it is already time to set out for a higher peak. With the right R&D efforts, the right products, and the right strategy, the semiconductor industry's best days will be still ahead.

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