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Research

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Market Profile: Semiconductor Industry

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The semiconductor industry forms the backbone of the IT supply chain. It involves a complex ecosystem of vendors across multiple markets, which total over $300 billion in revenue.

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1.0 Market Description

The semiconductor industry is defined by three key characteristics: industry cyclicality, cost structure and the rapid pace of technological development. For decades, the semiconductor industry has faced three- to four-year cycles of oversupply and undersupply and corresponding price decreases and increases. In good years, chip manufacturers, including foundries and integrated device manufacturers (IDMs), tend to overinvest in capacity. Lead times are long, and it takes time for investments in new fabrication plants (fabs) or new production equipment to bear results. The typical cycle for construction and qualification of a production fab is 18 to 24 months. Thus, capacity often comes online in large increments from multiple providers simultaneously. Because fabs are expensive, manufacturers must keep fab utilization as high as possible, and eventually, they must lower product prices to ensure this. As prices drop, profits decline across the industry, and less money is available to invest in further capacity. Demand for chips continues to rise gradually, and eventually, established production capacity tightens until chip prices once again begin to rise. This pricing cycle is most pronounced for commodity chips, such as memory, and leads to years of high growth and profits followed by years of market shrinkage and losses that ripple through the semiconductor industry.

The semiconductor industry is a mature market with generally high barriers to entry because of the increasingly complex nature of products, making both product design and manufacturing costs prohibitive. For example, a new 300-millimeter (mm), 90-nanometer (nm) production wafer fab costs more than $3 billion to build. As costs rise, the market continues to consolidate, collaborate in new ways and adopt new business models (consider, for example, the emergence of fabless semiconductor vendors).

Driven by Moore's Law, which roughly states that the number of transistors per chip will double every two years, the industry strives to shrink chips, thereby increasing the performance of semiconductor devices per area and/or chip cost. The industry also is driven to use bigger silicon wafers to increase manufacturing throughput. State-of-the-art production technology is based on 300-mm diameter silicon wafers and 65-nm (transistor) technology nodes. Also, chip vendors are increasing systems integration by combining multiple chips into a single system-on-a-chip (SOC). The rapid pace of such technology developments causes semiconductor vendors to face extremely high R&D costs and risk.

The increasing cost and associated risk in chip design coupled with the expense of manufacturing chips and the R&D for new manufacturing processes will lead to reduction in the number of vendors in the chip, the equipment and the materials markets. Thus, Gartner makes the following predictions related to industry consolidation:

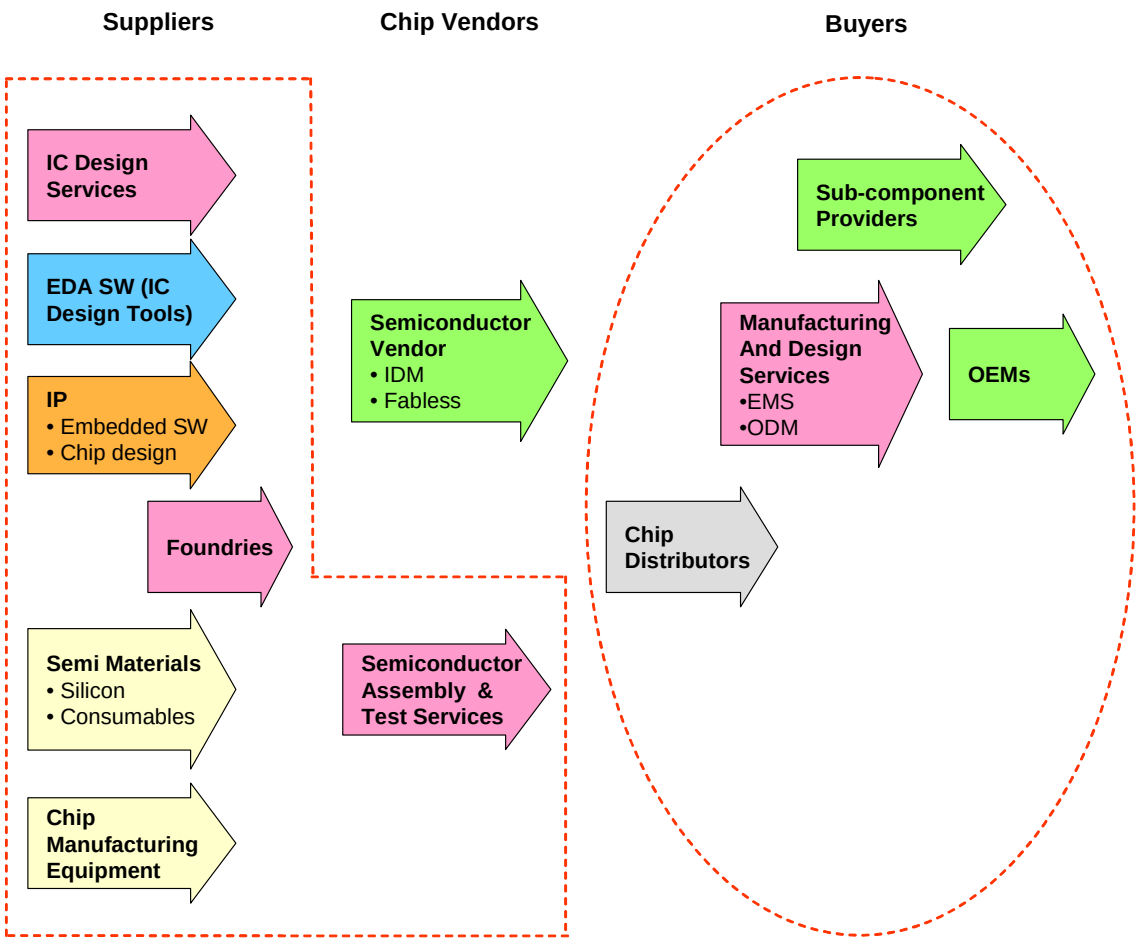
- By 2014, 40 percent of today's semiconductor vendors will no longer be shipping silicon (0.8 probability).
- By 2014, fewer than 25 manufacturers will be building new fabs (0.8 probability).
- By 2014, fewer than 10 equipment suppliers will satisfy 80 percent or more of semiconductor manufacturing equipment demand (0.9 probability).

1.1 Industry Landscape

The semiconductor industry comprises semiconductor device vendors, also known as chip or integrated circuit (IC) vendors, industry infrastructure suppliers and buyers of semiconductors as

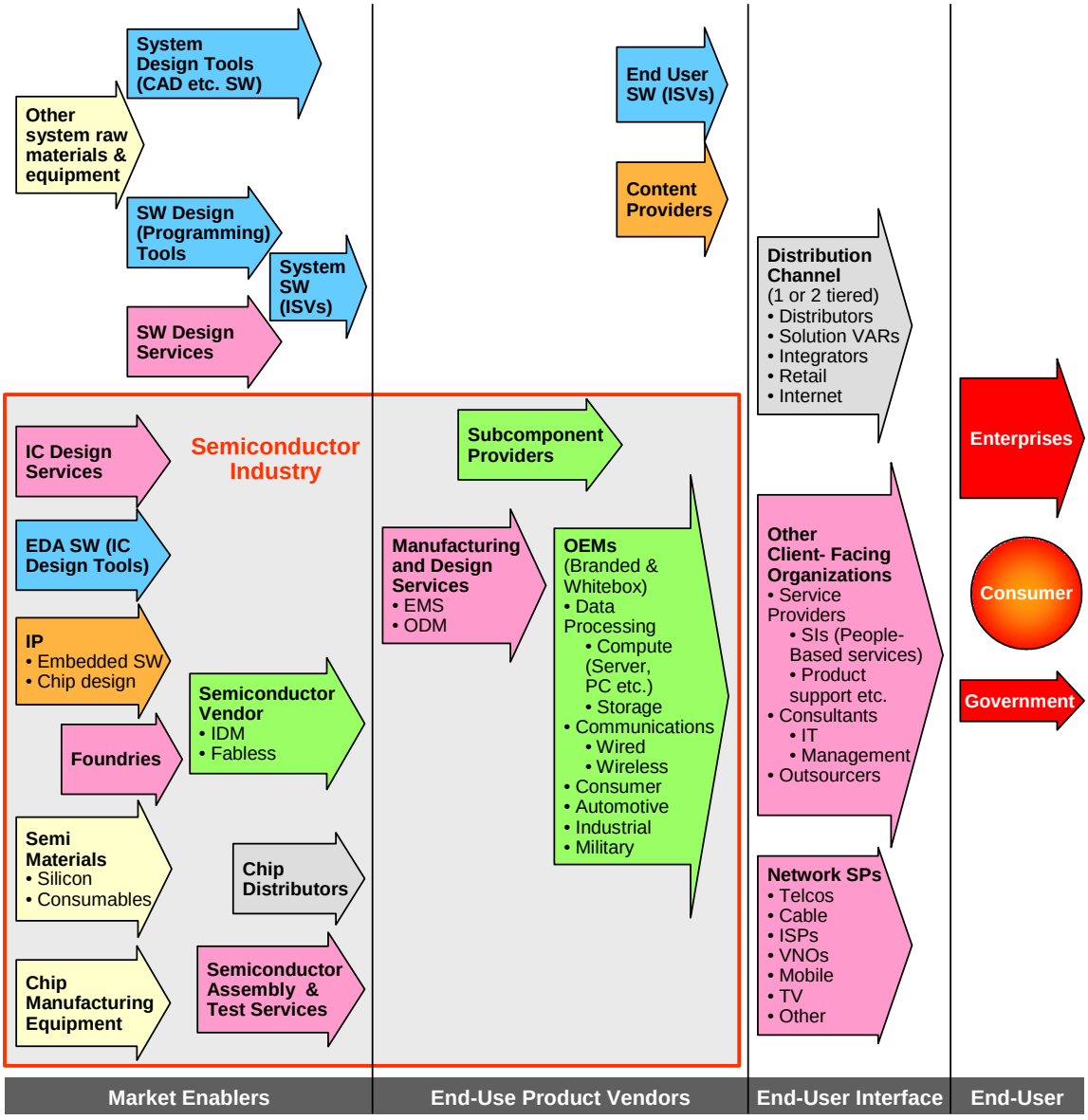
shown in Figure 1. These vendors form the backbone of the greater technology industry ecosystem as shown in Figure 2.

Figure 1. Semiconductor Industry Landscape



Source: Gartner (October 2005)

Figure 2. Technology Industry Landscape



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Color code: Green = product vendors; blue = software vendors; pink = service providers; gray = distribution channel; yellow = materials and equipment; orange = intangible asset vendors

Source: Gartner (October 2005)

1.1.1 Suppliers of Infrastructure Support

The following vendors form the supply end of the semiconductor supply chain. They support the operations of semiconductor chip vendors:

- Manufacturing equipment vendors provide equipment for making semiconductors. The equipment includes wafer fab equipment (for photolithography, deposition, removal,

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implant, thermal processing, clean, process control and automation), packaging and assembly equipment, and automated test equipment.

- Materials providers sell silicon and other manufacturing materials, such as photoresist and photomasks used in photolithography.
- Electronic design automation (EDA) software vendors provide software for designing chips, circuits and electronic equipment.
- Intellectual property (IP) vendors sell designs for part or all of a semiconductor chip. The financial arrangements covering IP can involve transfer of ownership or licensing.
- Foundries are service providers that manufacture chips for chip vendors without their own manufacturing facilities (fabless vendors). Foundries also provide manufacturing services to IDMs that outsource some of their semiconductor production.
- Other types of service providers enable semiconductor vendors to outsource testing and assembly of chips, packaging of chips or even design of chips.

1.1.2 Semiconductor Vendors

IC or semiconductor device vendors can be segmented by their business models, by the type of devices they provide and/or by the markets they target.

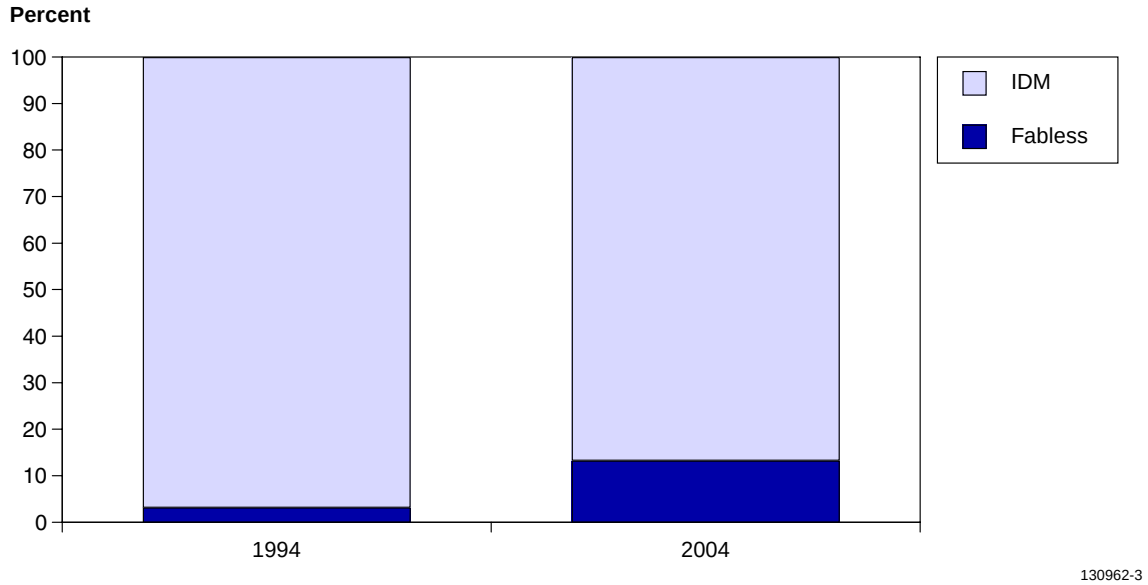
1.1.2.1 Business Model

Semiconductor chip vendors adopt one of the following two business models:

- IDMs are chip vendors that have their own fabs and can manufacture the chips they sell.
- Fabless vendors design, sell and market chips but outsource their manufacturing.

The key trend related to business models is that the percentage of fabless vendors is increasing, because of the industry's cost structure (see Figure 3). The impact of fabless vendors goes beyond their market share. Fabless companies produce many innovative and high-value semiconductor products, mostly in the application-specific standard product (ASSP) category. ASSPs are an example of chips that integrate multiple functions.

Figure 3. 2004 Semiconductor Revenue Share by Business Model



Source: Gartner (October 2005)

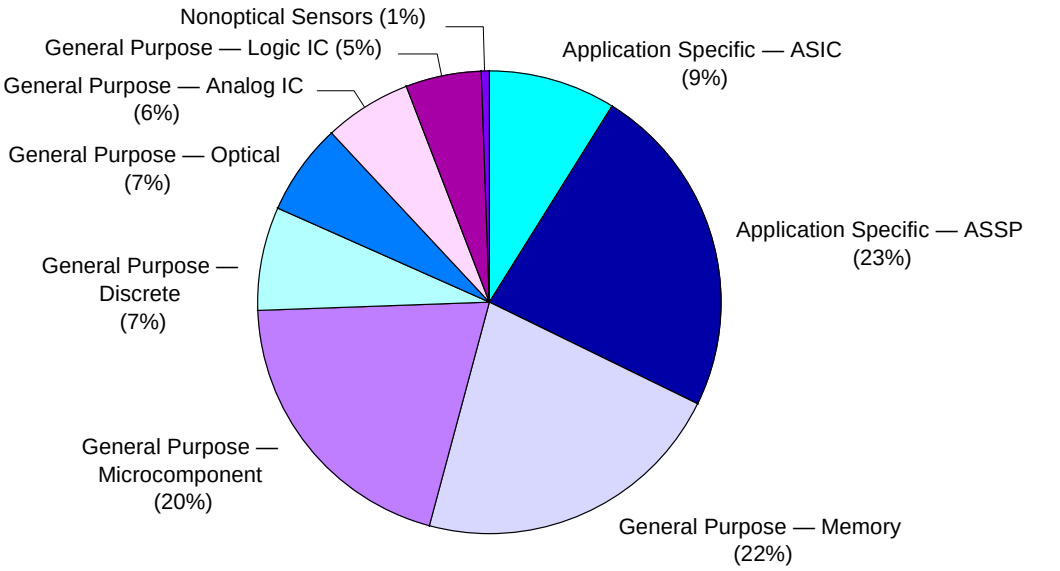
1.1.2.2 Device Types

Semiconductor chips are classified either as application specific or as general purpose depending on their usage:

- Application-specific integrated circuits (ASICs) and ASSPs are specialized chips that provide a feature or function specific to a certain type of electronic product (application). One example would be a chip that drives the operation of a cell phone.
- General-purpose devices are generic chips that can be used without modification in a variety of applications. Such devices include memory, microprocessor, microcontroller, analog, discrete, optoelectronic, sensor, field-programmable gate array (FPGA) or other logic chips.

Figure 4 shows a breakdown of the 2004 chip market. Application-specific chips are increasing in importance because of the trend toward SOC. Their market share is expected to grow from 32 percent in 2004 to 36 percent by 2010.

Figure 4. 2004 Semiconductor Revenue Share by Device Type (Total = $219.9 Billion)



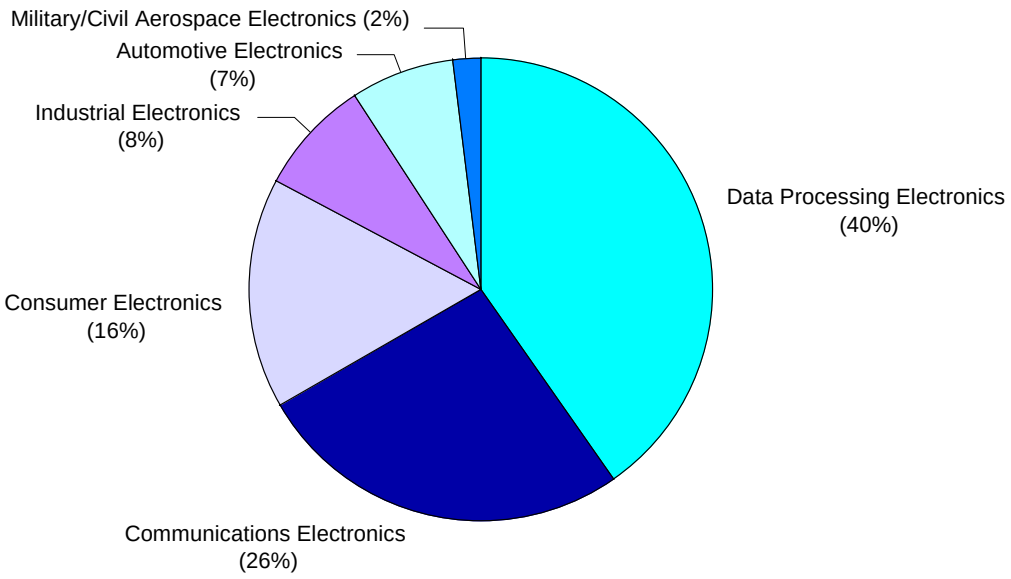
Source: Gartner (October 2005)

1.1.3 Target Markets (Application Categories)

Semiconductor chips are used (consumed) in all electronic products (see Figure 5):

- Data processing electronics consist of two subcategories: compute products, such as PCs and servers, and storage products, such as disk drives and enterprise storage systems
- Consumer electronics, such as digital cameras, home appliances and DVD players
- Communication electronics, including wireless products such as cell phones, as well as wired products such as enterprise routers and switches
- Automotive electronics, such as Global Positioning System (GPS) navigation systems and airbags
- Industrial, military and aerospace electronics, such as medical systems, radar systems and industrial controls
- It is worth noting that one of the key changes under way in the industry is the increased "consumerization" of demand. While, historically, most semiconductors were consumed in electronics purchased by governments and enterprises, Gartner now expects that, by 2010, more than half of all semiconductor revenue will be tied to electronic products bought by consumers (across all of the listed application categories).

Figure 5. 2004 Semiconductor Revenue Share by Application Category (Total = $219.9 Billion)



Source: Gartner (October 2005)

1.1.4 Buyers of Semiconductors

Semiconductor buyers can be broken down as follows:

- Original equipment manufacturers (OEMs) sell and market hardware products made in-house or by contract manufacturers.
- Contract manufacturers make electronic applications for OEMs. They are categorized as electronics manufacturing service (EMS) providers that manufacture only and original design manufacturers (ODMs) that manufacture and design products.
- Distributors provide OEMs and the EMS/ODM market with chips.
- Consumers are a new buying category for the semiconductor industry. With the introduction of flash memory cards and Universal Serial Bus (USB) storage devices, consumers are for the first time buying products directly from semiconductor chip vendors.

2.0 Market Statistics

2.1 Market Shares

Tables 1 through 8 outline Gartner's estimates for 2004 revenue and market share for the top players in key market segments in the semiconductor industry:

Table 1. Top 10 Semiconductor Device Vendors, Worldwide, 2004

	Revenue ($M)	Market Share (%)
Intel	30,730	14.0

	Revenue ($M)	Market Share (%)
Samsung Electronics	16,276	7.4
Texas Instruments	9,678	4.4
Renesas Technology	9,001	4.1
Infineon Technologies	8,945	4.1
STMicroelectronics	8,761	4.0
Toshiba	8,538	3.9
NEC Electronics	6,438	2.9
Philips Semiconductors	5,689	2.6
Freescale Semiconductor	5,519	2.5
Other	110,305	50.2
Total	**219,880**	**100.0**

Source: Gartner (October 2005)

Table 2. Top Five Semiconductor Manufacturing Equipment Vendors, Worldwide, 2004

	Revenue ($M)	Market Share (%)
Applied Materials	6,310	16.8
Tokyo Electron	4,035	10.7
ASML	2,683	7.1
Advantest	2,213	5.9
KLA-Tencor	1,567	4.2
Other	20,773	55.3
Total	**37,580**	**100.0**

Source: Gartner (October 2005)

Table 3. Top Five Foundries, Worldwide, 2004

	Revenue ($M)	Market Share (%)
TSMC	7,657	40.9
UMC	3,409	18.2
Chartered Semiconductor Manufacturing	1,103	5.9
SMIC	975	5.2
IBM Microelectronics	850	4.5
Others	4,738	25.3
Total	**18,732**	**100.0**

Source: Gartner (October 2005)

Table 4. Top Five IP Vendors, Worldwide, 2004

	Revenue ($M)	Market Share (%)
ARM	312	24.5

	Revenue ($M)	Market Share (%)
Rambus	145	11.4
TTPCom	104	8.2
Synopsys	76	6.0
MIPS Technologies	57	4.5
Others	580	45.5
Total	**1,274**	**100.0**

Source: Gartner (October 2005)

Table 5. Top Five EDA Vendors, Worldwide, 2004

	Revenue ($M)	Market Share (%)
Cadence	1,060	26.9
Synopsys	1,038	26.4
Mentor Graphics	635	16.1
Magma Design Automation	139	3.5
ARM	87	2.2
Other	979	24.9
Total	**3,939**	**100.0**

Source: Gartner (October 2005)

Table 6. Top Five Materials (Silicon + Epitaxial Wafer) Vendors, Worldwide, 2004

	Revenue ($M)	Market Share (%)
Shin-Etsu Handotai	2,373	31.1
SUMCO	1,726	22.6
Siltronic (formerly Wacker Siltronic)	974	12.8
MEMC Electronic Materials	974	12.8
Komatsu Electronic Metals	688	9.0
Other	904	11.8
Total	**7,639**	**100.0**

Source: Gartner (October 2005)

Table 7. Top Five Materials (Photoresist) Vendors, Worldwide, 2004

	Revenue ($M)	Market Share (%)
Tokyo Ohka Kogyo	204	21.7
JSR	194	20.7
Rohm & Haas	168	17.9
Fujifilm Arch	125	13.3
Shin-Etsu Chemical	92	9.8
Others	157	16.7

	Revenue ($M)	Market Share (%)
Total	**939**	**100.0**

Source: Gartner (October 2005)

Table 8. Top Five Semiconductor Assembly and Test Services Vendors, Worldwide, 2004

	Revenue ($M)	Market Share (%)
ASE Group	2,434	18.1
Amkor Technology	1,901	14.1
SPIL	1,049	7.8
STATS ChipPAC (Includes Winstek)	1,039	7.7
ChipMos Technologies	450	3.3
Other	6,594	49.0
Total	**13,466**	**100.0**

Source: Gartner (October 2005)

2.2 Market Forecast

The semiconductor device market is nearing its long-anticipated $300 billion milestone (see Tables 9 and 10 and Figure 6).

Table 9. Worldwide Semiconductor Revenue Forecast, 2005-2010 (Millions of Dollars)

Device Category	2005	2006	2007	2008	2009	2010
Application Specific — ASIC	21,028	23,438	24,841	26,426	27,197	28,798
Application Specific — ASSP	55,237	60,058	66,160	75,346	79,510	87,705
General Purpose — Analog IC	13,837	14,587	15,878	17,608	17,409	18,697
General Purpose — Discrete	16,455	17,406	19,115	21,294	20,127	21,598
General Purpose — Logic IC	13,340	15,528	17,602	20,225	21,565	23,671
General Purpose — Memory	49,178	52,359	45,498	60,921	50,956	49,462
General Purpose — Microcomponent	47,528	50,587	53,934	60,366	61,926	66,389
General Purpose — Optical	17,049	18,476	19,983	22,802	24,328	27,205
Nonoptical Sensors	1,699	1,977	2,217	2,523	2,834	3,154
Total	**235,351**	**254,416**	**265,228**	**307,512**	**305,852**	**326,679**

Source: Gartner (October 2005)

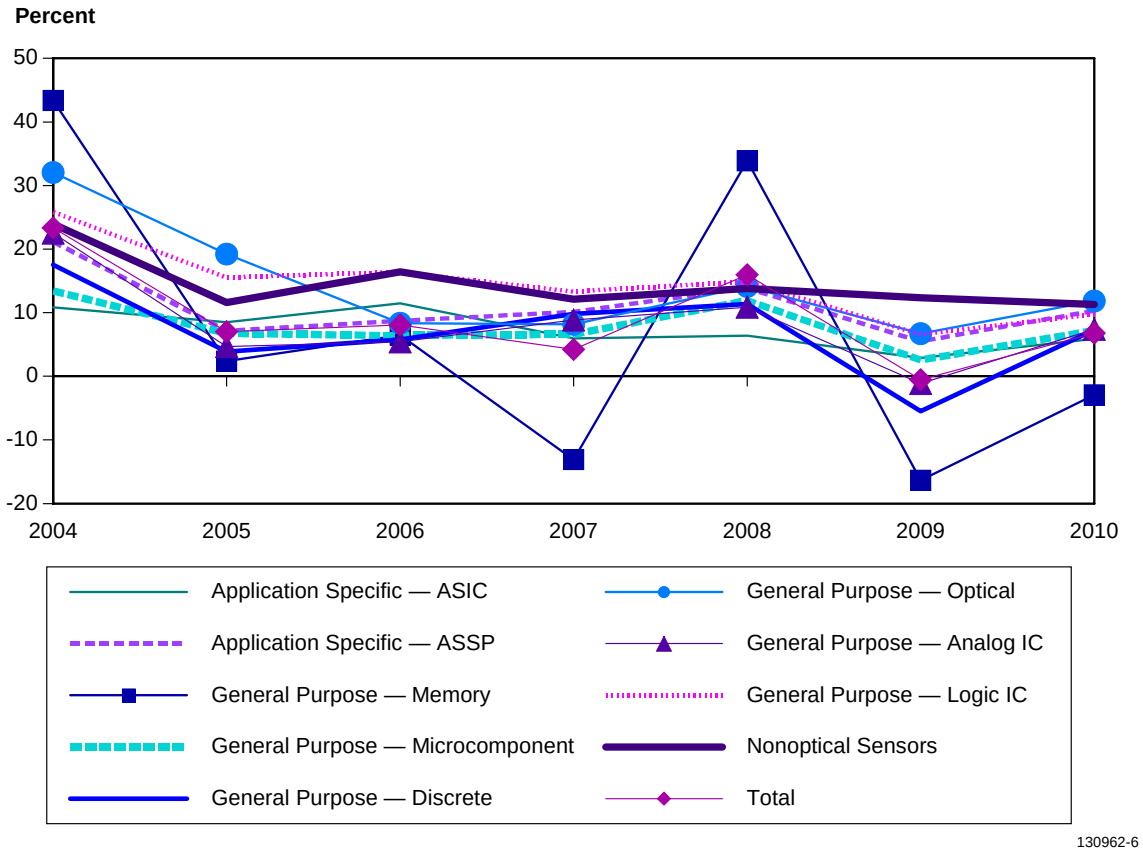
Table 10. Worldwide Semiconductor Revenue Growth Forecast, 2005-2010 (Millions of Dollars)

Device Category	2005	2006	2007	2008	2009	2010
Application Specific — ASIC	8.5	11.5	6.0	6.4	2.9	5.9
Application Specific — ASSP	7.2	8.7	10.2	13.9	5.5	10.3
General Purpose — Memory	2.4	6.5	-13.1	33.9	-16.4	-2.9
General Purpose — Microcomponent	6.8	6.4	6.6	11.9	2.6	7.2

Device Category	2005	2006	2007	2008	2009	2010
General Purpose — Discrete	3.9	5.8	9.8	11.4	-5.5	7.3
General Purpose — Optical	19.2	8.4	8.2	14.1	6.7	11.8
General Purpose — Analog IC	4.7	5.4	8.9	10.9	-1.1	7.4
General Purpose — Logic IC	15.5	16.4	13.4	14.9	6.6	9.8
Nonoptical Sensors	11.6	16.4	12.1	13.8	12.4	11.3
Total	**7.0**	**8.1**	**4.2**	**15.9**	**-0.5**	**6.8**

Source: Gartner (October 2005)

Figure 6. Worldwide Semiconductor Revenue Growth Forecast, 2005-2010



Source: Gartner (October 2005)

3.0 Market Trends

The following key trends define Gartner's outlook for the semiconductor industry.

3.1 Business Trends

- The long-term growth rate of the semiconductor chip industry has slowed from a compound annual growth rate (CAGR) of about 15 percent to a CAGR of 5 percent to 10

percent, in part, because of two key applications — PCs and cell phones — reaching market maturity.

- The minimum efficient scale of manufacturing plants will get bigger over time, increasing the cost of capital investments. Increasing device integration is leading to fewer, more-complex chips, which increases design costs (per chip). These trends lead to semiconductor industry consolidation, changes in vendor business models and a shift in the power balance, including new alliances and consortia.
- Manufacturing and process capabilities used to be the key differentiators in the semiconductor industry. Going forward, differentiation will be based on design, software, IP or other service capabilities.

3.2 Technology Trends

- Integration and complexity of chips will continue to increase per Moore's law. One key product of this trend is system-level integration on a single chip, and as a result, SOC remains the hottest segment of both the ASIC and ASSP markets. Gartner forecasts that more than 70 percent of all ASICs and ASSPs will be SOC by 2010.
- Mobility will be an important feature in electronic applications, and this implies increased focus on power management, connectivity and industry standards.
- As the cost of R&D investments increases, risk will increase for new product introductions (for chip vendors as well as for manufacturing equipment and materials vendors). Vendors will likely question return on investment and get more conservative in their efforts to push technology forward. For example, it is unclear who — if anyone — can fund transition to 450-mm silicon wafers.

3.3 Demand Trends

- By 2010, more than half the demand (in terms of revenue) for semiconductors will come from products bought by consumers. This presents vendors with new challenges, such as focus on marketing features as opposed to technological features, short product lifetimes, short time to market and low profit margins.
- Cell phones and PCs have been the dominant drivers of the semiconductor industry for years. No new "killer applications" are on the horizon. Instead, demand is driven by new consumer products, many of which represent digitization of established markets (digital cameras, home appliances, automotive electronics, MP3 players and so on) and provide beneficial "killer" features, such as wireless connectivity.
- Service providers will have an increasingly important role in the electronics market. They are positioned between OEMs, content owners and customers, and thus, they exert influence on product features and design.

3.4 Geographic Trends

- In the semiconductor industry, focus is on the Asia/Pacific region. Its performance will continue to outpace other regions because of growth in local consumption of electronics as well as geographic shifts in electronic equipment production. Some of the key regional trends are:
    - The semiconductor market growth is driven by demand for replacement mobile phones, consumer displays and digital cameras across Asia/Pacific and, notably, by

China's huge domestic consumption of mobile phones and PCs. In addition, increased automobile consumption in China and Southeast Asia is expected to drive semiconductor growth in the automotive electronics market. An increased trend toward outsourcing to reduce manufacturing costs will continue to drive production share for ODMs and electronic manufacturing services (EMSs). India presents a potential emerging semiconductor market.

    - In Japan, production of digital consumer products, such as cameras, camcorders, TVs and displays, is still strong, but electronics production in Japan is increasingly limited to high value-added products using advanced technology. The use of electronic products in automobiles will grow in Japan.

- In Europe, the Middle East and Africa (EMEA), key trends are focused on geographic shifts in production. Western Europe will retain a core of production capability, particularly for higher-end equipment for the telecommunications, automotive and consumer sectors. New production capability will continue to be established in Central and Eastern Europe to serve local EMEA demand. However, production of consumer equipment and mobile handsets is moving to Asia/Pacific. This reduces local demand for semiconductors and leaves semiconductor vendors questioning the role of Europe in the industry.

- In the Americas, electronic equipment production also will continue to shift toward Asia/Pacific, dampening semiconductor market growth prospects. The Americas region is a key driver of corporate IT spending.

3.5 Political, Economic and Social Trends

- The semiconductor industry will be affected by any policy changes that deal with electronics. The biggest political issue is duties imposed on semiconductor imports. The duties are tax penalties for goods exported at less than fair domestic market value (antidumping duties) or for subsidies provided by foreign governments (countervailing duties). Government also comes into play in specific policy decisions such as digital rights management or IT security, solutions that involve ICs. Furthermore, governments directly influence market development with education policy and as sponsors of R&D programs, especially when they make semiconductors a key part of their overall high-technology strategy.

- In some cases, sociopolitical changes raise the costs of chip making, challenging profitability, but in some cases, they create new markets or opportunities for differentiation. For example, advances in biotechnology may lead to exiting, presently unidentified applications of semiconductors. Similarly environmental concerns related to pollution (such as the European Union lead-free directive that becomes effective in mid-2006) will affect both materials and processes used to manufacture chips, while the issue of energy consumption will focus design attention on usage.

4.0 Key Issues

Gartner research and analysis focus on the challenges facing the semiconductor industry. For example, players in the semiconductor industry — regardless of their specific market segments — must understand the following:

- How will industry cyclicality and overall growth rate change going forward?

- What electronic applications will drive the semiconductor market growth going forward? How can we best differentiate our product offering?

- What business models maximize profitability? If partnering and alliances are required, who should we align with?
- How can the rate of technological development be sustained given the increasing capital and R&D costs and complexity of products?
- Who will our customers be? Which of our customers' needs should we prioritize in product design? How can we best differentiate our product offering?

5.0 Further Resources

5.1 Key Analysts

Jim Tully is Gartner's research area lead for semiconductors. Biographies for him and the rest of the more than 50 Gartner analysts covering the semiconductor space are available on the Analyst Biographies Section of gartner.com.

RECOMMENDED READING

Some of the general semiconductor research of interest would be:

"Hype Cycle for Semiconductors, 2005"

"Cool Vendors in Semiconductors, 2005"

”How to Respond to Changes in the Semiconductor Value Chain"

"Global Trends That Will Transform the Semiconductor Industry"

Gartner's semiconductor research team offers numerous documents on market statistics and other qualitative and quantitative analysis. You can find the further reading on the following Web portals:

Semiconductor Applications

Semiconductor Industry and Devices

Semiconductor Manufacturing and Design

The following guide books can be used as a reference for semiconductor research terminology:

"Semiconductor Forecast Methodology and Definitions"

"Semiconductor Outsourcing Industry Definitions, 2004"

"Technical Applications Software Guide, 2004"

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