

【特集：競合か協調か：トランプ習時代の米中経済関係を占う】
【特集論文】

Semiconductor Industry in China: China and United State Relationship

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【Keywords】 semiconductor industry, semiconductor companies, China and U.S. relationship, neuron, global eco-system

【JEL Classification Code】 L63, F51

Abstract

To investigate the China semiconductor industry affection on the worldwide economy and also the infrastructures (social/industrial/defense), it is important to consider the China and U.S. relationship. China consumes tons of products made by Trump's base. It is the second-largest market for U.S. cotton (14% in 2016), auto (17% in 2016), and semiconductors (15% in 2016). [1] SEMI (U.S. organization, Semiconductor Equipment and Materials International) has been acting as global eco-system build up moderator for China. SEMI China was started from 1985 and already 32 years to support China government and partner companies in China. Semiconductor is highly integrated with the global eco-system of architecture, software, IP core vendor, fabless design houses, foundries, IDM, Packaging & Assembly, testing, equipment and materials. These companies are widely distributed in the world. This global eco-system is centralized by United States that is already established using SEMI. The top leading companies are all United States, such as, Software/architecture; Apple, Google,

Microsoft, Semiconductor manufacturing; Intel, Equipment; AMAT, and Fabless design house; Qualcomm. Bottom hierarchy segments are shifting to China from Taiwan, Korea, and Japan. For coming super Si cycle, SEMI is expecting China is the largest market of semiconductor equipment/materials. Also, in China, fabless design house become very active, such as HiSilicon, Spreadtrum, and Datang under the China government strong support to make domestic virtual IDM, such as Huawei (End products) + Hisilicon (Chip Design) + SMIC (LSI Manufacturing) + JSET (Assembly, Testing). In addition, Huawei, China's leading smartphone maker surpassed Apple's global smartphone sales for the first time in June and July 2017, according to analysis by consulting firm Counterpoint Research. [2]

However, China semiconductor industry is growing rapidly and widely, the rest of the countries, such as U.S., Korea, Taiwan, and Japan are afraid of head on competition with China within the same industry, likes what was happened in Solar cells and flat panels display.

Therefore, the U.S. has initiated an investigation into China's theft of U.S.

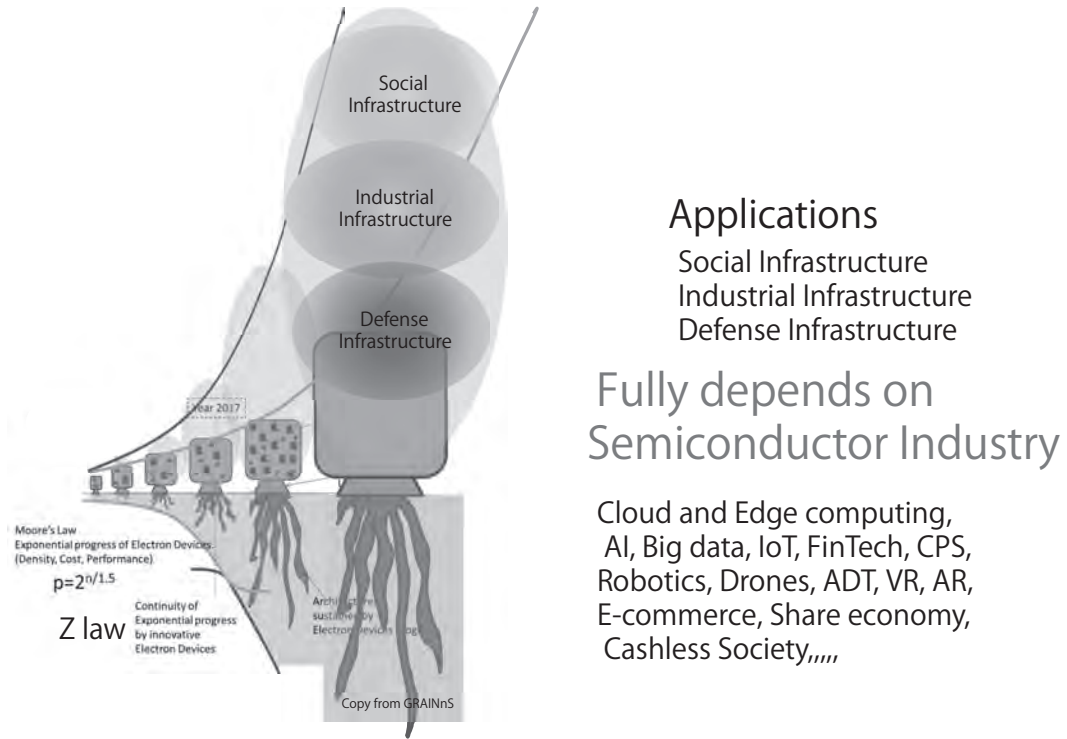


Fig. 1 Why Semiconductor Industry is Important so far?

intellectual property (IP) using Section 301 of the Trade Act of 1974. Also, U.S. blocked the proposed deal between Lattice and Chinese-backed Canyon Bridge Partners. Trump's decision to block the acquisition of the maker of custom communications chips known as field programmable gate arrays, or FPGAs, will certainly have broad effects in the chip industry. [3]

Here, we investigate current Chinese semiconductor industries, such as, devices manufacturing, fabless, and equipment/materials and U.S. companies in China. And, showing tight relationship of U.S. and China semiconductor companies, as eco-system that also SEMI's objective.

1. Importance of the industry

Why semiconductor industry is important?

Technology progress as time being, one

visible phenomenon is Moore's law.¹ Currently, electric products are grown rapidly, widely, and smartly obtaining benefit from semiconductor industry that is governed by Moor's law. Transistor price as well as performance is exponentially cheaper and higher. Another experience rule is Z law².

- 1 Moore's law; Semiconductor's density, cost, and performance are exponential progress. Represent as equation $p=2^{n/1.5}$.
- 2 Z law; An Economic unit of semiconductor work from A as start point and finally reach to Z as end point. Start moment is very slow to reduce transistor price because of lower technology readiness until first inflection point. After beyond the inflection point, it can keep Moore's law as exponential curve, then, beyond second inflection point, pace down and die. This two inflection points curve is just like stretching Z character. Then, another economic unit appears to follow Moore's law. And, continuously follow Moore's law to reduce transistor price and to enhance transistor performance.

Figure 1 shows an apple tree model of electric products. Horizontal axis is time and vertical axis of lower quadrant is transistor price or cost/transistor performance, vertical axis of upper quadrant is applications/electric products. As time being, applications swallow social infrastructure, industrial infrastructure, and also defense infrastructure, such as cloud/edge computing, AI, big data, IoT, CPS, Robotics, Drones, ADT, VR, AR, MR, fintech, e-commerce, share economy, cashless society, etc. These infrastructures are fully depends on semiconductor industry.

in fig.2. Another factor of electron devices progress is User Interface (UI). Currently Graphical User Interface (GUI) becomes majority from keyboard and mouse, as smart phone becomes majority than PC. And, UI will be shifted to Neural User Interface (NUI) in near future, such as Brain Computer Interface (BCI/BMI). In the era of NUI, semiconductors are increasing importance exponentially as neurons. And also it reforms the social structures.

Semiconductor=Neuron

Future prospects in the industry

Near future of electron devices is shown

Semiconductors are tools that extend human capabilities exponentially and have the power

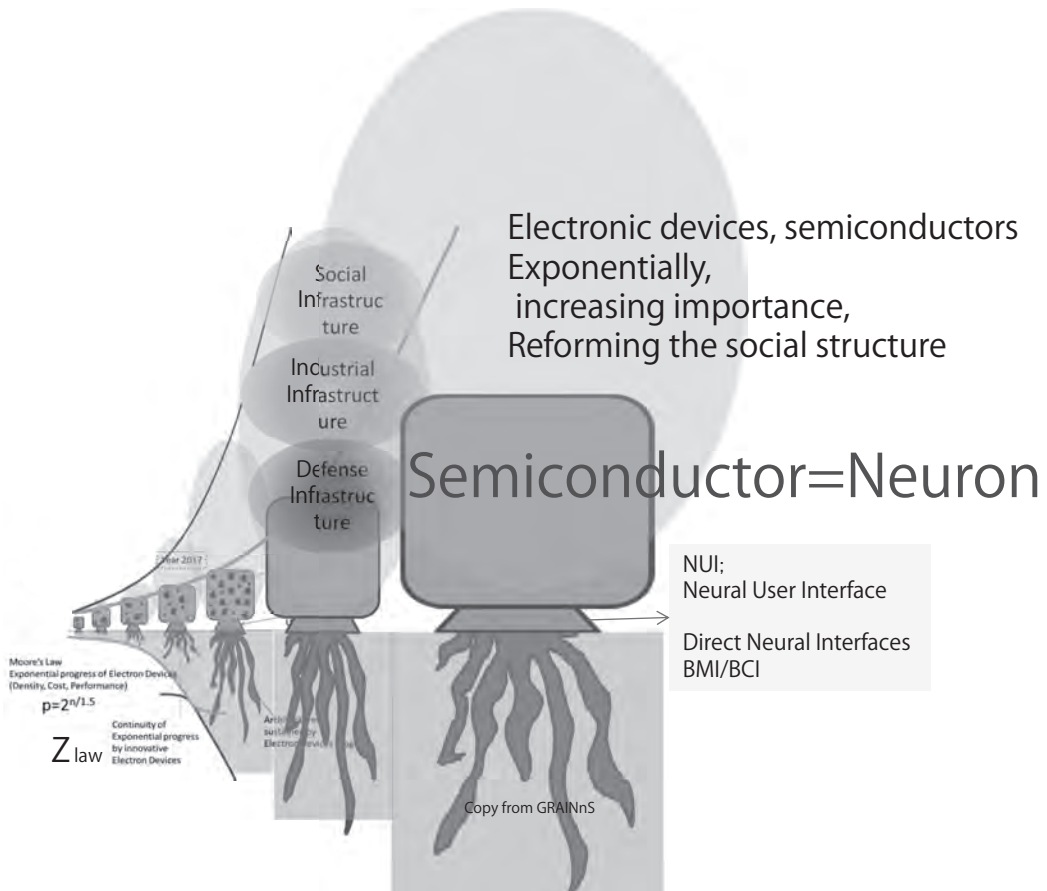


Fig. 2 Future Prospects in the industry

to transform human society/culture.

Roles of the two nations in semiconductor industry

China is the larger consumer on electron devices and is also biggest market worldwide. In figure 3, simply express the role of the two nations in semiconductor/electron device industry. China is assembly/testing majority. However, semiconductors manufacturing, design, equipment, and materials are still dominated by United State.

China semiconductor industry is still relying on United State semiconductor industry. The gap for semiconductor demand and

domestic supply is still there. China relies heavily in imported semiconductors from US and the rest of the world players. Therefore, investment activity of China government is focus on semiconductor eco-system to close the gap.

2. Current semiconductor industry in China

Table 1 shows the 2016 revenue ranking of semiconductor manufacturers that exclude foundry. [4] There are no Mainland China companies in the list, U.S. 5, Korea 2, Europe 1, Taiwan 1, and Japan 1. China Semiconductor Industry is still in a catching up mode compare to others worldwide players,

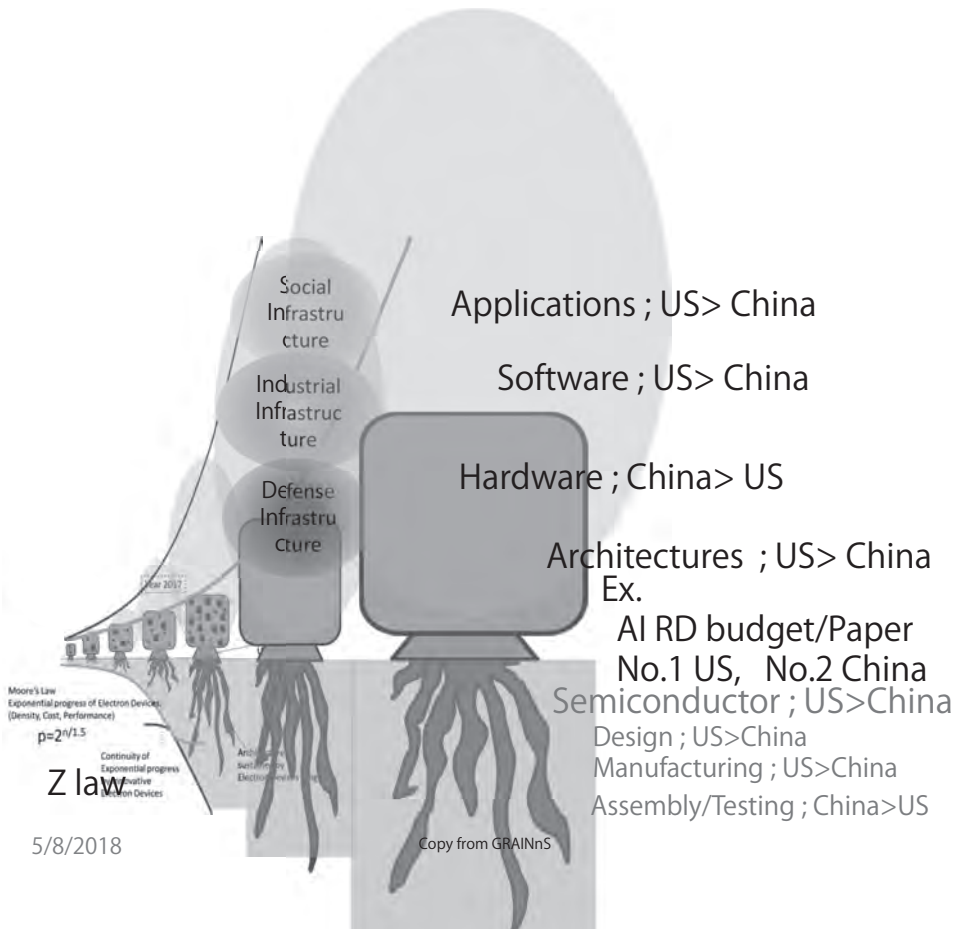


Fig. 3 Roles of the Two Nations

especially the United State.

Table 2 shows the top 10 pure-play foundry companies. [5] SMIC of mainland China is ranked as 4th position and Hua Hong Semi is

as 8th position. China has made tremendous efforts in semiconductor manufacturing to close the gap among other players in the past 30 years but is still lacking behind.

2016 Rank	2015 Rank	Vendor	2016 Revenue	2016 Market Share (%)	2015 Revenue	2015-2016 Growth (%)
1	1	Intel	53,996	15.9	51,690	4.5
2	2	Samsung Electronics	40,143	11.8	37,852	6.1
3	4	Qualcomm	15,351	4.5	16,079	-4.5
4	3	SK hynix	14,267	4.2	16,374	-12.8
5	16	Broadcom Ltd. (formerly Avago)	13,149	3.9	5,216	152.1
6	5	Micron Technology	12,585	3.7	13,816	-8.9
7	6	Texas Instruments	11,776	3.5	11,533	2.1
8	7	Toshiba	10,051	3.0	9,162	9.7
9	12	NXP	9,170	2.7	6,543	40.1
10	11	MediaTek	8,697	2.6	6,704	29.7
		Others	150,499	44.2	159,799	-5.8
		Total	339,684	100	334,768	1.5

Table 1. The 2016 revenue ranking of semiconductor manufacturers that exclude foundry. There is no Mainland China company in the list. US 5, Korea 2, Europe 1, Taiwan 1, and Japan 1. (Gartner, 2017.1.) [4]

Top 10 Pure-Play Foundry Companies

2016 Rank	2015 Rank	Company (Headquarters)	2014 Sales (\$M)	14/13 % Change	2014 Share of Total	2015 Sales (\$M)	15/14 % Change	2015 Share of Total	2016 Sales (\$M)	16/15 % Change	2016 Share of Total
1	1	TSMC (Taiwan)	25,138	25%	59%	26,574	6%	59%	29,488	11%	59%
2	2	GlobalFoundries (U.S.) ¹	4,355	6%	10%	5,019	15%	11%	5,545	10%	11%
3	3	UMC Group (Taiwan)	4,331	9%	10%	4,464	3%	10%	4,582	3%	9%
4	4	SMIC (China) ²	1,970	0%	5%	2,236	14%	5%	2,921	31%	6%
5	5	Powerchip (Taiwan)	1,291	9%	3%	1,268	-2%	3%	1,275	1%	3%
6	6	TowerJazz (Israel)	828	64%	2%	961	16%	2%	1,249	30%	2%
7	7	Vanguard (Taiwan)	790	11%	2%	736	-7%	2%	800	9%	2%
8	8	Hua Hong Semi (China)	665	14%	2%	650	-2%	1%	712	10%	1%
9	9	Dongbu HiTek (S. Korea)	541	20%	1%	593	10%	1%	672	13%	1%
10	11	X-Fab (Europe)	330	14%	1%	331	0%	1%	510	54%	1%
—	—	Others	2,280	3%	5%	2,405	5%	5%	2,251	-6%	<1%
—	—	Total	42,519	18%	100%	45,237	6%	100%	50,005	11%	100%

1. Includes \$740 million in 2H15 sales from IBM purchase. 2. Partially owned by TSMC.

Source: IC Insights, company reports

Table 2 In the top 10 pure-play foundry companies. SMIC of mainland China is ranked as 4th position and Hua Hong Semi is as 8th position. [5]

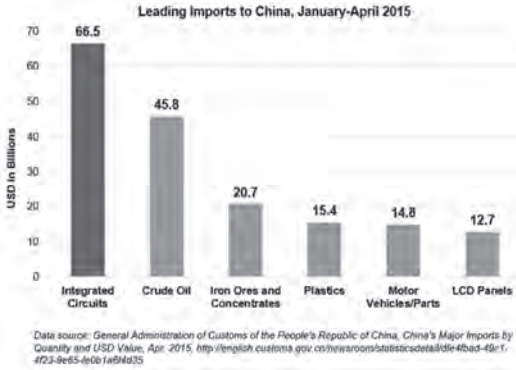


Fig. 4 Leading imports to China. [6]

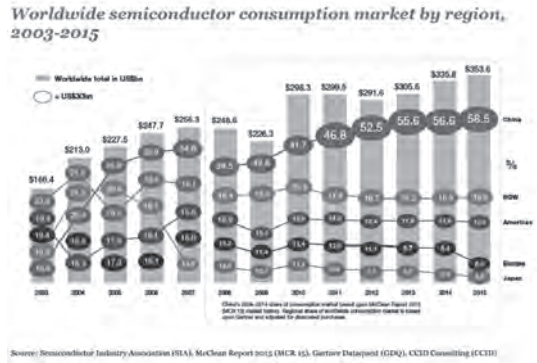


Fig. 5 Worldwide semiconductor consumption Market by region. [6]

Integrated Circuits, Semiconductor is ranked number one imported item in China surpassing crude oil and is the top semiconductor consumption market by region (Fig.4, 5).[6] This is the one of the motivation to make semiconductor all eco-system inside of mainland. In fig.5, Japan is bottom from 2008. United States is 3rd position. China is the most important semiconductor market in the world but it's own semiconductor industry

is still lack behind. Even making huge efforts to catch up for the past 30 years, the gaps for semiconductor demand and domestic supply keep growing. China still relies heavily in imported semiconductors from U.S. and the rest of the world (Fig.6). [7]

Price increase will continue due to supply shortages in DRAM and NAND flash. IHS Market predicted that the memory market

Comparison of China's integrated circuit consumption and production, 1999-2018

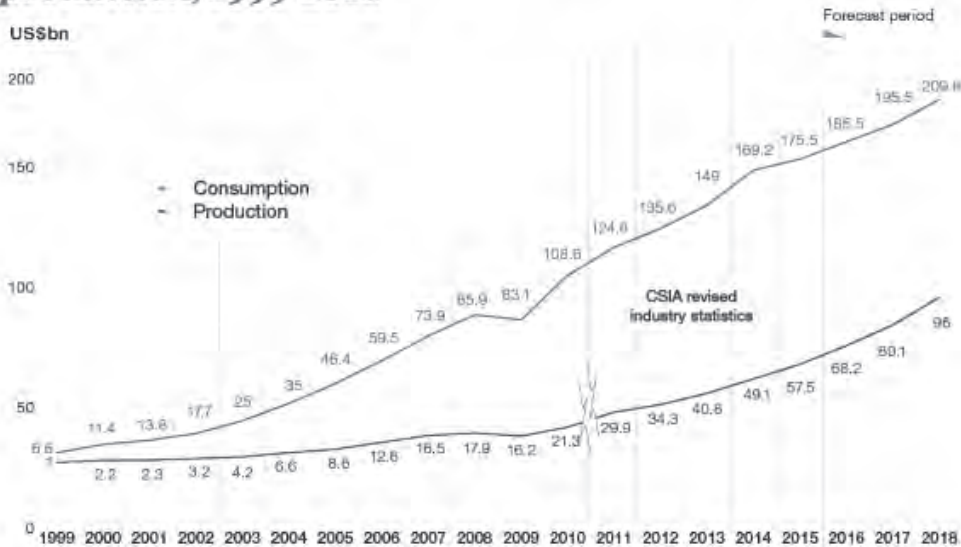


Fig. 6 Comparison of China's integrated circuit consumption and production, 1999-2018. [7]

would surpass \$ 100 billion for the first time this year, 30% growth YOY. Worldwide semiconductor revenue is forecast to total \$411.1 billion in 2017 new demand for information technology (IT) such as artificial intelligence (AI), big data, and machine learning. Memory products demand expected to go up by 10X (Fig.7). [8] Semiconductor super cycle begins again in 10 years. This may be the point of inflection for China Semiconductor Industry. China is determined to invest heavily into Semiconductor supplier chains to close the gap.

Table 3 shows the areas of high growth in 2020 to 2025. [9] In 2020 to 2025, big data infrastructure, 5G infrastructure, 5G client devices, image processing, IoT, ADAS (advanced driver assistance system), and

storage systems are predicted as high growth segments of electron devices. To prepare for these demands, China as world manufacturing hub and as for domestic demands, plans aggressively for front end Fab projects. With 20 or possibly more new Fab projects underway or announced in China since 2016, spending on fab equipment will surge above \$10B annually. (Table 4) China is projected to be the top spending region for fab equipment in 2019 and 2020. Figure 8 shows China Fab investment by parties that showing foreign companies investment become smaller than domestic companies from 2017. [10] U.S. and Japan equipment makers shall enjoy the most form this round of Chinese Fabs spending. Again, China still relies on U.S. for fab equipment. Table 5 shows top 10

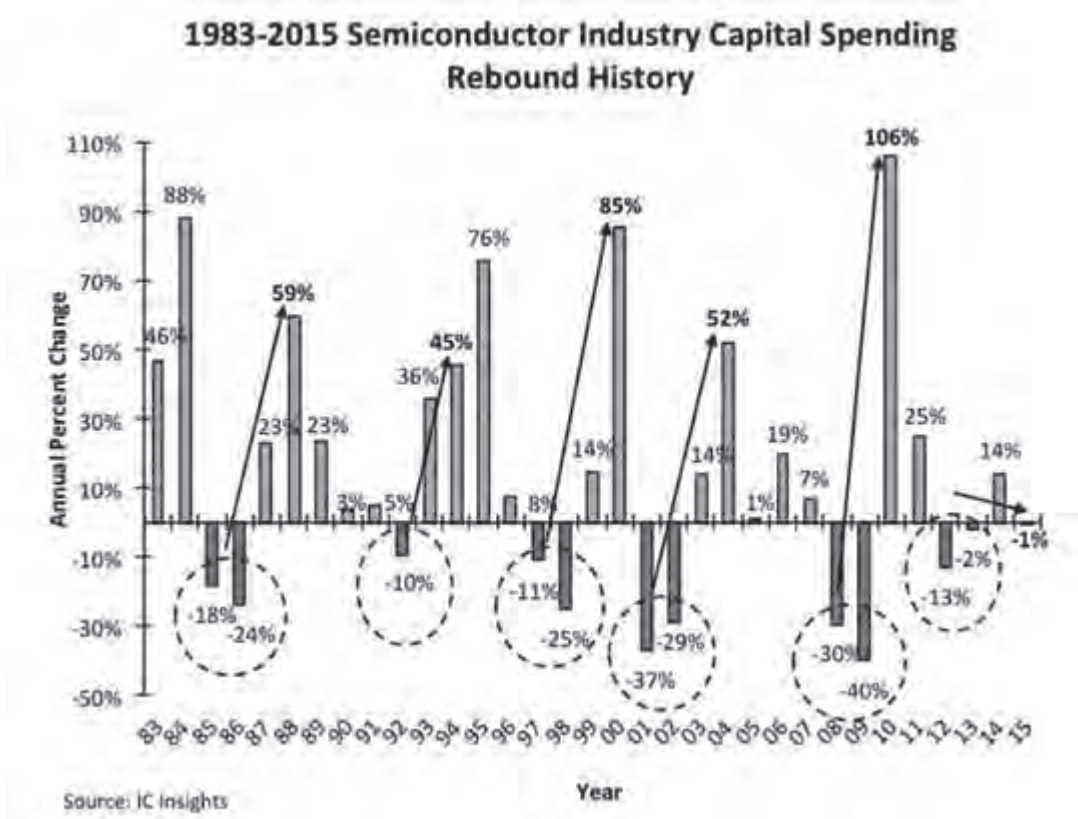


Fig. 7 Semiconductor Super Cycle Begins Again in 10 Years [8]

AREAS OF HIGH GROWTH IN 2020 TO 2025

IBS

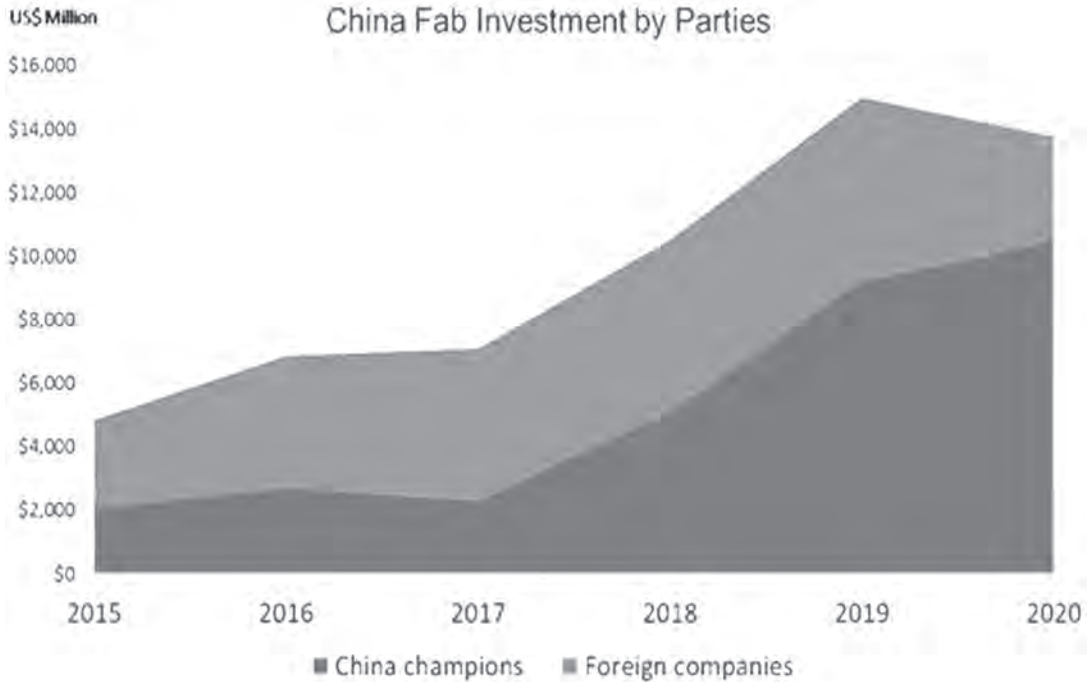
Areas of strategic importance	Key semiconductor products	Key technology requirements
Big data infrastructure	High-performance processors, high-bandwidth interface functionality, FPGAs, and ASICs	Very high performance and low power consumption. 10nm and 7nm Deep learning and AI will change many industries
5G infrastructure	High-performance processors, high-bandwidth interface functionality, FPGAs, and ASICs	Very high performance and low power. 10nm and 7nm Photonics
5G client devices (smartphones and other platforms)	Application processors, modems, and RF connectivity Signal processing building blocks	High performance and very low power. 10nm and 7nm. 22nm and 12nm FD SOI
Image processing	Image signal processors and supporting algorithms, including segmentation	High performance and very low power. 22nm and 12nm FD SOI Deep learning and AI
IoT	Sensors, processors, analog functionality, and embedded nonvolatile memory	Very low power consumption and RF integration to minimize size 22nm and 12nm FD SOI
ADAS	High-performance processors and FPGA Convergence algorithms	High reliability and temperature of 160°C 28nm, 16/14nm, 22nm, and 10nm
Storage systems	Low-latency 3D NAND and controllers HDD interfaces. Fibre channel	30nm 3D structures Photonics

Table 3 Areas of high growth in 2020 to 2025. [9]

Company	Location	Product	Begin Construction	Begin Production
Alpha & Omega	Chongqing	Power Discrete	tbd	tbd
Fujian Jin Hua	Fujian	DRAM	2016	2018
GigaDevice	Hefei	DRAM/Flash	tbd	tbd
GlobalFoundries	Chengdu	Foundry	2017	2018/2019
Hua Li Micro	Shanghai	Foundry	2016	2018
Powerchip	Hefei	Foundry	2015	2017
Samsung	Xian	3D NAND (Phase 2)	tbd	tbd
SMIC	Beijing Shanghai Shenzhen	Foundry Foundry Foundry	2016 2016 2016	2018 2018 2018
Tacoma Semiconductor	Nanjing	CMOS Image Sensor	tbd	tbd
Tsinghua Unigroup	Chengdu Nanjing	Foundry DRAM	tbd tbd	tbd tbd
TSMC	Nanjing	Foundry	2016	2018
UMC	Xiamen	Foundry	2015	2016
Yangtze River Memory/XMC	Wuhan	3D NAND	2016	tbd

Source: SEMI World Fab Forecast, 2016

Table 4 New 12inch Fab projects in China. [10]



Source: SEMI World Fab Forecast

Fig. 8 China Fab investment by parties [10]

2016 Rank	AOW	COMPANY	2016	Y-o-Y Growth
1	NA	Applied Materials	9875.5	17.9%
2	EU	ASML	7343.7	8.8%
3	NA	Lam Research	6375.0	8.0%
4	JA	Tokyo Electron	6064.2	15.5%
5	NA	KLA-Tencor	3199.6	13.4%
6	JA	SCREEN	1786.5	34.1%
7	JA	Advantest	1415.0	7.0%
8	NA	Teradyne	1368.5	13.9%
9	JA	Hitachi High-Technologies	1129.1	21.7%
10	CH	ASM Pacific Technology	930.1	22.8%

Source: VLSI Research inc.

Table 5 Top 10 Semiconductor Equipment Supplier Ranking for 2016 according to VLSIresearch [11]

semiconductor equipment supplier ranking of 2016. [11] U.S. companies are located as number 1, 3, 5, and 9. ASM pacific technology is Hong Kong based assembly equipment company as number 10.

In fables, two Chinese companies are in top 10, number 6 HiSilicon and 10 Spreadtrum shown in table 6. [12] In 2009, top 50 fabless IC suppliers was only HiSilicon, and after 5 years, 9 companies are in the rank. [13] China's Fabless Semiconductor Companies start to emerge to the top 10 list. There is going to be more Chinese companies to get into the list with huge domestic market in China.

In following sections, leading domestic and U.S. companies in China are shown to how deeply U.S. companies are involved in China semiconductor eco-system.

3. China domestic semiconductor companies

Semiconductor manufacturing

SMIC: Semiconductor Manufacturing International Corporation ("SMIC"; NYSE: SMI; SEHK: 981) founded by American-Chinese Dr. Richard Chang who's worked in TI (USA), WSMC (Taiwan) is the largest and most advanced foundry in mainland China. SMIC provides integrated circuit (IC) foundry and technology services on process nodes from 0.35 micron to 28nm. SMIC is headquartered in Shanghai, China. In October 2007, the United States Government enrolled SMIC in its Validated End User (VEU) program as a trusted customer of regulated U.S. technology, thereby reducing many of the export control barriers for SMIC. [14] [15]

2015F Top 10 Post-Merger Fabless Semiconductor Sales Leaders (\$M)

2015F Rank	Company	Headquarters	2014		2015F		2015F		2015/2014 % Change
			Tot IC	Tot O-S-D	Tot IC	Tot O-S-D	Tot Semi	Tot Semi	
1	Qualcomm/CSR*	U.S.	20,066	0	20,066	16,032	0	16,032	-20%
2	Avago/Broadcom*	Singapore	12,957	1,115	14,072	13,922	1,460	15,382	9%
3	MediaTek	Taiwan	7,032	0	7,032	6,504	0	6,504	-8%
4	Nvidia	U.S.	4,382	0	4,382	4,628	0	4,628	6%
5	AMD	U.S.	5,506	0	5,506	3,988	0	3,988	-28%
6	HiSilicon	China	3,220	0	3,220	3,830	0	3,830	19%
7	Apple/TSMC	U.S.	1,460	0	1,460	3,085	0	3,085	111%
8	Marvell	U.S.	3,733	0	3,733	2,875	0	2,875	-23%
9	Xilinx	U.S.	2,429	0	2,429	2,175	0	2,175	-10%
10	Spreadtrum	China	1,340	0	1,340	1,880	0	1,880	40%
—	Top 10 Total		62,125	1,115	63,240	58,919	1,460	60,379	-5%

*Includes both companies' sales for all of 2014 and 2015.

Source: Company reports, IC Insights' Strategic Reviews database

Table 6 Top 10 Fabless semiconductor sales leaders [12]

Hua Hong Semiconductor Limited (HHGrace, HLMC): Shanghai Huahong Grace Semiconductor Manufacturing Corporation ("HHGrace"), a wholly owned subsidiary of Hua Hong Semiconductor Limited (stock code: 1347) incorporated through the consolidation between Shanghai Hua Hong NEC Electronics Company, Limited ("Hua Hong NEC") and Grace Semiconductor Manufacturing Corporation ("Grace"). HHGrace provides professional and highly value-added foundry services covering technology solutions from $1.0\mu\text{m}$ to 90nm process nodes, focusing on advanced and differentiated technologies including eNVM (embedded Non-Volatile Memory), power management IC, power discrete, RF (Radio Frequency), as well as standard logic and mixed-signal. HHGrace is also in the process of developing MEMS solutions as one of its up-and-coming technologies. [16] Shanghai Huali Microelectronics (HLMC), the foundry company majority-owned by Shanghai's local government. Huali secured \$5.9 billion to build a 40,000 wafer/month Fab2 in Shanghai which schedules to start operation in mid 2018, to build 28 - 14nm chips. In the Fab 2 plan, Huali included FD-SOI as one of the process technologies the company is planning to offer. [17]

YMTC: Yangtze Memory Technologies Co., Ltd. (YMTC) is the main entity to implement China national memory base project with total share capital 38.6 billion. The construction of the Memory IC Base has started. This project's investment reaches 24 billion U.S. dollars with a core plant area of approximately 1.1 km² and aims to reach a monthly capacity of 300 thousand wafers after completion. [18]

Backend packaging/Testing: Backend packaging is already matured. China packaging companies have emerged as key providers of flip chip based technologies, with bumping used for various applications including wafer-level packaging (WLP) and CMOS Image Sensor Through Silicon Via (CIS-TSV). Both domestic and overseas companies have bumping facilities located throughout China. Table 7 shows China backend companies. [19]

Semiconductor equipment/materials

Top 10 electronics (including semiconductor) production equipment companies are shown in Table 8. [20] The top domestic semiconductor equipment company market share is smaller compare to U.S. AMAT at \$10B.

AMEC: AMEC was established in 2004 at Shanghai. Founder is Dr. Gerald Z. Yin who he is returnees from U.S.. Main products are advanced etcher and MOCVD. Customers include TSMC, Samsung, SMIC, etc. Management team is globalized. Dr. Gerald Z. Yin, Chairman of the Board and CEO has served as AMEC's chairman and CEO since the company was founded in 2004. Prior to AMEC, Dr. Yin spent 13 years at Applied Materials (U.S.). While there, he held a variety of executive positions, including corporate vice president and general manager of the Etch product business group, vice president of Asia sourcing and procurement, and chief technology officer of Applied Materials Asia. Dr. Yin joined Intel central technology development when he first arrived in Silicon Valley in 1984. In 1986, he moved to Lam Research(U.S.), where he led the Etch technology development and introduction initiatives for several key products. Dr. Yin received his Bachelor of Science in chemical

Company	Location	Wafer Size
Amkor	Shanghai	200mm, 300mm
Chipmore	Suzhou	150mm, 200mm
Millenium (MMS)	Shanghai	100mm - 200mm
JCAP (JCET)	Jiangyin	200mm (CIS) 125mm - 300mm bumping
NFME	Nantong	200mm, 300mm
Huatian	Kunshan	200mm
SilTech (SMIC)	Shanghai	200mm, 300mm
STATS ChipPAC	Shanghai	200mm, 300mm
Unisem	Chengdu	100mm - 200mm
WLCSP	Suzhou	200mm
NCAP	Wuxi	200mm, 300mm
NEPES	Huai'an	200mm, 300mm
SJ Semi	Jiangyin	200mm, 300mm
SPIL	Suzhou	200mm, 300mm
Texas Instruments	Chengdu	200mm, 300mm
NFMC	Hefei	200mm, 300mm

Table 7 China backend companies. [19]

physics from the University of Science and Technology, China. He pursued his graduate studies at Beijing University, Department of Chemistry. He received his Ph.D. in physical chemistry from the University of California, Los Angeles. Prior to his U.S. experience, he served the Chinese Academy of Sciences as a research group leader where he received two national science team awards. He holds 74 U.S. patents, with more pending. [21]

NAURA: NAURA Technology Group Co., Ltd. (Hereinafter referred to as NAURA), is a leading enterprise of integrated circuit high-end technological equipment in

China. It was formed through a strategic restructuring between Beijing Sevenstar Electronics Co., Ltd. (Hereinafter referred to as Sevenstar Electronics) and Beijing North Microelectronics Co., Ltd. (Hereinafter referred to as NMC). At present, NAURA owns four major industrial manufacturing bases, and its marketing service system covers major countries and regions in Europe, America and Asia. Management team is pure mainlanders. Key product segments are Semiconductors, Vacuum Technologies, New Energies, and Precision Components. [22]

ANJI Micro: Anji Microelectronics Co., Ltd.

No.	Company name	Revenue (10K RMB)		Electronics production equipment, tooling (10K RMB)		Profit (10K RMB)	
		2017 1-3Q	YonY%	2017 1-3Q	YonY%	2017 1-3Q	YonY%
1	Jiangsu Sujing Group Co., Ltd.	224045.7	5.2	183978.6	7.8	15069.3	2.3
2	CETC Electronics Equipment Group Co.,Ltd.	521288.2	-37	100698.7	-26.3	21050.1	14.2
3	NAURA	154968.7	49.2	99563.2	49	14239.4	22.3
4	Zhejiang Jingsheng Mechanical & Electrical Co.,Ltd	125747	87.3	113730	115.1	26863	91.9
5	S.C New Energy Technology Corporation	89023	82.8	86849	102.1	17530.9	359.1
6	Yinghe Technology	44948.6	84.9	44948.6	84.9	3098	-9.8
7	Haoneng Technology Co.,Ltd.	44075.1	27.6	44075.1	27.6	5454.4	259.7
8	TDG machinery technology Co.,Ltd.	43376	-18.3	41000	-14.8	5801	-23.2
9	The northwest machine Co.,Ltd.	185828	22.8	29525	68.1	1130	-92
10	Shanghai Micro Electronics Equipment (Group) Co., Ltd.	26169.4	156.5	22178	144.5	3841.7	-530.5
Total		1459469.7	-4.8	766546.2	27	114077.8	53.1

Table 8 Top 10 electronics (including semiconductor) production equipment companies in China. [20]

was founded in 2004 with core competency in liquid-substrate interface science, engineering, and extensive experience in semiconductor materials processing, this company focus on advanced materials development, contract R&D, qualification, and manufacturing. In semiconductor materials, ANJI ranked top supplier for CMP slurry and chemicals in China. One of the founders is returnees from U.S. who he was Micron technology (U.S.) and a guru in CMP technology. [23]

Fabless

HiSilicon: HiSilicon is founded in 2004 and is the leading Chinese fabless semiconductor design company based in Shenzhen and fully

owned by Huawei with over 7,000 employees worldwide. HiSilicon has already developed more than 200 types of chips successfully with proprietary IPR and filed over 5,000 patents. With process technologies covering 16nm, 10nm and 7nm nodes. Key focus products are Video & Audio, Connectivity, Semiconductor, and Software. Huawei's Kirin 970 SoC, the industry's first smartphone SoC to support Category 18(1.2Gbps) and build in AI for the newly launch Mate 10 out beating Apple i-phone 8. [24]

Spreadtrum Communications, Inc.: Spreadtrum Communications, Inc. is a Chinese fabless semiconductor company headquartered in

Shanghai which produces chipsets for mobile phones and other consumer electronics products, supporting 2G, 3G, and 4G wireless communications standards. It is the world's 10th-largest fabless semiconductor company measured by 2016 revenues. Key products are Modem/Baseband, Smartphone Chipsets, RF Transceiver, Power Management, Multimedia, Connectivity, and Software Platform. [25]

Datang Telecom Group: Datang Telecom Group (officially Datang Telecom Technology & Industry Group) is a Chinese telecommunications equipment group headquartered in Beijing, China. The group was founded in September 1998 by the China Academy of Telecommunications Technology, which acted as the parent company of the group. It is best known for its leading role in developing the Chinese TD-SCDMA 3G mobile telecommunications standard through subsidiary DT Mobile. Key products are TD-SCDMA Base Station & Chipset, Mix Signals IC design, TD-SCDMA SOC design, and 5G IoT. [26]

4. U.S. semiconductor companies in China

Semiconductor manufacturing

Intel: Intel has had a presence in China for over 20 years and continues to support the evolution of China's computing industry. To meet increased worldwide demand for their products, Intel began construction in 2007 of Fab 68, a 300mm wafer fabrication facility in the coastal Northeast China city of Dalian, which produce leading-edge 65nm chipsets for laptop computers, high-performance desktop PCs & powerful servers. Besides, has been expanding the NAND flash capacity at its Fab 68 in Dalian, China since 2015. Key products are 65nm Chipsets and 3D NAND flash. [27]

TI ChengDu: TI began manufacturing of front-end in 2010 with a wafer plant in Chengdu which is former SMIC/city-owned 8 inch fab. Also, in 2014, it added a 300 millimeter "wafer bumping" facility to its operations in Chengdu. [28]

Global foundries (Chengdu): Global foundries Chengdu hopes to advance the FD-SOI agenda. It's planning a fab in Chengdu equipped to produce chips using Global foundries' 22FDX FD-SOI technology. The Chengdu Fab will be part of \$10 billion Global foundries and Chengdu's project and is expected to volume production in 2019. [29]

Semiconductor equipment/ materials

AMAT: Applied Materials, Inc. is an American top supplier in equipment, services and software to enable the manufacture of semiconductor (integrated circuit) chips for electronics, flat panel displays for computers, smartphones and televisions, and solar products. The company is headquartered in Santa Clara, California, in the Silicon Valley. Key Accomplishments are Opened Technical Training Center in Beijing, China; opened major facility and Technical Training Center in Pudong area of Shanghai, China; and opened manufacturing facility in Tainan, Taiwan. [30]

LRMX: Lam Research offers a broad portfolio of market-leading products for thin film deposition, plasma etch, photoresist strip, and wafer cleaning – complementary processing steps that are repeated multiple times throughout the semiconductor manufacturing process flow. Founded in 1980, Revenue ~\$6.4 Billion (CY 2016), Employees ~8,200 (CY 2016), Headquarters locate at Fremont,

California, and 16 countries worldwide subsidiary companies. They have RD site and manufacturing site in China also. [31]

Fables

Qualcomm: In 1999, Qualcomm China was established in Beijing to work with the it's local partners and wireless operators in CDMA-based systems. Qualcomm China's key partners include network operators, equipment vendors and software developers. Key facts are 14 offices in China, SMIC ATD collaboration with Huawei, IMEC, and Guizhou Huaxintong Semiconductor Technology in partnership with the local government. [32]

Qualcomm need to negotiate with China's ministry of commerce on the NXP acquisition. [33][34]

5. Global Eco-system in Semiconductor industry

The role of SEMI

SEMI (formerly Semiconductor Equipment and Materials International); Global industry association of companies that provide equipment, materials and services for the manufacture of semiconductors, photovoltaic panels, LED and flat panel displays, micro-electromechanical systems (MEMS), and related micro and nano-technologies.

Offices are located worldwide, U.S.; Milpitas (Headquarter), Washington D.C., ASIA; Hsinchu, Taiwan, Seoul, Korea, Shanghai, China, Singapore, Tokyo, Japan, Bangalore, India, EUROPE; Berlin, Germany, Grenoble, France. Activities are Conferences, trade shows, Development of industry standards, Market research reporting, and Industry advocacy, etc. Member companies are around 2000 companies worldwide. SEMI was founded in 1970. Most companies in the semiconductor

industry exhibited at the Wescon Show on the west coast and the IEEE show on the east coast. Wishing to organize a show dedicated to semiconductor production equipment, 55 companies met in Palo Alto and agreed to found a new association, originally called Semiconductor Equipment and Materials Institute. [35] SEMI China is from 1985 for 33 years and local Member companies are around 300. Activities are Chinese industry and government trust partners. The latest technology and business model introduced to China's industry and the government, for Chinese enterprises to find international partners, for the Chinese government planning industry development path. Established close cooperation relationship with major provinces, municipalities and development zones gathered in China's semiconductor industry. It has received government cooperation at all levels in industrial planning, major project risk assessment and industry promotion. [36]

6. Summary

Semiconductor is highly integrated with the global eco-system of software/architecture, IP core vendor, fables, foundries, IDM, Assembly, testing, equipment/material.

These companies are widely distributed in the world and compete internationally. E.g. Intel and AMD, they are both U.S. companies but competing worldwide. Thus, in technology business, there are no such things as which country is dominating but which company in this time period taking the lead. Motorola and Nokia are a good example.

China is still in catching up mode with semiconductor supplies far meeting the need for domestic consumption. Almost every company in the world wants to have a slice of

the pie from Chinese semiconductor market while China is still relying on international companies to fill the gap. A win-win for both.

Chinese design companies are gaining footholds in domestic and worldwide markets, this will flip the landscape on the top tiers suppliers in years to come. Thus, competition is getting fiercer down the road with new Chinese players getting into the main stage.

China is also determined to stay independence on the whole semiconductor supply chain to fill the gap on domestic semiconductor manufacturing. E.g. Memories, CPU & GPU, Power devices, wafer substrate, packing materials, wafer fab equipment and technologies. When the manufacturing super hub can do these, nobody can compete with their price. This will be benefit to the whole world while forcing the current suppliers to improve with new products.

Finally, only those companies who can provide the best innovative products at the best value shall win the market. However, the leading position will be always challenged by new comers with even better cost effective solutions.

“The Lesson is, we all need to expose ourselves to the winds of change”

— Andrew S. Grove, Only the Paranoid Survive

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