



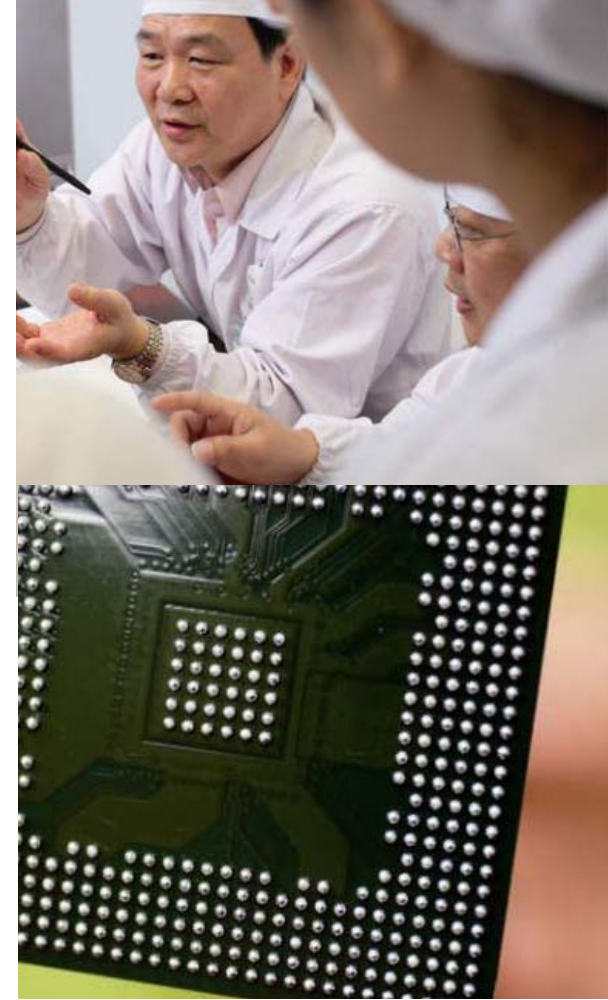
# **The Changing Landscape of the Foundry:** Semiconductor Manufacturing in the 21st Century

Ajit Manocha  
Executive Vice President & Chief Manufacturing Officer  
NXP Semiconductors  
GSF, March 2, 2007



# Outline

- ▶ Intro NXP Semiconductors
- ▶ Manufacturing within NXP
- ▶ Changing landscape of IDMs, fabless companies and foundries
- ▶ NXP initiatives in the changing landscape



# NXP Semiconductors – Reborn and Renewed

- ▶ Spin-out of Royal Philips Electronics' Semiconductor Division
- ▶ #2 in Europe, Top-10 global supplier
- ▶ Sales of € 4.8 Billion in 2005
- ▶ 37,000 employees
- ▶ Investing € 1 billion in R&D annually
- ▶ 25,000 patents
- ▶ Innovation Centers in Austria, France, Germany, Netherlands, UK, India, China
- ▶ Private Equity owned



# NXP Semiconductor Solutions drive markets

- ▶ Home (TV, STB and PC)
  - One chip DTV - HD Picture quality
  - Interconnectivity, media content from all sources
  - Ease of use
- ▶ Mobile phone and media players
  - Mobile Services, vibrant multimedia applications
  - Lowest power consumption
  - Thinnest/smallest products
- ▶ Automotive
  - Comfort and safety via sensors and Flexray networks
  - Car infotainment
  - Automotive Quality
- ▶ Identification
  - Secure contactless payment, access and identification
- ▶ MultiMarket Semiconductors
  - Broad array of analog-mixed signal and standard products



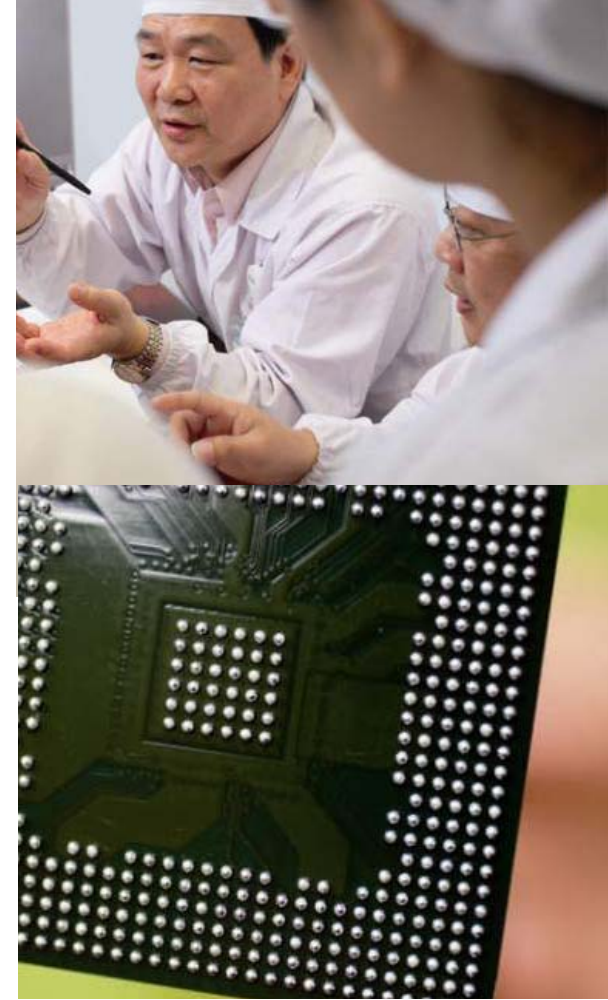
# NXP core values are our differentiator

- ▶ Insightful
  - Understanding Markets
  - Sharing Customer Vision
- ▶ Inventive
  - Smart strategies
  - Partnering in Innovation
  - Excellence in Research and Development
- ▶ Engaging
  - With customers on all levels
  - Unrivalled Design-in Support
  - Passionate people
- ▶ Excellence
  - Time-to-Market
  - Zero-Defect Quality
  - Responsive Manufacturing
  - Financial Results



# Outline

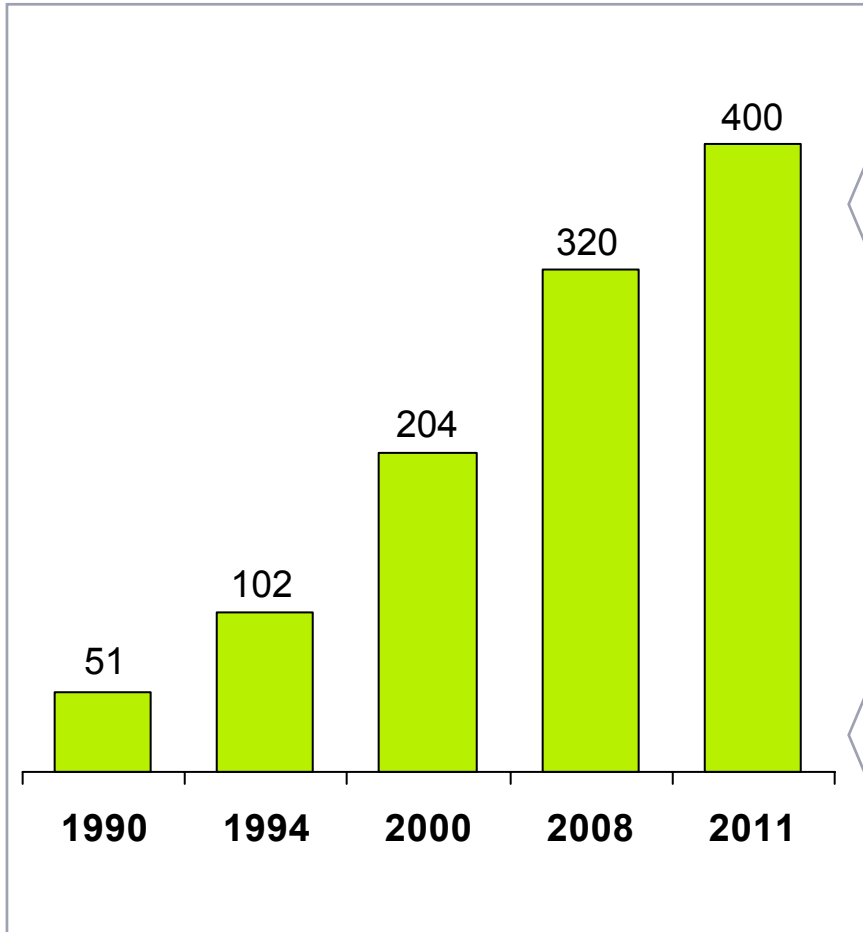
- ▶ Intro NXP Semiconductors
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- ▶ NXPs initiatives in the changing landscape



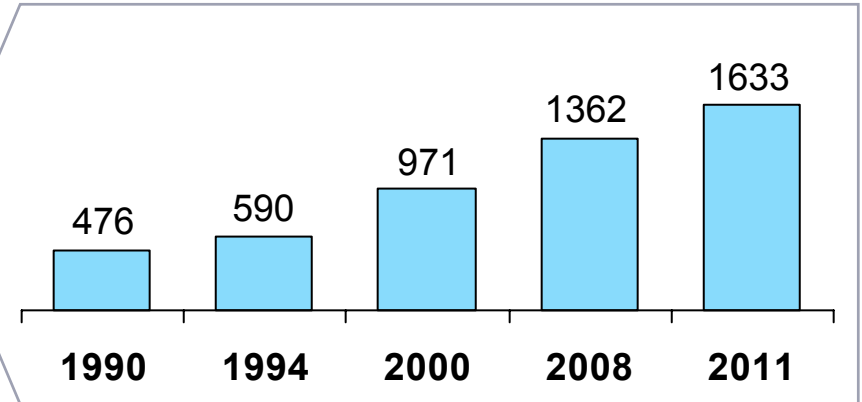
# Semiconductor market at large & fast growing

## Semiconductor market “milestone” years

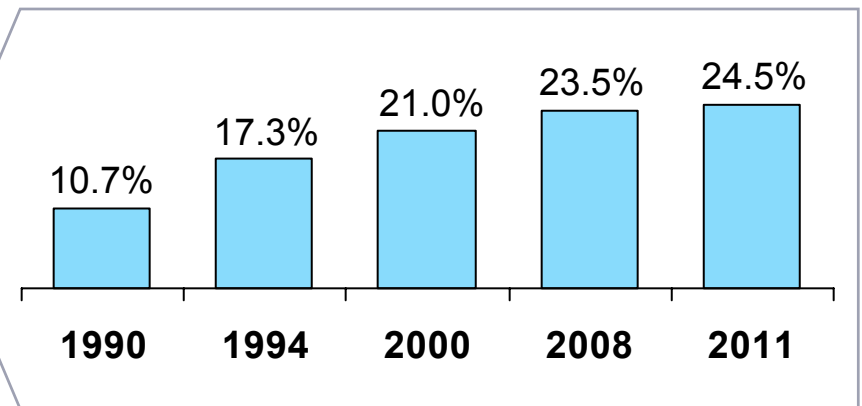
Market size, \$B



## Electronic equipment market (\$B)



## Semiconductor content (%)



Source: WSTS, IC Insights

# Semiconductor market segmentation 2006

General purpose (174)		Application specific (86)	
<b>Memory (60.4)</b> DRAM, SRAM, NAND Flash, NOR Flash, EEPROM, EPROM, ...		<b>Wireless Communications (24.9)</b> Mobile handset modems, application processors, connectivity & broadcast, mobile infrastructure	
<b>MPU (34.3)</b> Computer, Embedded		<b>mm. (9.9)</b>	
<b>MCU (10.9)</b>		<b>g (21.6)</b> Disk storage, pc servers, monitors, cards	
<b>Analog (15.2)</b>		<b>amer (18.7)</b> TV, Set-top boxes, DVD, VCR, Audio, Video Games, Portable Media Players, Appliances, ...	
<b>Discretes (16.2)</b> Transistors, Thyristors, RF		<b>Automotive &amp; ID (7.6)</b>	
<b>GP Logic (13.2)</b> FPGA/PLD, Display Drivers, Standard Logic, ...		<b>Industrial &amp; military (2.8)</b>	
<b>Opto-electronics (20.6)</b> CMOS sensors, CCD sensors, LEDs, IR, ...			
<b>Sensors (1.9)</b> Pressure, Accelerometer, Gyro, Magnetic, Temperature, ...			
<b>GP DSP (1.1)</b>			

**300+ distinct markets**

Source: GDQ



# Fragmented industry

2005 excluding foundries

1 Intel	34590	51 Robert Bosch	865	101 Creative Labs	247	151 Trident Microsystems	111	201 TranSwitch	33
2 Samsung Electronics	18347	52 Cypress Semiconductor	822	102 NewJR	243	152 ANADIGICS	108	202 GSI Technology	32
3	1119	53 Conexant Systems	813	103 Lite-On Technology Corp	239	153 Zetex	107	203 Wu Xi China Resources Semico	31
4	984	54 Novatek	809	104 Kyocera	236	154 O2Micro	105	204 Shanghai Huahong	31
5	821	55 Skyworks Solutions	742	105 Integrated Silicon Solution	233	155 M/A-COM	105	205 Peregrine Semiconductor	30
6	821	56 Micronas	713	106 Denso	230	156 Matrox	102	206 Supertex	30
7	8205	57 Seiko Epson	694	107 BP Solar	230	157 Legenthy	101	207 California Micro Devices	27
8	723	58 RF Micro Devices	691	108 PortalPlayer	225	158 VTI Technologies	93	208 Spreadtrum Communications Inc.	27
9 NEC Electronics	5657	59 OSRAM	666	109 Applied Micro Circuits Corp.	221	159 Pixart	89	209 Semikron International	25
10 NXP	5646	60 Winbond Electronics	655	110 Melexis	213	160 Deutsche Cell	87	210 Transmeta	25
11 Freescale Semiconductor	5599	61 Sunplus	633	111 Lattice Semiconductor	211	161 Princeton Technology Corporation	86	211 Beijing Sigma Jinhua Microelectronics Co.	25
12 Micron Technology	4620	62 Integrated Device Technology	619	112 Everlight Electronics	208	162 Ikanos Communications	85	212 Aimtron Technology Inc.	24
13 Sony	4304	63 Intersil	598	113 Schott	208	163 Richtek Technology Corp.	84	213 Alliance Semiconductor	24
14 Advanced Micro Devices	3936	64 VIA Technologies	590	114 Diodes Inc.	206	164 Cheertek	83	214 Chengdu Sino Microelectronics System Co	23
15	1779	65 Macronix International	566	115 Silicon Image	205	165 Vimicro	82	215 Huada Electronic Design	20
16	1569	66 Magnachip Semiconductor	559	116 SunTech Power	202	166 Aeroflex UTMIC	81	216 IC Plus	20
17	1457	67 Himax Technology Inc.	540	117 Vitesse Semiconductor	199	167 Zilog	79	217 CREE Inc	18
18	1919	68 Stanley Electric	497	118 Zarlink	192	168 Pericom Semiconductor	79	218 Micro Linear	18
19	1855	69 Cambridge Silicon Radio	486	119 Cirrus Logic	192	169 DenMOS Technology Inc.	78	219 Powerex	18
20	1671	70 Sanken	482	120 EM Microelectronic	191	170 ATS Automation Tooling Systems	78	220 Shanghai Belling	17
21	2587	71 Fuji Electric	469	121 DSP Group	188	171	77	221 Shenzhen State Microelectronics	16
22 Analog Devices	2434	72	456	122 Atheros Communications			77		
23 NVIDIA	2203	73	450	123 austriamicrosystems			77		
24 Sanyo Electric	2052	74	437	124 M-Systems			77		
25 Spansion	2003	75	426	125 Actel			6		
26 National Semiconductor	1961	76	419	126 Mtekvision			6		
27 Elpida Memory	1784	77	413	127 Elite Semiconductor Mem			6		
28 Marvell Technology Group	1741	78 Zoran	396	128 Semtech	173	178 Datang Microelectronics Technology	65	- Other	313
29 ATI Technologies	1736	79 Kawasaki Microelectronics (K-Micro)	394	129 Elmos Semiconductor	173	179 Catalyst Semiconductor	64		
30 Avago Technologies	1693	80 Solomon Systech	394	130 Pixelworks	172	180 Teridian Semiconductor	64		
31 Atmel	1676	81 Toyota Gosei	381	131 Etron Technology	168	181 Exar	63		
32 Maxim Integrated Products	1670	82 Q-Cells	372	132 Wolfson Microelectronics	166	182 Tundra Semiconductor	60		
33 Xilinx	1645	83 Silicon Storage Technology	371	133 ESS Technology	162	183 Amic Technology Corp.	58		
34 Agere Systems	1543	84 KEC	365	134 Dialog Semiconductor	162	184 Jiilin Sino-Microelectronics Co Ltd	58		
35	440	85 Silicon Integrated Systems	360	135 Opto Tech	161	185 General Electric	57		
36	438	86 Shindengen Electric	356	136 Faraday Technology Corp.	159	186 Microtune	57		
37	428	87 Realtek Semiconductor	329	137 Zhuhai Action Semiconductor	152	187 PLX Technology	54		
38	288	88 Sigmatel	325	138 Motech	151	188 Volterra	54		
39	284	89 Citizen	322	139 SiRF	148	189 Fujikura Ltd	53		
40	247	90 RICOH	316	140 Thine Electronics	148	190 Sirenza Microdevices	53		
41	244	91 Other Japanese	315	141 Elan	145	191 Honeywell	50		
42 Vishay	1184	92 Microsemi	309	142 Power Integrations	144	192 QuickLogic	48		
43 Oki Electric	1131	93 PMC-Sierra	291	143 Shell Solar	142	193 Evergreen Solar	44		
44 Altera	1124	94 SMSC	289	144 TriQuint Semiconductor	139	194 Uli Electronic Inc.	42		
45 SanDisk Corporation	1103	95 Eudyna Devices	287	145 Isofoton	138	195 Hi/fn Inc.	41		
46 International Rectifier	1078	96 Lite-On Semiconductor Corp	285	146 ALI Corporation	128	196 G-LINK Technology	40		
47 Linear Technology	1064	97 Micrel Semiconductor	262	147 Mindspeed	119	197 Kaneka	39		
48 Powerchip Semiconductor	1027	98 Genesis Microchip Inc.	262	148 Pan Jit	116	198 ChipX	39		
49 Microchip Technology	889	99 IXYS	256	149 Holtek Semiconductor	114	199 Avid Electronic Corp.	37		
50 ProMOS Technologies	871	100 Allegro MicroSystems	252	150 Sitronix	113	200 Alchip Technologies	35		

Top 10 = 39%

Next 15 = 21%

Next 50 = 10%

Next 100 = 5%

Last 150+ = 0.4%

# Consolidation starting to happen

## Consolidation drivers

- ▶ R&D cost rising fast in ASSP/systems businesses
  - Very large and increasing systems investments
  - Design/mask cost per chip in advanced CMOS rising fast
- ▶ Trend towards Systems-on-Chip and combo products eliminates (sustainable) standalone component plays
  - RF-integration possible with RFCMOS
  - Taiwan competition driving aggressive cost-down
- ▶ “Winner takes all” nature of application-specific businesses driving active portfolio management
  - Large players acquire/sell to achieve portfolio of leadership positions
  - Single application players expanding scope to reduce business risk

## Recent evidence

- ▶ LSI / Agere
- ▶ Small players in cellular components exiting/selling, e.g., Skyworks BB exit
- ▶ CSR, Atheros, QCOM ex-panding connectivity & broadcast portfolio
- ▶ Various DTV scaler companies for sale
- ▶ Marvell (various deals)
- ▶ AMD / ATI merger
- ▶ Intel, Avago (sellers)

Feb 8 NXP announced purchase of Silicon Labs' cellular business

# Ranking including foundries

2005

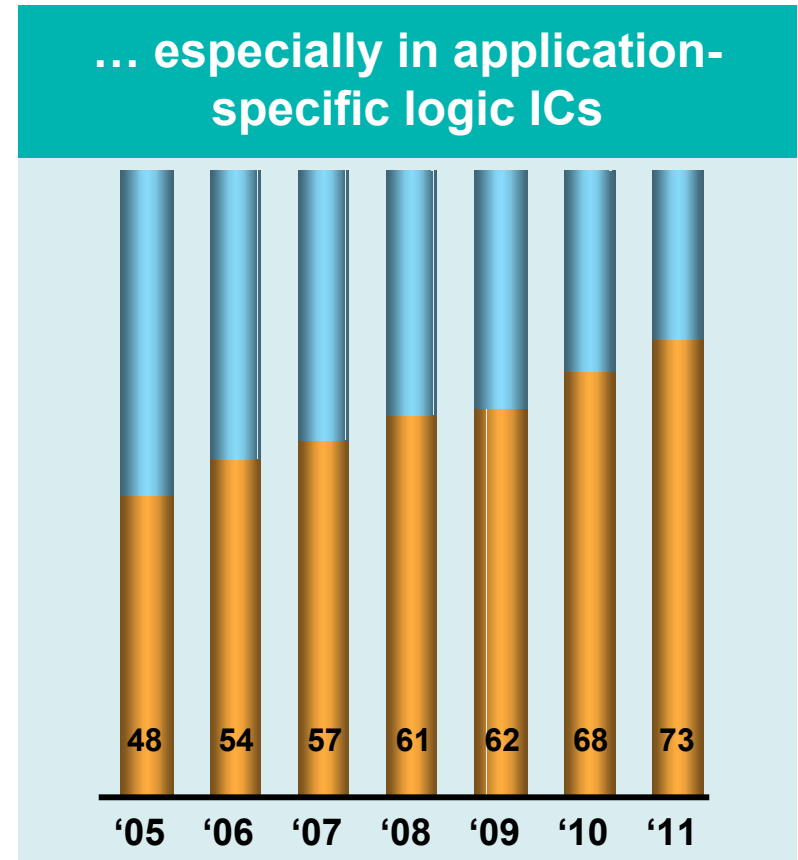
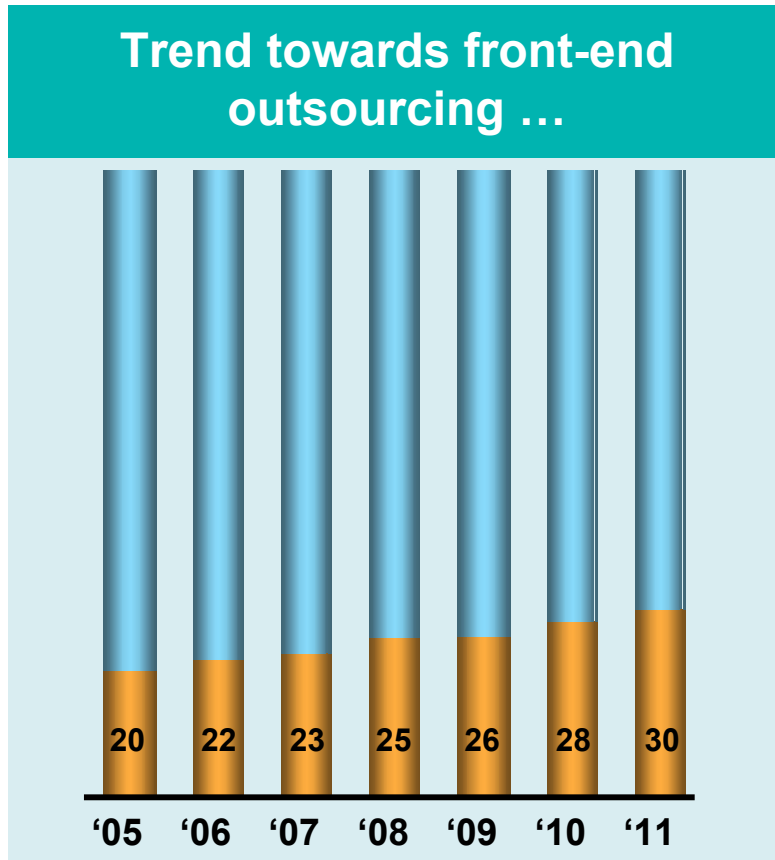
1	Intel	34590
2	Samsung Electronics	18347
3	Texas Instruments	10119
4	Toshiba	8984
5	STMicroelectronics	8821
6	Renesas Technology	8291
7	Infineon Technologies	8205
8	Hynix Semiconductor	5723
9	NEC Electronics	5657
10	NXP	5646
11	Freescale Semiconductor	5599
12	Micron Technology	4620
13	Sony	4304
14	Advanced Micro Devices	3936
15	Matsushita	3779
16	Sharp	3569
17	QUALCOMM	3457
18	Rohm	2919
19	IBM Microelectronics	2855
20	Broadcom	2671
21	Fujitsu	2587
22	Analog Devices	2434
23	NVIDIA	2203
24	Sanyo Electric	2052
25	Spansion	2003

(8) TSMC 8,180

(18) UMC 3,320

# Share of foundries in IC manufacturing

Percent



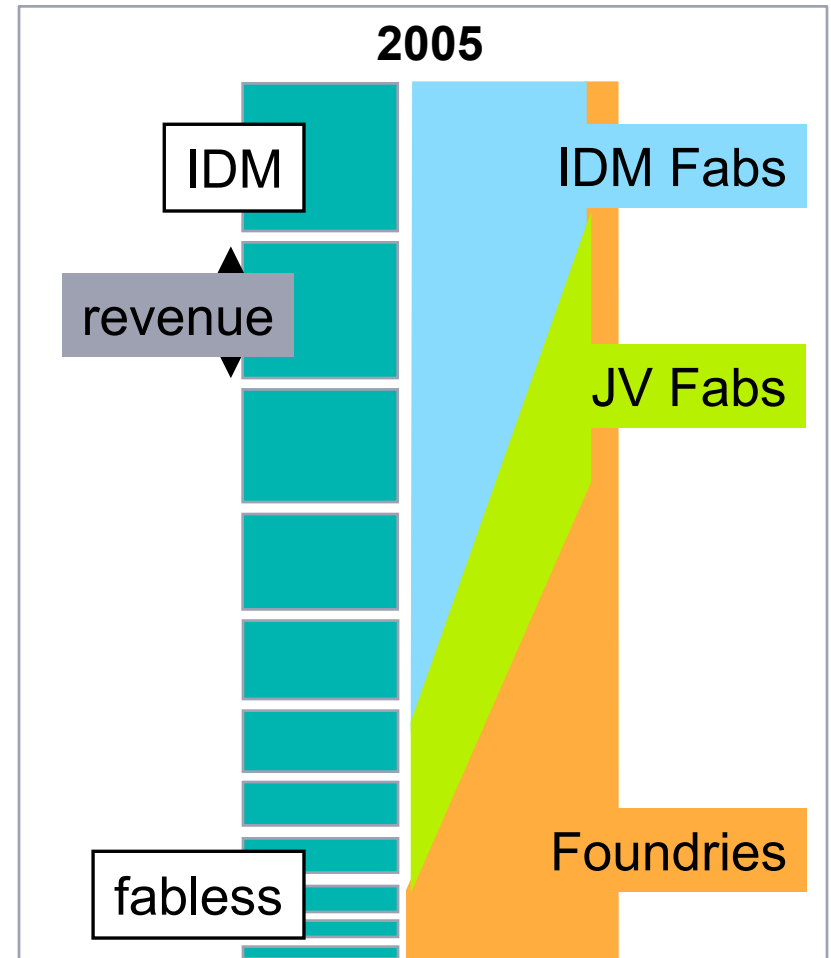
Source: IC Insights

 In-house fabs  Foundries

# IDMs, fabless companies and foundries

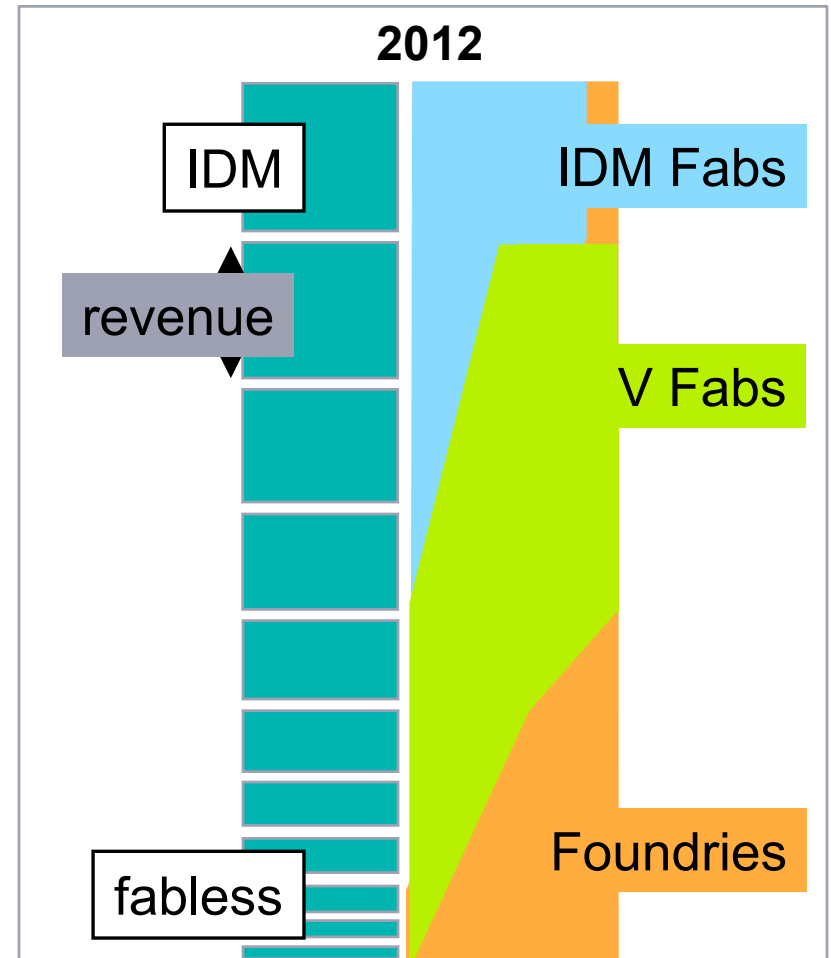
## Current landscape

- ▶ Major IDMs will continue to manufacture in-house
- ▶ More IDMs are starting to offer foundry services
- ▶ Fabless companies are fabless by definition with some J.V. temptation
- ▶ Medium size IDMs will share fabs with peers and foundries or consolidate to become major IDMs



# IDMs, fabless companies and foundries in 5 years

- ▶ Major IDMs will continue to manufacture in-house
- ▶ More IDMs are starting to offer foundry services
- ▶ Fabless companies are fabless by definition with some J.V. temptation
- ▶ Medium size IDMs will share fabs with peers and foundries or consolidate to become major IDMs
  - Sharing maybe legal J.V.s, alliances or long term take-or-pay contracts



# Consolidation in assembly and test

Subcontractors continue to suffer from questionable economic health

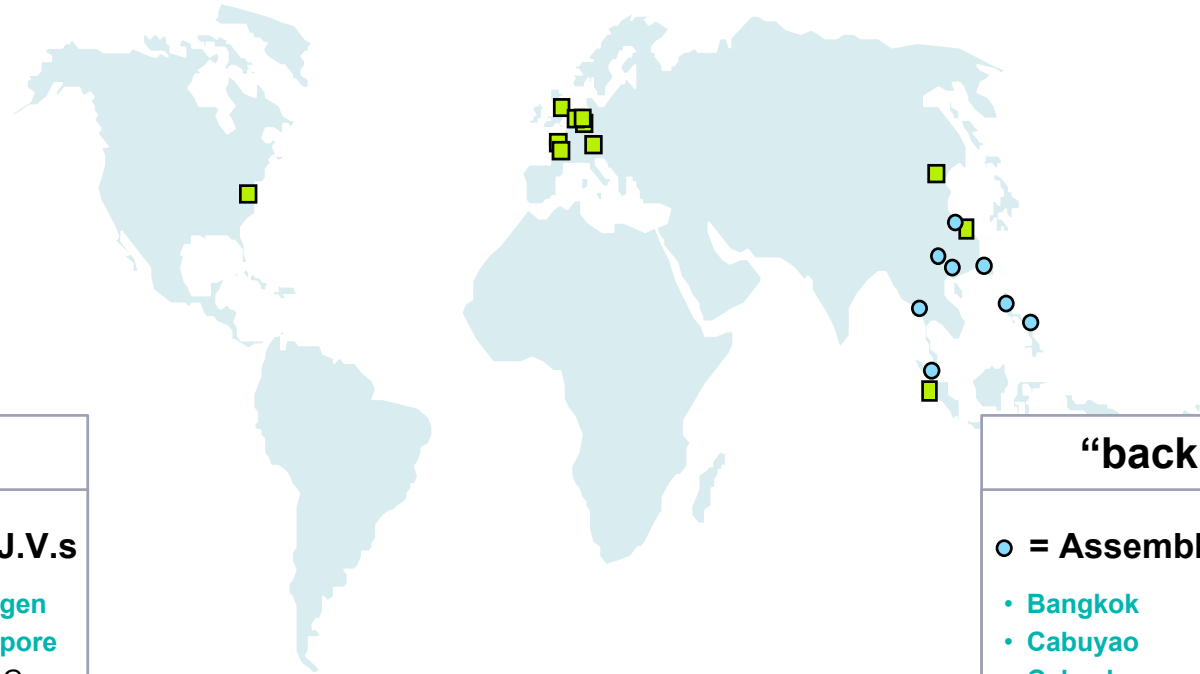
## Root causes

- ▶ Assembly and test subcons suffer from lack of effective standardization
- ▶ Dis-economy of scale with the overflow dynamics of the IDMs
- ▶ Capacity comes in small increments (\$)
- ▶ IDMs incremental decisions will not be in favor of subcon growth

**Top20 SATS Companies' Sales as a Percentage of Total Market, 2005**

Company	Region	Revenue (\$M)	Market Share (%)
ASE Group	Taiwan	2,583.0	17.0
Amkor Technology	U.S.	2,099.0	13.8
SPIL	Taiwan	1,343.0	8.9
STATS ChipPAC	Singapore	1,157.0	7.6
ChipMOS Technologies	Taiwan	462.9	3.1

# NXP Semiconductors Manufacturing Base



## “front-end”

■ = Waferfabs incl. J.V.s

- Böblingen
- Caen
- Crolles2
- Fishkill
- Hamburg
- Nijmegen
- Singapore
- Hazel Grove
- Jilin
- Hamburg

= ICs

= discretetes

## “back-end”

○ = Assembly sites

- Bangkok
- Cabuyao
- Calamba
- Suzhou
- Kaohsiung
- Hong Kong
- Seremban
- Guangdong

= ICs

= discretetes

# The NXP approach

**Exploit the opportunities of the changing landscape, building on a successful track record of manufacturing partnerships**

- ▶ SSMC
- ▶ JSMC
- ▶ ASMC

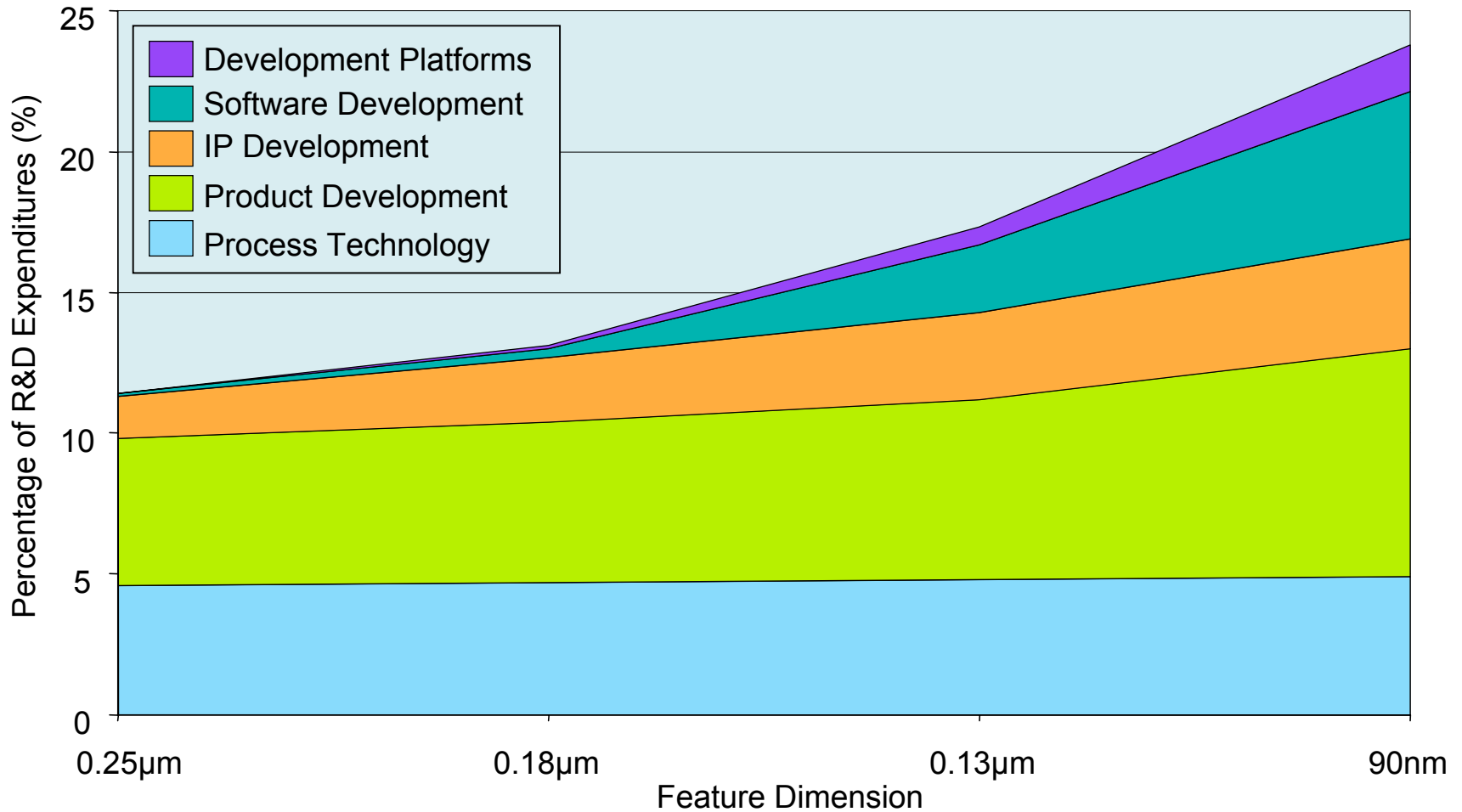
## **Recent steps**

- ▶ Increasing share in SSMC, buyout of EDB
- ▶ Partnership with TSMC for advanced CMOS – foundry service + research partnership
- ▶ Formation of assembly and test joint venture with ASE at Suzhou
  - Trying to mimic the success of SSMC into assembly and test
  - Pioneering to make assembly and test subcon industry as successful as the wafer foundries

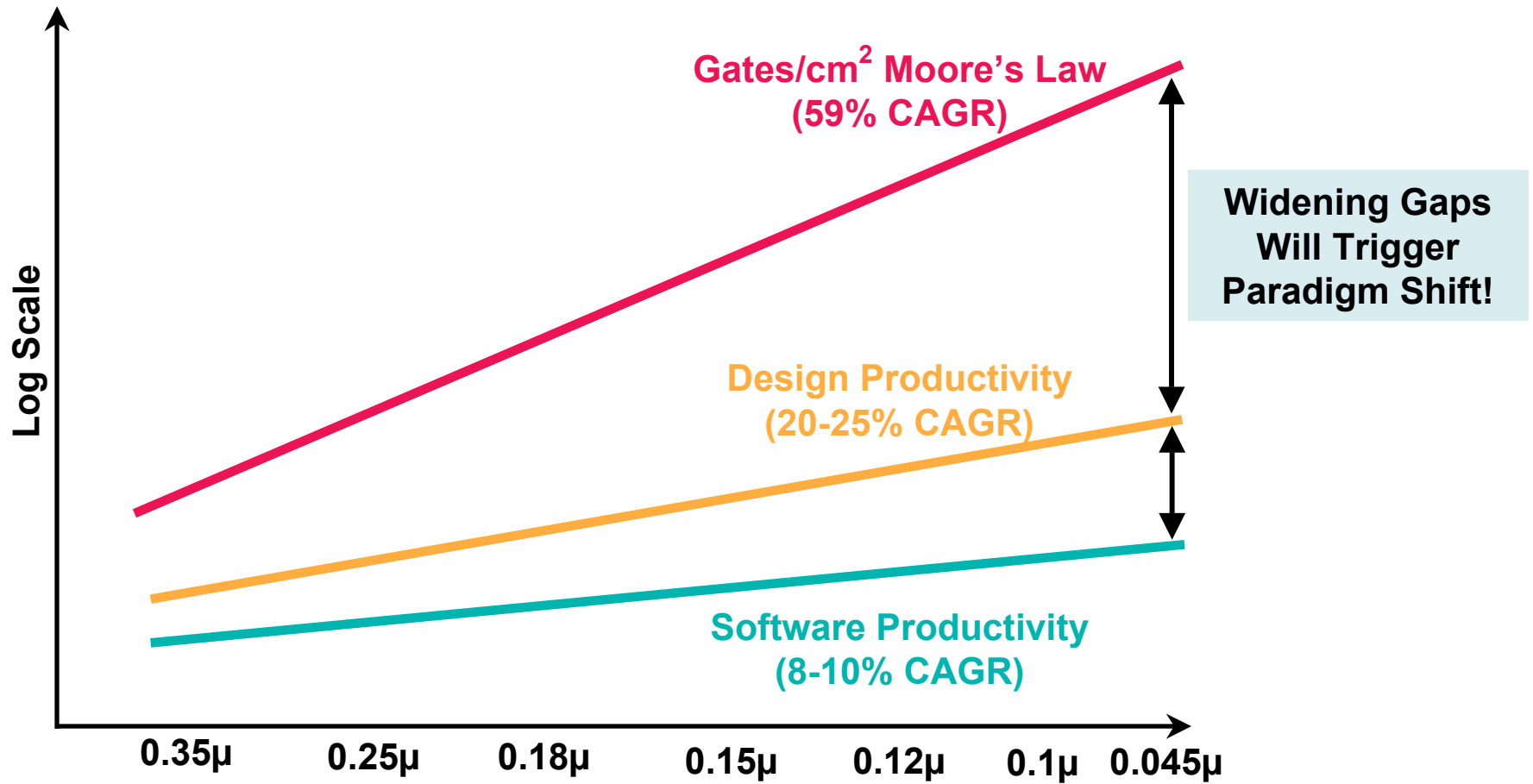
# Where is the industry going?

- ▶ Growth will continue and Moore still holds true
  - Still a while to go before we hit insurmountable technical barriers
- ▶ There is no end to consumers expectations with regard to cost reduction
- ▶ Product creation will be the gating factor
  - Every product in the future will be a big bet
  - Cost and resources equal to CPUs, but numerous players serving fragmented market segments

# R&D expenditure trends within IC industry

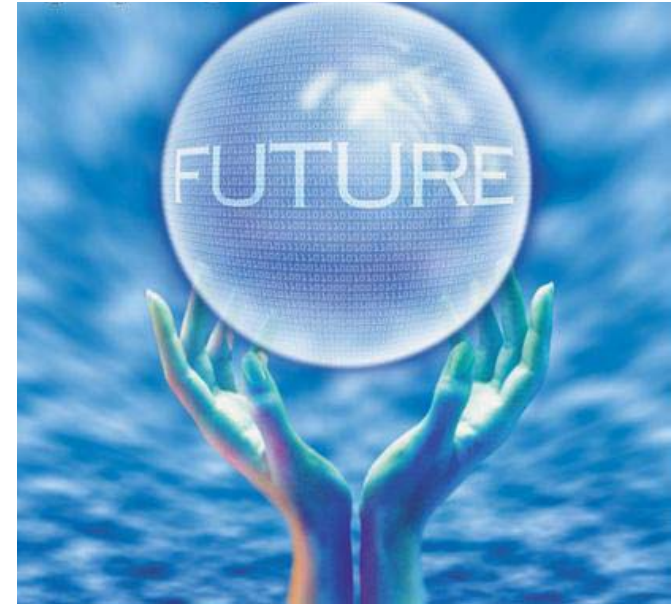


# Design & Software Challenge



# Looking forward – what we can expect

- ▶ Advanced CMOS manufacturing will consolidate
- ▶ Most IDMs become asset lighter
- ▶ Long term commitments between fabless companies and foundries will increase
- ▶ 200 mm wafer manufacturing is here to stay
- ▶ Assembly and test companies will find ways to play a more dominant role and improve their financial health



# In Summary

- ▶ The technical challenges and economic dynamics of semiconductor manufacturing are anything but natural
- ▶ Fabless companies and IDMs face many challenges
- ▶ Technical solutions and business models are evolving
- ▶ Consolidation is happening which will keep Moore's Law longer than can be imagined
- ▶ NXP is pioneering in the changing landscape

