Taiwan Semiconductor Industry: from Foundry to SOC Designs

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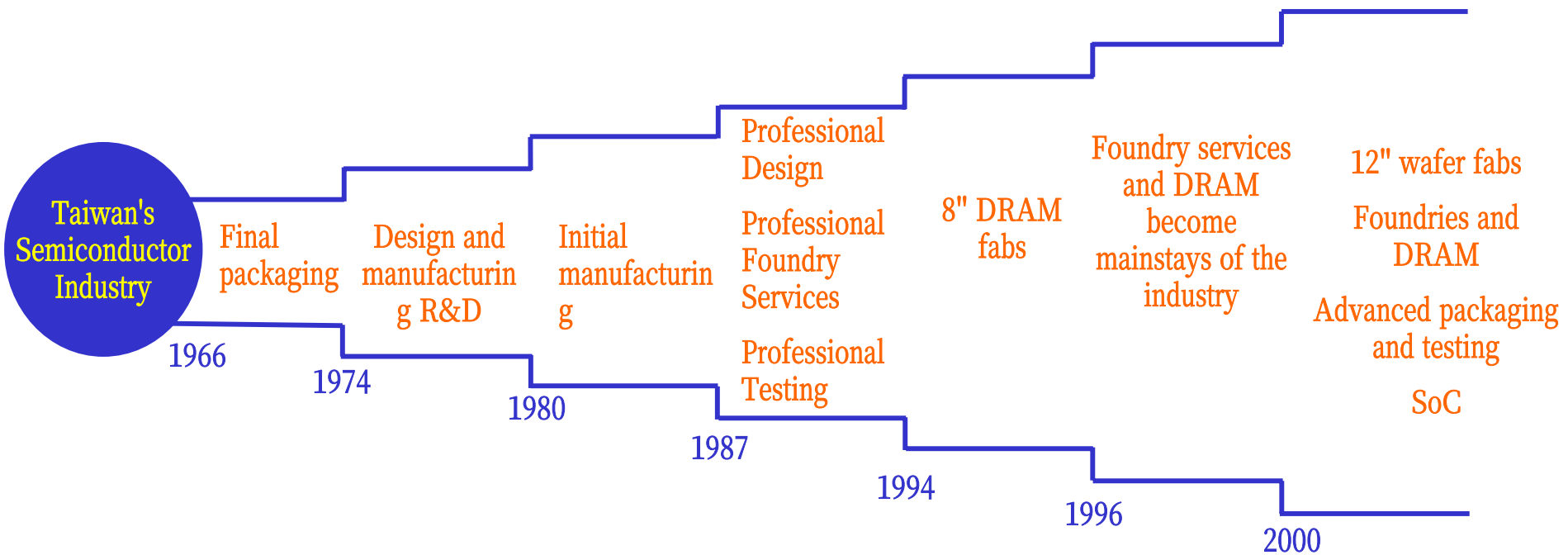
Outline

- Current Status of Taiwan Semiconductor Industry
- SWOT Analysis of Taiwan IC Industry
- Embedded Processor Market and Applications in Taiwan
- Development Strategies and Assistance Programs for the Semiconductor Industry
- STC/ITRI's projects related to MPU/DSP processors
- Conclusion

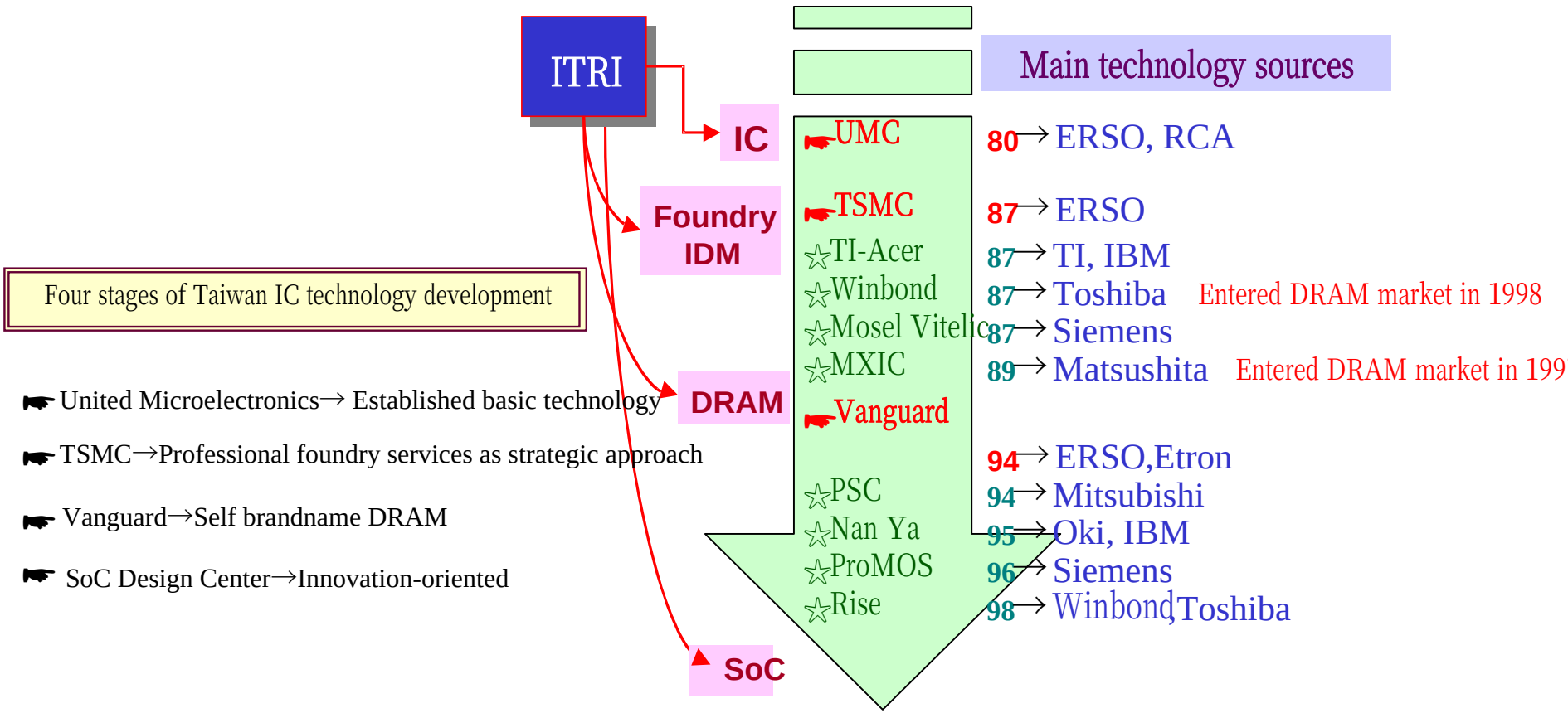
Current Status of Taiwan Semiconductor Industry

Industry Development Milestones



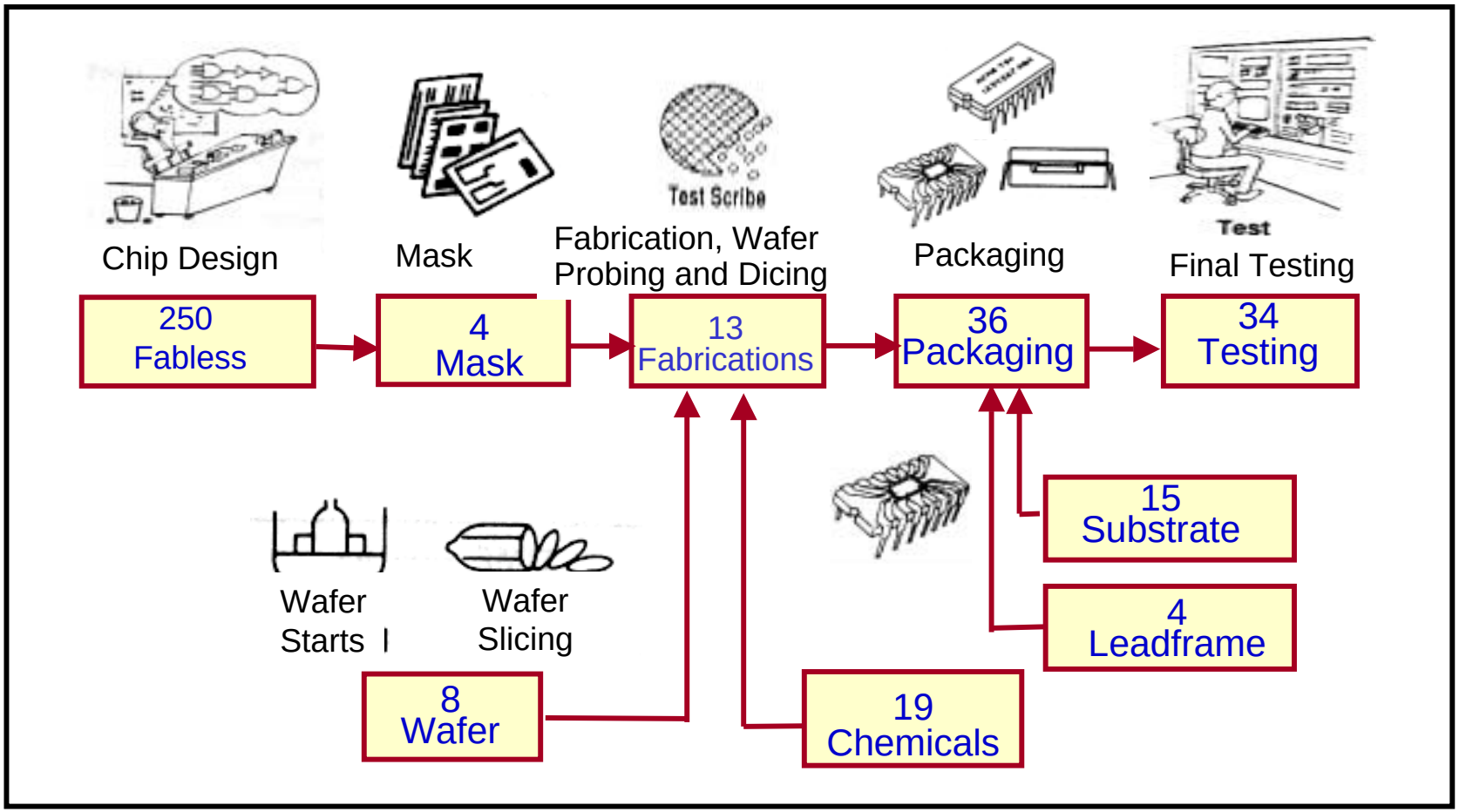
Source: ITRI (2004/03)

Industry Development Milestones(cont'd)



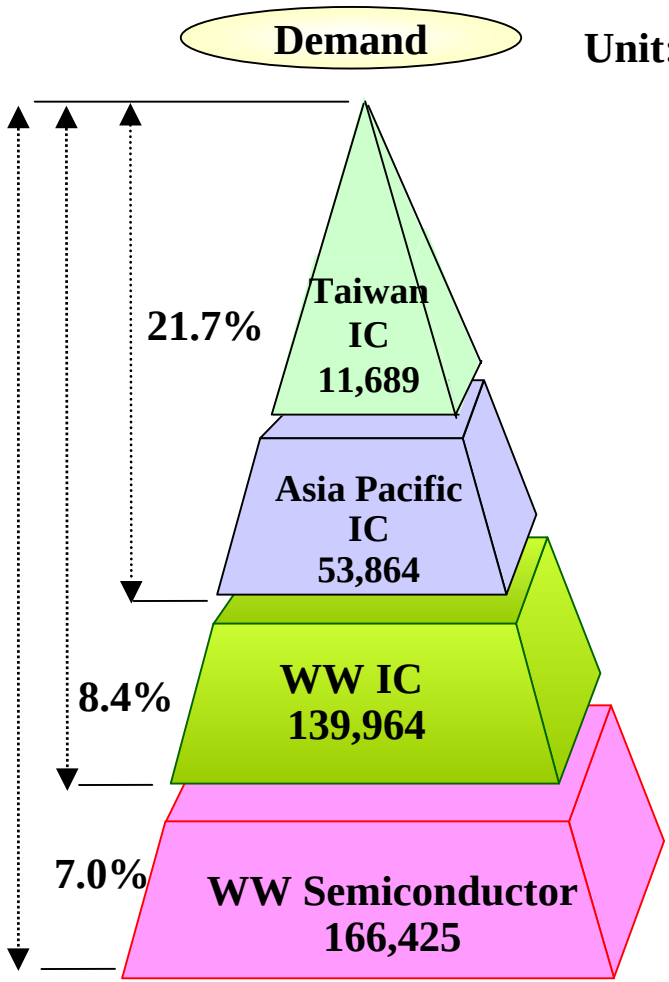
Source: ITRI (2004/03)

Unique Disintegrated Infrastructure in Taiwan (2003)



Source: ITRI/IEK (2004/03)

Taiwan's IC Industry vs. World (2003)



	Revenue	WW Share	WW Rank	Leaders
Self Brandname IC	10,215	7.3%	4	US/JP/KR
DRAM	3,132	19.1%	3	KR/US
SRAM	254	9.8%	4	JP/KR/US
Mask ROM	271	89.7%	1	TW
Fabless	5,529	28.7%	2	US
MFG	13,666	9.4%	4	US/JP/KR
Foundry	8,983	70.8%	1	TW
PKG	3,419	36.0%	1	TW
Testing	1,189	44.5%	1	TW
MFG Capacity	—	15.8%	3	JP/US

Source: ITRI/IEK (2004/03)

Worldwide top 20 Fabless

Company	Country	2003(e)		2002	2001
		Rank	Revenue US$M	Revenue US$M	Revenue US$M
Qualcomm	U.S.	1	2,440	1,942	1,395
Nvidia	U.S.	2	1,835	1,915	1,275
Broadcom	U.S.	3	1,595	1,083	962
Xilinx	U.S.	4	1,280	1,125	1,149
MediaTek	Taiwan	5	1,170	854	447
ATI	Canada	6	1,135	645	480
SanDisk	U.S.	7	930	493	317
Altera	U.S.	8	830	712	839
Marvell	U.S.	9	780	482	275
Conexant	U.S.	10	650	627	646
VIA	Taiwan	11	620	729	1,009
Qlogic	U.S.	12	520	415	357
GlobespanVirata	U.S.	13	360	229	265
Sunplus	Taiwan	14	320	250	195
Novatek	Taiwan	15	311	193	124
Silicon Lab	U.S.	16	310	182	74
Realtek	Taiwan	17	300	265	214
SST	U.S.	18	250	244	259
PMC-Sierra	Canada	19	245	213	323
ICS	U.S.	20	237	228	155

ITEM	RANK	COMPANY
FPGA	4	Xilinx
	8	Altera
Graph IC	2	NVIDIA
	6	ATI
PC Chipsets	11	VIA(威盛)
Memory	7	SanDisk
	18	SST
Comm. IC	1	Qualcomm
	3	Broadcom
	10	Conexant
	9	Marvell
	12	Q-Logic
	17	Realtek(瑞昱
	19	PMC-Sierra
	13	GlobeSpanVir
	16	Silicon Lab
Consumer	5	Mediatek(聯
	20	ICS
	15	Novatek(聯詁
	14	Sunplus(凌陽

Source：IC Insight；ITRI/IEK (2004/02)

Taiwan Top 10 IC Companies in 2003

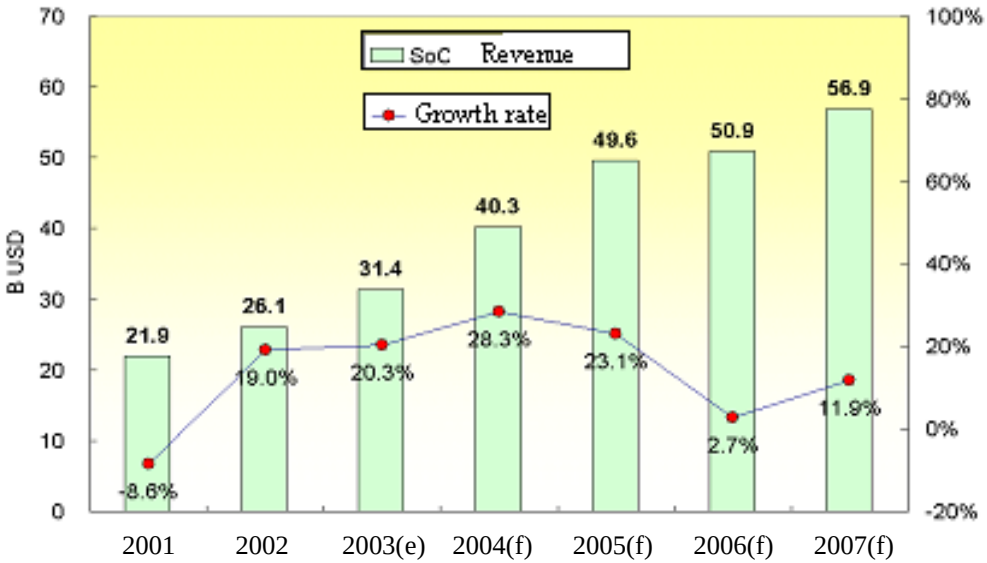
millions of US dollars

2002 Ranking	2003 Ranking	Company	Industry Segment	2003 Revenues	2002 Revenues	2003/2002 Growth (%)
1	1	TSMC	Foundry	6,118	4,876	25.5%
2	2	UMC	Foundry	2,572	2,042	25.9%
5	3	Mediatek	Fabless	1,154	894	29.1%
6	4	ASE	Package	954	776	23.0%
3	5	Windbond	IDM,DRAM	895	973	-8.0%
4	6	Nan-Ya	DRAM	861	909	-5.3%
8	7	SPIL	Package,Test	829	676	22.7%
9	8	Promos	DRAM	761	555	37.3%
—	9	PSC	DRAM	696	388	80%
7	10	VIA	Fabless	618	764	-19.0%

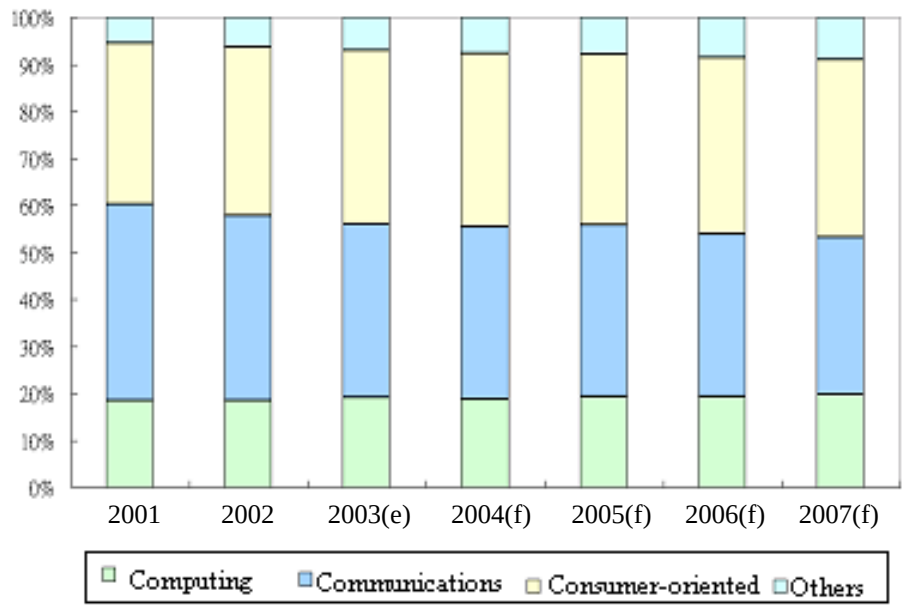
Source: ITRI/STC (2004/03)

Worldwide SoC Market Trend

WW SoC Market Forecast



SoC Applications



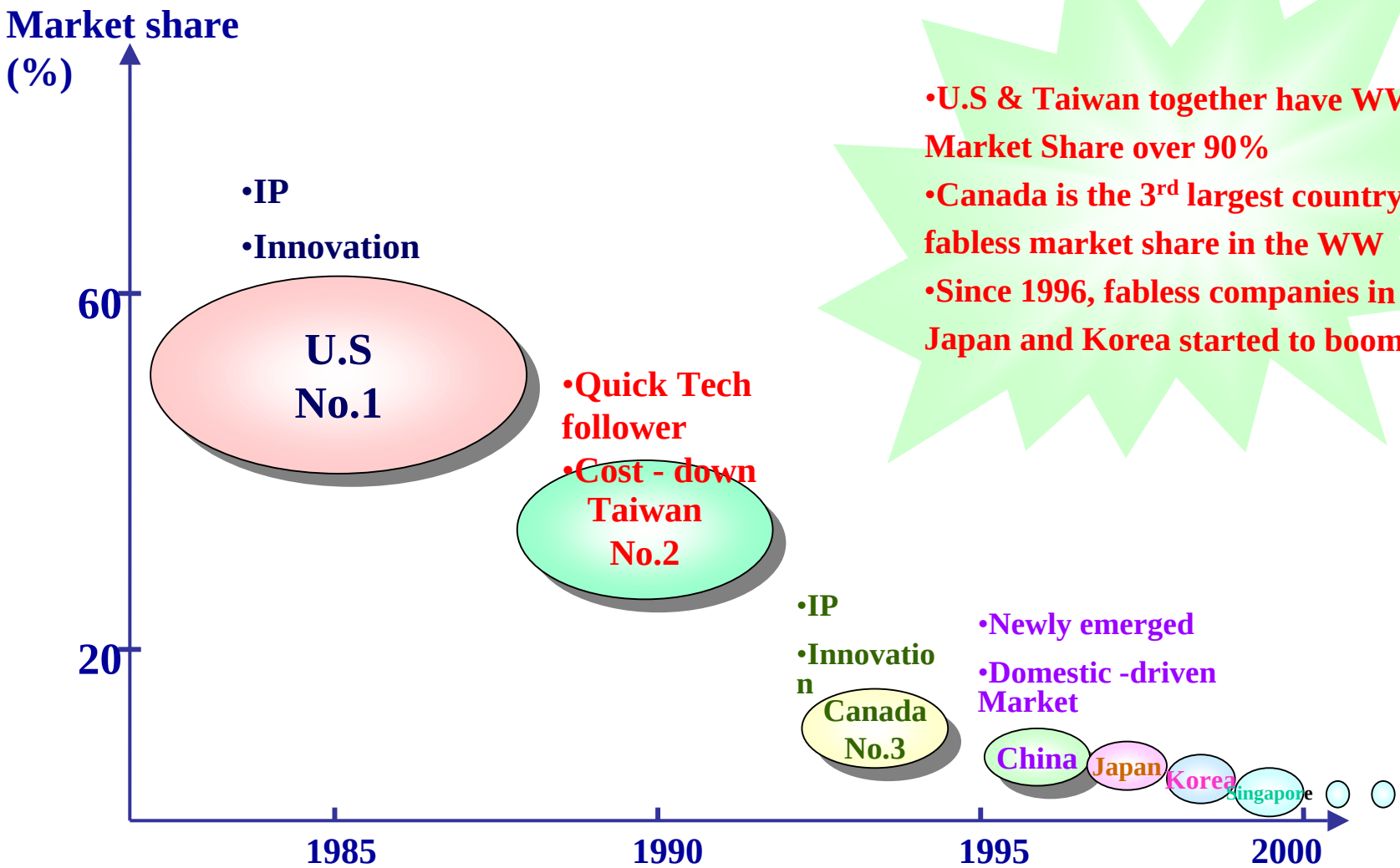
***WW SoC grow 20% in 2003：**

1. Globe economic recover gradually.
2. Demand of communication product increased, problem of stock-in-house released.
3. Demand of consumer product is expected to grows rapidly.

*** Communications & Consumer Electronics are two major SoC applications. Computer/Information takes ~20%.**

Source：Dataquest ；ITRI/IEK (2003/11)

Fabless Industry

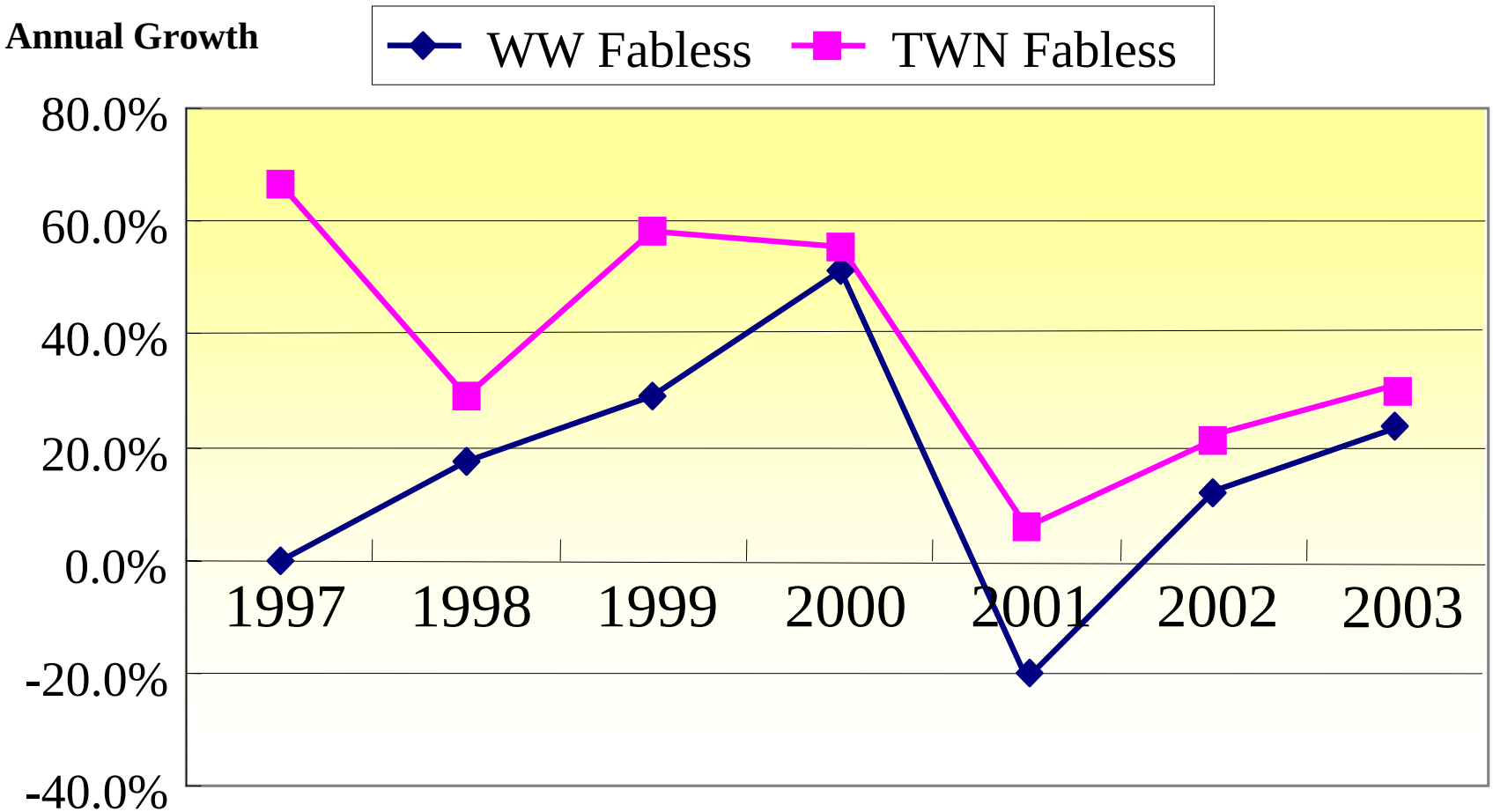


- U.S & Taiwan together have WW Market Share over 90%
- Canada is the 3rd largest country in fabless market share in the WW
- Since 1996, fabless companies in China, Japan and Korea started to booming

Source:ITRI/IEK(2004/03)

Notes: EMEA: Europe & Israel

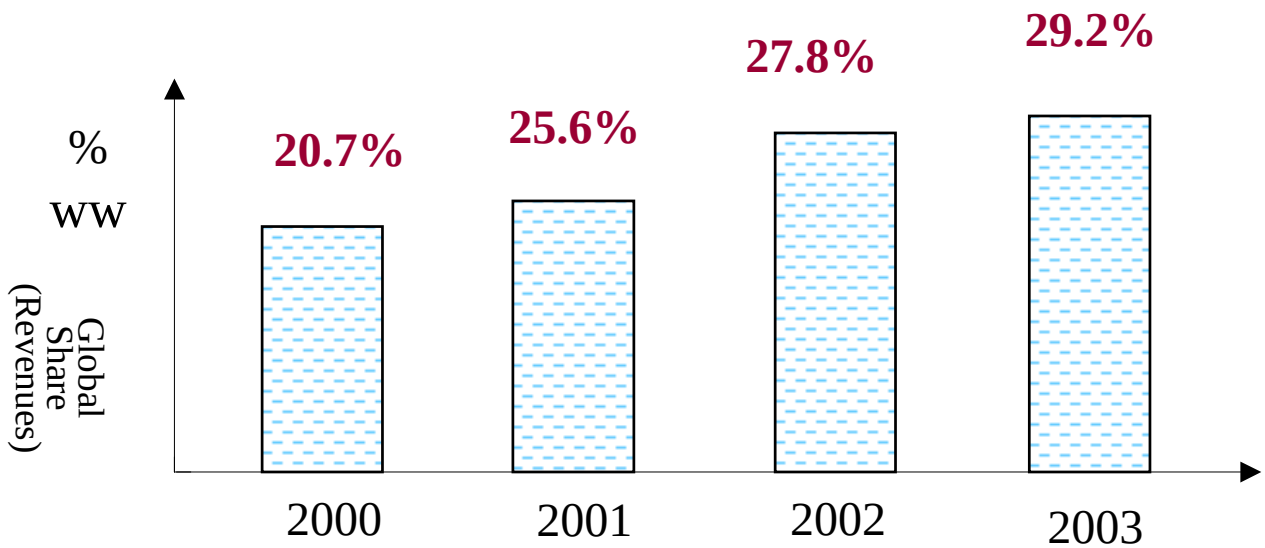
Superior Performance of Taiwanese Fabless



Source: STC(2004/03)

Strength of Taiwan Design Industry : Rising Year by Year

•**Performance of Taiwan Companies over the Past Few Years**



Top Ten Companies Worldwide (Number of Companies)	1	2	2	1
Top Twenty Companies Worldwide (Number of Companies)	3	3	4	5

Source: IC Insights; ITRI/IEK (2004/01)

Taiwan Top 10 Fabless in 2003

millions of US dollars

Rank	Company	Rev (2003)	Rev (2002)	GR (%)	Products
1	MEDIATEK	1154	894	29.1%	Optical storage
2	VIA	618	764	-19.0%	PC Chipsets
3	SUNPLUS	333	258	29%	Consumer
4	NOVATEK	330	201	62.8%	Consumer
5	REALTEK	279	276	0.8%	Networking
6	ALI	195	183	6.9%	PC Chipsets
7	ESMT	159	117	36.8%	Memory
8	ELAN	138	120	15.4%	Consumer
9	HiMAX	135	57	137%	Design Service
10	Etron	132	93	42%	Memory

Source: ITRI/ IEK (2004/03)

Taiwan Semiconductor Industry SWOT Analysis

SWOT Analysis of Taiwan's IC Industry

Strengths

- ✓Specialization within semiconductor industry, industry clustering effect evident
- ✓Strong professional foundry segment, stimulating development of upstream and downstream industries
- ✓Support of downstream PC industry
- ✓Operational flexibility
- ✓Comparative cost advantage
- ✓Strong in digital design technologies and CMOS process capabilities

Weakness

- ✓Redundancy in industry segments and products targeted for vendor investment, little innovation
- ✓Shortage of talent in high-frequency devices, wireless communications, analog design, and systems
- ✓SoC-related design, manufacturing, packaging, and testing technologies in need of strengthening
- ✓Marketing channels and market sensitivity insufficient

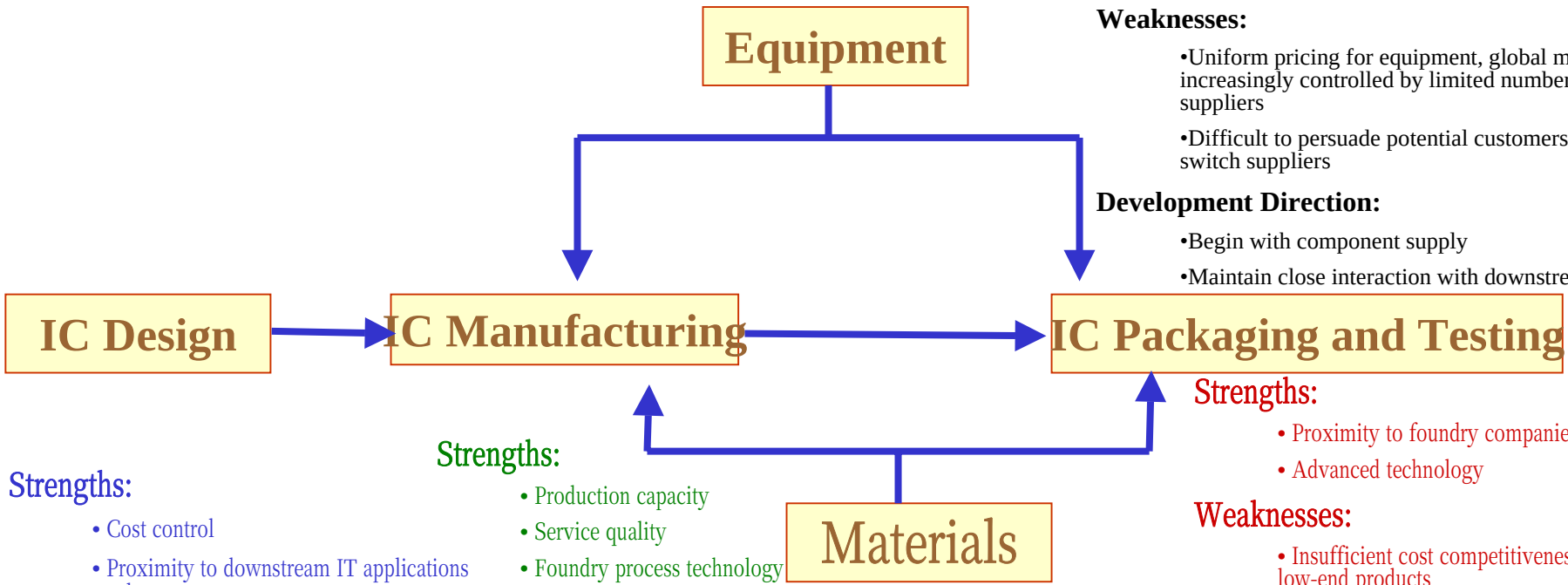
Opportunities

- ✓Great potential of China market for PCs and digital consumer devices
- ✓Demand for components for emerging IA products
- ✓Industry alliances, technology transfers, mergers are strengthening capabilities
- ✓Large IDM vendors are continuing to place orders, greatly benefiting the manufacturing, packaging, and testing industries

Threats

- ✓Competition in the foundry segment from new entrants, such as Korea, China.
- ✓Rapid development of latecomer design industries, such as Israel, Europe
- ✓Barriers to entry for wireless communications products is high; companies without key technologies or who enter too early find it difficult to survive

Industry Structure



Strengths:

•Many domestic wafer fab, IC packaging, IC testing companies

Weaknesses:

•Uniform pricing for equipment, global market increasingly controlled by limited number of suppliers

•Difficult to persuade potential customers to switch suppliers

Development Direction:

•Begin with component supply

•Maintain close interaction with downstream

Strengths:

- Cost control
- Proximity to downstream IT applications market

Weaknesses:

- Product innovation
- Analog, wireless communications
- SoC, technology lacking
- Weak marketing capabilities

Development Direction:

- Strengthen analog, telecoms, SoC technologies
- Develop mainland China market

Strengths:

- Production capacity
- Service quality
- Foundry process technology

Weaknesses:

- Weak in DRAM technologies
- Marketing capabilities

Development Direction:

- Global deployment
- Establish DRAM technologies
- Build 12-inch wafer fabs

Strengths:

- Domestic wafer fabs
- Numerous IC packaging, testing companies

Weaknesses:

- Difficult to develop technology for high-end products
- Customers for advanced products have little willingness to switch suppliers

Development Direction:

- Work with technology providers and jointly develop new technologies
- Maintain close interaction with downstream customers

Strengths:

- Proximity to foundry companies
- Advanced technology

Weaknesses:

- Insufficient cost competitiveness in low-end products
- Lack of strong presence in China

Development Direction:

- Raise capabilities in mixed-signal and SoC testing
- Small and medium-sized packaging vendors move toward high-end technologies

Embedded Processor Market and Applications in Taiwan

Worldwide MPU IP Revenue 2003

Rank	Company	2002 ($M)	2003 ($M)	Growth	Share	Cumulative Share
1	ARM	159.3	158.2	-1%	64%	64%
2	MIPS Technologies	43.1	47.0	9%	19%	83%
3	Tensilica	12.8	15.1	18%	6%	89%
4	ARC International	10.1	8.9	-12%	4%	93%
5	SuperH	4.2	7.5	76%	3%	96%
6	Faraday Technology	1.0	2.0	101%	1%	97%
7	Western Design Center	1.2	1.4	19%	1%	97%
8	Cast	0.7	0.9	24%	0%	98%
9	Mentor Graphics	1.0	0.7	-23%	0%	98%
10	Patriot Scientific	0.6	0.6	0%	0%	98%
	Others	4.6	4.1	-12%	2%	100%
	Total	**238.5**	**246.4**	**3%**	**100%**	**100%**

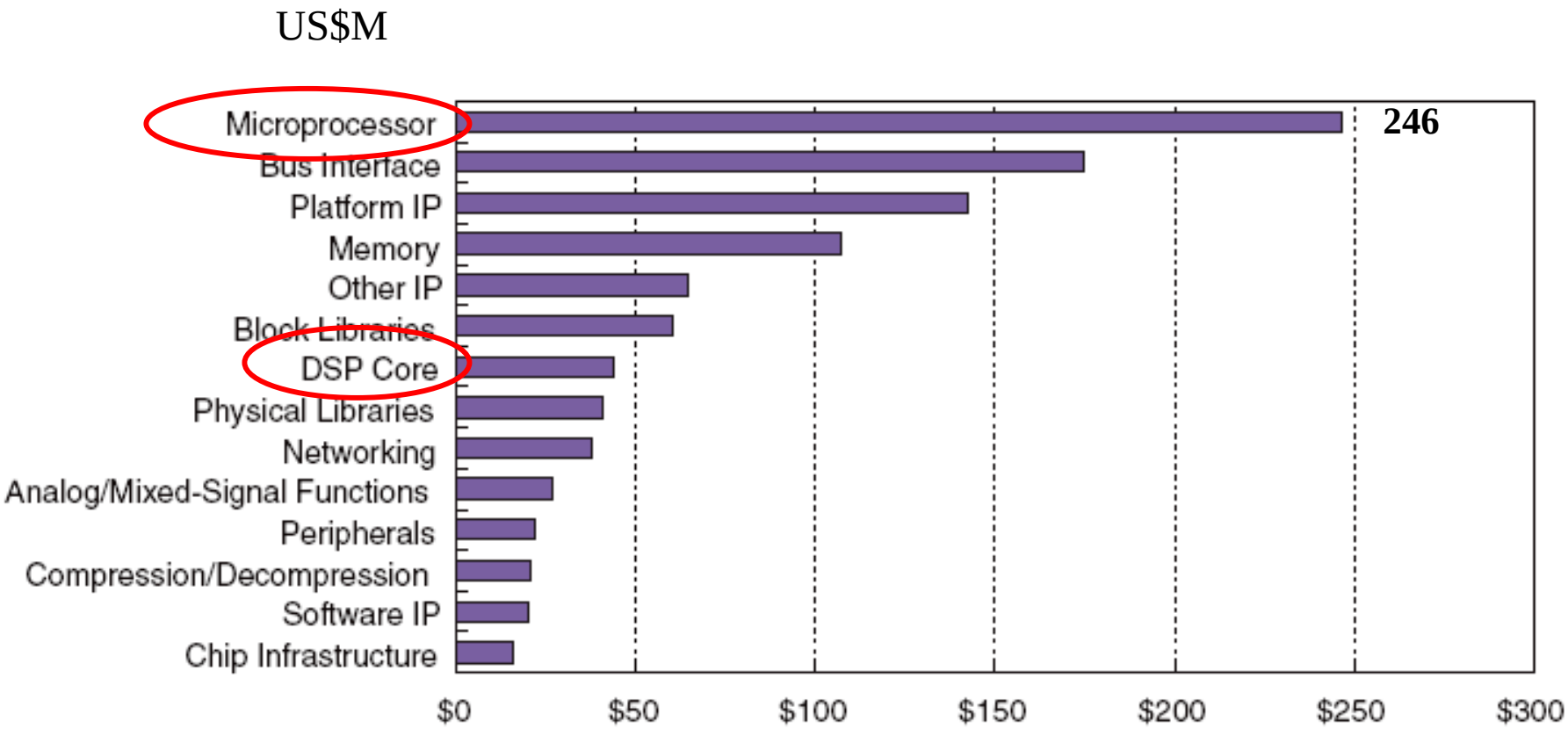
Source: Gartner Dataquest (2004/5)

Worldwide DSP Core IP Revenue 2003

Rank	Company	2002 ($M)	2003 ($M)	Growth	Share	Cumulative Share
1	Ceva	19.7	27.5	40%	63%	63%
2	Adelante Technologies	5.6	6.3	12%	14%	77%
3	StarCore	0.0	4.8	NA	11%	88%
4	3DSP	2.6	2.4	-9%	5%	93%
5	Improv Systems	2.3	2.2	-4%	5%	98%
6	Faraday Technology	0.2	0.4	104%	1%	99%
7	Clarkspur Design	0.2	0.2	0%	0%	100%
	Others	0.9	0.2	-82%	0%	100%
	Total	**31.5**	**43.9**	**39%**	**100%**	**100%**

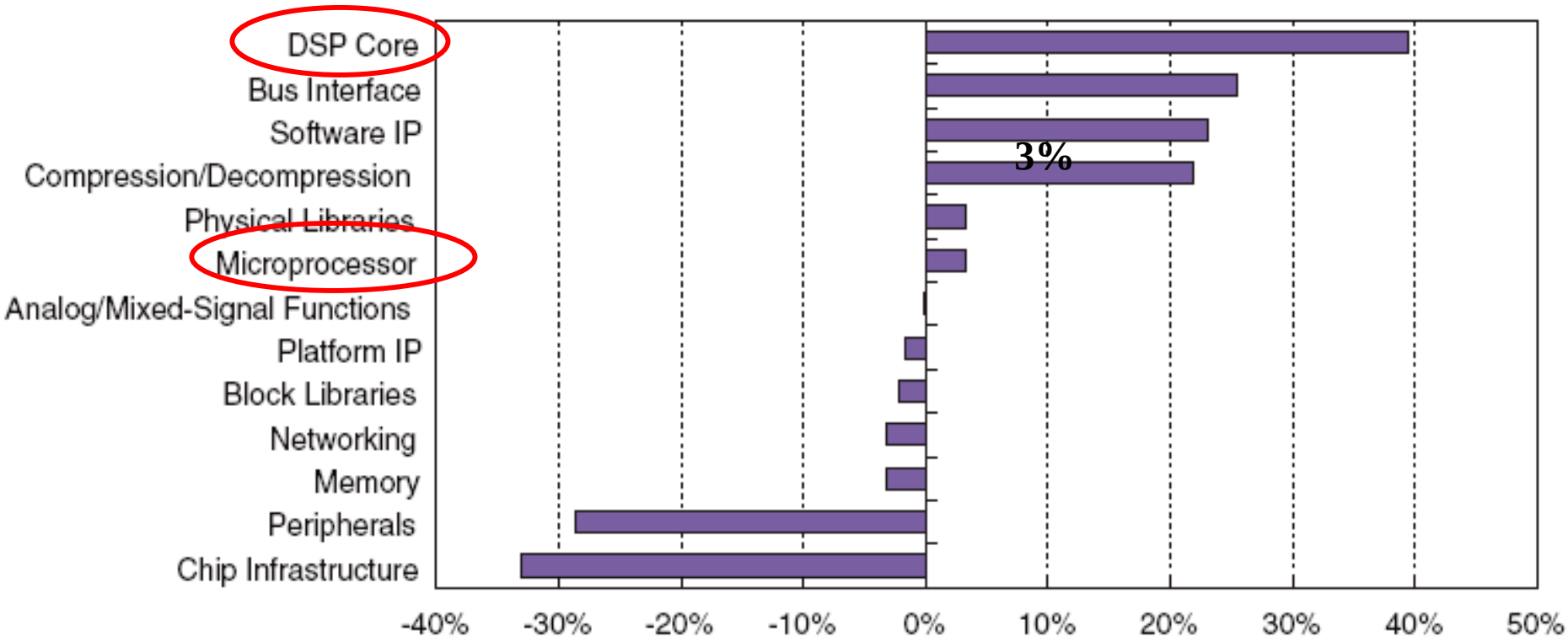
Source: Gartner Dataquest (May 2004)

IP Market by Function — Worldwide, 2003



Source: Gartner Dataquest (2004/5)

IP Revenue Growth by Function — Worldwide, 2003



Source: Gartner Dataquest (2004/5)

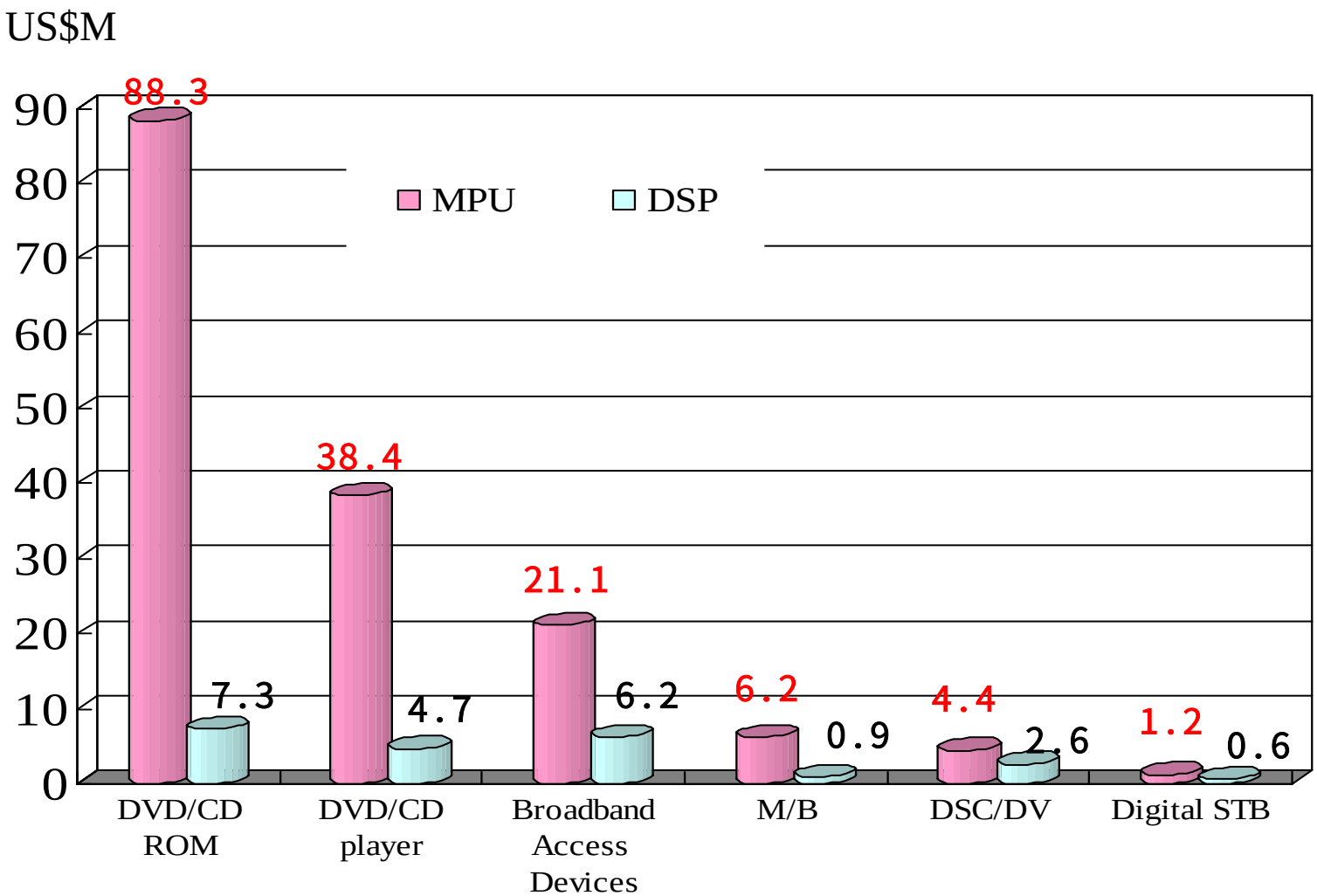
Top 10 Semiconductor IP Vendors by Total IP Revenue — Worldwide, 2003

Rank	Company	2002 ($M)	2003 ($M)	Growth	Share	Cumulative Share
1	ARM	185.6	175.2	-6%	17%	17%
2	Rambus	97.4	118.1	21%	12%	29%
3	Synopsys	73.2	81.2	11%	8%	37%
4	Artisan Components*	43.7	74.6	71%	7%	44%
5	TTPCom	70.5	73.5	4%	7%	51%
6	MIPS Technologies	43.1	47.0	9%	5%	56%
7	Virage Logic	47.5	40.0	-16%	4%	60%
8	CEVA**	51.2	36.8	-28%	4%	63%
9	Imagination Technologies	15.3	23.6	54%	2%	66%
10	Mentor Graphics	16.0	22.2	39%	2%	68%
	Others	326.6	326.4	0%	32%	100%
	Total	970.2	1,018.6	5%	100%	

Processor related vendors

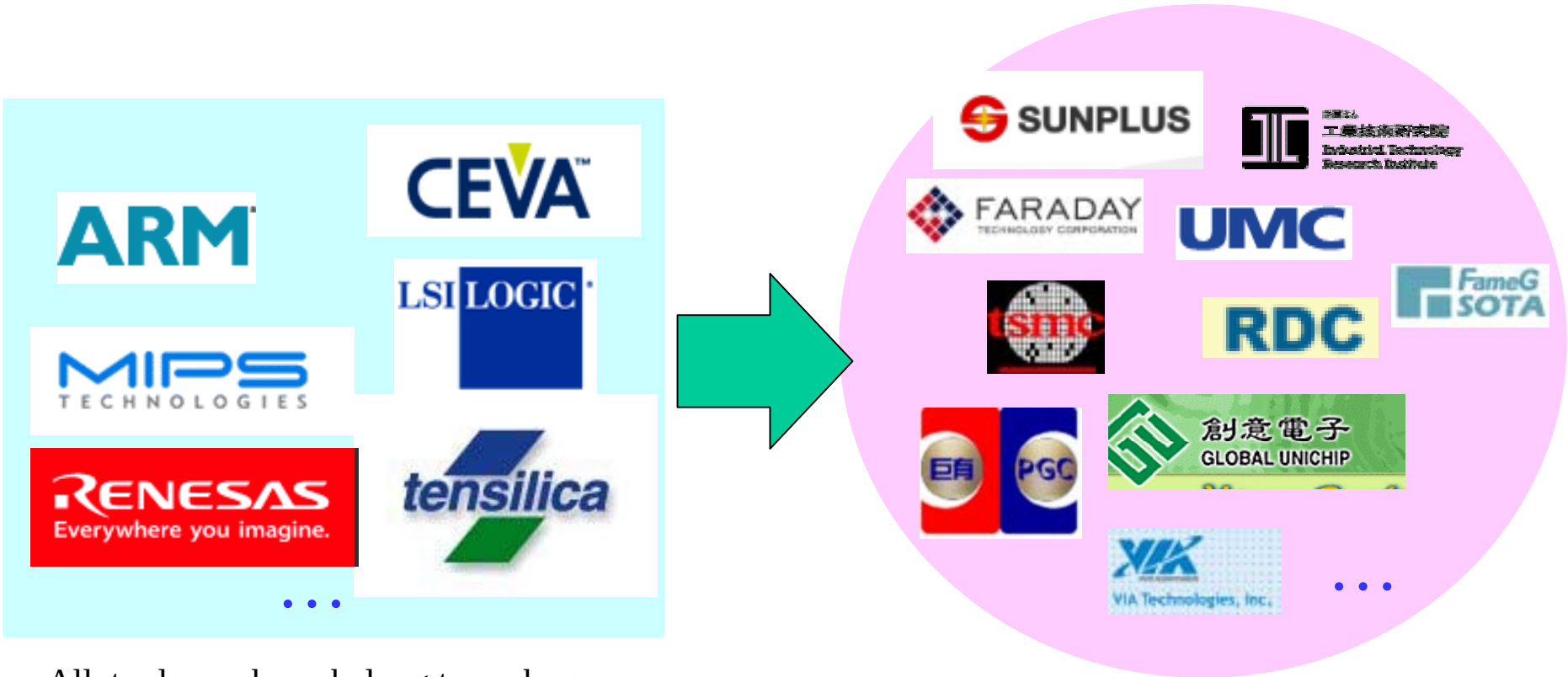
Source: Gartner Dataquest (2004/5)

Embedded Processor Market in Taiwan-2003(By Applications)



Source: ITRI/IEK (2004/7)

Current Developing Status of Embedded Processor in Taiwan



All trade-mark are belong to each company

Most of embedded processors(or IPs) are licensed from foreign countries . BUT…

Current Developing Status of Embedded Processor in Taiwan

Self-build Processor IPs

創意電子 GLOBAL UNICHIP — 16/24bit DSP

FARADAY TECHNOLOGY CORPORATION — 16/24bit DSP

16/32 bit RISC MPU

VIA Technologies, Inc. — x86 based MPU

SUNPLUS — 8/16/32 bit RISC MPU

RDC — 16 bit RISC MPU

. . .

Taiwan Foundry supporting for MPU

IP Vendor	IP	Process
ARM	ARM7TDMI ARM922T/ ARM946E/ ARM926EJ ARM1022E	0.25 µm / 0.18 µm / 0.18 low power µm 0.13 µm / 0.18 µm 0.18 µm 0.13 µm 0.13 µm
MIPS	MIPS4KEc/4KC MIPS5KC MPIS20Kc	0.15µm / 0.18 µm 0.18 µm 0.13µm / 0.18 µm
ARC	ARC tangent-A4 ARC tangent-A5 ARC600	0.25 µm /0.18 µm 0.25 µm /0.18 µm 0.25 µm /0.18 µm
SuperH	SH4-202	0.13 µm
CAST	16/32 bit Processor	0.25 µm
Tensilica	Xtensa	0.18 µm
Faraday	FA510 FA526	0.18 µm 0.18 µm
GUC	UMPU700/926/946	Same As ARM

Source: ITRI/STC (2004/5)

Taiwan Foundry supporting for DSP

IP Vendor	IP	Process
Ceva(DSPG)	TeakLite Oak Core Teak Core Palm Core	0.18 μm 0 .25μm /0.18 μm 0 .25μm 0.18 μm Low power
3DSP	DSP3/DSP5/DSP5 flex	0.18μm
Improv System	JAZZ	0.18 μm
LSI Logic	ZSP family	0.13 μm/0.18 μm
CAST	C32025 16/24 bit DSP (Softcore)	0.25 μm
Faraday	FD216 FD230	0 .25μm 0.18 μm
GUC	UDSP1600/2400	0.25 μm

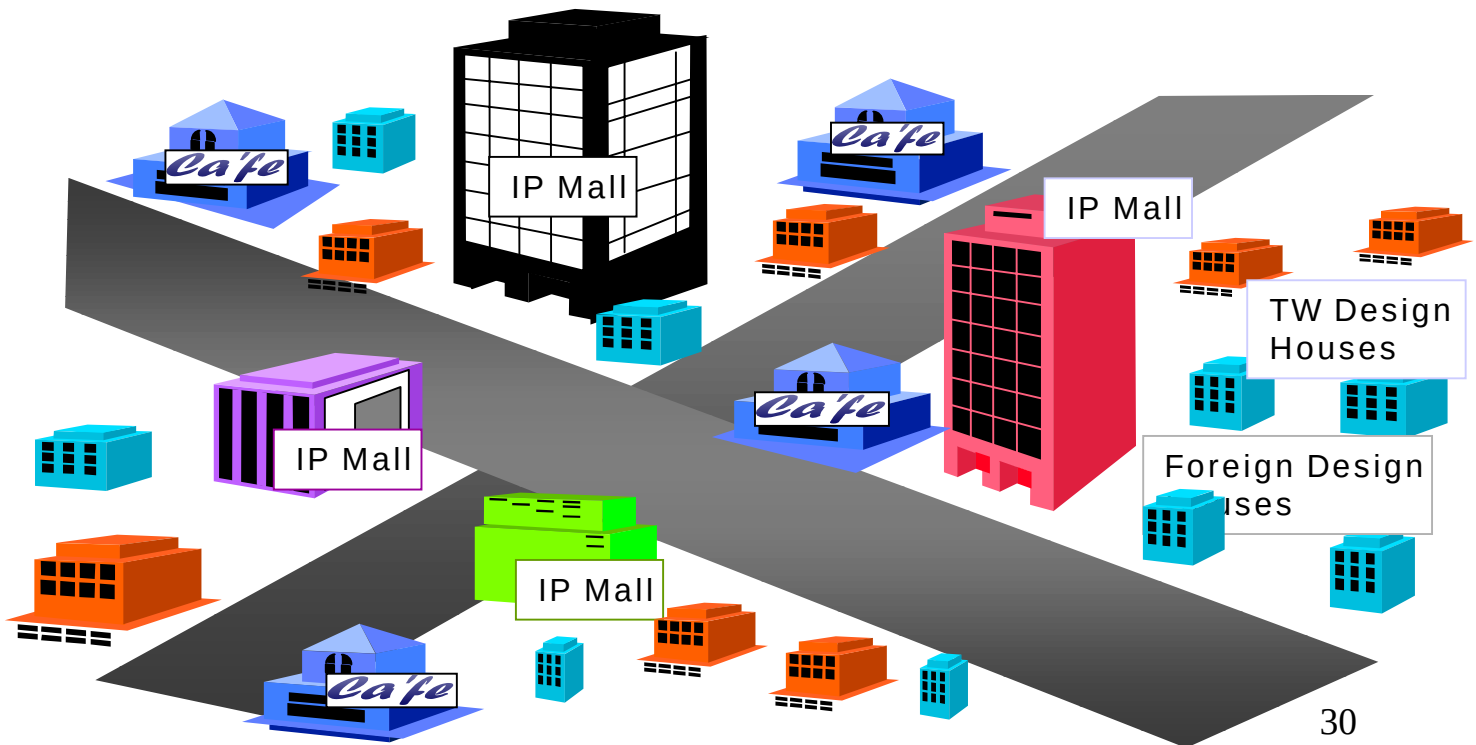
Source: ITRI/STC (2004/5)

Development Strategies an Assistance Programs for Taiwan Semiconductor Industry

Si-Soft National Program

- Platform Service
- IP Mall
- Demonstrated Product/Technology

Integrate national resources and focus on three forerunning pilot vehicles with a view to upgrade innovative product design capability, SoC design capability , and SoC infrastructure.



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National Si-Soft Program Vision&Strategy

- Establish Taiwan as Worldwide SoC Design Center
- Stimulate domestic industry's growth and attract oversea design services
- Conspicuous effect and long lasting operation
- Object-oriented development, encouraging basic research
- Set mechanism for pooling industrial, reaserch and academic resources and talents

Taiwan be an SoC advanced design center

Taiwan be a worldwide SoC design service center

Government Industry Policy

一、推動兩兆雙星產業，2006年產值總目標為新台幣3.58兆元		
	項目	目標
兩兆	半導體產業 (目前居全球第4名)	1.產值1.59兆元(全球第3名) 2.全球半導體設[illegible]製造中心 3.三家[illegible]全球十大
	影像顯示產業 (目前居全球第3名)	1.[illegible] 2.全球[illegible]
雙星	數位內容產業 (軟體產業目前居全球26名)	1.廠商3,[illegible]0家，產值[illegible]前15名 2.亞太數位內容製作中心及[illegible]
	生物技術產業	1.營業額2,500億元 2.五年帶動1,500億元投資，十年[illegible]

二、提升八項傳統產業產值，2006年達新台幣1.28兆	
項目	目標
1.高科技紡織品產業(Polyester filament, Nylon Fiber目前居全球第2名)	產值2,400[illegible]
2.保健機能性食品產業	產值 50[illegible]
3.保養品產業	產值 3[illegible]
4.高級材料產業	產值 5,[illegible]
5.光電電子用化學品產業	產值
6.輕金屬產業	產值
7.電動車輛產業(目前居全球第3名)	產值
8.運動休閒產業	產值 2,[illegible]

三、新服務業2006年產值總目標為新台幣3,7[illegible]	
項目	目標
研發服務產業	1.產值1,760億元 2.成為亞太研發服務[illegible]
資訊應用服務產業	1.營收值2,000億元 2.外銷值400億元 3.培育10家國際級廠商

四、資源化產業2006年產值總目標為新台幣350億[illegible]上	
項目	目標
資源化產業	產值350億元

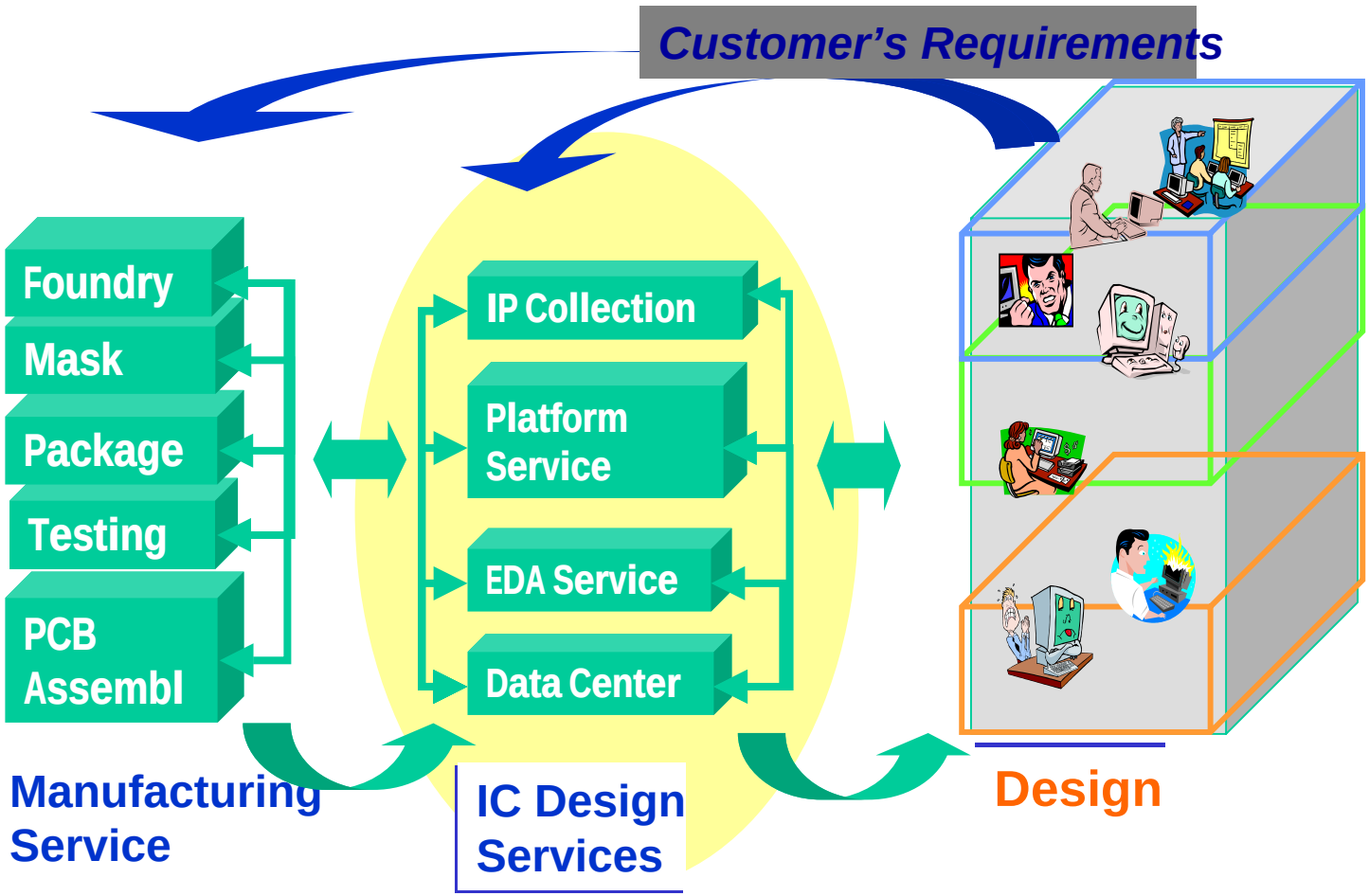
Two Trillion Twin Star-Products Project

IC Design Parks Network in Taiwan

- TaoYuan LongTan Aspire Park
- Wasia Scientific and Technological Park
  KGT Park
- HsinChu Science-Based Industrial Park
- TaiYuan Scientific Park
- TaiChung Scientific Park
- TaiNan Scientific Park
- TaiNan Scientific & Industrial Park
- LuZhu Scientific Park
- Seaboard Industrial Plaza
- NanKang Software Park,
- NeiHu Park,
  HsinTien,
  ZhongHo

IC Design Park's Vision

IC Design Demands for Integrated Services.



STC/ITRI's Projects Related to MPU/DSP Processors

STC Role & Executive Strategy in programs

IEK/ITRI
(Worldwide&Taiwan)
Market Information

ERSO/ITRI
(LTPS-TFT、TFT-LCD、OLED ...)
Flat Panel

OES/ITRI
(SOC/IP...)
Opto-electronics

CCL/ITRI
(RF IC/ Processor/Analog Mixed Signal...)
Broadband, Wireless

National Si-Soft Program Office/MOEA
Strategy designation
Program Controlling

STC/ITRI

Interaction/Cooperation with foreign country
Technology Cooperation or translation

Chung-Shan Institute of Science and Technology...
Technical Communication
Collocation & Integration
IP Qualification

National University..
Forward-looking research

(• Sweden ACREO SOC WARE Center
- SOCTRiX Demonstrator Program
• US CMU
- Analog IP: Methodology & Design …..)
• UCSB
- SoC Analog and Mixed Signals Design

Taiwan SOC Alliance/Association

SOC System Product | SOC Design House | IC Foundry | IP /Design Service | IP Company | EDA Company | Packaging /Testing Company

STC technology development plan – DSP Processor Core

Main items

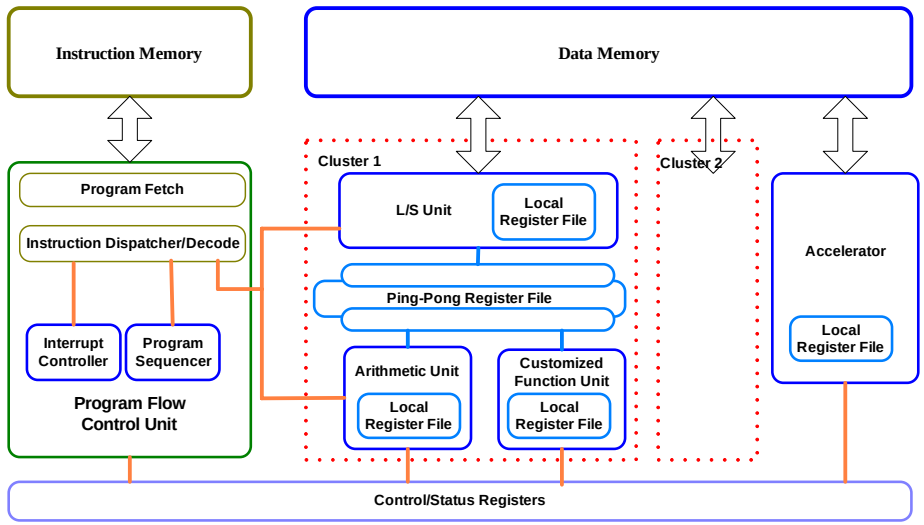
- 32-bit Low Power, High Performance DSP Core

Applications

- Portable Multi-function Device

Achievements

- 3 papers on IEEE conference
- 6 patents (4 patents submitted, 2 patents will submit in this year)



Vender / Property	ITRI/STC	TI		Motorola / Agere	ADI	Infineon
	PAC DSP	C6000	C5000	SC140	Blackfin	Tricore2
Architecture	VLIW + Scalar	VLIW	Dual MAC	VLIW	Dual MAC	Superscalar
Frequency (MHz)	300 ~ 450	300 ~ 1000	50~200	300	600	600
Process	0.13μm	0.13μm ~ 90nm	0.13 μm	0.13μm	0.13μm	0.13μm
Performance (MIPS)	1500 ~ 2250	1600 ~ 4800	30 ~ 532	1200	1200	900
Power Consumption (mW/MIPS)	0.5	1.21	0.42	0.39	0.25	0.33
Dynamic Power Management	Yes	Yes	Yes	Yes	Yes	Yes

STC technology development plan– Multimedia SoC

Main items

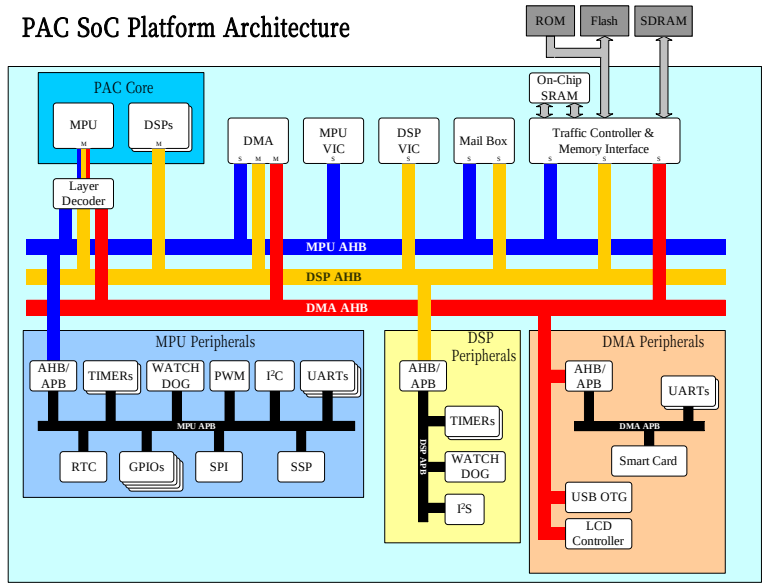
- Multimedia Platform Generator
- Virtual Prototyping
- System-level Design
- Intelligent Power Management

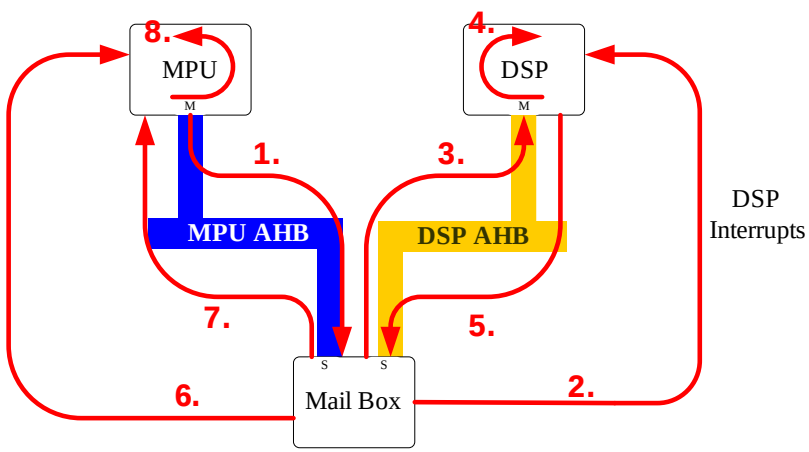
Applications

- Portable Media Player
- Smart Phone

Achievements

- C-Based Design flow
- Hardware Semaphore Patent submit





STC technology development plan– Low Power Design

Main items

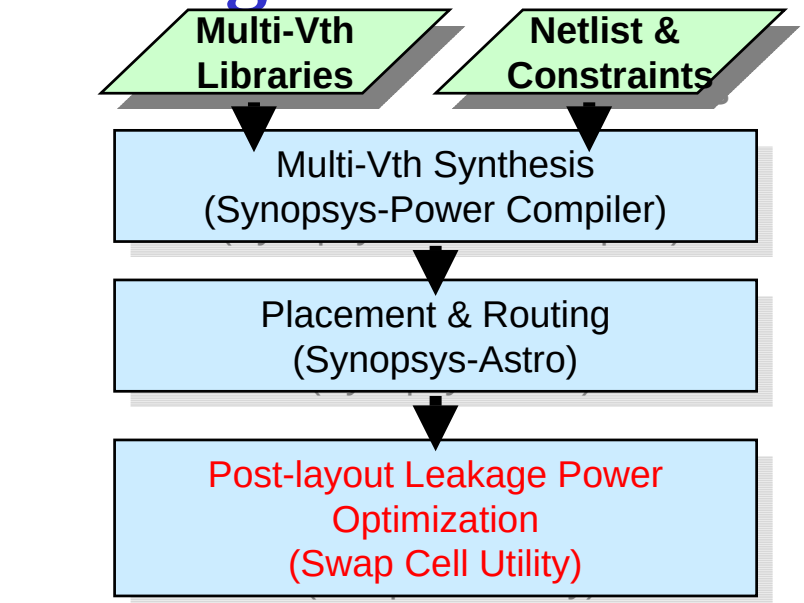
- Multi-Vth Design Flow & Methodology
- Low-Power Clock Tree Construction
- Low-Power Circuit Design

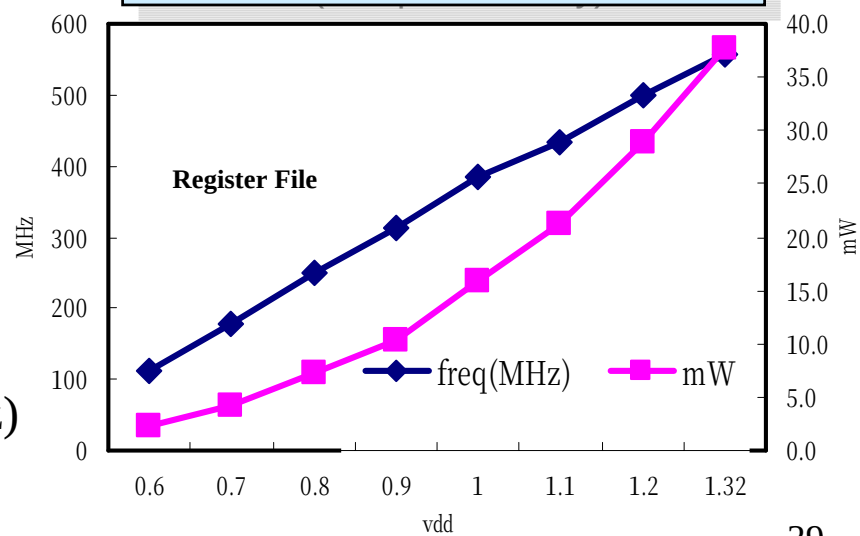
Applications

- Low Power ASSP/ASIC
- IC with Tunable Frequency

Achievement

- Multi-Vth Design Flow
- Low-Power Clock Tree Construction Methodology
- Low power MAC(patent submit)
- Register File w/ Wide Operating Voltage Range from (0.6V,100MHz) to (1.2V, 450MHz)





Conclusion

Conclusion

- In addition to foundry business, IC design is the key to the future of Taiwan Semiconductor Industry
- Key components such as MPU/DSP (star IP) play critical positions in design SOC products
- Taiwan IC design houses (both fabless and IDM) will keep use MPU/DSP world wide and also build them owns
- MPU/DSP processors built within Taiwan have to face global competition and patent challenges (quite different from China)