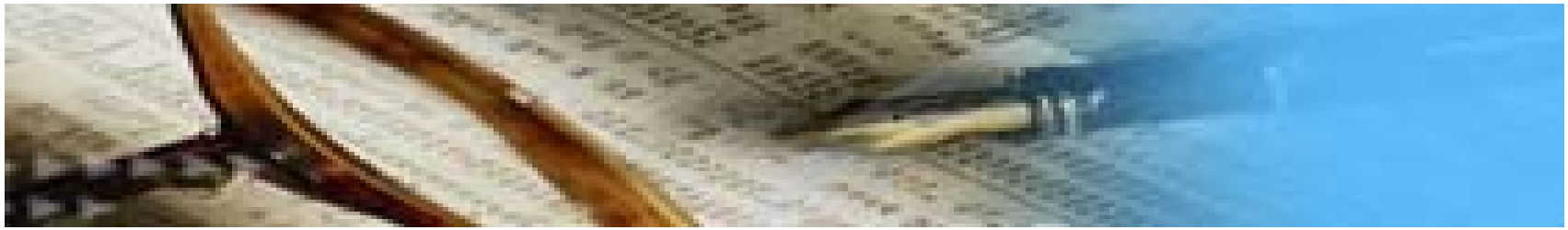
IC製造業與光電產業之介紹



Dr. 陳 柏 穎

義守大學　通訊工程系

W 01 上課資料

Sept./19/2008

學 歷

學校名稱　系所別

1. 國立交通大學　電子研究所博士 固態電子組 1991 (Sep.)-1995 (May.)

2. 國立中山大學　材料研究所 1989 (Sep.)-1991 (May.)

評 分 標 準

---對本課程評分之規定

- 期中考 30 %
- 出席率: 20% 每次缺席扣 3%

  隨堂考 每次 2%, (共5次)

- 期末考: 1x 30 %=40 %

- 期末報告: 1x 10 %=10 % (學期成績加分)

期中報告評分標準

---對IC製造與光電之規定

- 上台報告: 25 min presentation, 5min Q&A
- Power-point presentation
- 寫成Word格式13頁, 12號字書面報告
  - 題目與: IC 製造, 光電產業, 能源產業

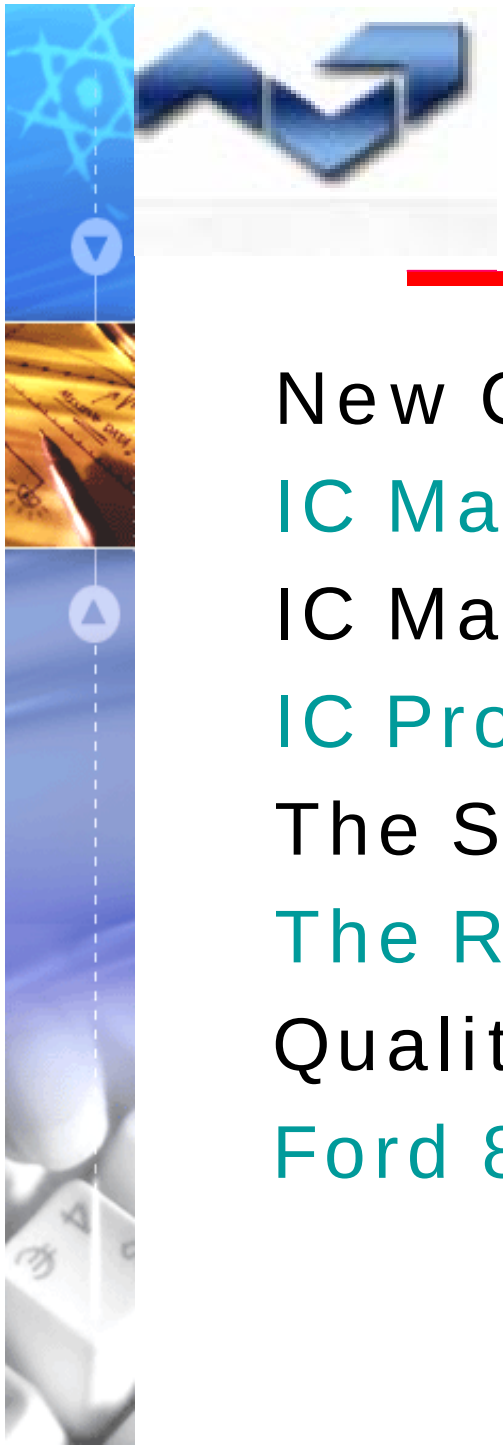
----　一切與對IC製造與光電有關的topics

期中報告評分標準

報告之格式

---普通物理之規定

1. 封面
2. 目錄
3. 簡介
4. 內容
5. 討論
6. 結論
7. 心得
8. 參考資料



Agenda

New Concept for Worldwide

IC Manufacturing History

IC Manufacturing Introduction

IC Process Flow Introduction

The Strategy for the IC Development

The Reliability test for IC Process

Quality Control

Ford 8-D

Agenda

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Ford 8-D

IC Manufacturing History

What is VLSI ?

- VLSI為Very Large Scale Integration之縮寫
- 整合(integration)什麼?
  - 整合電路(circuits)
- 什麼是電路?
  - 電晶體(transistors)和金屬線(wires)
  - 電阻(resistors)、電容(capacitors)和電感(inductors)
- IC & VLSI
  - 積體電路(Integrated circuits-ICs)：許多電晶體、金屬線及被動元件在一顆晶片(chip)上
  - 超大型積體電路(Very Large Scale Integration-VLSI)：非常多電晶體、金屬線及被動元件在一顆晶片上
- 為什麼要使用IC來製造電子電路
  - Printed a circuit, like you print a picture
    - Create components in parallel, cost no longer dependent on # of devices
  - 價格便宜、操作速度快及低功率消耗

IC Manufacturing History

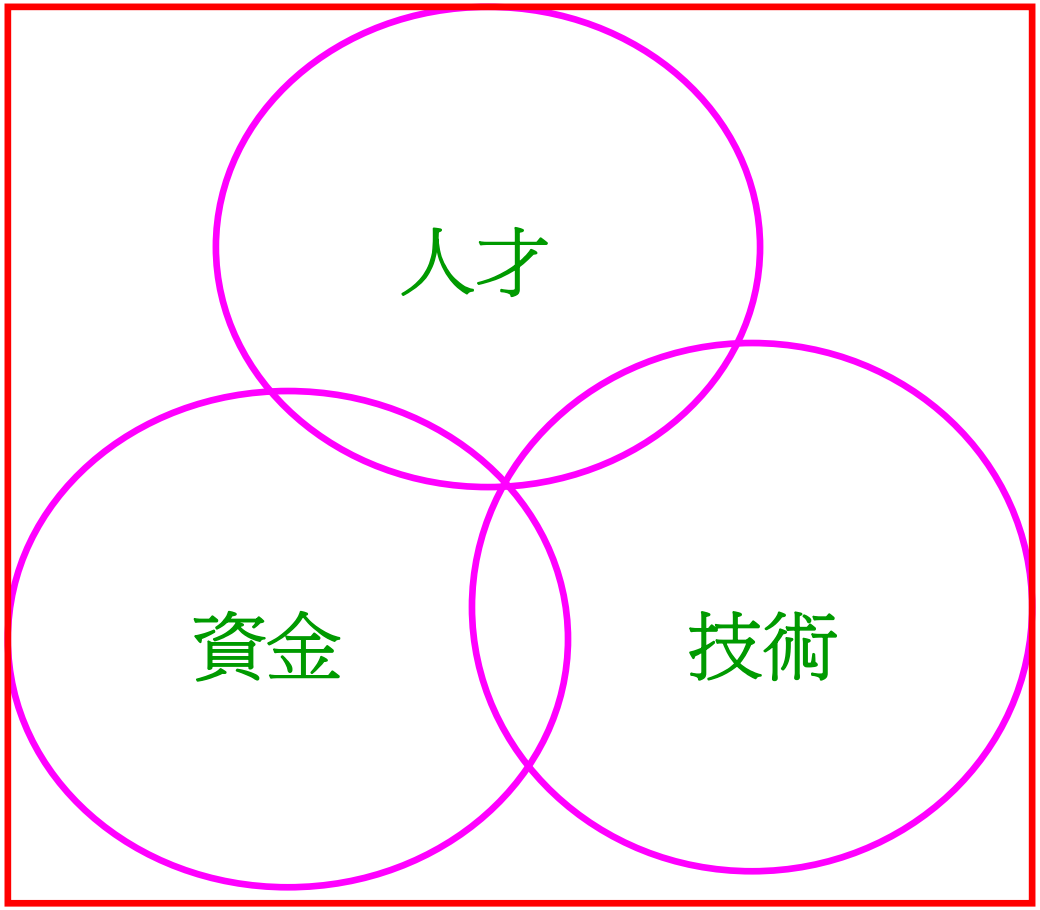
IC introduction-

Why Si ?

- **Single Crystal Structure**
  - -Periodic and predictable
- **Semiconductor- all electronic components but inductor**
  - -Diode (Asymmetric resistor), Transistor (Switch), Resistor, Cpactor
- **Abundant and cheap- made of sand**
- **Easy to transform to other materials**
  - -conductor (doping and anneal)
  - - insulator by oxidation (SiO2)

IC Manufacturing History

IC value:



IC Manufacturing History

- The beginning of the information age: invention of integrated circuit or IC about 40 years ago.

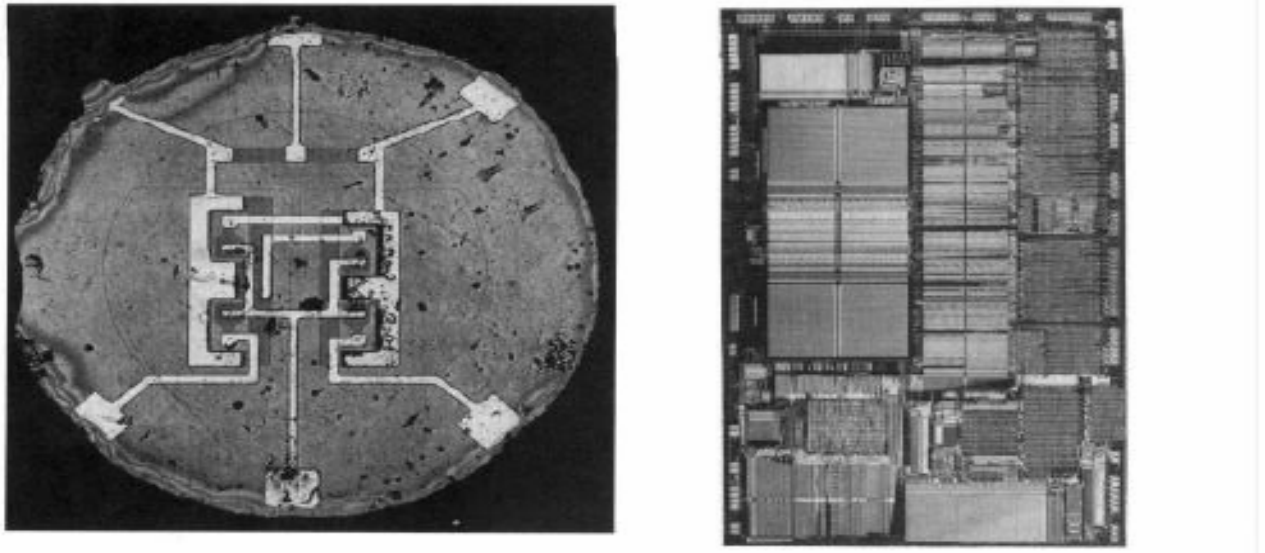


Figure 1–1 Photomicrographs of state-of-the-art ICs manufactured in the early 1960s (left) and in the early 1990s (right). The 1960s IC contains four bipolar transistors and several resistors. The 1990s chip contains over a million MOS transistors.

IC Manufacturing History

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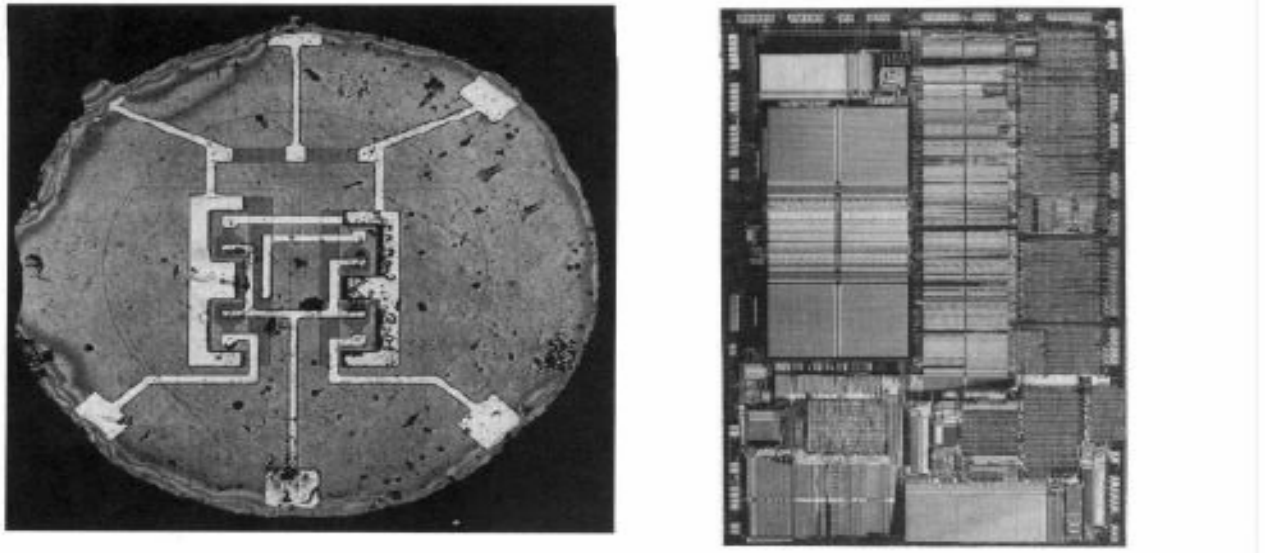
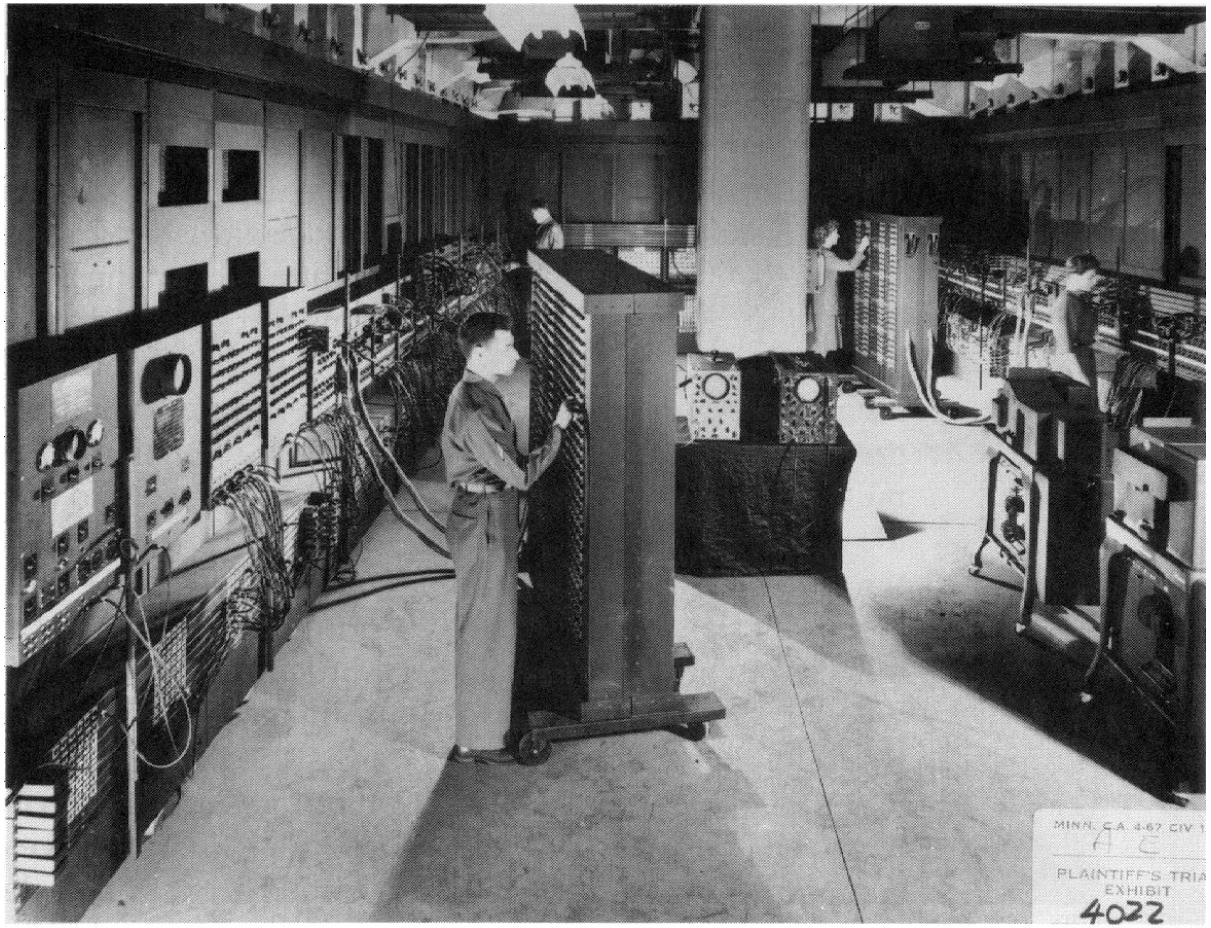


Figure 1–1 Photomicrographs of state-of-the-art ICs manufactured in the early 1960s (left) and in the early 1990s (right). The 1960s IC contains four bipolar transistors and several resistors. The 1990s chip contains over a million MOS transistors.

IC Manufacturing History

The first electronic computer (1946)



IC Manufacturing History

真空管電腦 － 第 1 代電腦 (1946 ~ 1953)

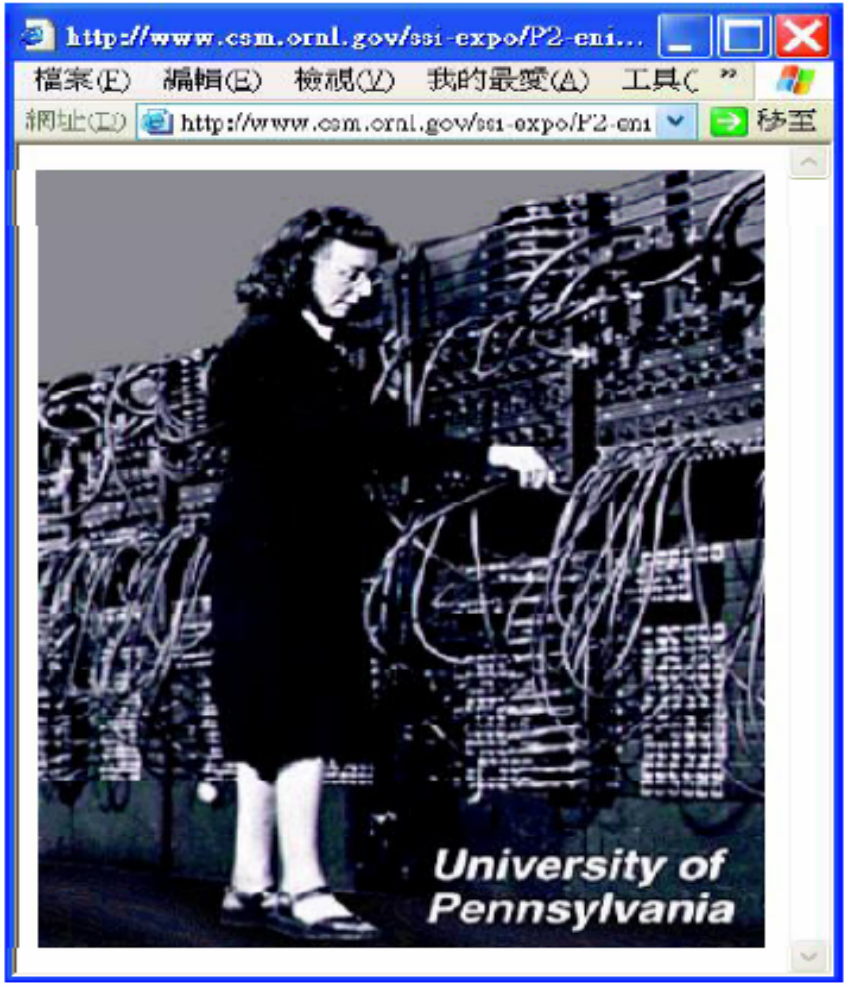
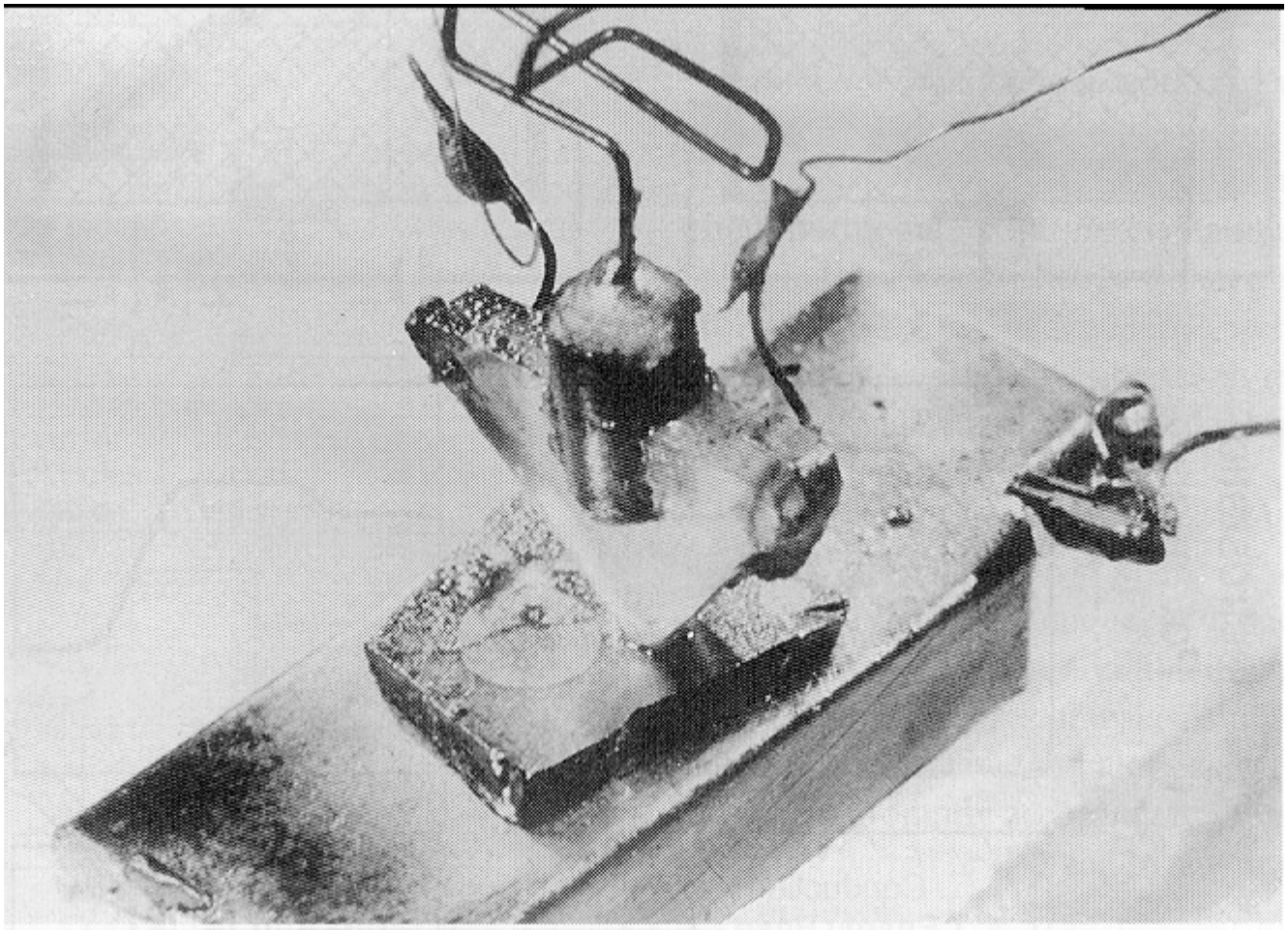


圖 1-5 人類第一部電腦 － ENIAC

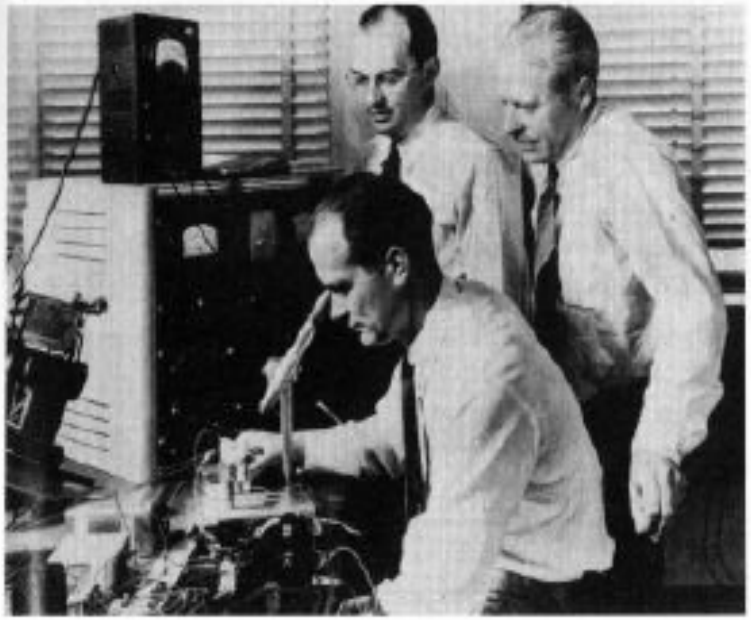
IC Manufacturing History

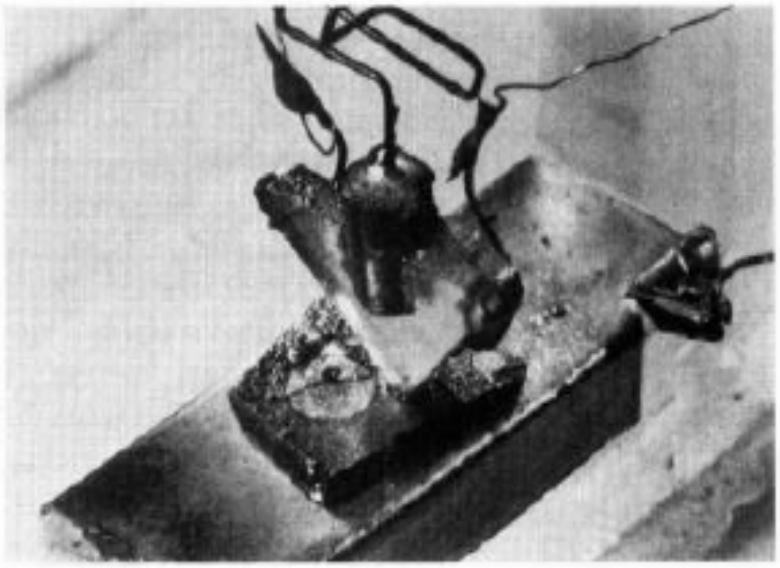
First transistor Bell Labs, 1948



IC Manufacturing History

First transistor Bell Labs, 1948

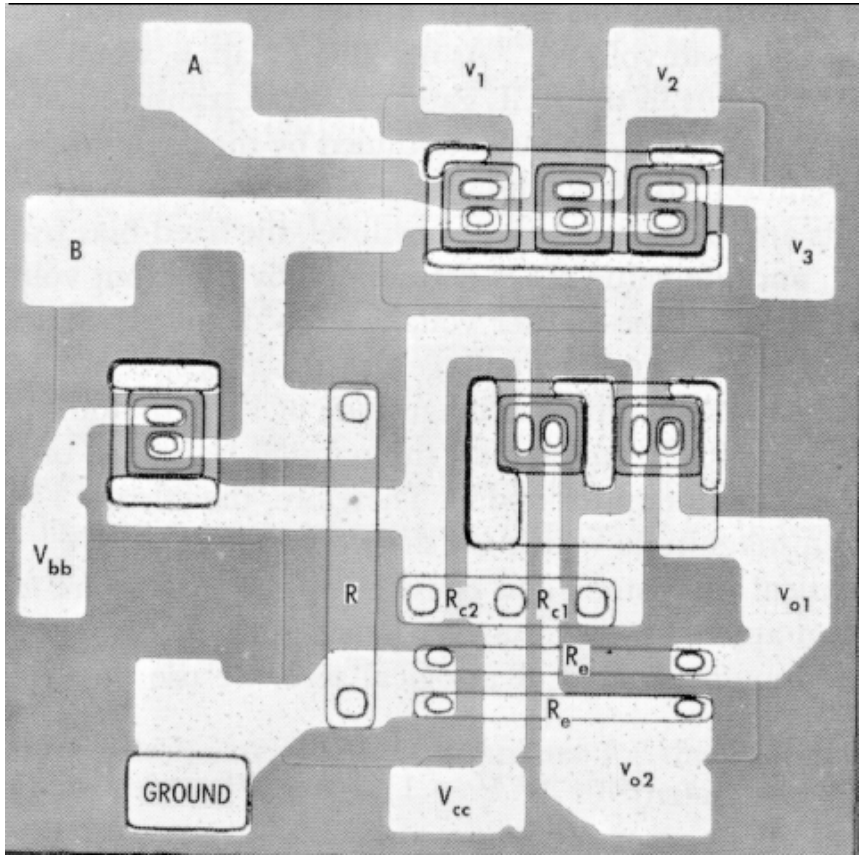




- 1947: the point contact transistor on polycrystalline Ge invented at Bell Lab by Bardeen, Brattain, and Shockley
- 1953: Bardeen and Brattain found the surface properties of semiconductors could be controlled by exposing them to oxygen, water, or ozone.
- Single crystal (controllable, stable, and reproducible) and SiO_2 are the two

IC Manufacturing History

The First Integrated Circuits

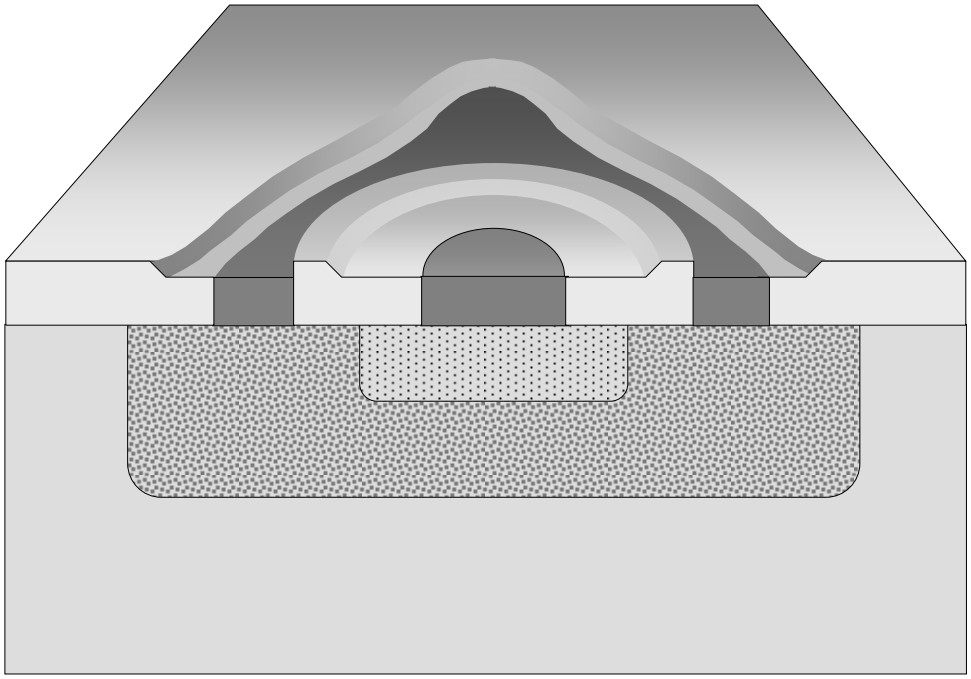


Bipolar logic 1960's

ECL 3-input Gate
Motorola 1966

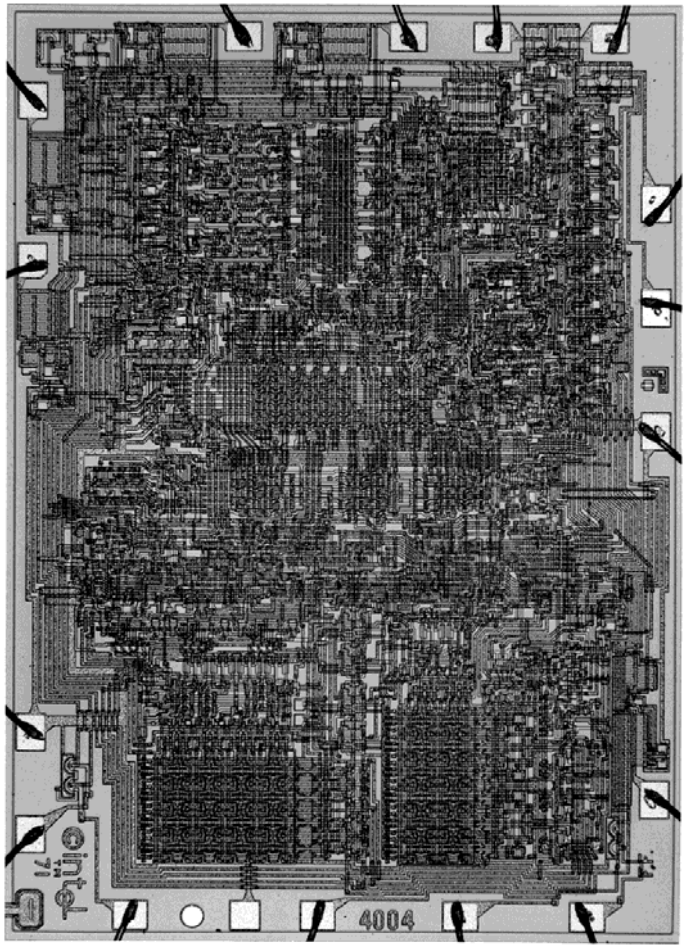
IC Manufacturing History

第一平面式電晶體



IC Manufacturing History

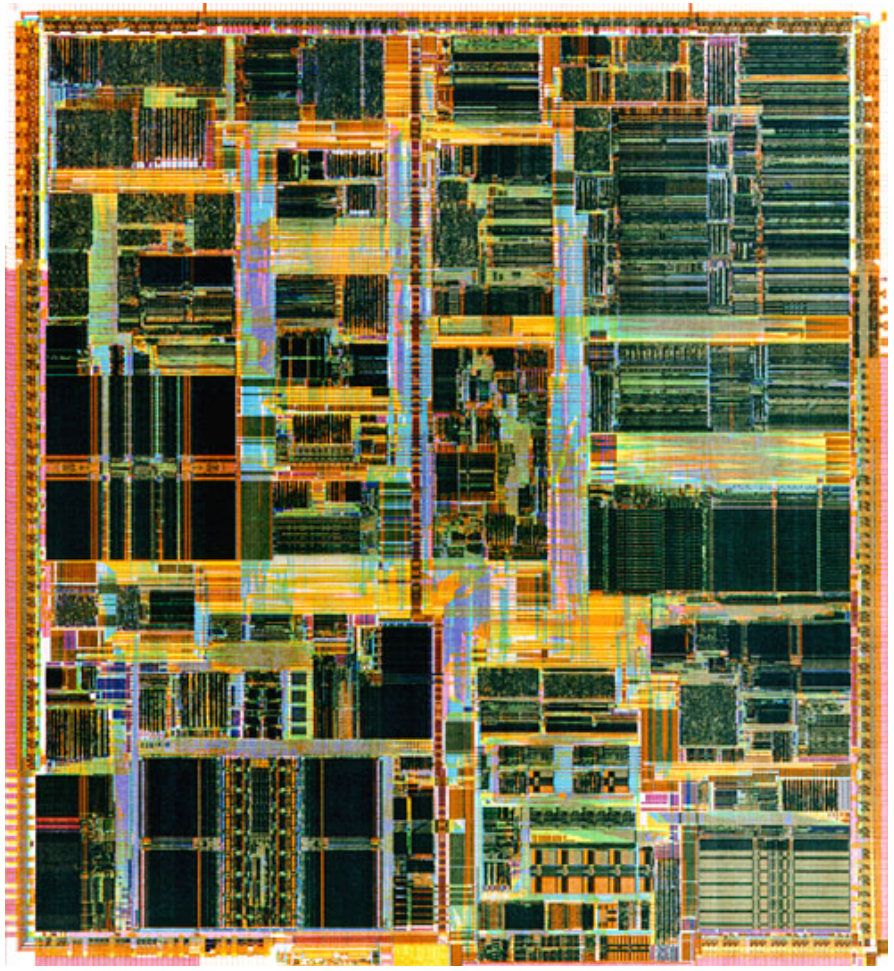
Intel 4004 Micro-Processor



1971
1000 transistors
1 MHz operation

IC Manufacturing History

Intel Pentium (IV) microprocessor

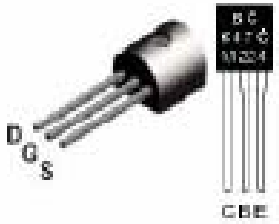


IC Manufacturing History

IC 發展之路程:

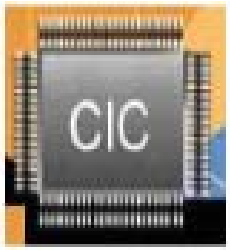
1906 ~ now

John A. Fleming



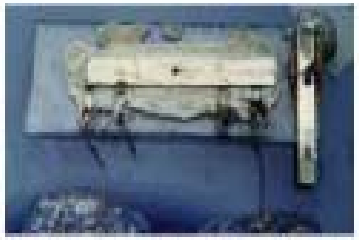
1947~now

John Bardeen, Walter Brattain, and William Shockley

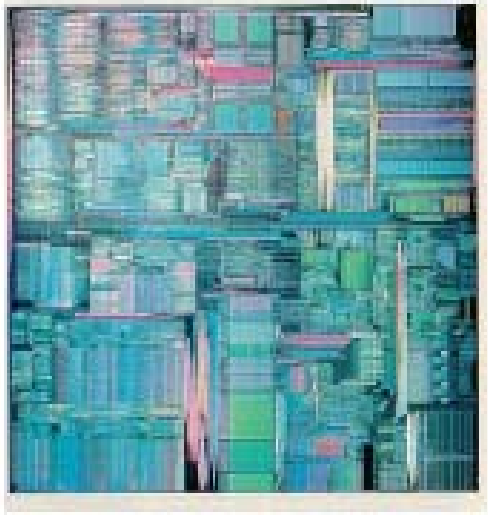


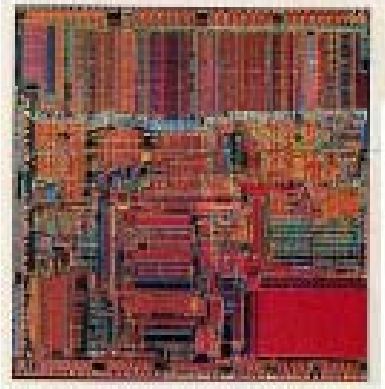
1958~now

Jack Kilby and Robert Noyce



Texas Instruments' first IC





386

4004

IC Manufacturing History

20世紀後半世紀之 IC 發展:

- SSI (Small-Scaled Integrated Circuits)
  - 小型積體電路→含數十個元件 (1970s)
- MSI (Medium-Scaled IC)
  - 中型積體電路→含數百個元件
- LSI (Large-Scaled IC)
  - 大型積體電路→含數千個元件 (1980s)
- VLSI (Very Large Scaled IC)
  - 超大型積體電路→含數萬個元件 (1990s)
- SoC (System on a Chip)
  - 單晶片系統→含數百萬個元件 (2000s)

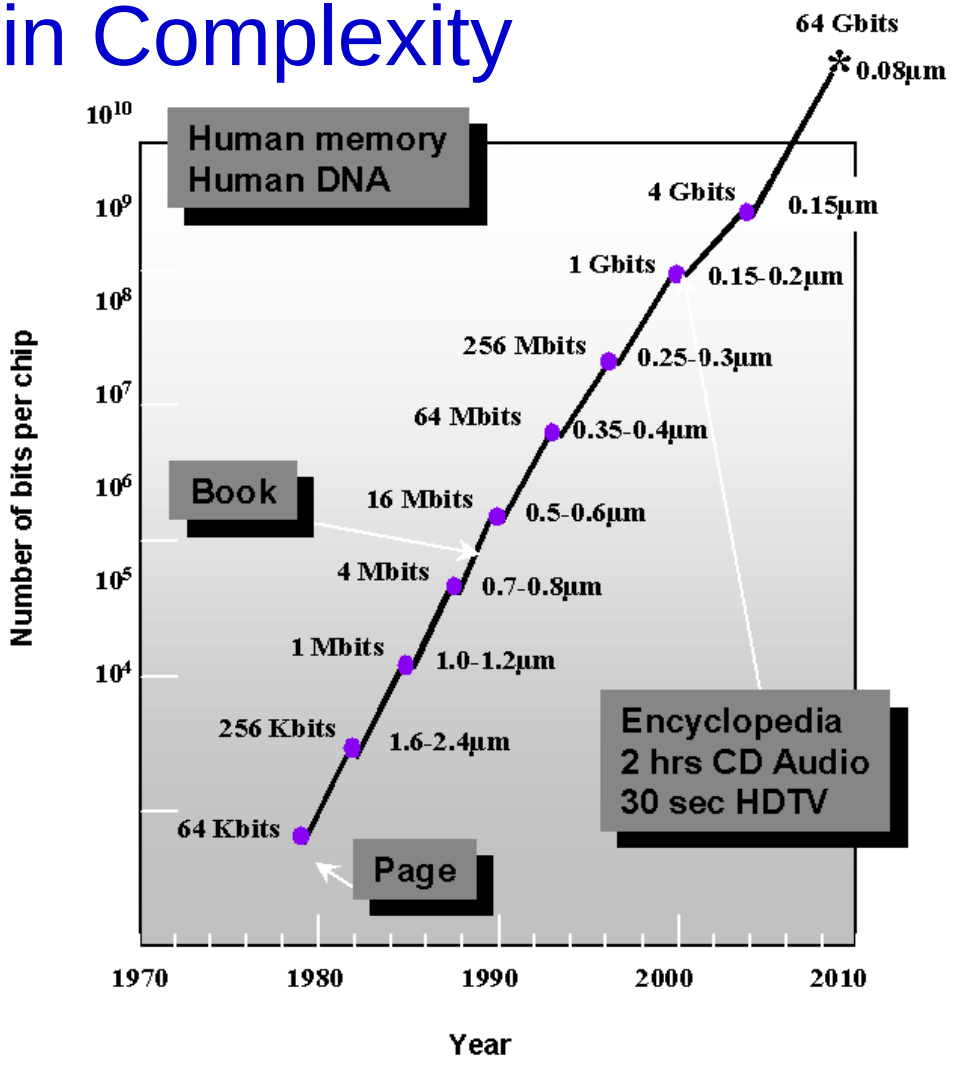
IC Manufacturing History

Moore's Law

- In 1965, Gordon Moore noted that the number of transistors on a chip doubled every 18 to 24 months.
- He made a prediction that semiconductor technology will double its effectiveness every 18 months

IC Manufacturing History

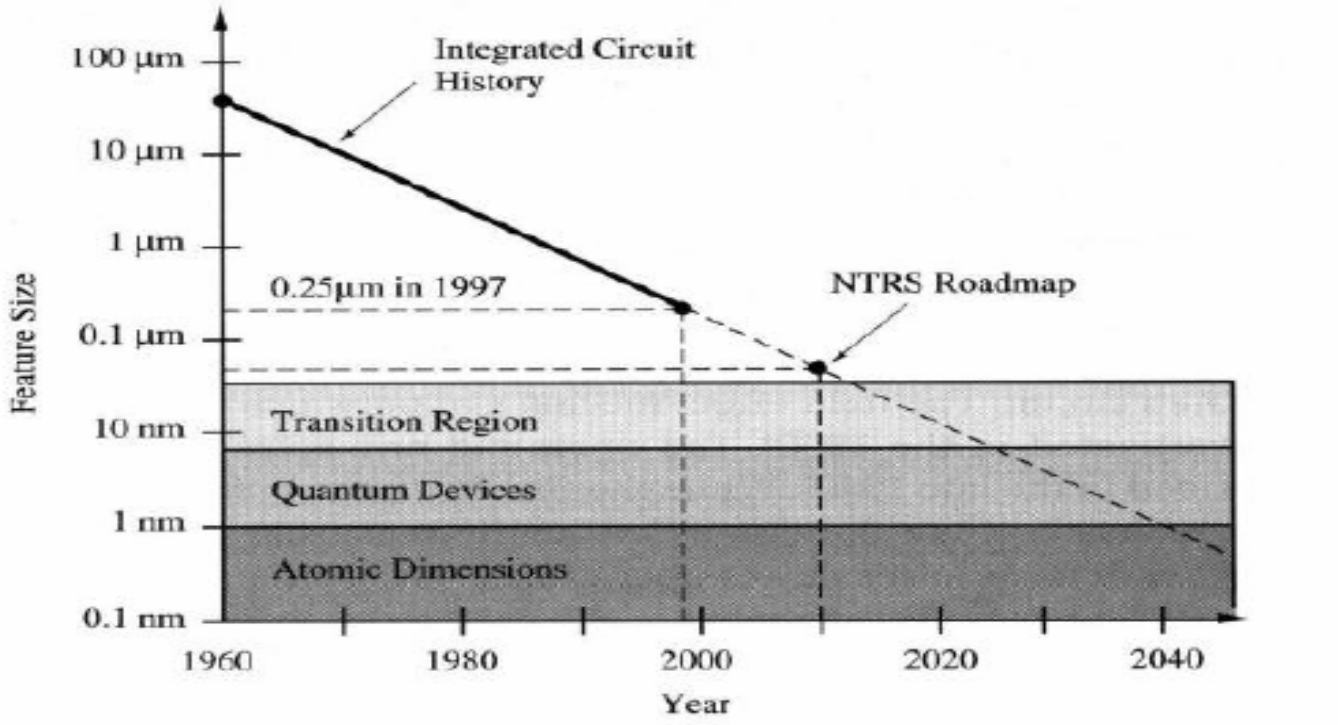
Evolution in Complexity



IC Manufacturing History

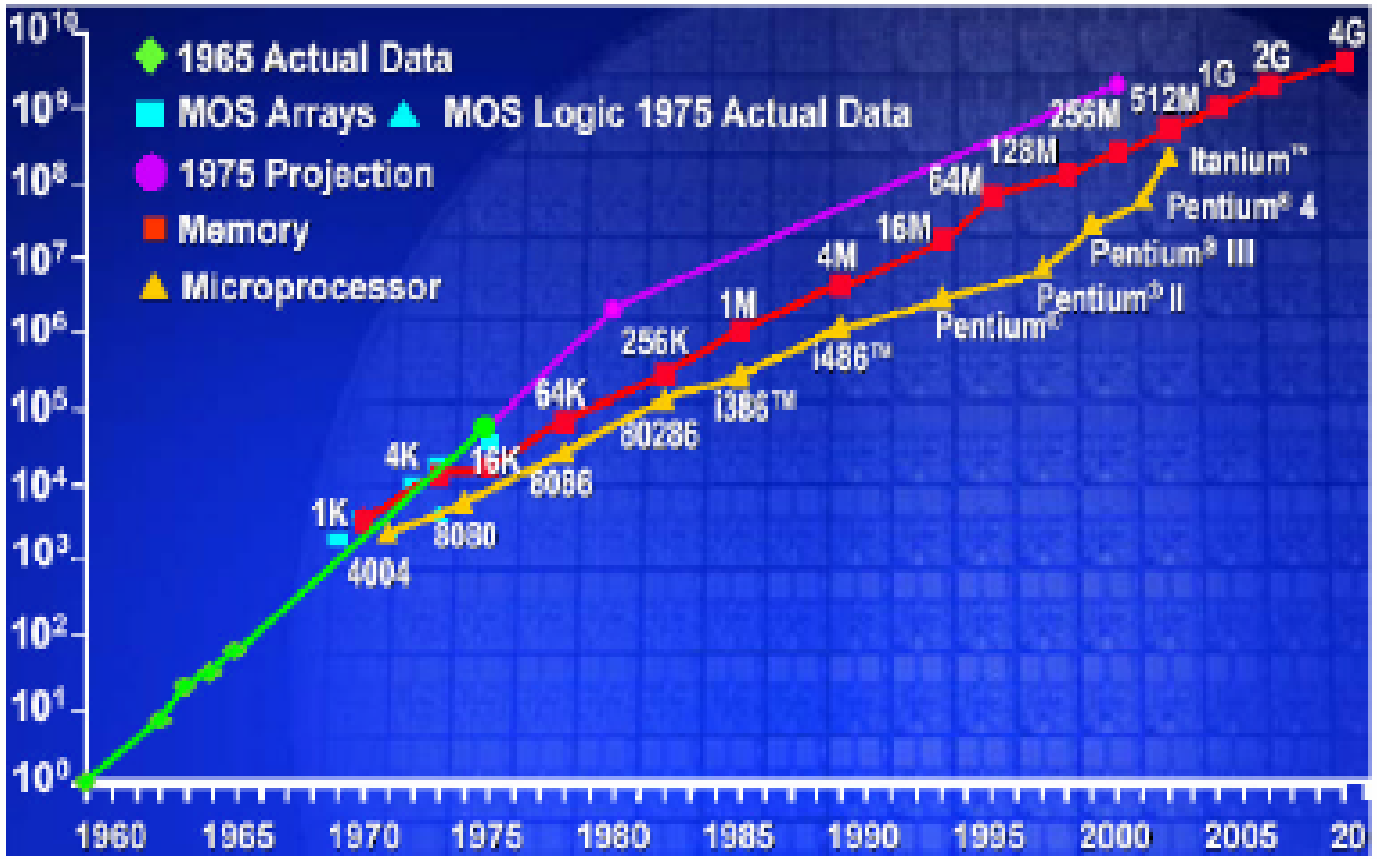
Moore's Law

Doubling of the number of transistors on a chip roughly every two years.



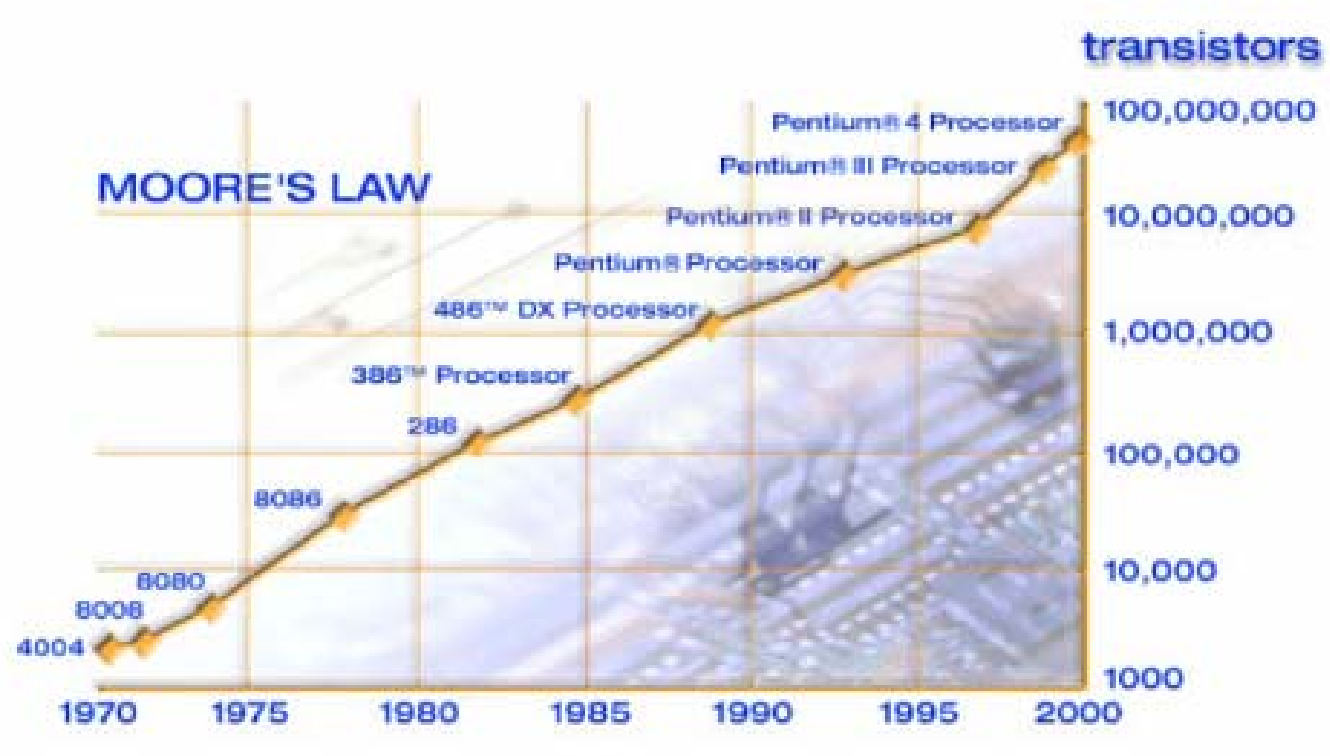
IC Manufacturing History

Moore's Law



IC Manufacturing History

Moore's Law



IC Manufacturing History

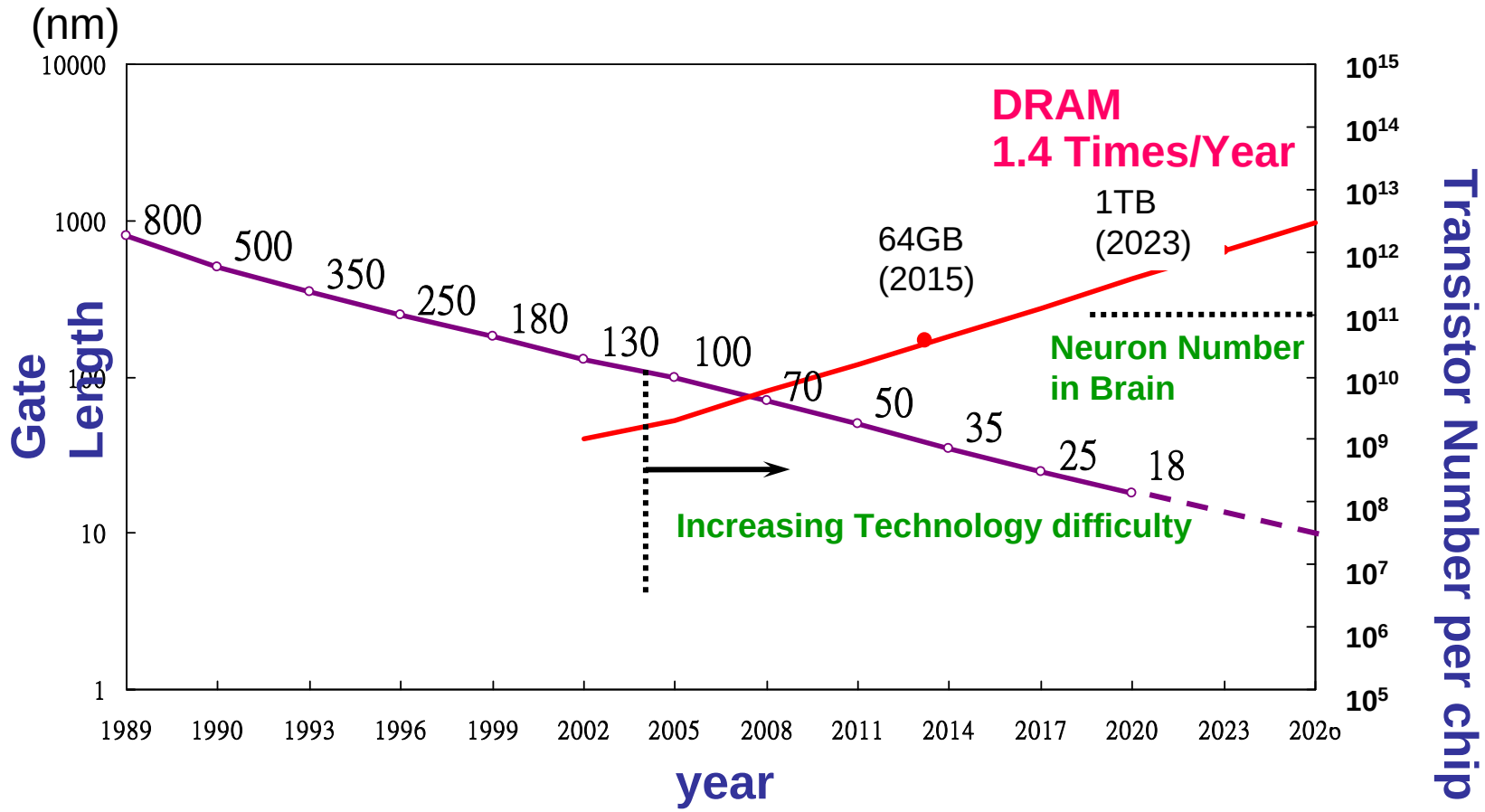
Roadmap of IC

Table 1–1 Future projections for silicon technology taken from the SIA NTRS [1.3]

Year of first DRAM shipment	1997	1999	2003	2006	2009	2012
Minimum Feature Size	250 nm	180 nm	130 nm	100 nm	70 nm	50 nm
DRAM Bits/Chip	256M	1G	4G	16G	64G	256G
DRAM Chip Size (mm^2)	280	400	560	790	1120	1580
Microprocessor Transistors/chip	11M	21M	76M	200M	520M	1.40B
Maximum Wiring Levels	6	6–7	7	7–8	8–9	9
Minimum Mask Count	22	22–24	24	24–26	26–28	28
Minimum Supply Voltage (volts)	1.8–2.5	1.5–1.8	1.2–1.5	0.9–1.2	0.6–0.9	0.5–0.6

IC Manufacturing History

Silicon Story



IC Manufacturing History

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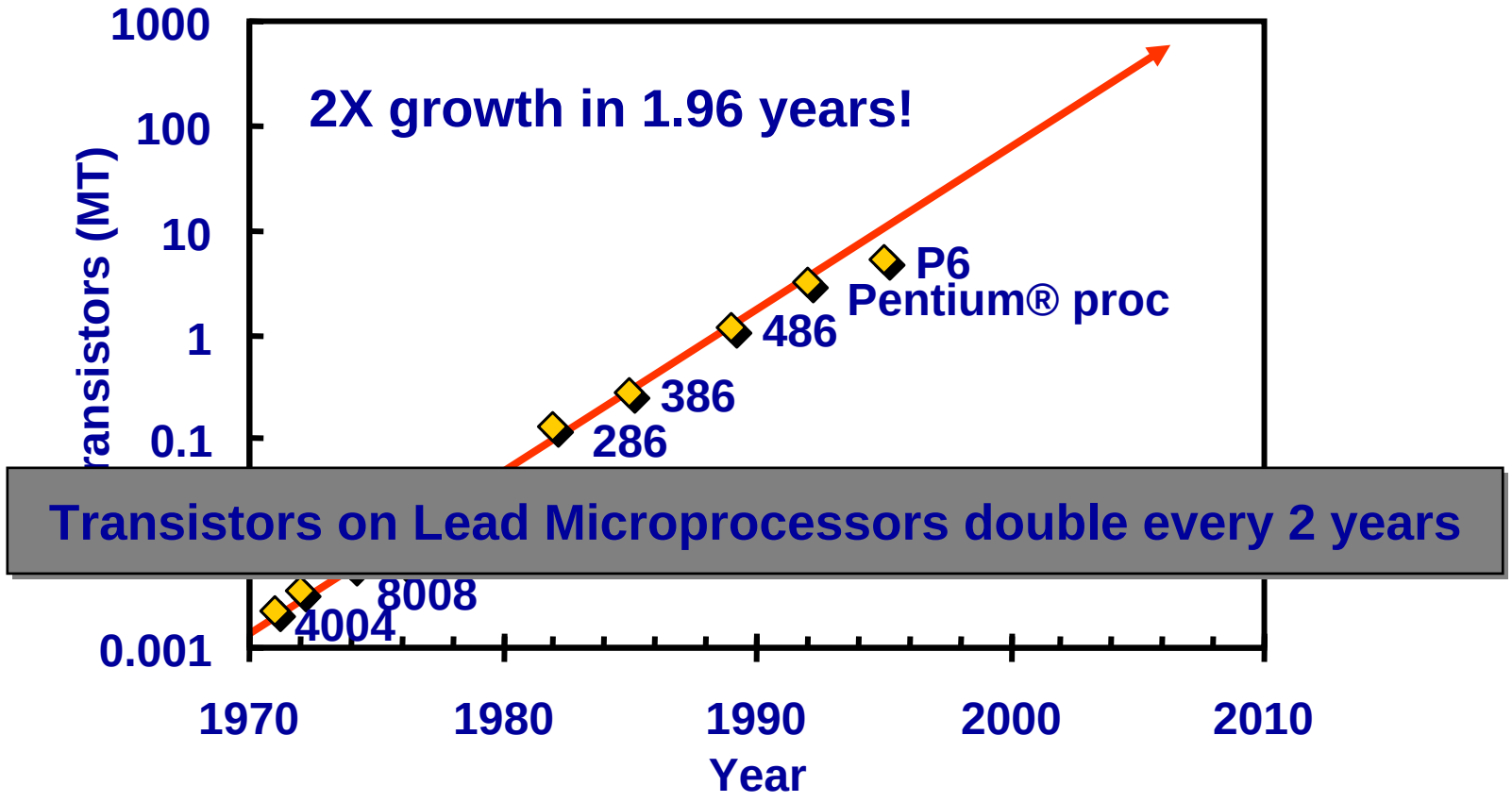
IC Manufacturing History

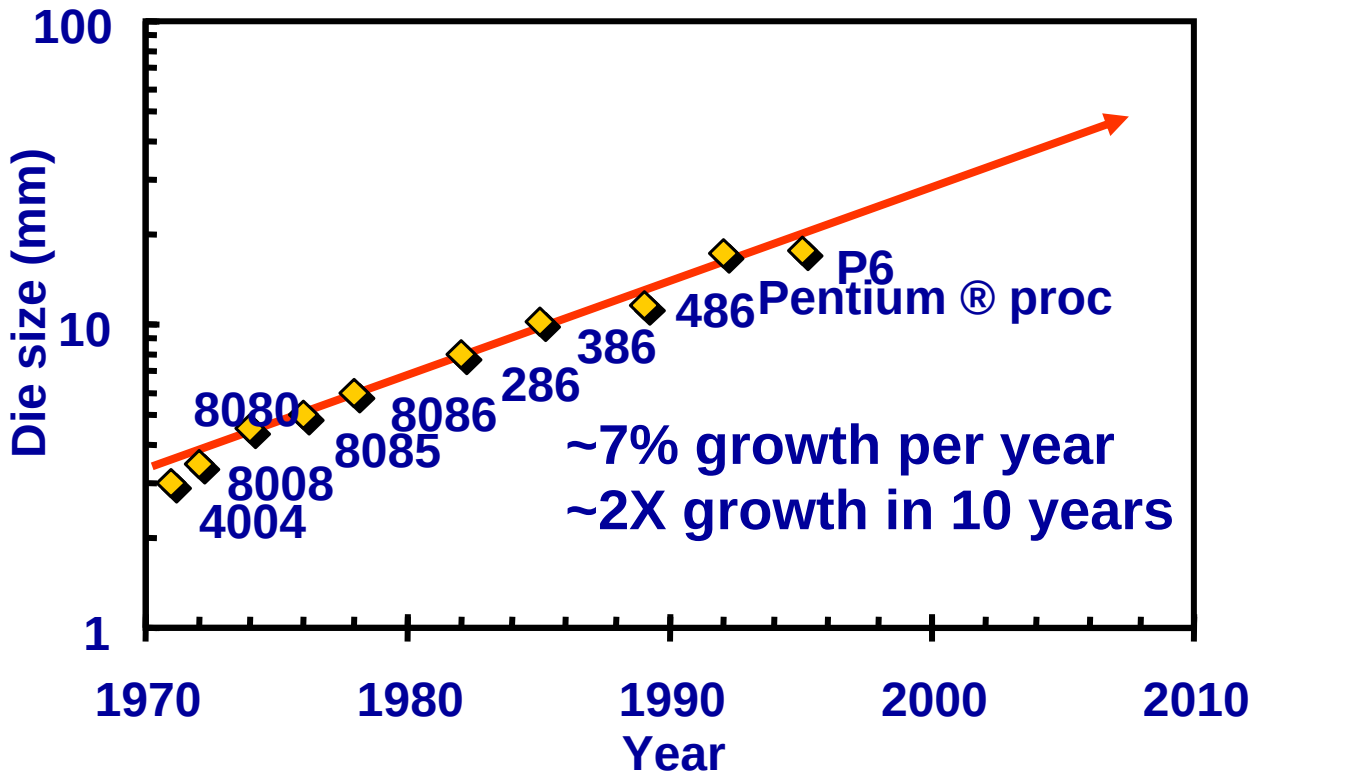
Moore's law in Microprocessors



Transistors on Lead Microprocessors double every 2 years

IC Manufacturing History

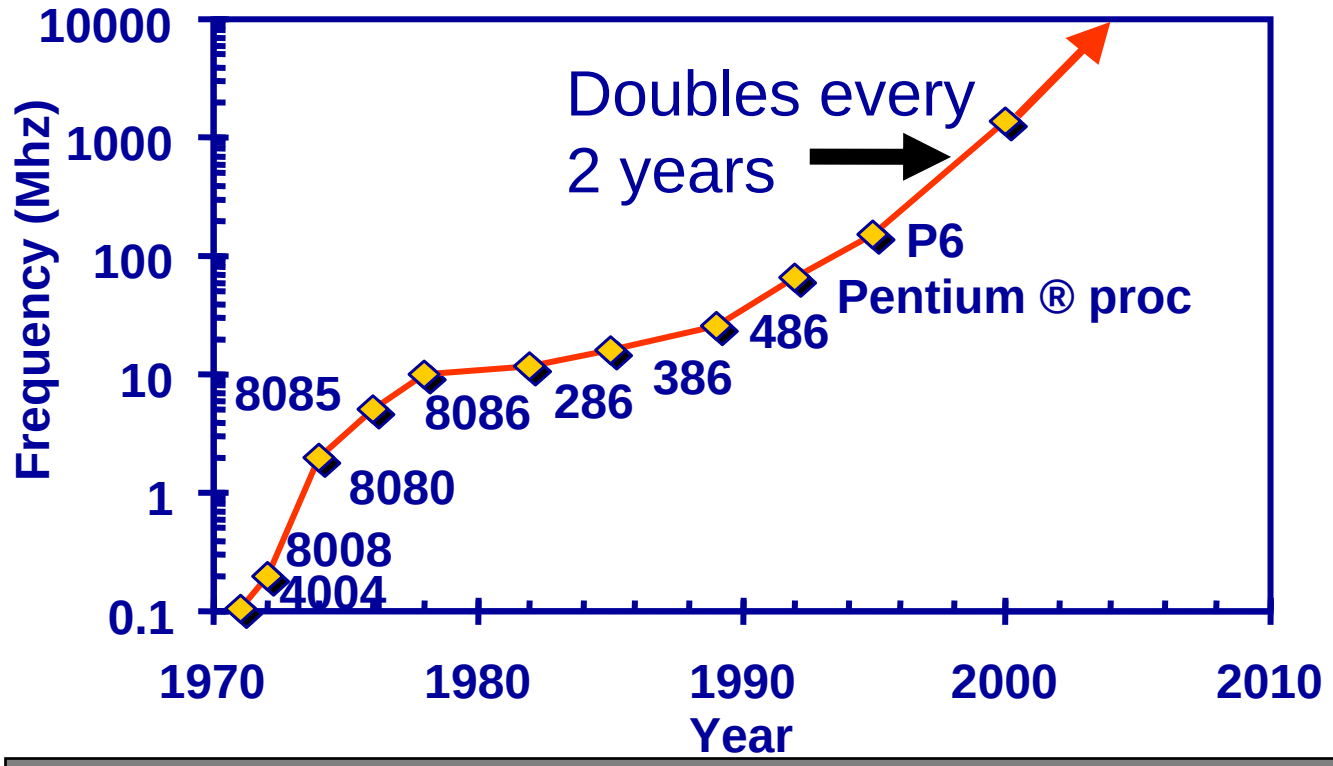
Die Size Growth



Die size grows by 14% to satisfy Moore's Law

IC Manufacturing History

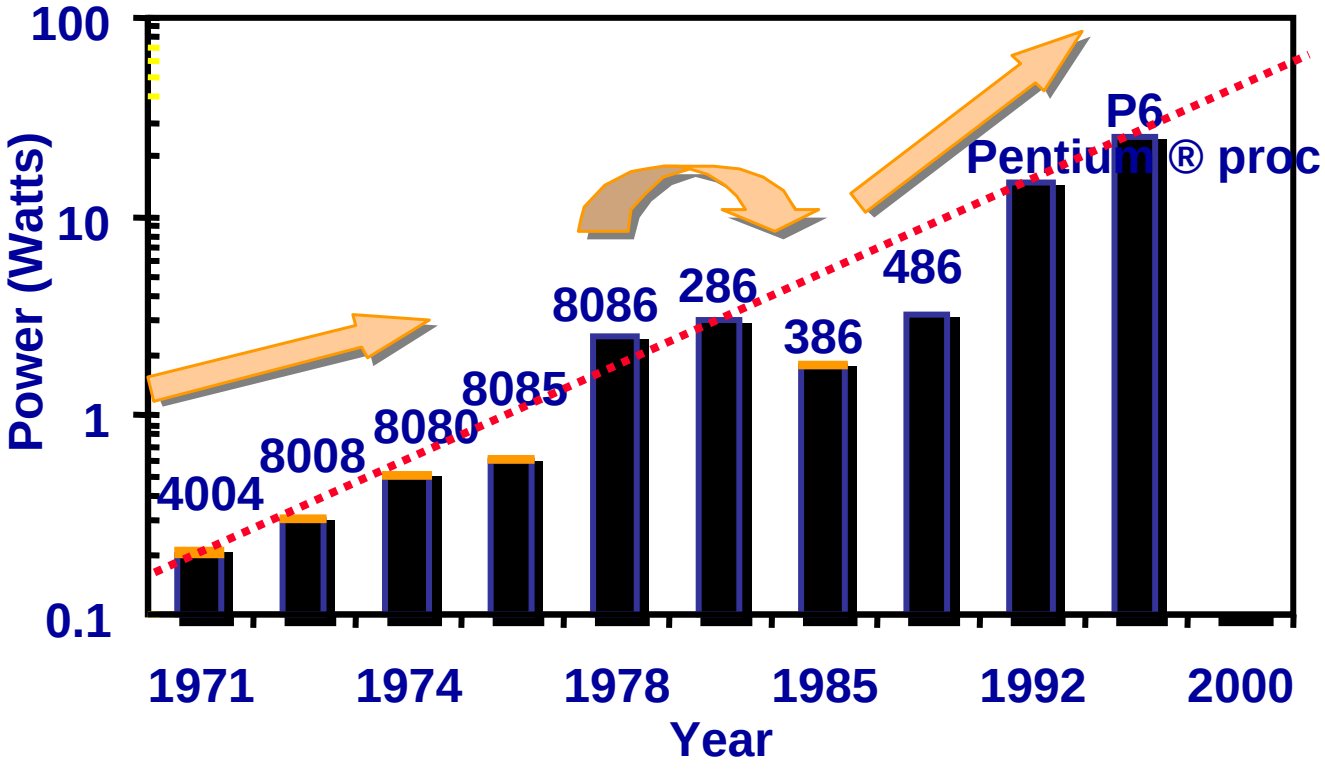
Frequency



Lead Microprocessors frequency doubles every 2 years

IC Manufacturing History

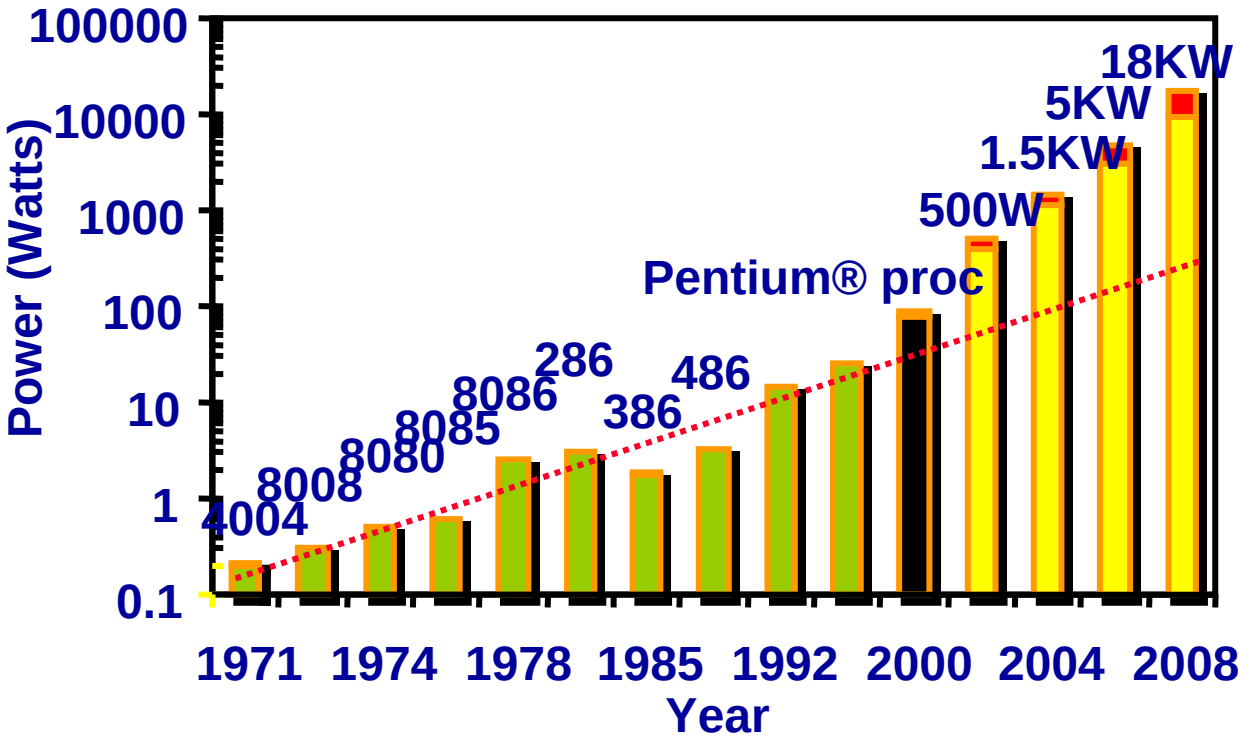
Power Dissipation



Lead Microprocessors power continues to increase

IC Manufacturing History

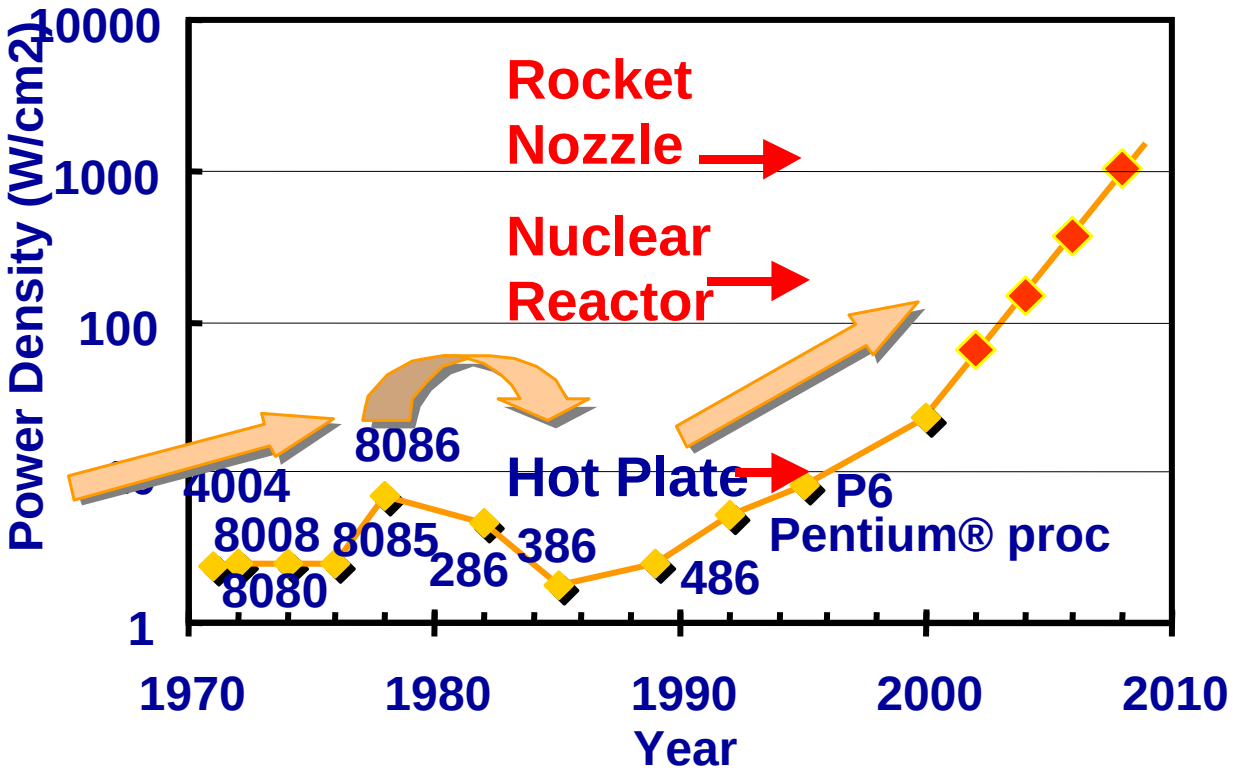
Power will be a major problem



Power delivery and dissipation will be prohibitive

IC Manufacturing History

Power density



Power density too high to keep junctions at low temp

IC Manufacturing History

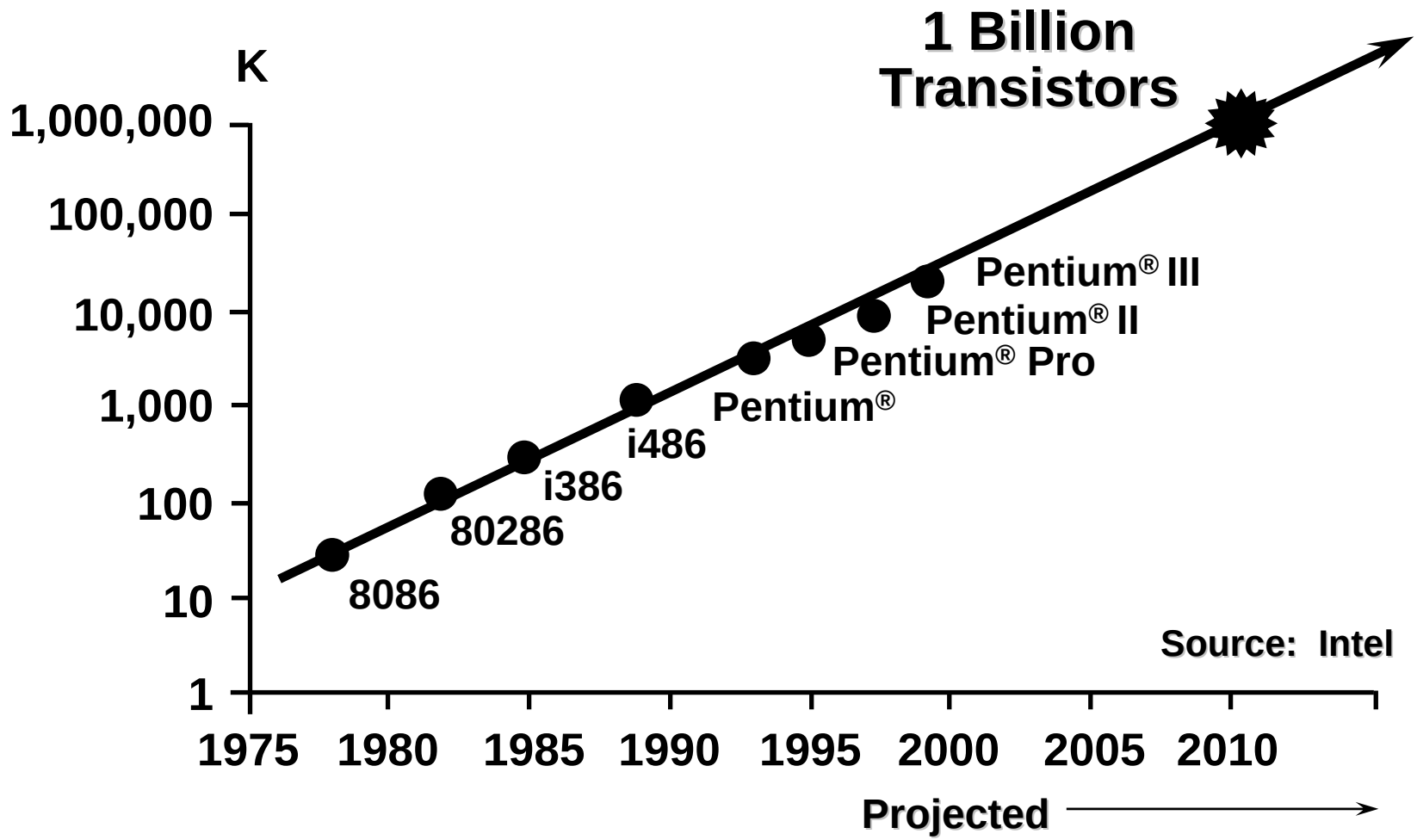
Integration level	Abbreviation	Number of devices on a chip
Small Scale Integration	SSI	2 to 50
Medium Scale Integration	MSI	50 to 5,000
Large Scale Integration	LSI	5,000 to 100,000
Very Large Scale Integration	VLSI	100,000 to 10,000,000
Ultra Large Scale Integration	ULSI	10,000,000 to 1,000,000,000
Super Large Scale Integration	SLSI	over 1,000,000,000

IC Manufacturing History

20世紀後半世紀之 IC 發展年代紀實:

- 1958 : Single transistor 1
- 1962+: SSI 10
- 1967 : MSI (Medium) 100
- 1972 : LSI 1000
- 1978 : VLSI 10^5-10^6
- 1990 : ULSI (Ultra) $>10^6$
- 2000 : SoC (System on Chip)

IC Manufacturing History



IC Manufacturing History

Why Scaling?

Technology shrinks by 0.7/generation

With every generation can integrate 2x more functions per chip; chip cost does not increase significantly

Cost of a function decreases by 2x

But …

How to design chips with more and more functions?

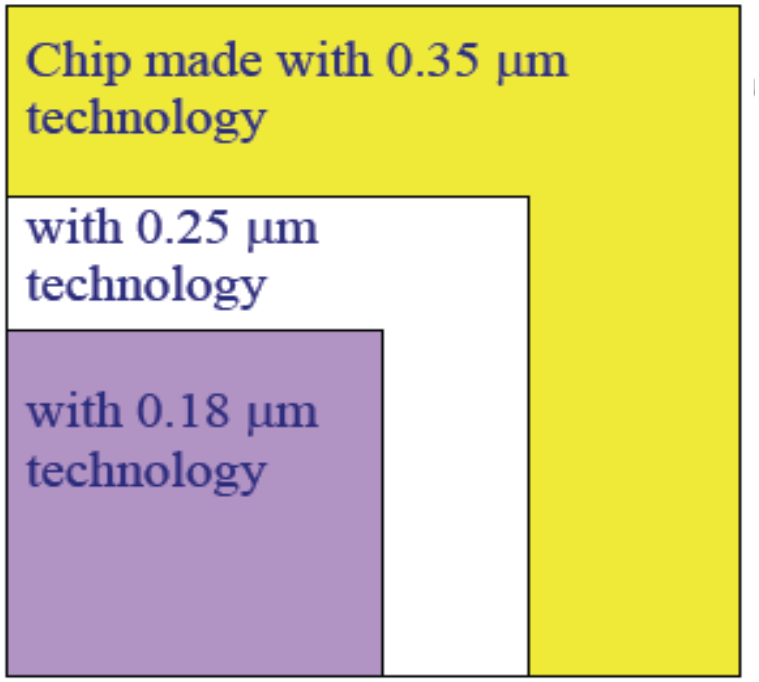
Design engineering population does not double every two years…

Hence, a need for more efficient design methods

Exploit different levels of abstraction

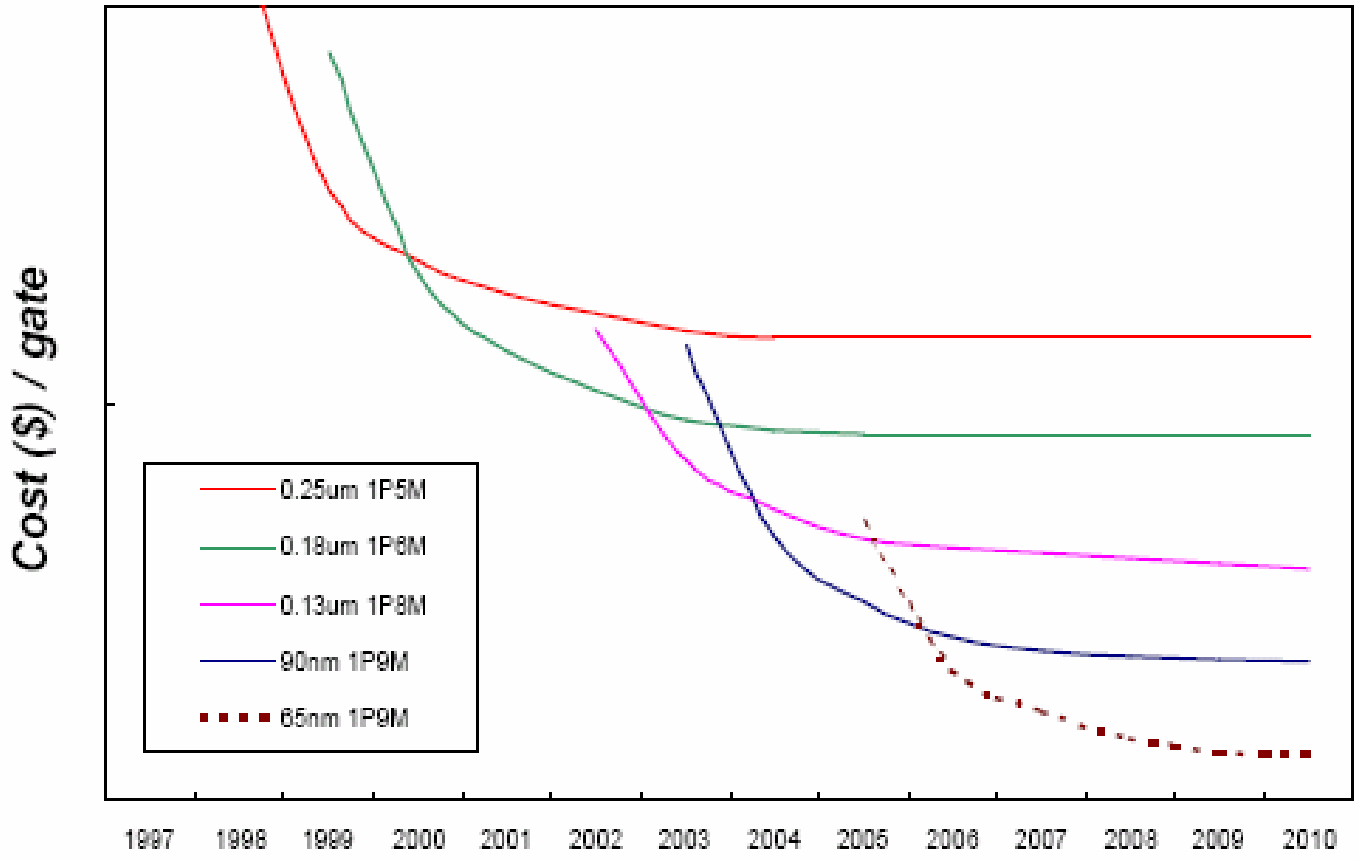
IC Manufacturing History

Why Scaling?



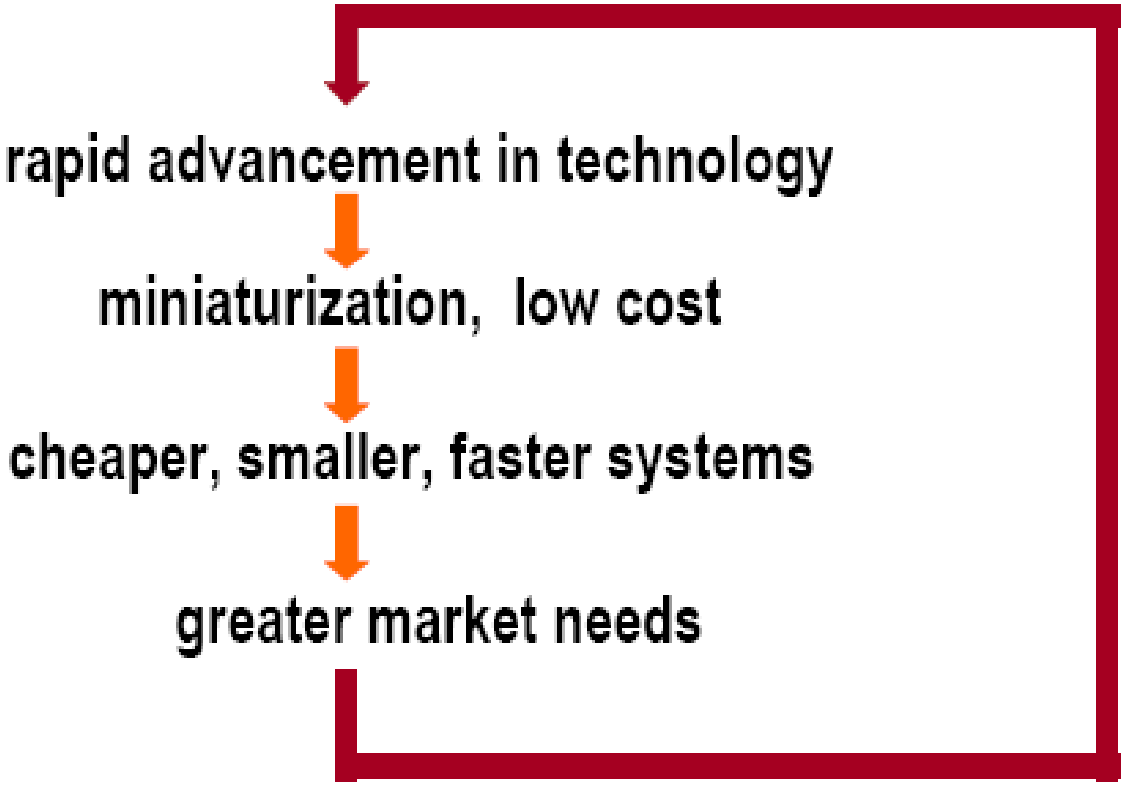
IC Manufacturing History

The trend of Semiconductor



IC Manufacturing History

Why Scaling?



Moore's Law