

Chapter 1



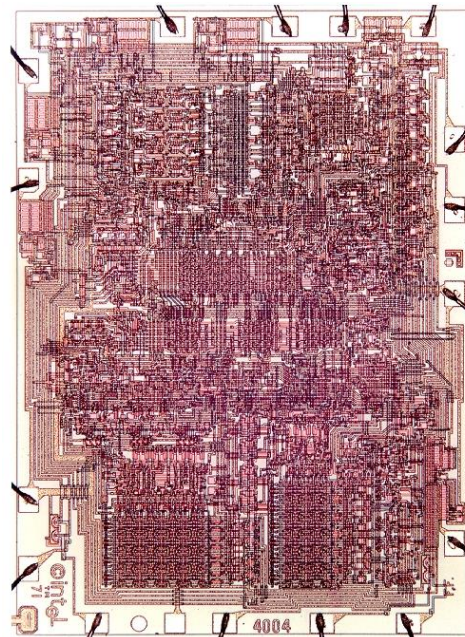
Introduction *- Extension*

1.1 Source: Foundations of Computer Science © Cengage Learning

Microprocessor Evolution

The First Microprocessor Intel 4004

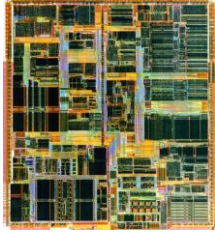
1000 transistors
1 MHz operation
4-bit CPU
1971



1.2

Courtesy, Intel

Intel Pentium IV Microprocessor, 2001



Intel core i7, 2013



source: google's web

1.3

512GB SanDisk Extreme PRO SDXC UHS-I (Source : SanDisk) 2014



Courtesy, Intel

Intel Core i7-6700K、Core 7-5775C、Core i7-4790K 規格比較表			
■ 處理器型號	Core i7-4790K	Core i7-5775C	Core i7-6700K
■ 微處理器架構	Haswell	Broadwell	Skylake
■ 製程	22nm	14nm	14nm
■ 總核心數 / 總執行緒	4 / 8	4 / 8	4 / 8
■ 工作時脈	4.0GHz	3.3GHz	4.0GHz
■ 外頻 x 倍頻	100 x 40	100 x 33	100 x 40
■ 自動超頻	TurboBoost : 4.4GHz	TurboBoost : 3.7GHz	TurboBoost : 4.2GHz
■ 對外連結	DMI	DMI	DMI
■ 記憶體支援	DDR3 / DDR3L	DDR3 / DDR3L	DDR3L / DDR4
■ L1 快取記憶體	(32KB+32KB) x4	(32KB+32KB) x4	(32KB+32KB) x4
■ L2 快取記憶體	256KB x4	256KB x4	256KB x4
■ L3 快取記憶體	共享 8MB	共享 6MB	共享 8MB
■ L4 快取記憶體	N/A	128MB eDRAM	N/A
■ 封裝	LGA1150	LGA1150	LGA1151
■ 內建繪圖晶片	HD Graphics 4600	Iris Pro Graphics 6200	HD Graphics 530
■ 繪圖晶片基頻	350~1250MHz	300~1150MHz	300~1150MHz

source: google's web

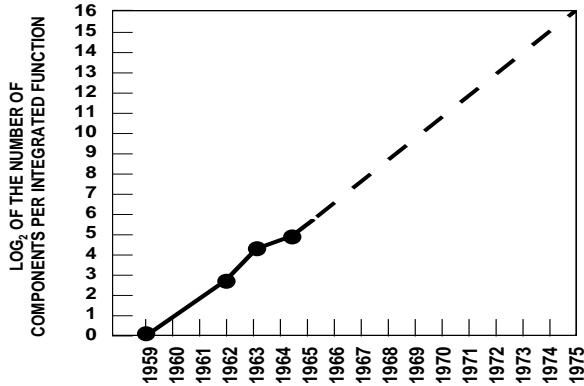
1.4

Courtesy, Intel

Moore's Law

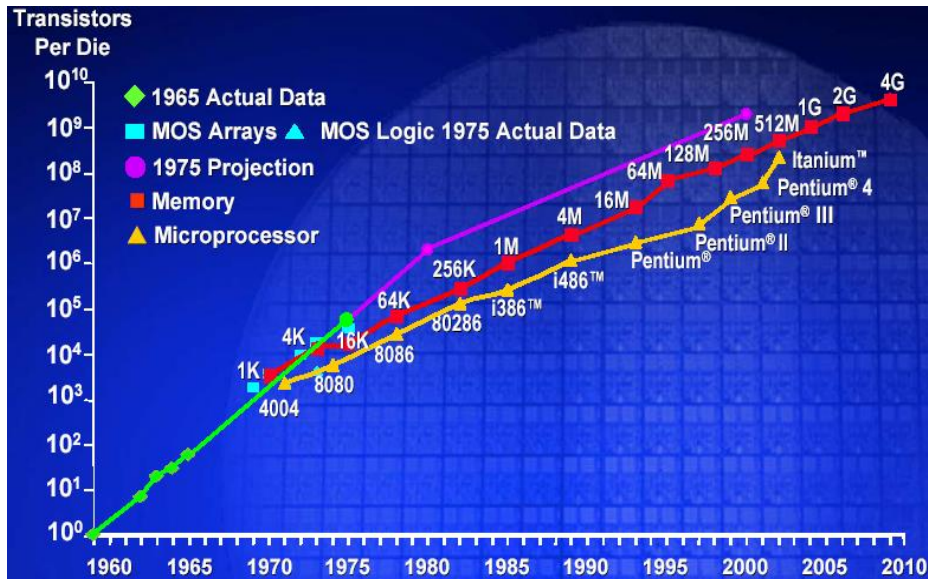
(*Electronics*, April 19, 1965)

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**.



1.5

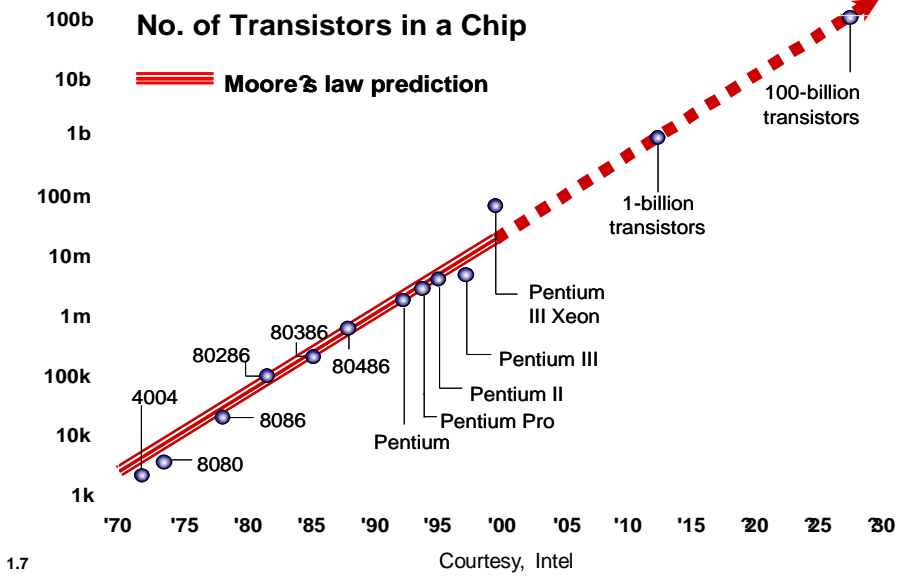
Exponent Growth to follow Moore's Law



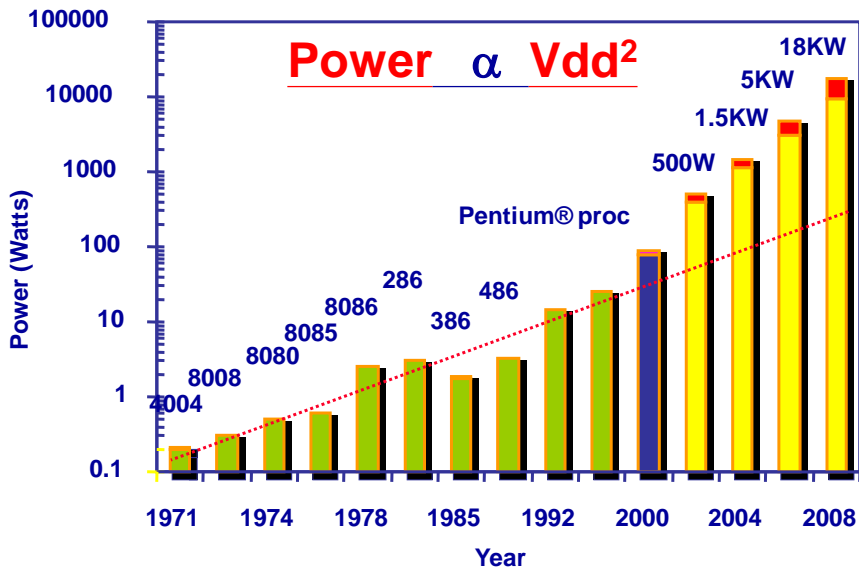
1.6

CPU Evolution CPU

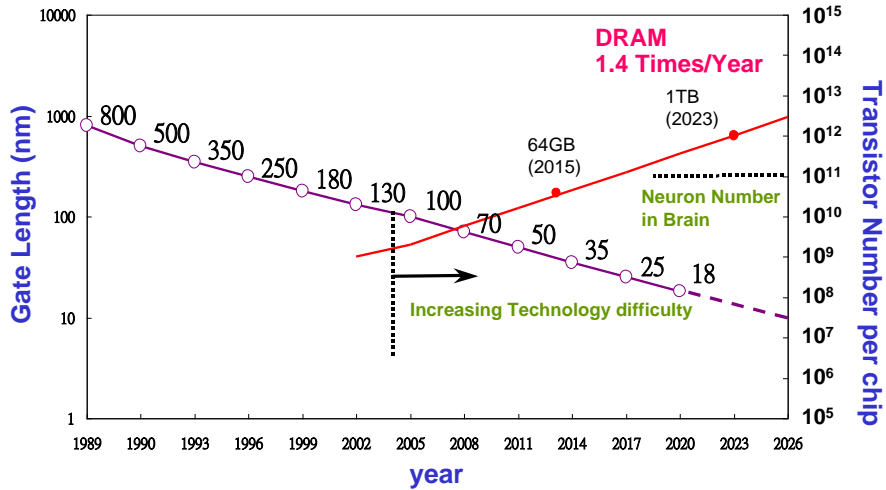
Die size grows by 14% to satisfy Moore's Law



Power will be a major problem



Process Technology Evolution



1.9

Courtesy, Intel

Nano-Meter Scaling

Human hair's diameter : 70~100μm

Human felling cell : 50~100 μm

Human ovum cell : 100 μm

Plant cell : 100 μm

Human red hemocyte : 5 μm

Germ : 1~8 μm

Virus : hundreds nm

Protein : number tens nm

DNA : 2nm

Atom : 0.1nm

T = 10¹²

G = 10⁹

M = 10⁶

k = 10³

m = 10⁻³

μ = 10⁻⁶

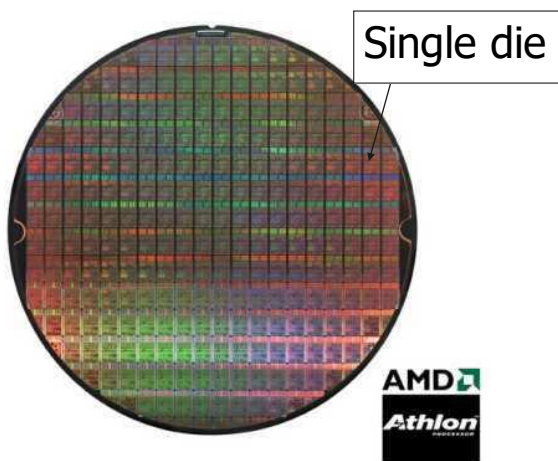
n = 10⁻⁹

p = 10⁻¹²

f = 10⁻¹⁵

1.10

Wafer Size



2", 3", and 5"

1987, 6" (150mm)

1991, 8" (200mm)

1999, 12" (300mm)

2007, 18" (450mm)

More dies per wafer,
low cost

From <http://www.amd.com>

1.11

➤ **iPhone XS/MAX 2018: A12 Bionic**, six-core, 2.49GHz (A11 2.39GHz), **7-nm process (TSMC)**; **Increase 15% in performance and 50% in GPU, but reduce 40% in power consumption than A11.**

➤ **Apple 2018: A13 Bionic, better than A12 in performance**

➤ **Globalfoundrie** gives up the invention of 7-nm process

➤ **Intel postpones** the schedule of 7-nm process.

➤ **Samsung** will have the schedule of 7-nm process in **2019.**

1.12

Key Terms

- Integrated Circuit (IC)
- Nano meter
- Wafer

Review Questions

- What is Moore's law?
- What is the mean of 7nm-processing technology.

1.13