Introduction to Computers and Programming

Lecture 1 – Computer ABC

Tien-Fu Chen

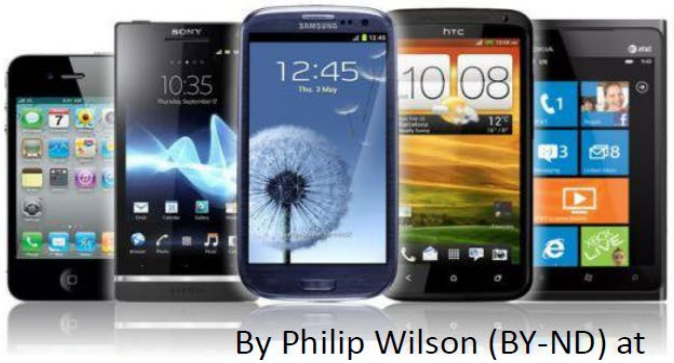
Dept. of Computer Science and Information Engineering

National Yang Ming Chiao Tung Univ.

ABC of Computers

The Age of Computing

From: https://pixabay.com/en/network-iot-internet-of-things-782707/

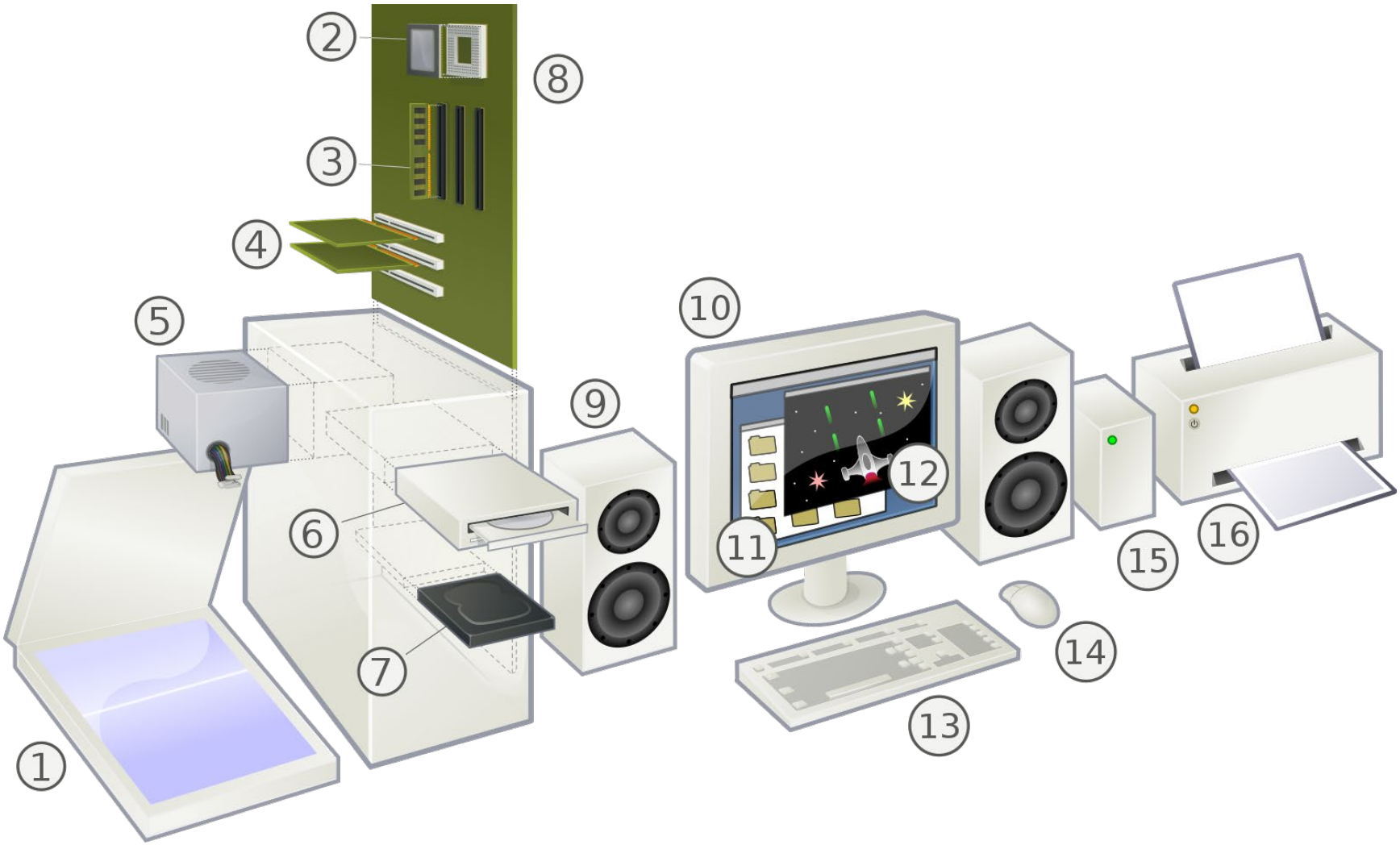


By Philip Wilson (BY-ND) at https://www.flickr.com/photos/internetsense/9900738813/

About computers

- Computing history

  http://www.computerhistory.org/timeline/computers/



https://en.wikipedia.org/wiki/File:Personal_computer,_exploded_6.svg

A computer program

- A computer program is a sequence of instructions to be executed by computers.
- Examples of computer programs in various forms:

```
0001 1001
1001 1110
1000 1011
1100 1011
1110 0010
1001 0111
1100 1011
1110 0010
1001 0111
1100 1011
```

Machine instructions

```
MOV    AX,10
SUB    BX,AX
MOV    [DX],AX
JMP    200
MOV    CX,5
MOV    AX,10
MUL    AX,CX
CMP    BX,AX
JLE    500
JMP    400
```

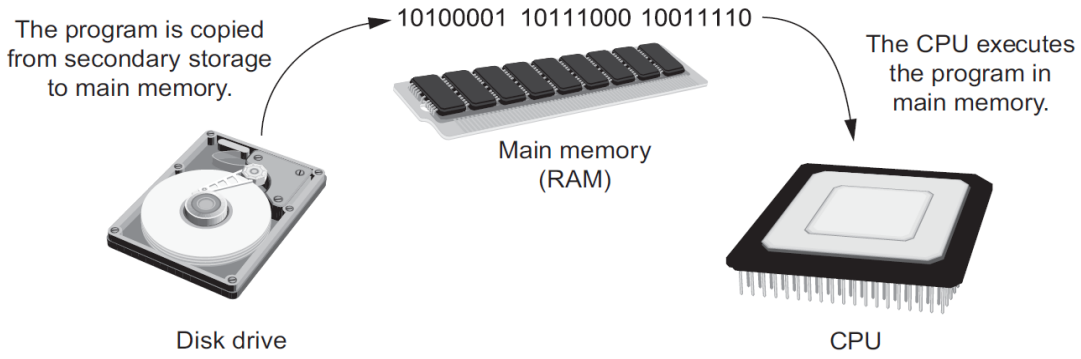
assembly language

```
sum = 0
for (i=0; i<100; i++)
  sum = sum + i
```

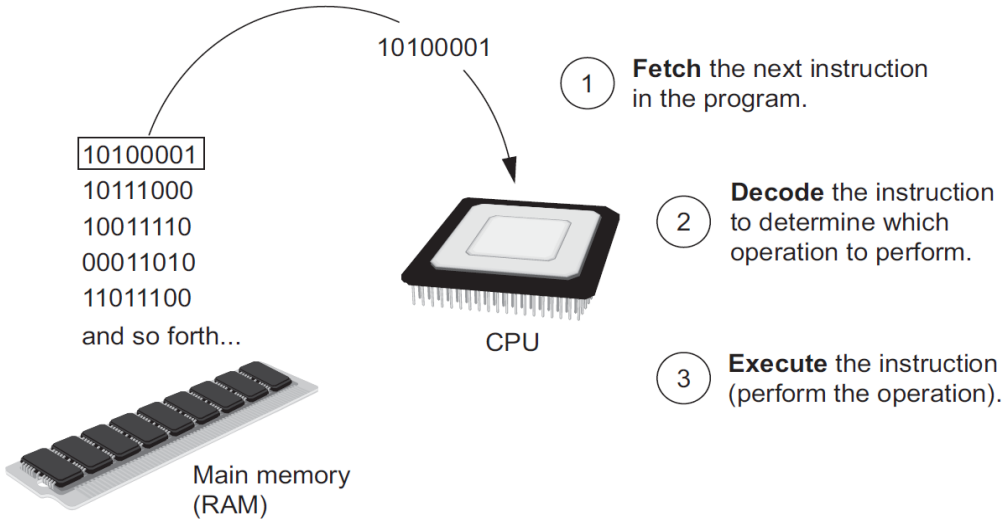
C language

How is a program executed?

1. program is copied into main memory

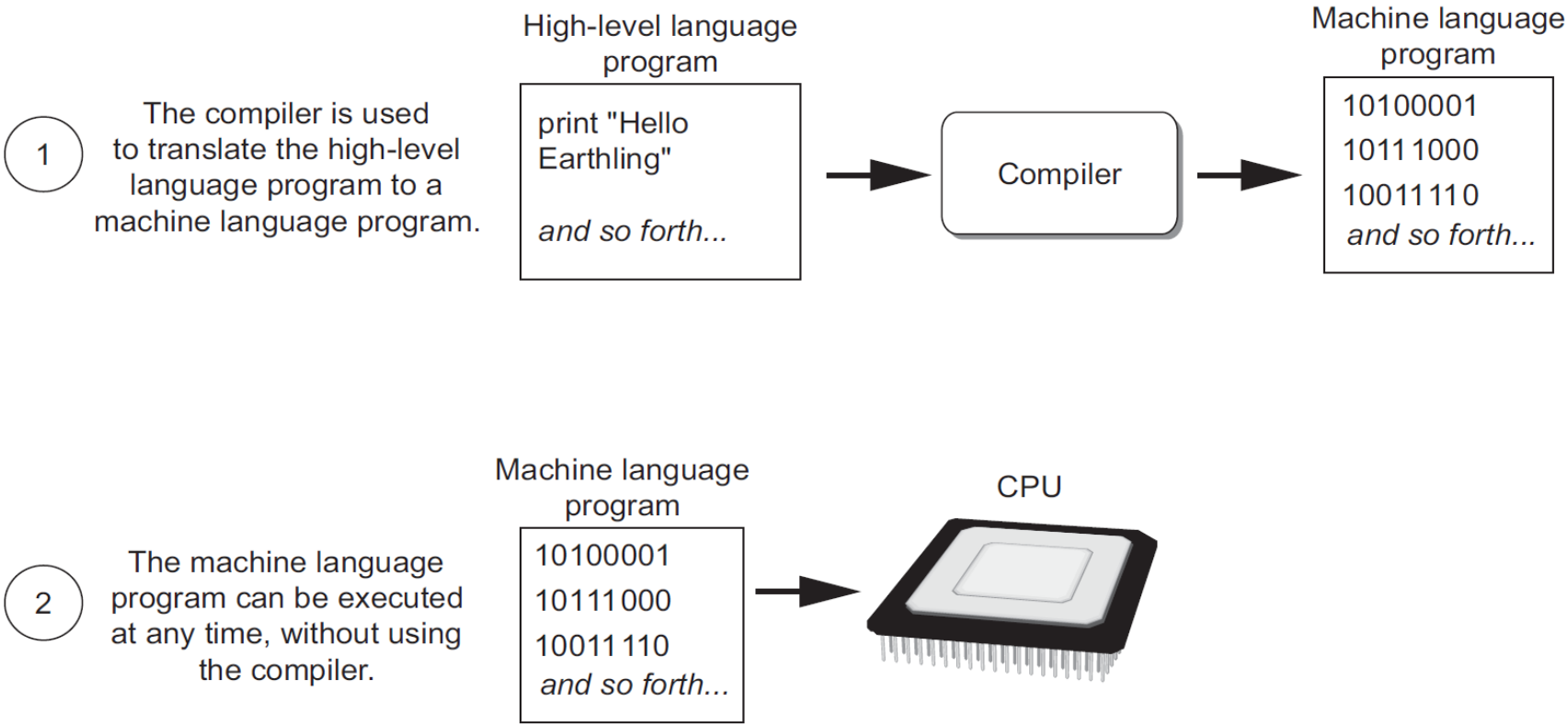


2. CPU executes the instructions by three steps



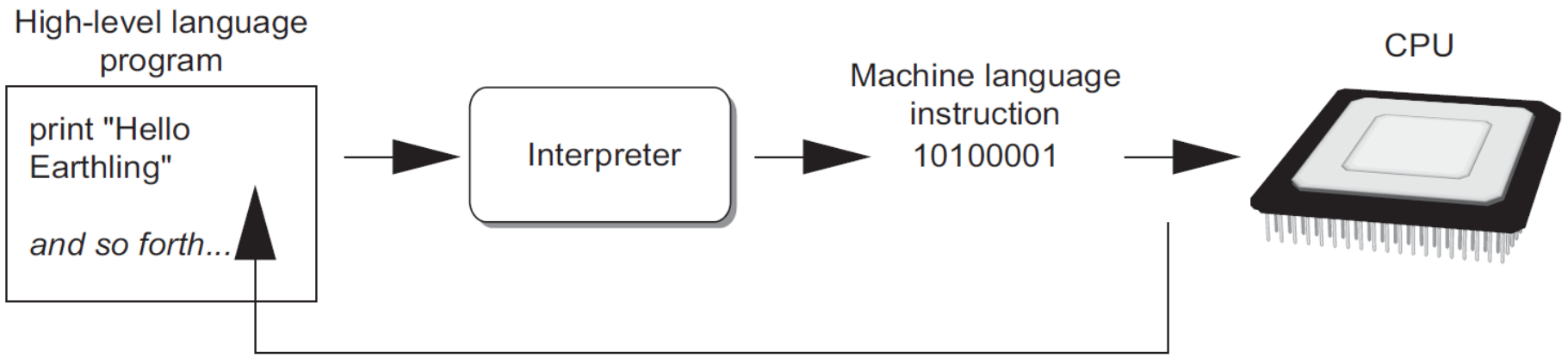
How program is generated – by compiler

- A compiler is a program that translates a high-level language program into a separate machine language program.



A program is executed - by interpreter

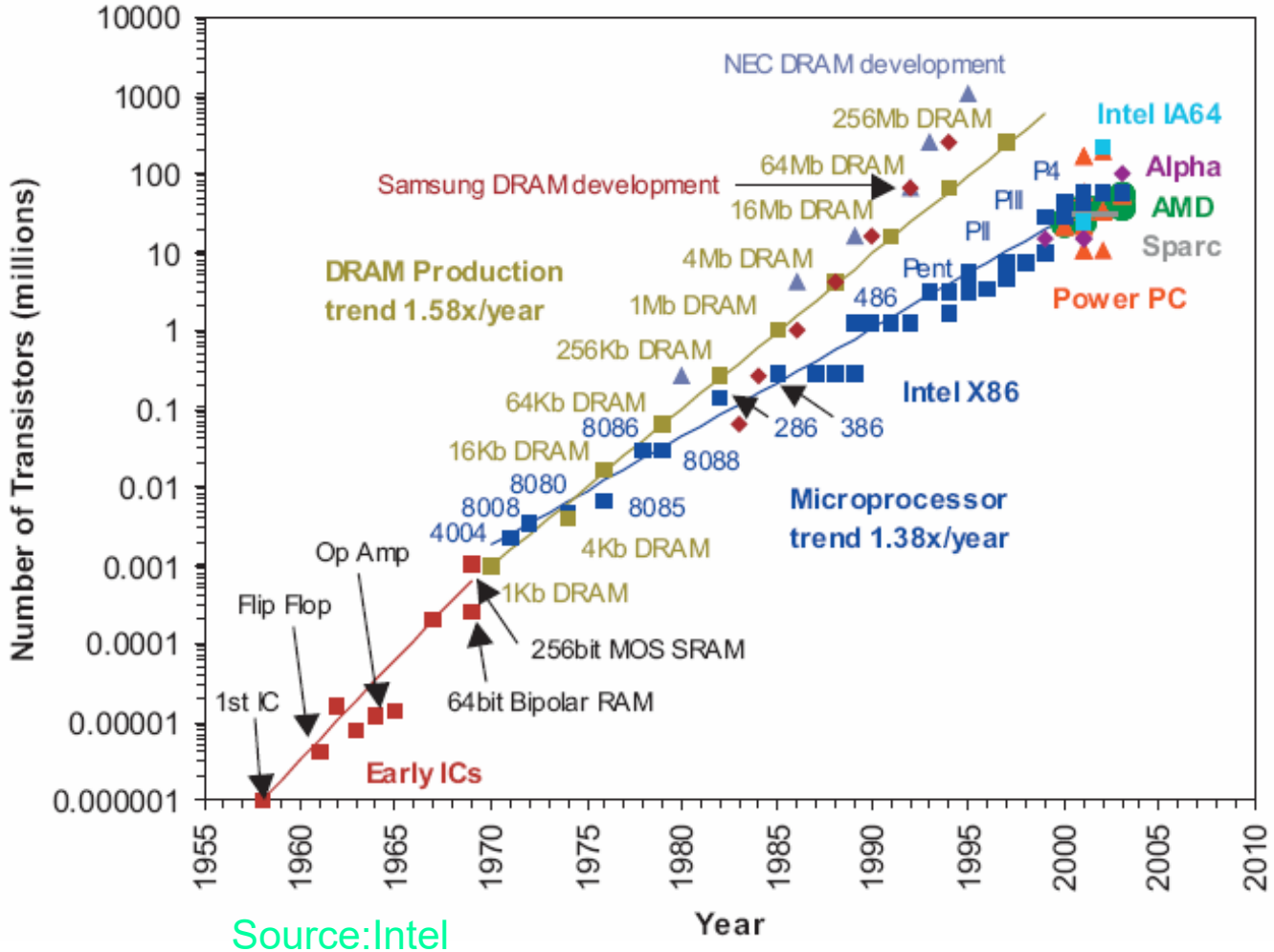
- The interpreter translates each high-level statement to its equivalent machine language instructions and immediately executes them.
- This process is repeated for each high-level statement.



Moore's Law

The number of transistors per square-inch doubles each 18 months

Gordon Moore
Co-founder of Intel 1965



Source:Intel

Technology => dramatic change

- Processor
  - logic capacity: about 30% per year
  - clock rate: about 20% per year
- Memory
  - DRAM capacity: about 60% per year (4x every 3 years)
  - Memory speed: about 10% per year
  - Cost per bit: improves about 25% per year
- Disk
  - capacity: about 60% per year
  - Total use of data: 100% per 9 months!
- Network Bandwidth
  - Bandwidth increasing more than 100% per year!

If car industry follows Moore's Law

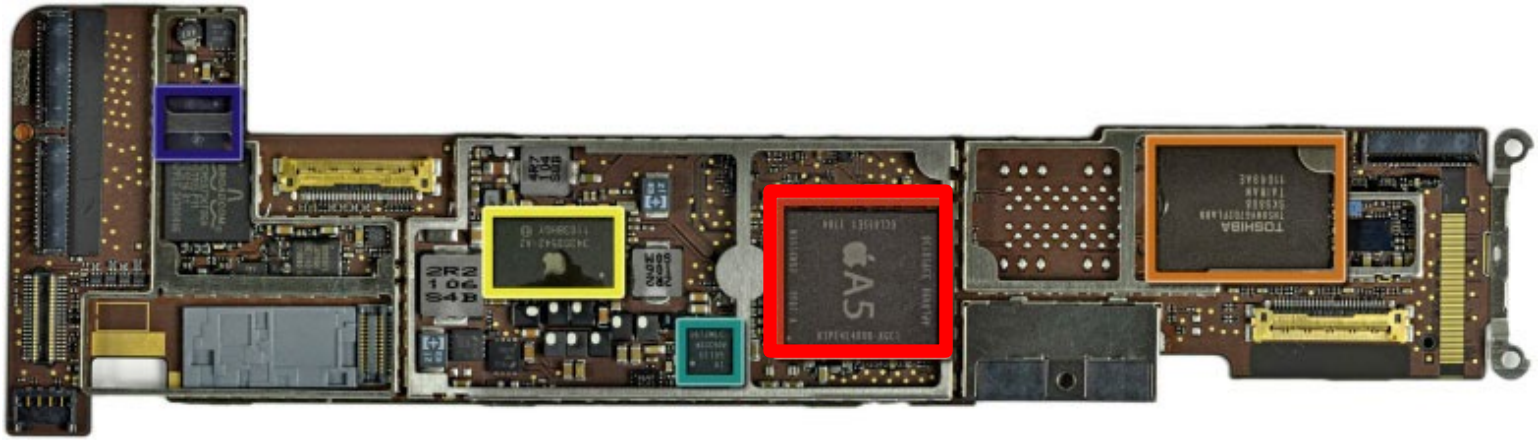
If the car industry followed the Moore's Law in the past forty years.

Nowadays the car should be

- Price → 12 cents/per car
- Speed → 40,000 km/per hour
- Gas mileage → 1200 km/per litter
- Capacity → 400,000 person/per car

Source : Prof. T. P. Ma

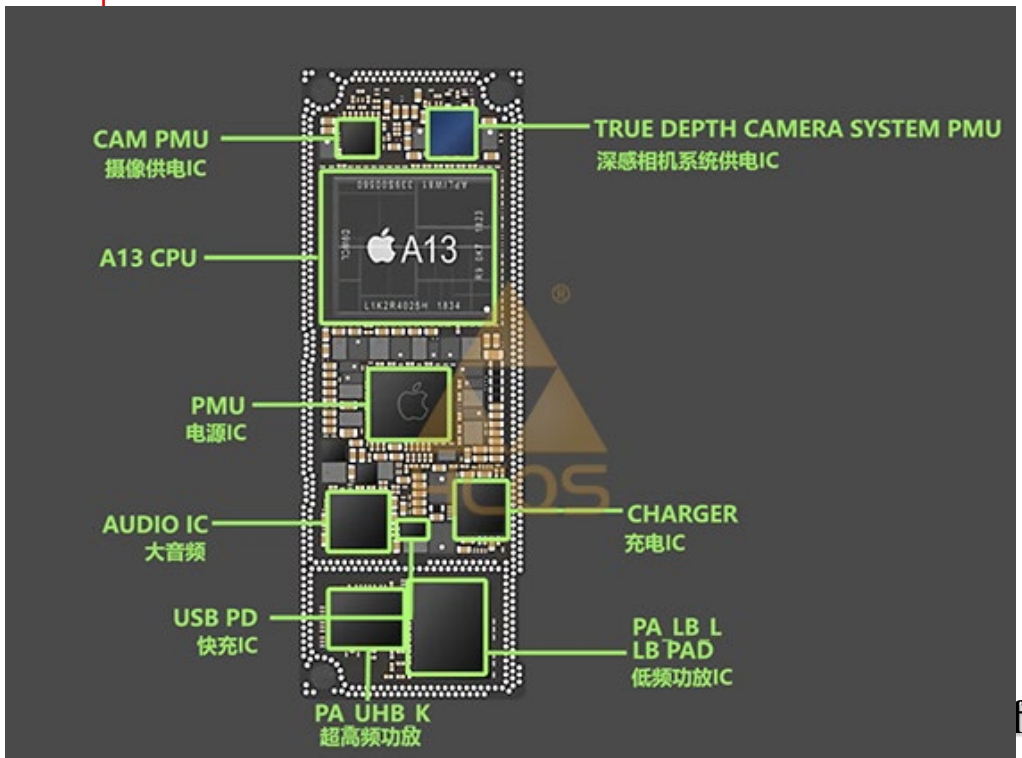
Zoom into contemporary CPU



Hugely powerful.
Enormously efficient.

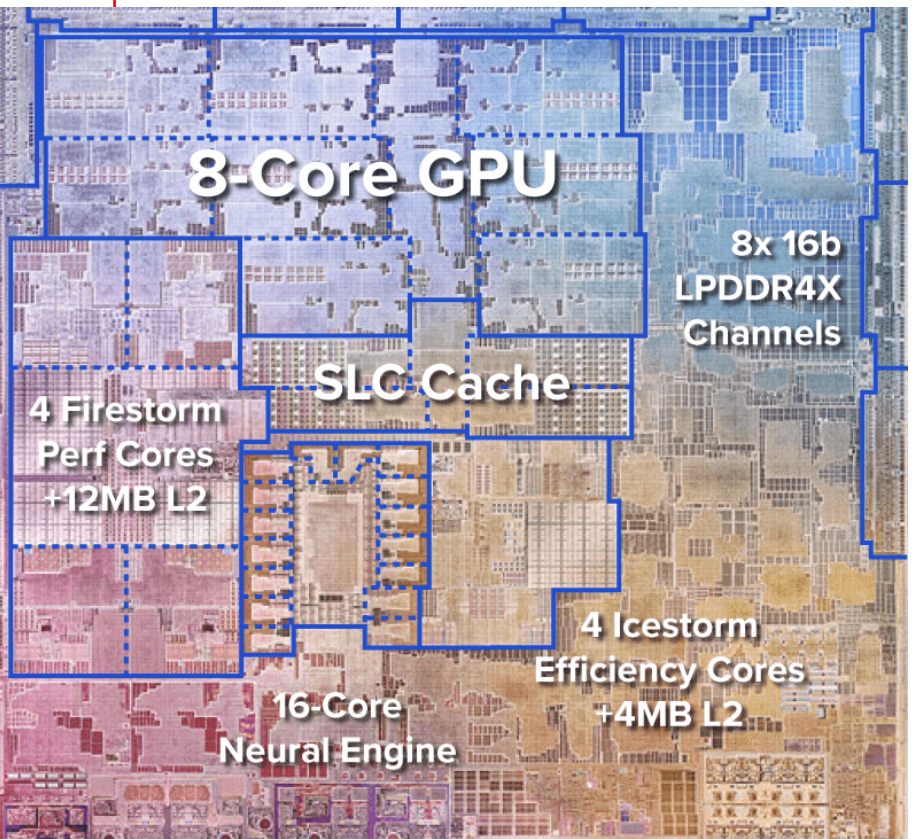
64-bit ARCHITECTURE | A8 CHIP | M8 MOTION COPROCESSOR

iPhone 11



iPhone 6 – A8

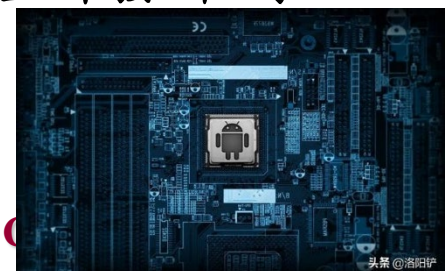
Apple M1 晶片配備 8 核心 CPU、8 核心 GPU 與 16 核心神經網路引擎



- The M1 is an ARM processor, not an x86 processor.
- It integrates more components than an Intel CPU.
- It features Rosetta 2 dynamic binary translation that allows it to run x86 software.
- The chip boasts eight CPU cores, in addition to the integrated GPU.
- It is manufactured using the 5nm-process and has 16 billion transistors.

Recent news

- 蘋果才發表M1 Pro及M1 Max兩款M1晶片的後繼版本，以冠絕群倫的性能吸引外界關注，也加速脫離Intel處理器的野心，同時顯示出蘋果與台積電的製程發展，要比Intel來得更快上一步。
- 熬十年，變Amazon金雞母！亞馬遜的雲端服務公司AWS，獲利竟超過母公司電商事業;成長速度快到看不到車尾燈，AWS 雲端服務榮登亞馬遜最新金雞母
- 物聯網三商機 五年內爆發(udn產經news)
- 物聯網開啟臺灣兆元商機(簡立峰Google 台灣董事總經理)
  - 物聯網三大商機健康照護、智能管理、智慧製造將在五年內爆發，以智慧製造成長最快，也是台廠機會所在，預估2020年產值上看1,332億美元（約新台幣4.37兆元）
- 挖角 Intel Qualcomm 專才 Google 強化硬體研發部門



“Computing” is the key to enable AI

Source: (1) 聯發科 梁伯嵩資深處長
(2) History of artificial intelligence, Wikipedia
(3) Yann LeCun, Facebook AI Research, “Deep Learning Hardware: Past, Present, & Future”, ISSCC

Basic
C Programming

Standardization of C

- *K&R C*
  - Described in Kernighan and Ritchie, *The C Programming Language* (1978)
  - De facto standard
- *C89/C90*
  - ANSI standard X3.159-1989 (completed in 1988; formally approved in December 1989)
  - International standard ISO/IEC 9899:1990
- *C99*
  - International standard ISO/IEC 9899:1999
  - Incorporates changes from Amendment 1 (1995)

C-Based Languages

- ***C++*** includes all the features of C, but adds classes and other features to support object-oriented programming.
- ***Java*** is based on C++ and therefore inherits many C features.
- ***C#*** is a more recent language derived from C++ and Java.
- ***Perl*** has adopted many of the features of C.
- ***Python*** is a interpreted, interactive, object-oriented, and high-level programming language.

Compare with other languages

Strengths of C

- Efficiency
- Portability
- Power
- Flexibility
- Standard library
- Integration with UNIX

Weaknesses of C

- Programs can be error-prone.
- Programs can be difficult to understand.
- Programs can be difficult to modify.

General Form of a Simple Program

- Even the simplest C programs rely on three key language features:
  - Directives
  - Functions
  - Statements

```
#include <stdio.h>

int main(void)
{
  printf("Hi! I'm Lin\n");
}
```

Directives

- Before a C program is compiled, it is first edited by a preprocessor.
- Commands intended for the preprocessor are called directives.
- Example:

```
#include <stdio.h>
```

- `<stdio.h>` is a ***header*** containing information about C's standard I/O library.

- Directives always begin with a `#` character.
- By default, directives are one line long; there's no semicolon or other special marker at the end.

Functions

- A ***function*** is a series of statements that have been grouped together and given a name.
- ***Library functions*** are provided as part of the C implementation.
- A function that computes a value uses a `return` statement to specify what value it "returns":

```
return x + 1;
```

The `main` Function

- The `main` function is mandatory.
- `main` is special: it gets called automatically when the program is executed.
- `main` returns a status code; the value 0 indicates normal program termination.
- If there's no `return` statement at the end of the `main` function, many compilers will produce a warning message.

Statements

- A ***statement*** is a command to be executed when the program runs.
- `pun.c` uses only two kinds of statements. One is the `return` statement; the other is the ***function call.***
- Asking a function to perform its assigned task is known as ***calling*** the function.
- `pun.c` calls `printf` to display a string:

```
printf("To C, or not to C: that is the question.\n");
```

- C requires that each statement end with a semicolon.
  - There's one exception: the compound statement.

Printing Strings

- When the `printf` function displays a ***string literal***—characters enclosed in double quotation marks—it doesn't show the quotation marks.
- `printf` doesn't automatically advance to the next output line when it finishes printing.
- To make `printf` advance one line, include `\n` (the ***new-line character***) in the string to be printed.

Printing Strings

- The statement

```
printf("To C, or not to C: that is the question.\n");
```

  could be replaced by two calls of `printf`:

```
printf("To C, or not to C: ");
printf("that is the question.\n");
```

- The new-line character can appear more than once in a string literal:

```
printf("Brevity is the soul of wit.\n  --Shakespeare\n");
```

Comments

- A ***comment*** begins with `/*` and end with `*/`.

```
/* This is a comment */
```

- Comments may appear almost anywhere in a program, either on separate lines or on the same lines as other program text.
- Comments may extend over more than one line.

```
/* Name: pun.c
   Purpose: Prints a bad pun.
   Author: K. N. King */
```

Comments

- *Warning:* Forgetting to terminate a comment may cause the compiler to ignore part of your program:

```
printf("My ");     /* forgot to close this
comment...
printf("cat ");
printf("has ");    /* so it ends here */
printf("fleas");
```

Comments in C99

- In C99, comments can also be written in the following way:

```
// This is a comment
```

- This style of comment ends automatically at the end of a line.
- Advantages of `//` comments:
  - Safer: there's no chance that an unterminated comment will accidentally consume part of a program.
  - Multiline comments stand out better.

Anatomy of a C program