1

Introduction

东南大学软件学院

The chief merit of language is clearness.

—Galen

Our life is frittered away by detail.... Simplify, simplify.

—Henry David Thoreau

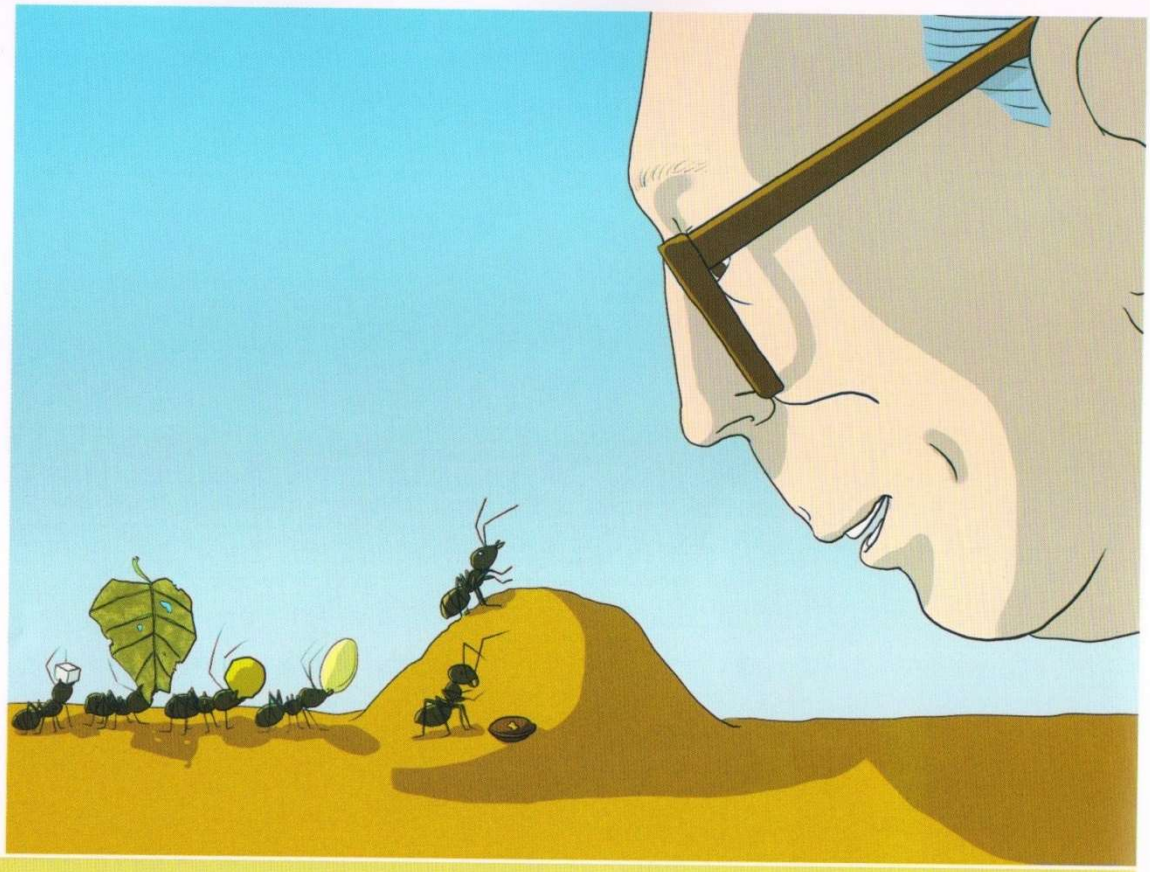
Man is still the most extraordinary computer of all.

—John F. Kennedy

生活智慧

Charles T. Munger

Life Wisdom



你需要对任何事物的来龙去脉有强烈的兴趣。长期保持那种投入的心态，会逐渐提高你在现实中关注重点的能力。如果你没有那种投入的心态，即使有高智商也注定要失败。

You need to have a passionate interest in why things are happening. That cast of mind, kept over long periods, gradually improves your ability to focus on reality. If you don't have the cast of mind, you're destined for failure even if you have a high I.Q.

Objectives

In this chapter you'll learn:

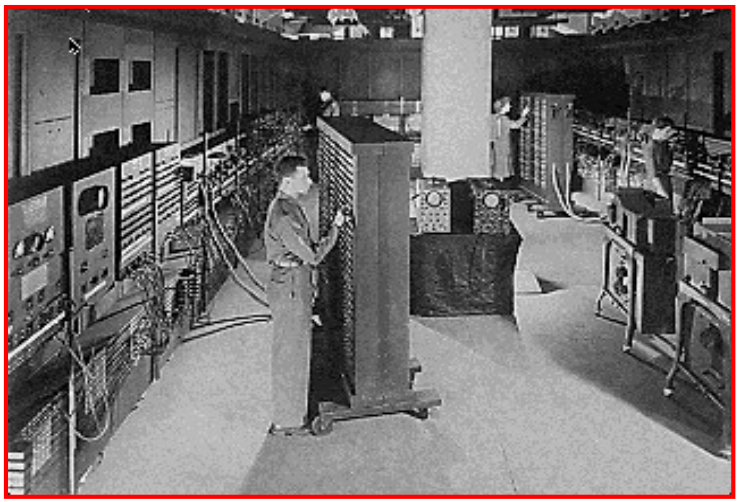
- Basic hardware and software concepts.
- The different types of programming languages.
- A typical C++ program development environment.
- C++ Standard Library, Boost Library.
- To test-drive C++ applications in Microsoft's Visual C++® on Windows® XP.

1.1 Introduction

- Hardware 硬件
- Software 软件
- Standardized version of C++
- Structured programming 结构化编程
- Object-oriented programming 面向对象编程

1.2 What Is a Computer?

- Computer 计算机
  - Device capable of performing computations 计算 and making logical decisions 逻辑判断



世界上第一台电子计算机（ENIAC），耗电150千瓦，占地170平方米，重达30吨。

China Grabs Supercomputing Leadership Spot in Latest Ranking of World's Top 500 Supercomputers

Thu, 2010-11-11 22:42

MANNHEIM, Germany; BERKELEY, Calif.; and KNOXVILLE, Tenn.—The 36th edition of the closely watched TOP500 list of the world's most powerful supercomputers confirms the rumored takeover of the top spot by the Chinese Tianhe-1A system at the National Supercomputer Center in Tianjin, achieving a performance level of 2.57 petaflop/s (quadrillions of calculations per second).

1.2 What Is a Computer?

- Hardware 硬件
  - Various devices comprising computer
    - Keyboard, screen, mouse, disks, memory, CD-ROM, processing units, etc.

1.4 Computer Organization

- Six logical units of computer 六大逻辑组件
  - Input unit 输入单元
    - “Receiving” section （接收）
    - Obtains information from input devices
      - Keyboard, mouse, microphone, scanner, networks, etc.
  - Output unit 输出单元
    - “Shipping” section（运输）
    - Places information processed by computer on output devices
      - Screen, printer, networks, etc.
      - Information can also be used to control other devices

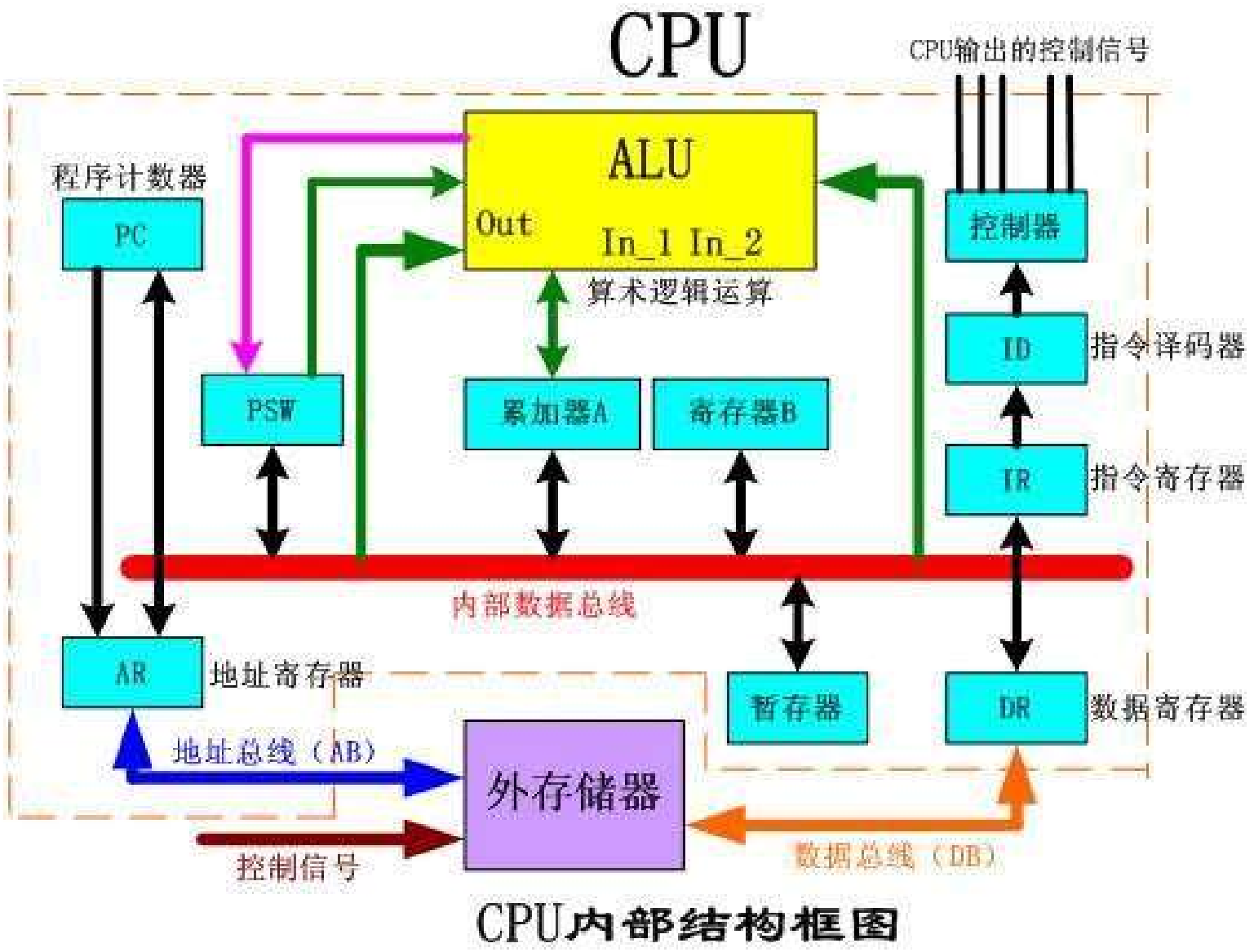
1.3 Computer Organization (Cont.)

- Six logical units of computer (Cont.)
  - Memory unit 内存单元

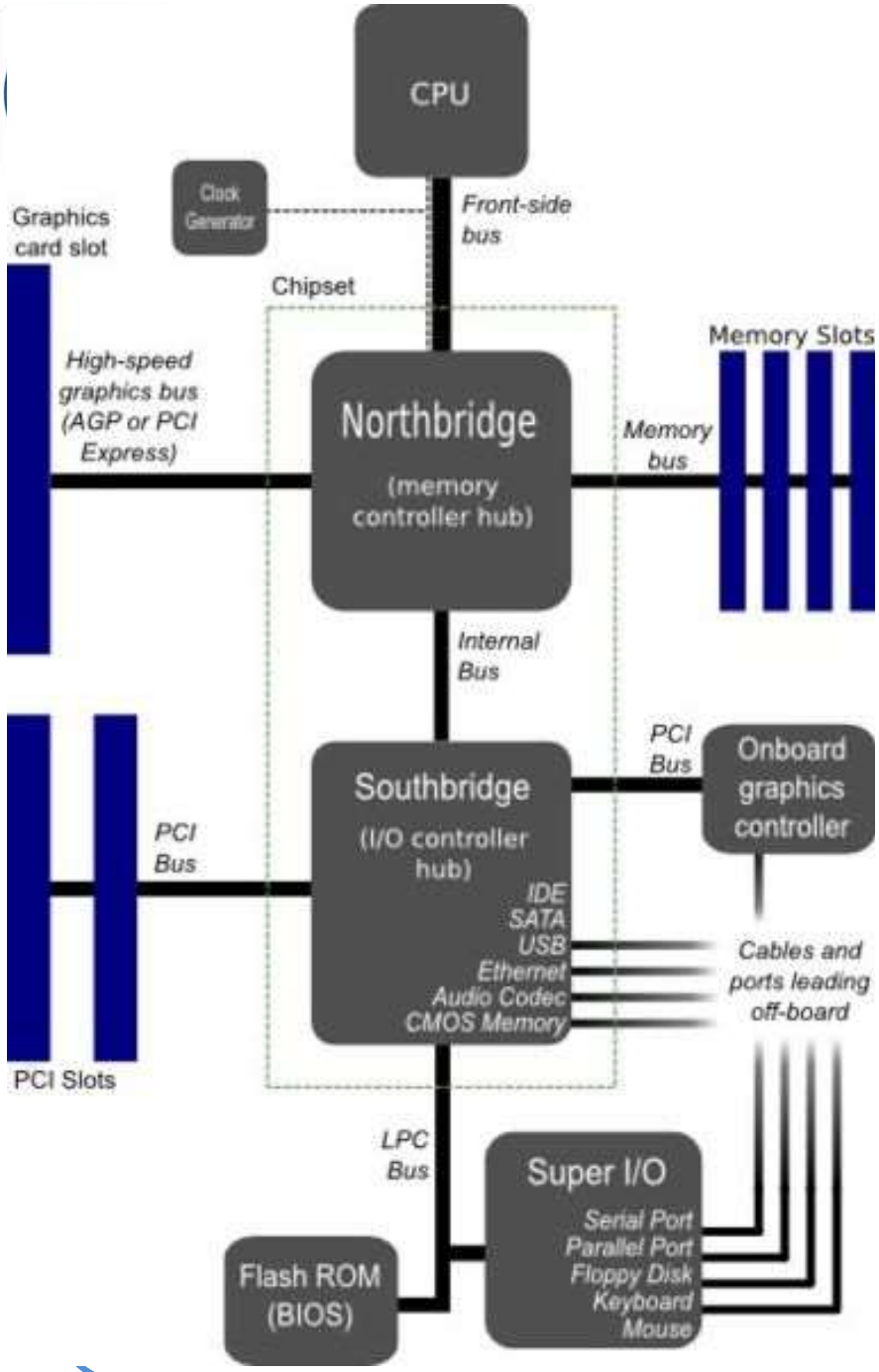
    - Rapid access, relatively low capacity "warehouse" section （DDR3 12800MB/s，“小仓库”）
    - Retains information from input unit
      - Immediately available for processing
    - Retains processed information
      - Until placed on output devices
    - Often called memory or primary memory （主存）
  - Arithmetic and logic unit (ALU) 运算与逻辑单元
    - "Manufacturing" section（生产）
    - Performs arithmetic calculations and logic decisions

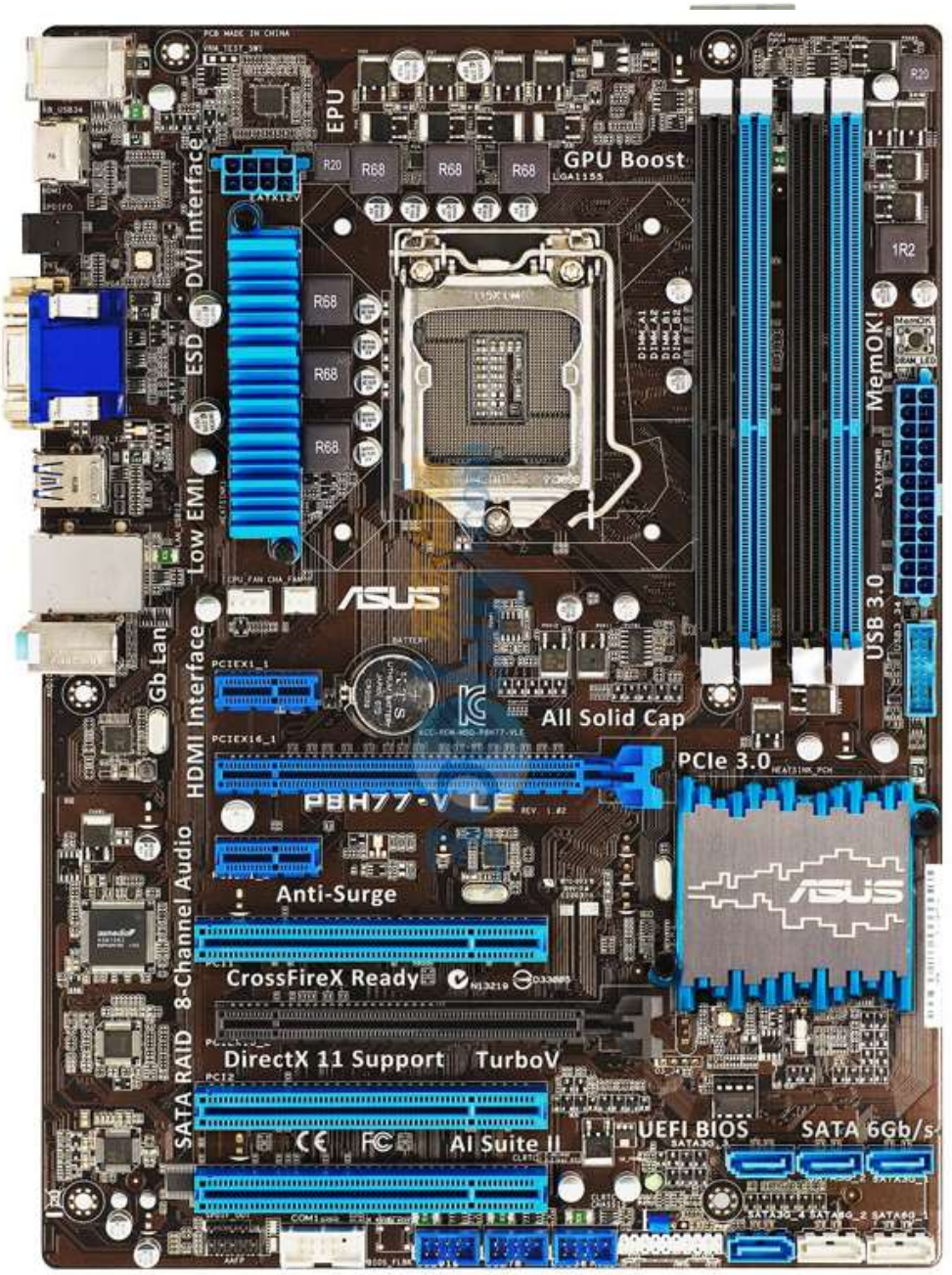
1.4 Computer Organization (Cont.)

- Six logical units of computer (Cont.)
  - Central processing unit (CPU) 中央处理单元
    - "Administrative" section（管理）
    - Coordinates and supervises other sections of computer
  - Secondary storage unit 辅助存储单元
    - Long-term, high-capacity "warehouse" section
    - Stores inactive programs or data
    - Secondary storage devices
      - Hard drives, CDs, DVDs
    - Slower to access than primary memory SATA3.0 750MB/s
    - Less expensive per unit than primary memory


CPU
CPU输出的控制信号
ALU
Out
In_1 In_2
算术逻辑运算
程序计数器
PC
PSW
累加器A
寄存器B
控制器
ID
指令译码器
IR
指令寄存器
内部数据总线
AR
地址寄存器
暂存器
DR
数据寄存器
地址总线（AB）
外存储器
控制信号
数据总线（DB）

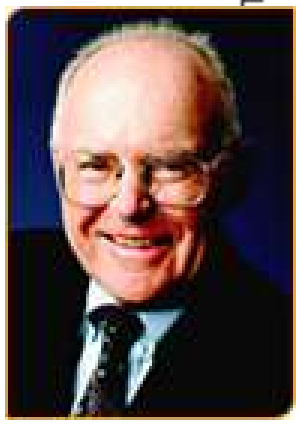
CPU内部结构框图


CPU
Clock Generator
Graphics card slot
Front-side bus
Chipset
Memory Slots
High-speed graphics bus (AGP or PCI Express)
Northbridge
(memory controller hub)
Memory bus
Internal Bus
PCI Bus
Onboard graphics controller
PCI Bus
Southbridge
(I/O controller hub)
IDE
SATA
USB
Ethernet
Audio Codec
CMOS Memory
Cables and ports leading off-board
PCI Slots
LPC Bus
Super I/O
Serial Port
Parallel Port
Floppy Disk
Keyboard
Mouse
Flash ROM (BIOS)

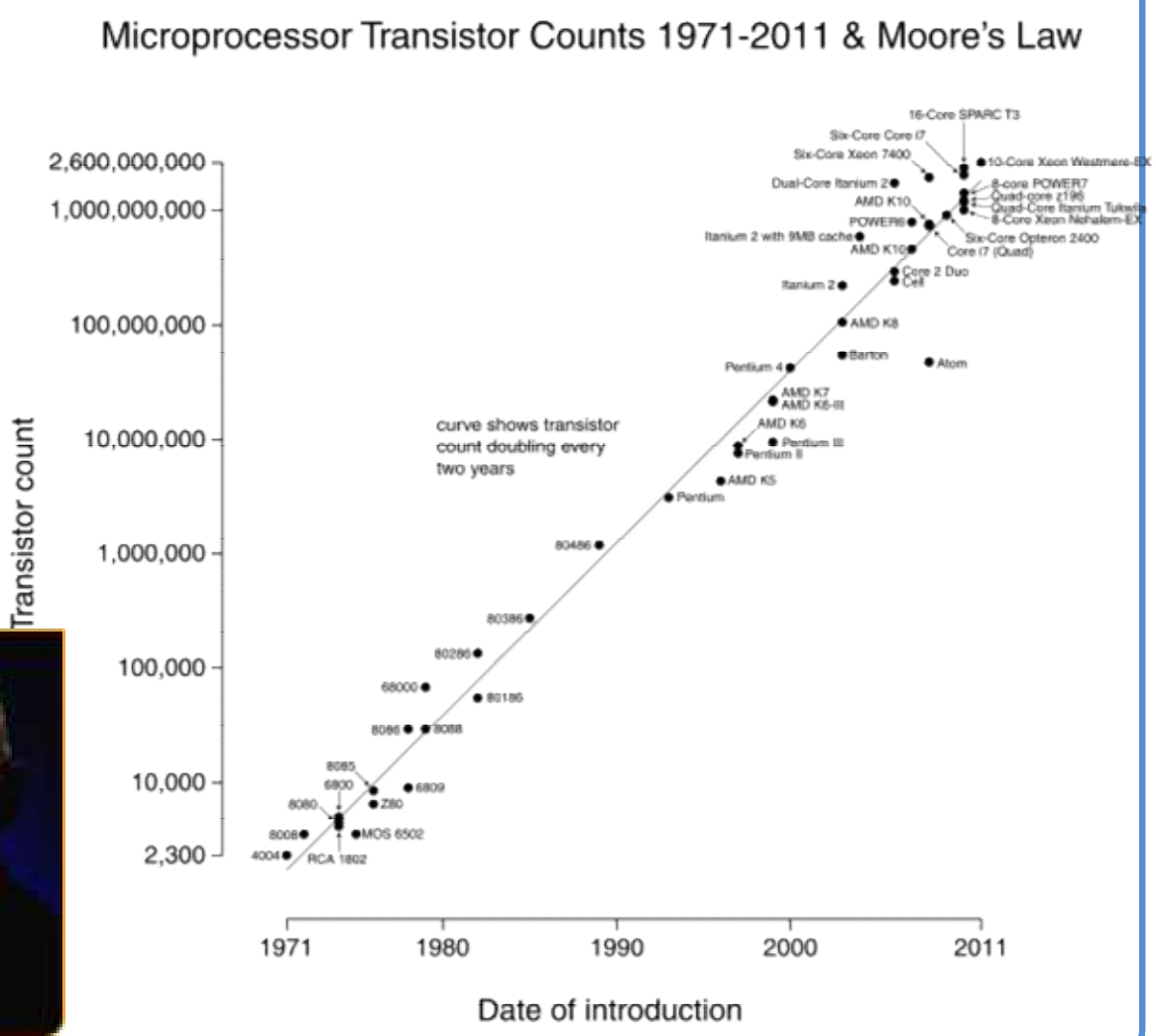

EPU
GPU Boost
DVI Interface
ESD
Low EMI
Gb Lan
HDMI Interface
8-Channel Audio
SATA RAID
MemOK!
USB 3.0
All Solid Cap
PCIe 3.0
P8H77-V LE
Anti-Surge
CrossFireX Ready
DirectX 11 Support
TurboV
UEFI BIOS
SATA 6Gb/s
AI Suite II

摩尔定律（1965）

- 当价格不变时，单位平方英寸芯片的晶体管数目每过18到24个月就将增加一倍，性能也将提升一倍。

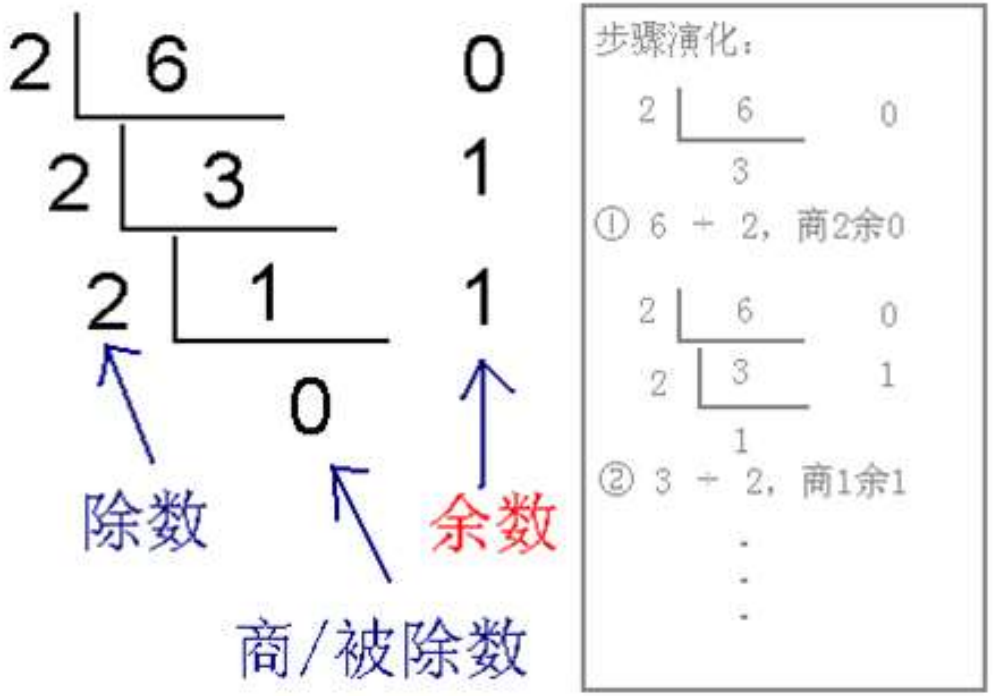


Gordon Moore



Appex D： Number Systems （P773）

- Binary number 二进制数
  - 计算机中所有的信息都是以二进制数的形式存在的



十进制数转换为二进制数

规则：除以2直至商为0，然后反向取余数

Appex D： Number Systems

- 将二进制数转换为十进制

位号	5	4	3	2	1	0
位值 Positional Value	32 (2^5)	16 (2^4)	8 (2^3)	4 (2^2)	2 (2^1)	1 (2^0)
符号值 Symbol value	1	1	0	1	0	1
乘积 Products	1×32	1×16	0×8	1×4	0×2	1×1
和 Sum	= 32 + 16 + 0 + 4 + 0 + 1 = 53					

规则：各符号值乘以对应位值，然后计算总和

Appex D： Number Systems

- Octal number 八进制数 （基数为8）
- Hexadecimal number 十六进制数（基数为16）
  - 符号值：1－9， A－F （10-15）
- 十进制数转换为其他进制的规则
  - 规则：除以基数直至商为0，然后反向取余数
- 其他进制数转换为十进制数的规则
  - 规则：各符号值乘以对应位值，然后计算总和

Appex D： Number Systems

- 二进6 + 3 = 9
- 制的加法

$$\begin{array}{r} 0\,1\,1\,0 \\ +\,0\,0\,1\,1 \\ \hline =\,1\,0\,0\,1 \end{array}$$

- 二进制的减法
  - 是否还可以取消掉减法装置呢？
  - 回答是肯定的。但要求二进制数采用一种称为补码的表示方法。
    - 补码把二进制的正数和负数表示成一种统一的去掉符号的纯数值形式。

Appex D： Number Systems

- 在计算机中，数值一律用补码来表示（存储）
  - 使用补码，可以将符号位和其它位统一处理
  - 减法也可按加法来处理
  - 两个用补码表示的数相加时，如果最高位（符号位）有进位，则进位被舍弃

- 反码与补码
  - 正数的补码：与原码相同
  - 负数的补码：符号位为1，其余位为该数绝对值的原码按位取反（反码），然后整个数加1

补码计算示例

- 求-7的补码

  1）确定符号位：因为给定数是负数，则符号位为“1”

  2）求绝对值的补码（后七位）：+7的原码（0000111）→按位取反（1111000）→加1（1111001）

  – 所以-7的补码是11111001（符号位+7的补码）

计算机中减法的示例

- 3 – 7 = 3 + (-7) = - 4

$$\begin{array}{r} 0\,0\,0\,0 \quad 0\,0\,1\,1 \\ +\,1\,1\,1\,1 \quad 1\,0\,0\,1 \\ \hline =\,1\,1\,1\,1 \quad 1\,1\,0\,0 \end{array}$$

➔结果是-4的补码

1.3 Computer Organization (Cont.)

- Computer programs计算机程序
  - Sets of instructions that control computer's processing of data
  - Written by people called computer programmers
- Computer language
  - Machine languages 机器语言
  - Assembly languages 汇编语言
  - High-level languages 高级语言

1.5 Machine Languages, Assembly Languages and High-Level Languages

- Three types of computer languages
  - Machine language（机器语言）
    - Only language computer directly understands
      - "Natural language" of computer
      - Defined by hardware design
    - Generally consist of strings of numbers
      - Ultimately 0s and 1s
    - Instruct computers to perform elementary operations
    - Cumbersome for humans
    - Example（基本工资 + 加班工资 = 总工资）
      - +1300042774（读取 基本工资）
+1400593419（加上 加班工资）
+1200274027（保存 总工资）

1.5 Machine Languages, Assembly Languages and High-Level Languages (Cont.)

- Three types of computer languages (Cont.)
  - Assembly language（汇编语言）
    - English-like abbreviations representing elementary computer operations
    - Clearer to humans
    - Incomprehensible to computers
      - Convert to machine language by translator programs (assemblers)
    - Example
      - ```
        load    basepay
        add     overpay
        store   grosspay
        ```
        ```

1.5 Machine Languages, Assembly Languages and High-Level Languages (Cont.)

- Three types of computer languages (Cont.)
  - High-level languages （高级语言）
    - Similar to everyday English
      - Uses common mathematical notations
    - Single statements accomplish substantial tasks
    - Example
      - `grossPay = basePay + overTimePay`
    - Execute in two ways:
      - Converted to machine language by translator programs (compilers 编译器) C++
      - Interpreter programs JAVA
        - » Directly execute high-level language programs
        - » Execute more slowly than the compiled program

1.9 History of C and C++

- History of C
  - Evolved from BCPL and B
    - Developed by Dennis Ritchie (Bell Laboratories)
  - Development language of UNIX
  - Hardware independent
    - Can write portable programs （可移植程序）
  - ANSI and ISO standard for C published in 1990
    - *ANSI/ISO 9899: 1990*

Portability Tip 1.1 可移植性

Because C is a standardized, hardware-independent, widely available language, applications written in C often can be run with little or no modification on a wide range of computer systems.

1.9 History of C and C++ (Cont.)

- History of C++
  - Extension of C
    - Developed by Bjarne Stroustrup (Bell Laboratories) in early 1980s
  - Provides new features to “spruce up”(美化) C
  - Provides capabilities for object-oriented programming (面向对象)
    - Objects（对象）: reusable software components （可重用的软件模块）
      - Model items in the real world
- Easier to understand, correct and modify

1.10 C++ Standard Library (C++标准库)

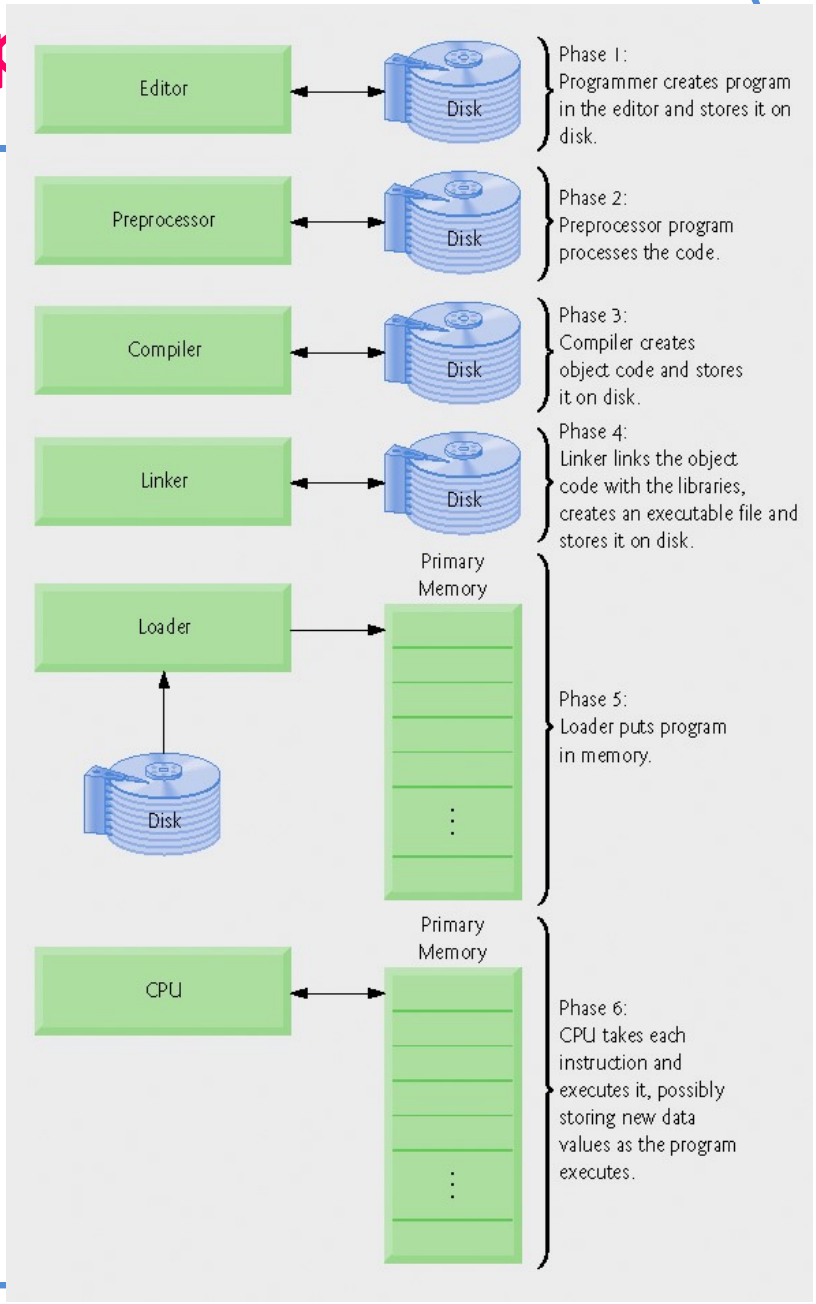
- C++ programs
  - Built from pieces called classes 类 and functions 函数
- C++ Standard Library
  - Rich collections of existing classes and functions
    - Reusable in new applications

Software Engineering Observation 1.2
软件工程知识点

Use a “building-block” approach to create programs. Avoid reinventing the wheel. Use existing pieces wherever possible. Called software reuse, this practice is central to object-oriented programming. 软件重用是面向对象编程的核心思想。

1.15 Typical C++ Develop

- C++ programs normally undergo six phases
  - Edit 编辑
    - Programmer writes program (and stores source code on disk)
  - Preprocess 预处理
    - Perform certain manipulations before compilation
  - Compile 编译
    - Compiler translates C++ programs into machine languages
  - Link 链接
    - Link object code with missing functions and data
  - Load 装载
    - Transfer executable image to memory
  - Execute 执行
    - Execute the program one instruction at a time



1.17 Test-Driving a C++ Application

- Running and interacting with a C++ application
  - Windows XP `Command Prompt`

Program Errors

- Compiler errors 编译错误
  - Syntax errors 语法错误
- Link errors 链接错误
- Run-time errors 运行错误
  - Non-fatal Errors 非致命性错误
    程序能够正常执行至程序结束，但通常不能得到正确结果
  - Fatal Errors 致命性错误
    程序不能正常执行至程序结束，例如: division by zero

Good Programming Practice 1.1

Write your C++ programs in a simple and straightforward manner. This is sometimes referred to as KIS (“keep it simple”). Do not “stretch” the language by trying bizarre usages.