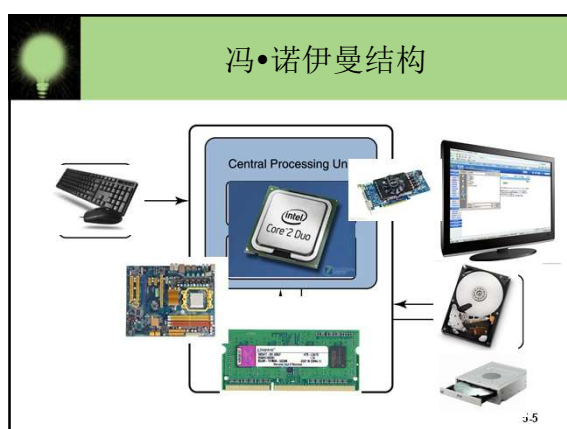
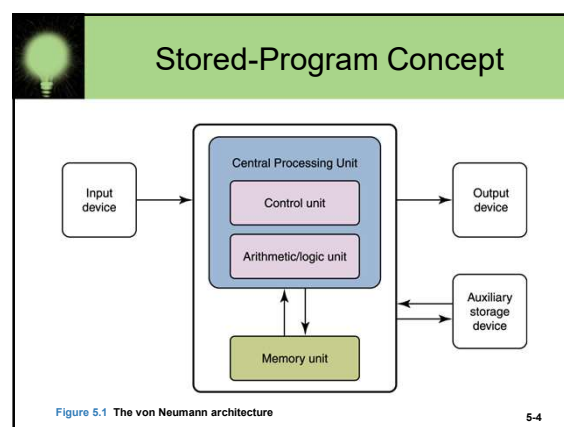


Chapter Goals

- List the **components** and their function in a **von Neumann machine**
- Describe how computer **memory is organized and accessed**
- Basic parts** of CPU
- Name and describe different auxiliary **storage devices**

5-2



Memory (存储器)

- Memory is a collection of cells, each with a unique physical address

Address	Contents
00000000	11100011
00000001	10101001
⋮	⋮
11111100	00000000
11111101	11111111
11111110	10101010
11111111	00110011

Address Space

- To access a byte in memory requires an identifier. The total number of uniquely identifiable locations in memory is called the address space (寻址空间).

Unit		Number of bytes	Approximation
Kilobyte (K)		2^{10} bytes	10^3 bytes
Megabyte (M)		2^{20} bytes	10^6 bytes
Gigabyte (G)		2^{30} bytes	10^9 bytes
Terabyte (T)		2^{40} bytes	10^{12} bytes

5-7

练习: Address Space

- A computer has 32 MB (megabytes) of memory. How many bits are needed to address any single byte in memory?
- The memory address space is 32 MB, or 2^{25} ($2^5 \times 2^{20}$). This means you need $\log_2 2^{25}$ or 25 bits, to address each byte.
- 一个PC主板, 支持最多16G物理内存, 它有多少地址线 (bit) ?

5-8

小知识: int 在内存中的存储

```
int a=10;
假设内存是从低——>高增长的
在低位优先的硬件里面, 内存布局如下:
00001010 00000000 00000000 00000000
而在高位优先的内存中:
00000000 00000000 00000000 00001010
#include <stdio.h>
main()
{
    int a=10;
    short b;
    memcpy(&b,&a,2);
    printf("%d\n",b);
}
```

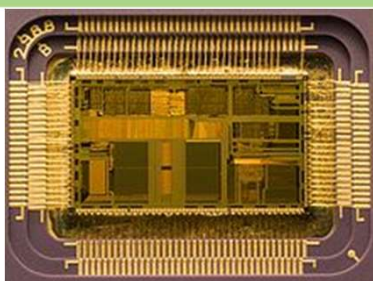
5-9

RAM and ROM

- RAM stands for **Random Access Memory**
 - Inherent in the idea of being able to access each location is the ability to change the contents of each location
- ROM stands for **Read Only Memory**
 - The contents in locations in ROM cannot be changed
- RAM is **volatile**, ROM is not
 - This means that RAM does not retain its bit configuration when the power is turned off, but ROM does

5-10

Fundamental about CPUs



an Intel 80486DX2 microprocessor

5-11

Arithmetic/Logic Unit

- Performing basic arithmetic operations such as **adding**
- Performing logical operations such as AND, OR, and NOT
- Most modern ALUs have a small amount of special storage units called **registers**

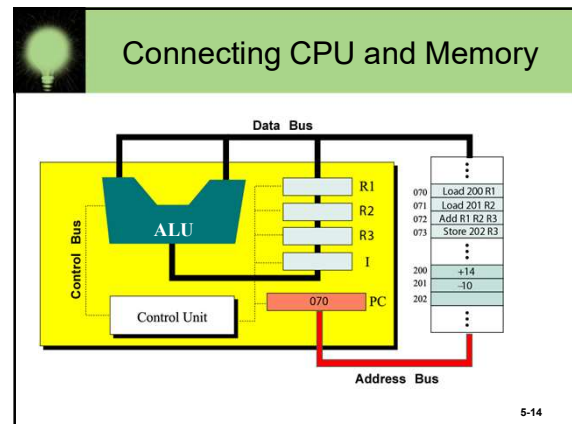
32位计算机指ALU能执行32位加法, 或寄存器有32位

5-12

Control Unit

- **Control unit** The organizing force in the computer
- There are **two registers** in the control unit
 - The **instruction register** (IR) contains the instruction that is being executed
 - The **program counter** (PC) contains the **address** of the next instruction to be executed
- ALU and the control unit called the **Central Processing Unit**, or CPU

5-13



Bus and Memory

- **Data BUS**
 - Transfer a word data to CPU parallel
 - **Word length** 32bit mean transfer 32bit between CPU and Memory
- **Address BUS**
 - Select a word data to CPU parallel
 - **Address BUS 32bit mean** address space 4G

5-15

小知识: 缓存(Cache Memory)

- A CPU cache (缓存)
 - is a cache used by the central processing unit of a computer to reduce the average time to access memory.
 - The cache is a smaller, faster memory which stores copies of the data from the most frequently used main memory locations.
- **Most** modern CPUs have at least three independent caches:
 - an **instruction cache** to speed up executable instruction fetch,
 - a **data cache** to speed up data fetch and store
 - a **translation lookaside buffer** used to speed up virtual-to-physical address translation for both executable instructions and data.

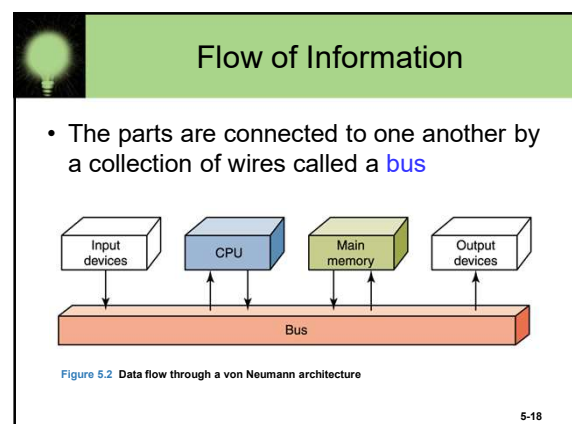
From http://en.wikipedia.org/wiki/CPU_cache

5-16

小知识: 关于CPU性能

- 64bit CPU指什么的宽度是64位的?
- 频率越高, 计算速度越快?
- 缓存越大, 计算速度越快?
- 核心越多, 计算速度越快?

5-17



Input/Output Units

- **Input Unit** A device through which data and programs from the outside world are entered into the computer
 - Keyboard, the mouse, and scanning devices
- **Output unit** A device through which results stored in the computer memory are made available to the outside world
 - Printers and video display terminals

5-19

鼠标(Mouse)

- 历史
 - 前身: 轨迹球
 - 1963, Douglas Engelbart 发明了鼠标, 并于 1970 年获得专利。他没有因此而大发, 在鼠标大规模使用前, 专利过期了。
 - 1973, Xerox Alto (第一台个人计算机) 开始使用鼠标。
 - 1983, Microsoft 发布 Word 被设计为使用鼠标。微软鼠标随 WYSIWYG (What You See Is What You Get, 所见即所得) 的 Word 而普及。



Operating an opto-mechanical mouse.

1. moving the mouse turns the ball.
2. X and Y rollers grip the ball and transfer movement
3. Optical encoding disks include light holes.
4. Infrared LEDs shine through the disks.
5. Sensors gather light pulses to convert to X and Y vectors.

- 原理与数字化
 - 基本原理: 光电-机械鼠
 - PS-2 接口通讯协议

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 1	YV	XV	YS	XS	1	MB	RB	LB
Byte 2	X movement							
Byte 3	Y movement							

[http://en.wikipedia.org/wiki/Mouse_\(computing\)](http://en.wikipedia.org/wiki/Mouse_(computing))

5-20

Secondary Storage Devices

- Because most of main memory is volatile and limited, it is essential that there be other types of storage devices where programs and data can be stored when they are no longer being processed
- Secondary storage devices can be installed within the computer box at the factory or added later as needed

5-21

Magnetic Disks

- A read/write head travels across a spinning magnetic disk, retrieving or recording data

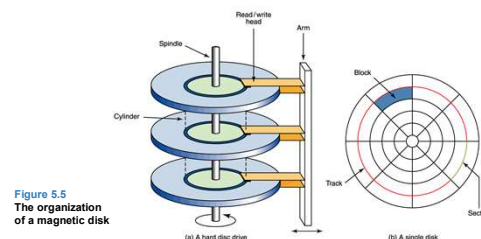


Figure 5.5
The organization of a magnetic disk

Compact Disks

- A CD drive uses a laser to read information stored optically on a plastic disk
- CD-ROM is Read-Only Memory
- DVD stands for Digital Versatile Disk

5-23

Magnetic Tape

- The first truly mass auxiliary storage device was the magnetic tape drive

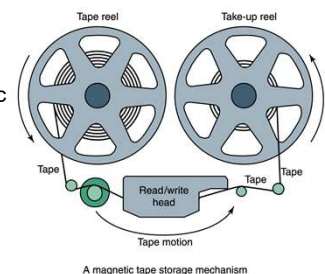
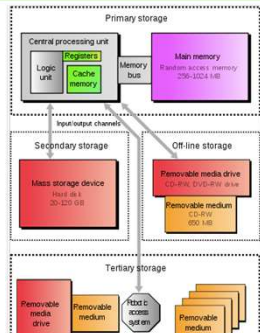


Figure 5.4 A magnetic tape

计算机多级存储结构



5-25

Synchronous processing

- One approach to parallelism is to have multiple processors apply the same program to multiple data sets

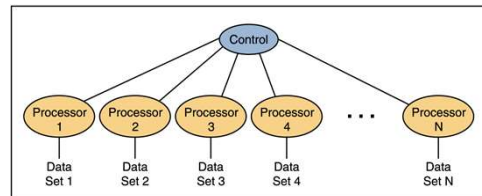


Figure 5.7 Processors in a synchronous computing environment

5-26

Pipelining

- Arranges processors in tandem, where each processor contributes one part to an overall computation



Figure 5.8 Processors in a pipeline

5-27

Parallel Computing

- Instruction level parallelism**
 - Instruction pipelining
 - Superscalar
 - SIMD (Single Instructions Multiple Data);
 - VLIW (very long instruction word)
- Thread level parallelism**
 - MIMD (Multiple Instructions-Multiple Data)
 - MP (multiprocessing)
- Data parallelism**
 - Vector processor and SIMD

5-28

应用知识: 'Play CPU'

- Overclocking (超频)**
 - Considerations:
 - Cooling
 - Stability and functional correctness,
 - Factors allowing overclocking,
 - Benchmarks to evaluate performance
- Unlock CPU core (开核)**
 - Advanced Clock Calibration
- Fun or Business ?**
 - Who has benefit?



Story short: Intel wants to charge PC users \$50 to give them the ability to unlock additional features on their CPU or even possibly add OCing capabilities (2010/9/18)

<http://www.extremecoverclocking.com/>
<http://en.wikipedia.org/wiki/Overclocking>
http://en.wikipedia.org/wiki/AMD_700_chipset_series

5-29

作业 1 / 1

- According to the von Neumann architecture, List basic parts of a computer.
- A computer has 64 MB (megabytes) of memory. How many bits are needed to address any single byte in memory?
- List basic parts of a CPU, include cache or not?
- What mean secondary storage. List some on your PC.
- 使用维基百科, 解释以下概念: CPU、RAM、ROM、Bus (computing)、Parallel Computing
- 写一段文字, 简单解释“云计算”(cloud computing)
- 小孙买了计算机主板, 说明书表明“支持双通道DDR3-1333内存, 最大支持16G”
 - DDR3内存, “3”和“1333”的含义是什么?
 - 小孙买8G DDR3-1600的内存能提高性能吗?
 - 小孙买4G*2 DDR3-1333的内存能提高性能吗?
 - 16G需要多少位地址?
 备注, 维基百科(中文)“DDR3 SDRAM”

5-30