Machine Called Computer

Part 1
Hardware Components

Tools

- 인간은 도구를 만든다
- Tools for farming, fishing, hunting
  - 동력원: 인간의 에너지
  - Transform the direction or magnitude of force

Image of hoe (괭이):
http://en.wikipedia.org/wiki/File:Peasant_in_the_vegetable_garden.JPG

Image of bow and arrow:
http://en.wikipedia.org/wiki/File:Aphaia_pediment_polychrome_model_W-XI_Glyptothek_Munich.jpg

Machines

- Steam engine, 산업혁명
  - 동력원: 화학에너지
  - 결과: 힘 (운동에너지)
  - 기계 (자동장치) - 인간의 힘을 대신함
- Used in all kinds of machines: 자동차, 트랙터, 공장기계, …
- Alternate forms: gasoline engine, electric motor

Image of steam engine:
http://en.wikipedia.org/wiki/File:52_8134_Hoentrop_2012-09-16.jpg

Image of electric motor:
http://en.wikipedia.org/wiki/File:Motors01CJC.jpg

Machine Called Computer

- Computer, IT혁명
  - 동력원: 전기에너지
  - 결과: 계산, 논리적 처리
  - 자동장치 - 인간의 머리 (계산, 논리)를 대신함
    - 범용컴퓨터
    - All kinds of "smart" machines

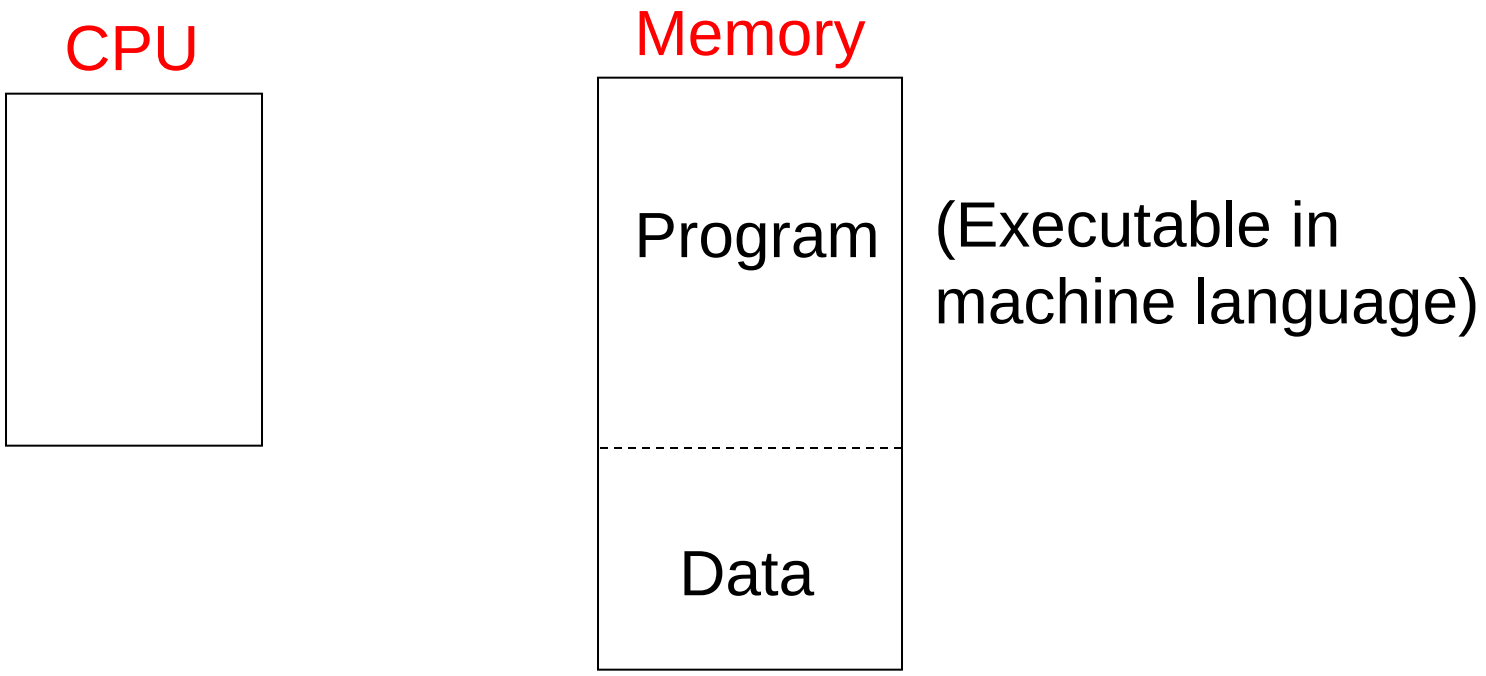
Image of PC (범용컴퓨터):
http://en.wikipedia.org/wiki/File:MSI_Laptop_computer.jpg
Image of robot (smart machine):
https://en.wikipedia.org/wiki/File:HONDA_ASIMO.jpg

What is the machine called computer?

- Keep removing things from your PC
  - Office, web browser, email, Windows, …
- Processor, memory, I/O (and interconnection logic)
  - Computer hardware or computer architecture

Machine Called Computer

- What is computer? How does it work?



I/O: Monitor/keyboard, LAN-Internet, …

† Fetch, decode, execute

Hardware - Inside PC

Image of Motherboard:

http://en.wikipedia.org/wiki/File:Acer_E360_Socket_939_motherboard_by_Foxconn.svg

Block diagram of a modern motherboard:

http://en.wikipedia.org/wiki/File:Motherboard_diagram.svg

ENIAC (1943-1946)

First fully-electronic, general-purpose computer

Image of ENIAC:

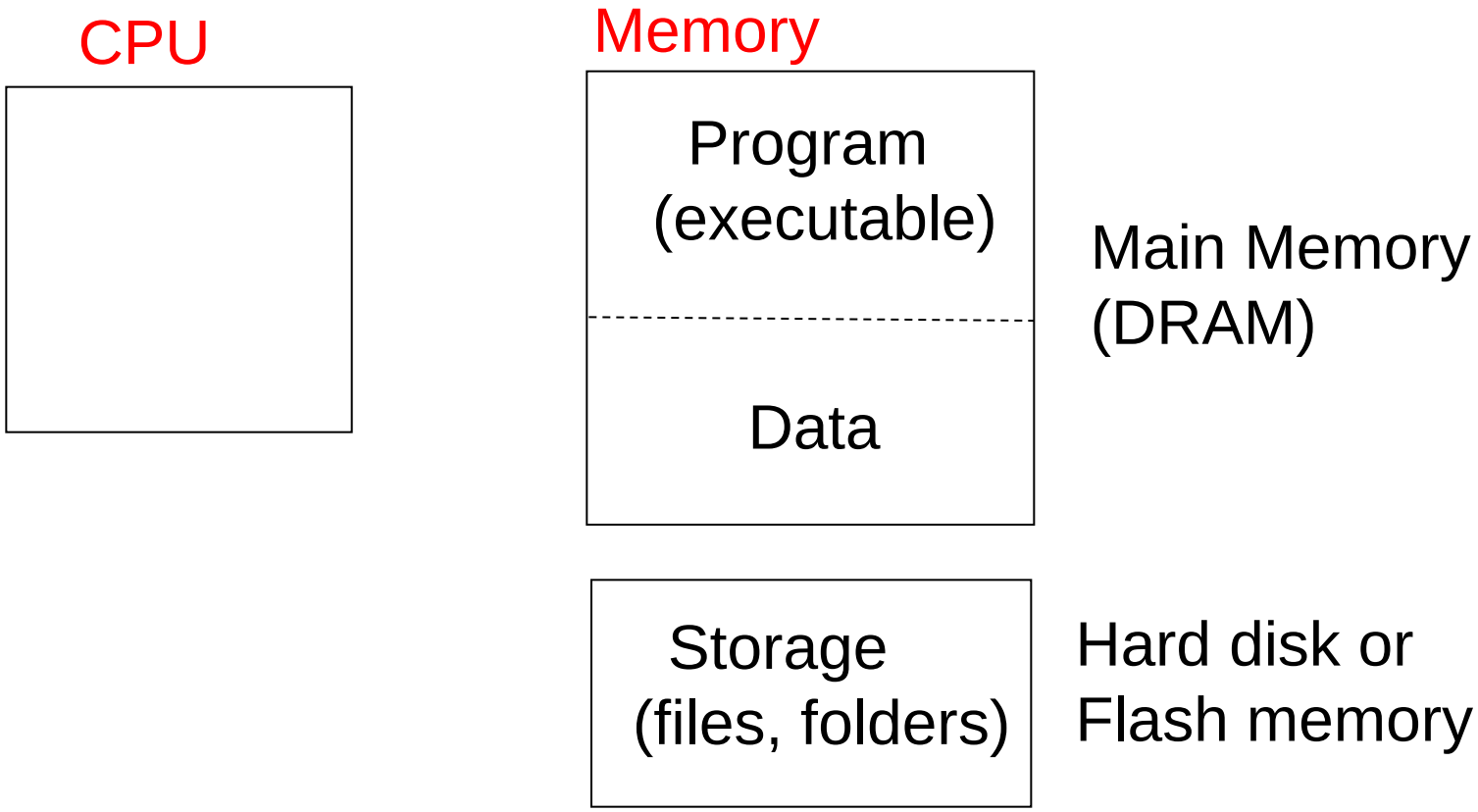
http://en.wikipedia.org/wiki/File:Classic_shot_of_the_ENIAC.jpg

Image of ENIAC:

http://en.wikipedia.org/wiki/File:Eniac.jpg

Machine Called Computer

- What is computer? How does it work?
  - Manipulate data by program execution



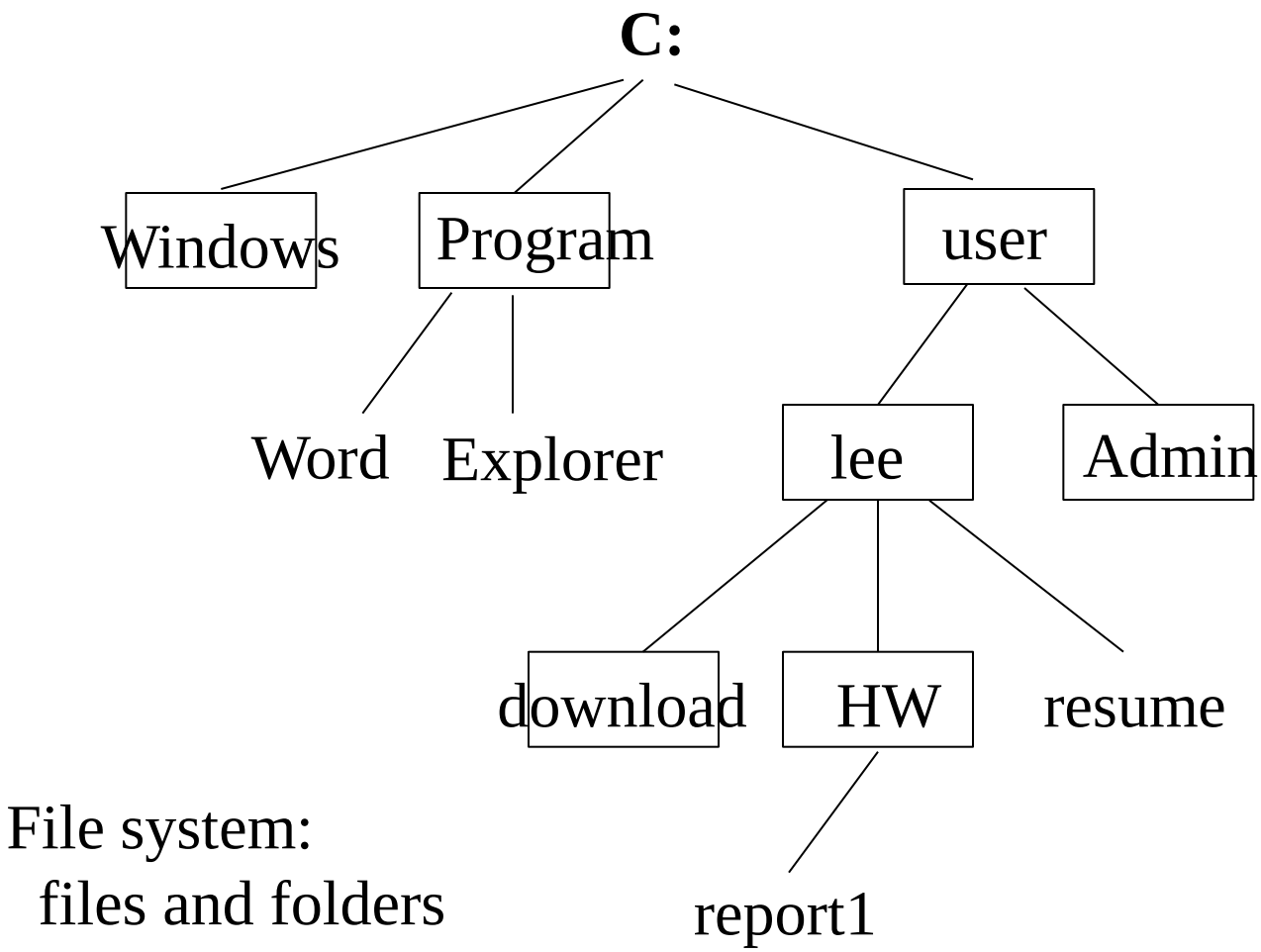
I/O: Monitor/keyboard, LAN-Internet, hard disk

CPU, Memory, I/O Devices

- CPU
  - Execute program (one instruction after another)
- Memory
  - Main memory (DRAM)
    - Program and data
  - Auxiliary storage (hard disk or flash memory)
    - Files and folders
- Input and output (I/O) devices: interact with outside
  - Keyboard, monitor, printer (human)
  - Interface with other machines (e.g., Internet)
  - Hard disk

Hard Disk in PC

Temporary data to support program execution



File system:
files and folders

My PC

- What if you click "report1" (Word file)?
- What if you click "Explorer"?
- Who does this hidden work?
  - Operating System (OS; 운영체제)
    - Graphic user interface (GUI)
    - Program execution (i.e., process; running program)
    - File system (files and folders)
      † Create, modify, delete

Computers

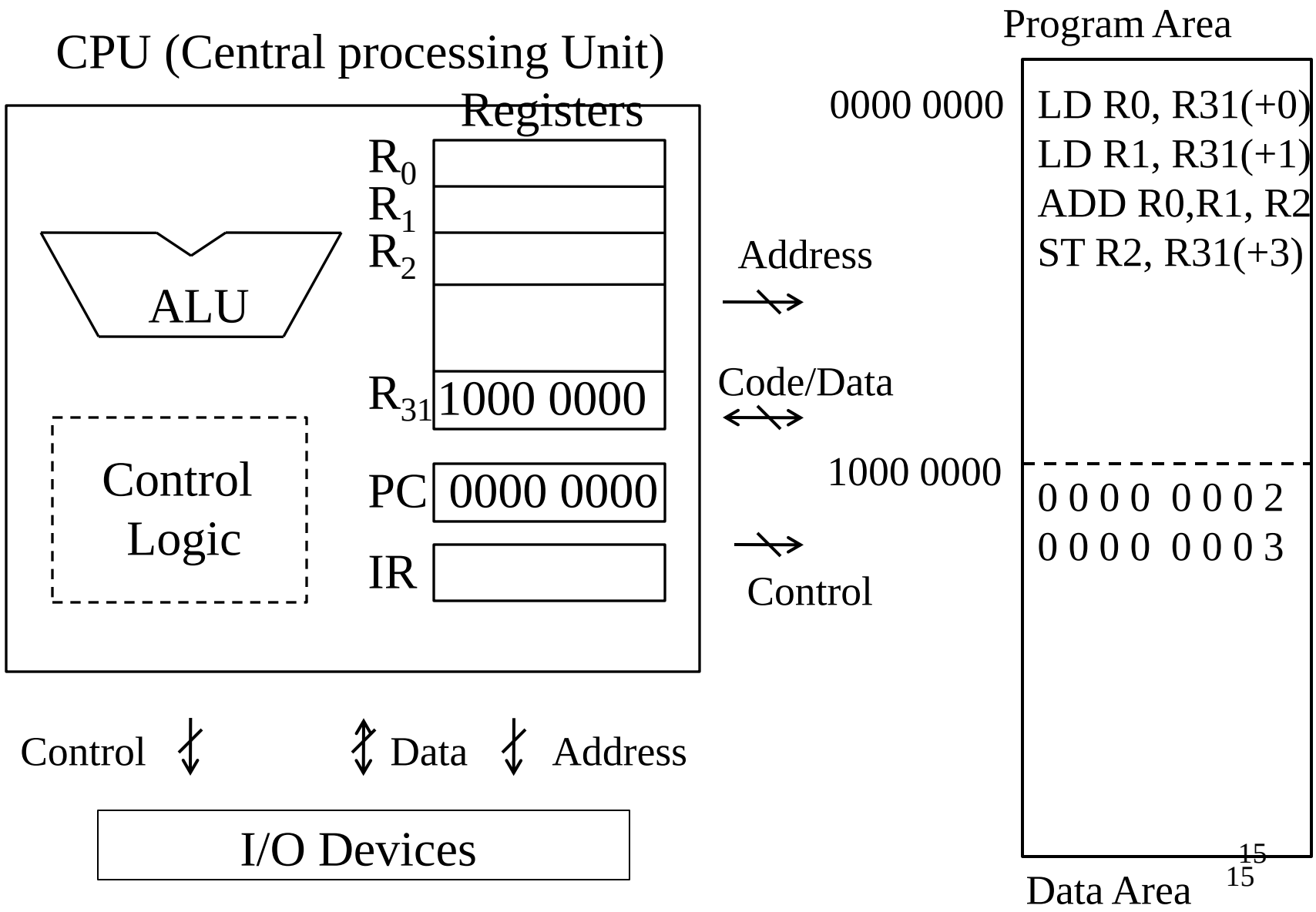
- Program execution (CPU; 계산)
  - Process: running program
    - Dynamic entity (has life)
- Storage (memory; 저장)
  - Files and folders (file system)
    - Static entity, non-volatile
- Input and output (I/O; 접속)
  - Human interaction, Internet connection, hard disk

† Why do you buy computers?

Memory (주기억장치)

- Main memory (DRAM)
  - Many instructions in program
    - One address per instruction
  - Many data items: one address per item
- Main memory (DRAM)
  - Must keep up with CPU speed
    - Access time ≈ 50 ns, still much slower than CPU
  - Support random access (thus, the name RAM)

Computer Hardware



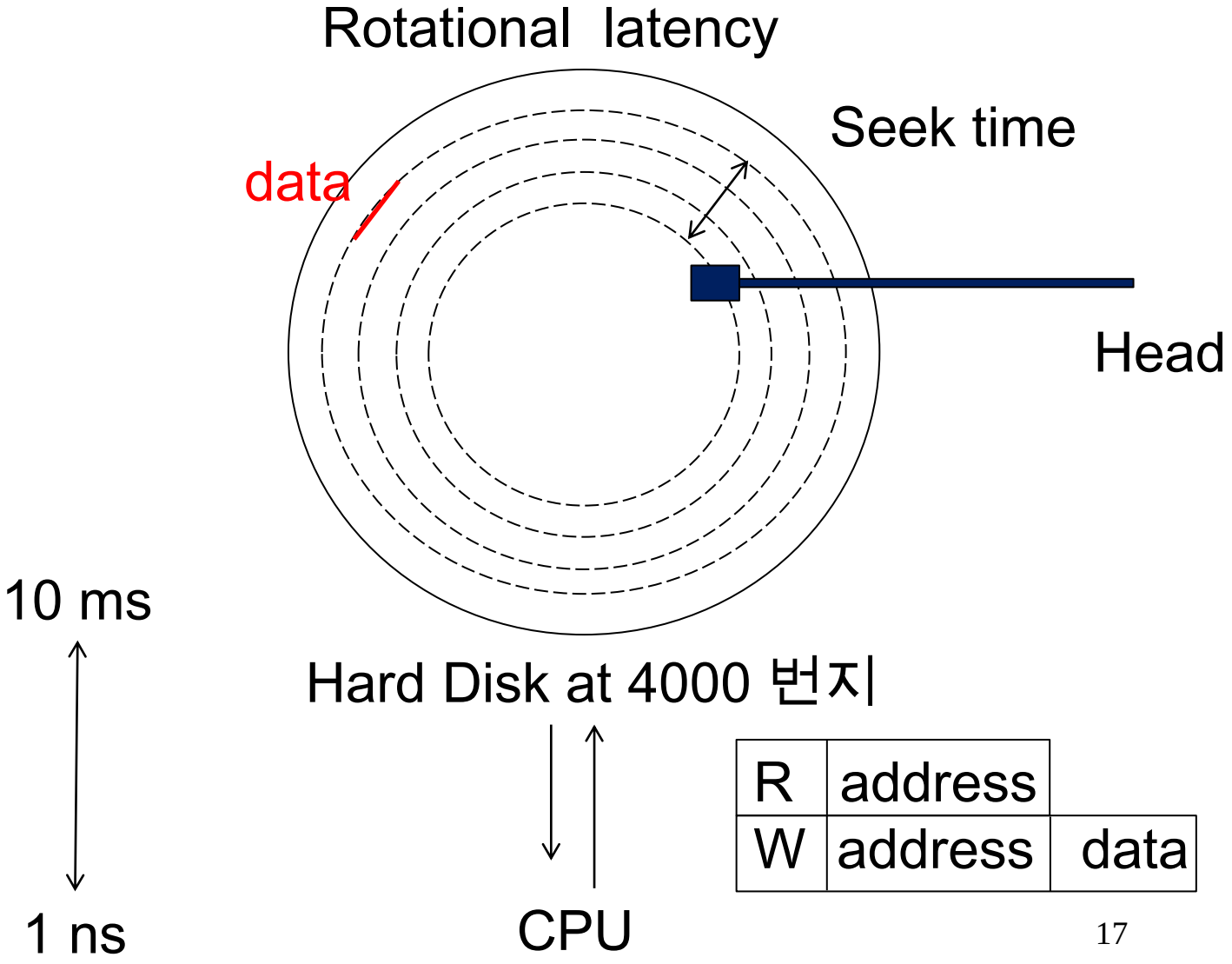
15

Memory (보조기억장치)

- Hard disk (or NAND flash memory)
  - Much slower, less expensive, larger storage space
    - Store everything in auxiliary storage device
    - Occasionally read it and copy files to main memory
  - I/O device
    - Not support random access

Image of hard disk:
http://en.wikipedia.org/wiki/File:Hard_drive-en.svg

Hard Disk (Magnetic Device)



Memory and I/O devices

- What is common (from CPU perspective)
  - What CPU can read from or write to
- What is different
  - Main memory: many addresses
  - I/O devices: single address (e.g., keyboard: 3000번지)
    - Slower, occasional use

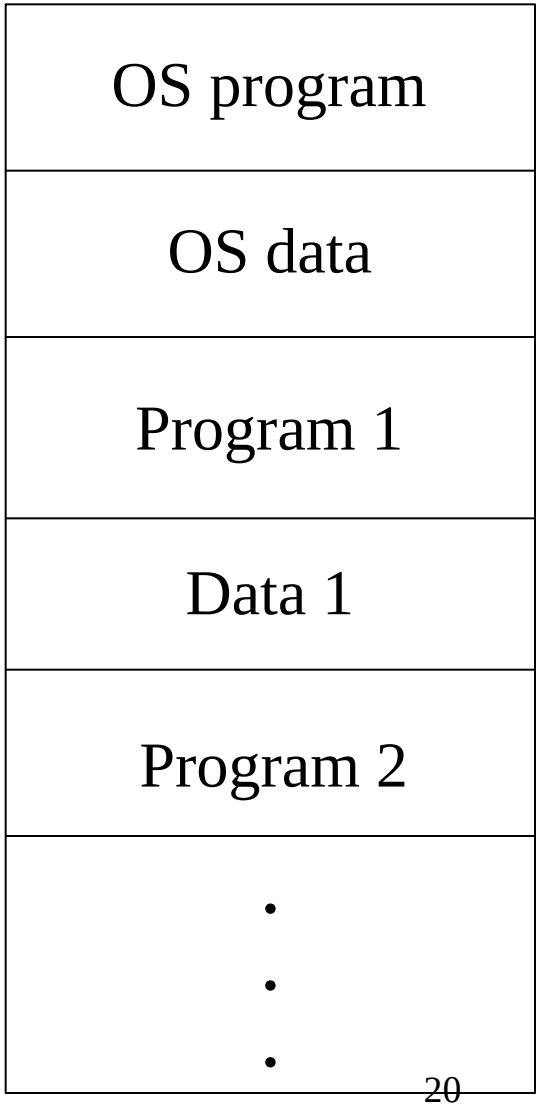
Hard Disk and Flash memory

- Hard disk (by IBM in 1953)
  - Least expensive, most storage capacity
  - Magnetic storage, rotating platter
    - 10 milliseconds of seek time
- (NAND) flash memory (Toshiba in 1989)
  - Semiconductor: fully electronic
    - Faster, more reliable, more power-efficient
  - Replace hard disk in mobile devices (c.f., USB memory)

† Survival of the fittest in technology world

Multiple Processes

- Where is OS?
- Can run both Word and Explorer?
- OS scheduling and management
  - Take turns to execute
  - User illusion of simultaneous executions
- † Multi-processors
- † Multicore processors



Main memory

Two Types of Computers

- General-purpose computer (범용컴퓨터)
  - 인간이 주는 (다양한 종류의) 프로그램을 실행함
    - PC, 한양대 데이터베이스 서버
- Embedded computer (내장형컴퓨터)
  - Machines 과 결합하여 다양하고 강력한 자동형 기계 형성
    - 항공기, 우주선, 자동차, 청소기, drone, 로봇, …
  - Many different types, so many of them
    - 프로그램은 한 가지로 고정되어 있음
  - 컴퓨터는 기계를 조종하는 머리 역할 수행
    - 컴퓨터는 작고 기계에 안에 내장되어 잘 보이지 않음

† Special-purpose computer, dedicated computer

CPU Industry

- Processors for general-purpose computers
  - Intel (IA-32, IA-64)
  - IBM (PowerPC)
  - MIPS Technologies (MIPS)
  - Sun Microsystems (SPARC)
- What is special about this business?
  - In contrast with memory
- Mobile AP (application processor) for smartphones
  - Qualcomm, Samsung, Intel
- GPU (graphics processing unit): Nvidia, AMD

Storage and Monitor Industry

- DRAM
  - Samsung, Hynix, Elpida, Micron
- Hard disk
  - Seagate, Toshiba, Western Digital
  - Closed business: IBM, HP, Quantum, Fujitsu, Samsung
- Flash memory
  - Samsung, Toshiba, Micron, Hynix
- Flat panel monitors
  - Samsung, LG, Taiwanese and Japanese companies

† Printers

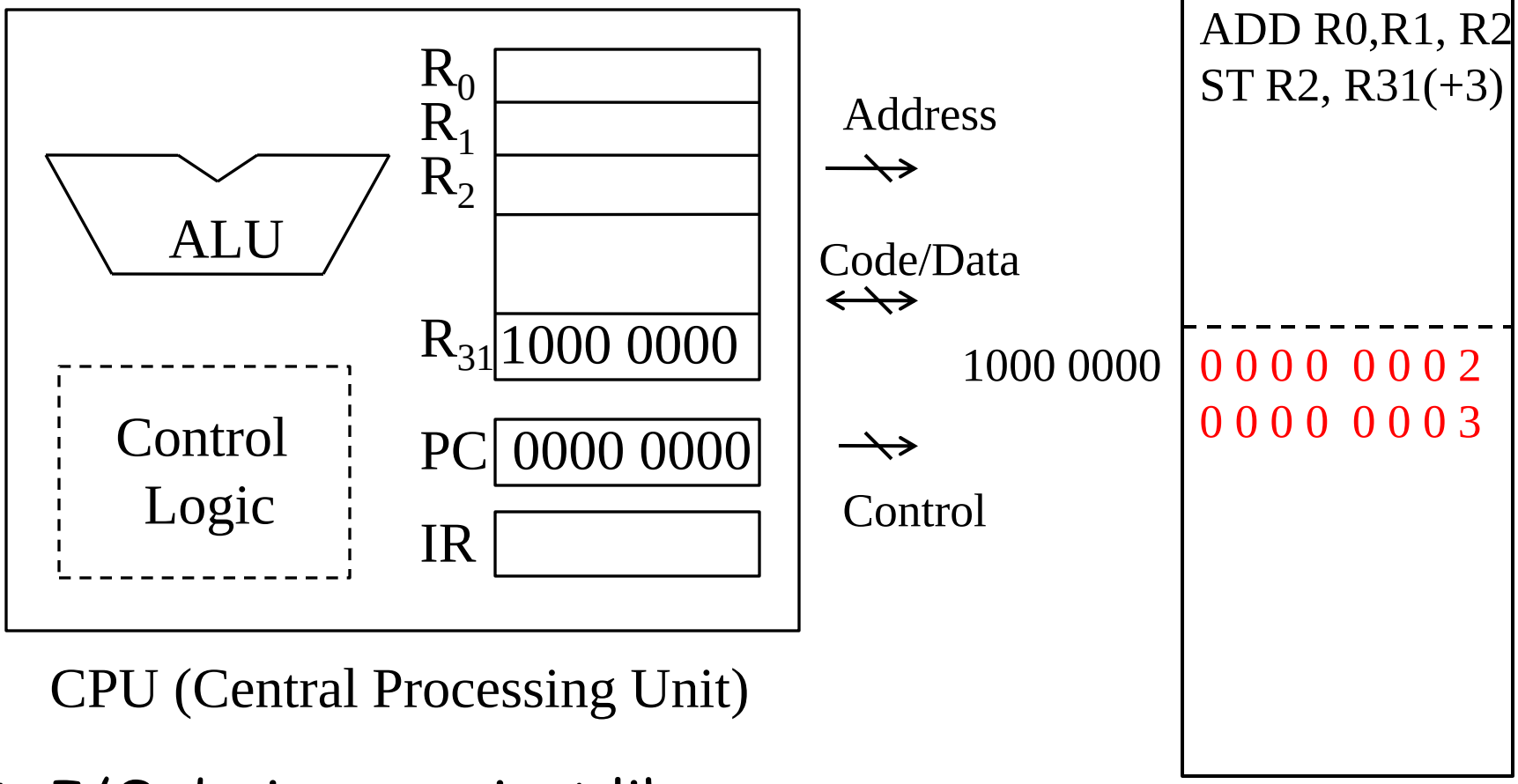
- HP, Xerox, Cannon, Samsung, Epson

Computer Systems Industry

- PC
  - Lenovo, HP, Dell, Acer Group
- Notebooks
  - HP, Acer, Lenovo, Dell
- Servers
  - IBM, HP, Dell, Oracle, Fujitsu
    - Many CPUs, hundreds of disks, thousands of terminals
    - Support OS, compiler
- Supercomputers
  - HP, IBM, Europe, Japan
    - Millions of processors, support OS and compiler

Machine Called Computer

- Data in binary form
  - Program and address as well



† I/O devices are just like memory

Inside CPU – Will come back soon

- ALU (arithmetic and logic unit)
  - Add, subtract, multiply, divide, AND, OR, NOT
  - Input: registers, output: register
- Registers
  - Storage of temporary data
- PC (program counter)
  - Address of the next instruction to execute
- IR (instruction register)
  - Instruction being executed
- Control logic
  - The rest of CPU for "fetch-decode-execute"