CSD1100

Types Of Computer Memory

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Definition

- Computer memory is any physical device capable of storing information temporarily or permanently.
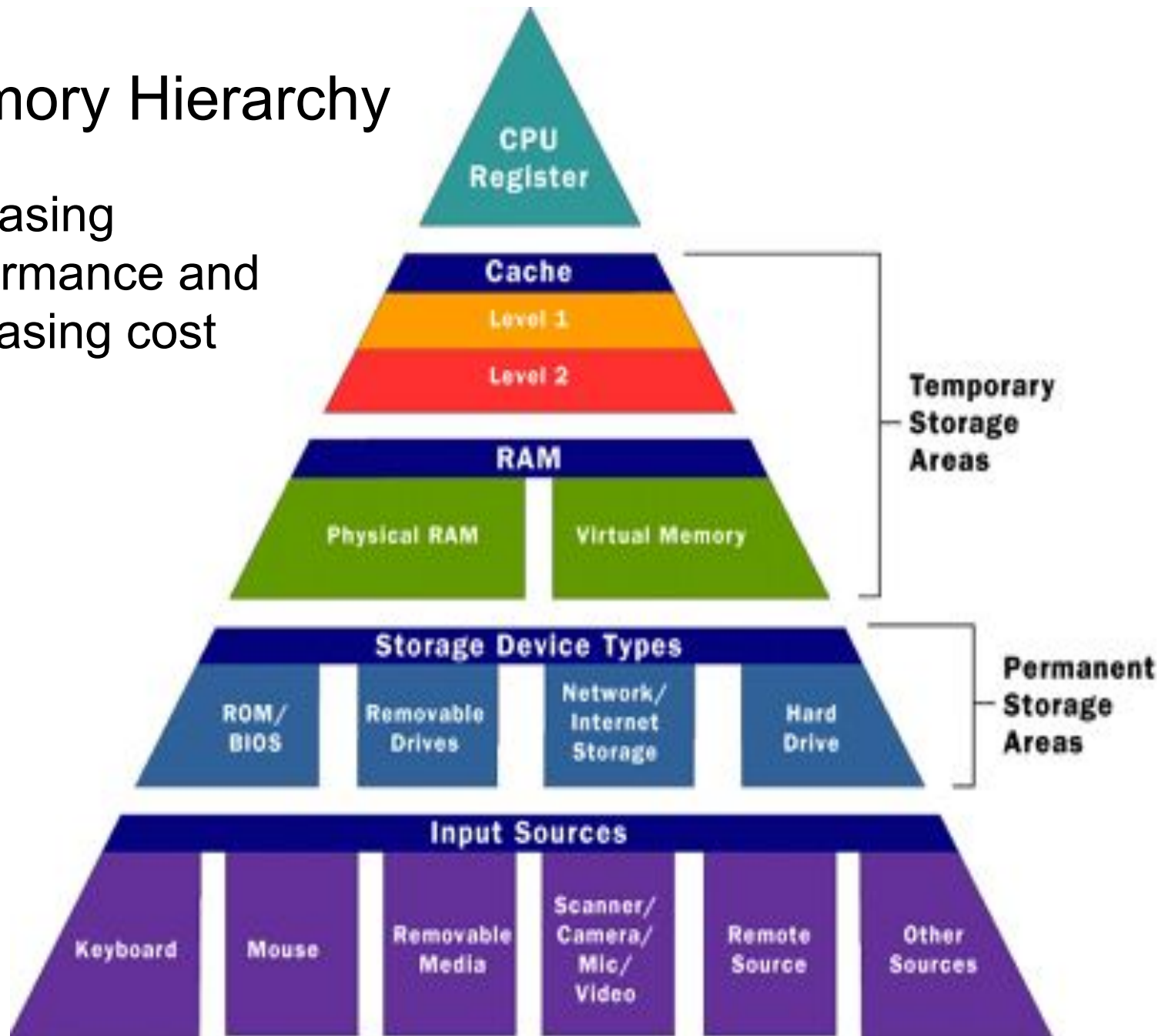
Definition

- **Volatile memory** - not able to store data when it is not being supplied with electricity
- **Nonvolatile memory** - able to store data without using electricity
- **Flip-flops** - implementation of a memory cell by using logic gates (more next week)
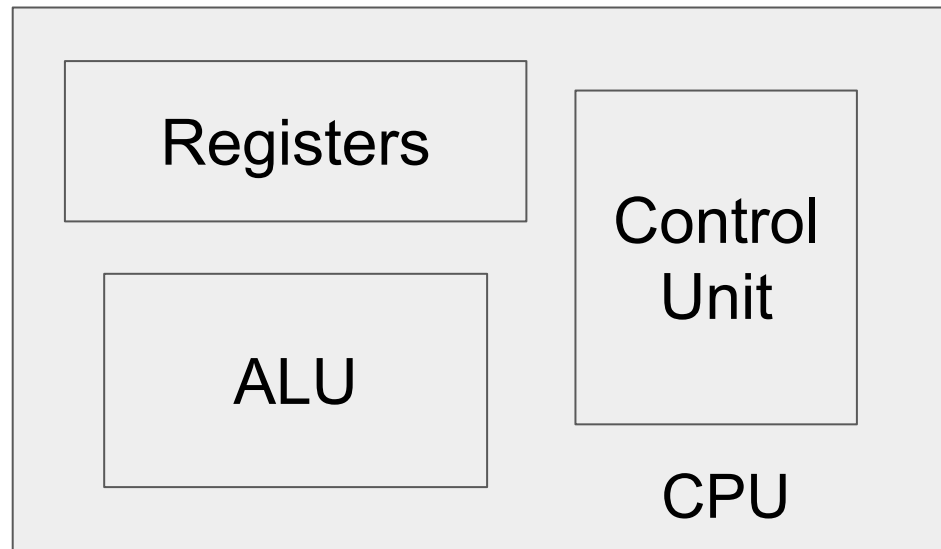
Memory Hierarchy

Increasing performance and increasing cost

CPU Registers

- Top in the hierarchy.
- Are circuits typically composed of flip-flops.
- Matched in speed to the CPU.
- But are large and consume significant power.
- Number of registers in a processor is small (usually 32).

Registers

Control
Unit

ALU

CPU

Kinds of Registers

- **General Purpose Registers** are available for general use by the programmer. Most modern CPU's have about 16, but some can have 64 general purpose registers.
- **Special Purpose Registers**:
  - Program Counter register (PC),
  - Instruction Register (IR),
  - ALU Input & Output registers,
  - Condition Code (Status/Flags) register,
  - Stack Pointer register (SP).

Using Registers

- Registers are referenced directly by specific instructions or by encoding a register number within a computer instruction.
- At the programming (assembly) language level of the CPU, registers are normally specified with special identifiers (e.g. R0, R1, R7, SP, PC).

- If we were to sum all the bits of all registers within CPU, the total amount of memory probably would not exceed 5,000 bits. **Most computational tasks undertaken by a computer require a lot more memory.**

RAM

- **Random Access Memory.**
- It is a read/write, volatile memory.
- The term "random" means any memory location can be accessed in the same amount of time regardless of its position in the memory.
- The data and programming instructions are stored in the RAM temporarily until that program is used.
- Computer architectures also impose an architectural constraint on the maximum allowable RAM. This constraint is normally equal to $2^{WordSize}$ memory locations.

Cache Memory

- Cache memory is RAM that a microprocessor can access more quickly than it can access regular RAM.
- The basic purpose of cache memory is to store program instructions that are frequently re-referenced by software during operation. Fast access to these instructions increases the overall speed of the software program.
- As the microprocessor processes data, it looks first in the cache memory; if it finds the instructions there (from a previous reading of data), it does not have to do a more time-consuming reading of data from larger memory or other data storage devices.

Static RAM (SRAM)

- Based on flip-flops. Each bit requires a 6-transistor circuit.
- Contents of each location persist as long as power is applied.
- Fast but relatively large.
- Consume a lot of power.
- **Due to its cost it is not used as main memory but rather for cache memory.**

Dynamic RAM (DRAM)

- Not as fast as SRAM but is cheaper and is used for main memory.
- Employ capacitors.
  - Capacitor stores electric charge whose level represents a 1 or 0.
  - Capacitors dissipate with time and hence the charge must be restored frequently (every few milliseconds).

ROM

- Read Only Memory.
- Data stored in these chips is nonvolatile -- it is not lost when power is turned off.
- On turn on, the computer loads BIOS (Basic Input/Output System) from ROM.
- Data stored in these chips is either unchangeable or requires a special operation to change.
- Applications: video consoles, calculators, microwave oven, etc.

Types of ROM

- PROM - Programmable Read Only Memory
  - It is a non-volatile memory. Instructions can be written once by the programmer using special equipment and then subsequently read.
- EPROM – Erasable Programmable Read Only Memory
  - It is an improvement over the PROM chips. Instructions can be rewritten by the programmer using special techniques. The instructions are erased using UV light and rewritten. To change the instructions the chip has to be removed from the machine and then put back after the changes have been made.

Types of ROM

- EEPROM – Electronic Erasable Programmable Read Only Memory.
  - It is advancement over EPROM, and the chip need not be taken out from the machine. Instead the programming is done using software.
  - These chips are used in Point-Of-Sale (POS) terminals to record price related information and can be updated as and when needed. However they are expensive compared to the normal ROM chips.

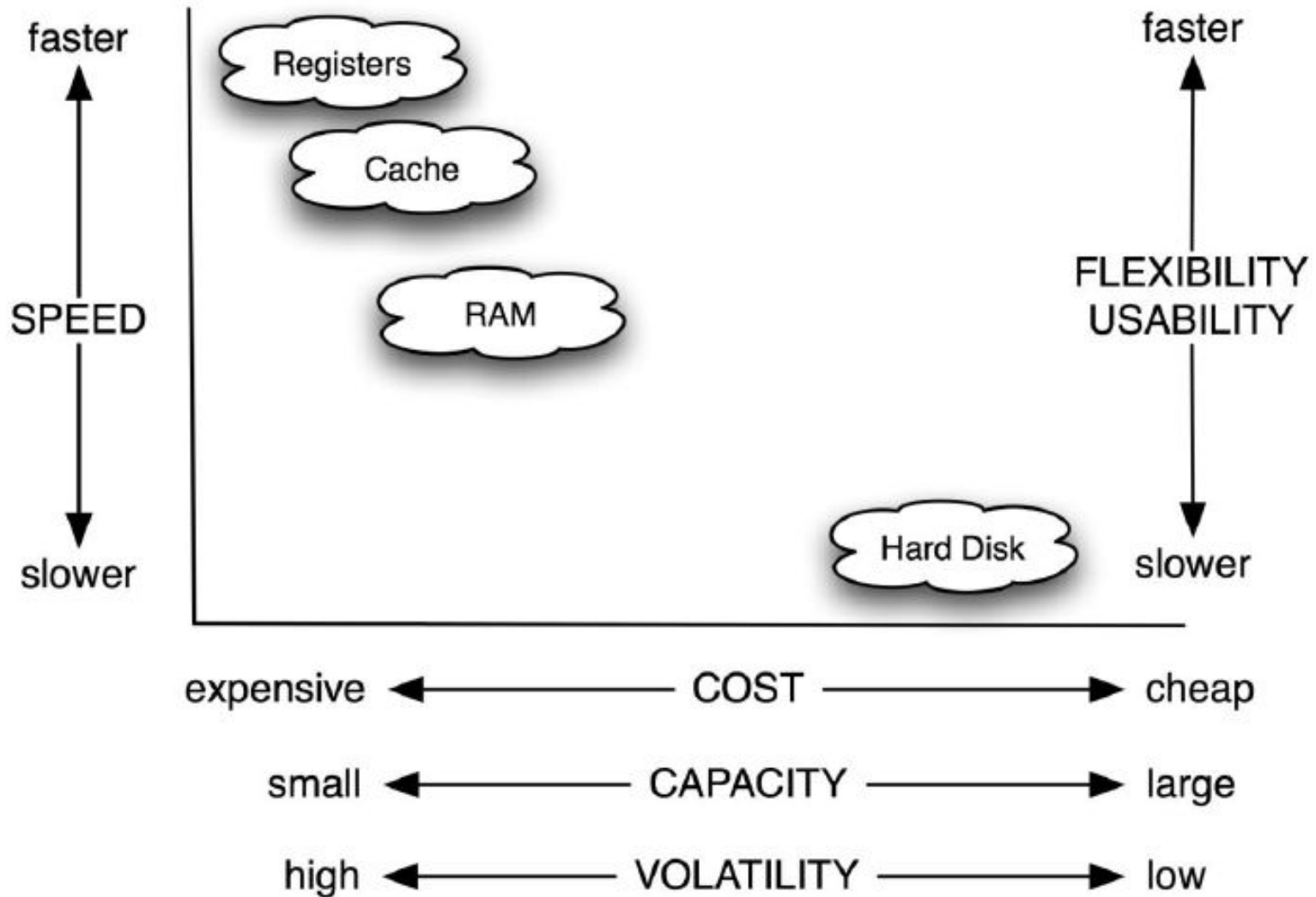# Flash Memory (BIOS chip, CompactFlash, SD …)

- A section of memory cells can be erased in a single step, or 'flash', thus the name.
- Nonvolatile memory.
- Flash memory is used for easy and fast information storage in such devices as digital cameras, mobile, video game consoles.

Storage Devices

- At the bottom of the hierarchy.
- Memory which stores the data and programming instructions permanently in the computer system for future use.
  - HDD, CD-ROM, Magnetic Tape, ...
- It could be placed within the computer or connected externally.
- The storage capacity is huge and it is permanent in nature.
- Cost per stored bit small in terms of money and power, but access time is very long compared to registers.

Summary

References

- https://www.computerhope.com/jargon/m/memory.htm