CSCI 210: Computer Organization
Lecture 3: Inside Your Computer

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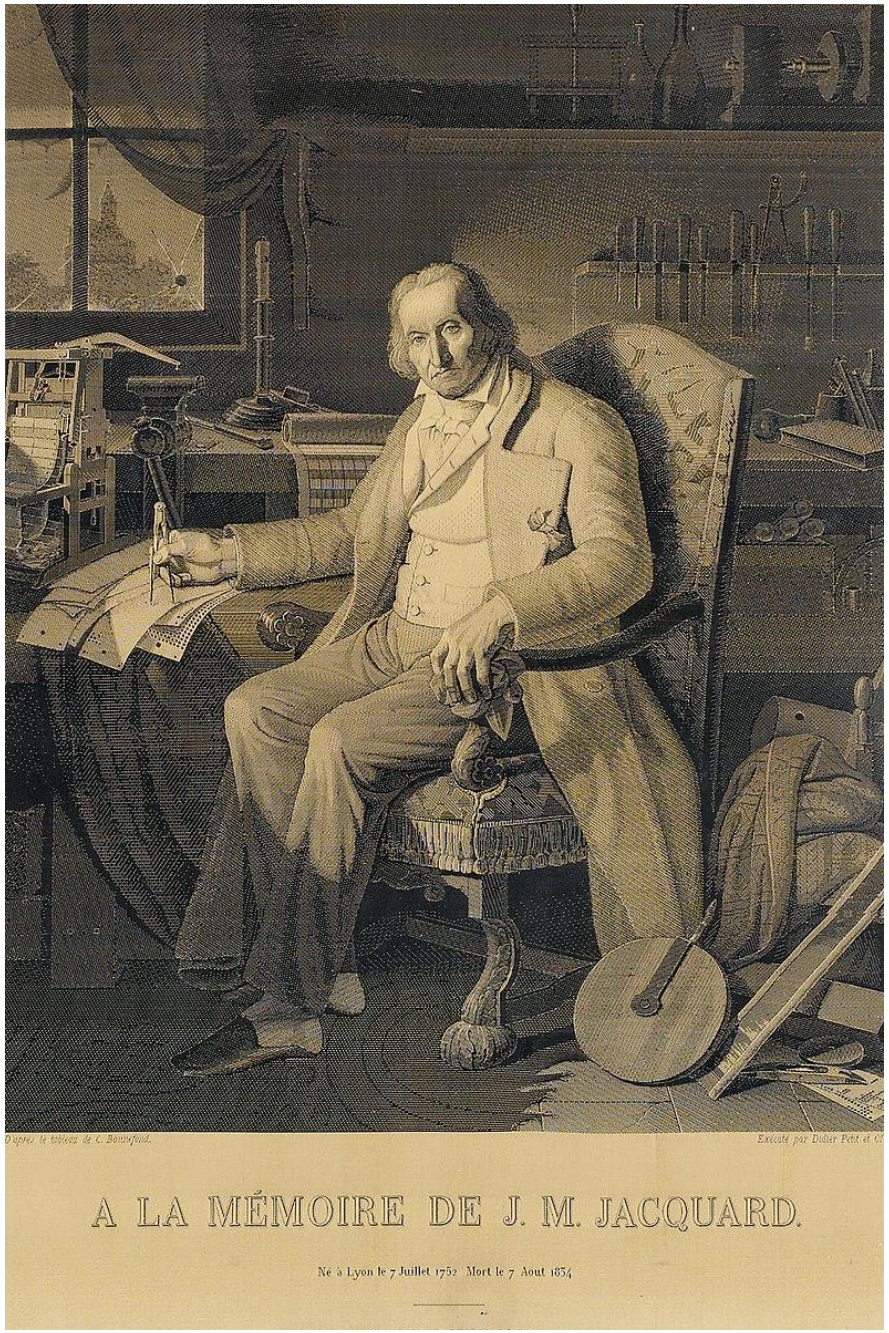
Announcements

- Problem set 0 due today at 11:59 p.m.
  - On GradeScope, linked from BlackBoard

CS History: The Jacquard Loom

- Uses punch cards to store weaving patterns
- The first stored program machine
- Allows a single weaver to create intricate patterns



The Jacquard Loom

- Weavings of Jacquard are produced and sold
- Charles Babbage buys one and is inspired to use punch cards in the Analytical Engine

CS History: The Luddites

- How do we use the word “luddite”?

CS History: The Luddites

- A group of weavers angry about their skilled labor being displaced by mechanized looms

- They smashed the new mechanized looms as a strike action

Group Discussion: What are similar movements or discussions happening today?

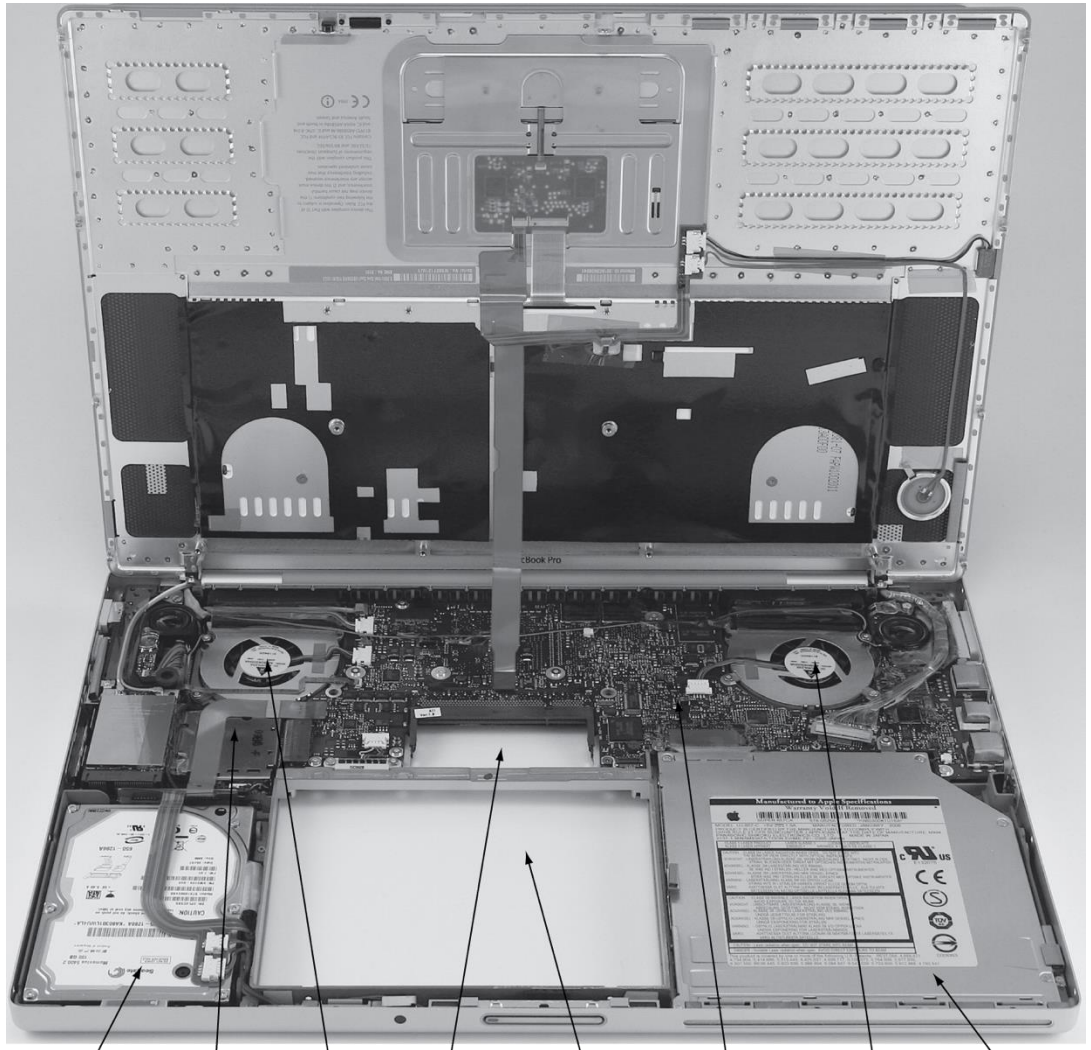
What’s Inside a Computer

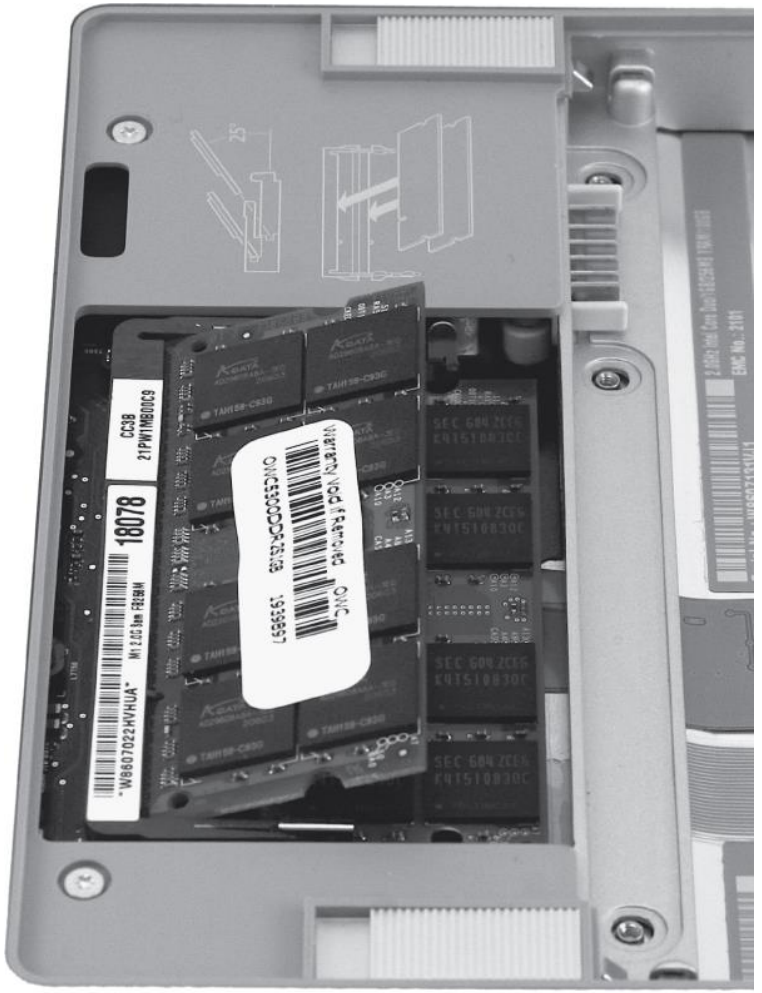
- CPU
  - Processes instructions
- Hard drive/Solid state drive (SSD)
  - Stores data, nonvolatile
- RAM
  - Stores data currently in use

What’s Inside a Computer

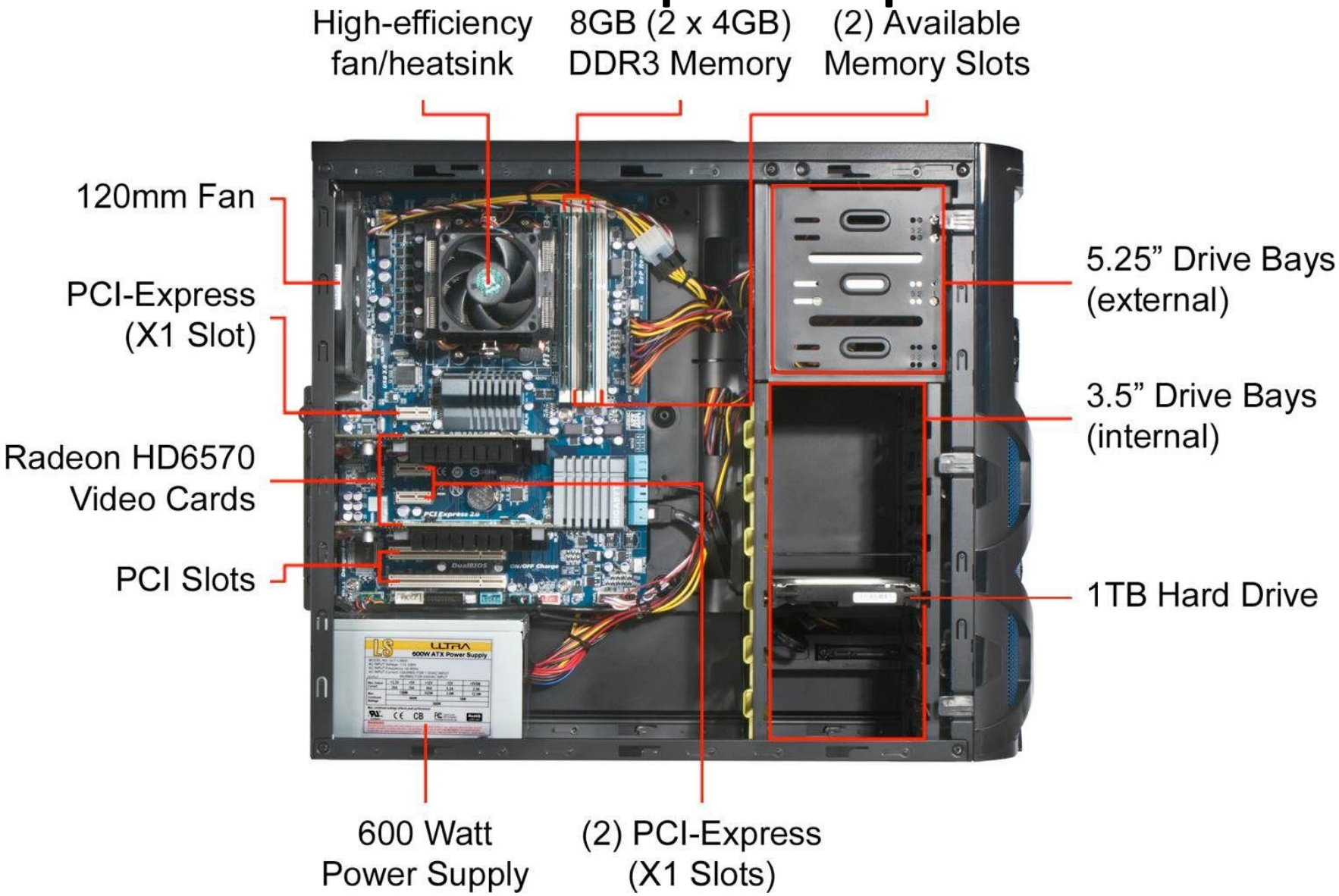
- Motherboard
  - Connects everything
- Graphics card, Networking Card
  - I/O devices
- Monitor, Keyboard
  - Peripherals

Opening the Box

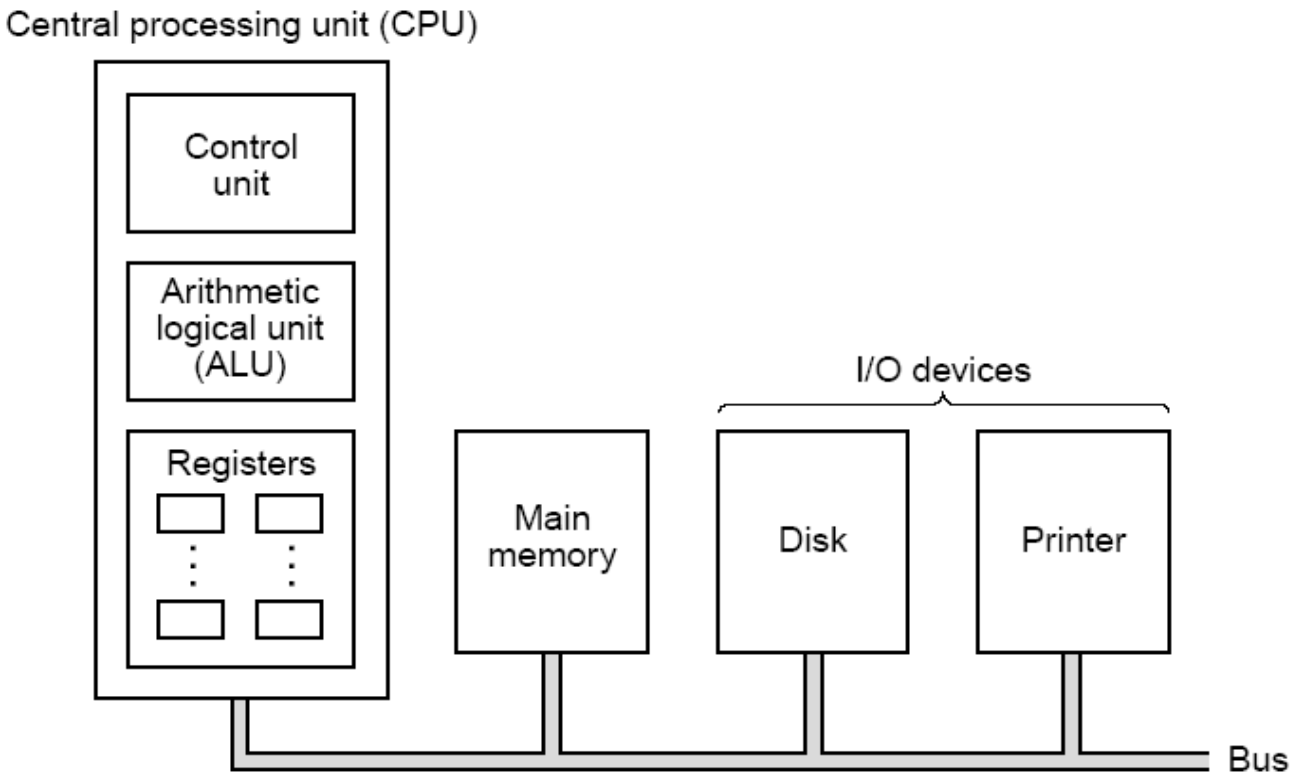




Inside a desktop computer

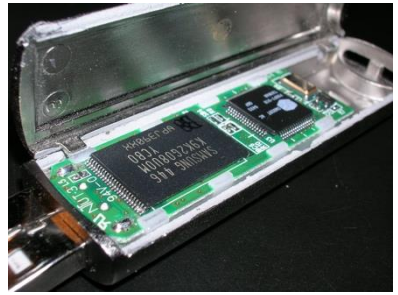


Very simplified diagram



A Safe Place for Data

- Volatile main memory
  - Loses instructions and data when power off
- Non-volatile secondary memory
  - Magnetic disk
  - Flash memory
  - Optical disk (CDROM, DVD)



Main Memory (RAM)

Index	Data
0	0011 1000
1	0000 0011
2	0111 0001
…	…
4294967295	0001 1000

4 GB of RAM

Basic structure: A 1-dimensional array of cells, each with a unique address. A cell is normally one byte (8 bits).

Basic Memory Operations

- read (load) the contents of the cell at a given location
- write (store) a given value to the cell at a given location
- Bytes may be grouped into 2-, 4-, or 8-byte words. A word is a basic unit of storage for binary integers, MIPS instructions, registers.

How much slower is it to get a byte from main memory (RAM) instead of the registers?

A. 2x slower

B. 10x slower

C. 100x slower

D. 1000x slower

E. None of the above

Cache Memory

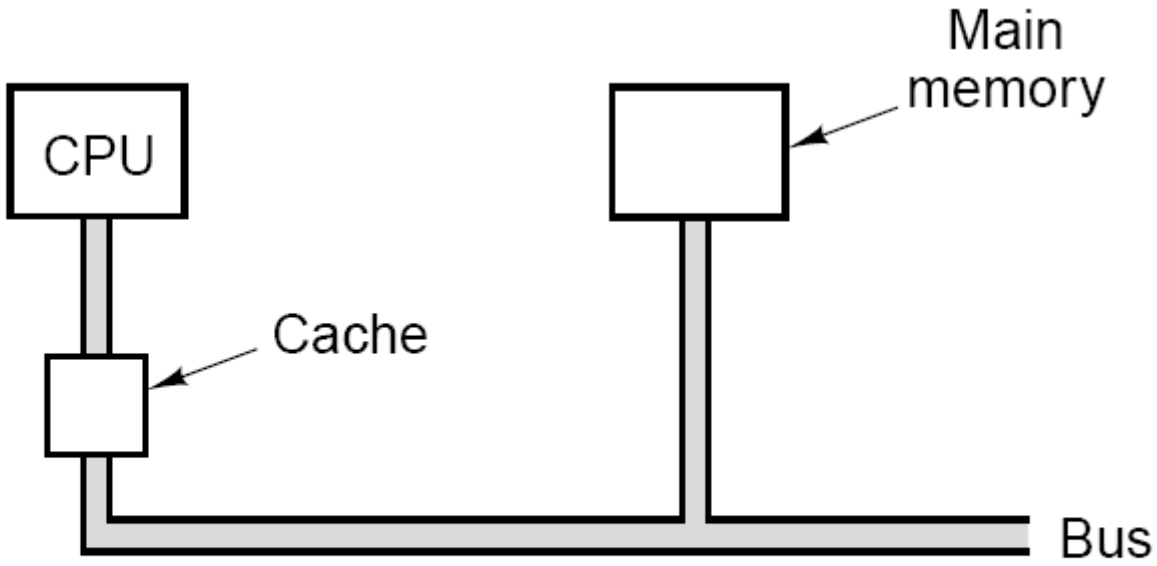
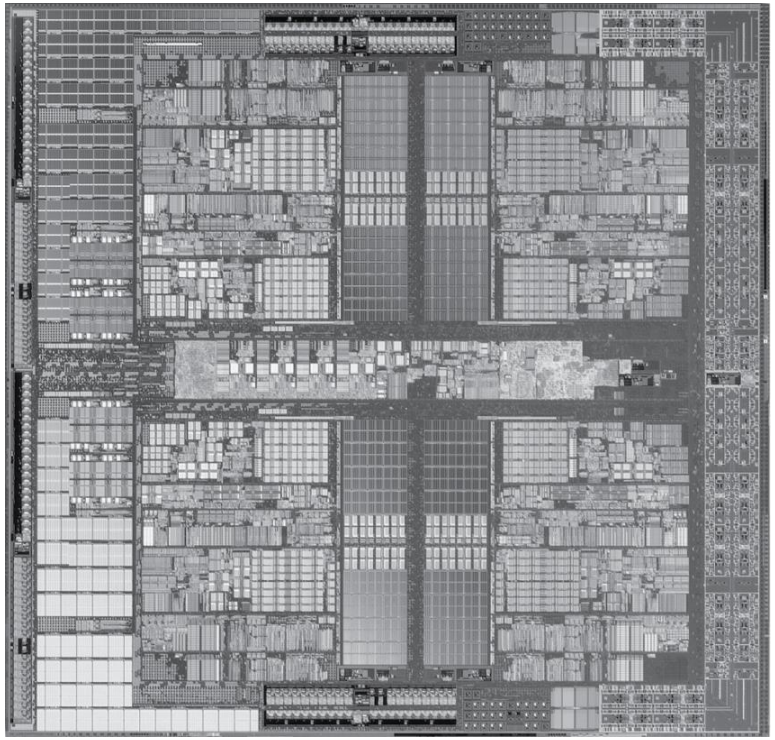


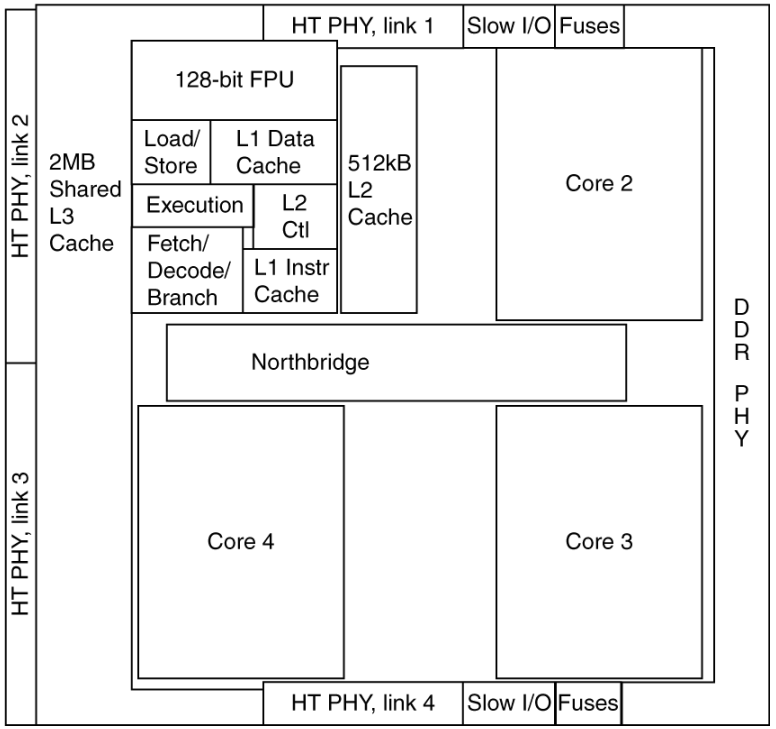
Figure 2-16. The cache is logically between the CPU and main memory. Physically, there are several possible places it could be located.

- Problem: Memory access is slower than CPU operations. Cache memory is used to speed up memory operations
- A cache is a small, fast memory positioned on the CPU, or between the CPU and the main memory
- Transparent to programmers

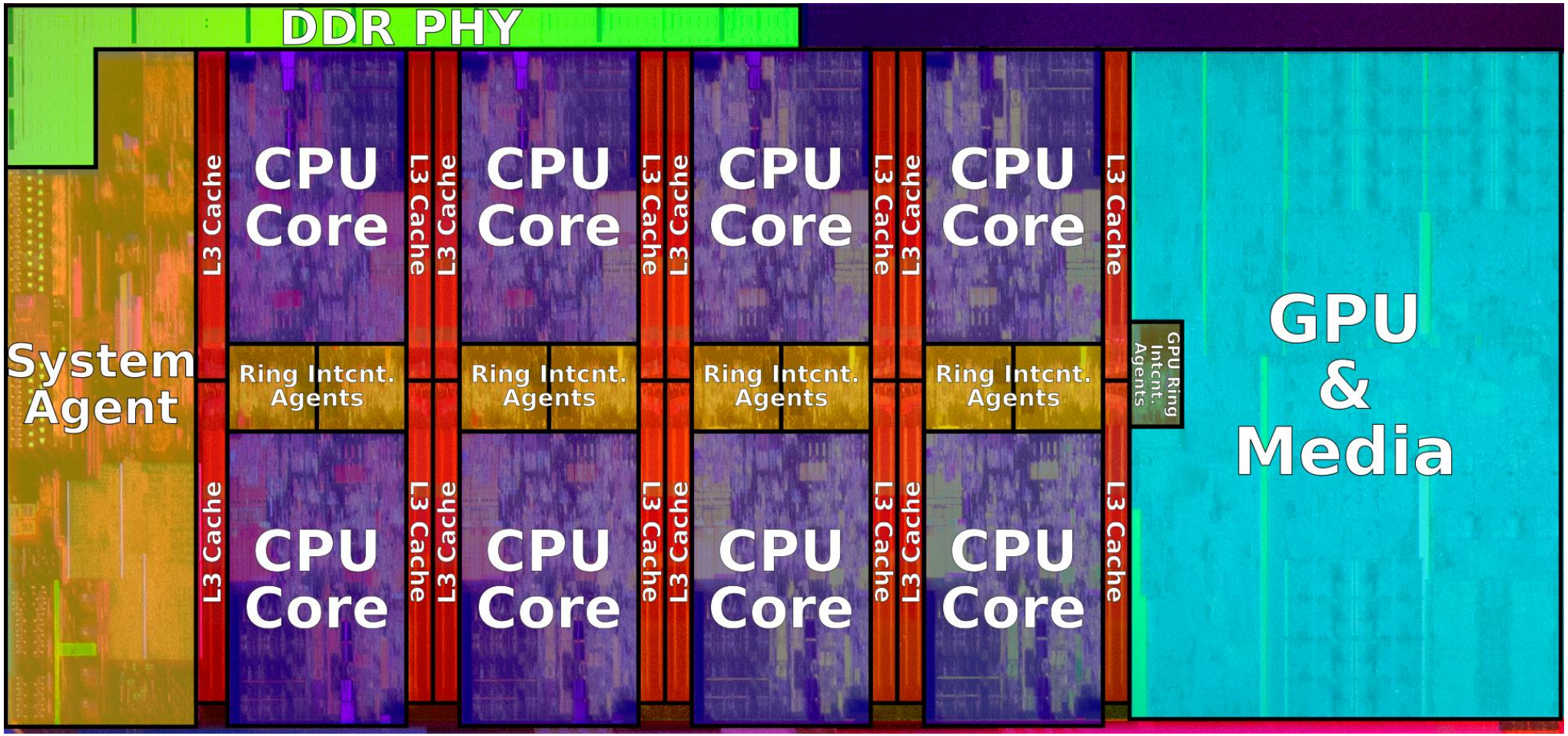
Inside the Processor

- AMD Barcelona: 4 processor cores

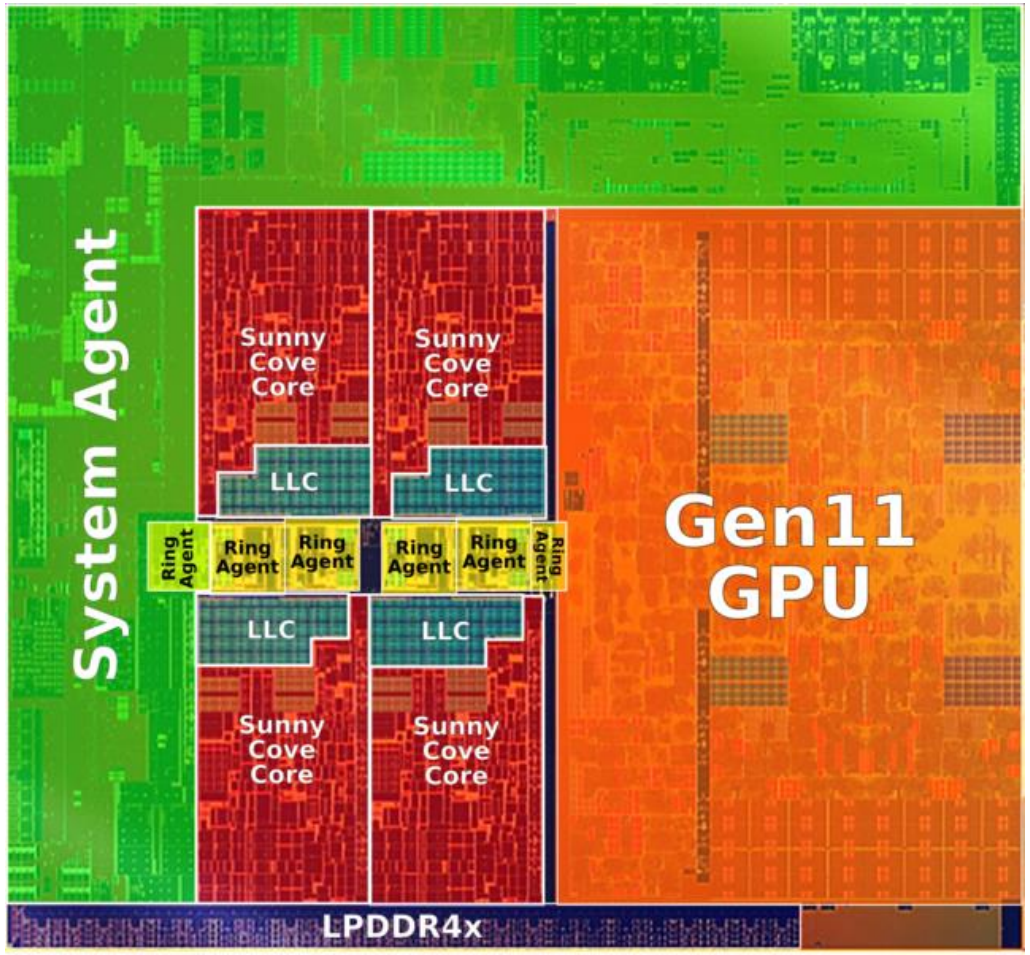


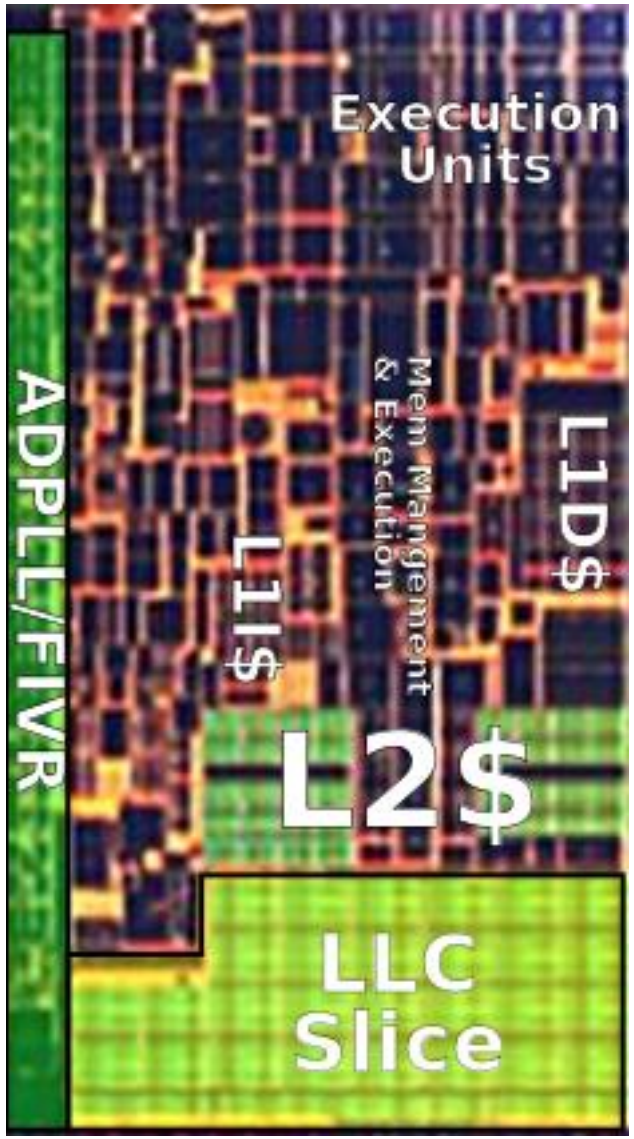


Inside the Intel Coffee Lake 8-core



Intel Ice Lake processor die





Central Processing Unit

- The CPU contains
  - Registers — words of memory inside the CPU
  - ALU (Arithmetic and Logic Unit) — performs computations
  - Control Unit — issues control signals

- Its job is to execute (i.e., run) machine language programs, one instruction at a time.

How Programs Run

- A program is a sequence of machine language instructions, stored in consecutive memory locations.

- To execute programs, the CPU uses two special registers:

  – PC (program counter) — contains the memory address of the current or next instruction to be executed

  – IR (instruction register) — contains the current instruction being executed

How Programs Run

- Instructions are executed in a sequence of operations called the instruction cycle:
  - fetch (IR ← Memory[PC]; PC ← PC + 1)
  - decode
  - execute
- The instruction cycle is repeated indefinitely, as long as the machine is on.

Incrementing the PC gets us the next instruction because

A. Instructions are stored in a linked list, and we are moving to the next node of the list.

B. Instructions are simply an array of numbers in memory, we are indexing into the array.

C. Instructions are stored in a special instruction array, and we are indexing into that array.

Questions about the CPU?

Reading

- Next lecture: Assembly Programming
  - Sections 2.1 and 2.2

- Problem Set 0 due Friday!