

# CSCI 210: Computer Organization

## Lecture 3: Inside Your Computer

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Slides from Cynthia Taylor

# Announcements

- Problem set 0 due TONIGHT at 11:59 p.m.
  - On gradescope, linked from blackboard
- Readings and problem set for next week up on blackboard (or will be shortly after class)

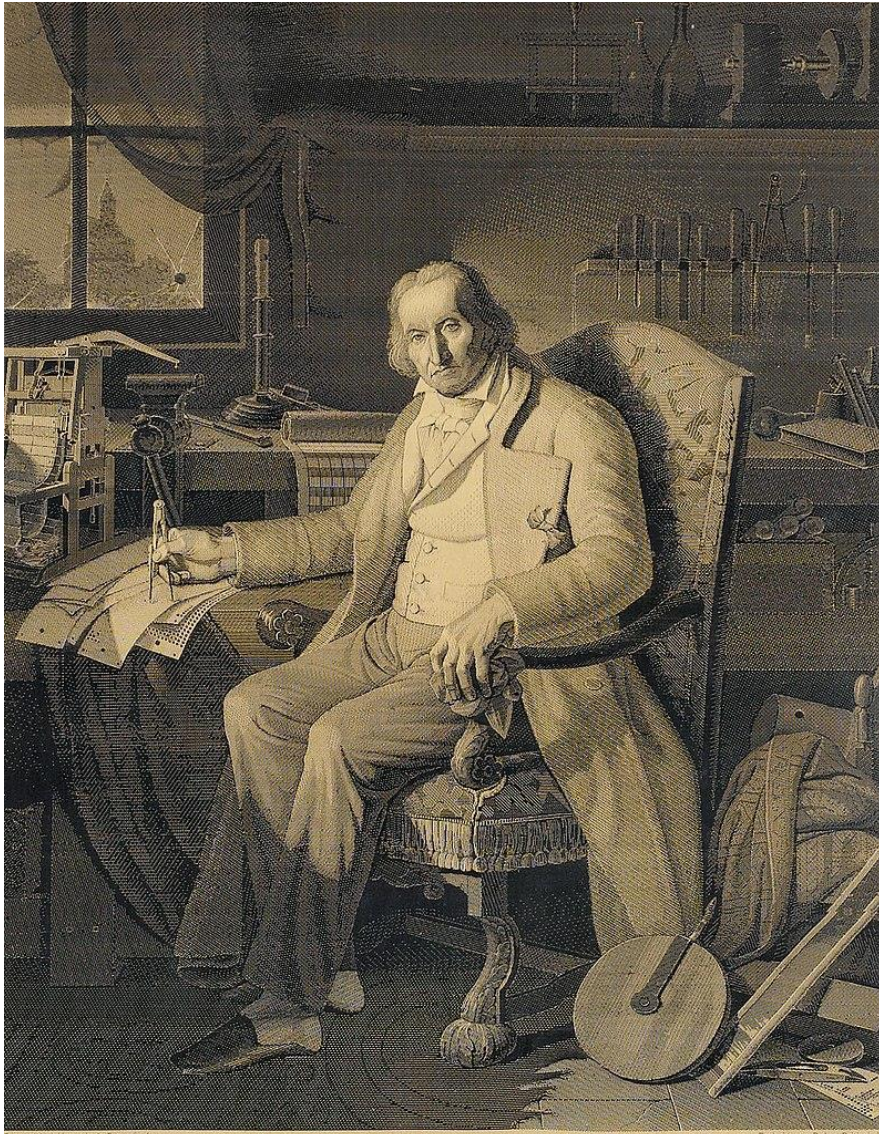
# CS History: The Jacquard Loom



- 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



A LA MÉMOIRE DE J. M. JACQUARD.

Né à Lyon le 7 Juillet 1752 Mort le 7 Aout 1834

# CS History: The Luddites

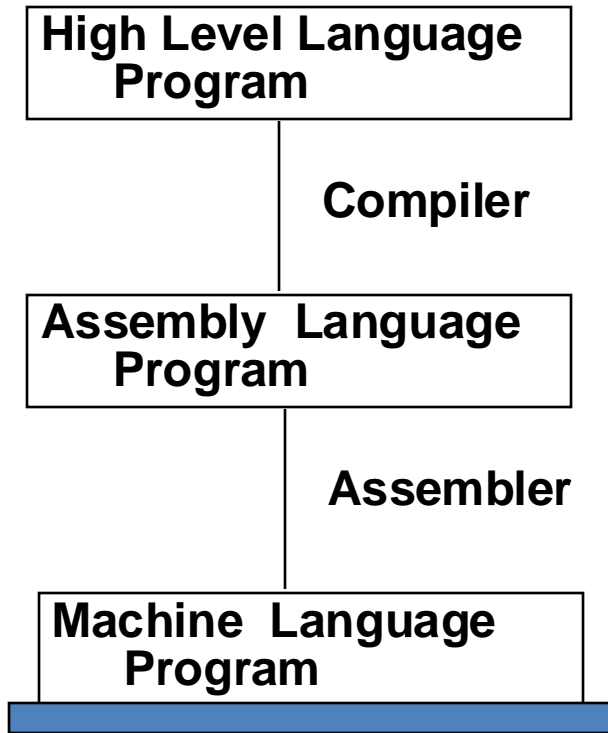
- How do we use the word “luddite”?

# 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?

# From Wednesday



```
temp = v[k];  
v[k] = v[k+1];  
v[k+1] = temp;
```

```
lw $15, 0($2)  
lw $16, 4($2)  
sw $16, 0($2)  
sw $15, 4($2)
```

```
10001100011000100000000000000000  
10001100111100100000000000000100  
10101100111100100000000000000000  
10101100011000100000000000000100
```

**Machine Interpretation**



A single program written in a high-level language can be compiled into \_\_\_\_\_ assembly language programs

- A. Exactly one
- B. Multiple
- C. At most three

A single program written in assembly can be assembled into \_\_\_\_\_ machine language programs

A. Exactly one

B. Multiple

C. At most two

# Group Discussion: What's Inside a Computer?

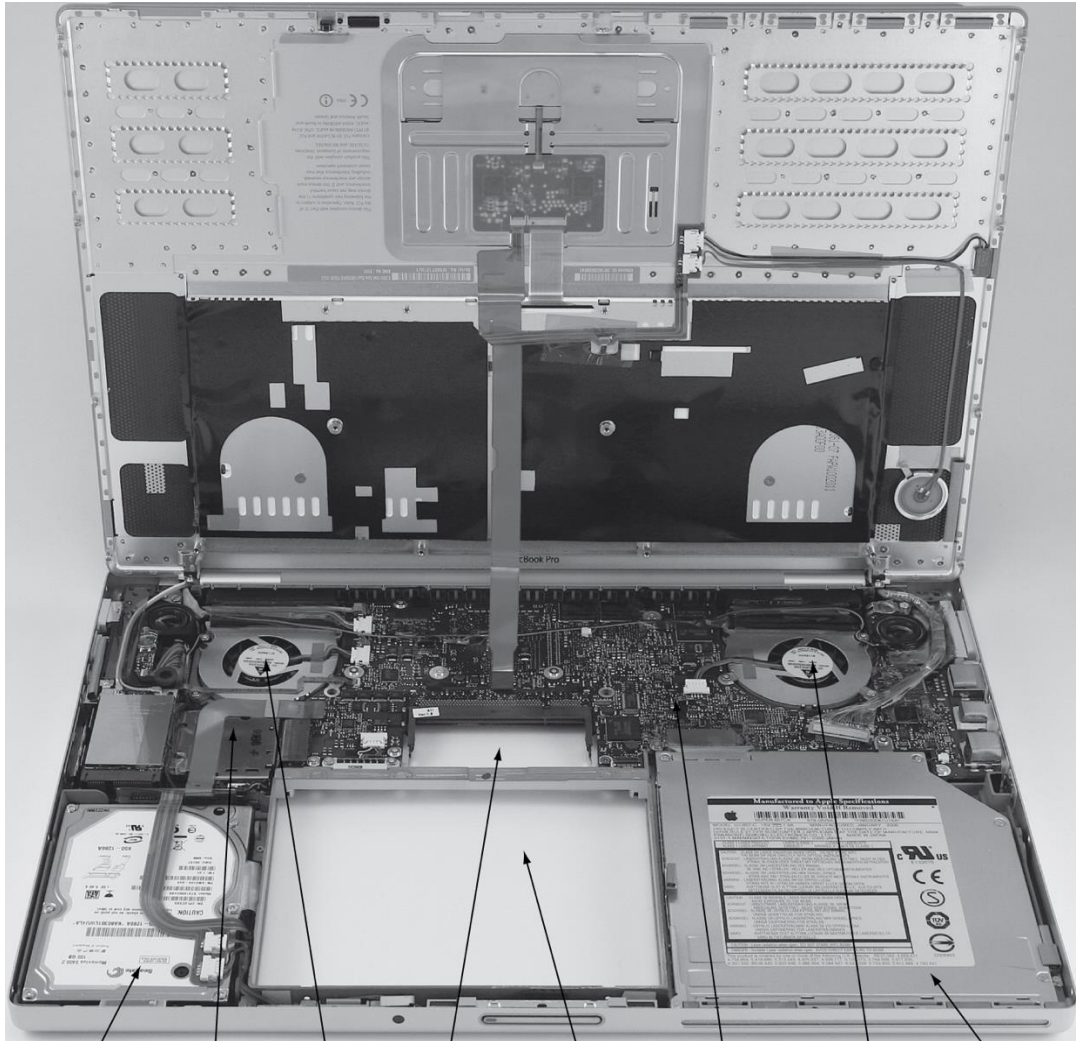
# What's Inside a Computer

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

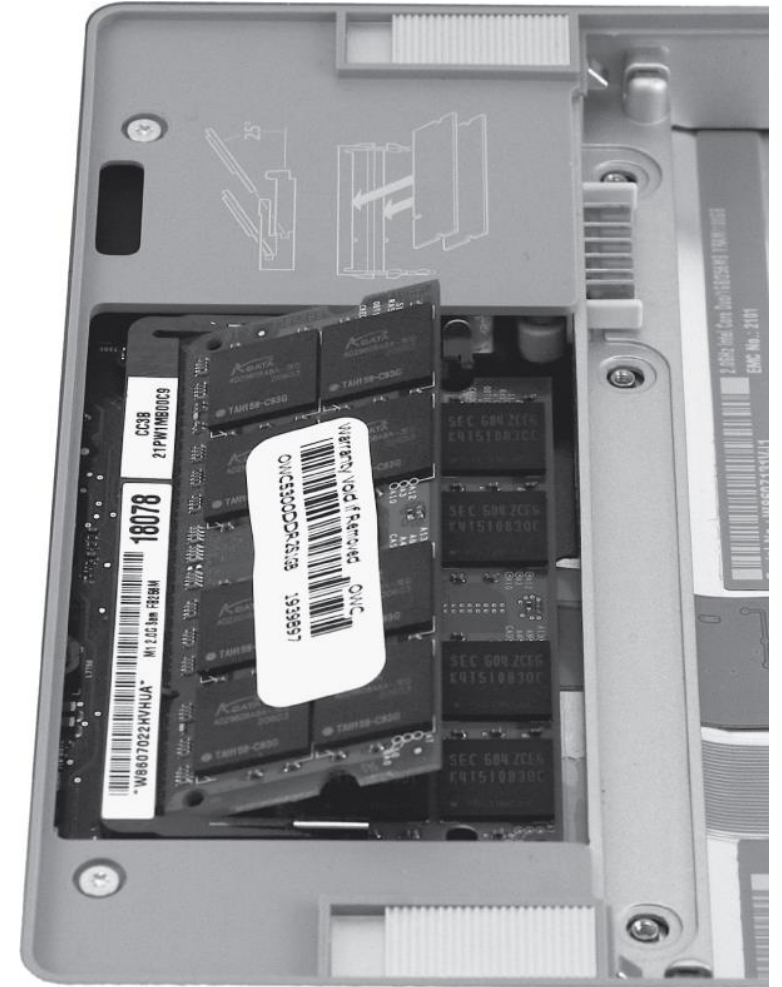
# What's Inside a Computer

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

# Opening the Box

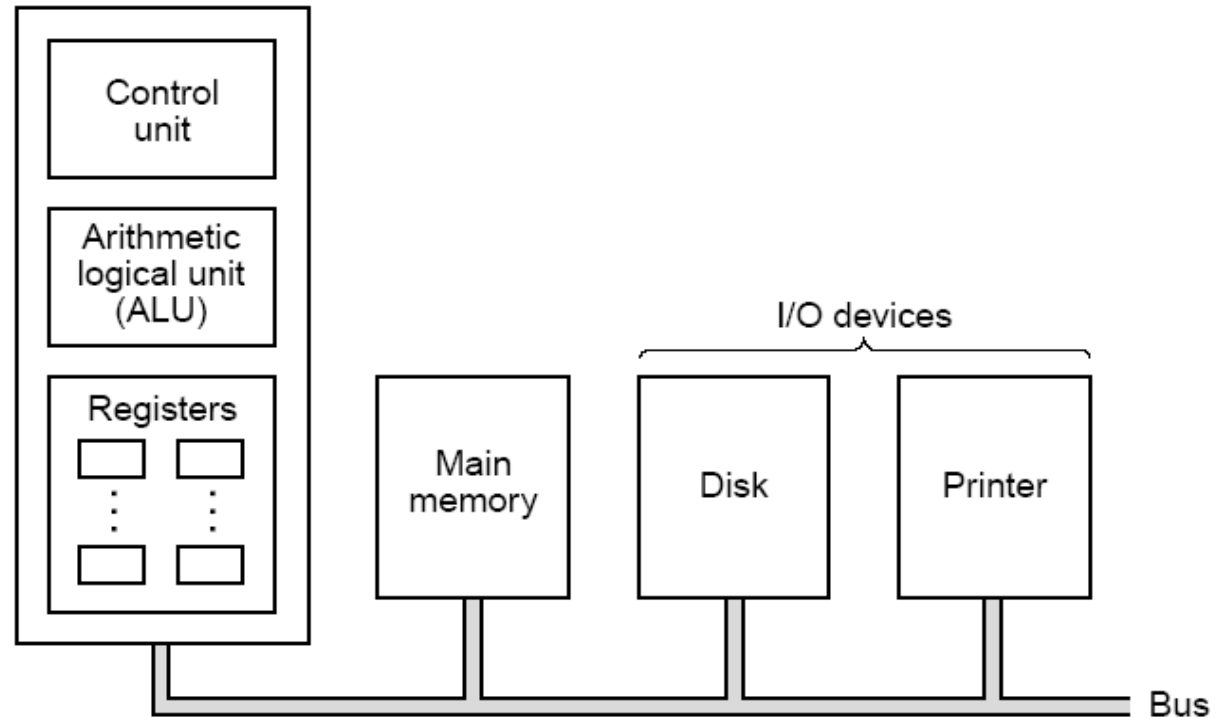


Hard drive Processor Fan with cover Spot for memory DIMMs Spot for battery Motherboard Fan with cover DVD drive cover



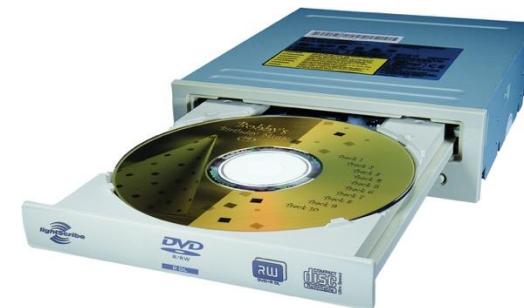
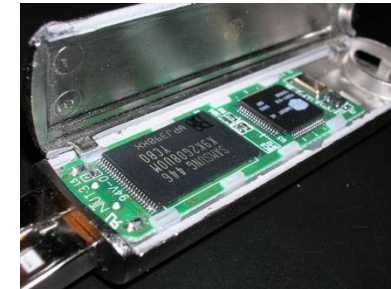
# Inside the Computer

Central processing unit (CPU)



# 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)

<b>0000</b>	<b>01101010</b>
<b>0001</b>	<b>10101011</b>
<b>0002</b>	<b>00100010</b>
<b>FFFF</b>	<b>11110010</b>

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

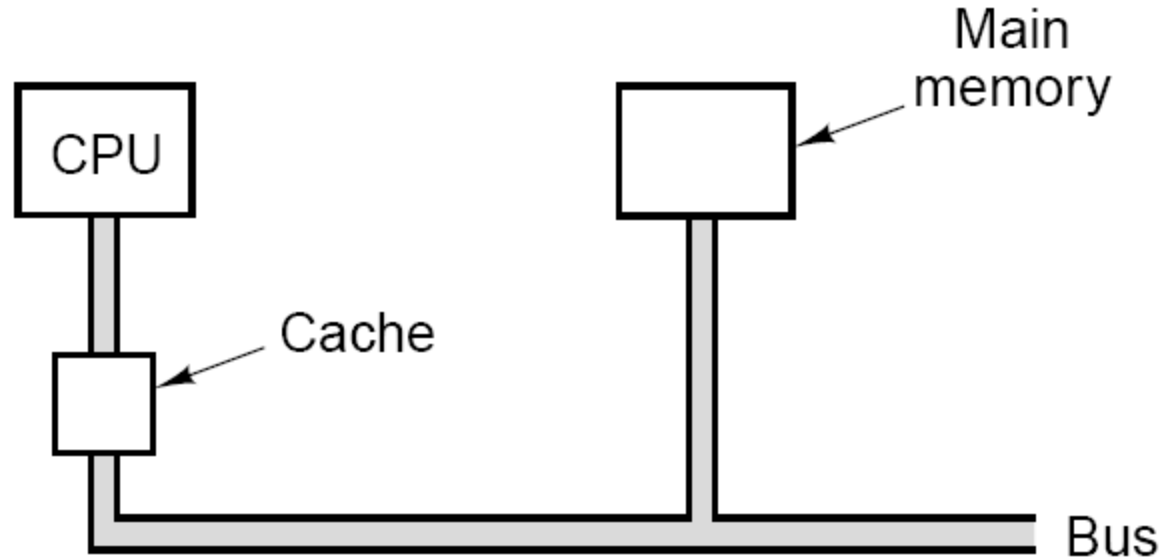
# Basic Memory Operations

- 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

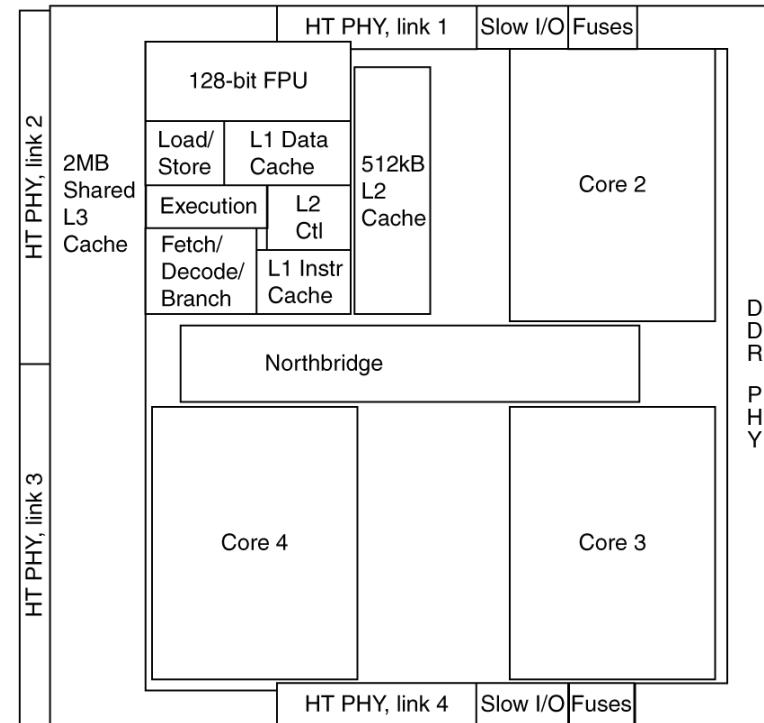
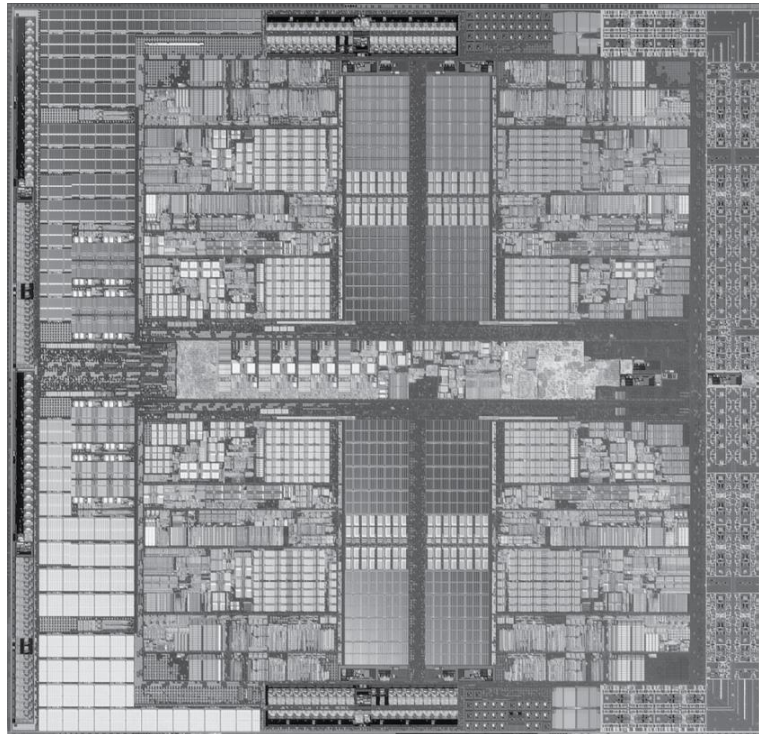


**Figure 2-16.** The cache is logically between the CPU and main memory. Physically, there are several possible places it could be located.

- 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

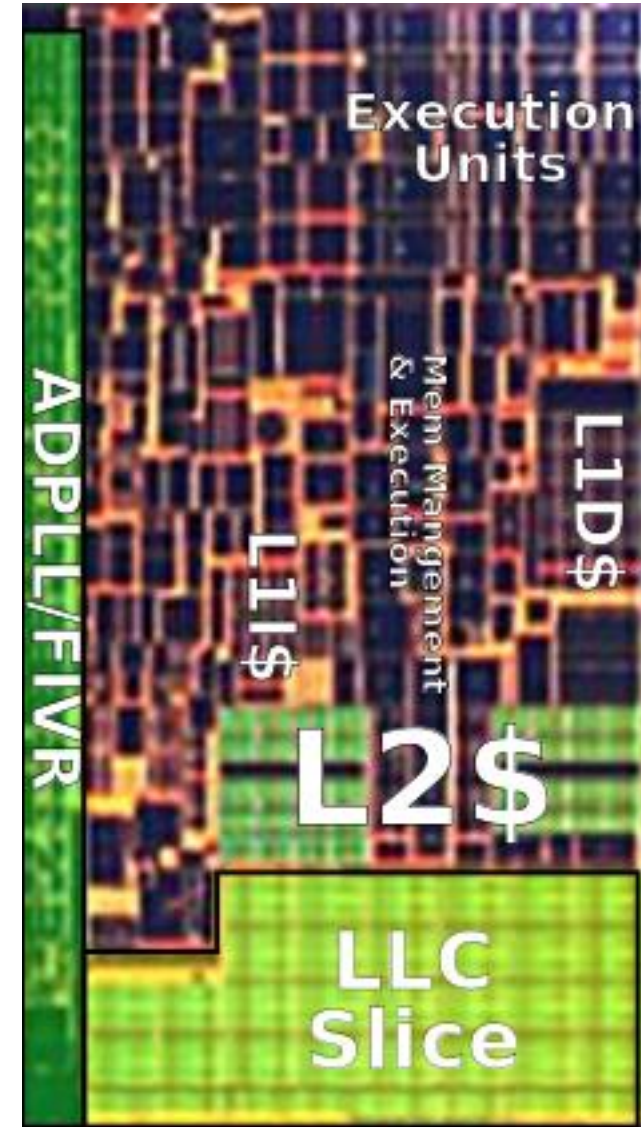
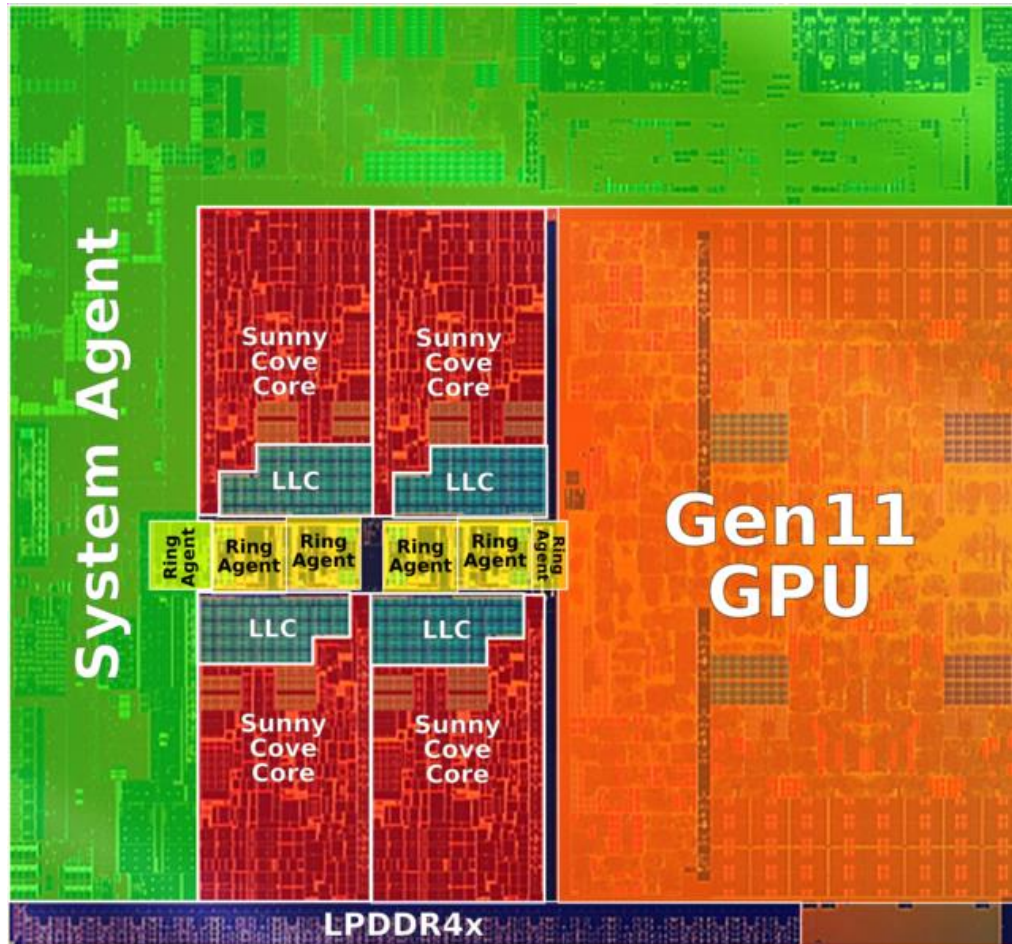
# Inside the Processor

- AMD Barcelona: 4 processor cores





# Intel Ice Lake processor die



# What does this mean?



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# 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 ( $IR \leftarrow \text{Memory}[PC]; PC \leftarrow PC+1$ )
  - 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 2.2
- Problem Set 0 due Tonight!