

Roadmap

C:

```
car *c = malloc(sizeof(car));
c->miles = 100;
c->gals = 17;
float mpg = get_mpg(c);
free(c);
```

Java:

```
Car c = new Car();
c.setMiles(100);
c.setGals(17);
float mpg =
    c.getMPG();
```

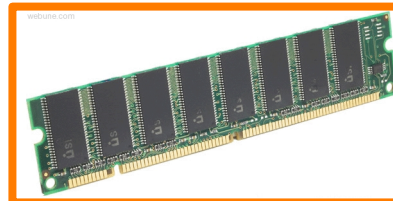
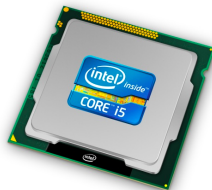
Assembly
language:

```
get_mpg:
    pushq    %rbp
    movq     %rsp, %rbp
    ...
    popq     %rbp
    ret
```

Machine
code:

```
0111010000011000
100011010000010000000010
1000100111000010
110000011111101000011111
```

Computer
system:



Preliminaries

Memory & data

Integers & floats
Machine code & C
x86 assembly
Procedures & stacks
Arrays & structs
Memory & caches
Processes
Virtual memory
Memory allocation
Java vs. C

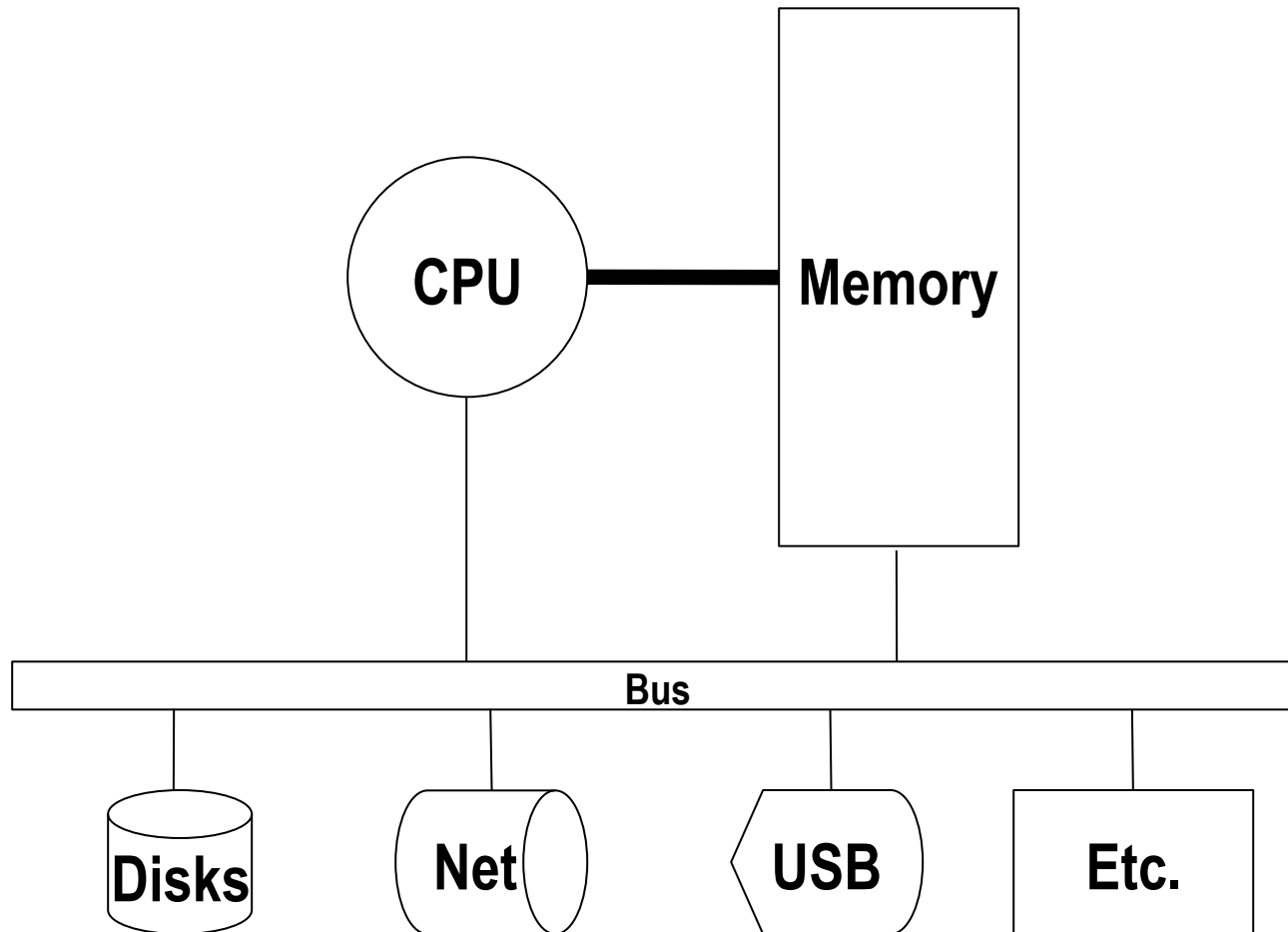
OS:



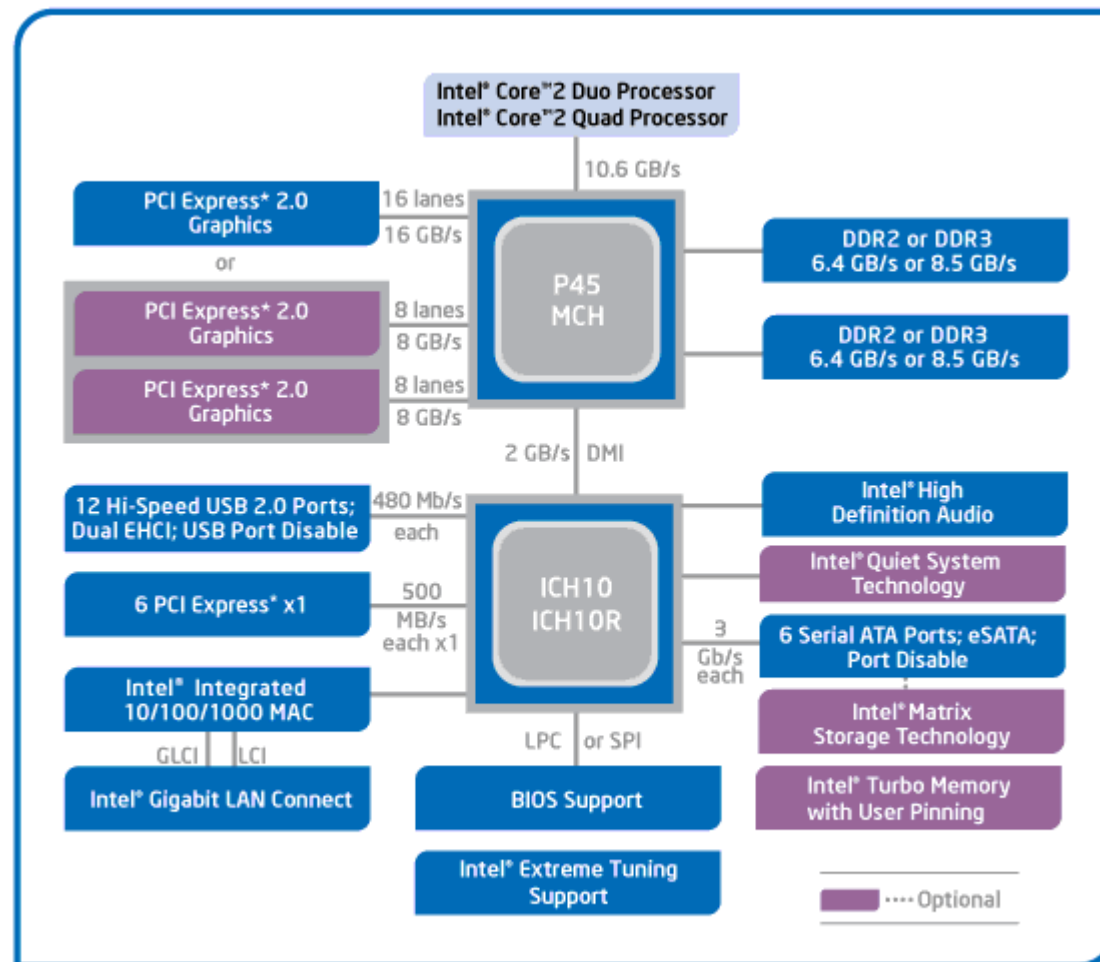
Section 1: Memory, Data, and Addressing

- Preliminaries
- Representing information as bits and bytes
- Organizing and addressing data in memory
- Manipulating data in memory using C
- Boolean algebra and bit-level manipulations

Hardware: Logical View

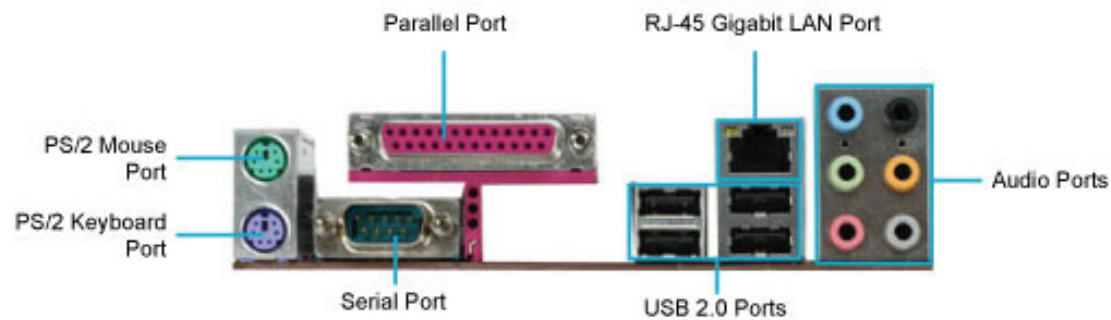
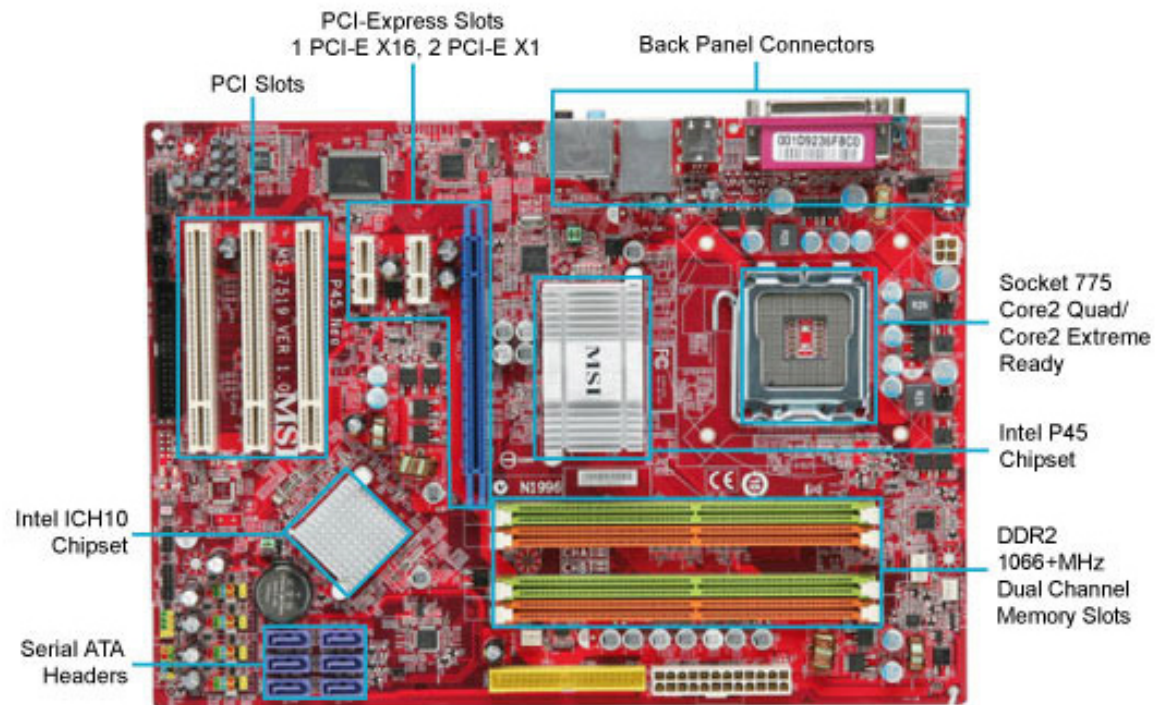


Hardware: Semi-Logical View



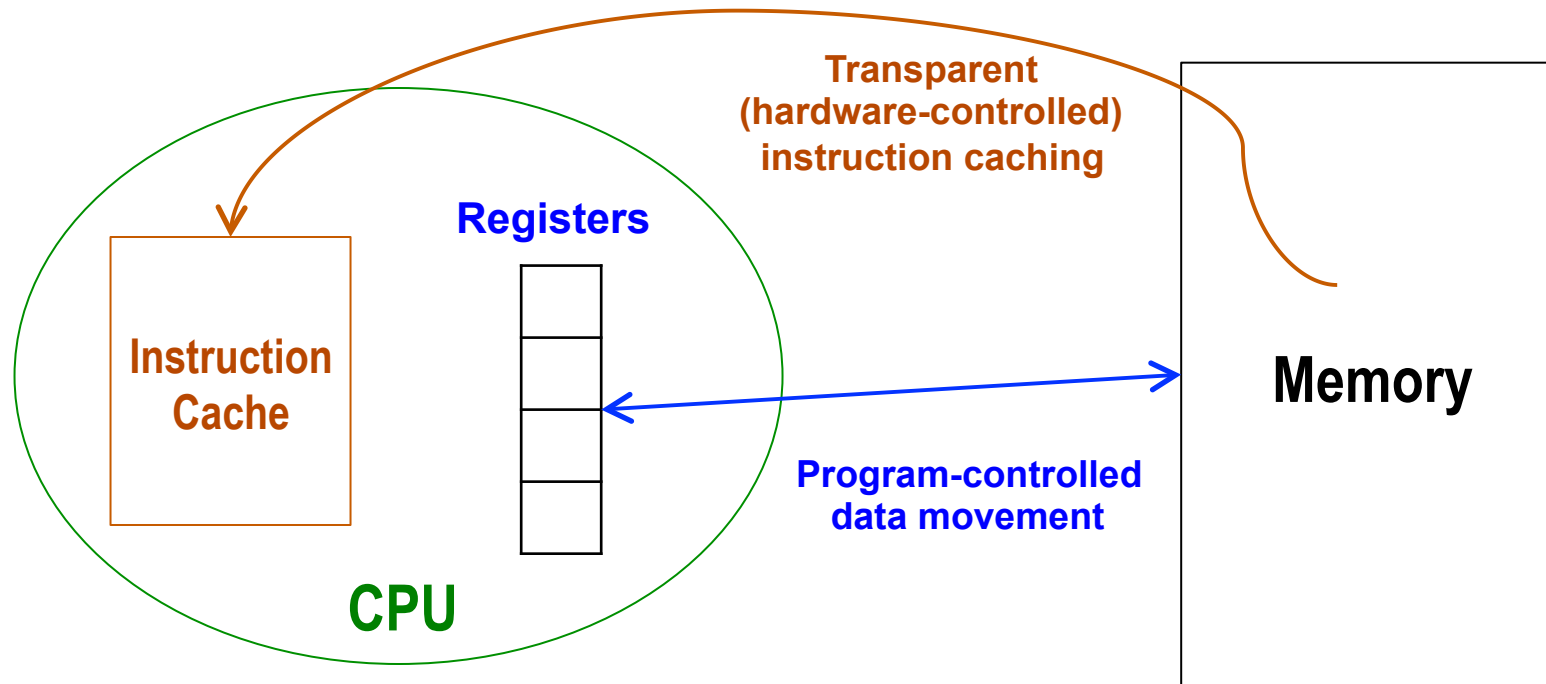
Intel® P45 Express Chipset Block Diagram

Hardware: Physical View



Preliminaries

CPU “Memory”: Registers and Instruction Cache



- There are a fixed number of registers in the CPU
 - Registers hold data
- There is an I-cache in the CPU that holds recently fetched instructions
 - If you execute a loop that fits in the cache, the CPU goes to memory for those instructions only once, then executes them out of its cache
- *This slide is just an introduction.*
We'll see a fuller explanation later in the course.

Performance: It's Not Just CPU Speed

■ Data and instructions reside in memory

- To execute an instruction, it must be fetched into the CPU
- Next, the data on the which the instruction operates must be fetched from memory and brought to the CPU

■ CPU \leftrightarrow Memory bandwidth can limit performance

- Improving performance 1: hardware improvements to increase memory bandwidth (e.g., DDR \rightarrow DDR2 \rightarrow DDR3)
- Improving performance 2: move less data into/out of the CPU
 - Put some “memory” in the CPU chip itself (this is “cache” memory)

Binary Representations

■ Base 2 number representation

- Represent 351_{10} as 0000000101011111_2 or 101011111_2

■ Electronic implementation

- Easy to store with bi-stable elements
- Reliably transmitted on noisy and inaccurate wires

