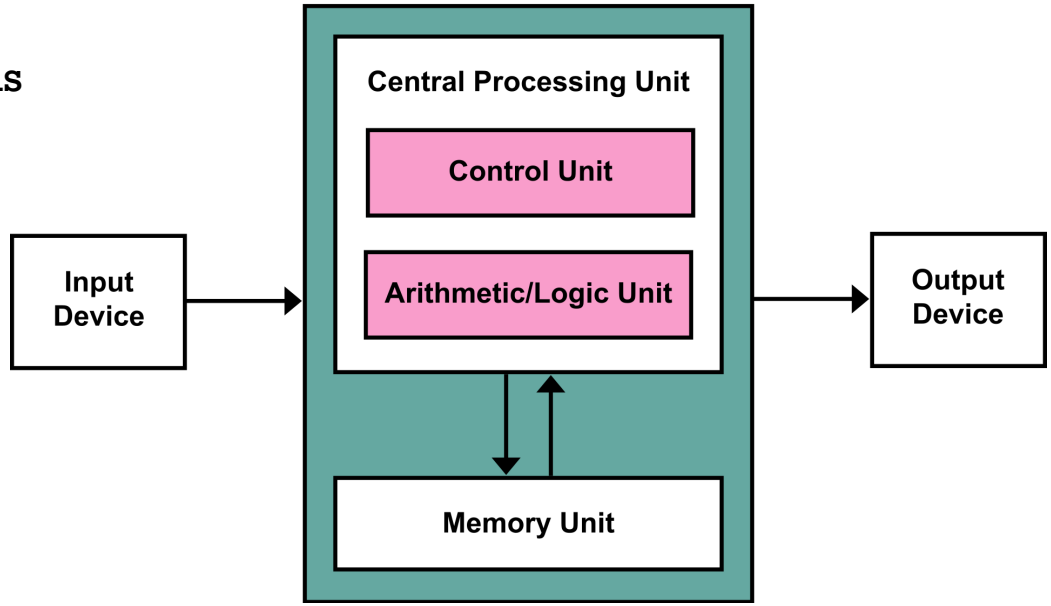
Computer Hardware

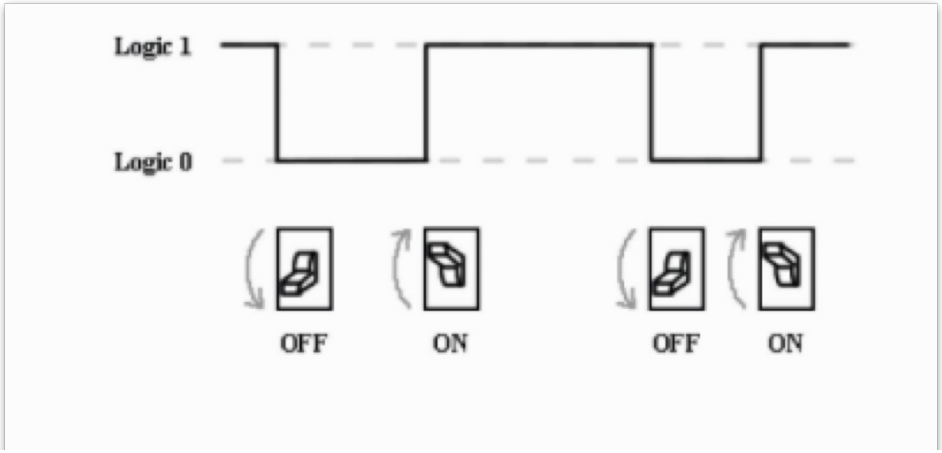
Von Neumann architecture

- A design architecture for an electronic digital computer with these components:
  - A processing unit with both an arithmetic logic unit and processor registers
  - A control unit that includes an instruction register and a program counter
  - Memory that stores data and instructions
  - External mass storage
  - Input and output mechanisms



Representing Data Digitally

- Electrical signals
- Lots of switches!
- "on" or "off" states
- Binary: 0's and 1's



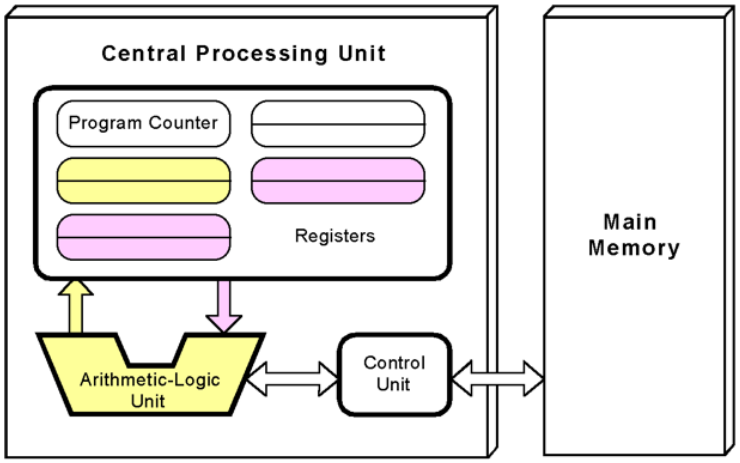
Decimal value	Binary value
0	00000
1	00001
2	00010
3	00011
4	00100
5	00101
6	00110
7	00111
8	01000

Decimal value	Binary value
9	01001
10	01010
11	01011
12	01100
13	01101
14	01110
15	01111
16	10000
17	10001

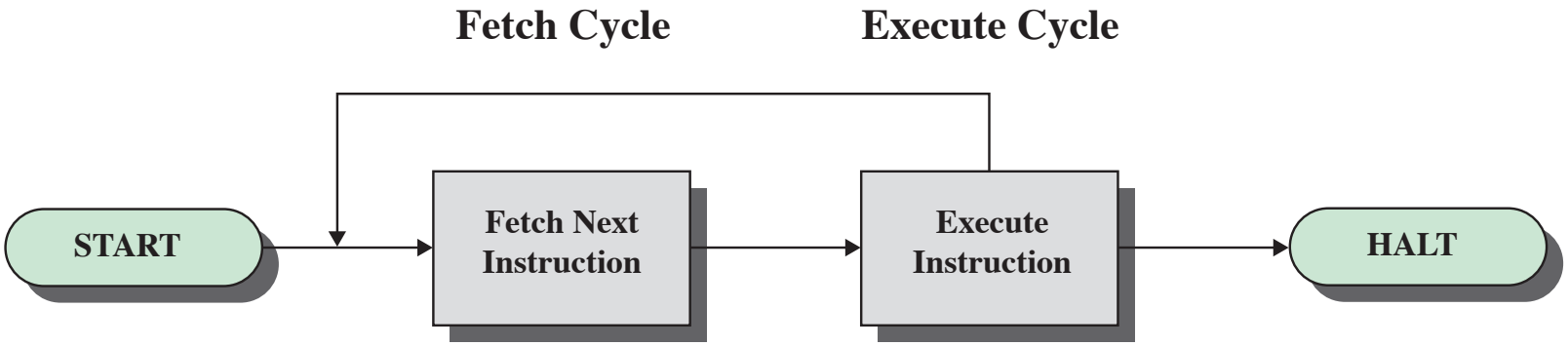
Processor

- Also called CPU: Central Processing Unit
- This is the primary "brain" of the computer. It is responsible for carrying out the logic and arithmetic operations described in computer programs.
- Operation: The fundamental operation of (most) CPUs is to execute a sequence of stored instructions that is called a program.

Processor

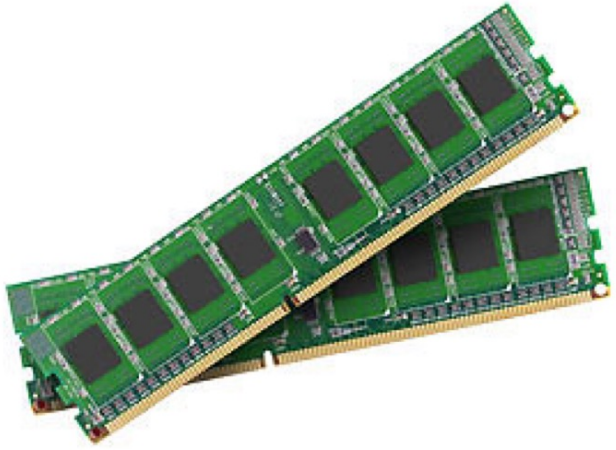


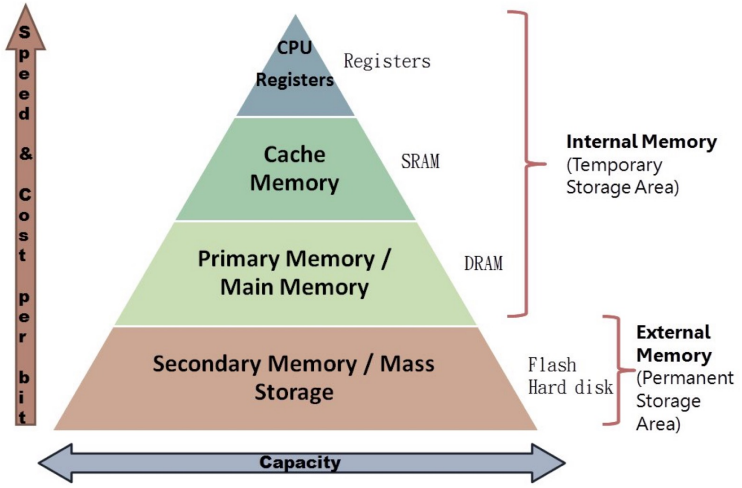
- CPUs follow the fetch, decode and execute steps in their operation, which are collectively known as the instruction cycle.
- After the execution of an instruction, the entire process repeats, with the next instruction cycle normally fetching the next-in-sequence instruction



Memory

- Modern computers have many different types of memory.
- Performance, Capacity, and Cost are all factors that computer designers need to consider when selecting how much of a particular memory should be used at each level of the design.
- Memory is classified by whether it is volatile or non-volatile.
  - Volatile memory: does not retain binary state when power to the circuit is lost
  - Non-Volatile storage: for internal mass storage, this is the solid-state or hard disk that stores data and instructions for longer periods and when the power is cycled. Capacity and cost (per byte) are favorable, but access times are quite slow.





Peripheral Devices

- Audio: Speaker, microphone, sound card, MIDI
- Communications: Modem, network adapter, Wi-Fi, Human interface: Mouse, keyboard, trackpad
- Image: Webcam, scanner
- Printer: Laser printer, inkjet, and CNC (Computer Numerical Control) used in automating machinery.
- Mass storage: USB flash drive, memory card reader, digital audio player digital camera, external hard drive
- USB hub: Controls connected USB devices that are connected to the hub
- Video: Webcam, surveillance cameras, consumer and professional video cameras and so on