University Of Diyala
College Of Engineering
Computer Engineering Department

COMPUTER SYSTEM ARCHITECTURE

Chapter 1
Introduction

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Second stage

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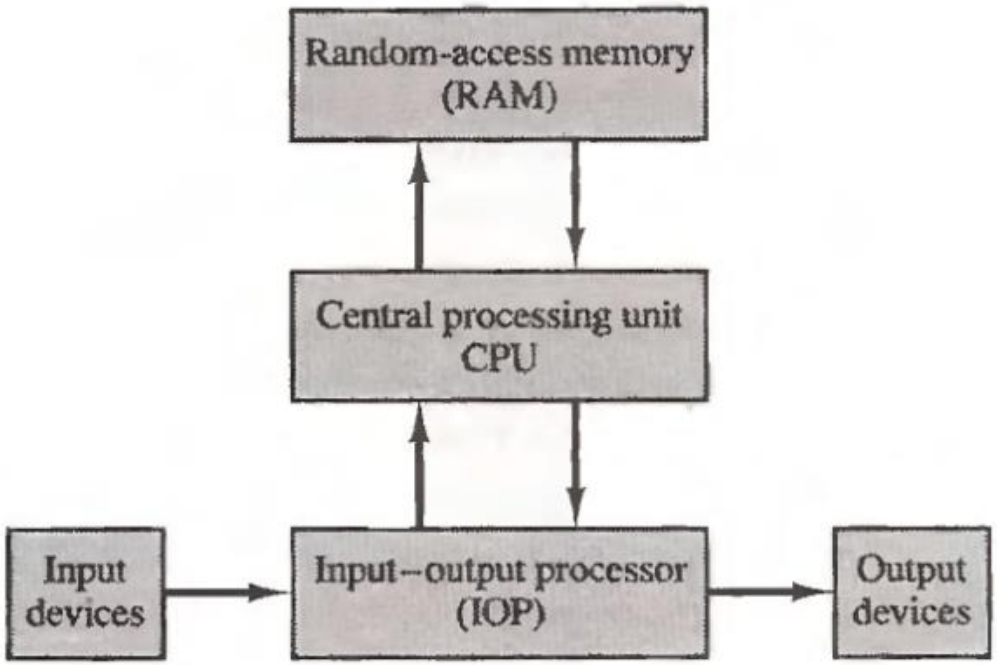
Computer System Architecture

- **COMPUTER ORGANIZATION:** is concerned with the way the hardware components operate and the way they are connected together to form the computer system. The various components are assumed to be in place and the task is to investigate the organizational structure to verify that the computer parts operate as intended.
- **COMPUTER DESIGN**: is concerned with the hardware design of the computer. Once the computer specifications are formulated, it is the task of the designer to develop hardware for the system. Computer design is concerned with the determination of what hardware should be used and how the parts should be connected. This aspect of computer hardware is sometimes referred to as computer implementation.
- **COMPUTER ARCHITECTURE :** is concerned with the structure and behaviour of the computer as seen by the user. It includes the information formats, the instruction set, and techniques for addressing memory. The architectural design of a computer system is concerned with the specifications of the various functional modules, such as processors and memories, and structuring them together into a computer system.

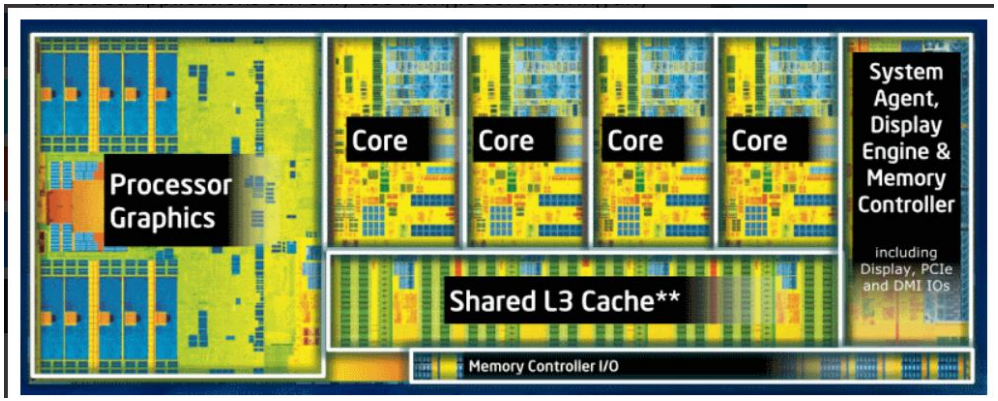
Block diagram of a digital computer.



Architecture & Organization

- Architecture is those attributes visible to the programmer
  - Instruction set, number of bits used for data representation, I/O mechanisms, addressing techniques.
  - All Intel x86 family share the same basic architecture
  - The IBM System/370 family share the same basic architecture
- Organization is how features are implemented
  - Realization and implementation of architecture
  - Control signals, interfaces, memory technology.
  - This gives code compatibility
    - At least backwards
  - Organization differs between different versions

Intel Core i3, i5 and i7 have same architectures?



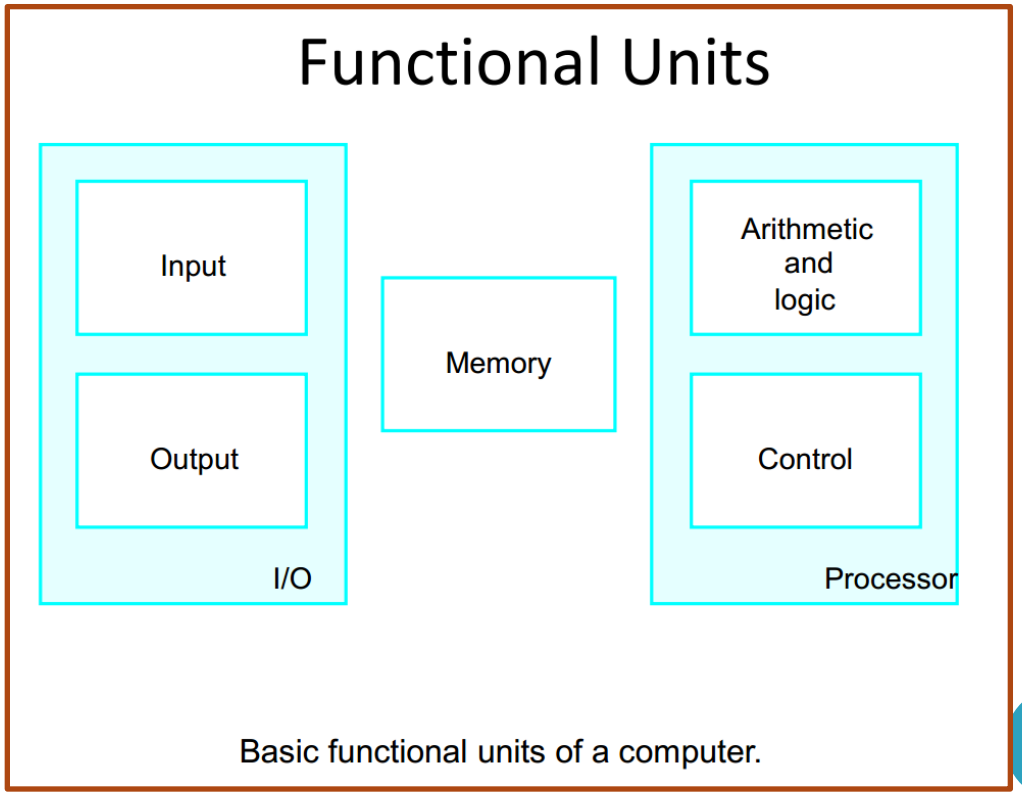
Model	Core i3	Core i5	Core i7
Number of cores	2	4	4
Hyper-threading	Yes	No	Yes
Turbo boost	No	Yes	Yes
K model	No	Yes	Yes

Structure & Function

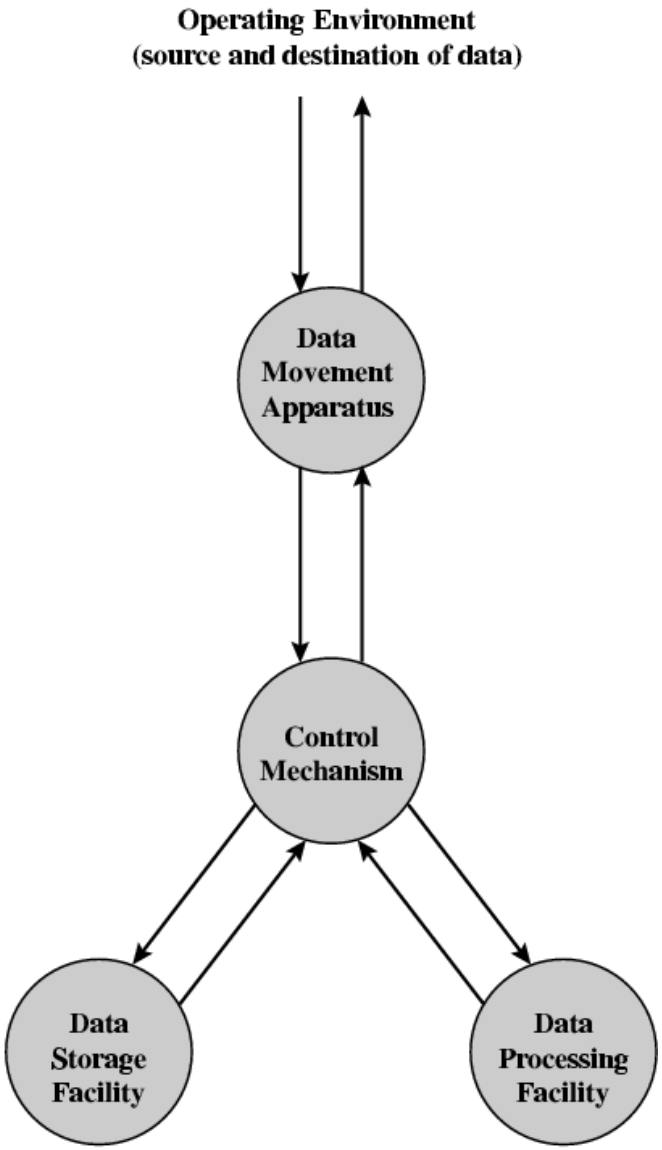
- Structure is the way in which components relate to each other
- Function is the operation of individual components as part of the structure

Function

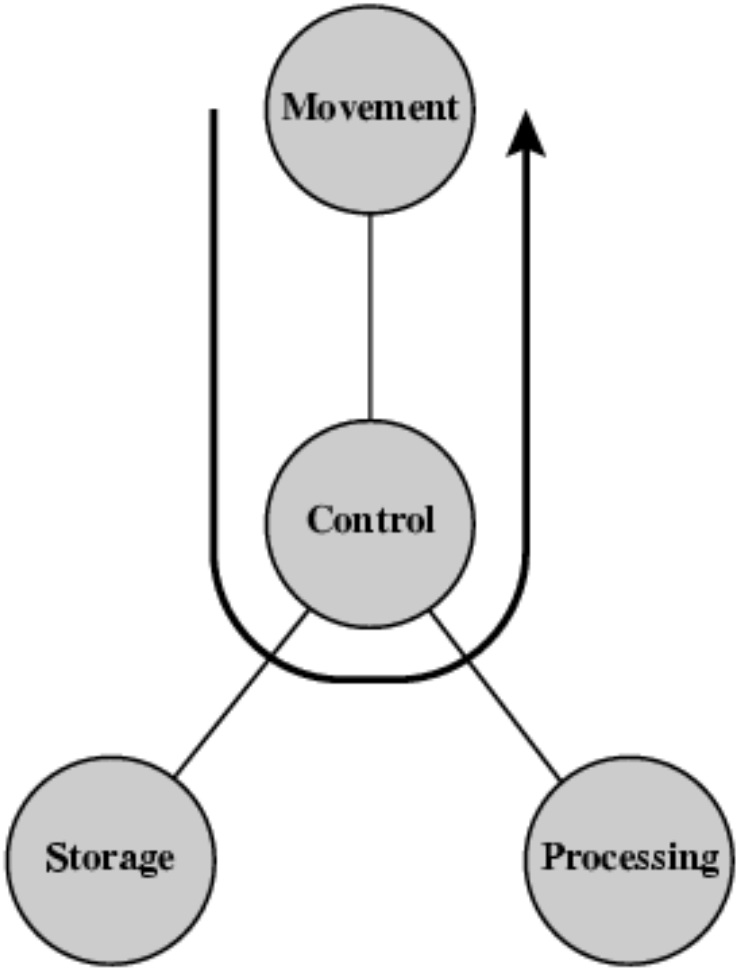
- All computer functions are:
  - Data processing
  - Data storage
  - Data movement
  - Control



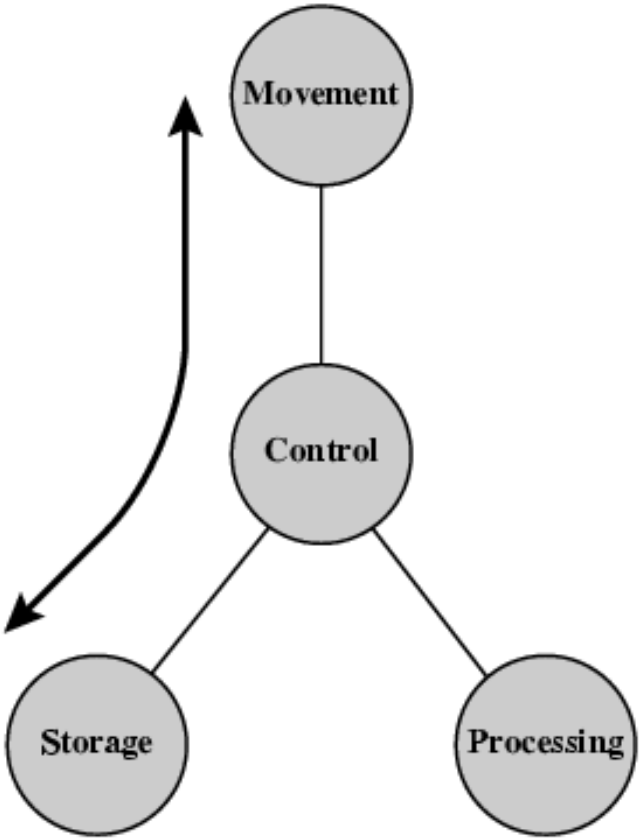
Functional view



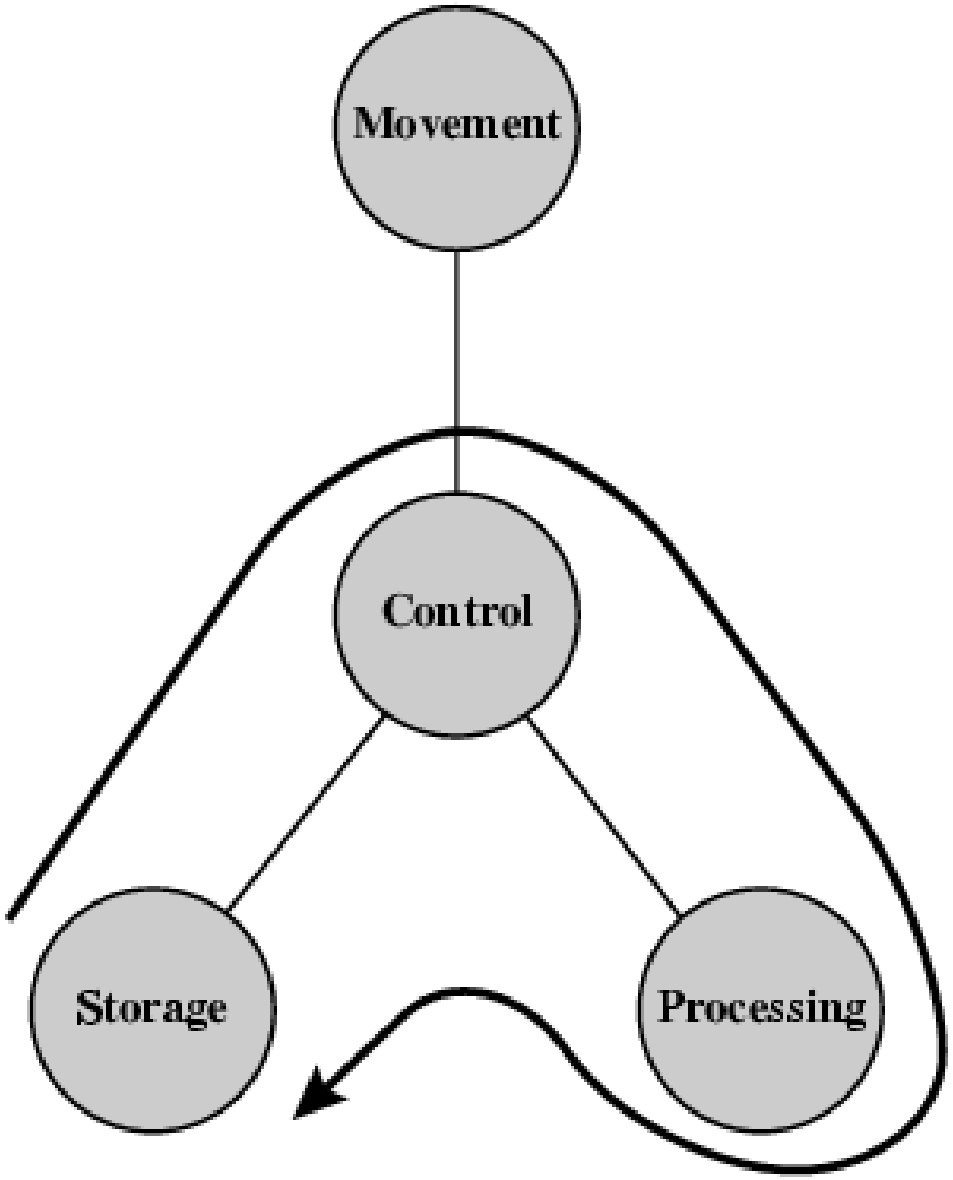
Operations (1) Data movement



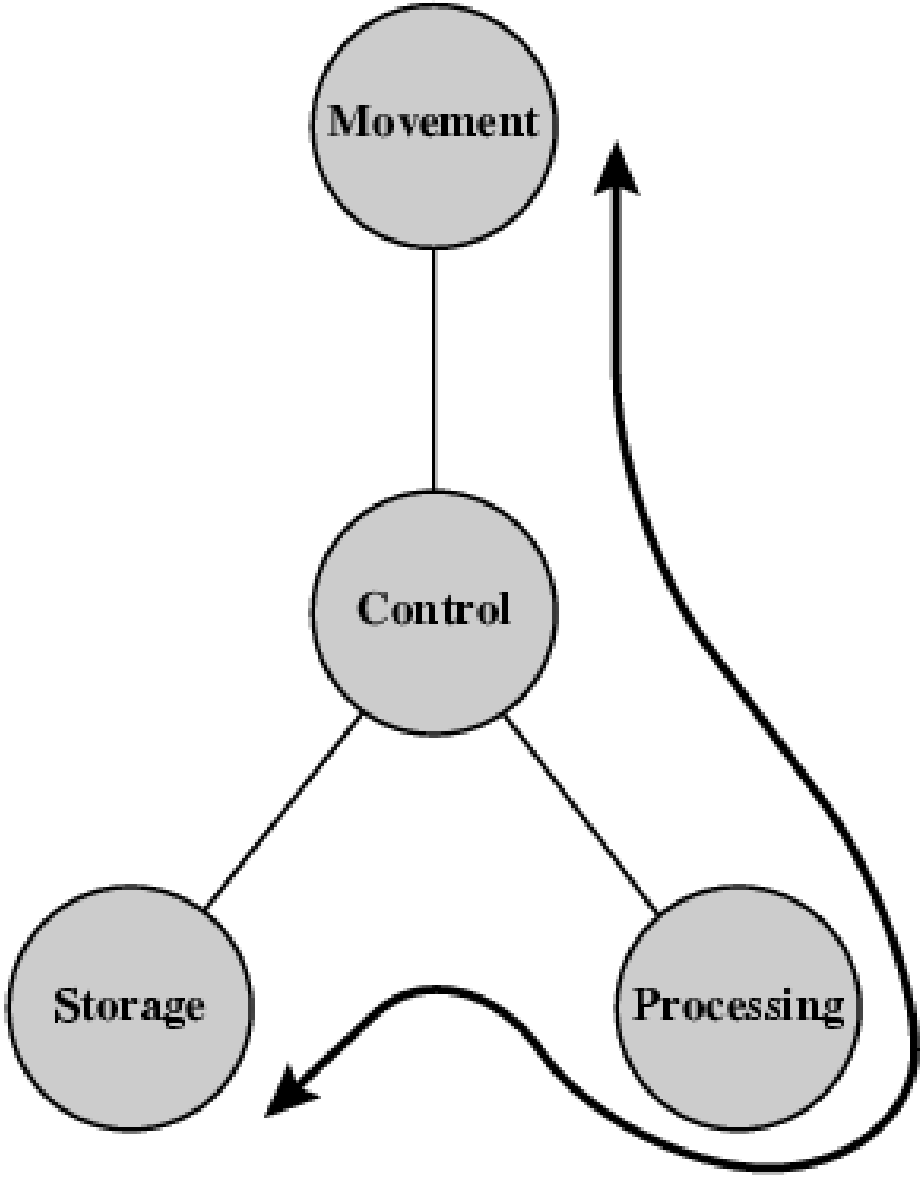
Operations (2) Storage



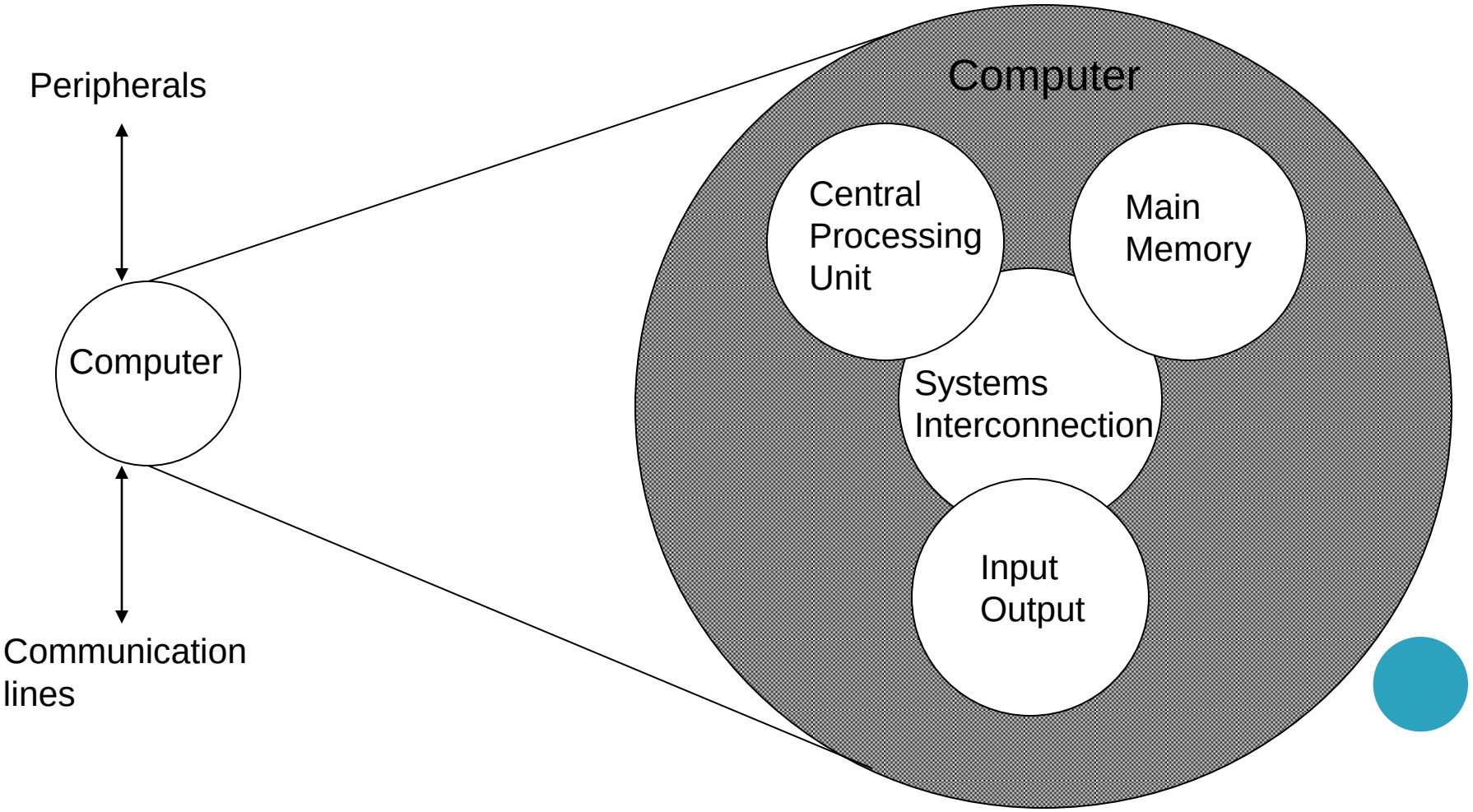
Operation (3) Processing from/to storage



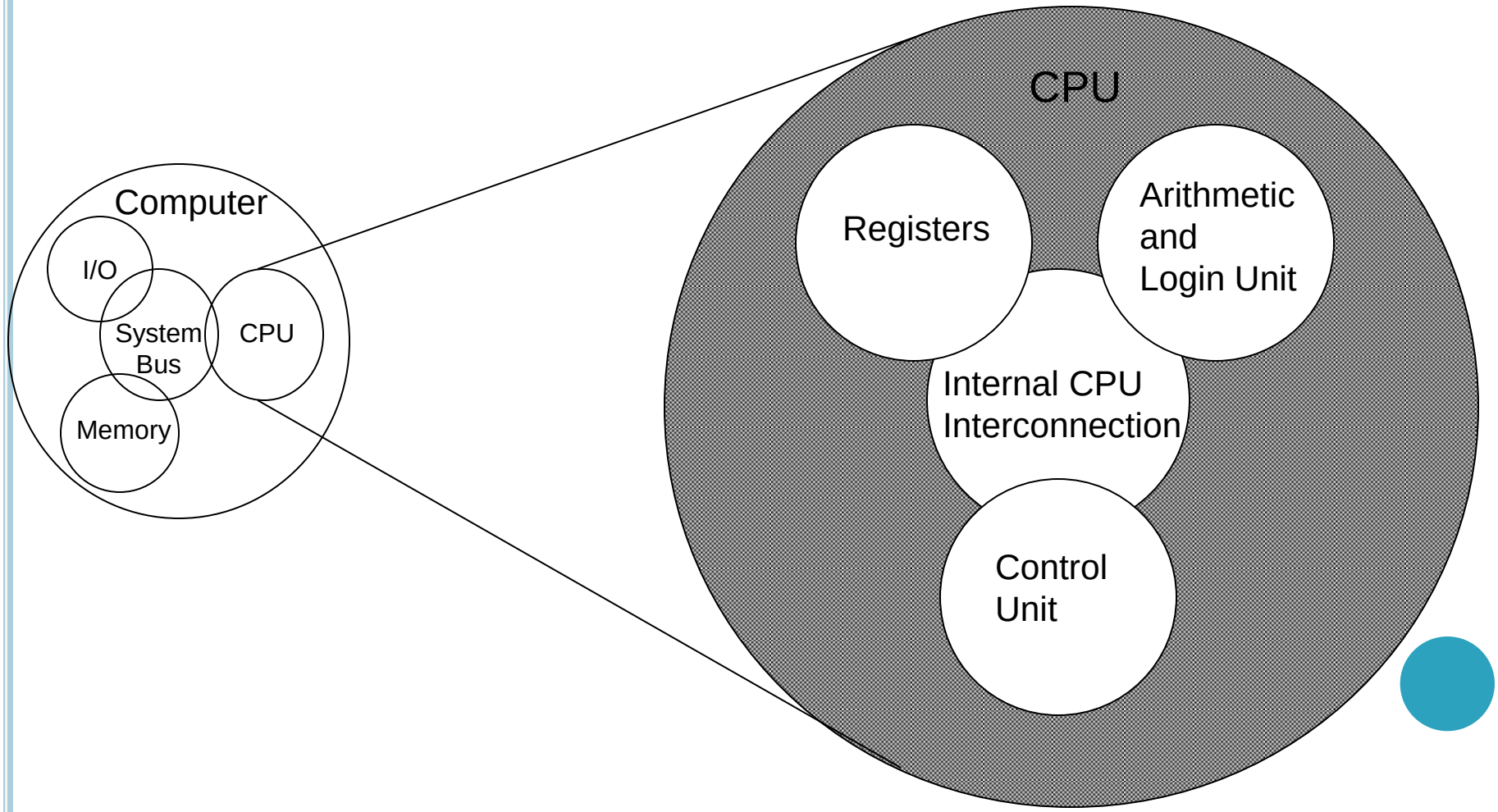
Operation (4) Processing from storage to I/O



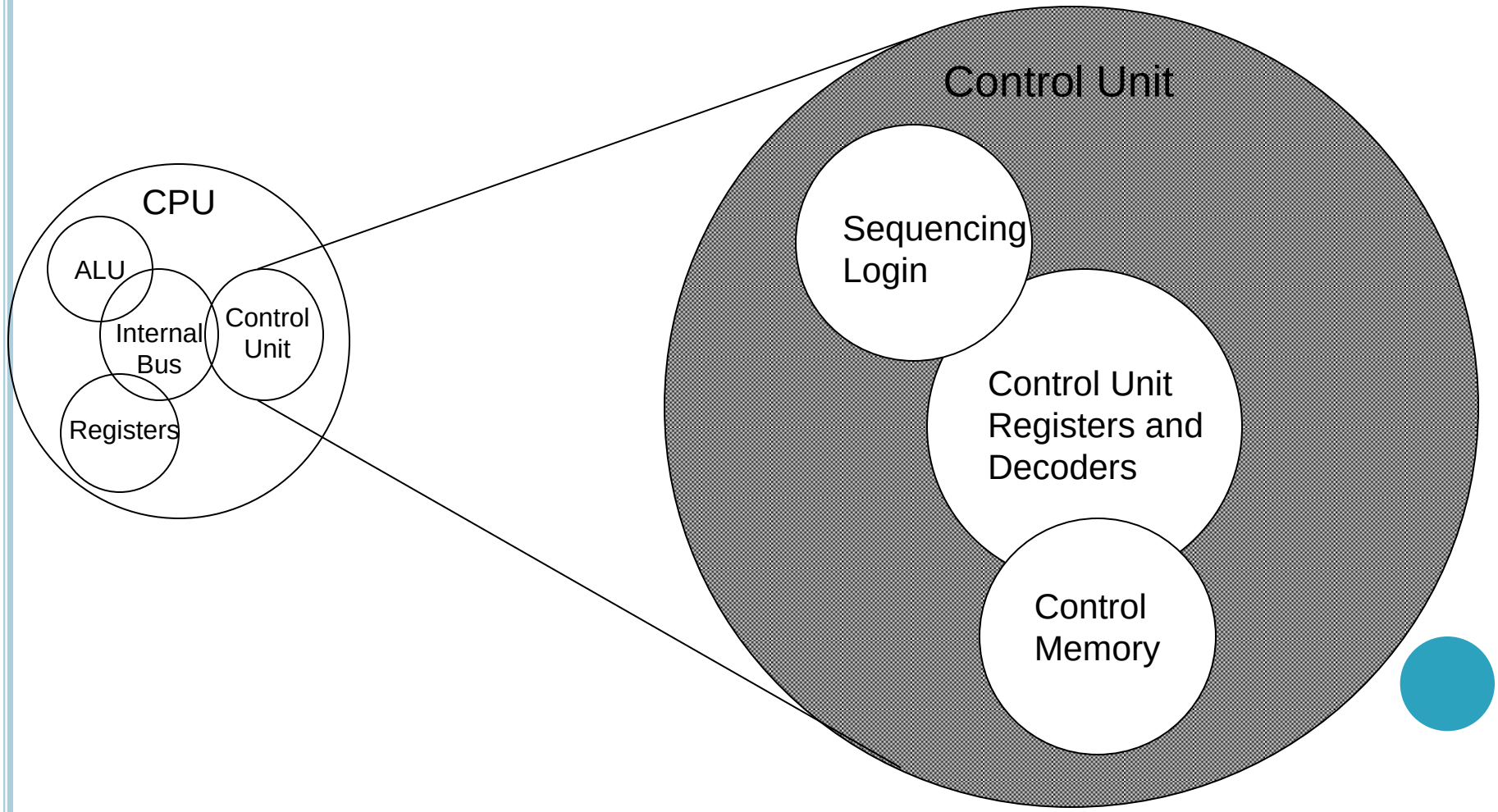
Structure - Top Level



Structure - The CPU

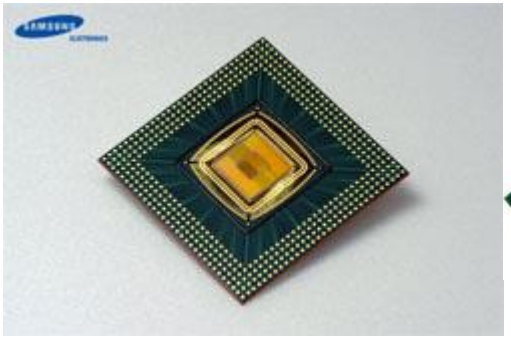


Structure - The Control Unit



Major Components of a Computer

- Central Processing Unit (CPU)
- Random Access Memory (RAM)
- Hard Drive / Disk



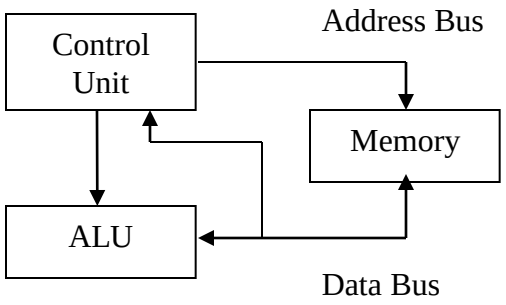
What does memory look like?

- Memory ~ RAM
- Looks like a table
- Address and Data
- Address is the location
- Data is the actual value
- Memory stores both data and **assembly instructions**

Address	Data
0	36
1	3765
2	786
3	356
4	252
5	67980
6	2355
7	4234
8	3466

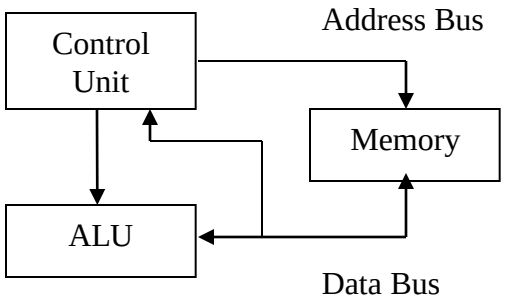
Central Processing Unit (CPU)

- Also called the “chip” or “processor”
- The brain of the computer
- Major components:
  - Arithmetic Logic Unit (ALU)
    - calculator
  - Control unit
    - controls the calculator
  - Communication bus systems
- What’s a bus?!?



Fetch-Execute Cycle

1. Fetch instruction from memory
2. Decode instruction in control unit
3. Execute instruction (data may be fetched from memory)
4. Store results if necessary
5. Repeat!

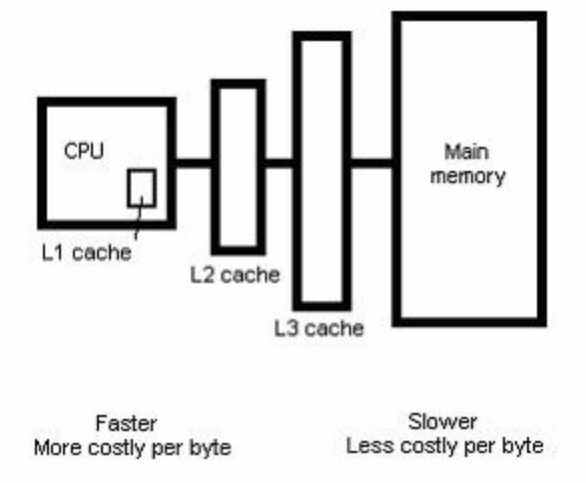


Registers

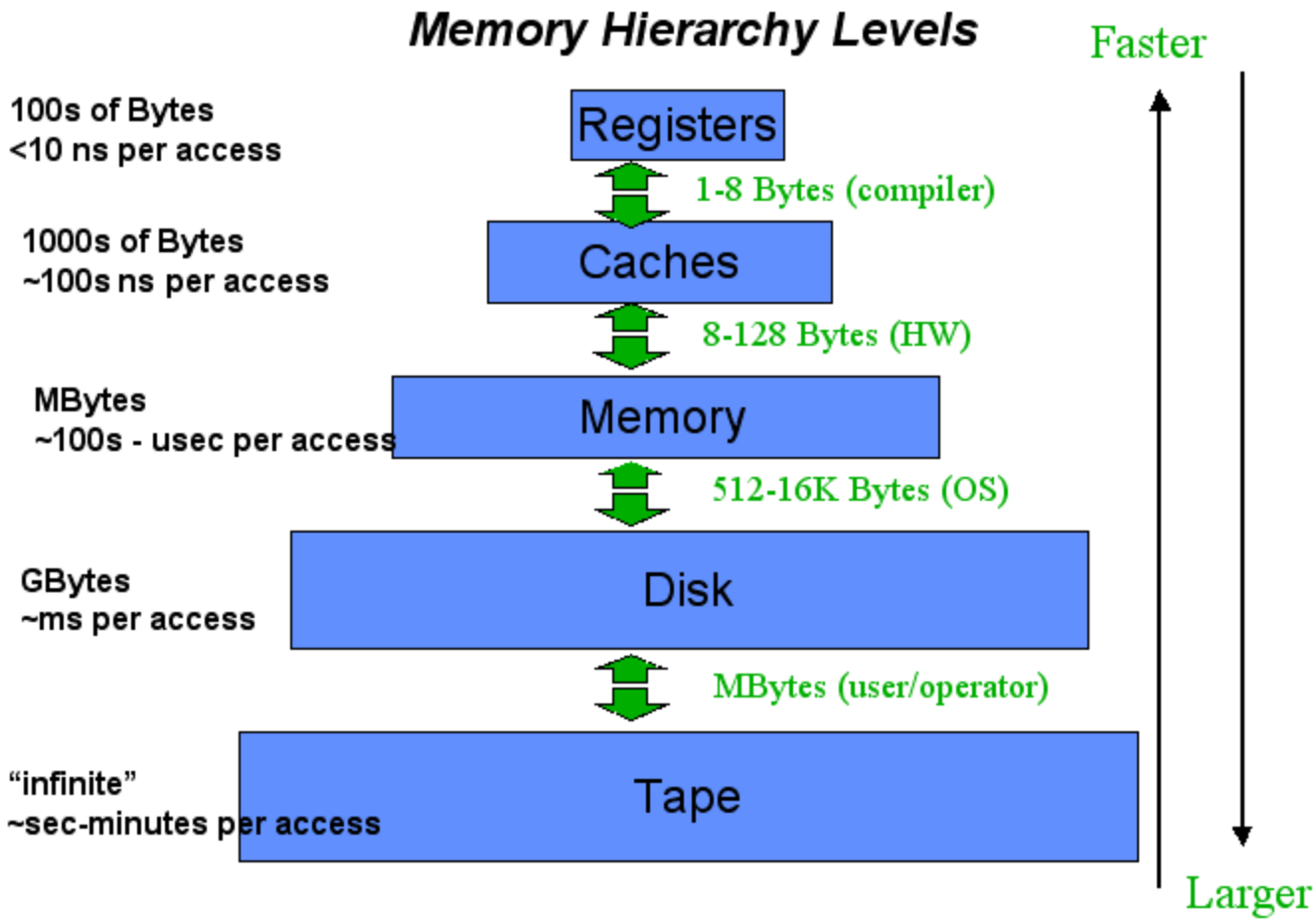
- Temporary storage containers used inside the CPU
- Extremely fast
- Fixed size, usually multiples of 8-bits
  - Also called a “word”
  - Example: 32-bit machines (4-byte words)
- How large is a word in a 64-bit machine?

Cache

- Slower than registers
- Faster than RAM
- Located in front of main RAM
- Different levels of cache
- Level1 (L1) and Level2 (L2)
- Size is usually around 1 MB



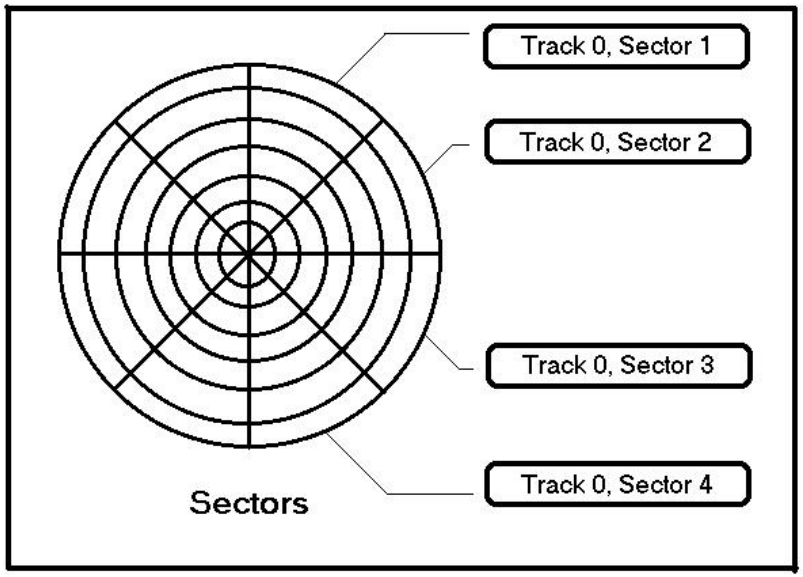
Memory Hierarchy

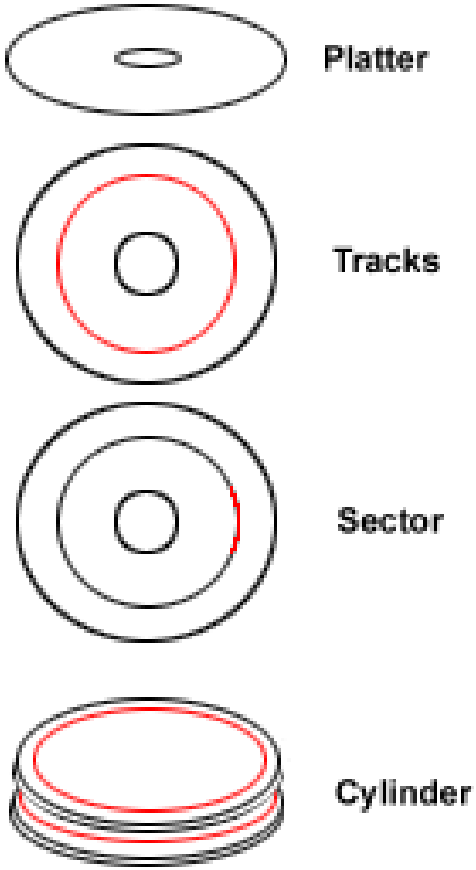


Virtual Memory

- What if a program is too big for RAM?
- If a program is too big for memory (RAM), then we start using the hard drive (disk) to store data

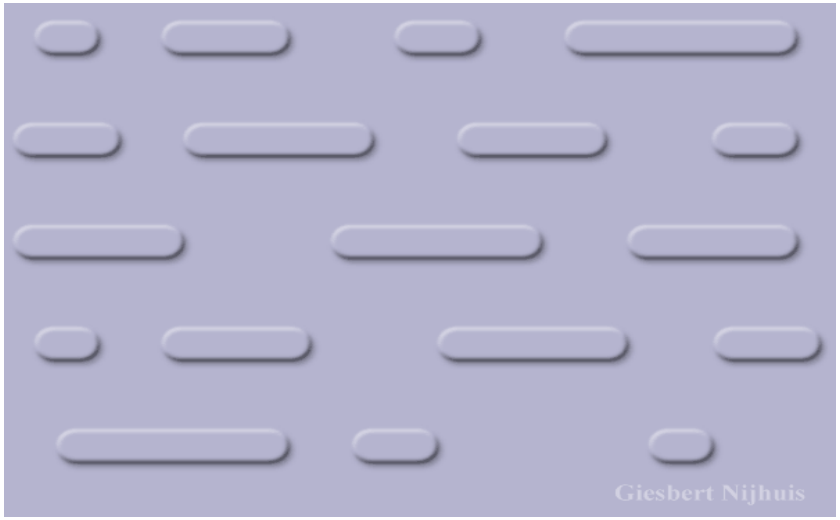
Hard Drives


Track 0, Sector 1
Track 0, Sector 2
Track 0, Sector 3
Track 0, Sector 4
Sectors


Platter
Tracks
Sector
Cylinder
http://www.computerhope.com

CD/DVDs

- Lands and pits used to represent binary
- Optical medium - lasers and refraction used to read lands and pits



Direct Access

- also known as “random access”
- No need to go through other data to get the data you want
- We already know where the data is, so we just get it
- “Magic data retrieval” – no movement/motion
- Example: registers, cache, RAM

Sequential Access

- also known as “serial-access”
- Data is ordered in some sequential fashion
- To get to your data, you need to go through other data in front of it
- Example:
  - Fast-forwarding through a tape to get to the song you want