

William Stallings

Computer Organization and Architecture

Chapter 1

Introduction

Why Study CA?

- Computer is not just a black box that execute programs by magic.
- It is necessary to acquire the some understanding and appreciation of a computer system's
 - Functional Components
 - Characteristics
 - Performance
 - Interaction between Components
- Students need to understand computer architecture in order to structure the program so that it runs more efficiently on a real machine

Why Study CA?

- When selecting a system to use, one should be able to understand the tradeoff among various components such as CPU clock speed vs. memory size.
- It is difficult to design an operating system well without knowledge of underlying architecture.

Why Study CA?

- Suppose a graduate enters the industry and is asked to select the most cost-effective computer for use throughout a large organization.
- An understanding of the implications of spending more for various alternatives, such as
 - a larger cache or a higher processor clock rate, is essential to making the decision.

Why Study CA?

- Concepts used in computer architecture find application in other courses.
- In particular, the way in which the computer provides architectural support for programming languages and operating system facilities reinforces concepts from those areas.

Abstract Outline

- Overview of typical computing machine
- Operations of System
- Basic principles
- Register addressing & working
- Working of I/O devices
- Memory organization
- Interaction between system components

Architecture & Organization 1

- Architecture is those attributes visible to the programmer
 - Instruction set, number of bits used for data representation, I/O mechanisms, addressing techniques.
 - e.g. Is there a multiply instruction?
- Organization is how features are implemented
 - Control signals, interfaces, memory technology.
 - e.g. Is there a hardware multiply unit or is it done by repeated addition?

Architecture & Organization 2

- All Intel x86 family share the same basic architecture
- The IBM System/370 family share the same basic architecture
- This gives code compatibility
 - At least backwards
- Organization differs between different versions

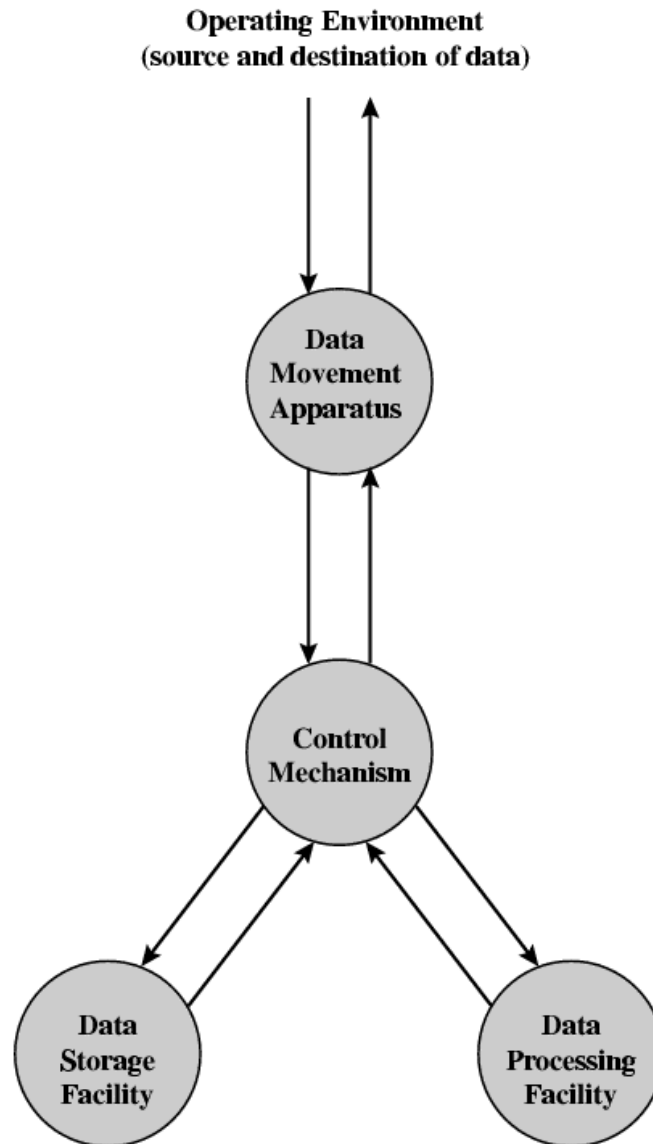
Structure & Function

- Computer is complex system
 - Millions of elementary components
 - Hierarchical structure is essential both for design and description
 - At each level, the system consists of a set of components and their interrelationships.
 - The behavior at each level depends only on a simplified, abstracted characterization of the system at the next lower level. At each level, the designer is concerned with structure and function:
 - Structure is the way in which components relate to each other
 - Function is the operation of individual components as part of the structure

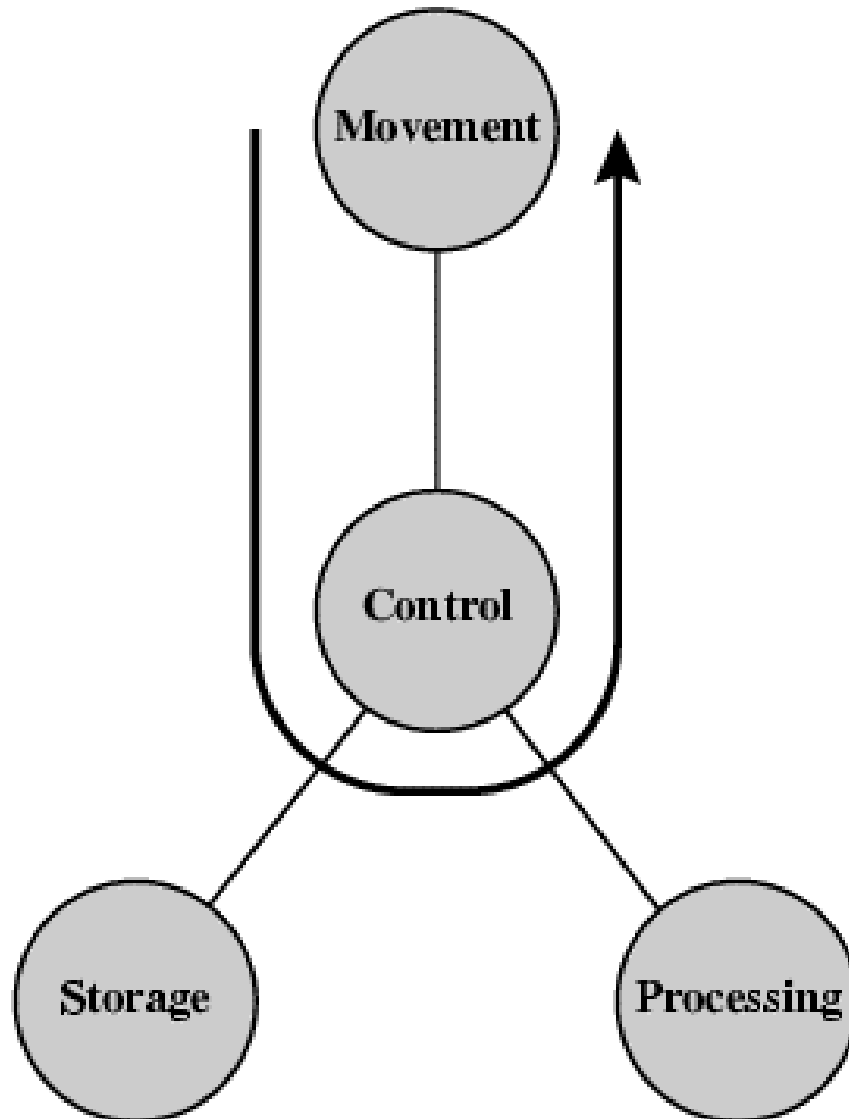
Function

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

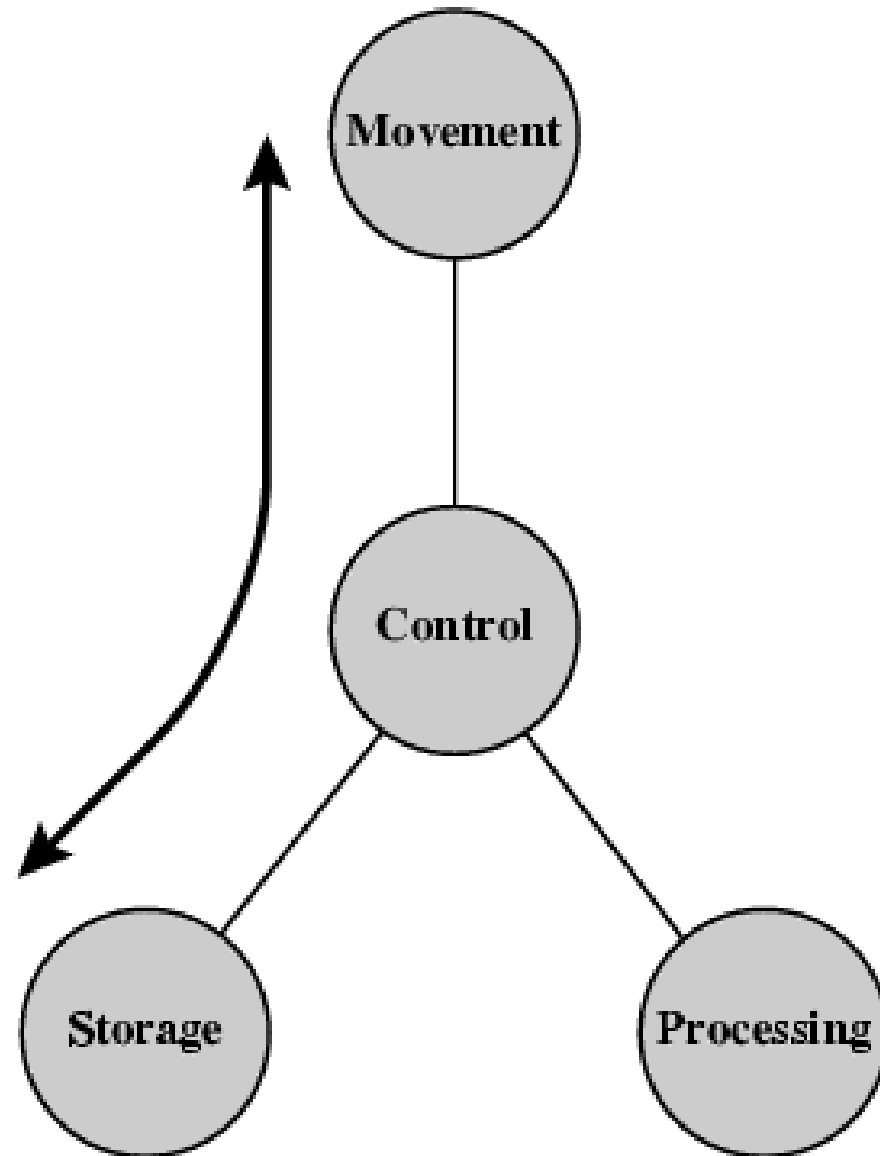
Functional View



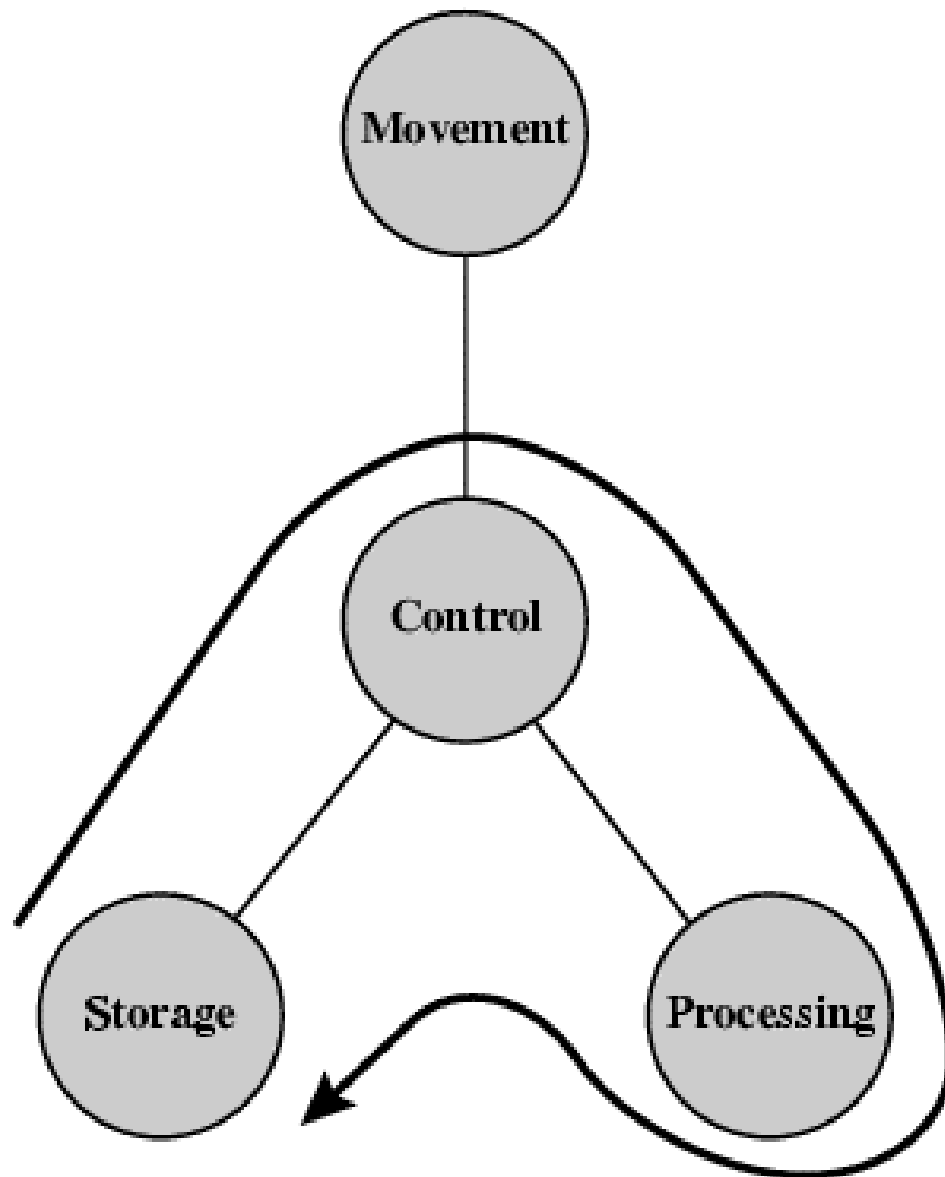
Operations (a) Data movement



Operations (b) Storage

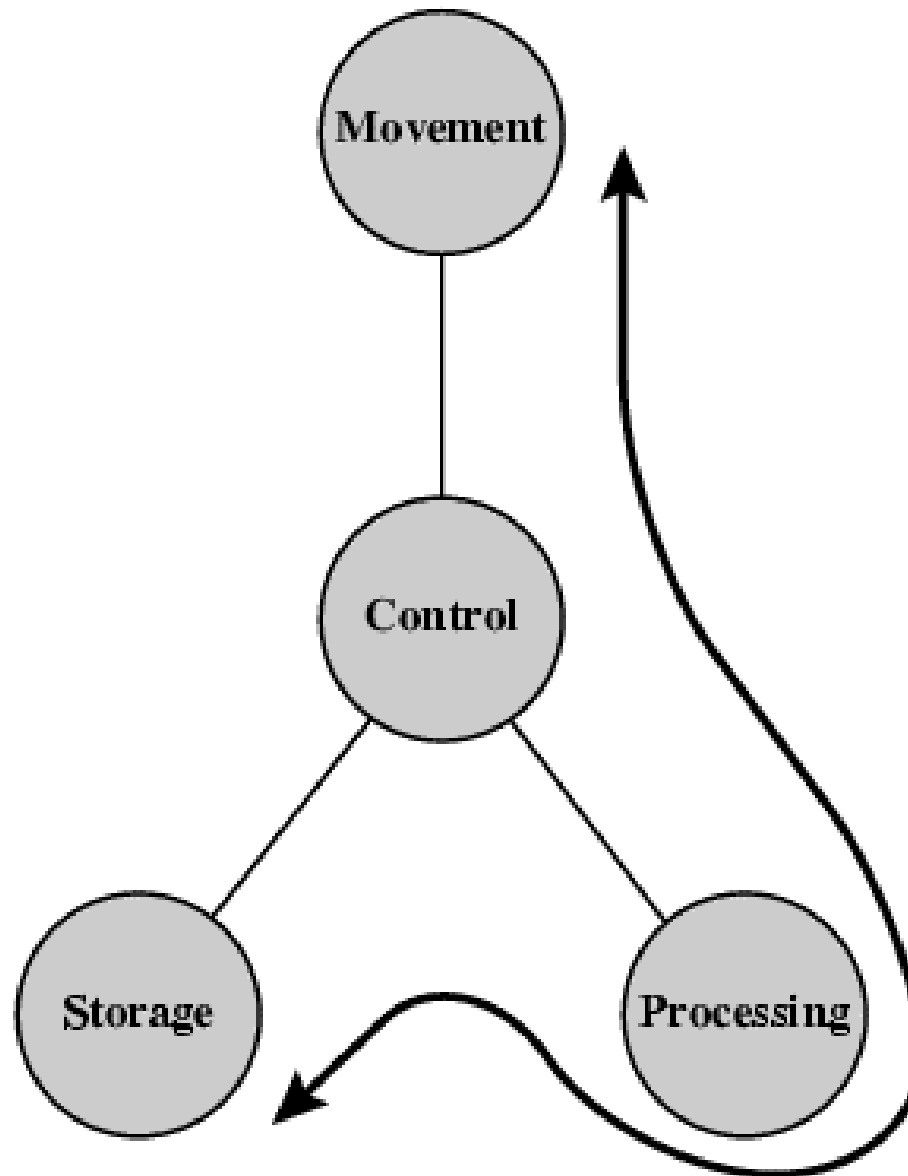


Operation (c) Processing from/to storage

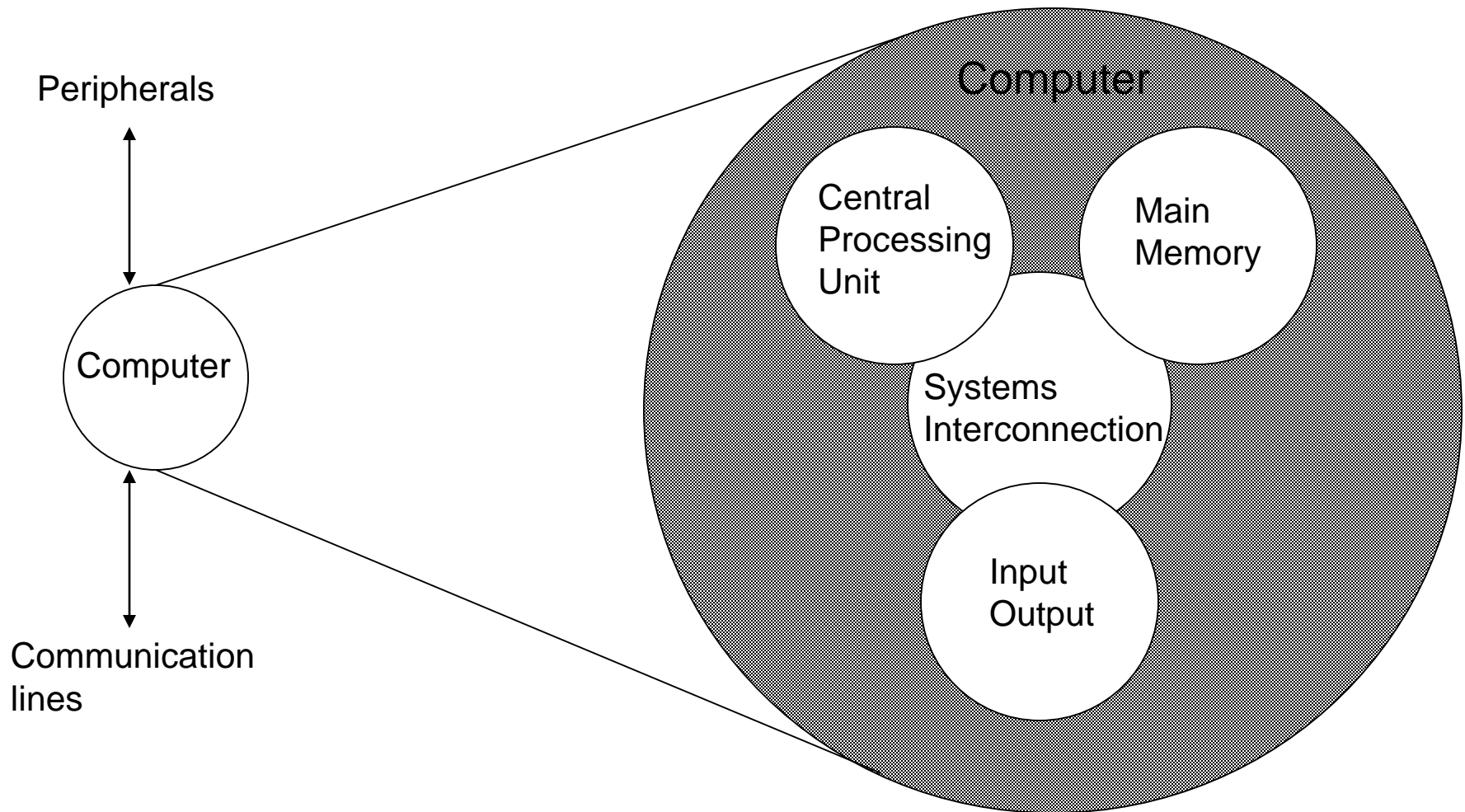


Operation (d)

Processing from storage to I/O



Structure - Top Level

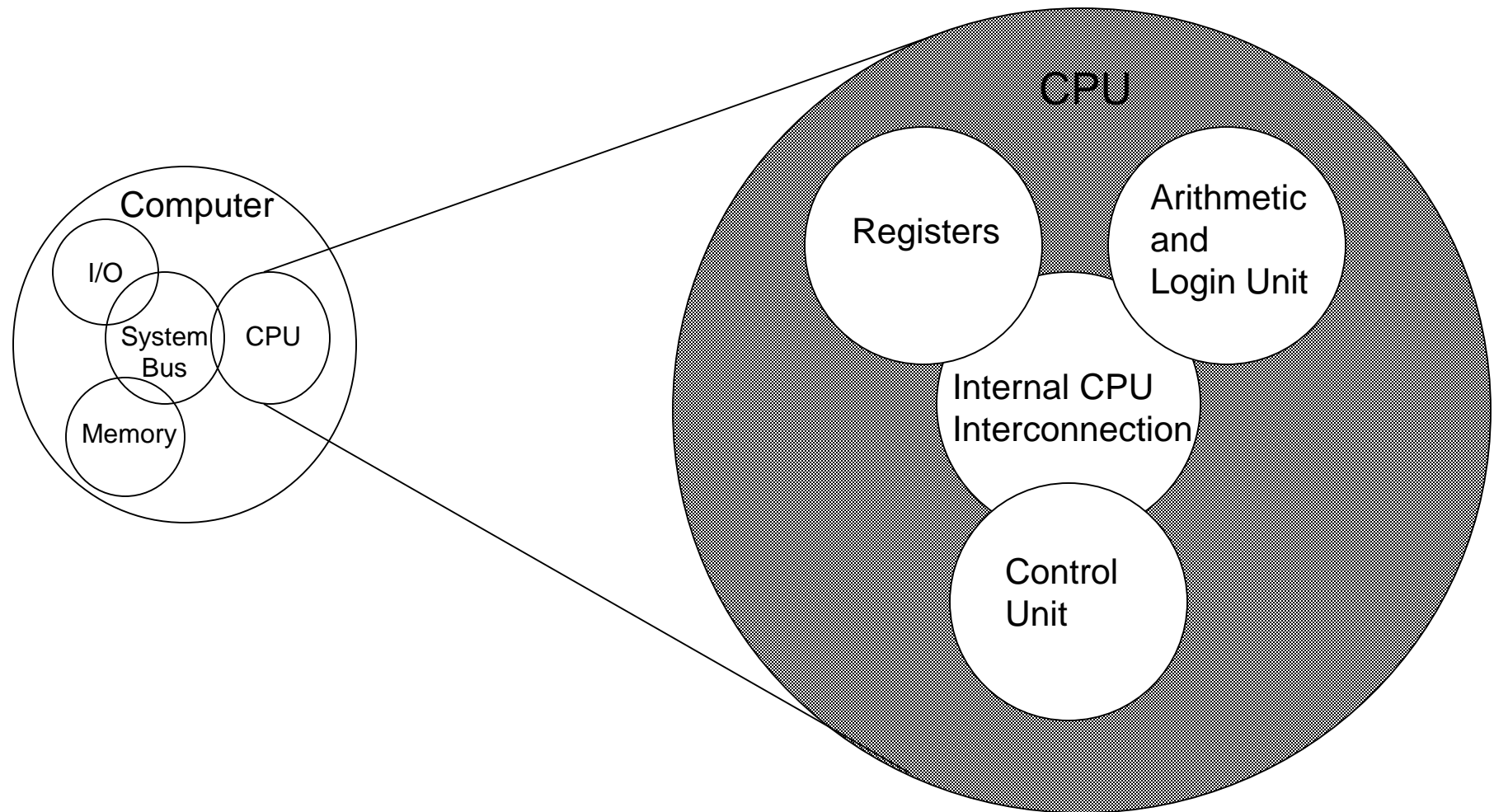


Internal Structural of Computer

There are four main structural components of computer:

- ✓ **Central processing unit (CPU): Controls the operation of the computer and** performs its data processing functions; often simply referred to as **processor**.
- ✓ **Main memory: Stores data.**
- ✓ **I/O: Moves data between the computer and its external environment.**
- ✓ **System interconnection: Some mechanism that provides for communication** among CPU, main memory, and I/O. A common example of system interconnection is by means of a **system bus, consisting of a number of conducting** wires to which all the other components attach.

Structure - The CPU

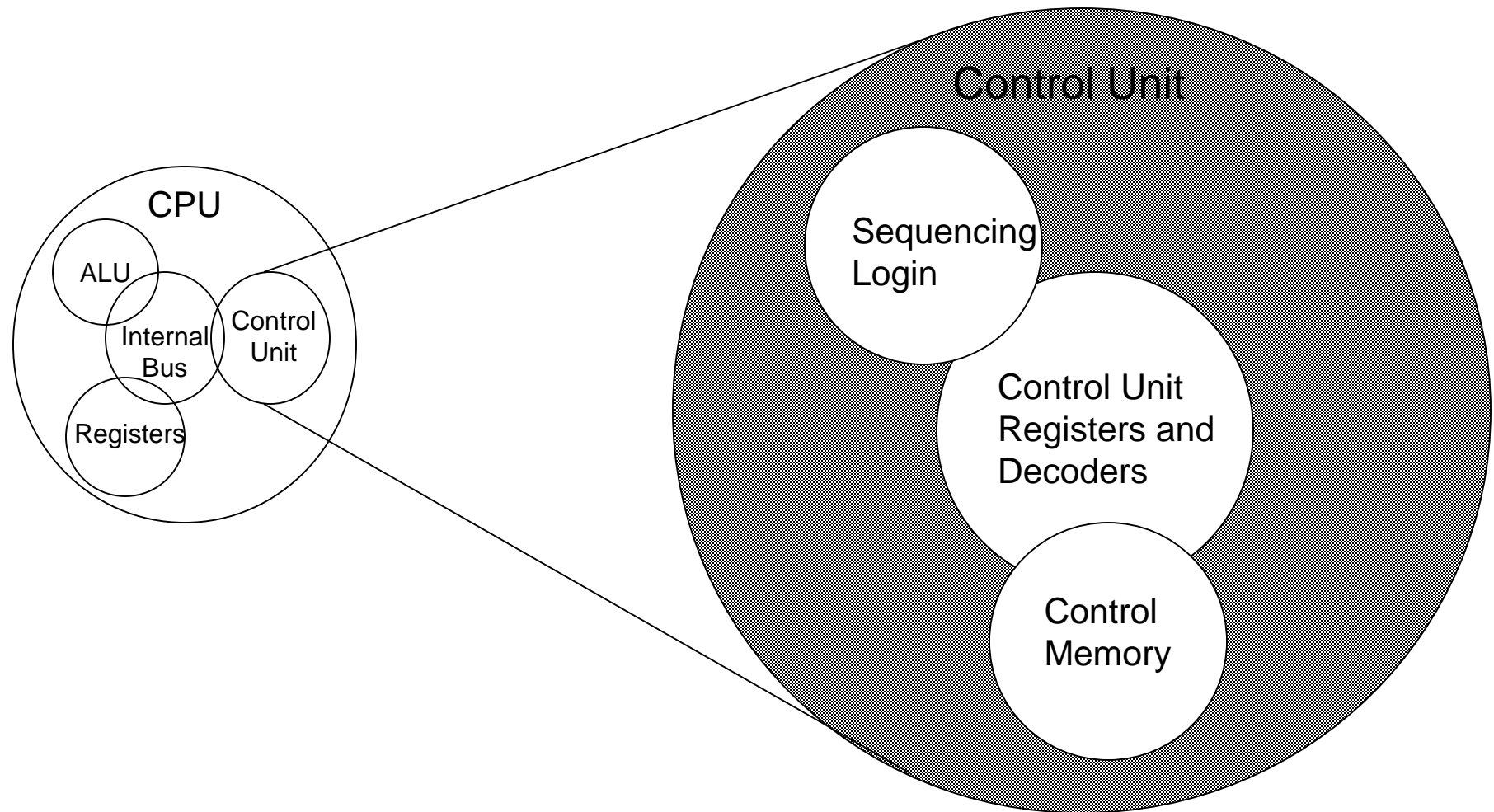


Structural Components of CPU

Its major structural components are as follows:

- ✓ **Control unit:** Controls the operation of the CPU and hence the computer.
- ✓ **Arithmetic and logic unit (ALU):** Performs the computer's data processing functions.
- ✓ **Registers:** Provides storage internal to the CPU.
- ✓ **CPU interconnection:** Some mechanism that provides for communication among the control unit ,ALU , and registers.

Structure - The Control Unit



Question

➤ Where the Design of Modern Computer has Come from?.

Outline of the Book (1)

- Computer Evolution and Performance
- Computer Interconnection Structures
- Internal Memory
- External Memory
- Input/Output
- Operating Systems Support
- Computer Arithmetic
- Instruction Sets

Outline of the Book (2)

- CPU Structure and Function
- Reduced Instruction Set Computers
- Superscalar Processors
- Control Unit Operation
- Microprogrammed Control
- Multiprocessors and Vector Processing
- Digital Logic (Appendix)

Internet Resources

- Web site for book

- <http://WilliamStallings.com/COA/COA7e.html>
 - links to sites of interest
 - links to sites for courses that use the book
 - errata list for book
 - information on other books by W. Stallings
- <http://WilliamStallings.com/StudentSupport.html>
 - Math
 - How-to
 - Research resources
 - Misc

Internet Resources

- Web sites to look for

- WWW Computer Architecture Home Page
- CPU Info Center
- Processor Emporium
- ACM Special Interest Group on Computer Architecture
- IEEE Technical Committee on Computer Architecture
- Intel Technology Journal
- Manufacturer's sites
 - Intel, IBM, etc.

Internet Resources

- Usenet News Groups

- comp.arch
- comp.arch.arithmetic
- comp.arch.storage
- comp.parallel