Computer Architecture

Course Code: CSE 360

Presented by

Dr. Md. Nawab Yousuf Ali

Professor, Dept. of CSE

Lecture 1
Introduction

Objectives

After undergoing this course, students should be

- able to grasp the basic concept of computer architecture and organization, and understand the key skills of constructing cost-effective computer systems.
- able to evaluate different designs and organizations of modern computers to provide quantitative arguments in evaluating different designs.

.

Objectives

- able to articulate design issues in the design and development of different components of a computer such as processor, memory, and control unit etc.
- able to understand the design issues of scalable and parallel computer architectures to cope up with future high performance computing systems.

Scalable Computer:

It is the ability of a computer application or product (hardware or software) to continue to function well when it (or its context) is changed in size or volume in order to meet a user need.

Parallel Computer:

A **computer** that utilizes **parallel** processing that can be upgraded by adding more CPUs to it, effectively increasing its **computing** power.

Architecture & Organization

- **Computer architecture** refers to those attributes of a system visible to the programmer
  - Examples of architectural attributes includes:

1. The instruction set,
2. The number of bits used to represent various data types (e.g. numbers, characters)
3. I/O mechanisms and
4. Techniques for addressing memory

For example, it is an architectural design issue whether a computer will have a multiply instruction

Architecture & Organization

- **Organizational attributes** include hardware details transparent to the programmer such as

1. Control signals
2. Interfaces between the computers and peripherals and
3. The memory technology

For example, it is an organizational issue whether that **instruction will be implemented by a special multiply unit** or by **a mechanism that makes repeated use of the add unit of the system.**

Architecture & Organization 2

- Historically and still today, the distinction between architecture and organization has been important one.
- Many computer manufacturers offer a family of computer models with the same architecture but with differences in organization
- A particular architecture may span many years and encompass a number of different computer models, its organization changing with technology
- The IBM System/370 family share the same basic architecture since 1970
- Over the years, IBM has introduced many new models with improved technology to replace older models, offering the customer greater speed, cost , or both; these newer models retained the same architecture.
- The relationship between architecture and organization is very closed.
- Changes in technology not only influence organization but also introduces more powerful and more complex architecture, e.g., RISC (reduced instruction set computer)

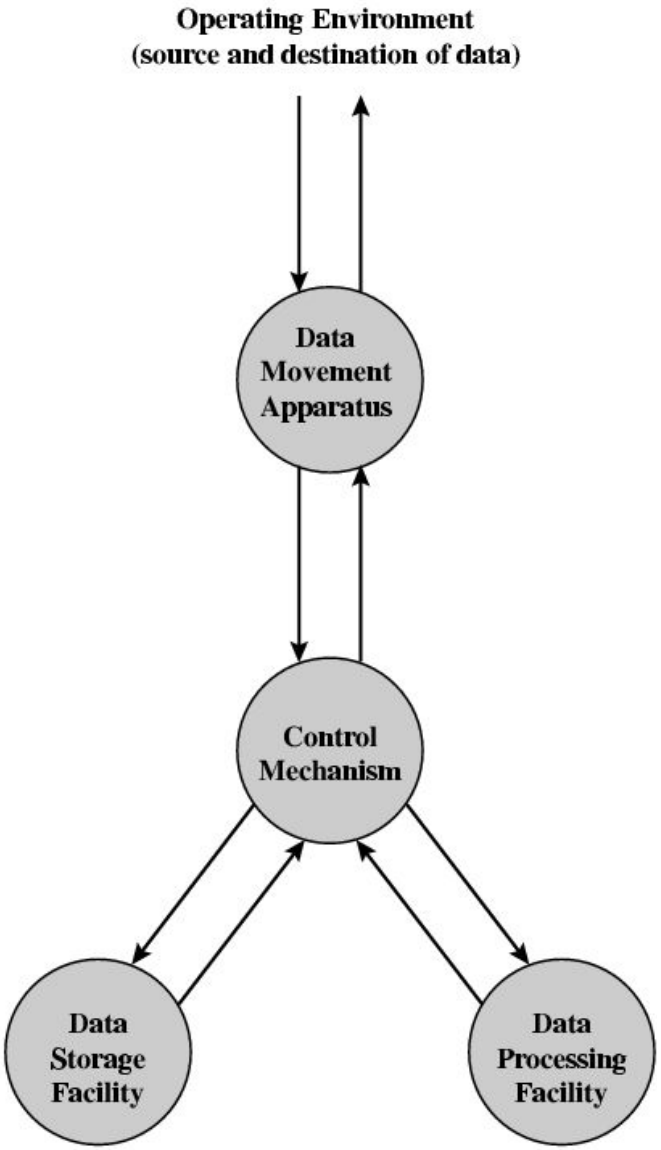
Structure & Function

- A computer is a complex system; contemporary computers contain millions of elementary electronic components.
- Structure is the way in which the components are interrelated.
- 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



Function (1)

- The computer must be able to *process data*.
  - Data may take a wide variety of forms.
  - The range of processing requirements is broad.

- It is also essential that a computer *store data*.
  - Files of data are stored in a short-term data storage or long term-data storage on the computer for subsequent retrieval and update.

Function (2)

- The computer must be able to *move data* between itself and the outside world.

- The computer's operating environment consists of devices that serve as either sources or destinations of data.
- When data are received from or delivered to a device that is directly connected to the computer, the process is known as *input-output* (I/O), and the device is referred to as a peripheral.
- When data are moved over longer distances, to or from a remote devices, the process is known as *data communications*.

Function (3)

- Finally, there must be *control* of these three functions.
- This control is exercised by the individual (s) who provides the instructions to the computer.

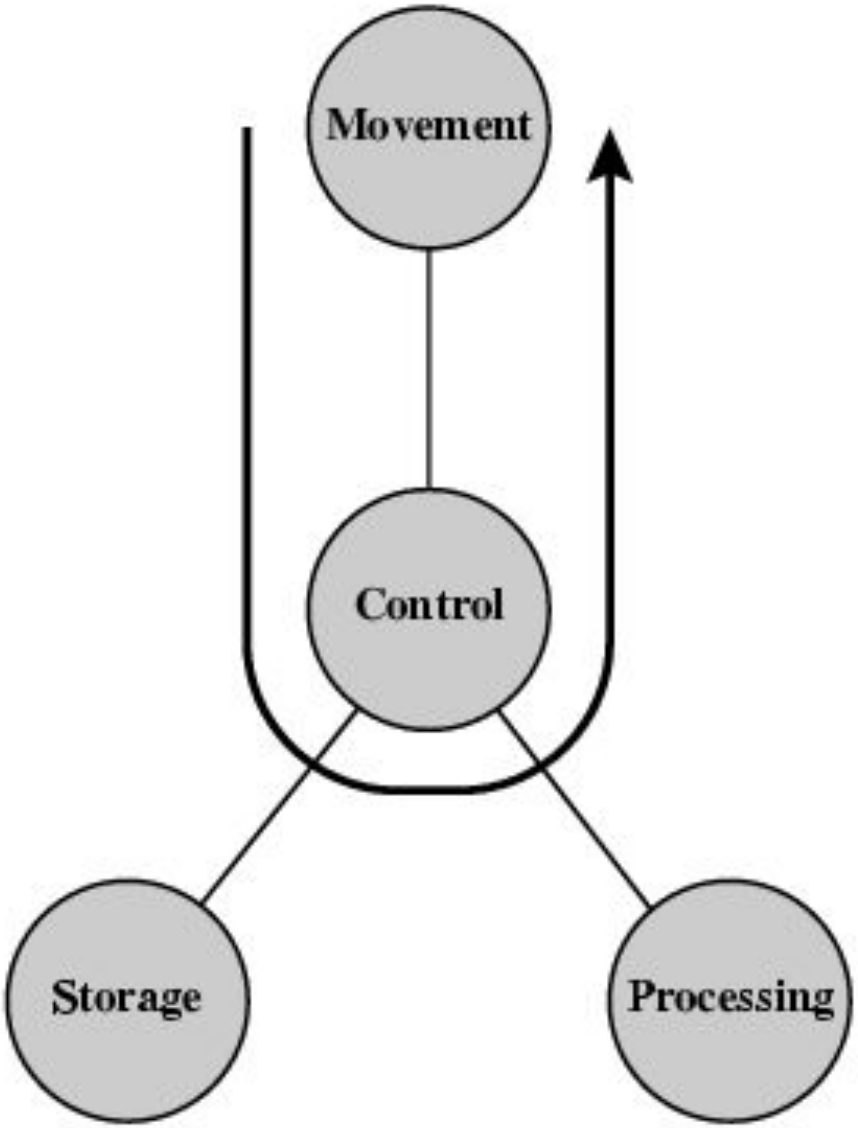
Four Possible Computer Operations

- The computer can function as a *data movement device*, simply transferring data from one peripheral or communications line to another [See (a)]

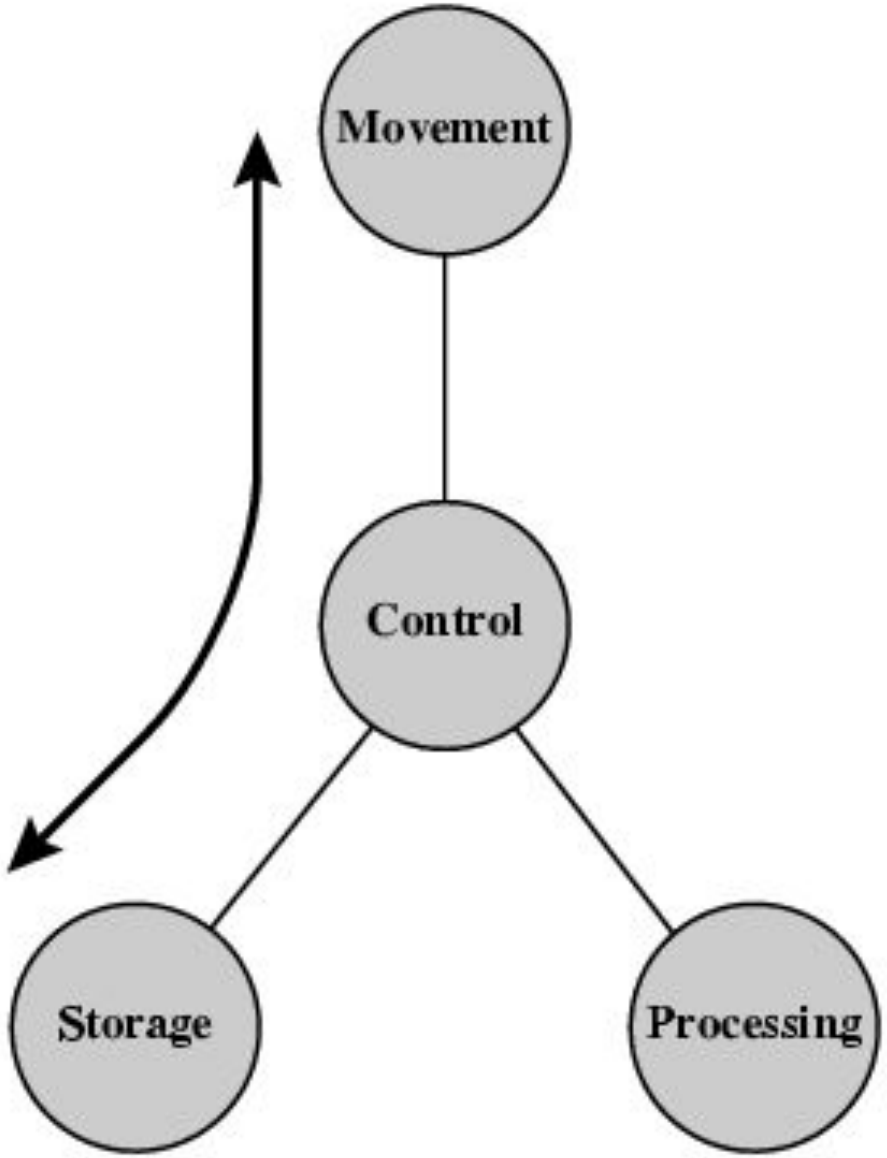
- It can also function as a *data storage device*, with data transferred from the external environment to computer storage (read) and vice versa (write) [See (b)]

- Final two operations involving data processing either *from/to storage* or *from storage to I/O*. [See (c) and (d)]

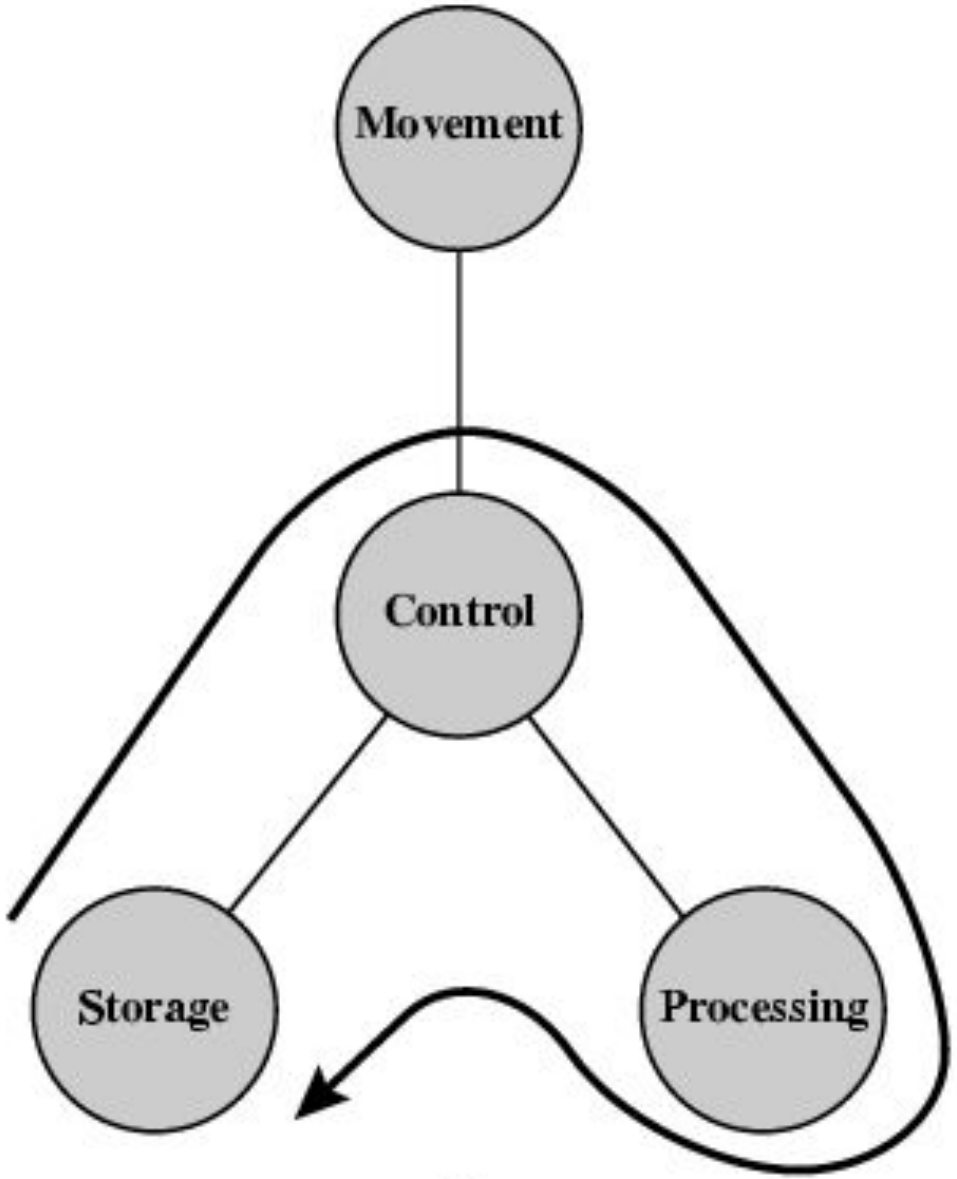
Operations (a) Data movement



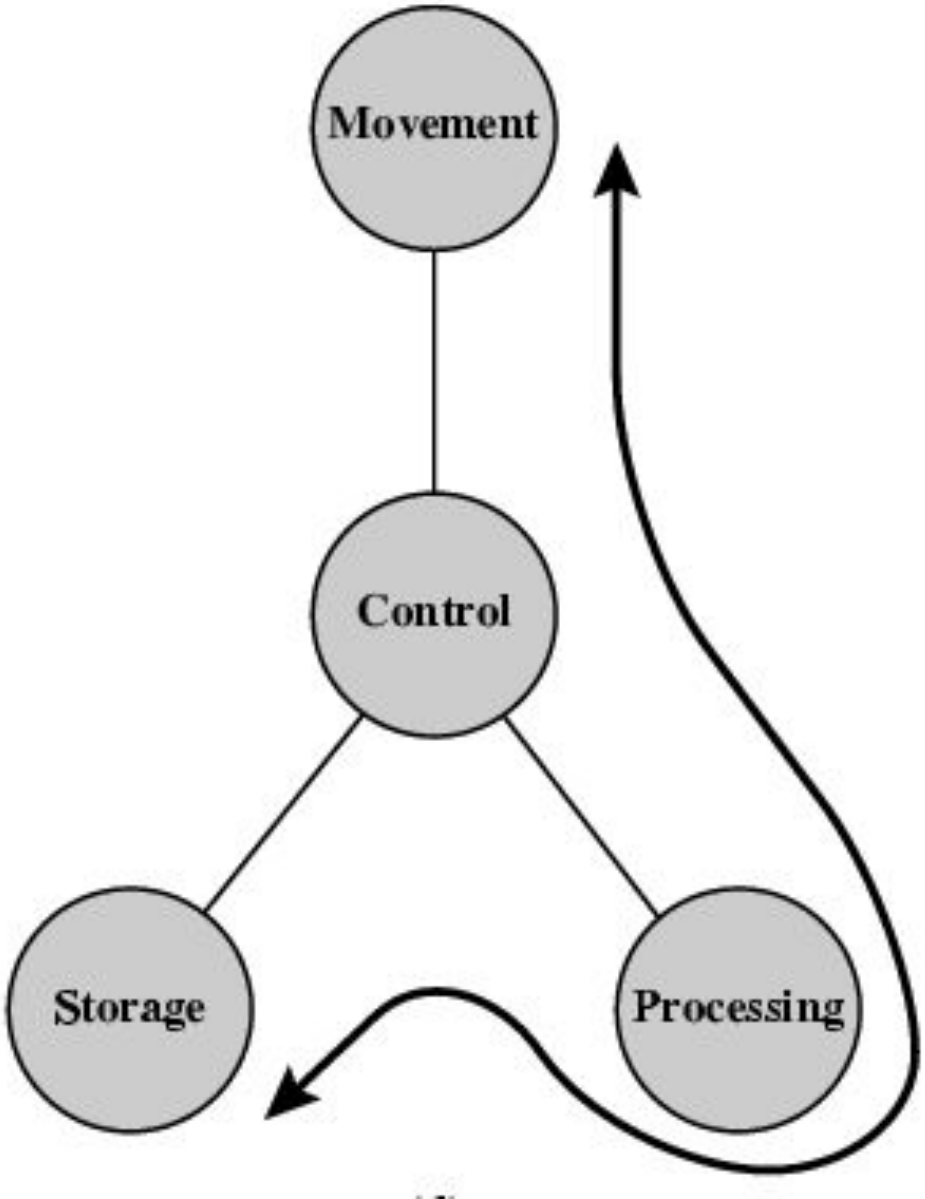
Operations (b) Storage



Operation (c) Processing from/to storage

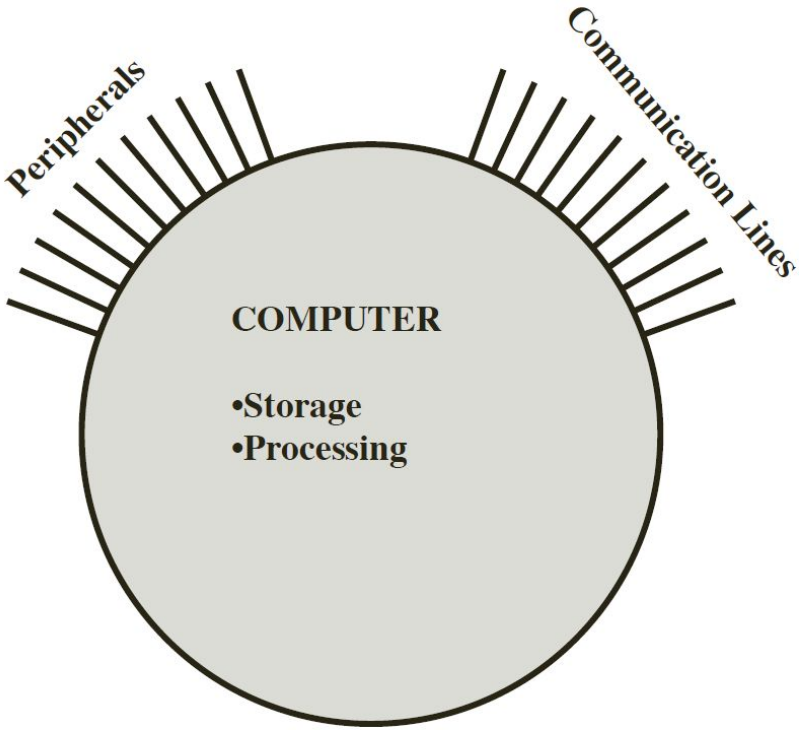


Operation (d)
Processing from storage to I/O



Structure

- The computer is an entity that interacts in some fashion with its external environment.
- In general, all of its linkages to the external environment can be classified as *peripheral devices* or *communication lines*.



Structural Components:

- Four main structural components:

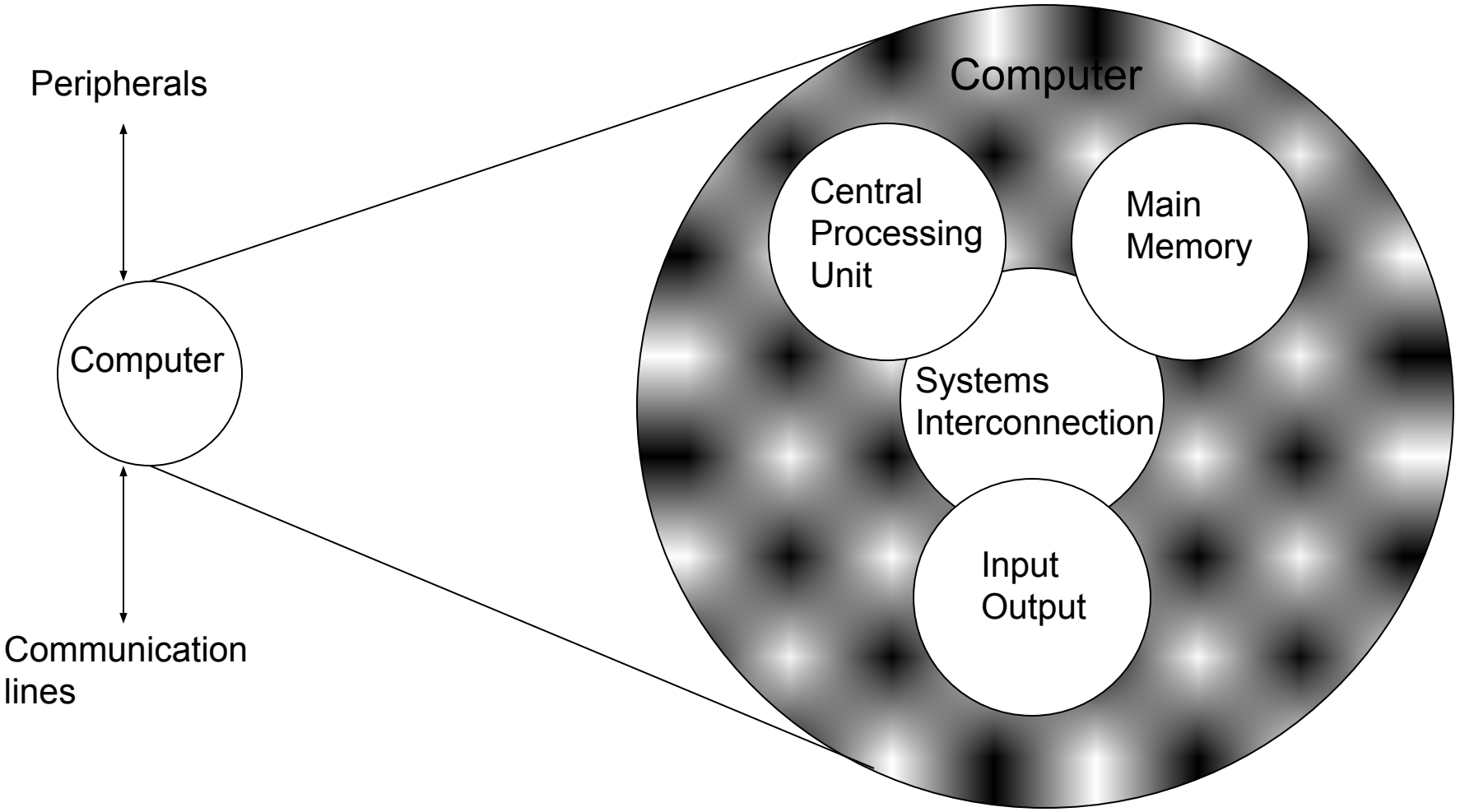
- Central Processing Unit (CPU): Controls the operation of the computer and performs its data processing functions (referred as *processor*).

- 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.

Structure - Top Level



Structure - The CPU

- Major structural components are:

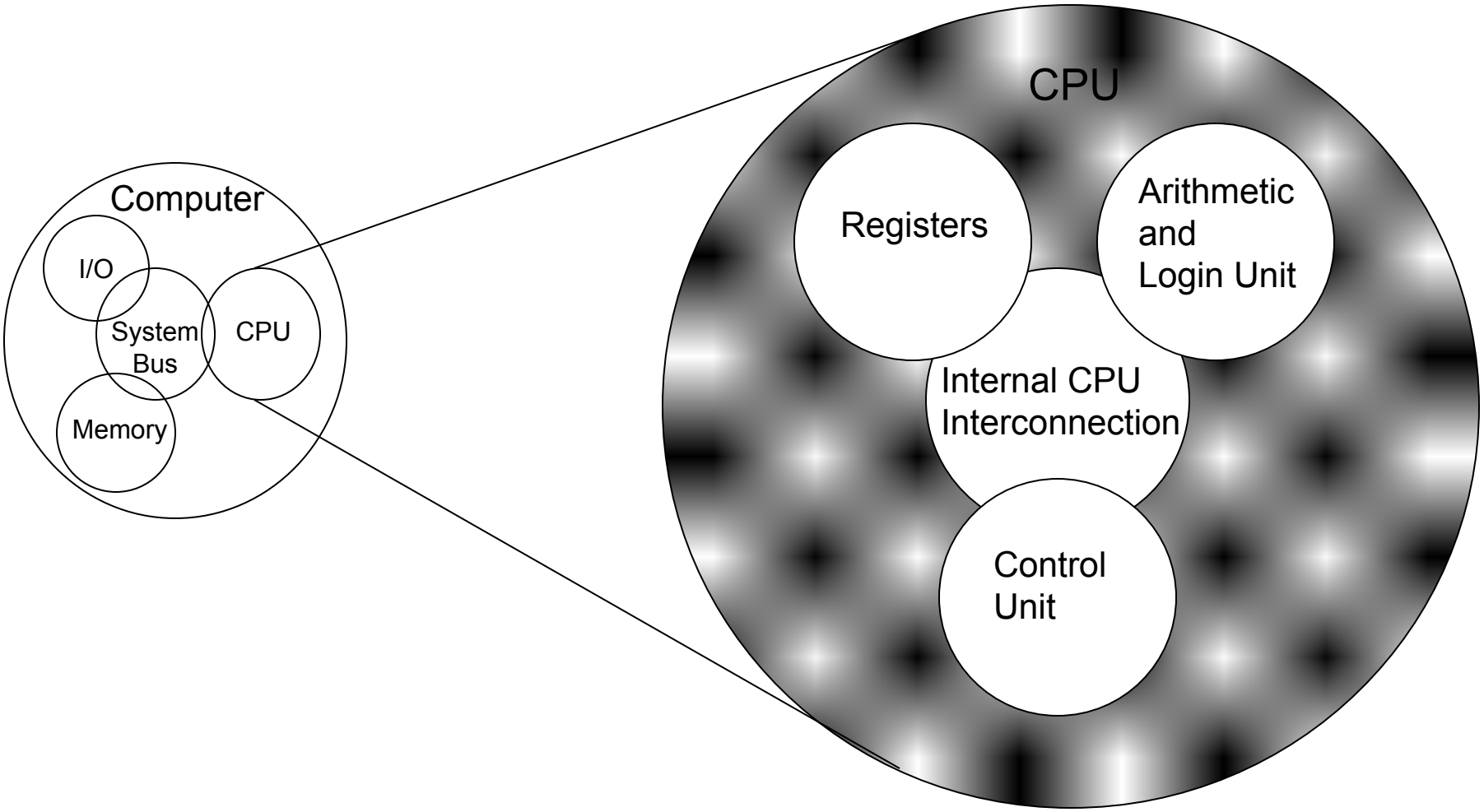
- Control Unit: Controls the operation of the CPU and hence all the computer resources.

- Arithmetic and Logic Unit (ALU): Performs (Arithmetical and logical functions and controls the speed of those operations) the computer's data processing functions.

- Registers: Provide storage internal to the CPU.

- CPU Interconnection: Some mechanism that provides for communication among the control unit, ALU, and registers.

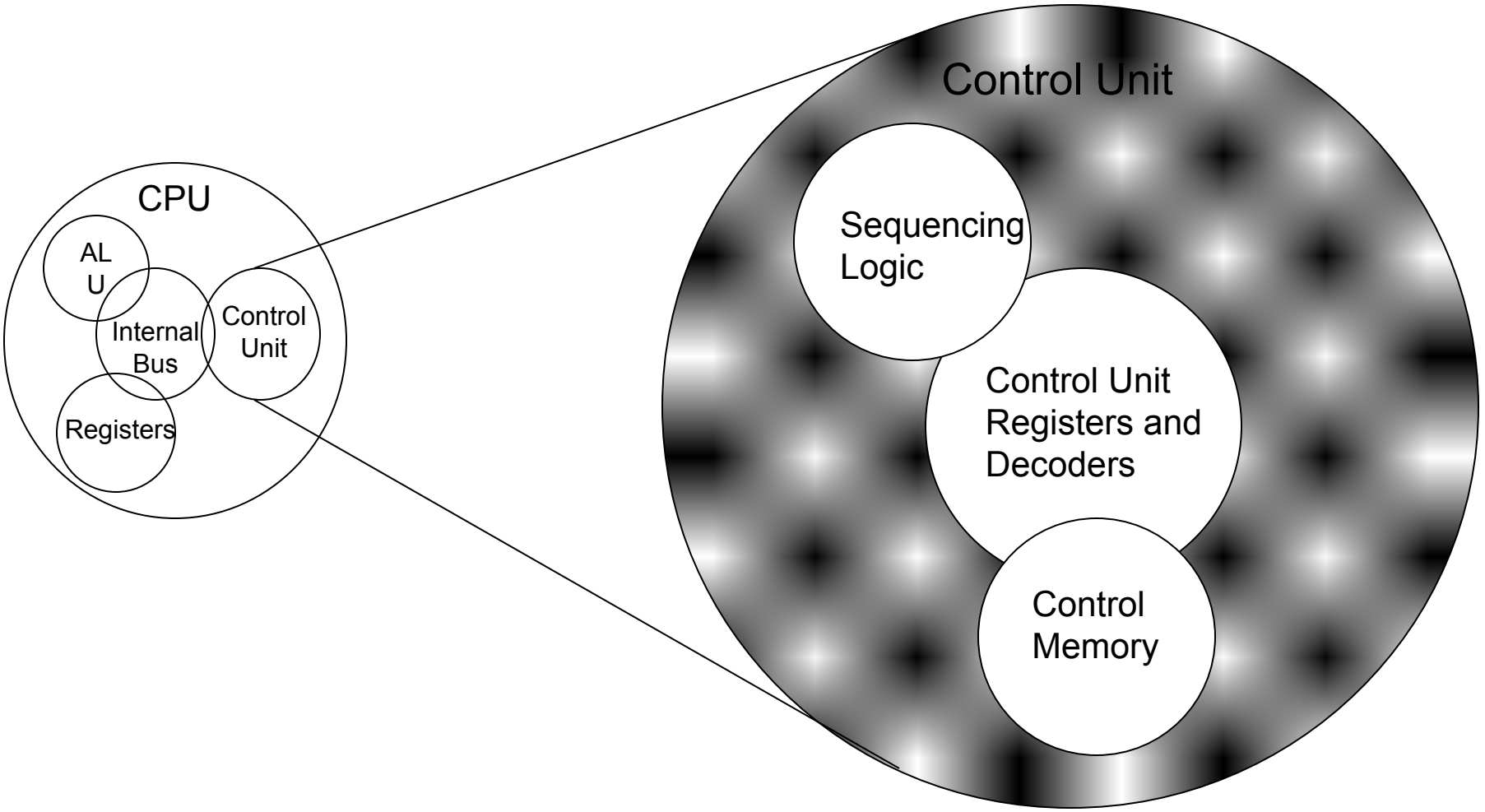
Structure - The CPU



Structure - The Control Unit

- The most interesting component is the control unit.
- The control unit can be implemented using the technique of microprogramming.
- Portion of control storage contains microcode.
- Micro-operations generally involves a transfer between registers, a transfer between a register and an external bus, or a simple ALU operation.
- It causes the processor to execute micro-operations in the proper sequence, determined by the program being executed.
- It generates the control signals that cause each micro-operation to be execute.

Structure - The Control Unit



Lecture Summary

- This lecture introduces –

- Overall course structure and overview of entire course.
- the organization and architecture of the computer.
- the structure and function of the computer.