Bahria University
Discovering Knowledge

Computer Architecture and Logic Design (CALD)

Lecture 01

Dr. Sorath Hansrajani

Assistant Professor

Department of Software Engineering

Bahria University Karachi Campus

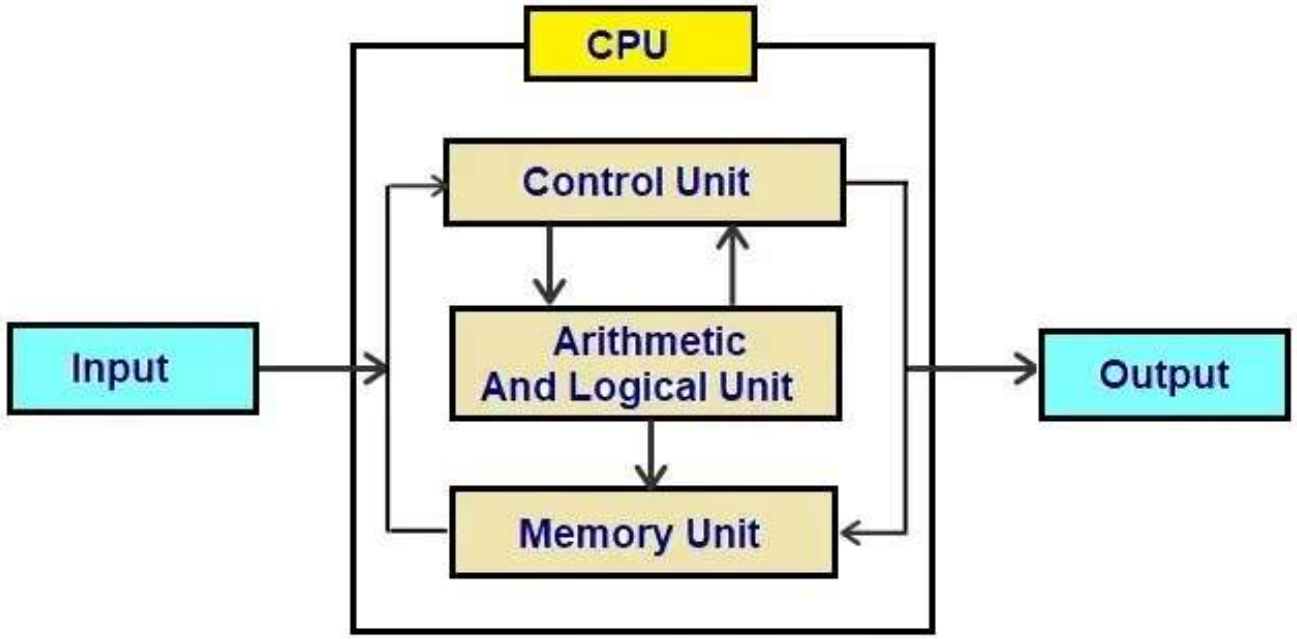
Email: sorathhansrajani.bukc@bahria.edu.pk

Recommended Books

- Computer Architecture and Organization, Designing for Performance by William Stallings, 10th Edition.
- Computer Organization and Design, by David Patterson and John Hennessy, 5th Edition.
- Digital Logic & Computer Design by M. Morris Mano, latest Edition.

Basic Concepts of Computer Architecture

Block diagram of a Computer



Block Diagram of a Computer

Computer Architecture

- Architecture refers to those attributes visible to the programmer or the attributes that have direct impact on the logical execution of a program.
  - Instruction set
  - Number of bits used for data representation
  - I/O mechanisms
  - Addressing techniques

Example: Architectural design issue - whether a computer will have a multiply instruction.

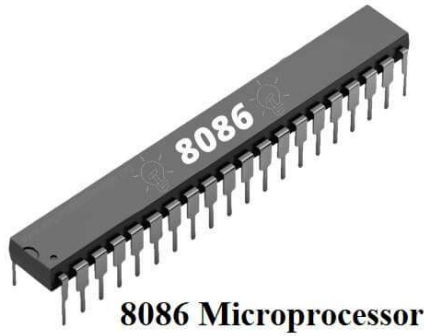
Computer Organization

- Organization refers to the operational units and their interconnections that realize the architectural specifications.
- Organizational attributes include those hardware detail transparent to the programmer.
  - Control Signals
  - Interfaces between the computer and peripherals
  - Memory technology

Example: Organizational issue – is there a special multiply unit or is it done by repeated addition.

Architecture and Organization

- Computer manufacturers offer a family of computer models all with same architecture but differences in organization.
- Different models - different prices and performance characteristics.
- Examples:
  - All Intel x86 family share the same basic architecture
  - The IBM System/370 family share the same basic architecture
- This gives backward code compatibility.
- Organization differs between different versions.



8086 Microprocessor

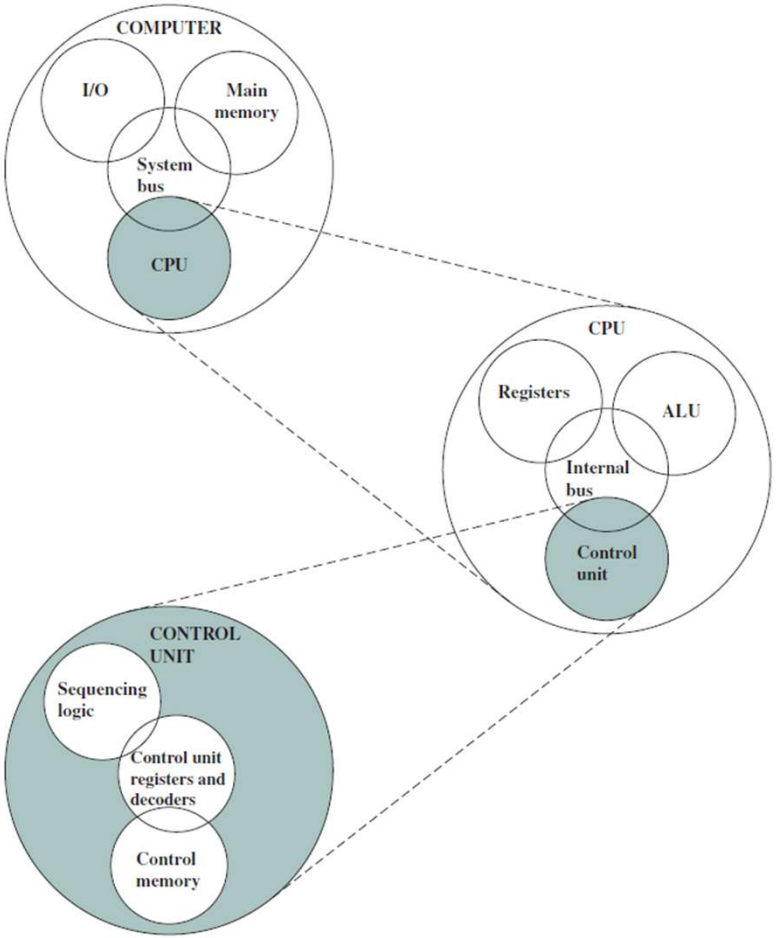
Structure and Function

- Structure is the way in which components relate to each other
  - How different components, like ALU, control, I/O, and memory are connected?
  - How they interface with each other?
- Function is the operation of individual components as part of the structure
  - What is the function of a component?

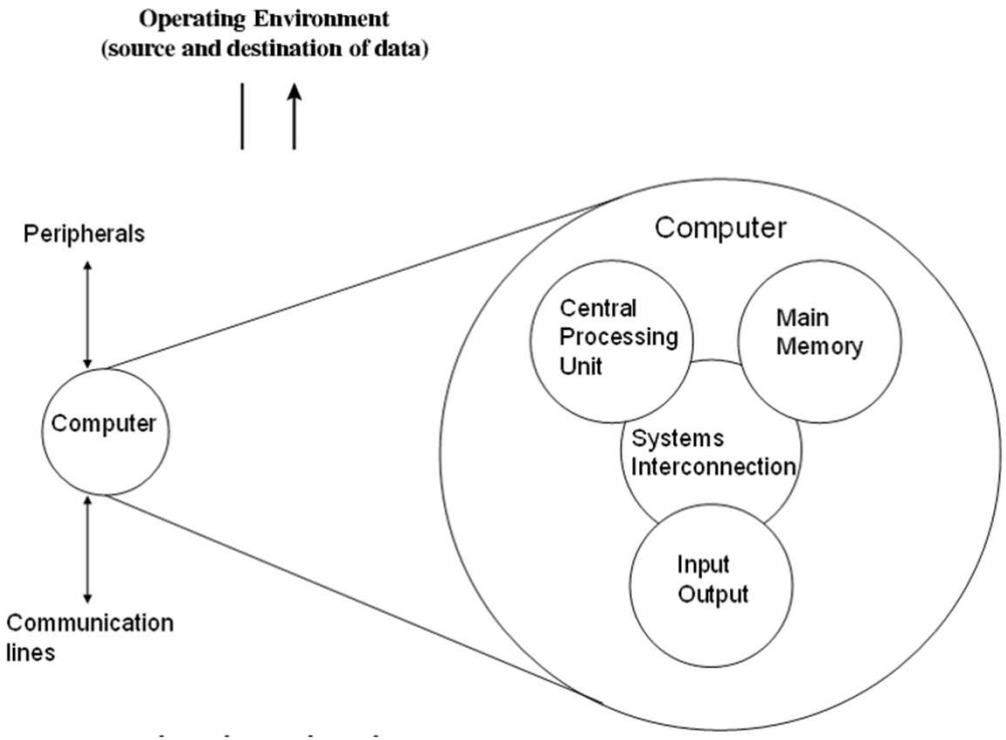
Functions of a Computer

- Data Processing
  - Data may take a wide variety of forms
  - Performing various operations on data
- Data Storage
  - Short and long term data storage
- Data Movement
  - Input-Output: Data is received from or delivered to a device that is directly connected to the computer. The device is referred to as a peripheral.
  - Data Communications: Data is moved over longer distances, to or from a remote device.
- Control
  - A control unit manages the computer's resources.

Top Level Structure of a Computer

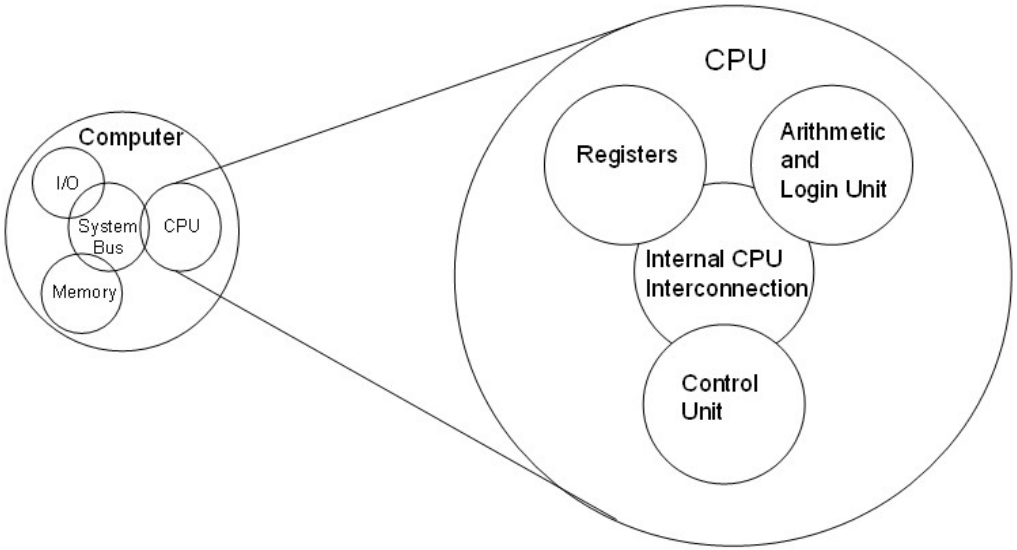


Structural Components: Computer



- Central Processing Unit (CPU):
  - Controls computer operations and performs data processing
- Main Memory:
  - Stores data
- I/O:
  - Data movement to and from computer and external environment
- System Interconnection:
  - Communication among CPU, main memory and I/O.

Structural Components: CPU



- Control Unit:
  - Controls the operations of a CPU.
- Arithmetic and Logic Unit (ALU):
  - Performs the computer's data processing functions.
- Registers:
  - Provides internal storage to CPU.
- CPU Interconnection:
  - Communication among the control unit, ALU, and registers.

Multicore Computer Structure

- Computers generally have multiple processors
- Multicore computer – multiple processors reside on a single chip.
- Each processing unit is called a core and it consists of a control unit, ALU, registers, and cache memory.

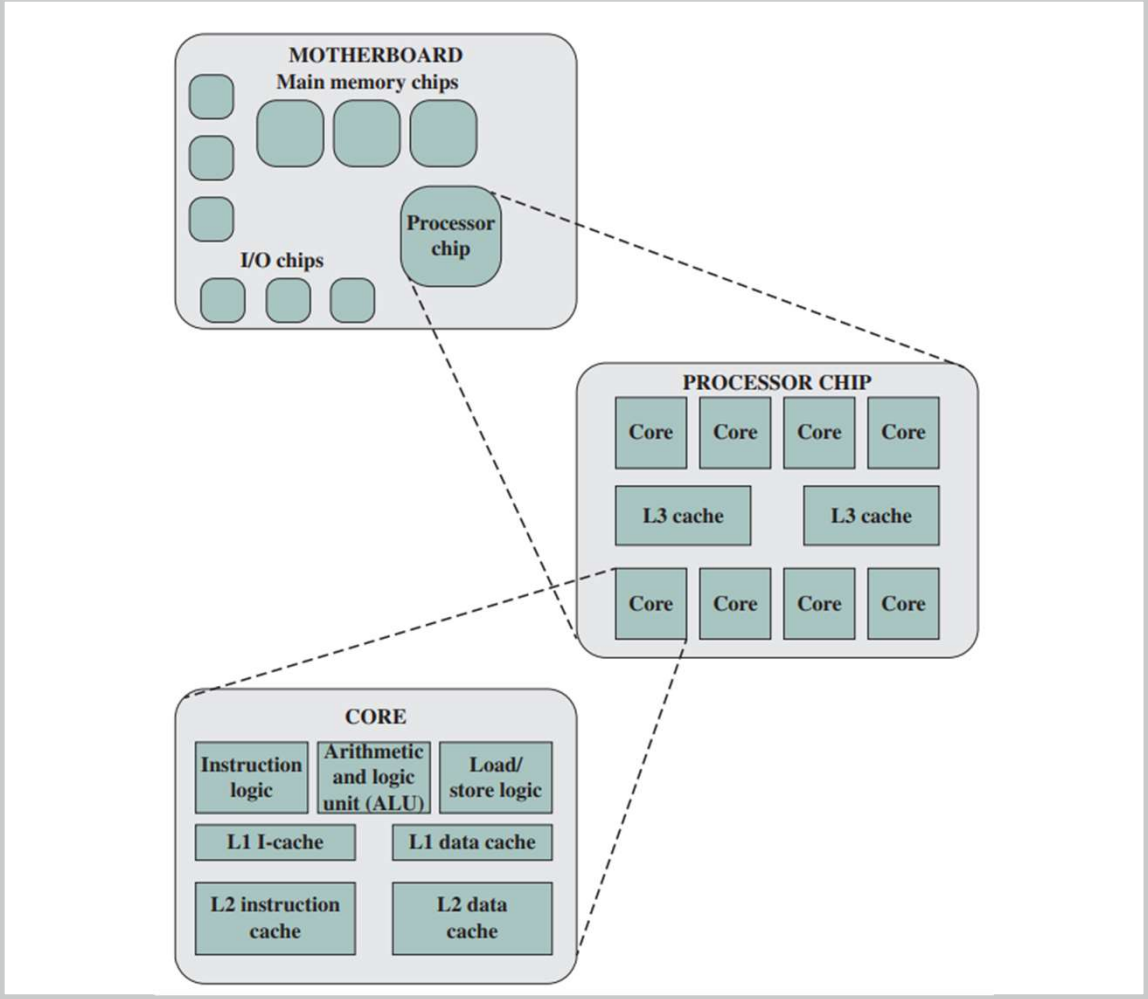
Multicore Computer Structure

- Central Processing Unit (CPU):
  - The portion of a computer that fetches and executes instructions.
  - It consists of an ALU, a control unit and registers.
- Core:
  - An individual processing unit on a processor chip.
  - Equivalent in functionality to a CPU on a single-CPU system.
- Processor:
  - A physical piece of silicon containing one or more cores.
  - Interprets and executes instructions.
  - If a processor contains multiple cores it is referred to as a multicore processor.

Cache Memory

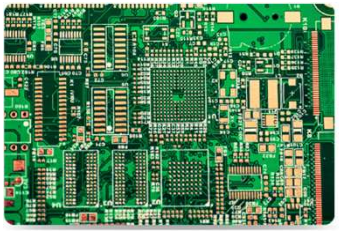
- Cache memory lies between the processor and main memory.
- It is smaller and faster than main memory.
- It is used to speed up memory access, by placing data from main memory into cache memory that is likely to be used in near future.
- Multiple levels of cache (L1, L2, L3, ...) can be used to improve performance.
- Level L1 is closest to the core and additional levels (L2, L3, and so on) are farther away from the core.
- Level *n* is smaller and faster than level *n+1.*

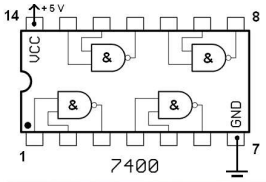
Elements of a Multicore Computer

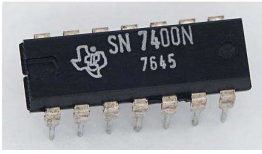


Elements of a Multicore Computer

- Printed Circuit Board (PCB):
  - A rigid, flat board that holds and interconnects chips and other electronic components.
- Motherboard:
  - Motherboard is the main printed circuit board (PCB) in a computer.
  - It is also known as system board.
- Chip:
  - The most prominent elements on the motherboard are called chips.
  - A chip is a single piece of semi-conducting material, typically silicon, upon which electronic circuits and logic gates are fabricated.
  - The resulting product is referred to as an Integrated Circuit (IC).







Elements of a core

- Instruction Logic:
  - Fetching and decoding instructions.
  - Determine instruction operations and memory locations of any operands.
- Arithmetic and Logic Unit (ALU):
  - Performs the operation specified by an instruction.
- Load/Store Logic:
  - Manages the transfer of data to and from main memory via cache.
- Instruction Cache:
  - Used for transfer of instructions to and from main memory.
- Data Cache:
  - Used for transfer of operands and results to and from main memory.