

Computer Organization and Operating System

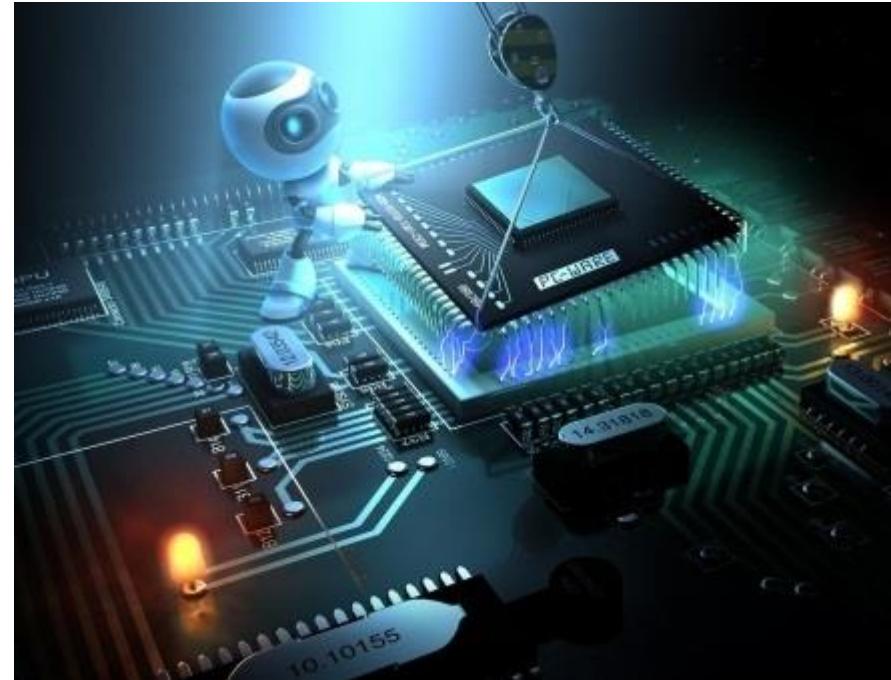
Computer Organization Overview

Akharin Khunkitti

KMITL

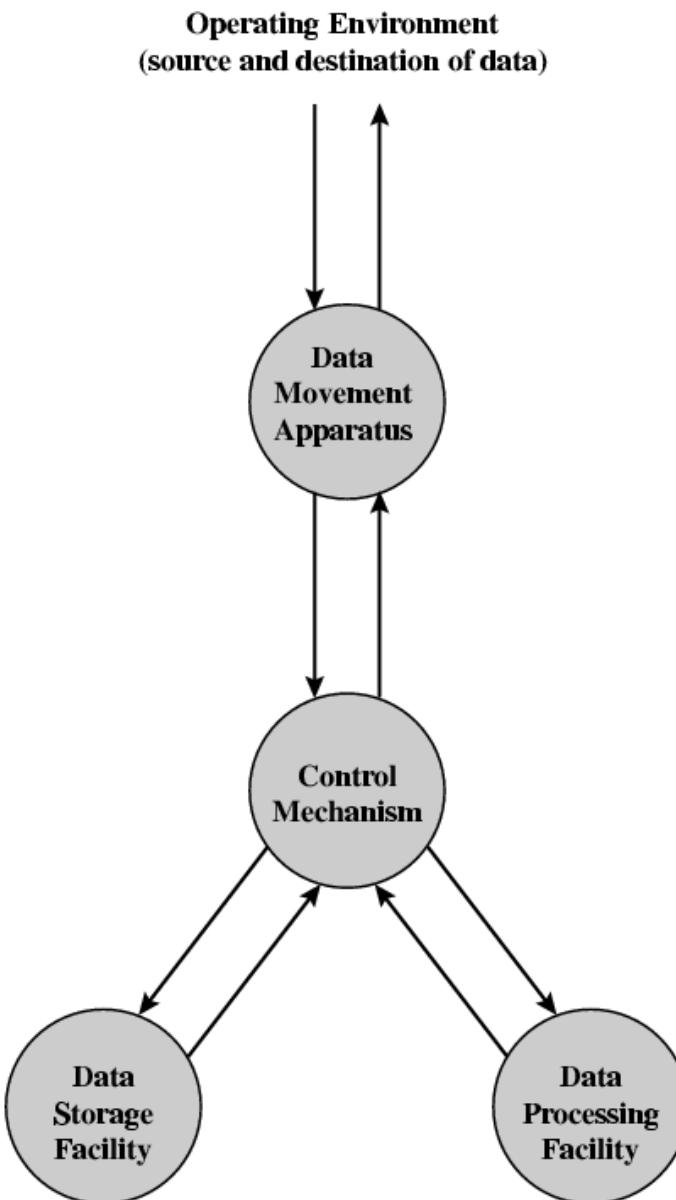
Topic

- Computer Functions
- Computer Architecture
- CPU Architecture
- Computer Program Execution
- Conclusion



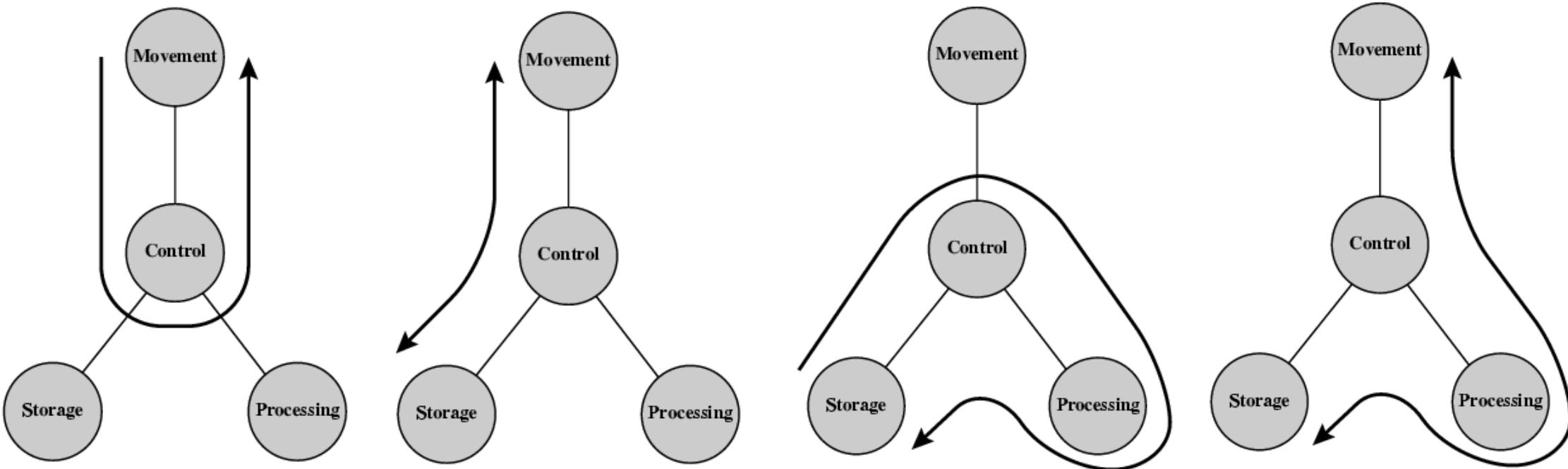
Computer Functions

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

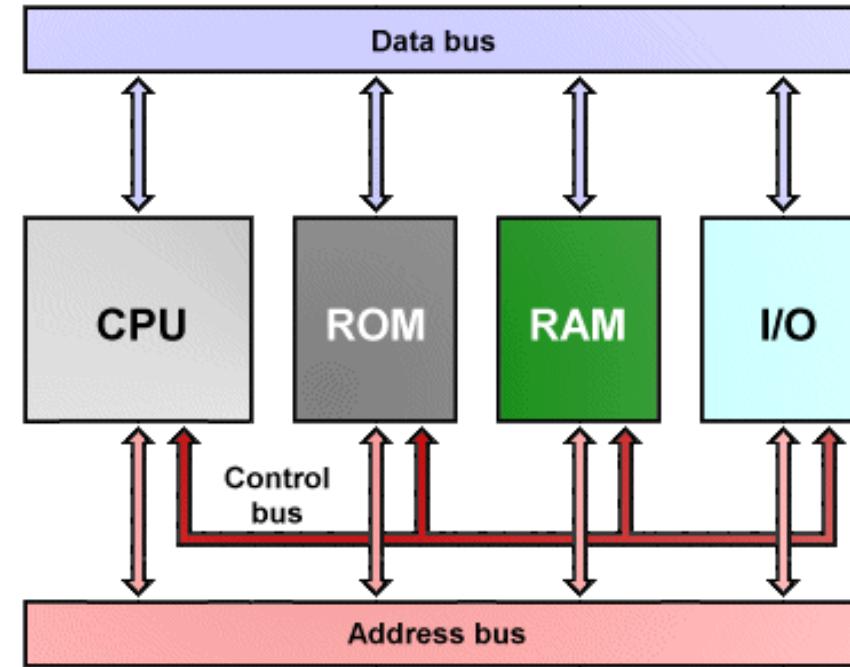


Computer Functions

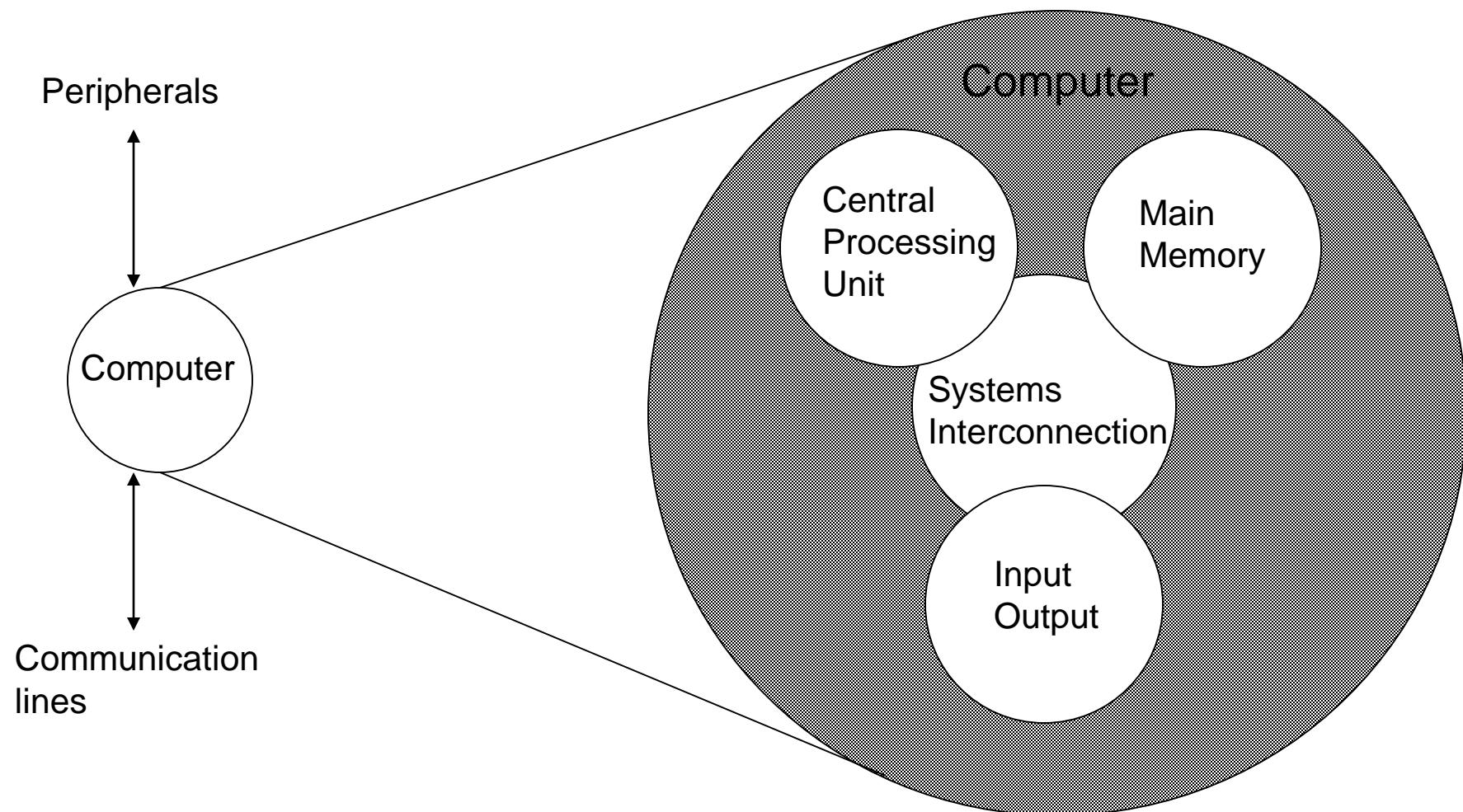
- Functional Views
 - (a) Data movement
 - (b) Storage
 - (c) Processing from/to storage
 - (d) Processing from storage to I/O



Computer Architecture

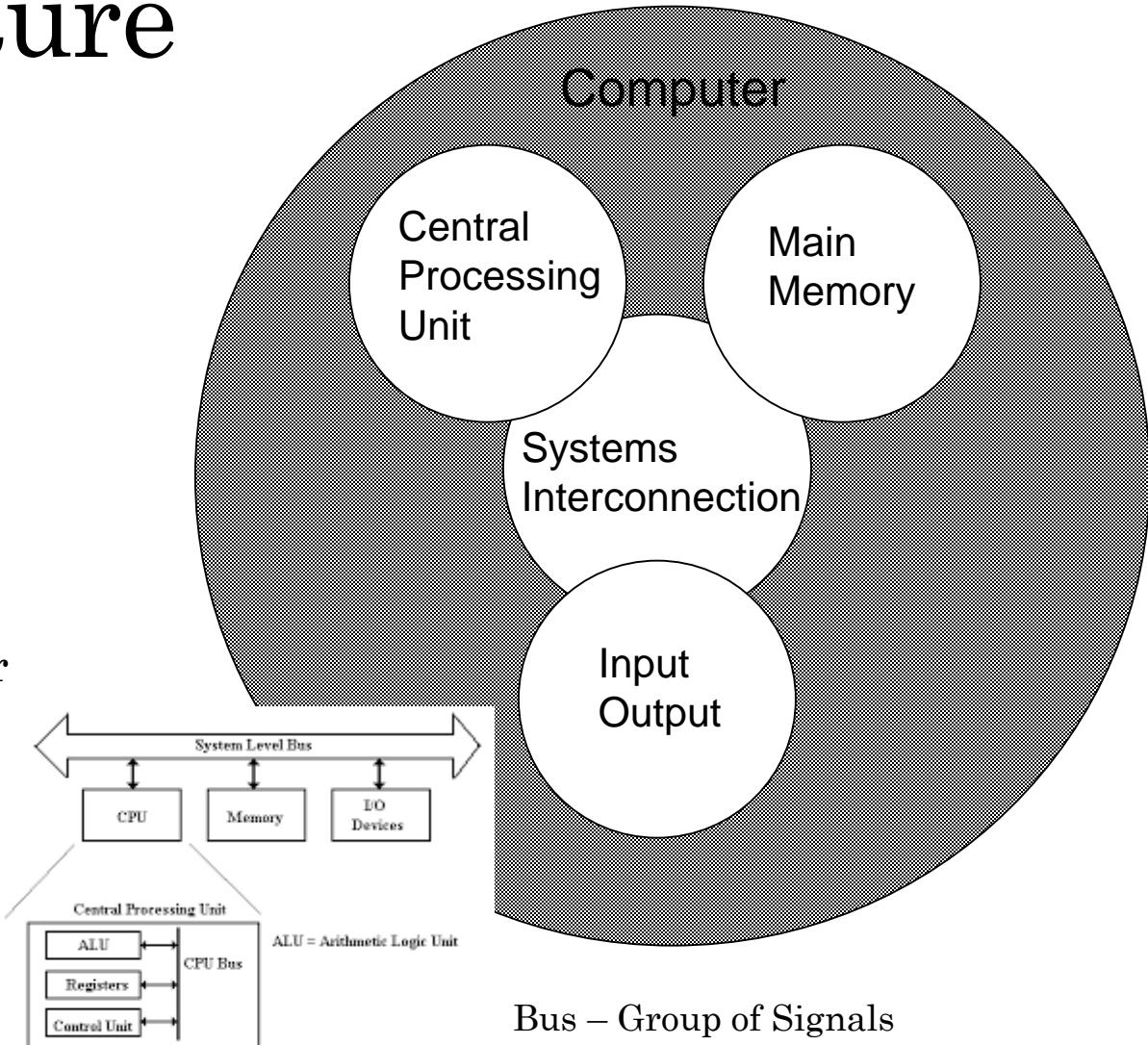


Structure - Top Level



Computer Architecture

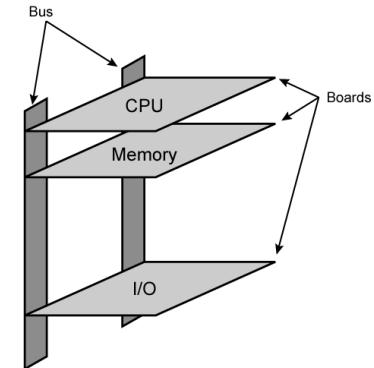
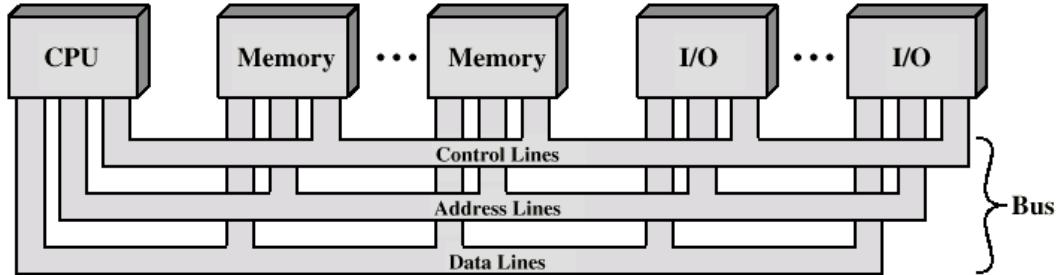
- 3+1 Components
- Processor / CPU (Central Processing Unit)
 - Control and Process Data
- Main Memory - Store
 - Program – Sequence of Instructions
 - Data
 - State / Status
- Processor + Memory = Minimum Computer
 - But Useless
- Input and Output (IO)
 - Outside or World Communication
 - Human Use
- Interconnection
 - Bus – Only One Sender at a time, Simple
 - Switch – Multiple Senders at the same time, more performance



- Bus – Group of Signals
- Data Bus
 - Address Bus
 - Control Bus

What is a Bus?

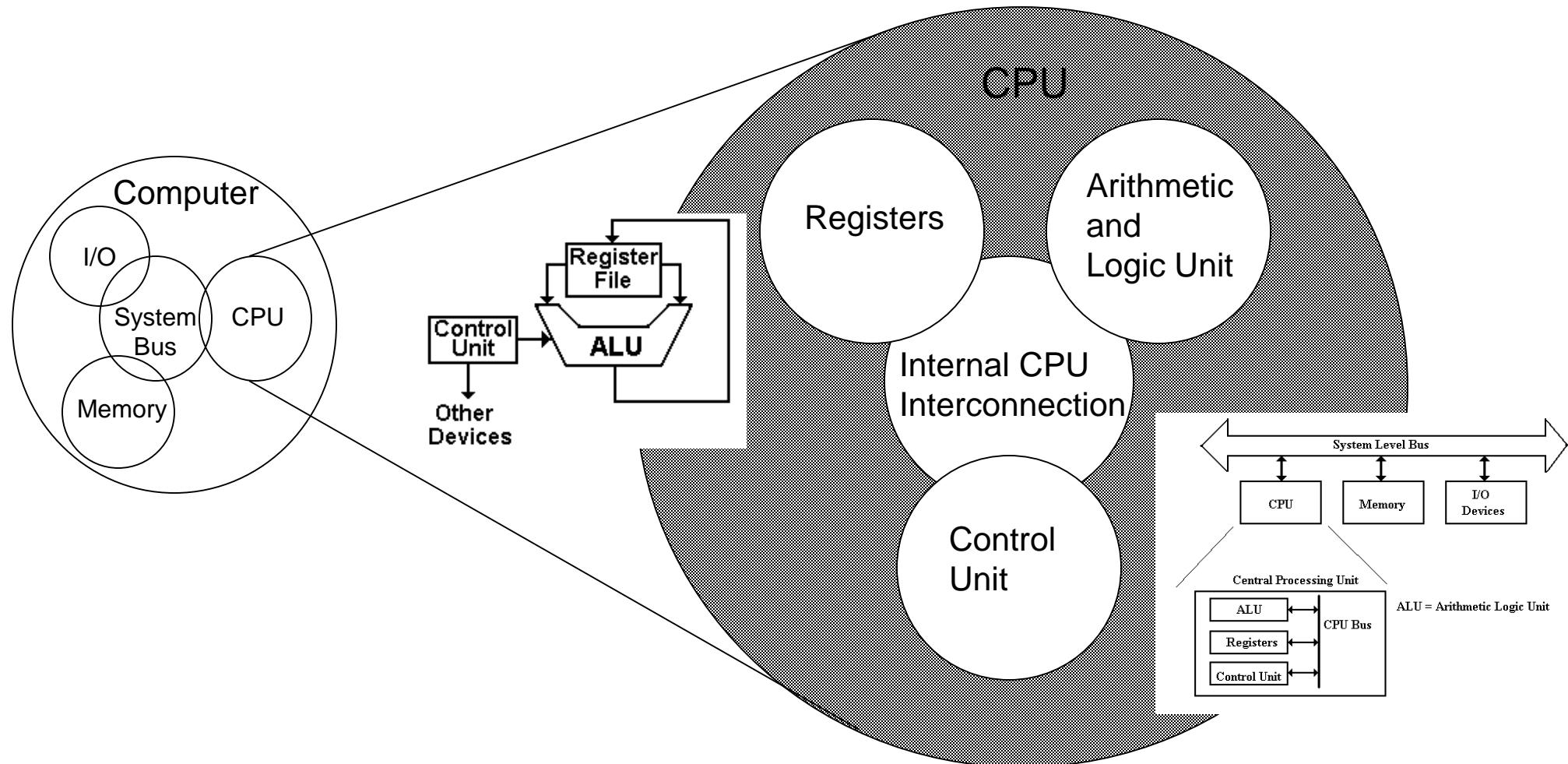
- A communication pathway connecting two or more devices
 - Usually broadcast
 - Often grouped
 - A number of channels in one bus
 - e.g. 32 bit data bus is 32 separate single bit channels
 - Power lines may not be shown
- Data Bus
 - Carries data
 - Remember that there is no difference between “data” and “instruction” at this level
 - Width is a key determinant of performance
 - 8, 16, 32, 64 bit
- Address Bus
 - Identify the source or destination of data
 - e.g. CPU needs to read an instruction (data) from a given location in memory
 - Bus width determines maximum memory capacity of system
 - e.g. 8080 has 16 bit address bus giving 64k address space
- Control Bus
 - Control and timing information
 - Memory read/write signal
 - Interrupt request
 - Clock signals



What do buses look like?

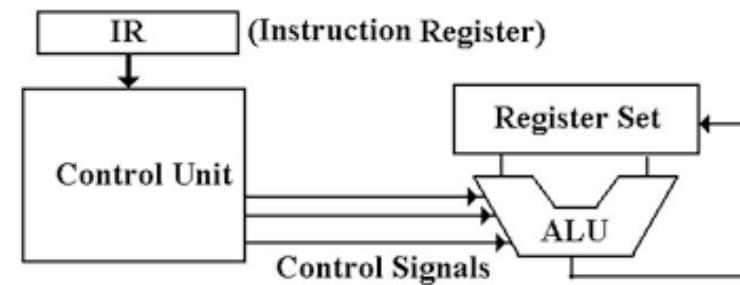
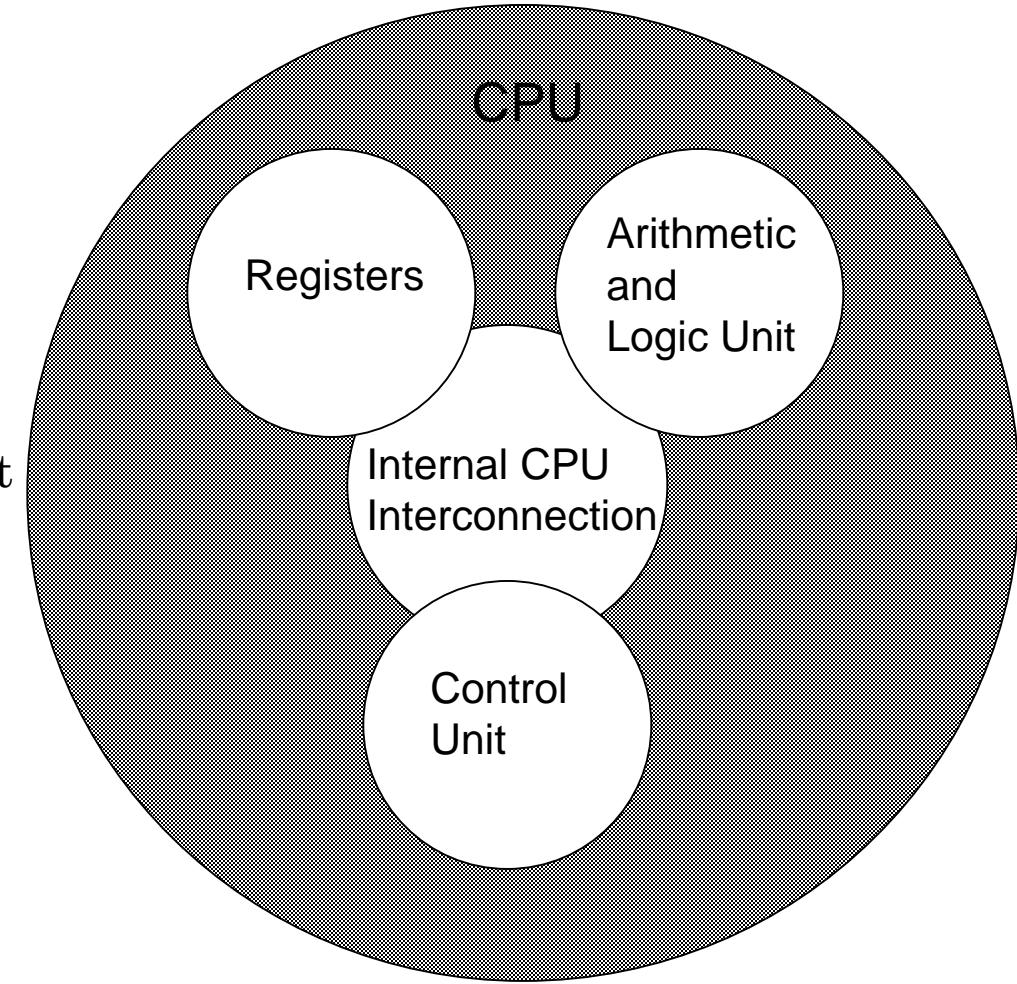
- Parallel lines on circuit boards
- Ribbon cables
- Strip connectors on mother boards
 - e.g. PCI
- Sets of wires

Structure - The CPU

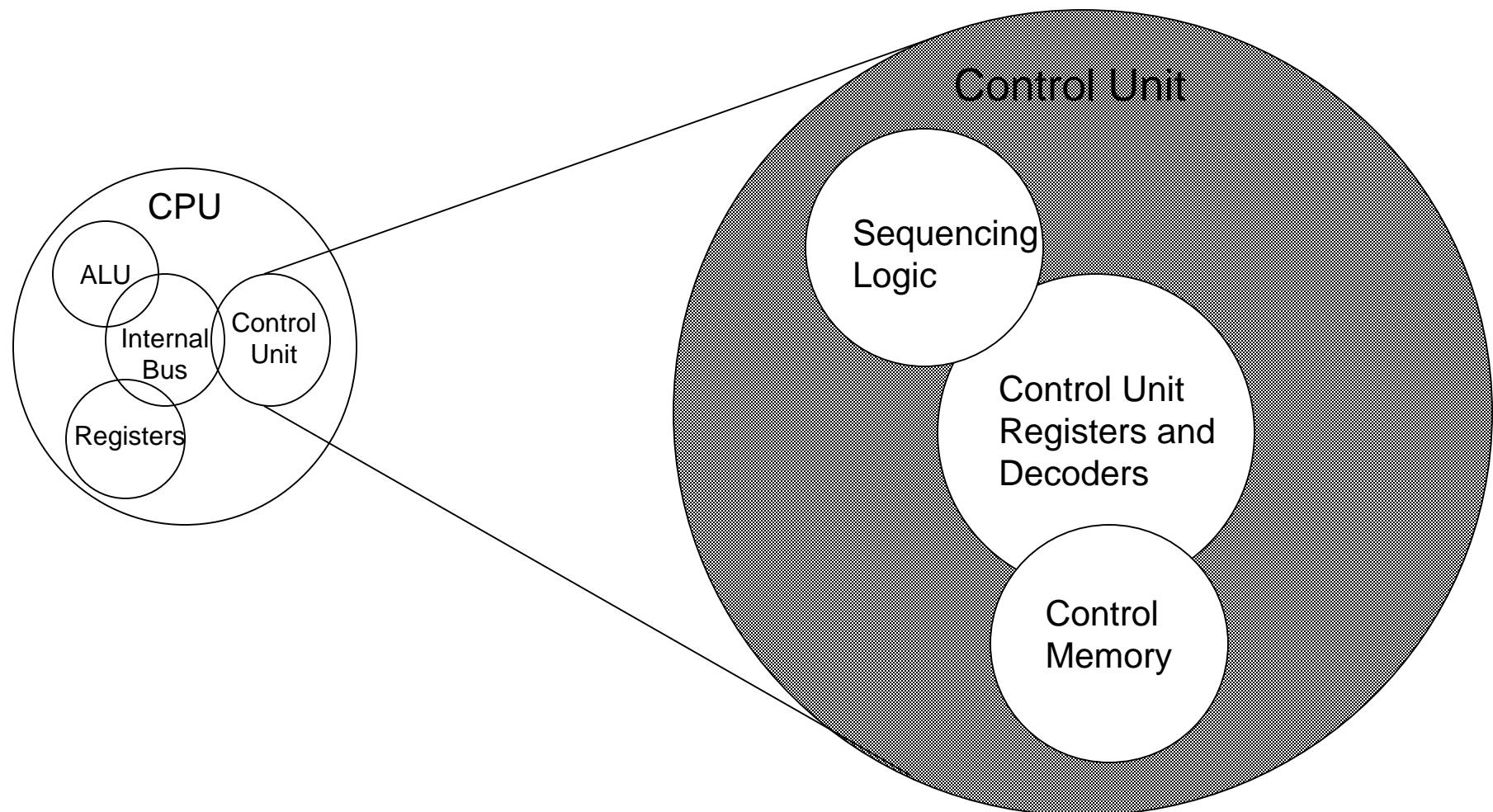


CPU Architecture

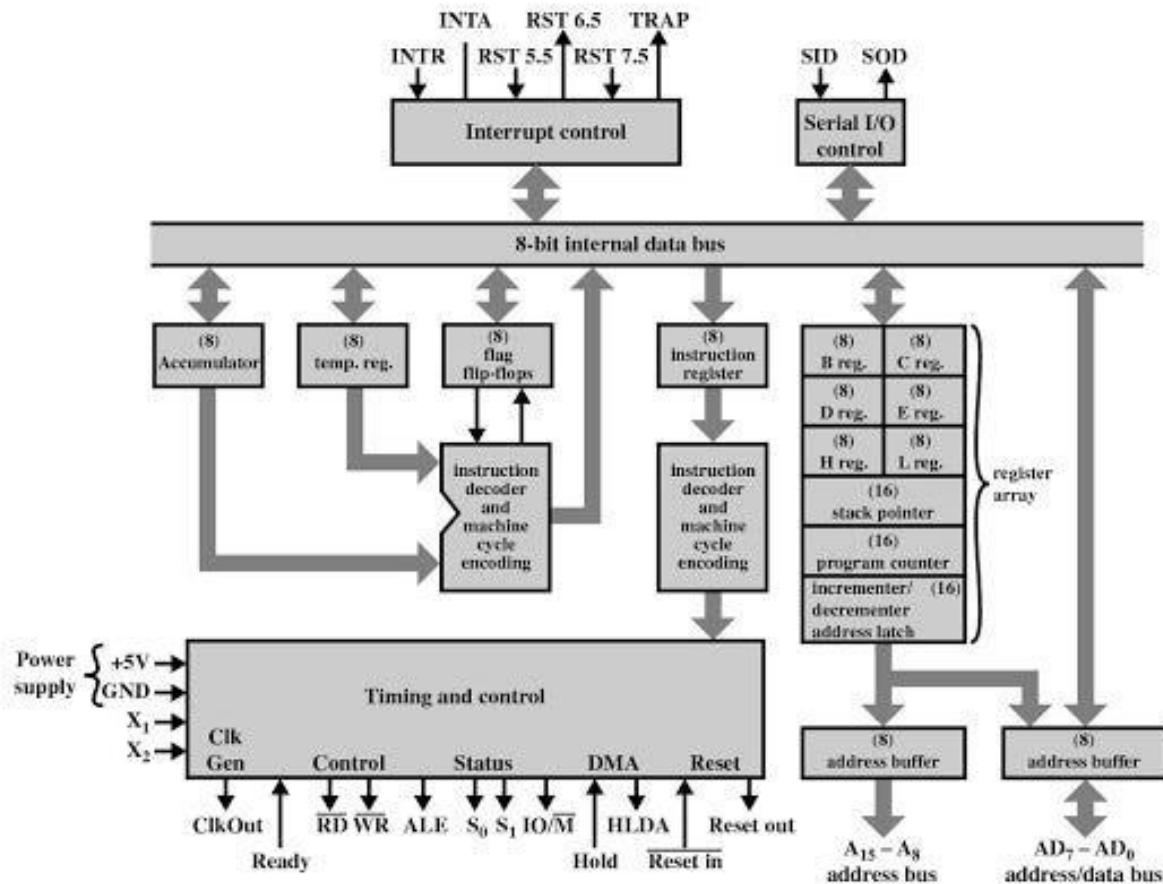
- 3+1 Components
- Registers – Store (Temporary) everything
- ALU (Arithmetic and Logic Unit) – Operating Unit
 - Many Digital Logic Blocks/Modules
 - Number Operations
 - Associated with Instructions
 - E.g. Add, Subtract, Multiply, Divide, AND, OR, NOT, SHIFT, etc.
- Control Unit – Logic Control Signals
 - Control Signals to others
 - Inside and Outside CPU
- Internal CPU Interconnection
 - Bus
 - Switch



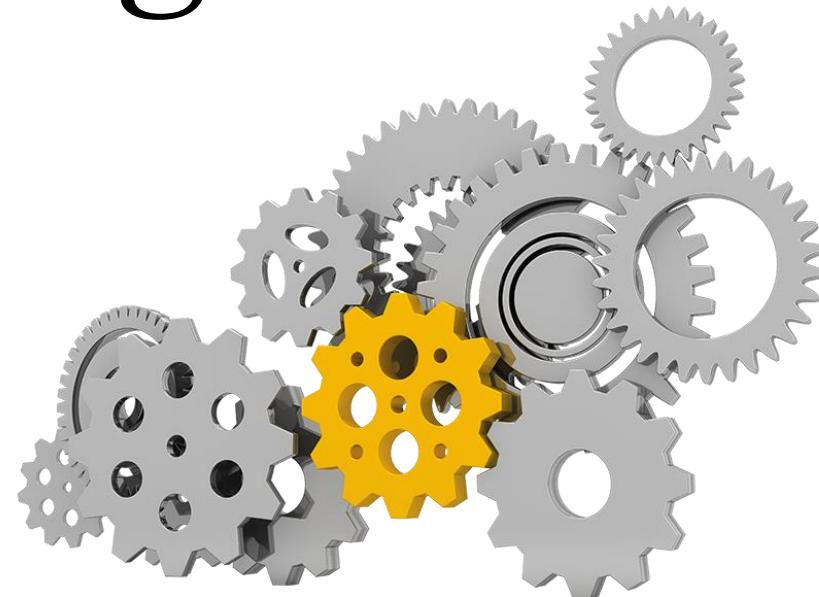
Structure - The Control Unit



Example: Microprocessor - 8085 Architecture

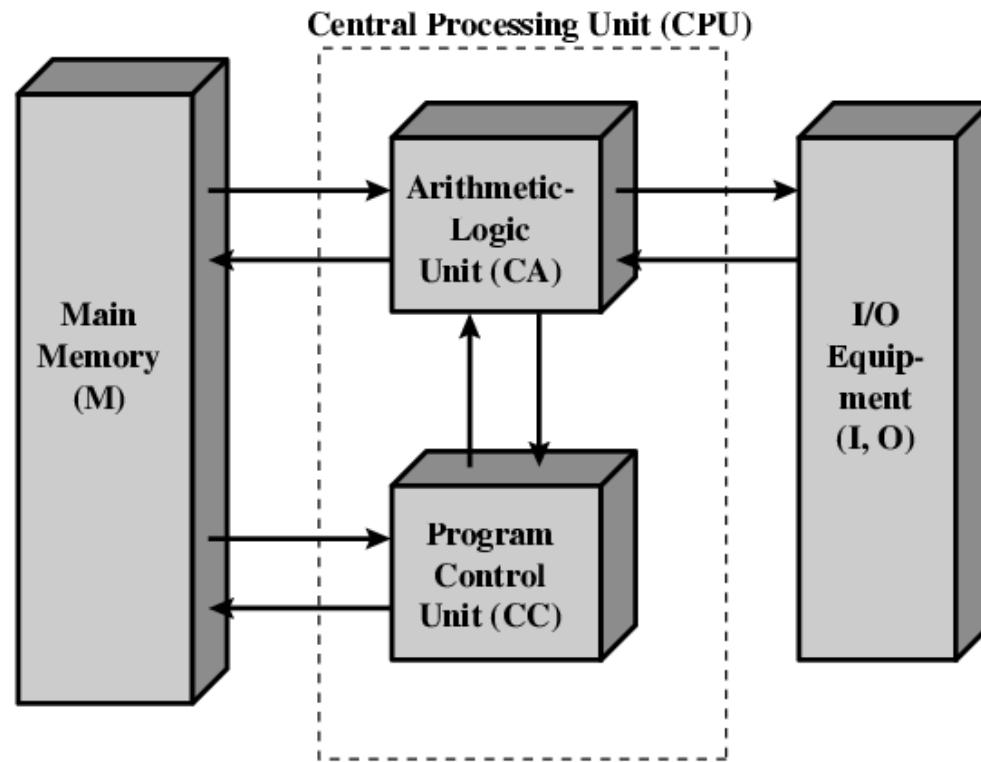


Computer Program Execution



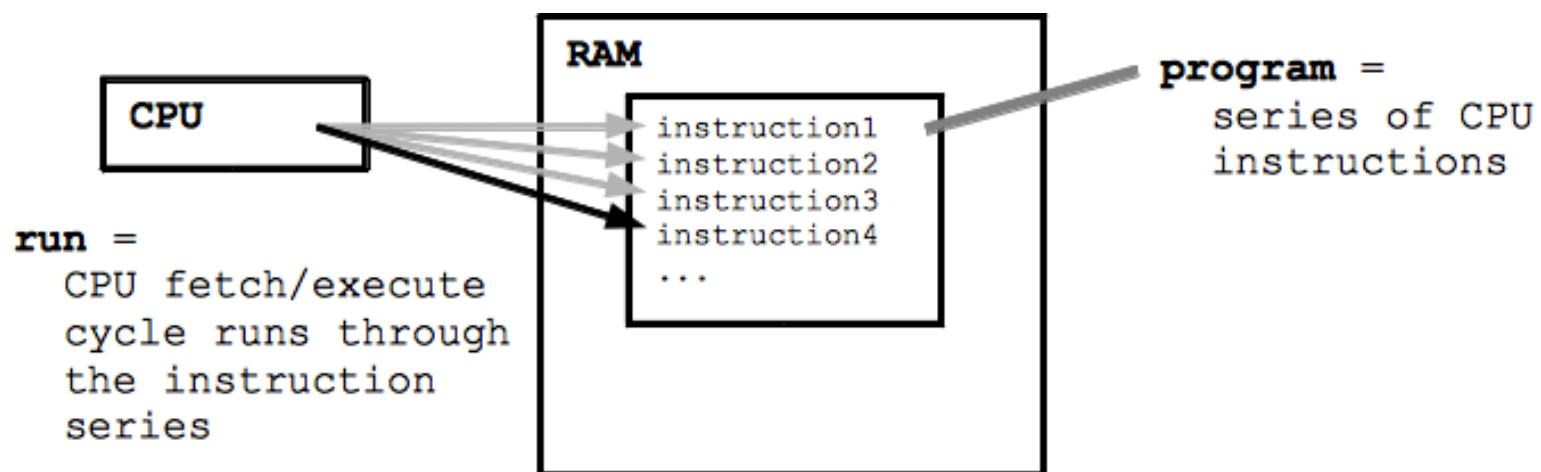
von Neumann/Turing

- Stored Program concept
- Main memory storing programs and data
- ALU operating on binary data
- Control unit interpreting instructions from memory and executing
- Input and output equipment operated by control unit
- Princeton Institute for Advanced Studies
 - IAS
- Completed 1952

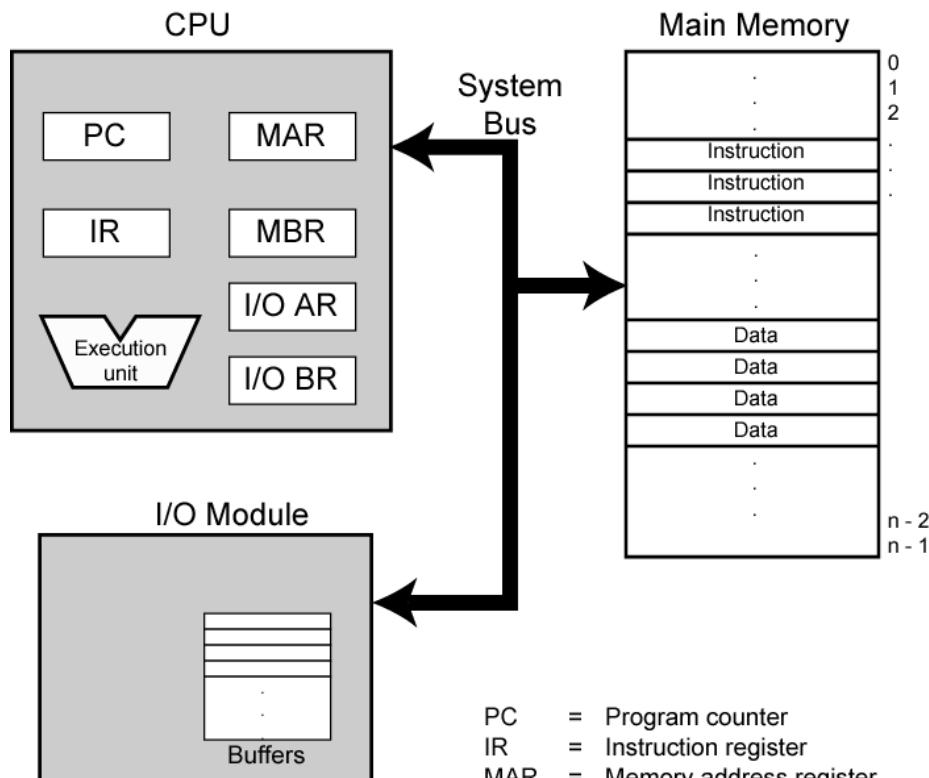


What is a program?

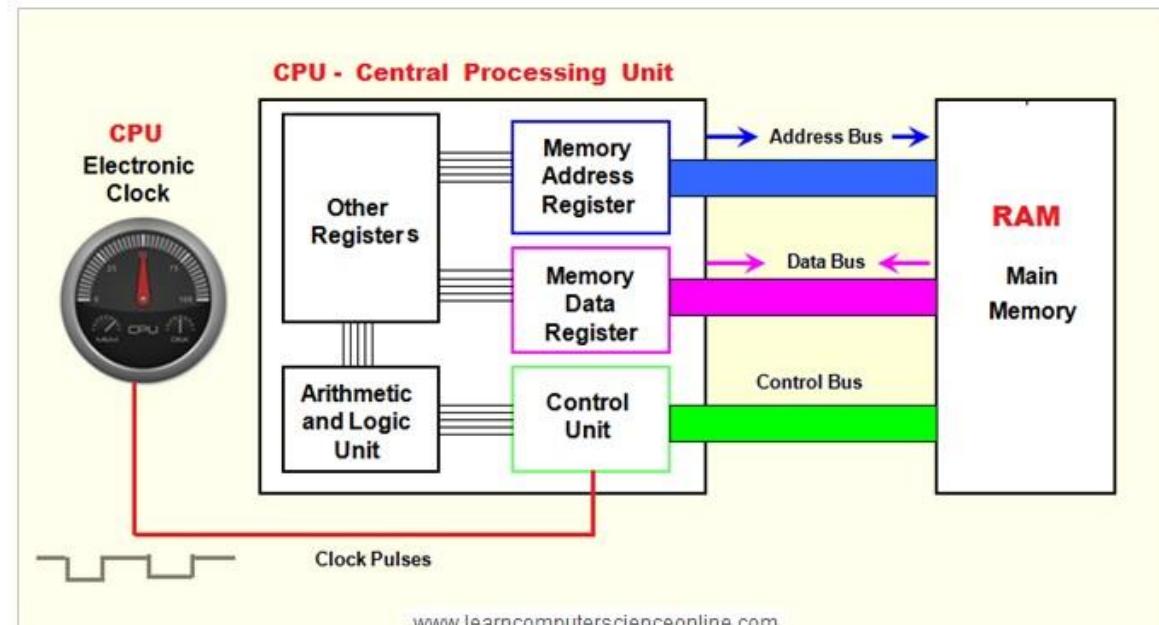
- A sequence of steps / Instructions
- For each step, an arithmetic or logical operation is done
- For each operation, a different set of control signals is needed



Computer Execution Components: Top Level View

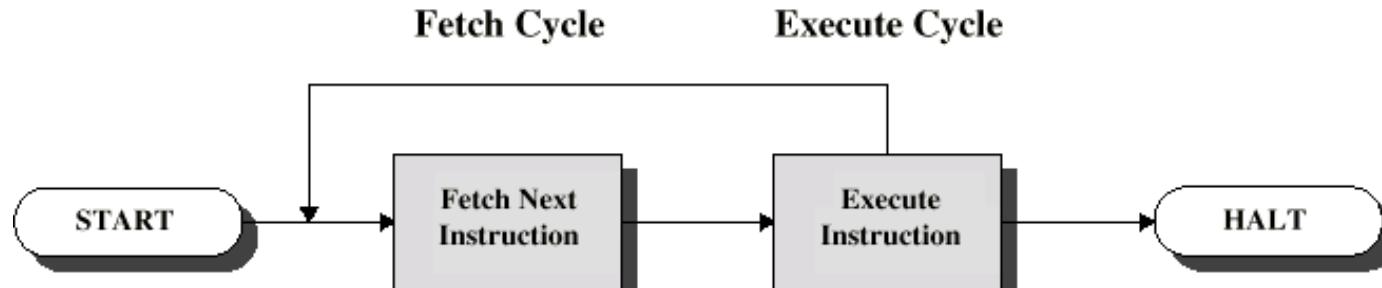


PC = Program counter
 IR = Instruction register
 MAR = Memory address register
 MBR = Memory buffer register
 I/O AR = Input/output address register
 I/O BR = Input/output buffer register



Basic Instruction Cycle

- Two steps:
 - Fetch
 - Execute



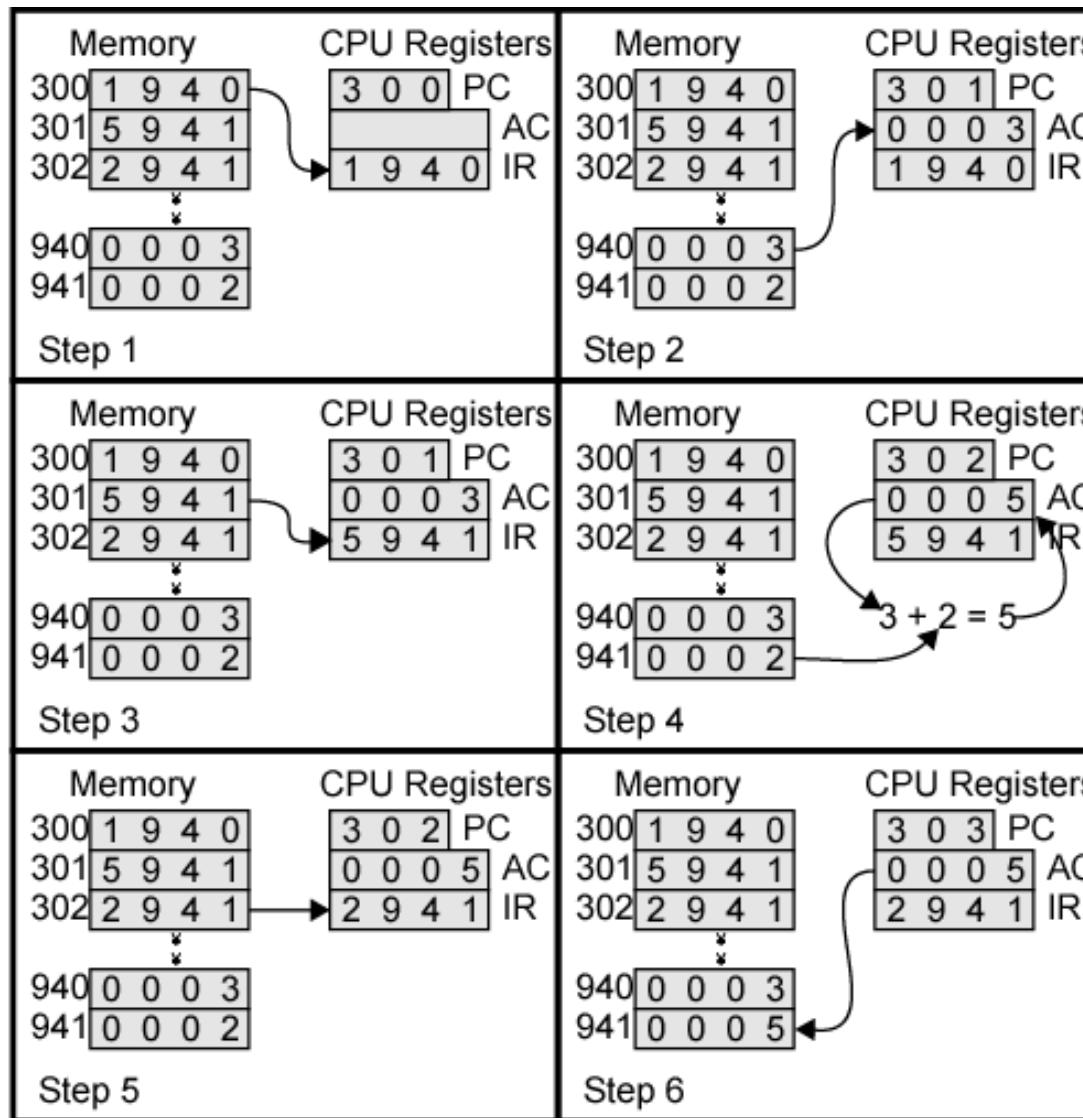
Fetch Cycle

- Program Counter (PC) holds address of next instruction to fetch
- Processor fetches instruction from memory location pointed to by PC
 - Send PC to address bus
 - Read memory content, address bus located
- Increment PC (To next Instruction)
 - Unless told otherwise
- Instruction loaded into Instruction Register (IR)
- Processor (Control Unit) interprets (Decode) instruction and performs required actions

Execute Cycle

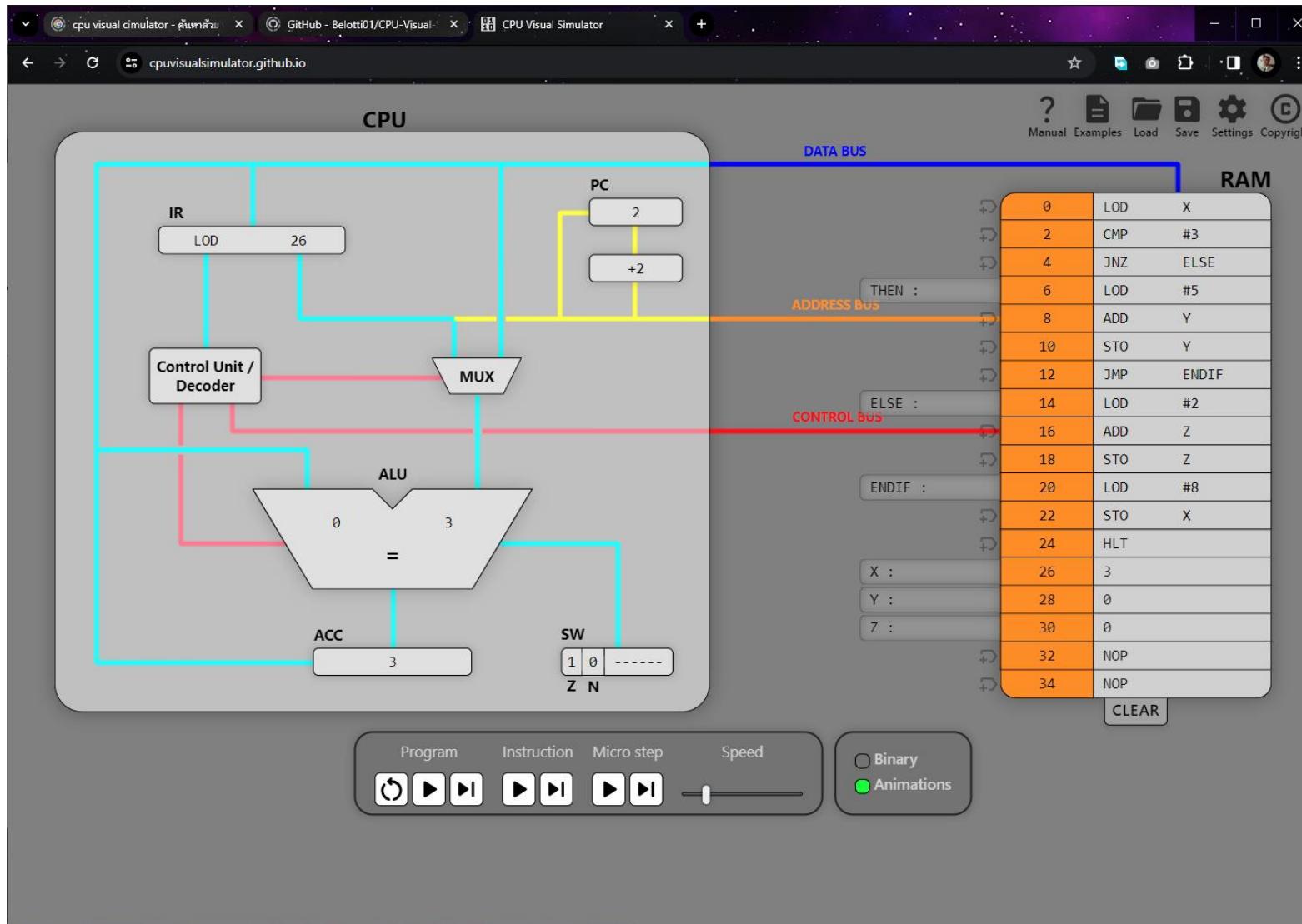
- Control Unit sends control signals to activate working modules
- Working types:
 - Processor-memory - data transfer between CPU and main memory
 - Processor I/O - Data transfer between CPU and I/O module
 - Data processing - Some arithmetic or logical operation on data
 - Control - Alteration of sequence of operations
 - e.g. jump
 - Combination of above

Example of Program Execution



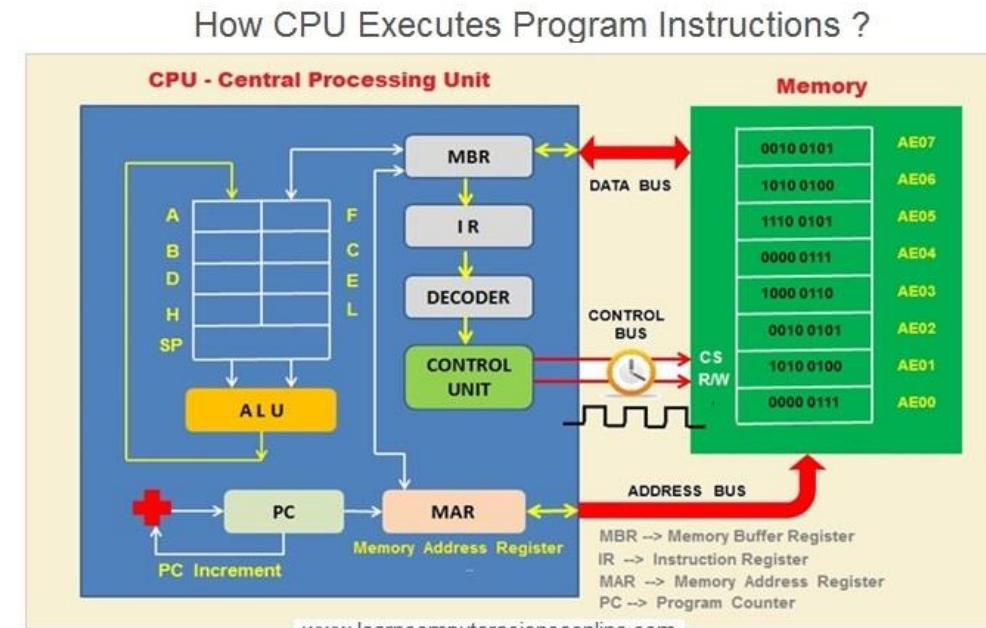
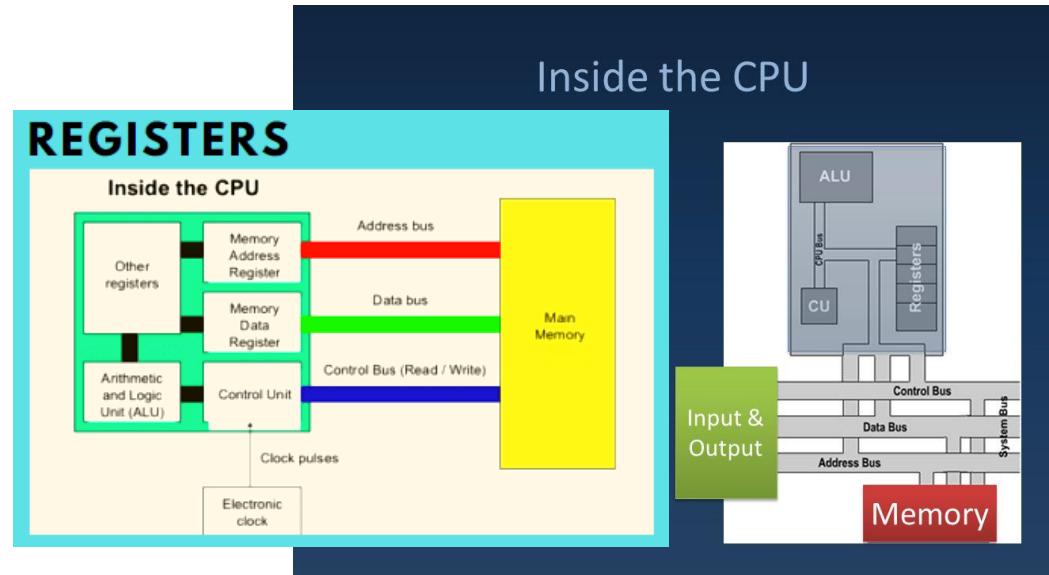
Computer Program Execution

- <https://cpuvisualsimulator.github.io/>



Conclusion

- Computer Functions
 - Data Processing, Data Storage, Data Movement, Control
- Computer Architecture
 - Processor, Memory, Input/Output, Interconnection (Bus vs Switch)
- CPU Architecture
 - Registers, Arithmetic and Logic Unit (ALU), Control Unit, Interconnection
- Control Unit
 - Control by control signals
 - Sequencing Unit, Decoder, Controllers
- Computer Program Execution
 - Program – a set/sequence of instructions/steps
 - Instruction execution – Loop of fetch and execute cycles
 - Instructions (program) will be executed forever, until halted.



END

Questions?