Basic Computer Organization

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Book Chapter

- “Assembly Language for x86 processors”
- Author “Kip R. Irvine”
- 6th Edition
- Chapter 2
  - Section 2.1

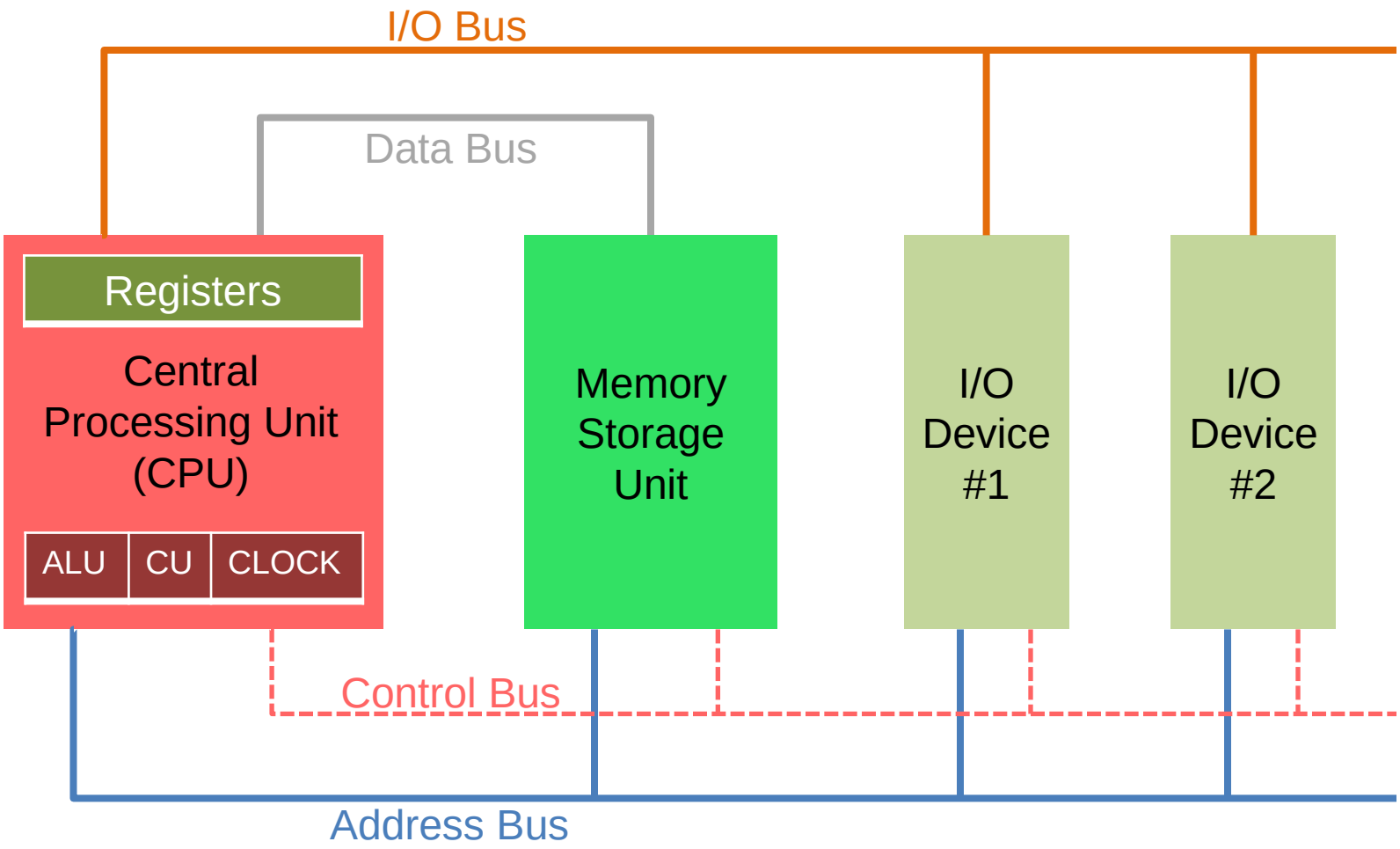
Organization and Architecture

- Computer Architecture
  - Attributes of a computer that have a direct impact on the logical program execution
  - e.g. I/O mechanisms, memory addressing techniques
- Computer Organization
  - Operational units and their interconnection that realizes the architectural specifications
  - e.g. control signals, interconnection between computer and its peripherals

Basic Computer Organization (1/2)

- Computer has 3 main components
  - Processor, also called Central Processing Unit (CPU)
  - Memory and Storage Devices
  - I/O Devices
- These components communicate with each other through
  - Data Bus
  - I/O Bus
  - Address Bus
  - Control Bus

Basic Computer Organization (2/2)



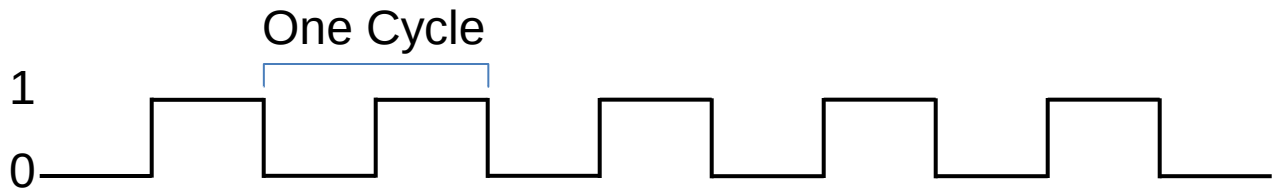
Central Processing Unit (CPU)

- Generally called Processor
- Contains
  - Clock
  - Registers
  - Arithmetic Logic Unit (ALU)
    - Performs arithmetic and logic instructions
  - Control Unit (CU)
    - Generates the control signals required to execute the instructions

Clock (1/2)

- Clock cycle is basic unit of time for machine instructions
- Synchronizes Processor and Bus operations
- Clock cycle = Clock period = 1/(Clock Rate)
- Clock Rate = Clock Frequency = Cycles per sec
  - 1 Hz clock produces 1 Clock Cycle in 1 second
  - 1 KHz clock produces 1000 Clock Cycles in 1 second
  - 1 MHz clock produces 1,000,000 cycles in 1 second
  - 1 GHz clock produces 1,000,000,000 cycles in 1 second

Clock (2/2)



Clock Frequency	Clock Period (sec)	Time to execute one instruction
1 Hz	1	1 sec
1 KHz	0.001	1 ms (millisecond)
1 MHz	0.000,001	1 μs (microsecond)
1 GHz	0.000,000,001	1 ns (nanosecond)

Memory (1/2)

- Ordered sequence of bytes
  - Sequence number is called memory address
- Byte addressable memory
  - Each byte has a unique address
- Physical address space
  - Determined by the address bus width
  - Pentium has 32-bit address bus
    - Physical address space of Pentium = 2^{32} bytes = 4 GB
  - Itanium with 64-bit address bus can support up to 2^{64} bytes of physical address space

Memory (2/2)

- Address of location to be read/written is placed on the address bus
- Data to be read/written is places on the data bus by memory/processor
- Two control signals read and write decide the reading or writing operations

Physical Address Space

- Address space is the set of addressable memory locations (bytes)

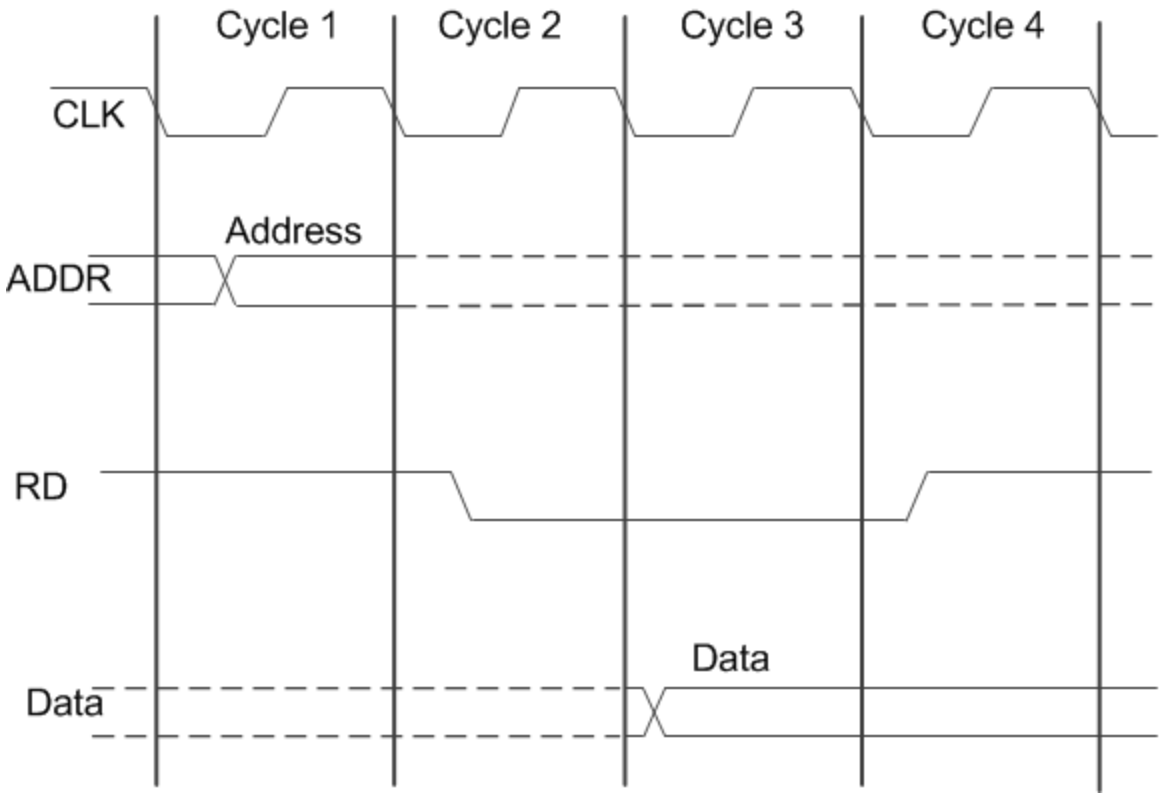
Reading from Memory

- Multiple clock cycles are required
- Memory responds much more slowly than CPU
- Reading process is carried out in this way
  - Address is placed on the address bus
  - Read Line (RL) goes low indicating that processor wants to read
  - CPU waits for memory to respond
  - Read Line (RL) goes high indicating that data has been placed on the data bus

Memory Read and Write Cycles

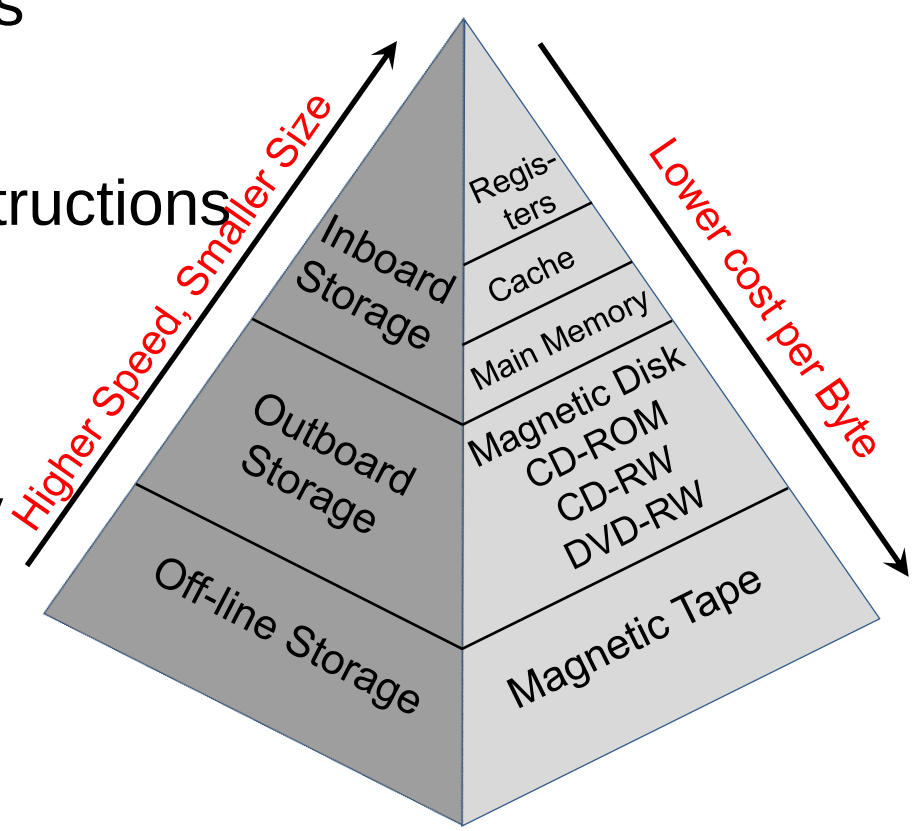
- In Read Cycle, the Processor
  - places address on address bus
  - asserts the memory read control signal
  - waits for memory to place data on the data bus
  - reads the data from data bus
  - drops the memory read signal
- In Write Cycle, the Processor
  - places address on the address bus
  - asserts the memory write control signal
  - places the data on the data bus
  - waits for memory to store the data
  - drops the memory write signal

Reading from Memory



Memory Hierarchy

- Registers
  - Fastest storage elements
- Cache Memory
  - Stores recently used instructions
- Main Memory
- Magnetic Disk
  - Stores data permanently
- Magnetic Tape



Next Lecture

- IA-32 Registers
  - General Purpose Registers
  - Special-Purpose and Segment Registers
  - EFLAGS Registers