

# Text Chapters Covered

**1:** Structure of computers

**2** and **4:** Software: Assembly language

**2:** Hardware and Software:

Instruction Set Architecture (ISA)

**3:** Input and Output (I/O)

**8:** The memory system

**5:** Processing unit (CPU)

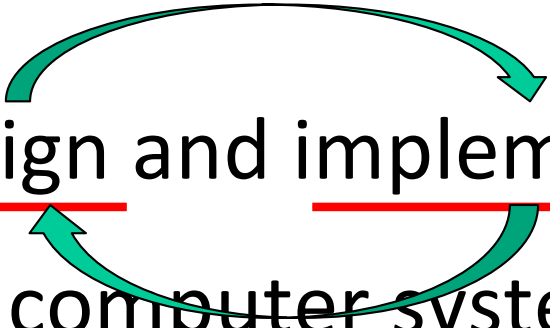
**6:** Pipelining

**9:** Arithmetic (covered throughout the course also in ECE241)

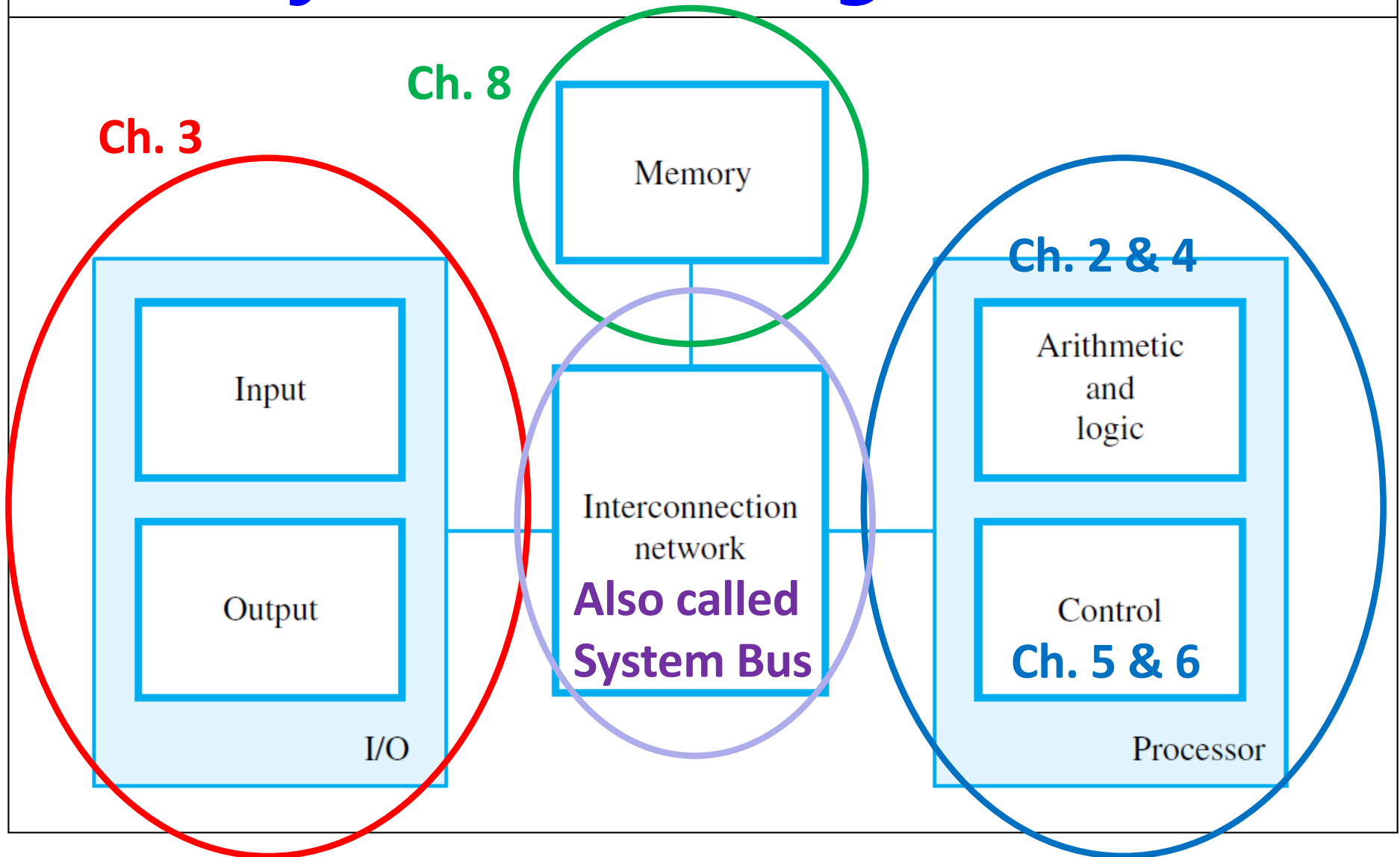
# What is Computer Architecture?

- The art of assembling digital logic elements into a computing device
- The specification of the relation between parts of a computer system
- The organization and interaction of a computer's hardware and system software

# An Engineer's Perspective

- A cost-effective design and implementation of components in a computer system, satisfying the required functional specifications
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# System Building Blocks

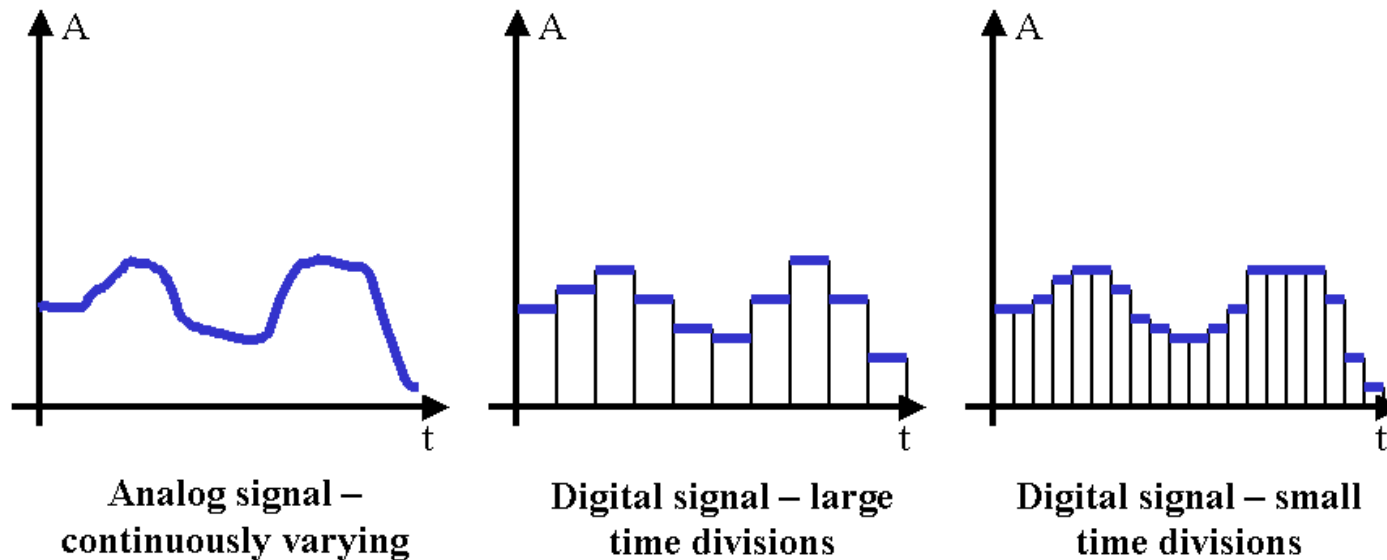


# Input/Output

- Computer processes information in digital format
- External analog information must be converted to internal digital format before processing
- Internal digital information must be converted to analog format for external output control

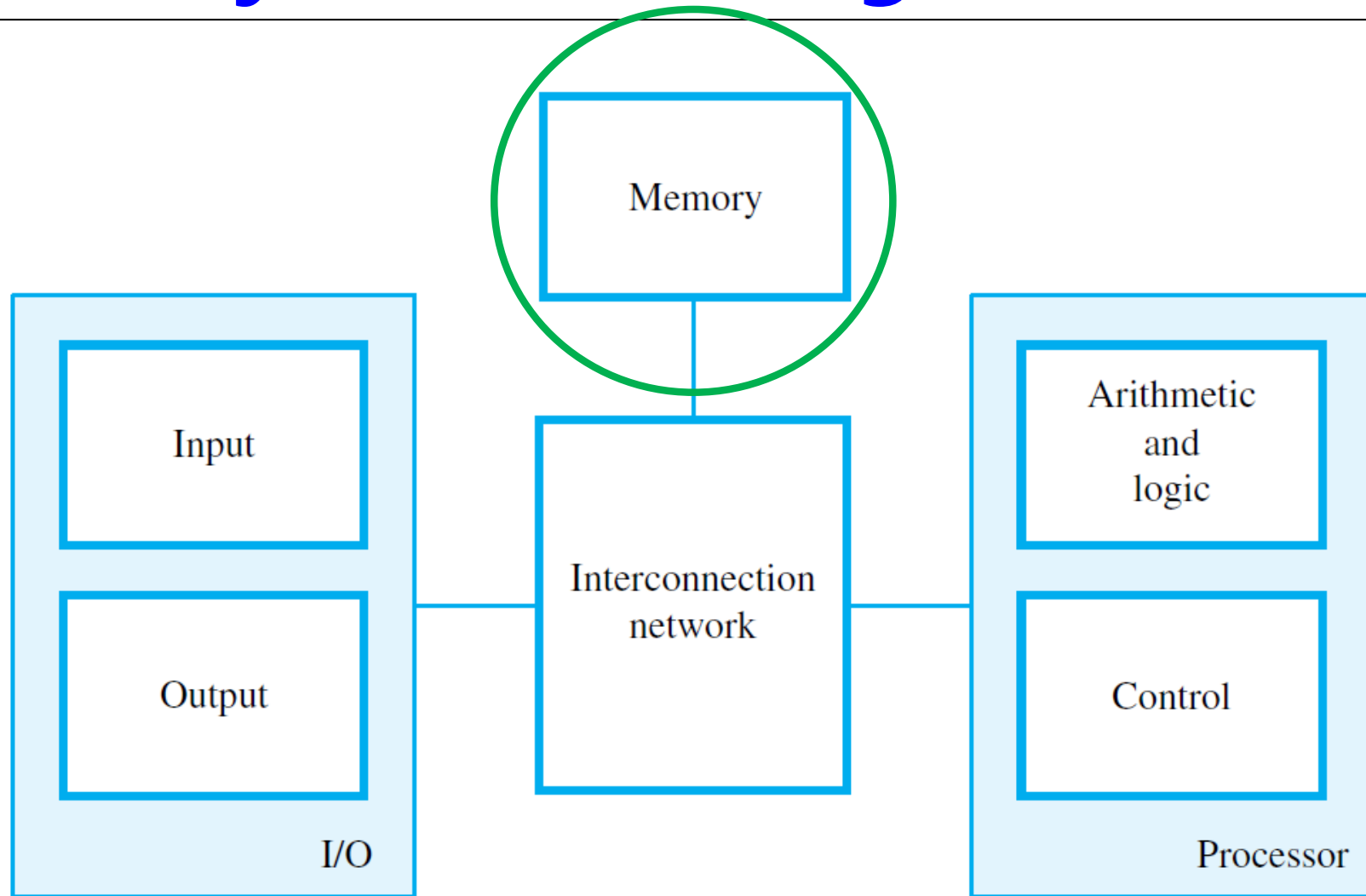
**Which format is artificial?**

# Analog vs Digital



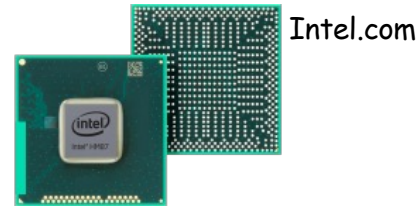
**Checking room temperature:**  
**1. Every 1 second?**  
**2. Every 2 second?**

# System Building Blocks



# Memory

- Cache Memory
- Primary (Main) Memory
  - Random Access Memory (**RAM**)
  - Read Only Memory (**ROM**)
- Secondary Memory
  - Hard drive, DVD, flash
- For **Programs** and **Data** storage



Jotuts.  
com



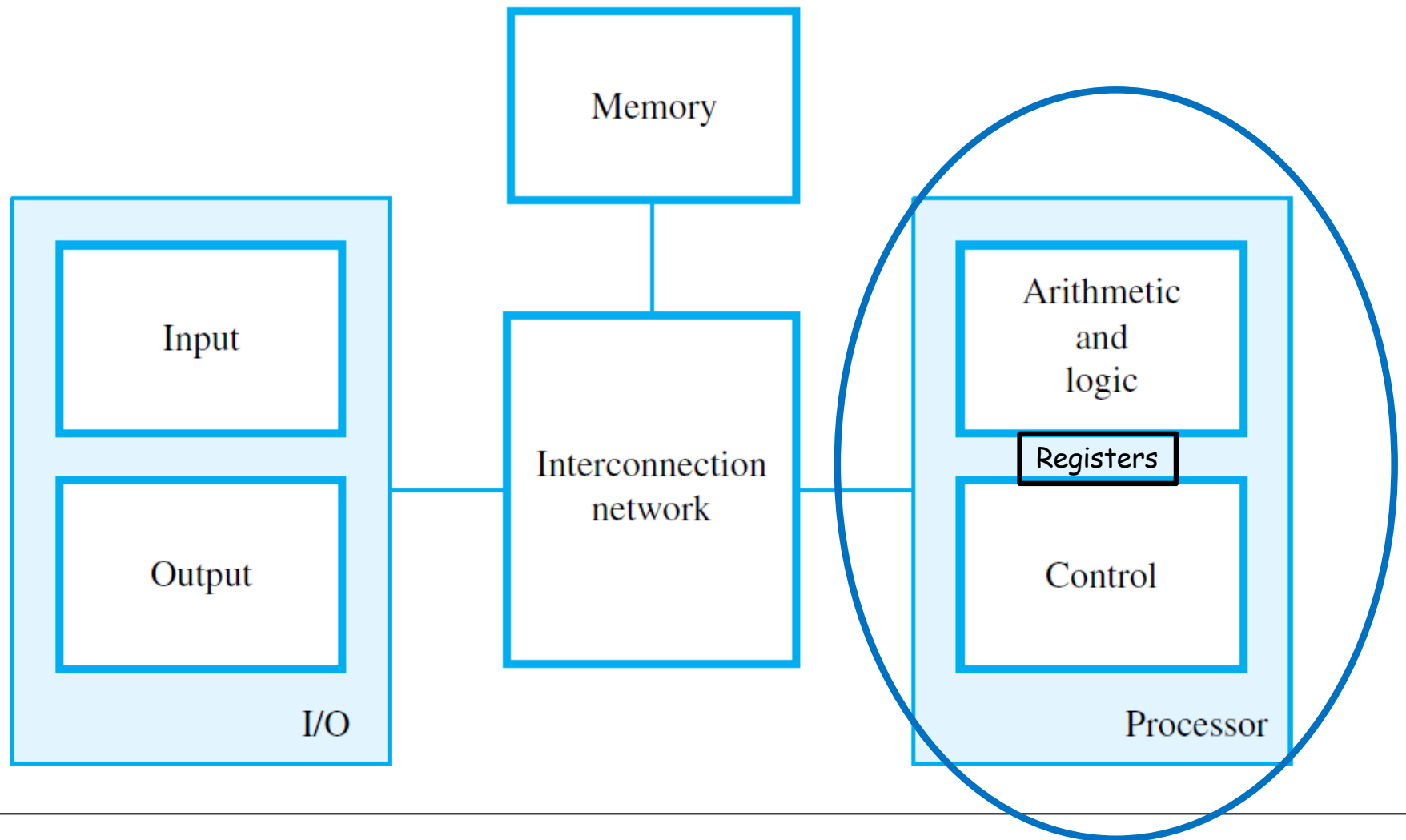
Seagate.com



Wikipedia



# System Building Blocks



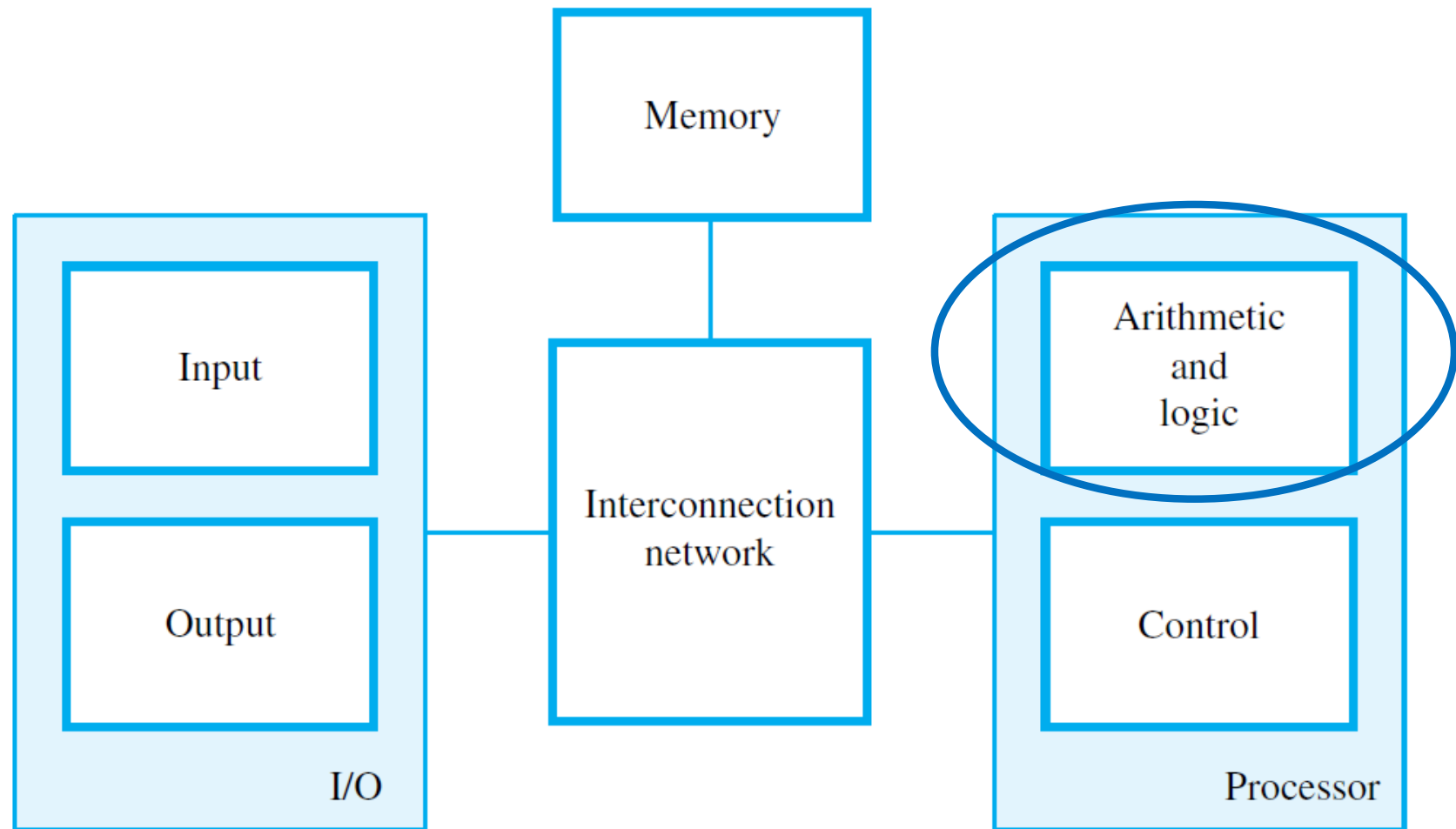
# Processor

- Arithmetic and Logic Unit (ALU)
  - Electronic circuits for arithmetic & logic operations
- Control Unit
  - Circuits for controlling other components
  - Fetch and execute instructions (called instruction cycle)
- Registers
  - Temporary storage for data

**Why temporary?**

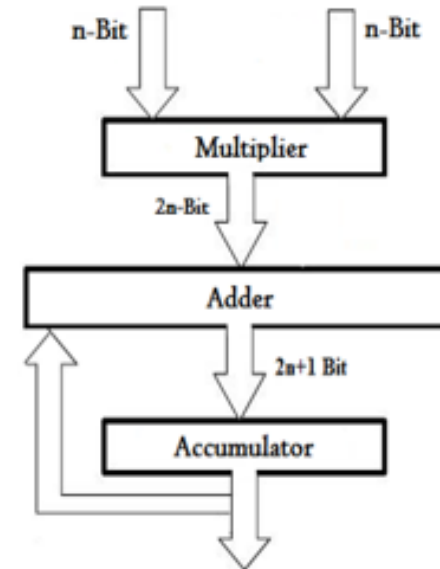
**Data needed for  
processor  
calculation**

# System Building Blocks

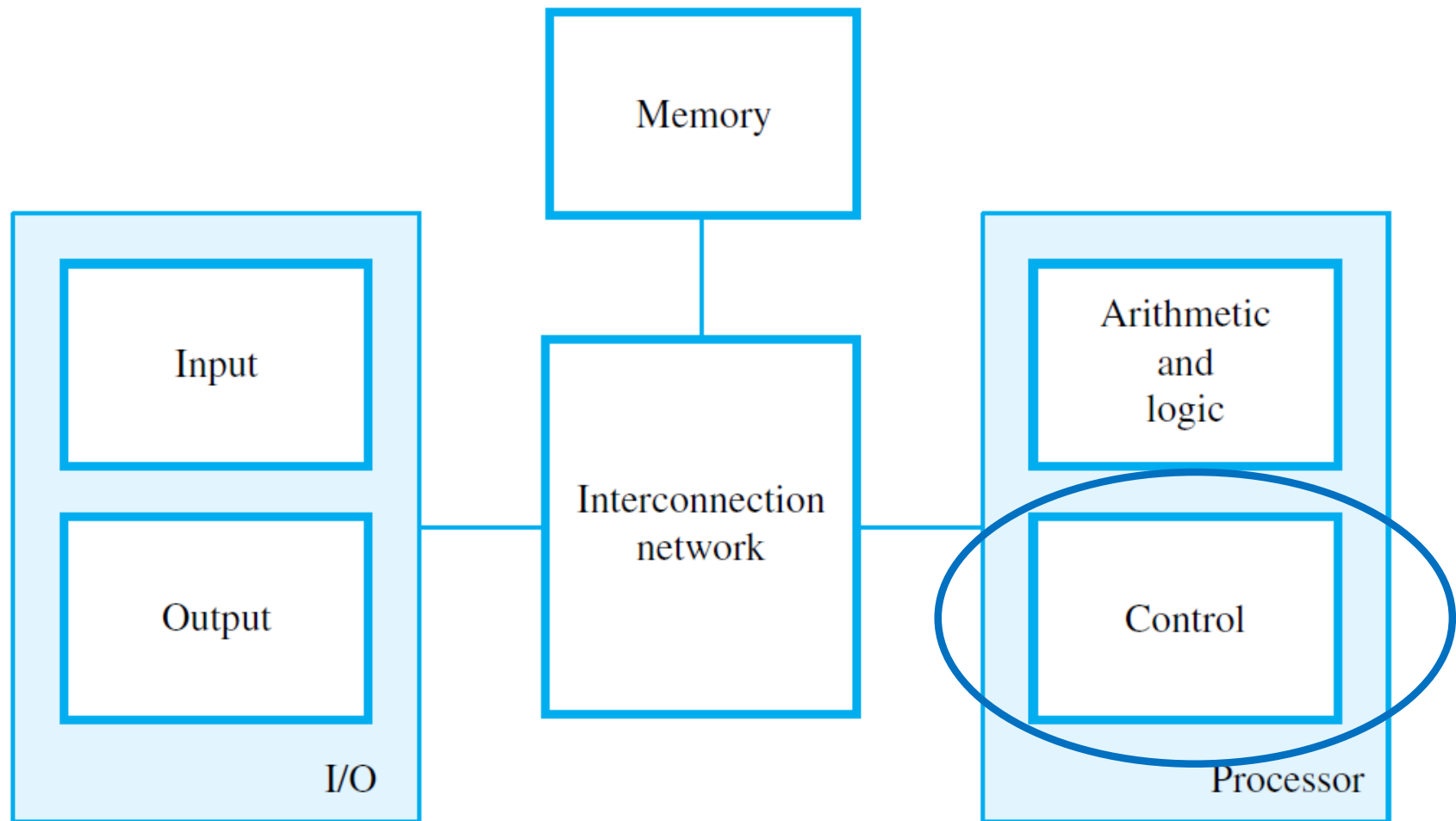


# Arithmetic Logic Unit ALU

- Arithmetic operators:
  - $+$ ,  $-$ ,  $*$ ,  $/$
- Logic operators:
  - AND ( $\wedge$ ), OR ( $\vee$ ), INVERT ( $\sim$ )
- Special purpose – Multiply and Accumulate (MAC)
- Integer and/or Floating-point operations



# System Building Blocks



# Control Unit

- Sends control signals to other units at regular time intervals
- 2 important aspects:
  - Sequencing – events occurrence in order
    - e.g., event #4, #9, #3 (out of 36 possible events)
  - Timing – when to do what
    - e.g., every 2ns for one event

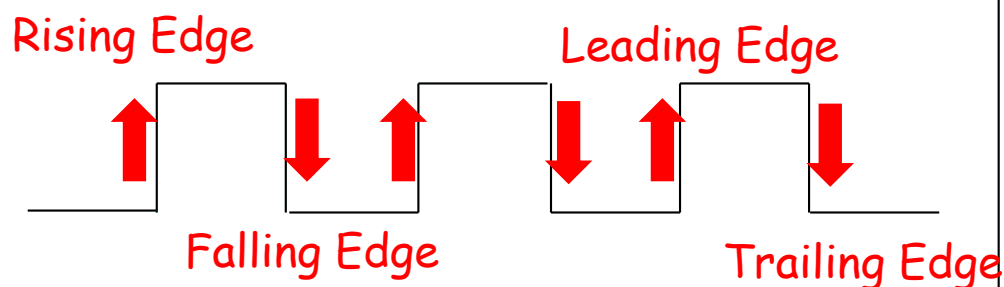
Events of  $x:=y+1$  ?

1. Get y
2. Add 1 to y
3. Move to x

# Control Unit

- System Clock to synchronize events

- e.g., 500 MHz



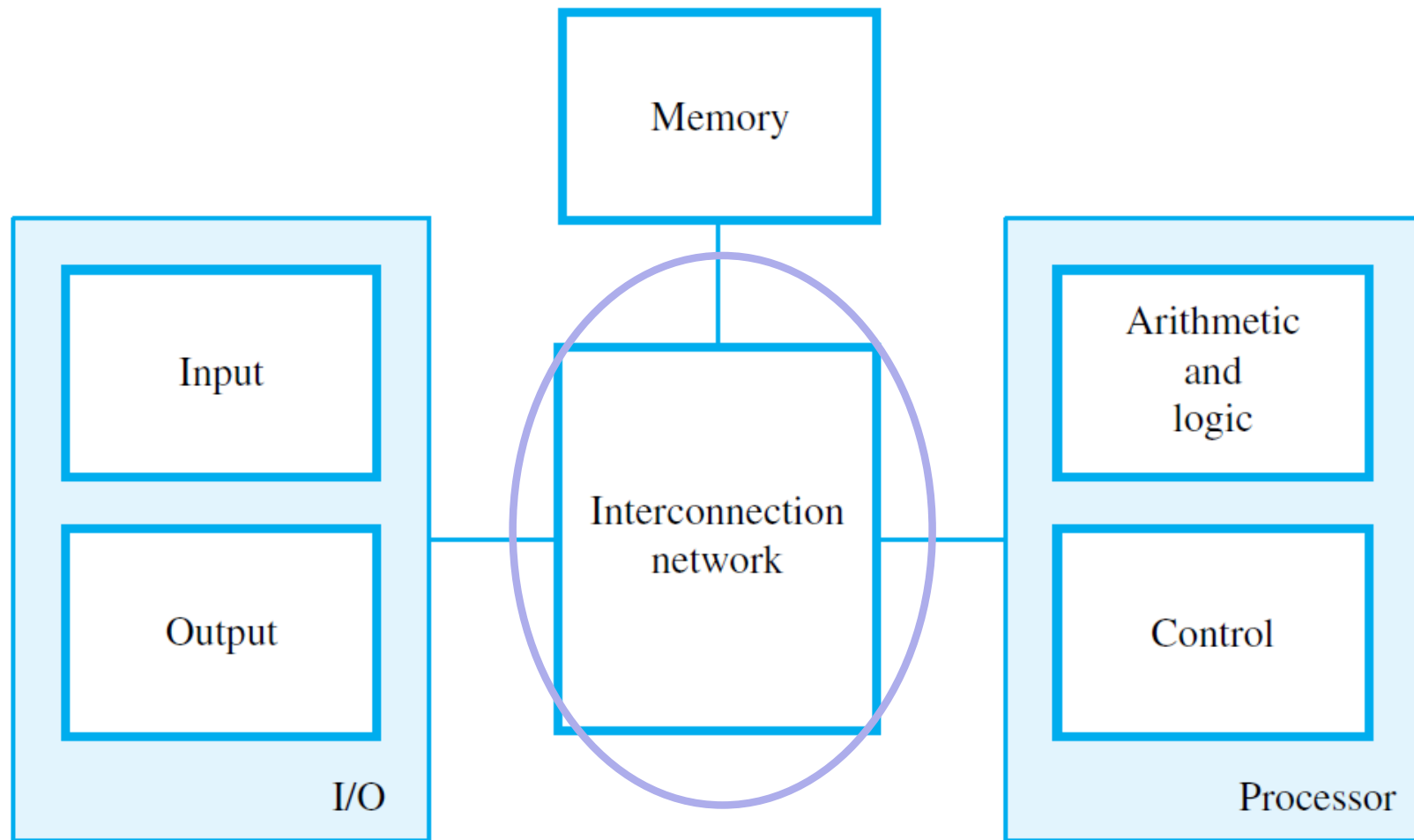
- Clock speed
  - Period (unit: **sec**)
  - Frequency (unit: **Hz**)
  - 500 MHz = ? nsec

What is One Clock Cycle?

What is the width of the  
of a clock cycle?

What is the height of the  
of a clock cycle?

# System Building Blocks





# Interconnection Network (System Bus)

- 3 groups of signals/bits
  1. Data Bus: 8/16/32/64/128 bits
    - An X-bit processor can manipulate X-bit data
  2. Address Bus: 8/16/32/64 bits
    - Location in memory; usually the same as data
  3. Control Bus: Read, Write, Start, Stop...(number of bits **depends on the processor**)