Starter

Convert

a) 10101 to decimal

b) *FACE* to binary

c) 87 to binary

Introduction to Computer Architecture

Abstraction

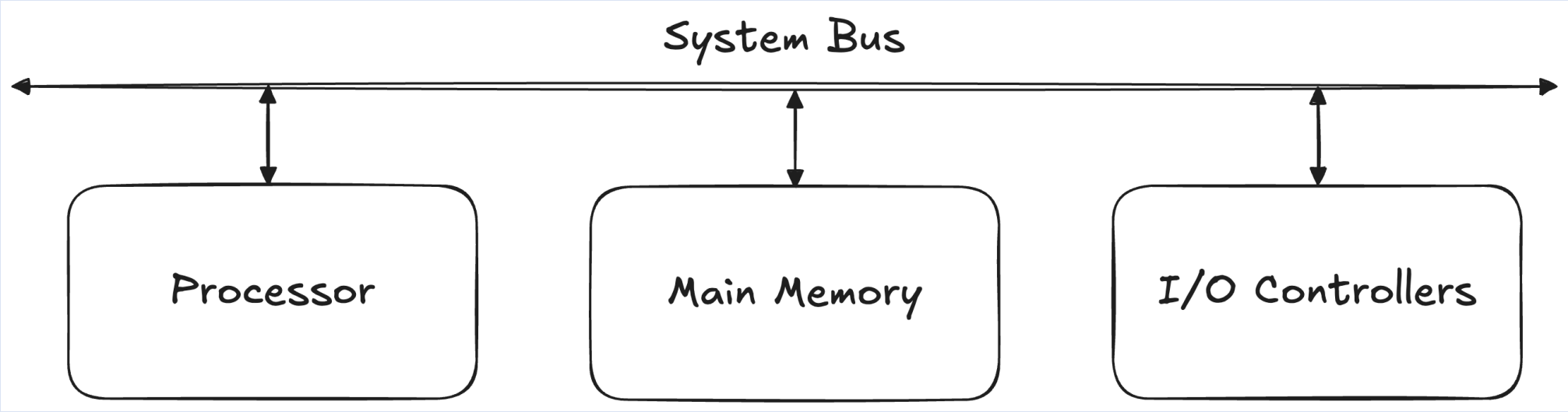
- What is abstraction?
  - AQA: Representation that is arrived at by removing unnecessary details

Abstraction

- What is abstraction?
  - AQA: Representation that is arrived at by removing unnecessary details
- Throughout the course, we will use simplified models to describe complicated systems and processes
  - This is especially true in Computer Architecture
  - This is a form of **abstraction**

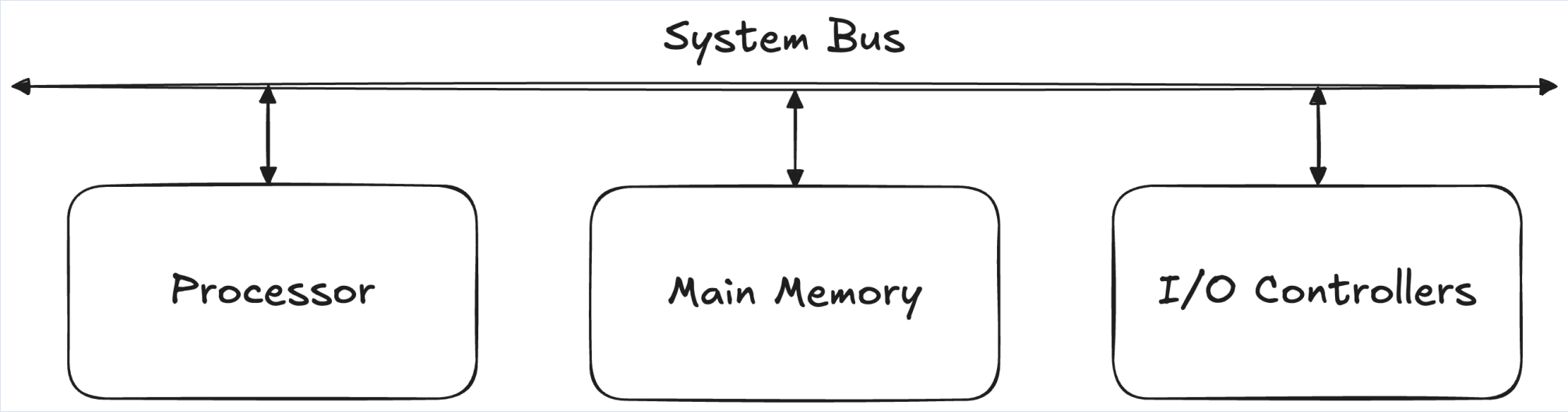
Three-box model

- The three-box model describes, in a simplified form, a von Neumann architecture



Three-box model

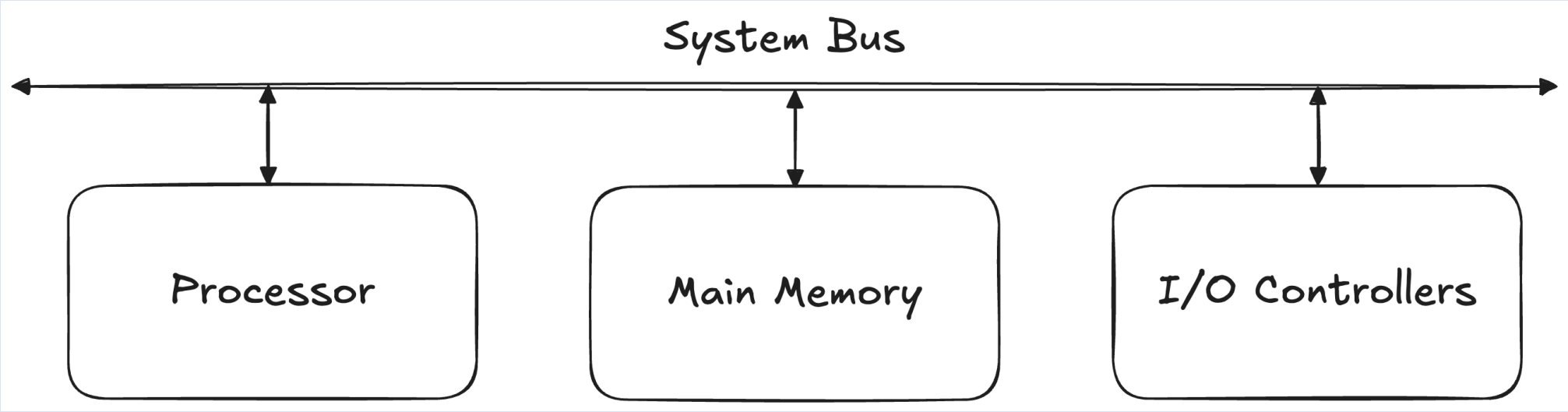
- The three-box model describes, in a simplified form, a von Neumann architecture



- What does I/O mean?

Three-box model

- The three-box model describes, in a simplified form, a von Neumann architecture



- What does I/O mean? Input/output

Processor

- Also known as the CPU (central processing unit)
- Processes data by **executing program instructions**
- Each processor has a particular set of operations it can perform, known as its **instruction set**
- We'll see more about processors in a future lesson

Main memory

- Memory that can be accessed directly by the processor
- Memory is stored on chips (integrated circuits)
- Each memory location has a unique physical address
- Volatile: data is only maintained while power is maintained
- Two main types:

Main memory

- Memory that can be accessed directly by the processor
- Memory is stored on chips (integrated circuits)
- Each memory location has a unique physical address
- Volatile: data is only maintained while power is maintained
- Two main types:
  - RAM (random access memory)
    - Provides working memory that is read from and written to by the processor
    - Used during the fetch-decode-execute cycle

Main memory

- Memory that can be accessed directly by the processor
- Memory is stored on chips (integrated circuits)
- Each memory location has a unique physical address
- Volatile: data is only maintained while power is maintained
- Two main types:
  - RAM (random access memory)
    - Provides working memory that is read from and written to by the processor
    - Used during the fetch-decode-execute cycle
  - ROM (read-only memory)
    - Used to store information for use during the boot sequence when a computer is first powered on

I/O Controllers

- All external (peripheral) devices are connected to the processor with I/O controllers
- They satisfy the power requirements of the connected devices
- They allow input data to be received from devices, and output data to be transmitted to devices

Buses

- A **bus** is a set of parallel wires used to connect individual components of a computer system
- Signals are sent between components via buses, representing:
  - Data
  - Memory addresses
  - Control information

Control bus

- The **control bus** is used to transport control signals between components

Control bus

- The **control bus** is used to transport control signals between components
- It is **bidirectional**

Control bus

- The **control bus** is used to transport control signals between components
- It is **bidirectional**
- Control signals include:
  - Clock
  - Reset
  - Memory read
  - Memory write
  - I/O

Address bus

- The **address bus** is used to transport addresses for main memory locations and I/O controllers

Address bus

- The **address bus** is used to transport addresses for main memory locations and I/O controllers
- It is **unidirectional**
  - The processor writes to it; other components read from it

Data bus

- The **data bus** is used to transport data between components

Data bus

- The **data bus** is used to transport data between components
- It is **bidirectional**

Data bus

- The **data bus** is used to transport data between components
- It is **bidirectional**

Example:

1. Processor places a memory address on the address bus
2. Processor sends a `MEMORY READ` signal over the control bus
3. Main memory reads the address from the address bus
4. Main memory places the requested data on the data bus

Stored program concept

Two parts:

1. A program must be resident in main memory to be executed
2. Machine code instructions are fetched sequentially and executed one at a time by the processor

Types of stored program concept

- We need to consider two types of stored program concept
- von Neumann architecture
  - Data and instructions are stored in the same main memory
- Harvard architecture
  - One memory for instructions, one memory for data

Advantages and disadvantages

Discuss: What are the advantages and disadvantages of these two architectures?

Advantages and disadvantages

- von Neumann
  - (-) same buses for instructions and data, so competition for resources
- Harvard
  - (+) reading instructions and reading/writing data can happen in parallel, so can be faster
  - (+) Avoids bottleneck of single data/address buses
  - (+) Instruction and data memory can have different word lengths
  - (+) Avoids possibility of data being executed as code, which can be exploited by hackers

Where are they used?

- von Neumann architecture is preferred for general-purpose computing devices (e.g. a laptop or PC)
- Harvard architecture is preferred for embedded systems and DSP systems
  - Digital signal processing (DSP) is the realtime processing and mathematical analysis/manipulation of signals (e.g. audio, temperature, pressure etc.)
  - Data and instruction memory can be specifically designed for the application, resulting in more efficient systems

Ada Computer Science

- Join my group
- We'll use this to apply content from the lesson at the end

L103 – Intro to CompArch