Computer Architecture and Organization

Arithmetic and Logic unit

&

Control unit

Lecture 6

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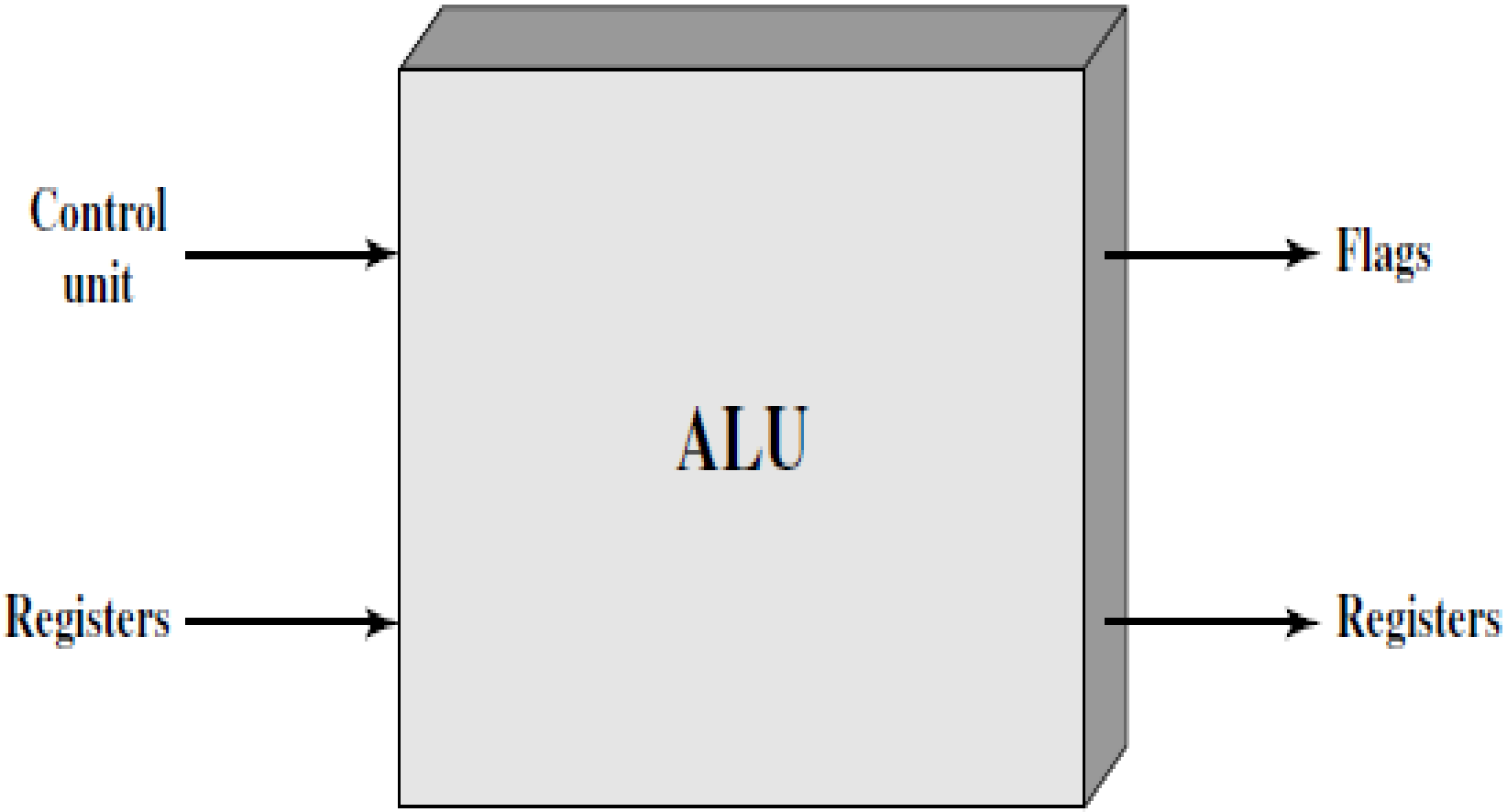
ARITHMETIC AND LOGIC UNIT

- The **ALU** is part of the computer that performs **arithmetic** and **logical** operations on data.
- All of the other elements of the computer system—control unit, registers, memory, I/O—are there mainly to bring data into the ALU for it to process and then to take the results back out.

ALU Inputs and Outputs



ARITHMETIC AND LOGIC UNIT

- ALU is interconnected with the rest of the processor.
- Data are presented to the ALU in registers, and the results of an operation are stored in registers.
- These registers are temporary storage locations within the processor that are connected by signal paths to the ALU.
- The ALU also set flags as the result of a operation.

Control Unit

- The control unit provides signals that control the operation of the ALU and the movement of the data into and out of the ALU.
- The **control unit** issues control signals **external** to the **processor** to cause data **exchange** with memory and **I/O modules**.
- The **control unit** also issues control signals **internal** to the processor **to move** data **between** registers, to cause the ALU to perform a specified function, and to regulate other **internal operations**.

CONTROL Unit

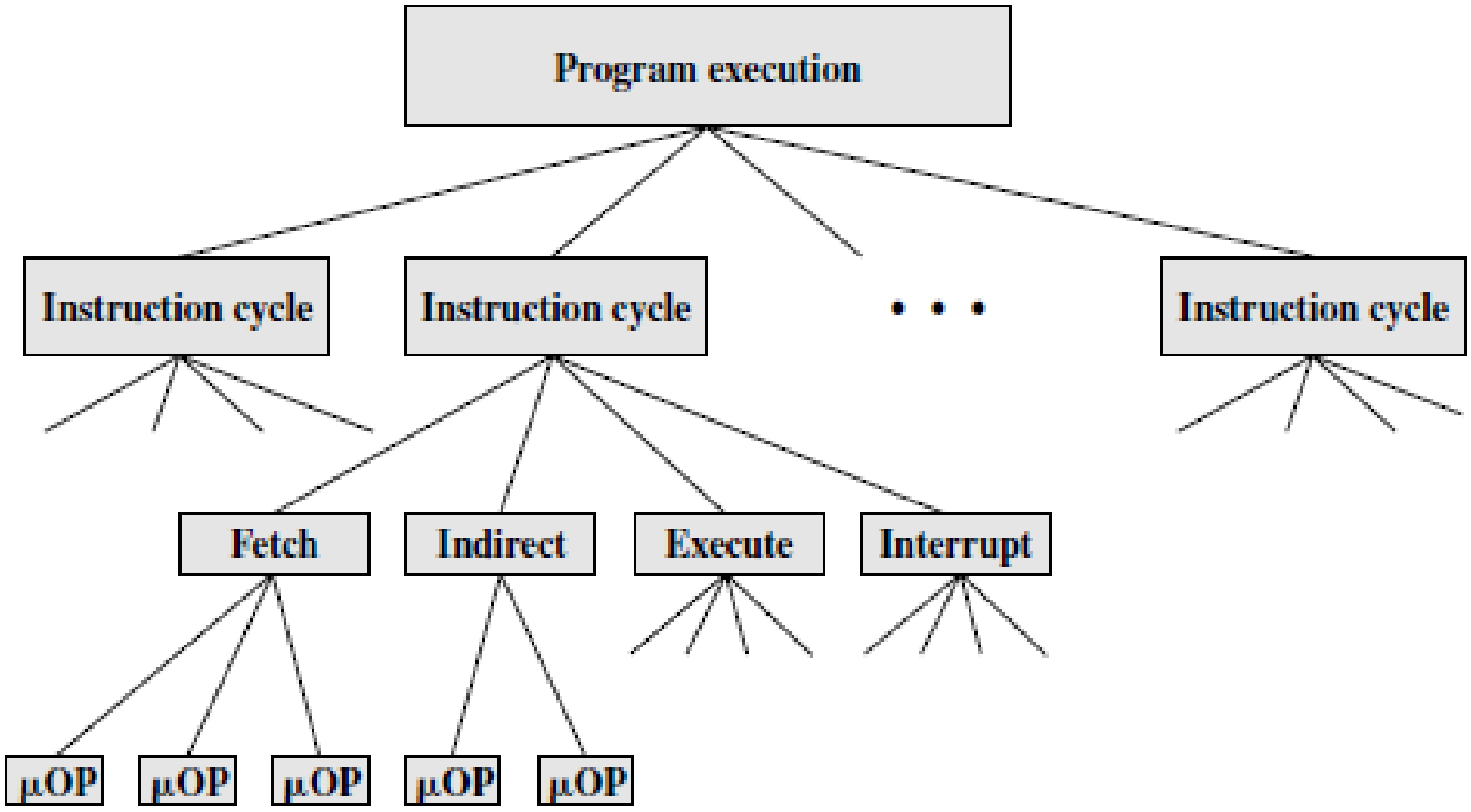
- Three-step process leads to a characterization of the control unit:

1. Define the basic elements of the processor.
2. Describe the micro-operations that the processor performs.
3. Determine the functions that the control unit must perform to cause the micro-operations to be performed.

Control Of Processor

- **Micro- operations:** Each of the smaller cycles involves a series of steps, each of which involves the processor registers .
- The prefix **micro** refers to the fact that each step is very simple and very little .
- Each instruction is executed during an instruction cycle made up of shorter subcycles (e.g., fetch, indirect , execute, interrupt).
- The execution of each subcycle involves one or more shorter operations, that is, **micro-operations.**

Control Of Processor



Control Of Processor

- The basic functional elements of the processor are :
  - ALU
  - Register
  - Internal data paths
  - External data paths
  - Control unit

Control Of Processor

- The ALU is the functional essence of the computer.
- Registers are used to store data internal to the processor.
- Some registers contain status information needed to manage instruction sequencing . Others contain data that go to or come from the ALU, memory, and I/O modules.

Control Of Processor

- Internal data paths are used to move data between registers and between register and ALU.
- External data paths link registers to memory and I/O modules, by means of a system bus.
- The control unit causes operations to happen within the processor.

Diagram of the Control Unit

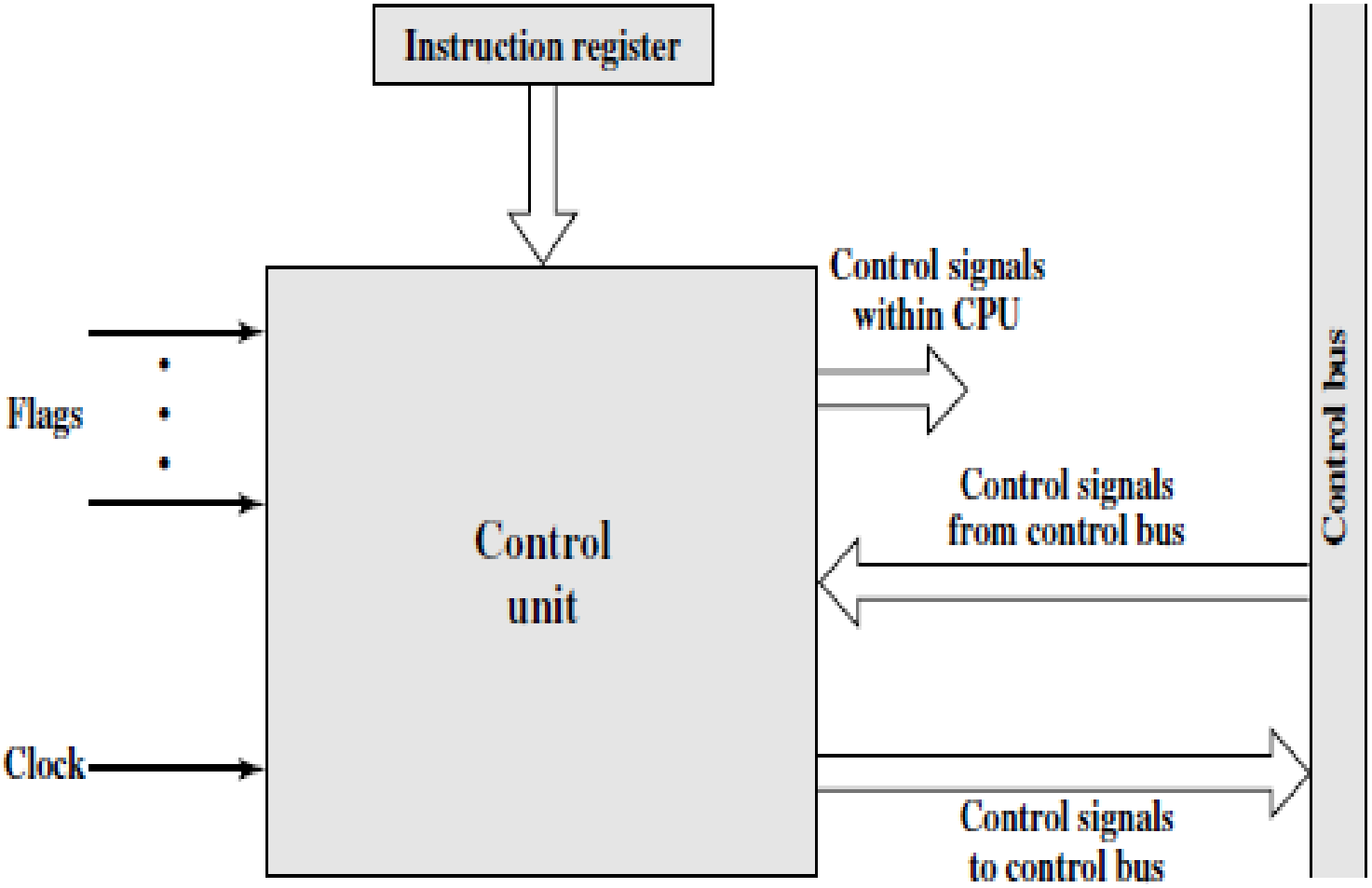


Diagram of the Control Unit

The inputs are :

- **Clock**: This is how the control unit "keeps time." The control unit causes one micro-operation (or a set of micro-operations) to be performed for each clock pulse .This is sometimes referred to as the processor cycle time, or the clock cycle time.
- **Instruction register**: The opcode and addressing mode of the current instruction are used to determine which micro-operations to perform during the execute cycle.

Diagram of the Control Unit

The inputs are :

- **Flags**: These are needed by the control unit to determine the status of the processor and the outcome of previous ALU operations.
- **Control signals from control bus**: The control bus portion of the system bus provides signals to the control unit.

Diagram of the Control Unit

The outputs are:

- **Control signals within the processor**: These are two types: those that cause data to be moved from one register to another, and those that activate specific ALU functions.
- **Control signals to control bus:** These are also of two types: control signals to memory, and control signals to the I/O modules.

CONTROL UNIT

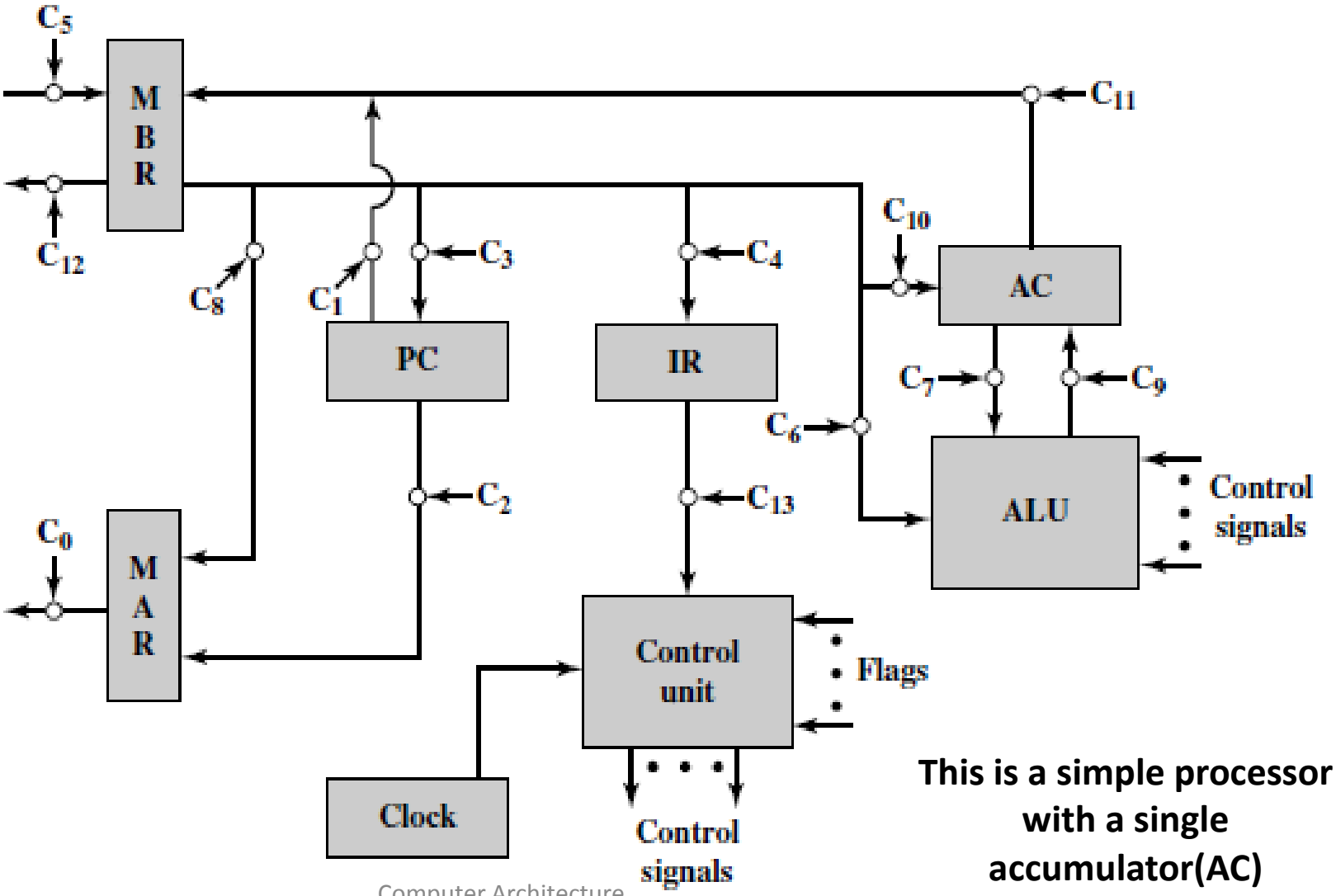
- Three types of control signals are used:

  - activate an ALU function.

  - activate a data path,

  -activate signals on the external system bus or other external interface.

Control Signals Example



This is a simple processor with a single accumulator(AC)

Control Signals Example

- The data paths between elements are indicated.
- The control paths for signals emanating from the control unit are not shown, but the terminations of control signals are labeled C_i and indicated by a circle.
- The control unit receives inputs from the clock, the instruction register, and flags.
- With each clock cycle, the control unit reads all of its inputs and emits a set of control signals.

Control Signals

- **Data paths-** The control unit controls the internal flow of data.

For example- on instruction fetch, the contents of the memory buffer register are transferred to the instruction register.

- **ALU-** The control unit controls the operation of the ALU by a set of control signals. These signals activate various logic circuits and gates within the ALU.
- **System bus:** The control unit sends control signals out onto the control lines of the system bus (e.g., memory READ).