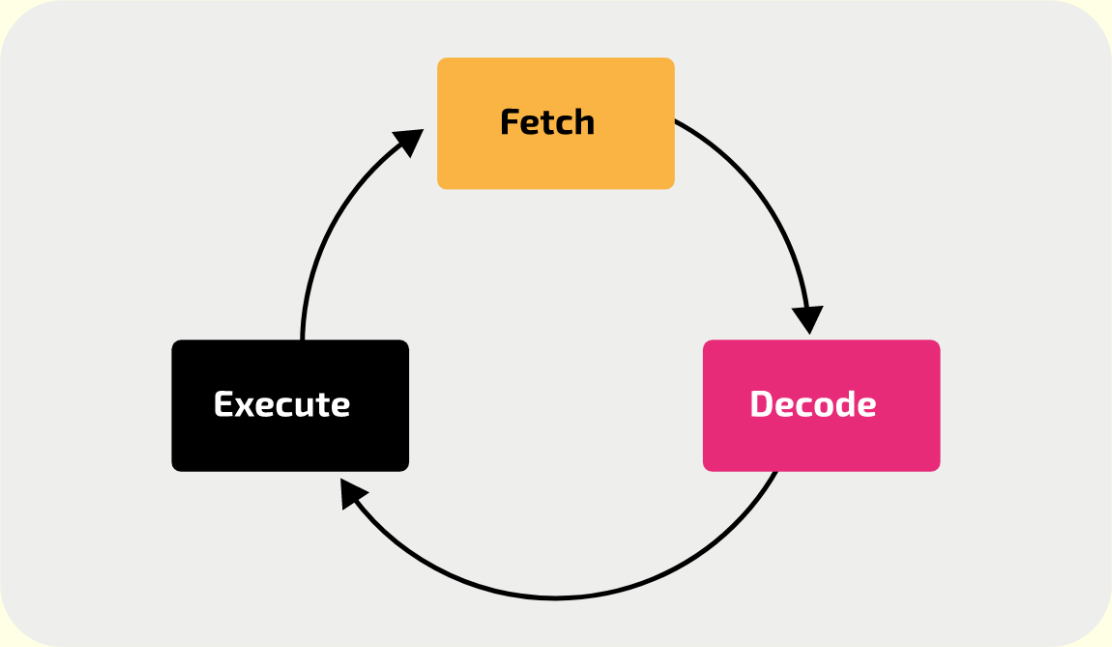
Learning Aims

- Be able to describe the **FDE cycle**



Fetch next instruction from memory
Decode instruction
Execute the instruction

Key Terms

Fetch
Decode
Execute
Data
Instructions
Memory Address
Bus Width

Recap - Fill in the gaps

The [redacted] manages the execution of instructions.

The [redacted] carries out calculations

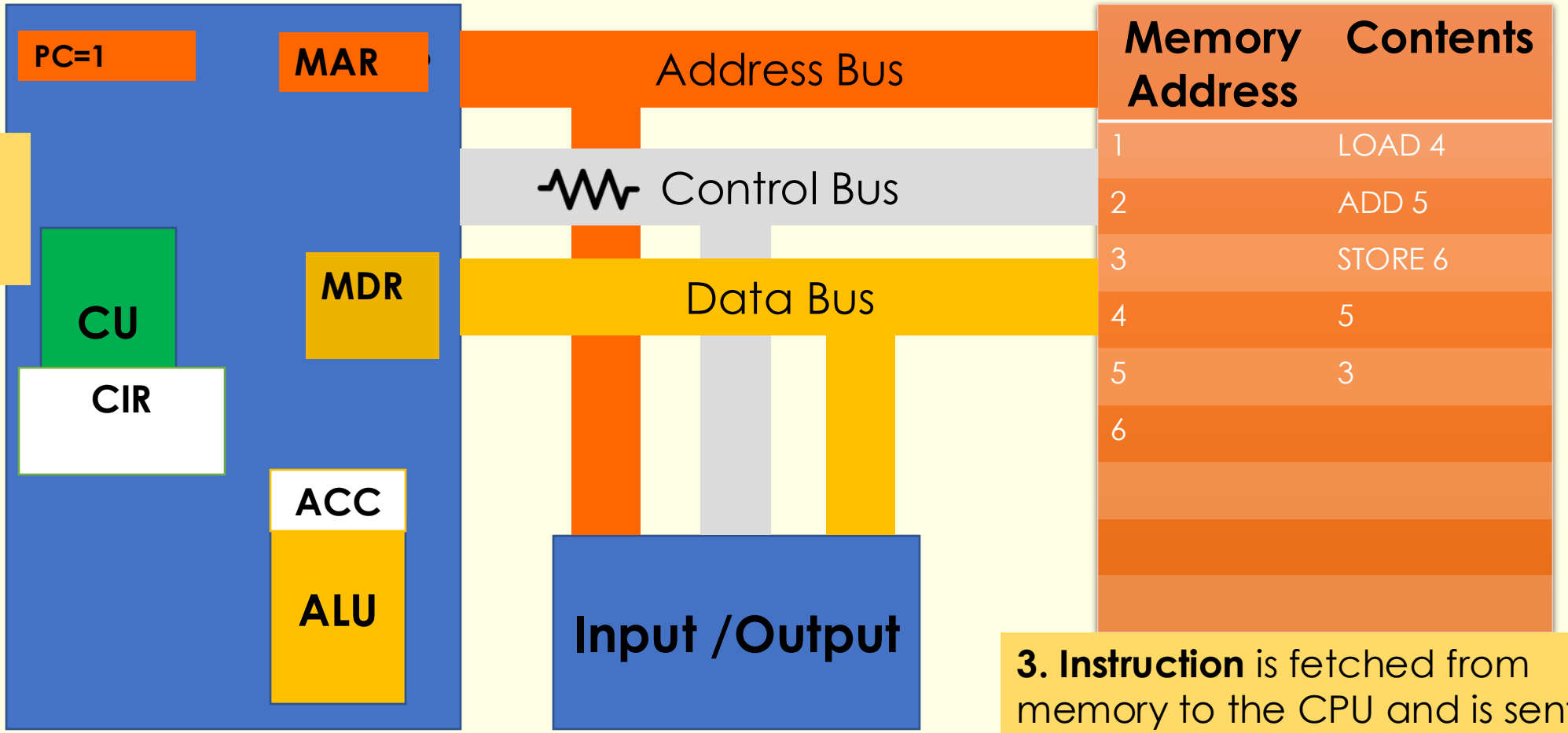
[redacted] are small areas of memory in the CPU

Instructions and data are [redacted] from main memory

Fetching **Load 4** instruction

1. Address of the next instruction to be fetched is sent from the CPU to main memory across the **address bus.**

2. Control unit sends a signal along the **control bus** to start a **read** operation.



4. Increase **program counter** by 1

3. Instruction is fetched from memory to the CPU and is sent along the **data bus**

Instruction Set

- Every processor has a unique instruction set.
- The instruction set is the full list of operations that a microprocessor chip can carry out.

Example of an instruction set:

Mnemonic	Action
LDA	Loads a value from a memory address
STA	Stores a value in a memory address
ADD	Adds the value held in a memory address to the value held in the accumulator
SUB	Subtracts from the accumulator the value held in a memory address
MOV	Moves the contents of one memory address to another

Simple program loaded into memory

Memory Address	Contents
1	LOAD 4
2	ADD 5
3	STORE 6
4	5
5	3
6	

Simple program loaded into memory to add 2 numbers together

1. LOAD Data from Memory Address 4 (5)
2. ADD Data from Memory Address 5 (3 + 5)
3. STORE Result into Memory Address 6 (8)

Control Unit

The control unit also sends command signals

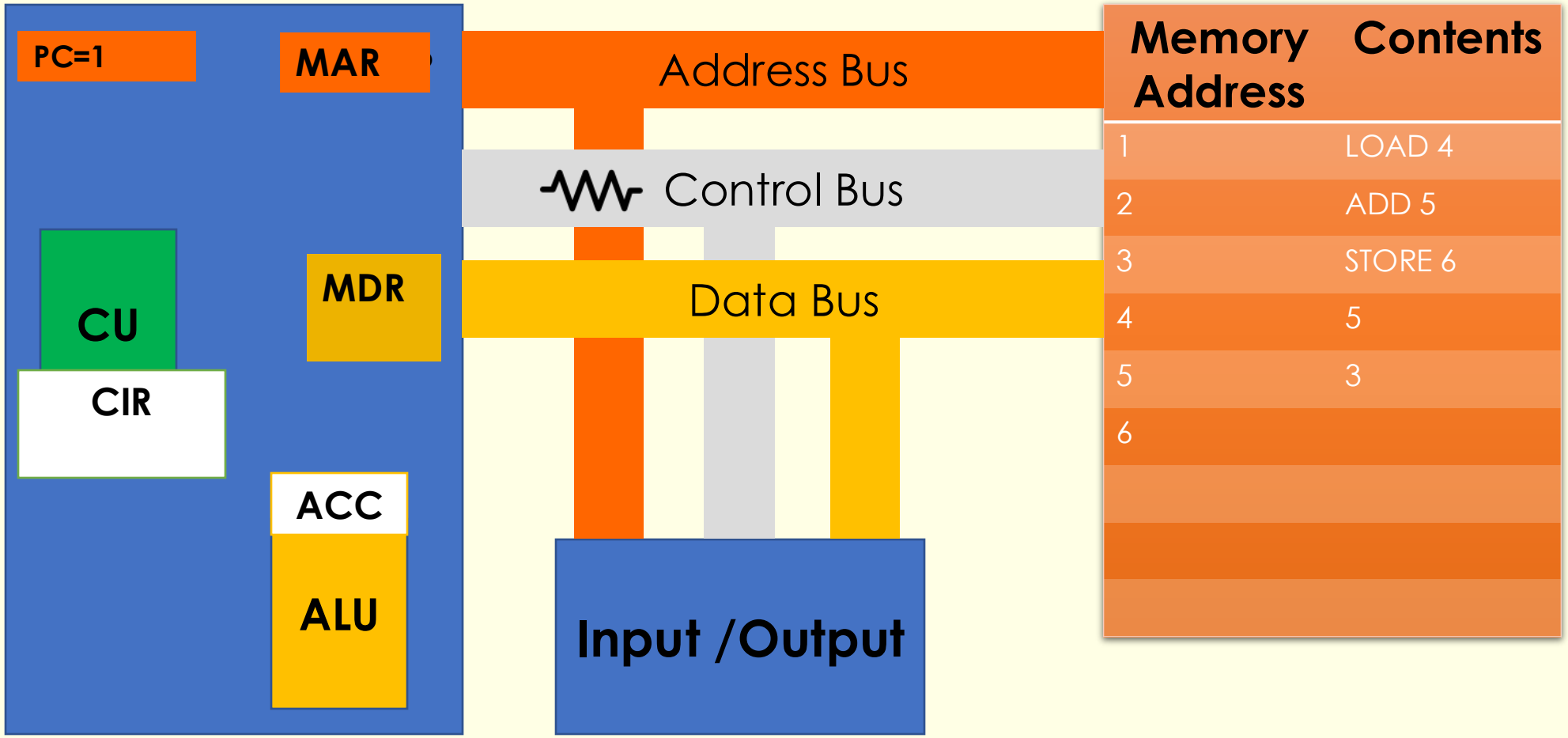
For example:

Memory Read: causes data from the addressed location to be placed on the data bus

Memory Write: causes data on the data bus to be written into the addressed location

Decode Load 4

5. The instruction is decoded by the **Control Unit**.
The CPU is designed to understand a specific set of commands. These are called the '**instruction set**' of the CPU.



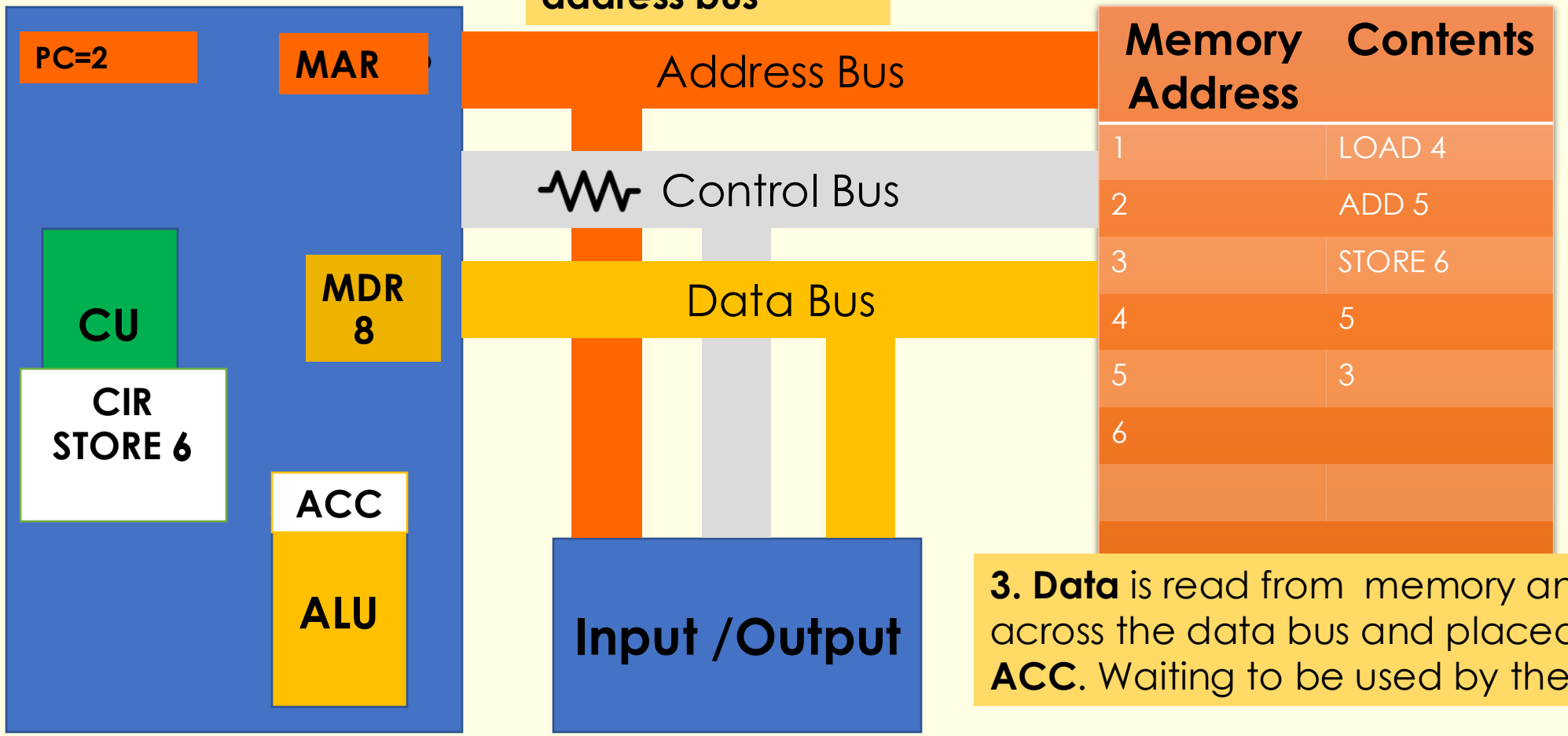
Executing **LOAD 4** instruction

1. Control unit sends a signal on the **control bus** to start a **READ** operation

2. Address 4 is placed on the **address bus**

6 The instruction is executed
This could be:

- **Load data** from memory
- **Write data** to memory
- Do a **calculation** or logic operation using the ALU
- Change the address in the PC
- Halt the program



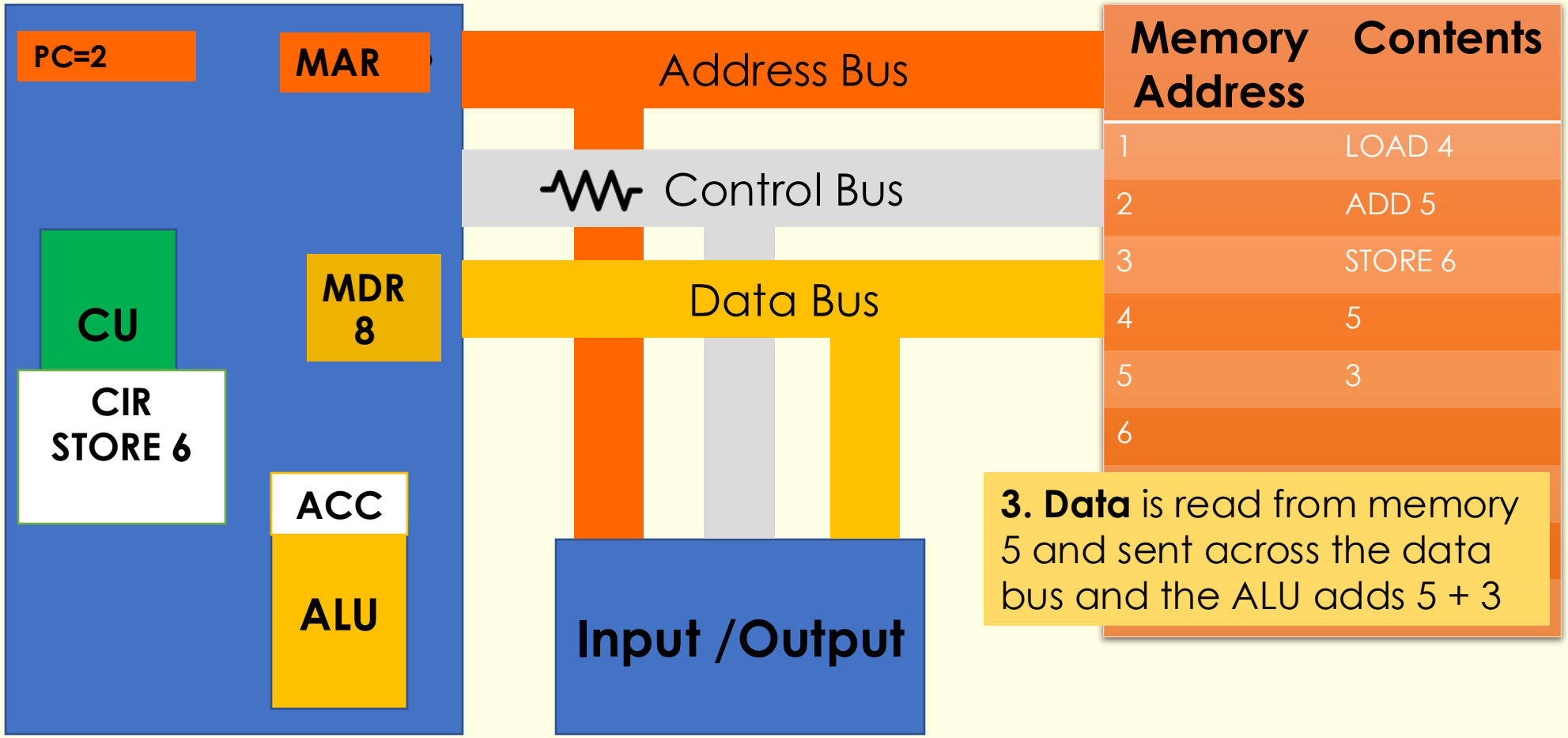
Memory Address	Contents
1	LOAD 4
2	ADD 5
3	STORE 6
4	5
5	3
6	

3. Data is read from memory and is sent across the data bus and placed on the **ACC**. Waiting to be used by the ALU

Executing **ADD 5** instruction

1. Control unit sends a signal on the **control bus** to start a **READ** operation

2. Address 5 is placed on the **address bus**



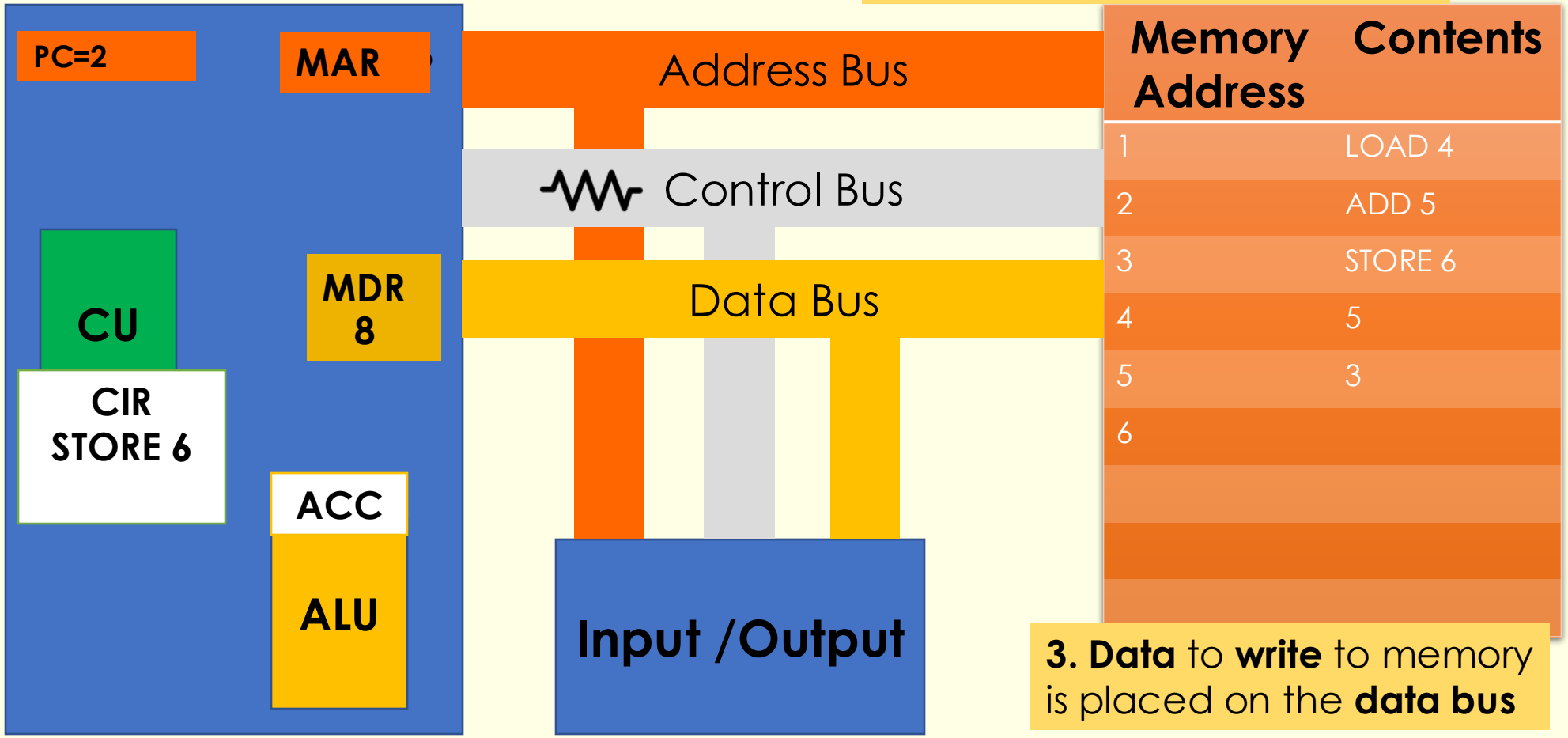
3. Data is read from memory 5 and sent across the data bus and the ALU adds 5 + 3

Executing **STORE 5** instruction

STORE 5 is an instruction used to write data to memory.

1. Control unit sends a signal on the **control bus** to start a **write** operation

2. Address of memory (to store data) is placed on the **address bus**



3. Data to **write** to memory is placed on the **data bus**

FDE

Fetch Instruction

1. Memory address is copied from a CPU register(Memory Address Register) and sent along the **address bus** to main memory
2. Instructions are fetched from the memory address and sent along the **data bus** to the CPU.
3. Instruction is copied into registers (Memory data register and moved to Current Address Register)
4. Increase program counter by 1

Decode Instruction

5. The instruction is decoded by the **Control Unit**.
The CPU is designed to understand a specific set of commands. These are called the '**instruction set**' of the CPU.

Execute Instruction

6. The instruction is executed
This could be:
- Load data from memory
- Write data to memory
- Do a calculation or logic operation using the ALU
- Change the address in the PC
- Halt the program

Clock

Clock sends electrical signals at regular intervals so that operations can be synchronized

The **clock cycle** is a single tick of the computer's clock

Each clock cycle triggers the CPU to perform a basic operation, such as fetching an instruction, decoding it, or executing it.

The speed of a CPU is often measured in clock cycles per second, known as **clock speed** or frequency, typically measured in gigahertz (GHz).

A higher clock speed means the CPU can process more instructions in a given time, leading to faster performance.

A 3GHZ – 3 billion F-D-E cycles per second

Recap System Bus

Buses

- **address bus**
  - The address of memory (holding instruction) is placed on the address bus
  - **uni-directional**
- **data bus**
  - Contents (instruction/data) of the memory are placed on the data bus
  - **bi-directional**
- **control bus**
  - Control unit sends a signal on the control bus to start an operation and communicate with other devices within the computer.
  - Receive status messages of devices
  - **bi-directional**

Address Bus Width

- Bus Width – number of connections on a bus
- Each connection represents a binary digit (0 or 1)
- A greater bus width means larger number values can be communicated

For example: