Overview of Microcomputer Structure and Operation

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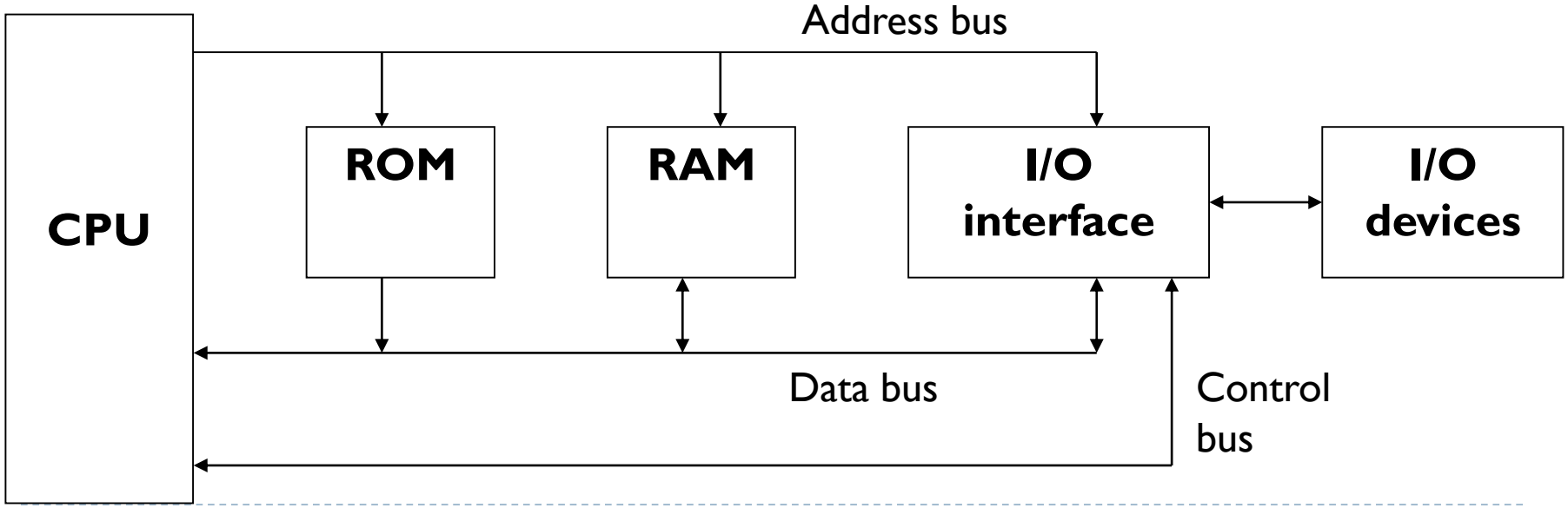
Lecture References:

- **Book:**
  - *Microprocessors and Interfacing: Programming and Hardware,* **Author:** Douglas V. Hall
- **Lecture Materials:**
  - *E4160: Introduction of Microprocessors.*

Block Diagram of a Simple Microcomputer

Components of Microcomputer:

- CPU
- Memory
- Input / Output circuitry
- System Buses:
  - Address bus
  - Data bus
  - Control bus



CPU - Central Processing Unit

- It controls the operation of computer
- The CPU fetches binary-coded instructions from memory
- Decodes the instructions into a series of simple actions
- Carries out these actions in a sequence of steps
- **Important components:** IP (Instruction Pointer), General purpose registers and Control bus signal generating circuits

Pentium D dual core processors

Memory

- It stores the binary codes for the sequence of instructions and binary coded data. Example: ROM, RAM and Magnetic disks
- RAM can be read and written to anytime the CPU commands it, but ROM is pre-loaded with data and software that never changes, so the CPU can only read from it.
- ROM is typically used to store the computer's initial start-up instructions.
- In general, the contents of RAM are erased when the power to the computer is turned off, but ROM retains its data indefinitely.
- In a PC, the ROM contains a specialized program called the BIOS that orchestrates loading the computer's operating system from the hard disk drive into RAM whenever the computer is turned on or reset.

I/O Unit

- **Input/output (I/O)**, refers to the communication between an information processing system (such as a **computer**), and the outside world possibly a human, or another information processing system.
- **Inputs** are the signals or data received by the system, and **outputs** are the signals or data sent from it
- Devices that provide input or output to the computer are called peripherals like the **keyboard** and **mouse**, and output devices such as the **display** and **printer Hard disk drives**, **floppy disk drives** and **optical disc drives** serve as both input and output devices.
- **Computer networking** is another form of I/O.

System Bus

- The microcomputer's system bus contains three buses, **address, data,** and **control bus**
- When a memory or an I/O chip receives data from the microprocessor, it is called a ***WRITE operation,*** *and* data is written into a selected memory location or an I/O port (register).
- When a memory or an I/O chip sends data to the microprocessor, it is called a ***READ operation, and data is*** read from a selected memory location or an I/O port.

Address Bus

- *It is a Unidirectional bus.*
- Information transfer takes place from the MP to the memory or I/O elements.
- Typically 16, 20, 24, 32 or 36 bits long.
- On these lines the CPU sends out the address of the memory location or I/O port that is to be **written** to or **read** from
- The number of locations that the CPU can address is determined by the number of address lines

For example :

1. **microprocessor with 16 address pins can generate 2^{16} = 65,536 bytes**
2. **microprocessor with 20 address pins can generate 2^{20} = 10,48,576 bytes**
3. **microprocessor with 32 address pins can generate 2^{32} = 4,294,964,296 bytes**

Data Bus

- It is a bidirectional bus
- Data can flow in both directions, that is, to or from the microprocessor.
- The size of the data bus varies from one microprocessor to another.
- Usually matches the *word length* of the microprocessor
- Usually a multiple of 8
- We talk of 4-bit (**nibble**), 8-bit, 16-bit , 32-bit and 64-bit processors which refers to the normal word length of the microprocessor

Control Bus

- It consists of a number of signals that are used to synchronize operation of the individual microcomputer elements.
- Consists of potentially many signals. Typically:-
  - Read
  - Write
  - Could be single signal - Read/notWrite line
  - Interrupt control
  - Bus control signals for DMA (Direct Memory Access)

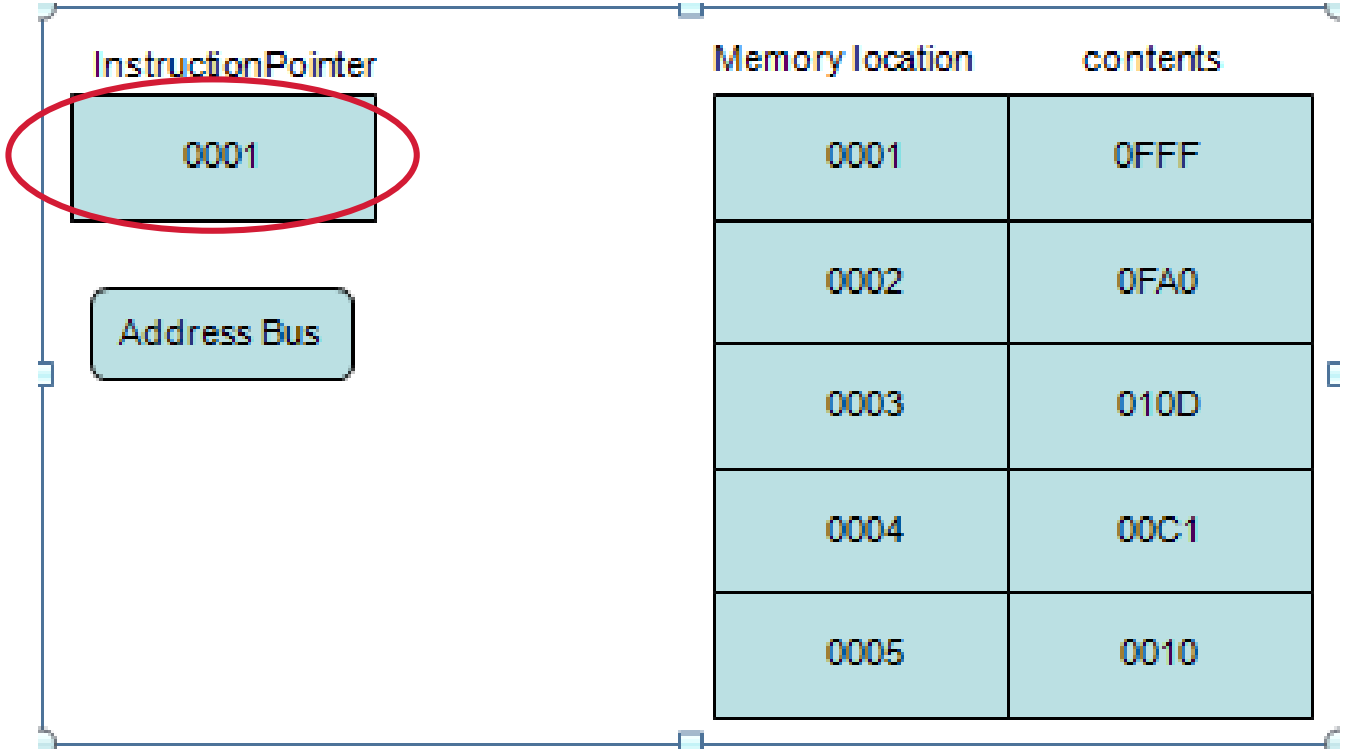
Fetching & Execution Cycles

- **Fetching Cycles**
  - The fetch cycle takes the instruction required from memory, stores it in the instruction register, and
  - moves the program counter on one so that it points to the next instruction.
- **Execute cycle**
  - The actual actions which occur during the execute cycle of an instruction.
  - depend on both the instruction itself and the addressing mode specified to be used to access the data that may be required.

Fetching an Instruction

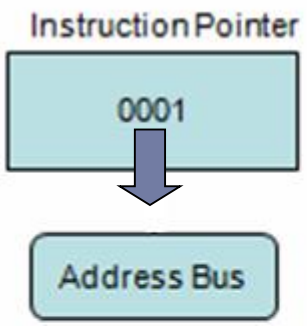
- **Step 1**

Instruction Pointer (IP) or a program counter is register, that holds the address of the next instruction to be fetch.



Fetching an Instruction

- **Step 2**

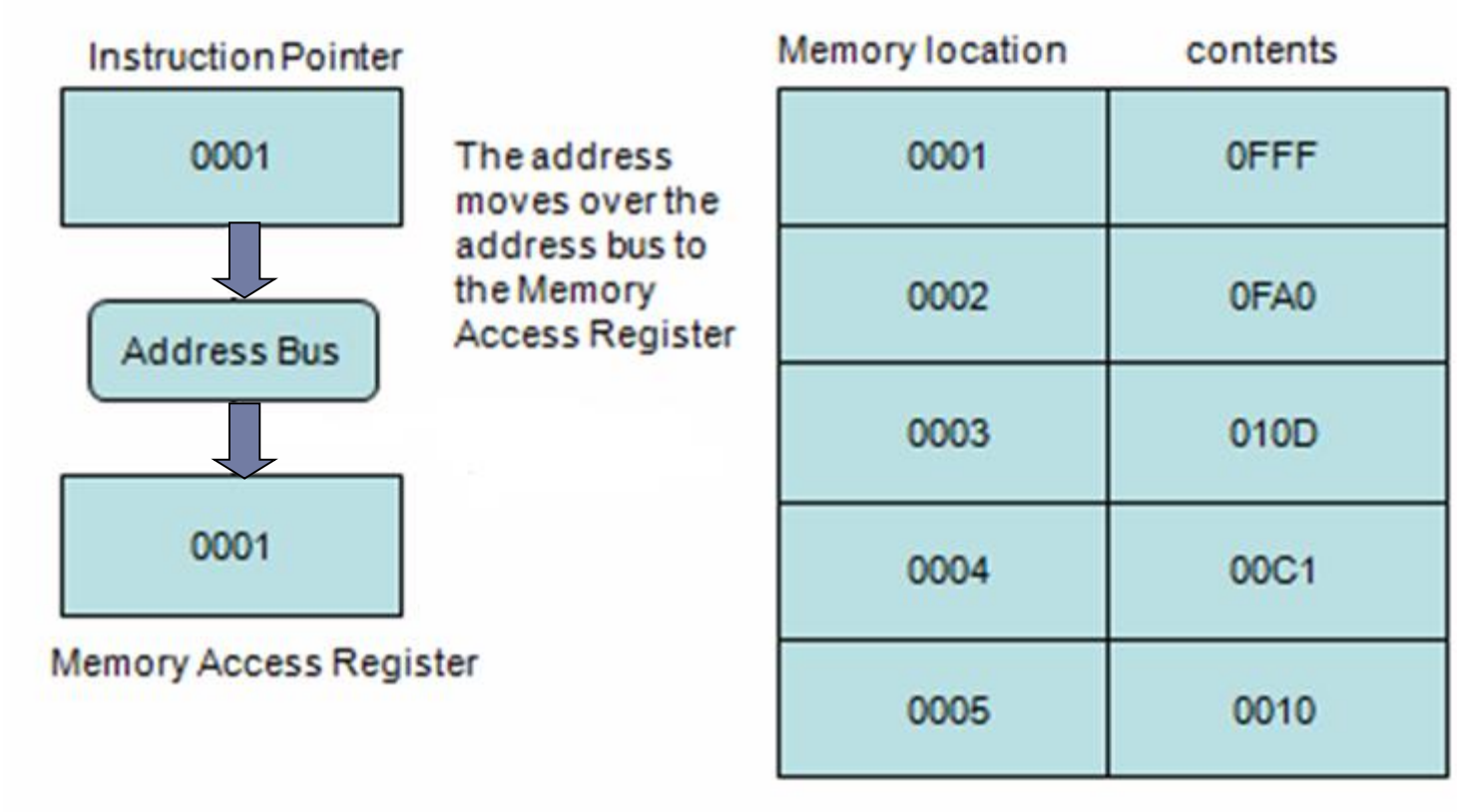


Contents of the Program Counter are passed across the Address Bus

Memory location	contents
0001	0FFF
0002	0FA0
0003	010D
0004	00C1
0005	0010

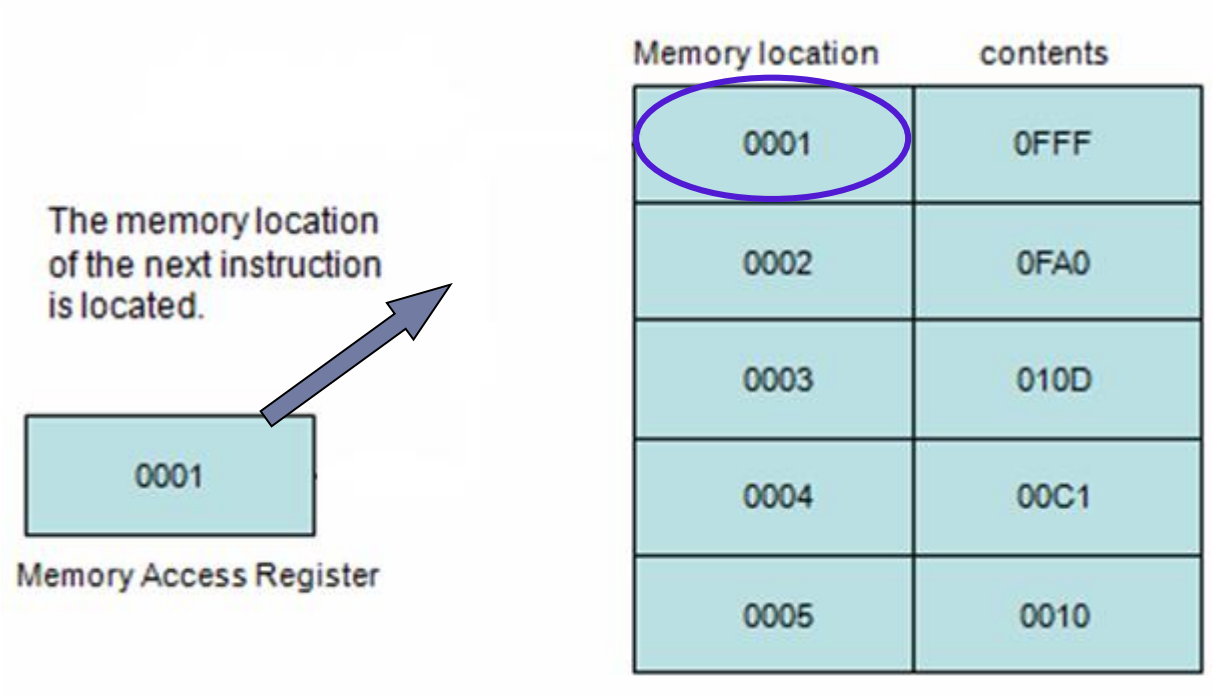
Fetching an Instruction

- **Step 3**



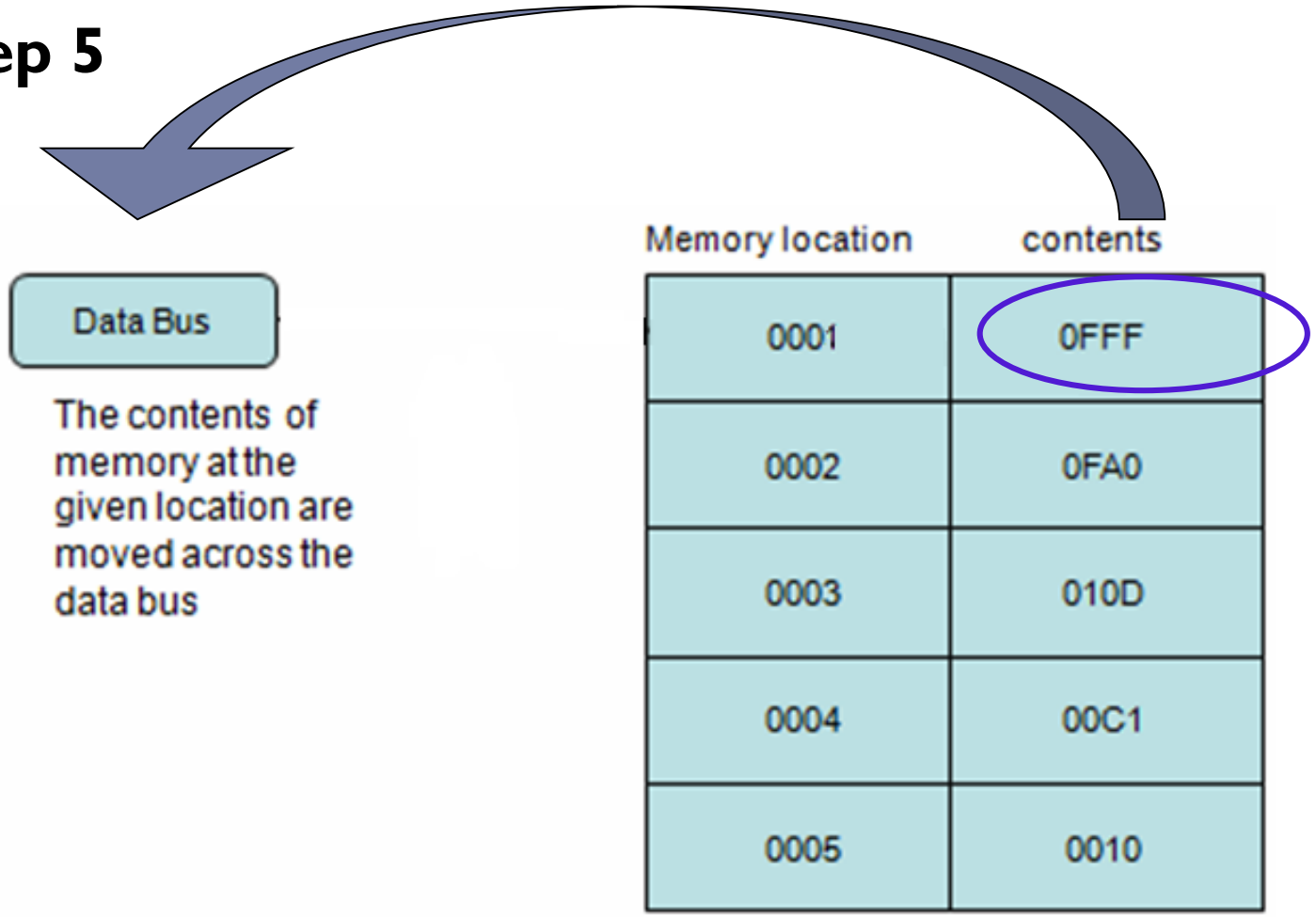
Fetching an Instruction

- **Step 4**



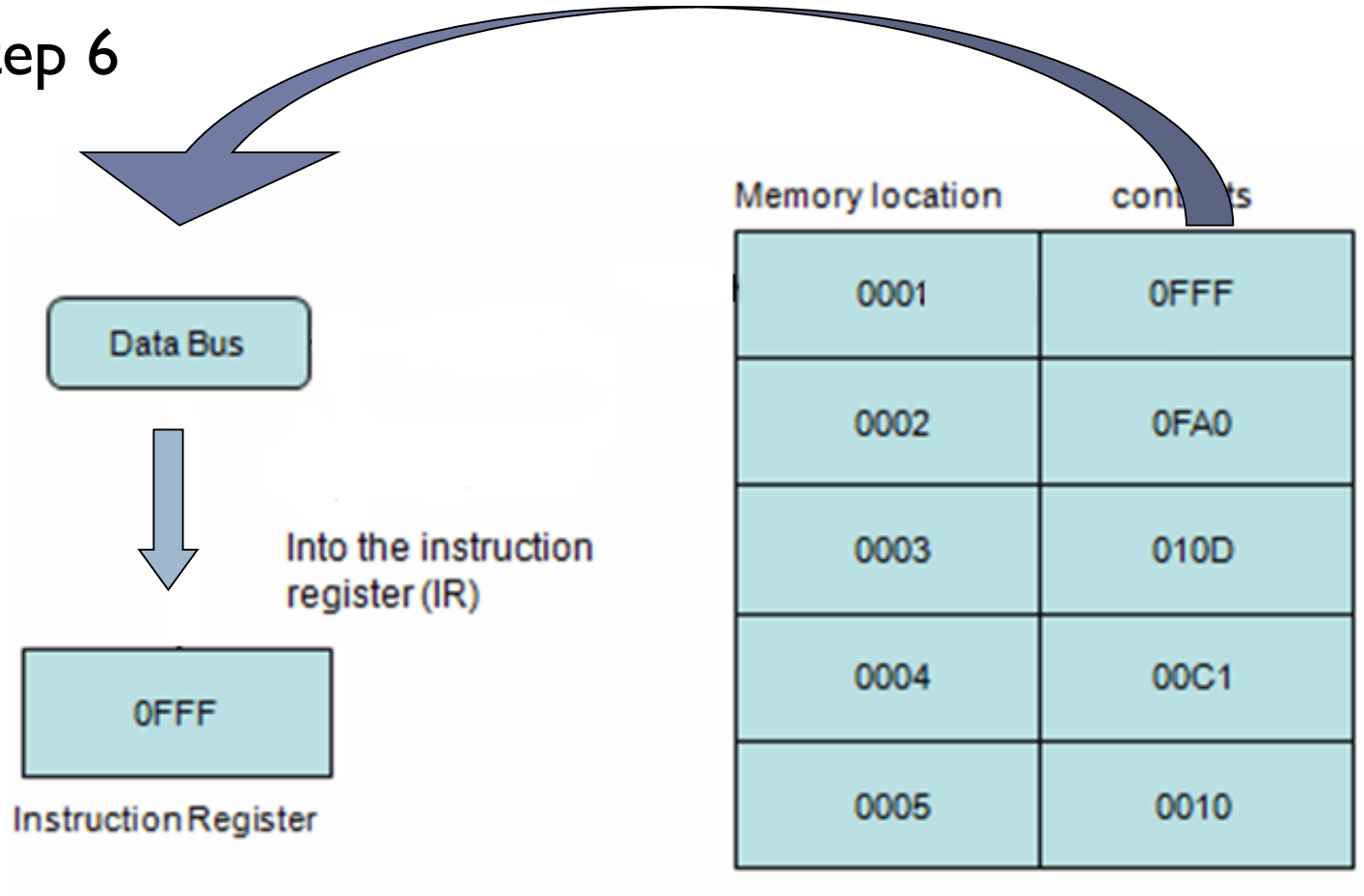
Fetching an Instruction

- **Step 5**



Fetching an Instruction

- Step 6



Execution of a Three Instruction Program

- 1. Input a value from a keyboard connected to the port at address 05h
- 2. Add 7h to the value read in
- 3. Output the result to a display connected to the port at address 02h

Memory Address	Contents (Binary)	Contents (Hex)	Operation
0100h	11100100	E4	Input From
0101h	00000101	05	Port 05h
0102h	00000100	04	ADD
0103h	00000111	07	07h
0104h	11100110	E6	Output To
0105h	00000010	02	Port 02h

Thank You !!