

Microcomputer Systems

Course Code: CSC 2106

Course Title: Computer Organization and
Architecture



Dept. of Computer Science
Faculty of Science and Technology

Lecturer No:	1	Week No:	1	Semester :	24-25 Fall
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Lecture Outline



1. Introduction to the architecture of microcomputers and IBM PC
 2. Peripherals and their relations to the software or Programs
 3. What computer does while executing instructions
 4. Advantages and disadvantages of assembly language programming
- **As a microcomputer user, you already know most of these terms**

Components of Microcomputer System



- SYSTEM UNIT**

- I/O DEVICES OR PERIPHERALS**

- Keyboard
- Display Unit
- Disk drives

- INTEGRATED-CIRCUIT (IC)**

- Contains transistors. Digital circuits
[0's& 1's]
- Binary Digits/ Bits: 0 or 1



Components of Microcomputer System



CPU:

- Brain of the computers
- Controls all the operations
- A single chip processor (microprocessor)

MEMORY CIRCUITS : Stores information

I/O CIRCUITS : Communicate with I/O devices

The System Board



System Board/motherboard resides in the system unit

It **contains** microprocessors and memory circuits

- It has **expansion slots** to connect additional circuit boards called **add-in cards/add-in boards**

I/O circuits are located in add-in cards

A Glimpse of Motherboard



The Components of a Microcomputer System

Memory



Bytes and Words:

- Information processed is stored in memory
- A memory circuit element can store one bit of data [i.e. 0 or 1]
- Memory circuits are organized as a group of **8 bits** of data
- 8 bits of string = 1 Byte
- Memory bytes are known as **address**(i.e. street address of a house).



Address Vs Contents



The stored data in a memory byte are called **contents/value**.

Address	Contents
The address of a memory byte is FIXED and different from other addresses(unique).	Contents are NOT unique as they deal with current data.
The number of bits in an address depend on the processor [i.e. Intel 8086 = 20-bit & Intel 80286=24-bit]	Contents of memory byte are always 8 bits

Address Vs Contents



Address	Contents							
7	0	0	1	0	1	1	0	1
6	1	1	0	0	1	1	1	0
5	0	0	0	0	1	1	0	1
4	1	1	1	0	1	1	0	1
3	0	0	0	0	0	0	0	0
2	1	1	1	1	1	1	1	1
1	0	1	0	1	1	1	1	0
0	0	1	1	0	0	0	0	1

Memory byte addressing



Suppose a processor uses 20 bits for an address.
How many memory bytes can be addressed using this processor?

- A bit can have two possible values (i.e. 0 or 1)
- So, in a 20-bit address, we can have 2^{20} or **10,48,576**

In computer terminology $2^{20} = 1$ Mega

Therefore, 20-bit address can be used to address **1 MB**.

Memory Word



In a Microcomputer, **Two bytes = a word**

So to store a word data, IBM PC needs :

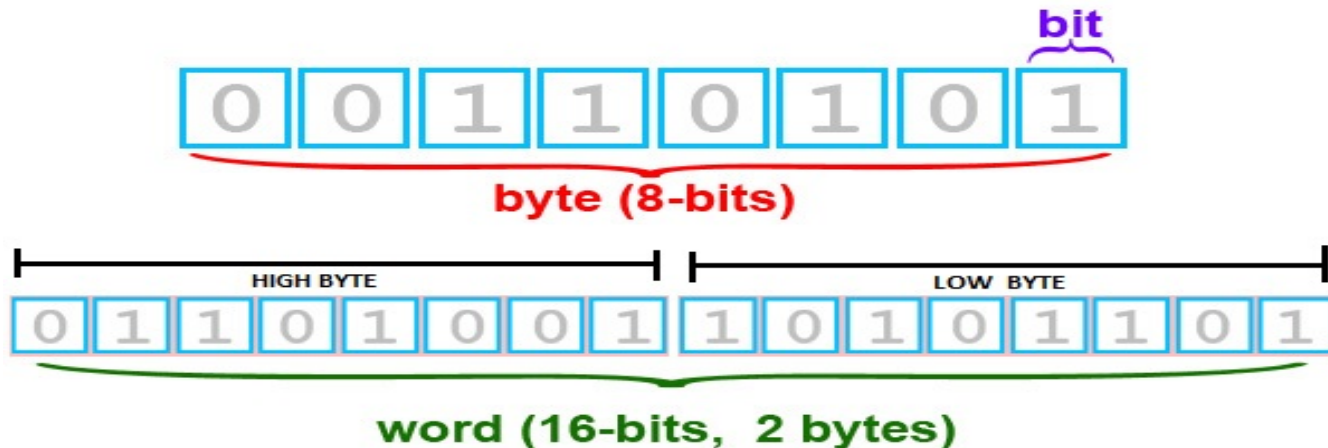
- A pair of successive memory bytes
- **A pair of memory bytes = Memory word**

The **lower** address of the two memory bytes is the memory address.

- i.e. a memory word with address 2 is made up of address 2 and 3

A microprocessor can detect memory byte or memory word from memory **location/address**.

Bit Positions in byte and Word



- Bit positions are numbered from **Right to left**
- **Bit 0-7 = low byte** [Lower address of word]
- **Bit 8-15 = high byte** [Higher address of word]

Memory Operations



The processor can perform **two** operations on memory

- **Read** or fetch the contents from a location

Processor only gets a copy of the data

Original contents of the location are **unchanged**

- **Write** or Store data at a location

The data written become the new contents

The Original/previous **contents are lost**

RAM and ROM



RAM: Random Access Memory

- RAM locations can be **read** and **written**
- Program instructions and data are stored
- RAM memory are lost when the machine is turned off

ROM: Read Only Memory

- Once initialized can't be changed (**Read Only**)
- Retain values unlike RAM [example]
- ROM based programs are known as **firmware**
- Responsible for loading start-up programs

BUSES



A processor communicates with memory and I/O devices by using signals.

Signals are travelled along set of wires or connections called buses.

There are three kinds of signals and buses

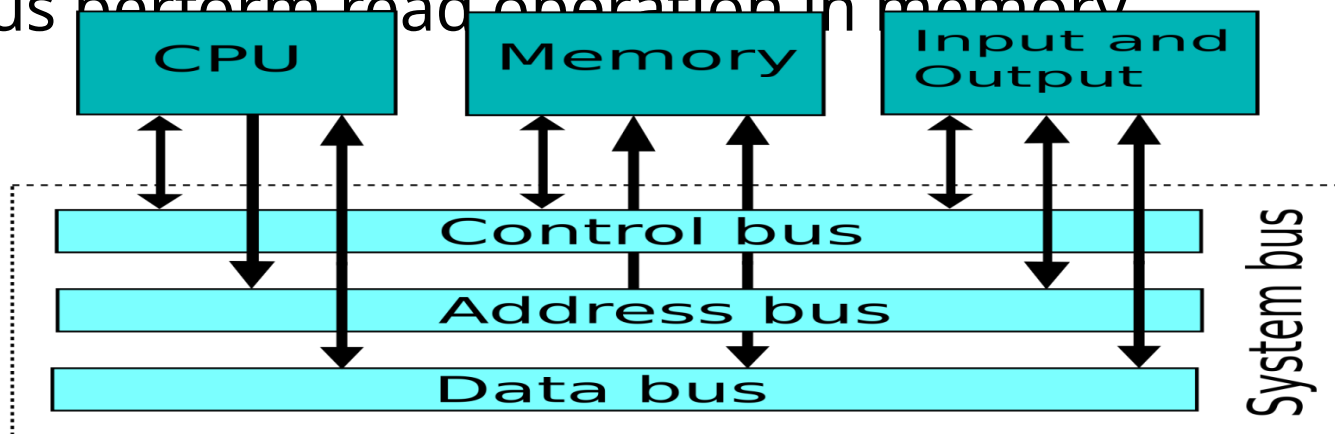
- Address → Address Buses
- Data → Data Buses
- Control → Control Buses

BUSES(cont'd...)

Address Bus: The CPU places the **address** of memory location on address bus to **read** the contents.

Data Bus: CPU receives the data, sent by memory circuits on the data bus.

Control Bus: CPU sends control signals on control bus perform read operation in memory.



CPU



CPU is the brain of computer.

CPU controls computer by executing programs (i.e. system or application).

Each instruction CPU executes, is a **bit** string.

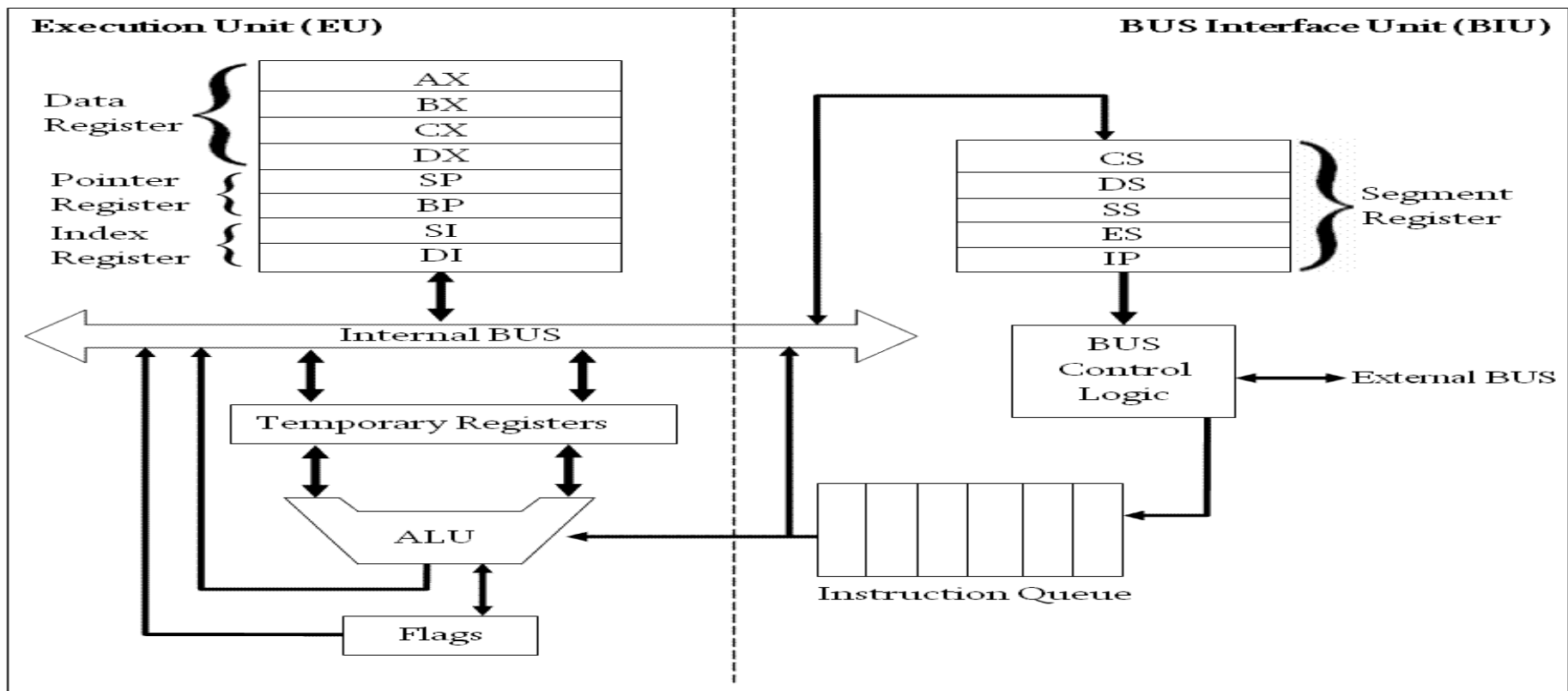
Machine language: The language of 0's and 1's

- Instructions are designed to be simple
- Sequence of very basic operations

Instruction Set: The instructions performed by CPU.

- The instructions set for each CPU is unique

Intel 8086 Microprocessor Organization



Execution Unit (EU)

- EU contains ALU circuits.
- ALU performs **arithmetic** and **logical** operations.
- **Data operations** are stored in **registers**.
- A **register** is like **memory location**; however, we refer to it by name not number.
 - **i.e. AX, BX, CX, DX, SI, DI, SP, BP**
- Also, EU Contains **temporary registers** for **holding operands** for the ALU and FLAGS registers.
- FLAG register's **individual bits** reflect the **result of computation**

Bus Interface Unit (BIU)

- BIU **enables communication** between the EU and memory or I/O circuits.
- Primarily responsible for transmitting address, data and control signals on the buses.
- BIU registers are: **CS, DS, ES and IP**
 - BIU registers hold the addresses of the memory locations

EU and BIU

- EU and BIU are connected by **internal bus** and they work together.
- While EU executes an Instruction, BIU fetches up to six bytes of the next instruction and places instructions in instruction queue (IQ).
- The overall process is called ***instruction prefetch*** and its purpose is to speed up the processor.
- However, if EU needs to communicate with memory, BIU suspends instruction prefetch and performs required operations.

I/O Ports



I/O ports functions as **transfer points** between the CPU and I/O devices.

I/O devices are connected through I/O ports



Serial	Parallel
Transfers 1 bit at a time	Transfers 8 or 16 bits at a time
Serial ports tend to be slower	Requires more wiring connection
Slow devices are connected to serial port. (i.e. Keyboard)	Fast devices are connected to parallel port. (i.e. disk drive)



Instruction Execution

How the CPU operated?

Machine language has two parts

- **Opcode:** Type of operation
- **Operands:** Data to be operated on (Memory addresses are used)

The fetch- execute cycle

Fetch

- Fetch an instruction from memory
- Decode the instruction to determine the operation
- Fetch data from memory if necessary

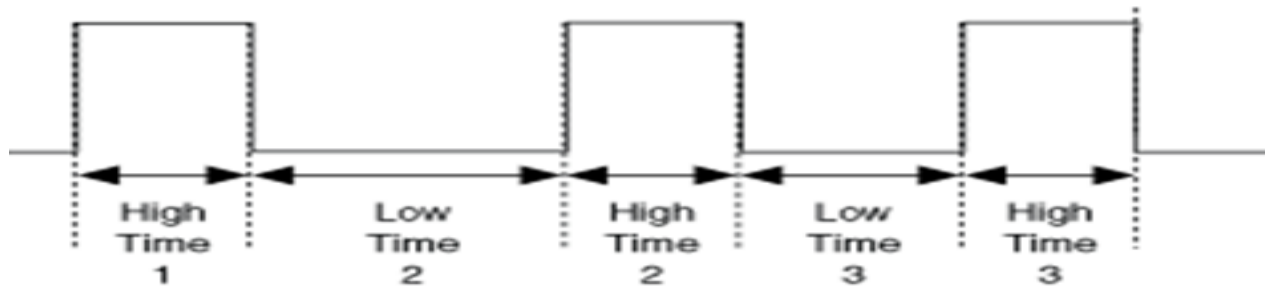
Execute cycle

- Perform operation on the data
- Store the result if needed

Timing



To ensure execution steps are carried out in an **orderly fashion**, a clock circuit controls the processor by generating a **train of clock pulses**



Clock Period: The time interval between two pulses.

Clock rate/speed: Number of Pulses per second.

- Measured in Megahertz (MHz)
- 1 MHz = **1000000** (1 million) pulses per second



Timing Task

If you have computer with processor 2.3 GHz, How many pulses are generated per seconds from your computer?

➤ $2.3 \times 1000 \times 1000000 = 2,30,00,00,000$ pulses

Programming Languages



- **Machine Language:** Bit strings (i.e. 0 & 1)
- **Assembly language:**
 - Symbolic names are used to represent operations, registers and memory locations(i.e. MOV AX, A)
 - Assembly program must be converted into machine language using assembler.
- **High-Level language:**
 - Allows programmer to write program in more natural language text.
 - A Compiler is needed to translate high-level programs into machine language

Advantages



High-level

- Closer to natural language. So, algorithm conversion is easier.
- Less instruction and time required than assembly language.
- Programs can be executed in any machine

Assembly

- So close to the machine language. So programs are faster and shorter.
- Reading or writing to specific memory location, I/O ports is easy.
- It can be a sub program of a high-level language.
- Going into more details like how computer thinks.



References

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Books

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