Introduction to Microprocessors

General Architecture of a Microcomputer System

The hardware of a microcomputer system can be divided into four functional sections: the **Input unit, Micro processing Unit, Memory Unit, and Output Unit**. See Fig. 1

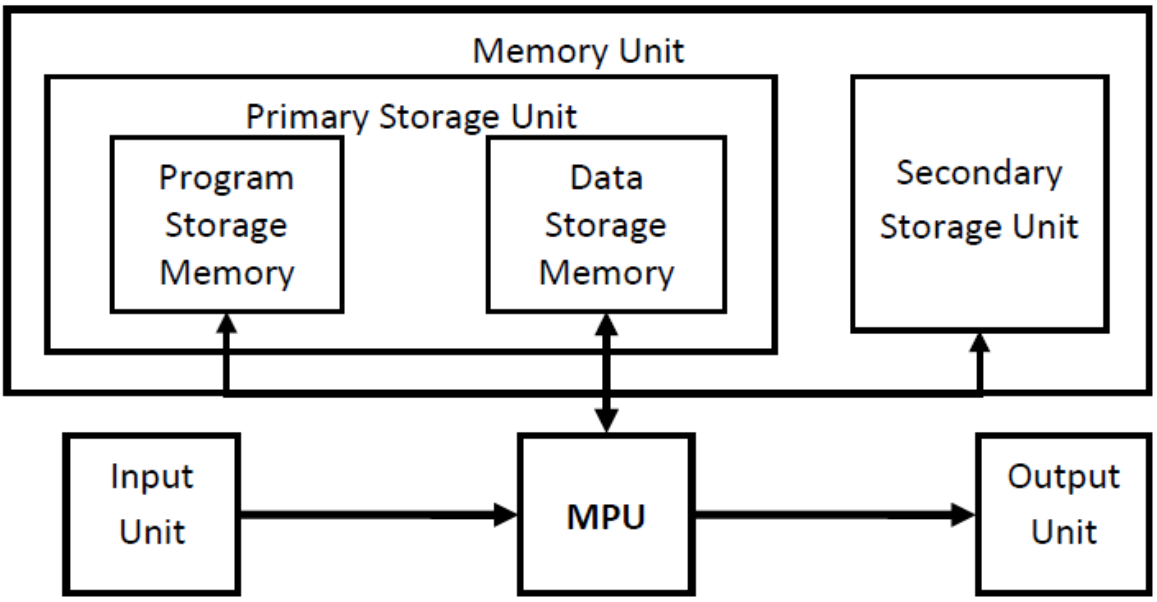

Figure 1

Microprocessor Unit (**MPU**) is the heart of a microcomputer. A microprocessor is a general purpose processing unit built into a single integrated circuit (IC).

The Microprocessor is the part of the microcomputer that executes instructions of the program and processes data. It is responsible for performing all arithmetic operations and making the logical decisions initiated by the computer's program. In addition to arithmetic and logic functions, the MPU controls overall system operation.

Input and Output units are the means by which the MPU communicates with the outside world.

- Input unit: keyboard, mouse, scanner, etc.
- Output unit: monitor, printer, etc.

Memory unit:

- **Primary:** is normally smaller in size and is used for temporary storage of active information. Typically ROM, RAM.
- **Secondary:** is normally larger in size and used for long-term storage of information. Like Hard disk, Floppy, CD, etc.

Types of Microprocessors

Microprocessors generally is categorized in terms of the maximum number of binary bits in the data they process – that I, their word length. Over time, five standard data widths have evolved for microprocessors: 4-bit, 8-bit, 16-bit, 32-bit, 64-bit. Table 1 represents Bit, Byte, and Larger units.

Table1: Bit, Byte, and Larger units.

Name	Number of Byte
Bit	0 or 1
Byte	is a group of bits used to represent a character, typically 8-bit.
Word	2-bytes (16-bit) data item
Double Word	4-byte (32-bits)
Quadword	8-Bytes (64-bit)
Paragraph	16-bytes (128-bit)
KiloByte (KB)	the number 2^{10} = 1024 = 1K for KiloByte, (thus 640K = 640 * 1024 = 655360 bytes)

There are so many manufacturers of Microprocessors, but only two companies have been produces popular microprocessors: *Intel* and *Motorola*. Table 2 lists some of types that belong to these companies (families) of microprocessors.

Table2: some types of microprocessors

Type	Data bus width	Memory size
Intel family:		
8085	8	64K
8086	16	1M
80286	16	16M
80386EX , 80386DX	16 , 32	64M , 4G
80486DX4	32	4G + 16K cache
Pentium	64	4G + 16K cache
PentiumIII , Pentium4	64	64G+32K L1 cache +256 L2 cache
Motorola family:		
6800	8	64K
68060	64	4G + 16K cache

Note that the 8086 has data bus width of 16-bit, and it is able to address 1Megabyte of memory. It is important to note that 80286, 80386, 80486, and Pentium-Pentium4 microprocessors are **upward compatible** with the 8086 Architecture. This mean that 8086/8088 code will run on the 80286, 80386, 80486, and Pentium Processors, but the reverse in not true if any of the new instructions are in use.

Beside to the *general-purpose* microprocessors, these families involve another type called *special-purpose* microprocessors that used in **embedded control applications.** This type of embedded microprocessors is called *microcontroller*. The 8080, 8051, 8048, 80186, 80C186XL are some examples of microcontroller.

خلاصة:

تصنف المعالجات من حيث التطبيقات الى قسمين الاول مايسمى بال (Embedded MP) والثاني (Programmable MP) يمتاز الاول بأمكانية العمل في ظروف قاسية (درجة الحرارة العالية) وكذلك يكون عدد الايعازات (Instruction set) اقل بالمقارنة مع النوع الثاني.

8086 Microprocessor

The internal architecture of the 8086 contains two processing units:

- The ***bus interface unit*** (**BIU**) and the
- ***Execution unit*** (**EU**).

Each unit has dedicated functions and both operate at the same time. This parallel processing makes the fetch and execution of instructions independent operations. See Fig. 2

The BIU is responsible for performing all external bus operations, such as instruction fetching, reading and writing of data operands for memory, address generating, and inputting or outputting data for input/output peripherals. These operations are take place over the system bus. This bus includes **16-bit bidirectional data bus, a 20-bit address bus, and the signals needed to control transfer over the bus.**

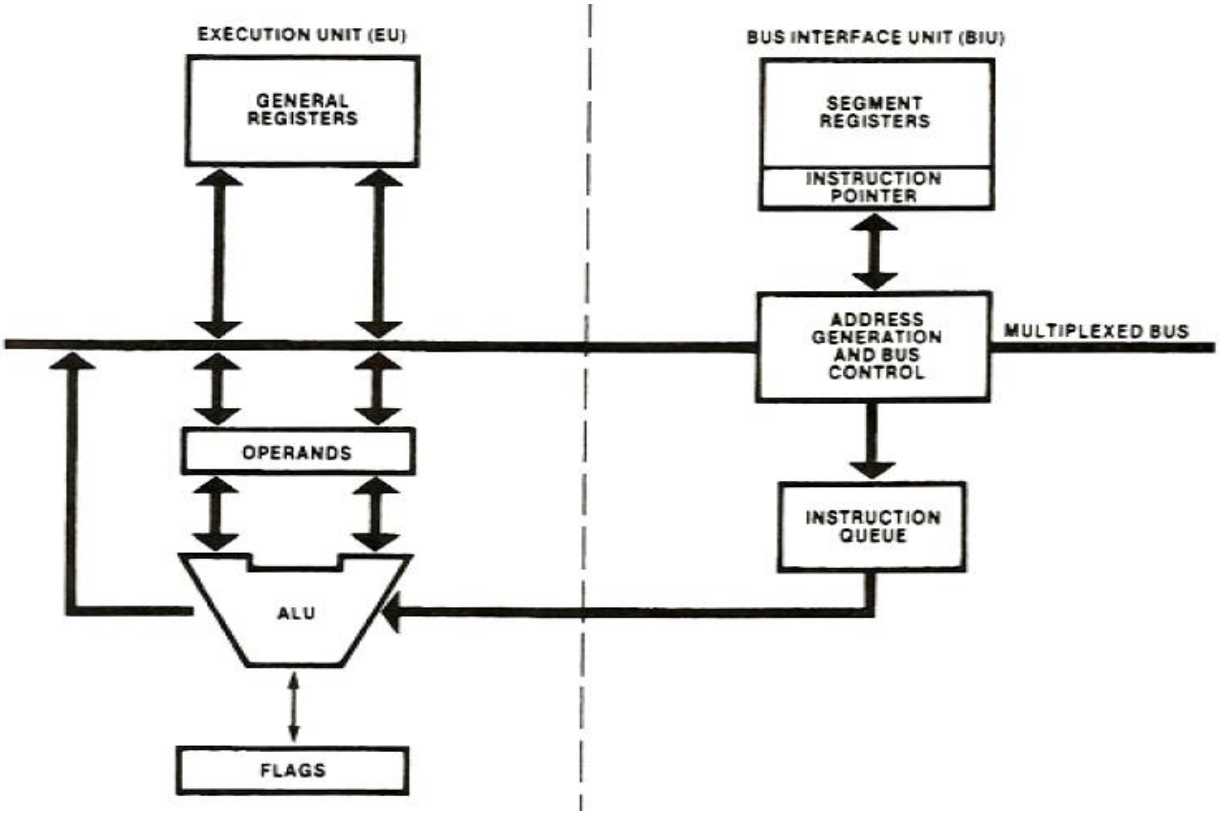

Fig 2: Execution and bus interface units

The BIU uses a mechanism known as *instruction queue.* This queue permits the 8086 to prefetch up to 6 bytes of instruction code.

The EU is responsible for decoding and executing instructors. It contains *arithmetic logic unit* (ALU), status and control flags, general-purpose register, and temporary-operand registers.

8086 contains three types of buses

1- **Data buses: connect MP and memory (data transfer 16-bit)**
2- **Address buses: connect MP and memory (address transfer 20-bit)**
3- **Control buses: control the previous buses**

Software model of 8086 microprocessor

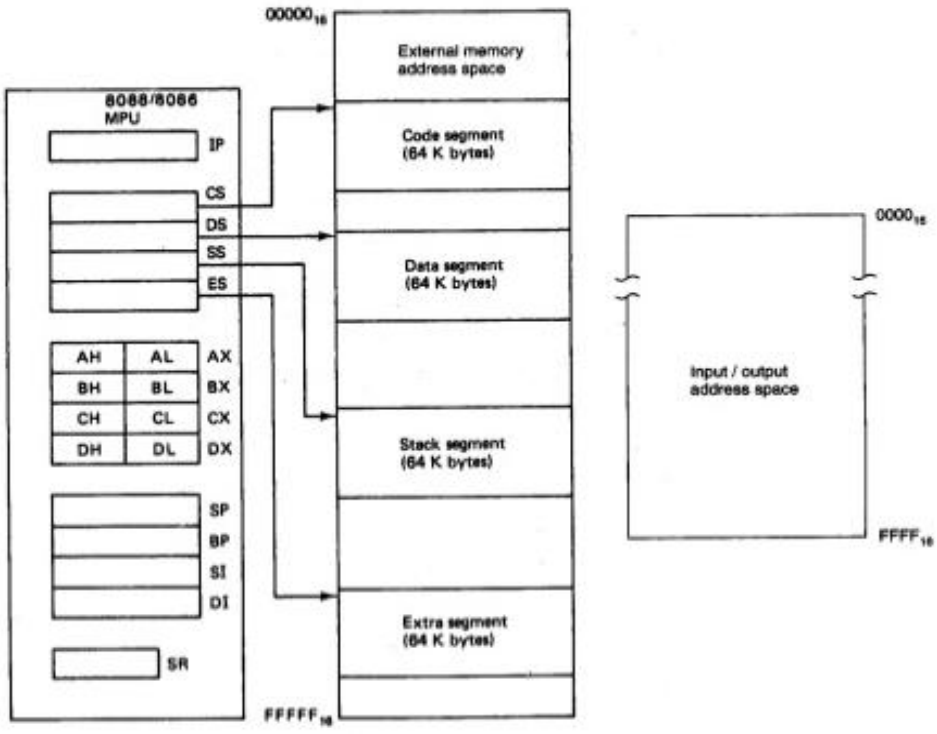

Fig3: Software model of 8086 microprocessor

Even though the 8086 has a 1Mbyte address space, not all this memory is active at one time. Actually, the 1Mbytes of memory are partitioned into 64Kbyte (65,536)

segments. Each segment is assigned a *Base Address* that identifies its starting point (identify its lowest address byte-storage location). **Only four of these 64Kbyte segments are active a time: the *code segment, stack segment, data segment,* and *extra segment.***

The addresses of these four segments are held in four segment registers:

- **CS** (code segment),
- **SS** (stack segment),
- **DS** (data segment), and
- **ES** (extra segment).

These registers contain a 16-bit base address that points to the lowest addressed byte of the segment (see Fig 3). Note that the segment registers are *user accessible*. This means that the programmer can change their contents through software. There is one restriction on the value assigned to a segment as base address: it must reside on a 16-byte address boundary. This is because the memory address is 20 bits while the segment register width is 16 bits. Four bits (0000) must be added to the segment register content to evaluate the segment starting address.