Microprocessor and Assembly Language CSC-321

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Microprocessor Organization

THE CPU

CPU

- Brain of Computer; controls all operations
  - Uses Memory Circuits to store information
  - Uses I/O Circuits to communicate with I/O Devices
- Executes programs stored in memory
  - System programs
  - Application programs
- **Instruction Set:** Instructions performed by CPU
- Two main components:
  - Execution Unit (EU)
  - Bus Interface Unit (BIU)

Execution Unit (EU)

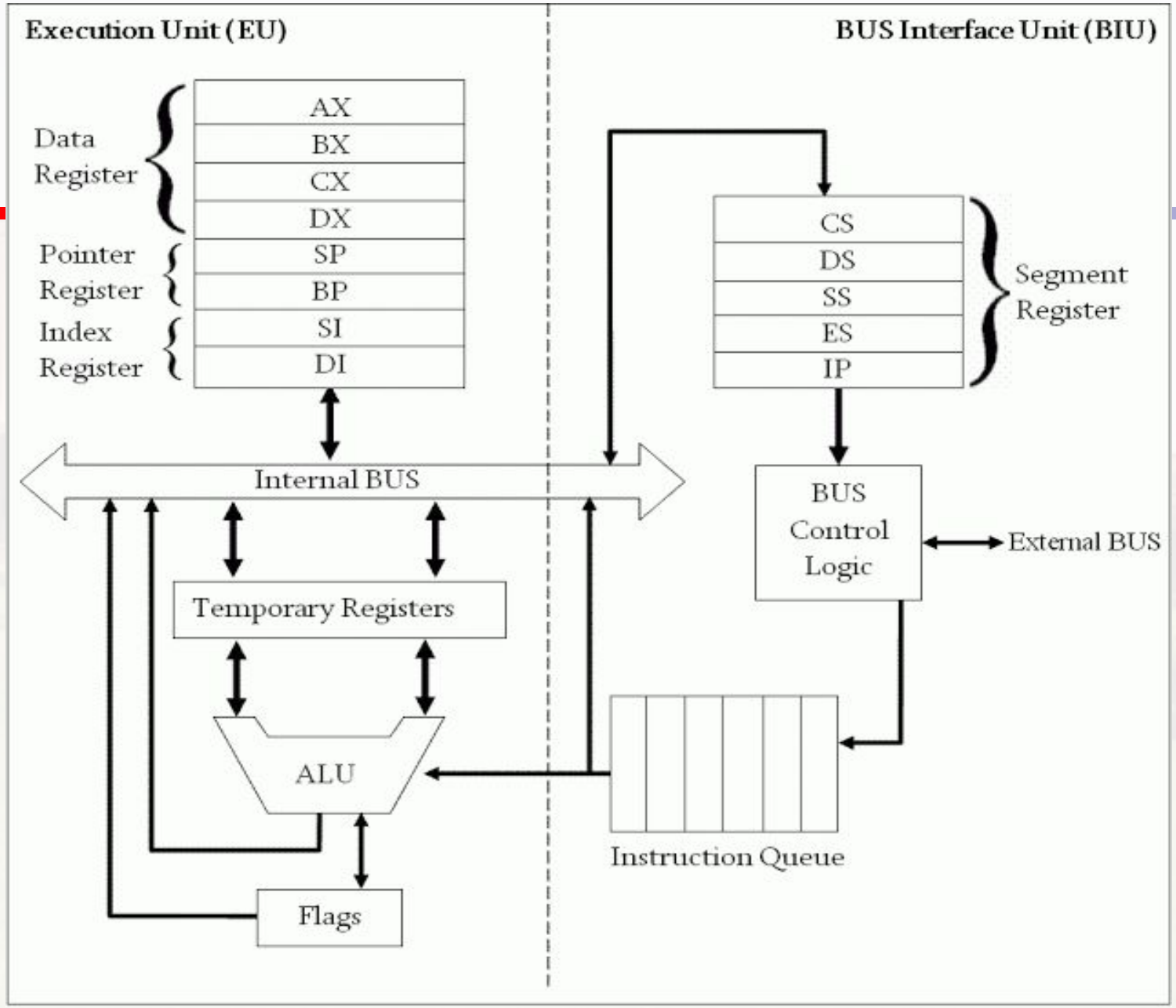
- Purpose: Execute instructions
- Contains ALU (Arithmetic & Logic Unit)
  - To perform arithmetic (+, -, x,/) and logic (AND, OR, NOT) operations.
- The data for the operations are stored in circuits called **Registers**.
- A register is like a memory location except that it is referred by a name not a number (address).
- EU uses registers for:
  - Storing data.
  - Holding operands for ALU
  - To reflect result of a computation – FLAG register

Bus Interface Unit (BIU)

- Facilitates communication between the EU and the memory or I/O circuits.
- Responsible for transmitting address, data and control signals on the buses.

Internal Bus

- The EU and BIU are connected by an internal bus and they work together.
- While EU is executing, the BIU fetches up to six bytes of the next instruction and places them in the instruction queue.
  - Instruction Pre-fetch
  - Purpose: Speed up the processor
- If the EU needs to communicate with memory or the peripherals, the BIU suspends instruction pre-fetch and performs the needed operations.



Intel 8086 Microprocessor Organization

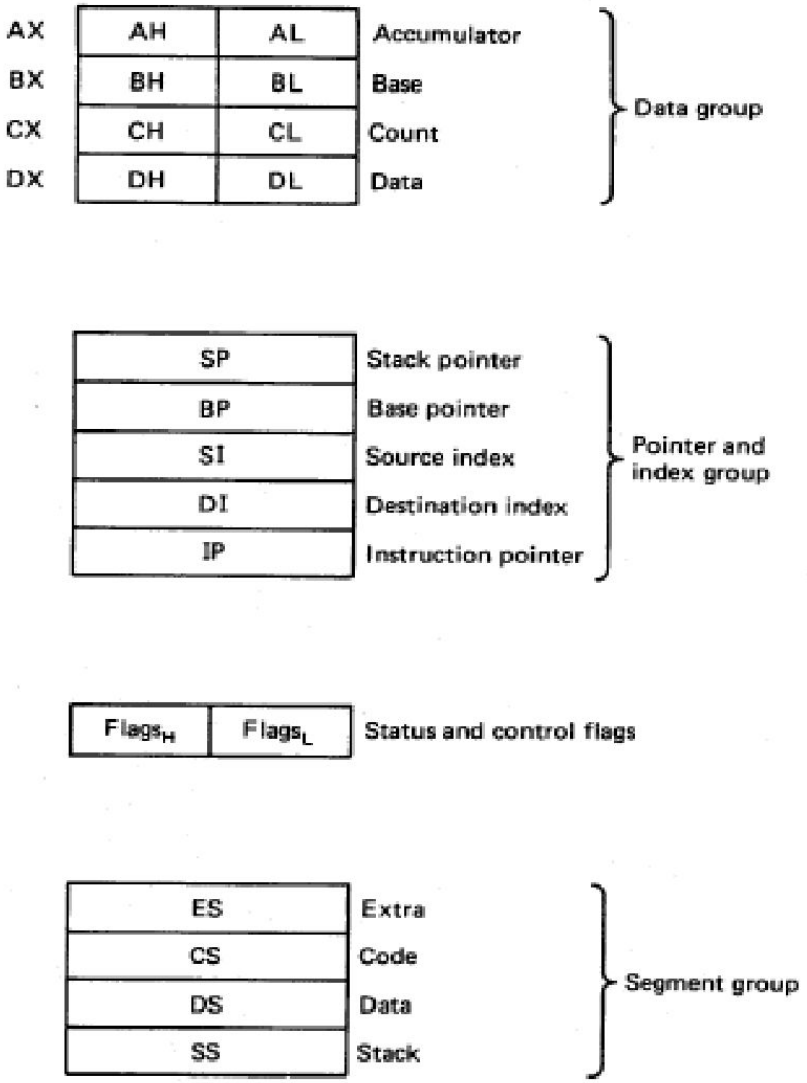
REGISTERS

Registers

- Registers are high-speed storage locations inside the microprocessor.
- Designed to be accessed at much higher speed than conventional memory.
- Registers are classified according to the functions they perform.
- General Types of Registers:
  - **Data Registers**: To hold data for an operation.
  - **Address Registers**: To hold the address of an instruction or data.
  - **Status/Flag Register**: keeps the current status of the processor or result of an arithmetic operation.

  - The 8086 has four general data registers.
  - The address registers are divided into segments, pointer and index registers.
  - The status register is called the FLAG register.

8086 Internal registers 16 bits (2 bytes each)



AX, BX, CX and DX are two bytes wide and each byte can be accessed separately

These registers are used as memory pointers.

6 status; 3 control ; 7 unused

Segment registers are used as base address for a segment

General Purpose/Data Registers

- Following four registers are available to the programmer for general data manipulation:
- **AX (Accumulator):** Used in arithmetic, logic and data transfer instructions. Also required in multiplication, division and input/output operations.
- **BX (Base):** It can hold a memory address that points to a variable.
- **CX (Counter):** Act as a counter for repeating or looping instructions. These instructions automatically repeat and decrement CX and quit when equals to 0.
- **DX (Data):** It has a special role in multiply and divide operations. Also used in input/output operations.

Segment Registers

- Store addresses of instruction and data in memory.
- These values are used by the processor to access memory locations.
- **CS (Code)**: Defines the starting address of the section of memory holding code.
- **DS (Data)**: Defines the section of memory that holds most of the data used by programs.
- **ES (Extra)**: This is an additional data segment that is used by some of the string instructions.
- **SS (Stack)**: It defines the area of the memory used for stack

Pointers and Index Registers

- These can be accessed only as 16 bit registers.
- **IP - instruction pointer**: Always points to next instruction to be executed. IP register always works together with CS segment register.
- **SI - source index register**: Can be used to point to memory locations in the data segment addressed by DS. Offset address relative to DS.
- **DI - destination index register**: performs same function as SI. The string operations use DI to access memory locations addresses by ES. Offset address relative to ES
- **SI** and **DI** used in string movement instructions.
- **SP** and **BP** are used to access data inside the stack segment
- **BP - base pointer**: Primarily used to access parameters passed via the stack. Offset address relative to SS
- **SP – stack pointer**: Always points to top item on the stack. Offset address relative to SS

FLAGS

- The purpose of the FLAGS register is to indicate the status of the microprocessor. It does this by the setting of individual bits called flags.
- There are two kinds of flags: status flags and control flags.
- The status flags reflect the result of an instruction. For example, when a subtraction operation results in a 0, the ZF (zero flag) is set to 1 (true).
- .The control flags enable or disable certain operations of the processor. For example, if the IF (interrupt flag) is cleared (set to 0), inputs from the keyboard are ignored by the processor.

80386 Extended Registers

- The 80386/80486 processor contain 32-bit registers which greatly improve the efficiency of program that take advantage of them.
  - EAX, EBX, ECX, EDX,
  - EFLAGS
  - EIP
  - EBP, ESP, ESI, EDI.