

Microprocessors and Micro controllers

CSE3815

Fairuz Bilquis Khan

April 2024

Evolution of Microprocessors

There should be overview chart of difference between intel 4004 to pentium 4.

Microprocessors:

'-->Is a semiconductor device consisting of electronics logic circuit.
'--->Manufactured by using various fabrication schemes.
'---->Capable of performing computing functions.
'----->Capable of transporting data/information.

Can be divided into 3 segments:
 (-)Arithmetic and logic unit
 (-)Registers unit
 (-)Control unit

Von Neumann Machine:

Von Neumann machine may refer to: Von Neumann architecture, a conceptual model of nearly all computer architecture

Three key concepts:
(-)Data and instructions are stored in a single set of read-write memory.
(-)Contents of memory are accessed by memory address without regard to the type of data.
(-)Execution occurs in a sequential fashion, unless explicitly stated otherwise.

Computer System Components:

(-) Memory:
 Stores data and instructions.
(-) Input/Output:
 Called peripherals.
 Used to input and output data and instructions.
(-) Arithmetic and Logic Unit:
 Performs arithmetic(+, -) operations.
 Performs logical(AND, OR, XOR, Shift, Rotate) operations.
(-) Control Unit:
 Coordinates the execution of instructions by managing the flow of data between the CPU's components.
(-) System Interconnection and Interaction:
 (+)BUS: A group of lines used to transfer bits between µp and other components.
 Bus is used to communicate between parts of the computer. There is only one transmitter at a time and only the addressed device can respond.
 ^types:
 >> address
 >> data
 >> control

CPU Components:

(-) Registers:

Small, fast storage in the CPU for data, instructions and other items.
Includes the program counter (PC) and memory address registers (MAR).
These registers need to match the width of the address bus for proper memory access.

Data registers should match memory word size for efficient data transfer.

(-) Control Unit:

Generates control signals which are necessary for execution of instructions.
Connect registers to the bus.

Controls the data flow between CPU and peripheral components.

Provides status, control and timing signals required for the operations of memory and I/O devices.

Acts as a brain of computer system.

All actions of the control unit are associated with the decoding and execution of instructions(fetch and execute cycles).

(-) Arithmetic and Logic Unit:

Execute arithmetic and logical operations.

Accumulator is a special 8-bit register associated with ALU. Register 'A' in 8085 is an accumulator.

Source of one of the operands of an arithmetic or logical operation serves as one input to ALU.

Final result of an arithmetic or logical operation is placed in the accumulator.

Arithmetic and Logic Unit:

ALU performs the following arithmetic and logical operations:

- >> Addition
- >> Subtraction
- >> AND
- >> OR
- >> XOR
- >> NOT
- >> Increment
- >> Decrement
- >> Left Shift, Right Shift, Rotate .
- >> Clear etc.

Status Flag:

Intel 8085 microprocessor contains five flip-flops to serve as status flags. These flip-flops are set or reset according to the conditions which arise due to an arithmetic & logical operation.

Sign Flag (S): Indicates the sign of the result after an arithmetic operation.

Zero Flag (Z): Indicates whether the result of an operation is zero.

Auxiliary Carry Flag (AC): Indicates use for decimal arithmetic operations.

Parity Flag (P): Indicates the parity of the result.

Carry Flag (CY): Indicates whether there is a carry-out from the most significant bit.

next is difference between 8085 and 8086 architecture diagram (will add later . not needed for Ct)

The Microprocessor and its Architecture

Internal Microprocessor Architecture:

Program or instructions are written based of microprocessor's internal configuration. In multiple core processors, each core contains the same programming model. Each core runs as a separate task or thread simultaneously.

A thread consists of

- >> a program counter
- >> a register set, and
- >> a stack space

A task shares with peer threads its code section, data section and operating system resources.

The programming Models:

8086 through Core2 registers are considered program-visible. While other registers are considered program-invisible.

>> program-visible registers are used during programming while are directly specified by the instructions.

>> program-invisible registers are not addressable directly during applications programming.

80286 and above contain program-invisible registers to control and operate protected memory and other features of the microprocessor.

80386 through Core2 microprocessors contain full 32-bit internal architecture.

8086 through 80286 are fully upward compatible to the 80386 through Core2.

Intel Microprocessor Evolution:

4004 → 8008 → 8080 → 8085 → 8086/8088 → 80286 → 80386 → 80486 → Pentium → Pentium Pro → Pentium II → Pentium III → Pentium 4 → Core → Core 2

Multipurpose Registers:

RAX is a versatile register with different sizes: 64-bit as RAX, 32-bit as REAX (accumulator), 16-bit as AX, or split into two 8-bit registers, AH and AL.

EAX, known as the accumulator, handles math operations like multiplication and division.

Intel aims to extend the address bus to 52 bits, allowing access to 4 petabytes (4P) of memory.

Address Space(Main Memory: RAM):

- With a 16-bit address bus, it can access 64 kilobytes of memory.
- Expanding to a 20-bit address bus allows access to 1 megabyte.
- A 32-bit address bus extends access to 4 gigabytes.
- Progressing to a 34-bit address bus increases the capacity to 16 gigabytes.
- A 36-bit address bus reaches 64 gigabytes.
- Expanding further to a 38-bit address bus accesses 256 gigabytes.
- Intel's plan for a 52-bit address bus would enable access to a massive 1015 bytes of memory.
- **RBX:** Addressable as RBX, EBX, BX, BH, BL.
 - RBX register (base index) sometimes holds the offset address of a location in the memory system in all versions of the microprocessor.
- **RCX:** Addressable as RCX, ECX, CX, CH, or CL.
 - RCX, a (count) general-purpose register, also holds the count for various instructions.
- **RDX:** Addressable as RDX, EDX, DX, DH, or DL.
 - RDX, a (data) general-purpose register, holds a part of the result from a multiplication or part of the dividend before a division.
- **RBP:** Addressable as RBP, EBP, or BP.
 - RBP points to a memory (base pointer) location for memory data transfers.
- **RDI:** Addressable as RDI, EDI, or DI.
 - RDI often addresses the destination index string destination data for the string instructions.
- **RSI:** Addressable as RSI, ESI, or SI.
 - RSI, the source index register, addresses source string data for the string instructions. Like RDI, RSI also functions as a general-purpose register.
- **R8 - R15:** Found in the Pentium 4 and Core2 if 64-bit extensions are enabled.
 - Data are addressed as 64-, 32-, 16-, or 8-bit sizes and are of general-purpose.