2. Architecture
What does a Microprocessor do?

• Move Data
• Manipulate Data
• Make Decisions
Major Components

- Central Processing Unit (CPU) – decodes instructions and use them to control activity within system; performs arithmetic and logical operations
- Memory – stores data and instructions currently being used
- Input/Output (I/O) Devices– facilitate communication with external world or provide data storage
- System Bus – connects system components. Consists of Data Bus, Address Bus and Control Bus
CPU

- Internal Components:
  - Control Logic – controls the flow of operands and results
  - Arithmetic Logic Unit (ALU) – performs arithmetic and comparison operations
  - Data Registers – hold operands and results
  - Pointers – base and index registers used to compute memory offsets
  - Segments Registers – used to compute physical memory addresses
  - Instruction Queue – 6-byte FIFO that holds either current or next instruction
  - Program Status Word (PSW) – holds flags that reflect results or control execution
• Instruction Cycle:
  o Fetch – instruction read from memory into Instruction Queue
  o Decode – based on instruction, Control Logic routes operands from registers or memory to ALU, and fires ALU function
  o Execute – based on instruction, Control Logic stores results from ALU to registers or memory and updates PSW

• Can manipulate byte (8-bit), words (16-bit) and double-words (32-bit) data types
Memory

- Used to store:
  - Code – machine language instructions for a program
  - Data – program information such as unsigned numbers, signed numbers and ASCII codes.
  - Stack – temporary program information such as return addresses, saved registers or passed data
- Basic memory unit is byte (byte-addressable)
- Multi-byte values stored in “little-endian” (low order byte at lower address)
- Memory Space is 1 Mega-Byte (20 address lines)
- Organized on 64K “Segments” and can start at any modulo 16 address
- Example: DOS Memory Map:

```
+-----------------+-----------------+-----------------+-----------------+
| ROM             | Video Memory    | RAM             | RAM             |
| (BIOS & Extensions) |               | (DOS & User Programs) | (BIOS Data)     |
| 80000           |                 | 00000           | 00000           |
| RAM             |                  | RAM             |                  |
| (Interrupt Vector Table) |       |                  |                  |
| 00000           |                  | 00400           |                  |
```
I/O Devices

- Accessible through “ports”
- Ports can be “memory mapped” or part of the “I/O Space”
- I/O Space is a 64K region separate from memory (16-address lines)
- Special CPU instructions used to read and write from I/O space
System Bus

- Consists of:
  - Data Bus (16-bits) – move data between CPU, memory and I/O
  - Address Bus – select memory (20-bits) or I/O location (16-bits)
  - Control Bus – control how data is transferred (bus cycle type, data size, direction, etc.)

- Bus Cycle Types:
  - Memory Read (MEMR) – CPU “fetch” instructions or read data from memory
  - Memory Write (MEMW) – CPU writes data to memory
  - I/O Read (IOR) – CPU reads from “port”
  - I/O Write (IWR) – CPU writes to “port”