Computers Architecture

Lecture 3

Basic architecture

Some Important Terminology

How much memory?

- a ***bit*** is a binary digit that can have the value 0 or 1.
- A ***byte*** is defined as 8 bits.
- A ***nibble*** is half a byte, or 4 bits.
- A ***word*** is two bytes, or 16 bits.
- A ***kilobyte (K)*** is 2^{10} bytes, which is 1024 bytes.
- A ***megabyte (meg)*** is 2^{20} bytes or 1024 K.
- A ***gigabyte*** is 2^{30} bytes or 1024 meg.
- A ***terabyte*** is 2^{40} bytes or 1024 gig.

Inside the Computer

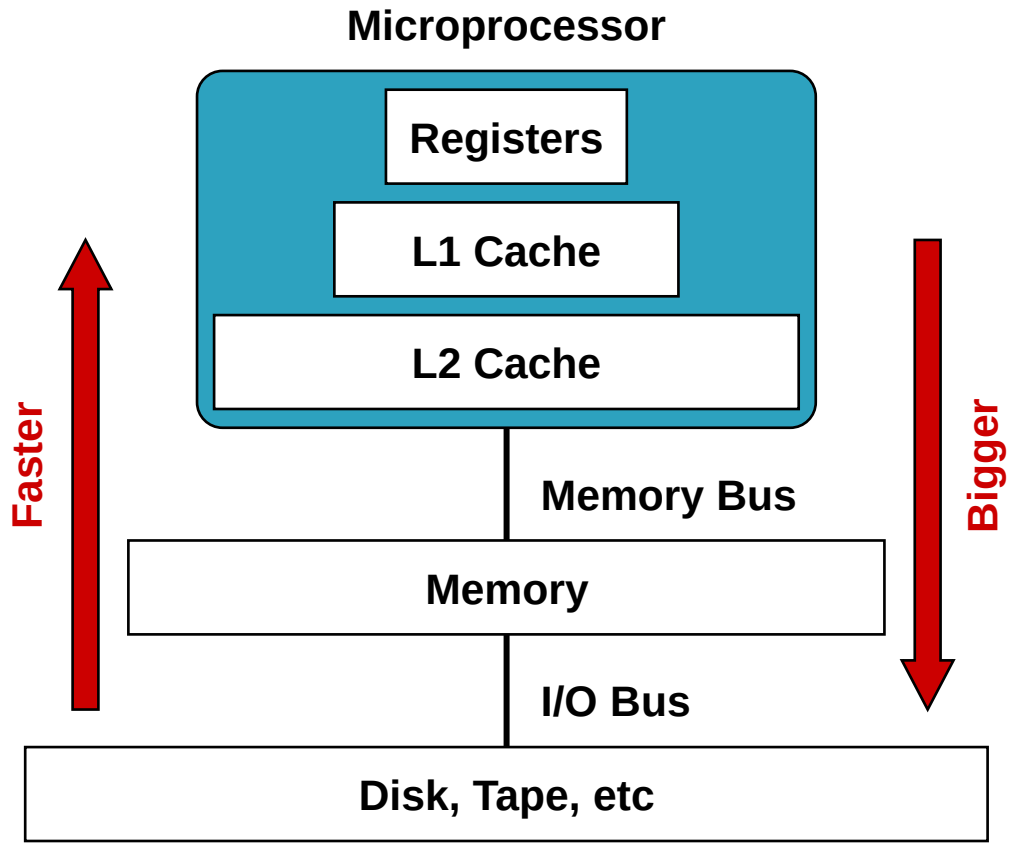
Two types of memory used in microcomputers are *RAM and ROM.*

- **RAM**
  - RAM stands for random access memory (called *read/write memory).*
  - RAM is used by the computer for temporary storage of programs that it is running.
  - RAM is sometimes called *volatile memory.*
- **ROM**
  - ROM stands for read-only memory. It contains programs and information essential to operation of the computer.
  - It is called *nonvolatile memory.*

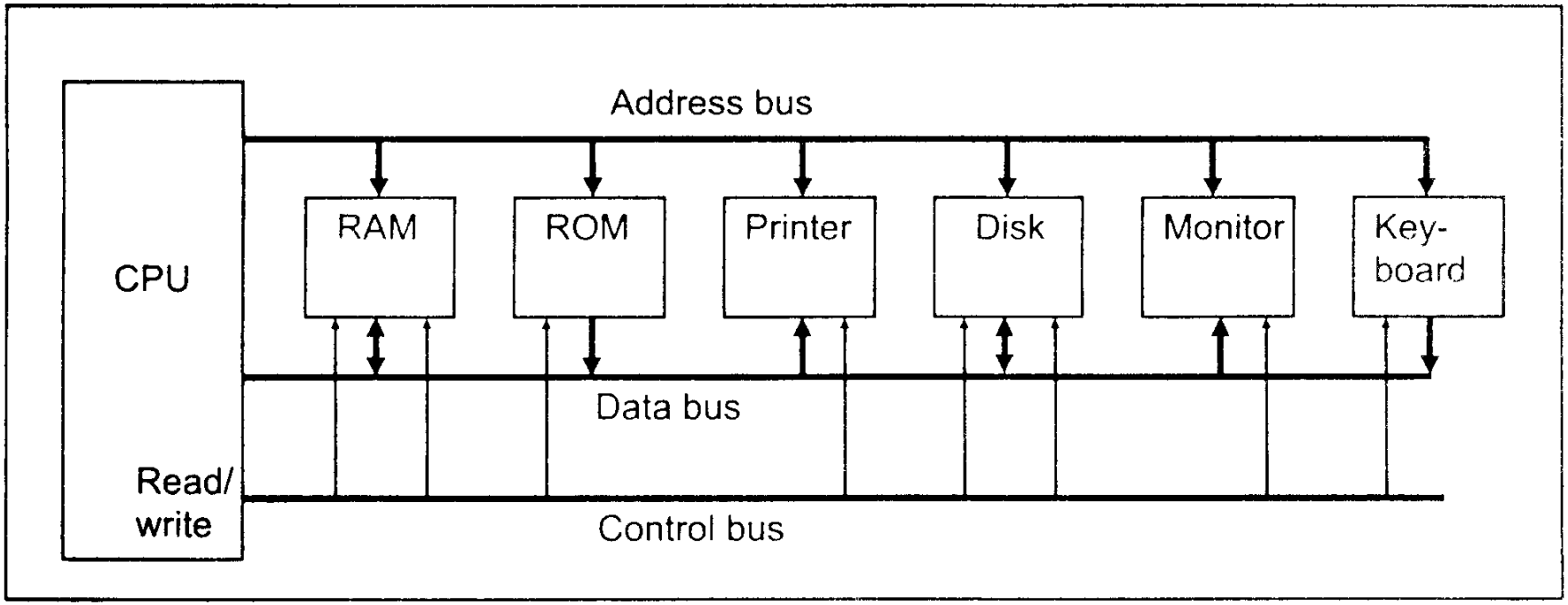
Inside the Computer

- Cache
  - A very fast type of RAM that is used to store information that is most frequently or recently used by the computer
  - Recent computers have 2-levels of cache; the first level is faster but smaller in size (usually called internal cache), and the second level is slower but larger in size (external cache).

Typical Memory Hierarchy



Internal organization of computers



Internal organization of computers

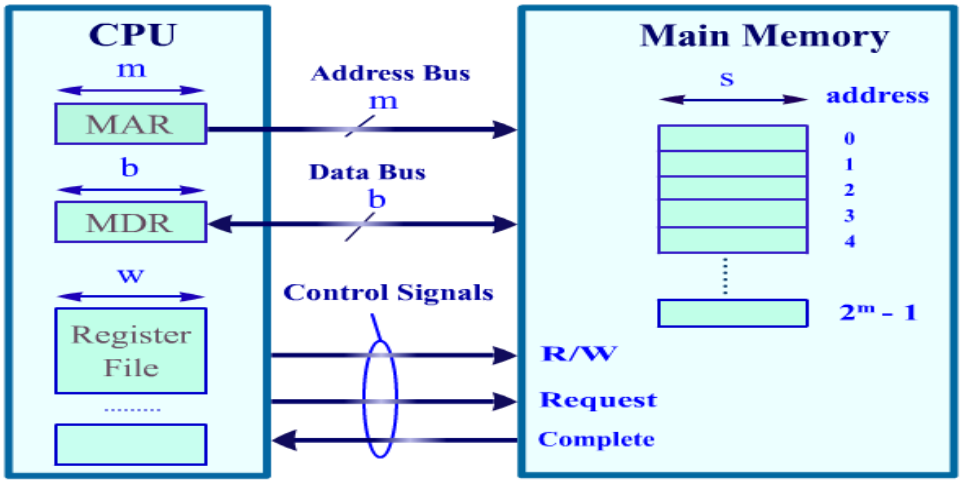
- ***CPU*** **(Central Processing Unit). Its function is to execute (process) information stored in memory.**
- ***I/O*** **(Input/Output) Devices. They provide a means of communicating with the CPU.**
- ***A Bus*** is a common group of wires that interconnect components in a computer system. The buses that interconnect the sections of a computer system transfer address, data, and control information between the microprocessor and its memory and I/O systems.

Internal organization of computers

- **The address bus** requests a memory location from the memory or an I/O location from the I/O devices. If I/O is addressed, the address bus contains a 16-bit I/O address from 0000H through FFFFH.
- **The data bus** transfers information between the microprocessor and its memory and I/O address space. Data transfers vary in size, from 8 bits wide to 64 bits wide in various members of the Intel microprocessor family.
- **The control bus** contains lines that select the memory or I/O and cause them to perform a read or write operation.

CPU Memory Interface

- Address Bus
  - Memory address is put on address bus
  - If memory address = m bits then 2^m locations are addressed
- Data Bus: b-bit bi-directional bus
  - Data can be transferred in both directions on the data bus
  - Note that b is not necessary equal to w or s. So data transfers might take more than a single cycle (if w > b) .
- Control Bus
  - Signals control transfer of data
  - Read request
  - Write request
  - Complete transfer

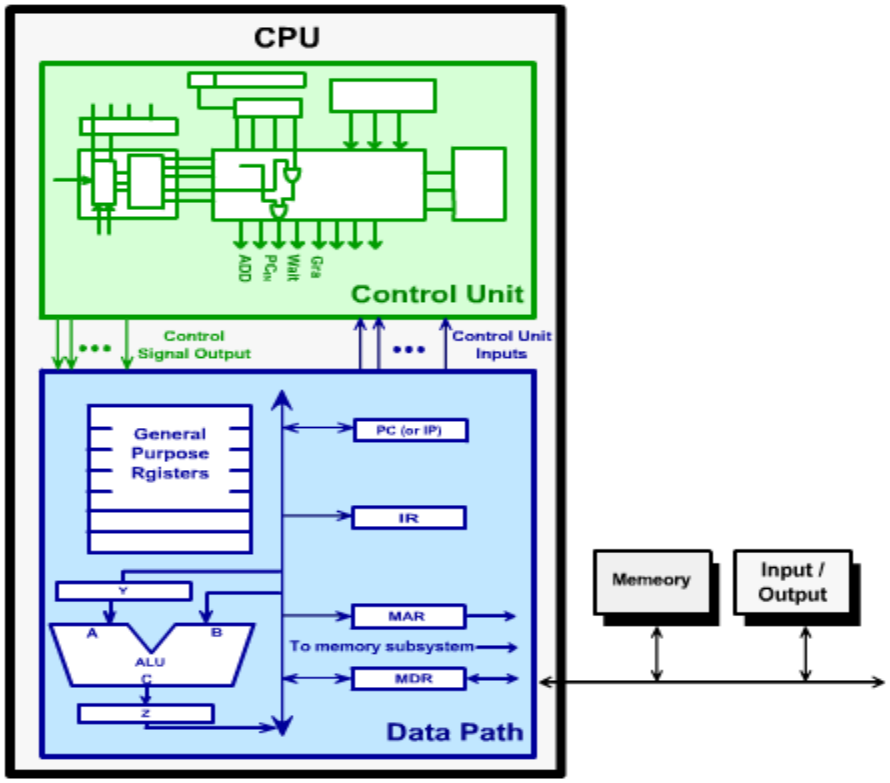


Brief History of the CPU

- The heart of the computer system is the microprocessor integrated circuit.
- The microprocessor, sometimes referred to as the CPU is the controlling element in a computer system.
- The microprocessor controls memory and I/O through a series of connections called buses.
- The microprocessor performs three main tasks for the computer system:
  1. data transfer between itself and the memory or I/O systems.
  2. simple arithmetic and logic operations.
  3. program flow via simple decisions. Albeit these are simple tasks, but through them, the microprocessor performs virtually any series of operations or tasks.

Processor (CPU)

- Processor consists of
  - Data path
    - ALU
    - Registers
  - Control unit
- ALU
  - Performs arithmetic and logic instructions
- Control unit (CU)
  - Generates the control signals required to execute instructions



implementation varies from one processor to another

Brief History of the CPU

- 8080: The world's first 8-bit general-purpose microprocessor.
- 8086: A far more powerful, 16-bit machine.
- 80286: This extension of the 8086 with memory 16-MByte.
- 80386: Intel's first 32-bit machine,
- 80486: Full cache technology and sophisticated instruction pipelining.
- Pentium: Intel introduced the use of superscalar techniques.
- Pentium Pro: Move into superscalar organization.
- Pentium II: The Pentium II incorporated Intel MMX technology.
- Pentium III: Additional FP instructions to support 3D graphics.
- Pentium 4: Additional FP and other enhancements for multimedia.
- Itanium: This new generation of Intel processor makes use of a 64-bit organization with the IA-64 architecture.

Brief History of the CPU