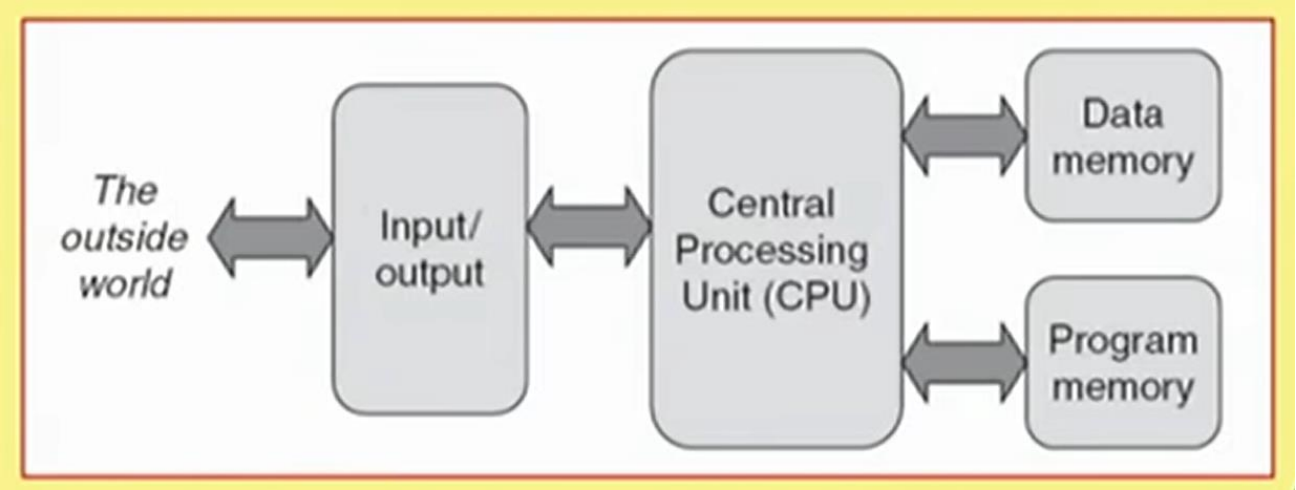
Lecture 1 – Microprocessors and Microcontrollers

Topics

- Classification of computer architecture
- Characteristics of a microprocessor
- Characteristics of a microcontroller

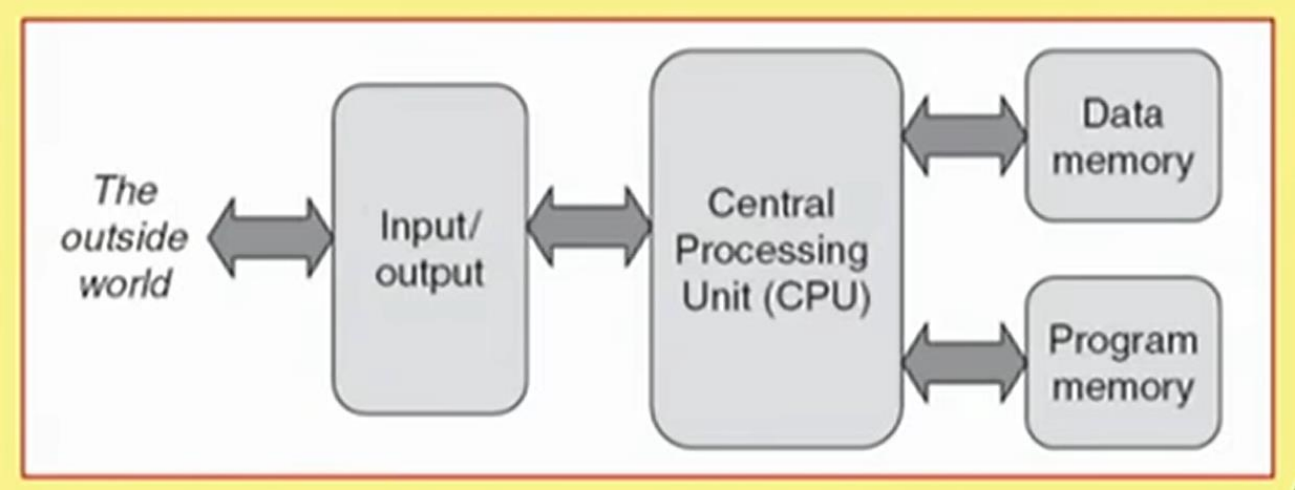
Basic Operation of a Computing System

- The Central processing unit (CPU) carries out all computation
  - Fetches instructions from the program memory and executes
  - May require access to data in data memory



Basic Operation of a Computing System

- The input/output block provides interface with the outside world
  - Allows users to interact with the computing system
  - Observe the output results



Instructions sets

- Any CPU has an instruction set architecture (ISA)
- This is one way in which to classify computers
- CISC – complex instruction set computer
  - Typically in desktops, laptops, serveys
  - Intel dominated
- RISC – reduced instruction set computers
  - Typically used in microcontrollers that are used to build embedded systems

Memory categorization

- Two different types of memory
- Random Access Memory (RAM)
  - Volatile
  - Used for data memory in microcontroller
- Read Only Memory (ROM)
  - Non-volatile
  - Use for program memory in micrcontrollers

CPU hardware architectures

- Broadly two types of architectures

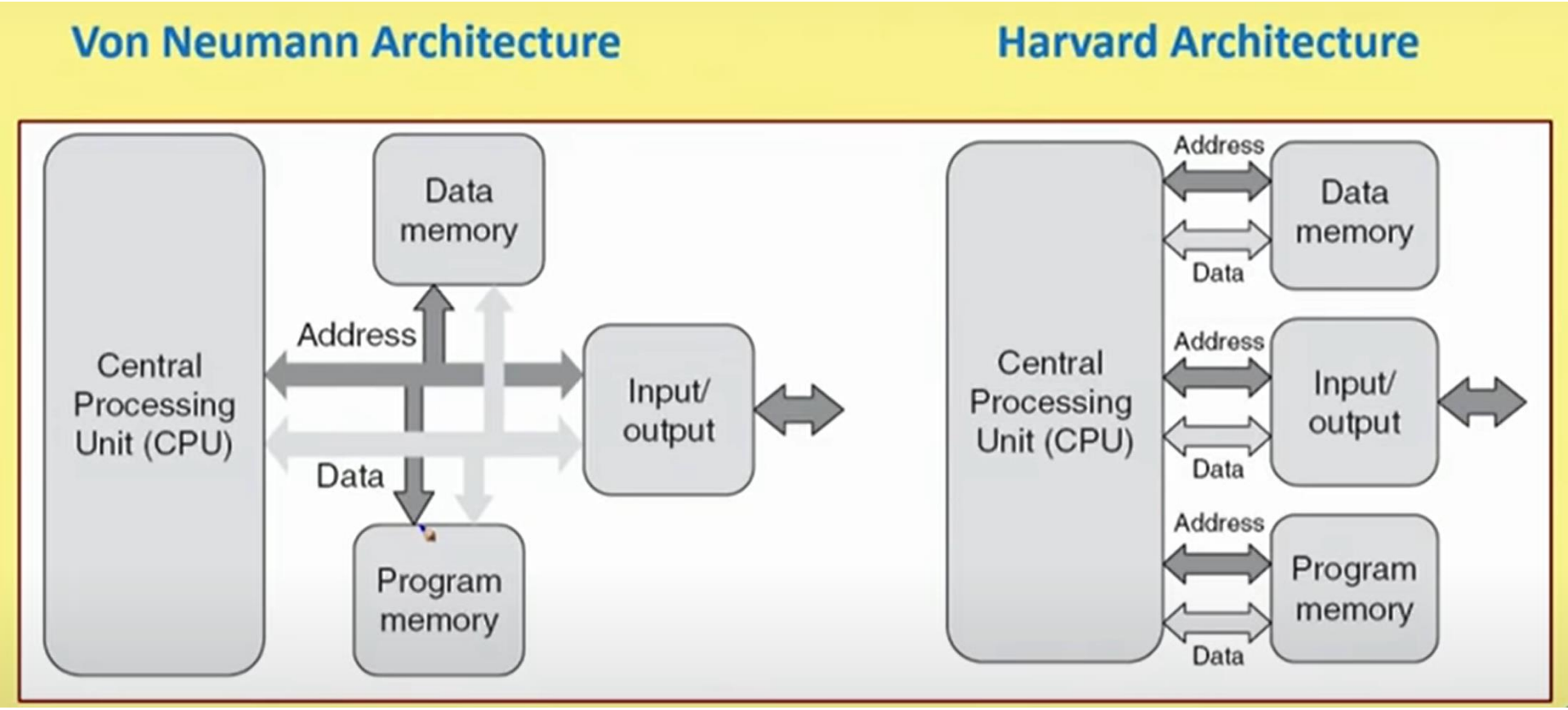
1. Von Neuman Architecture
   - Both instruction and data are stored in the same memory
   - This model is followed in conventional computing systems

CPU hardware architectures

2. Harvard Architecture

- Instructions and data are stored in separate memories
- Typically followed in microcontrollers
- Instructions are stored in a ROM (permanent)
- Temporary data is stored in RAM

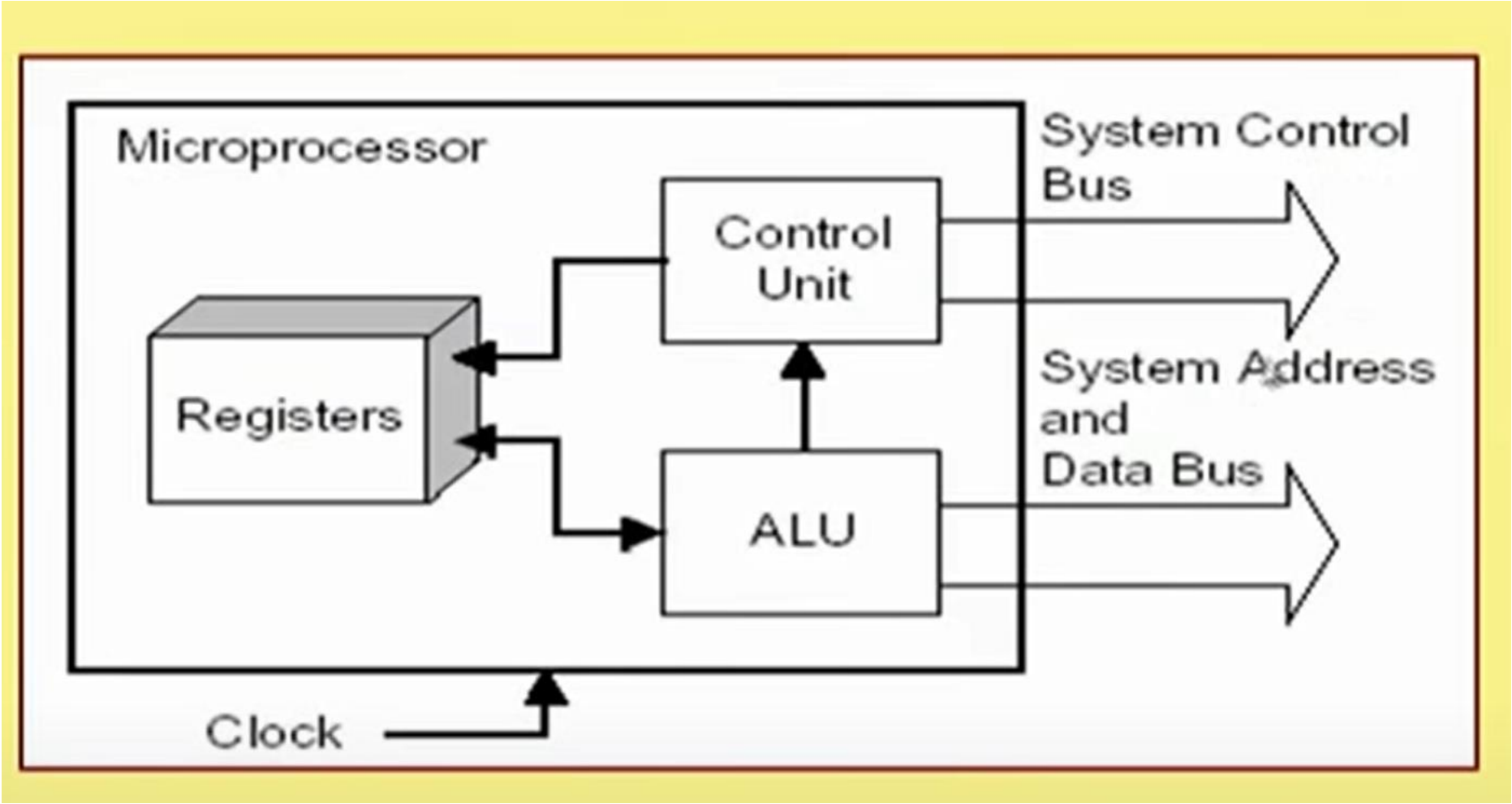
CPU hardware architectures



What is a microproccesor?

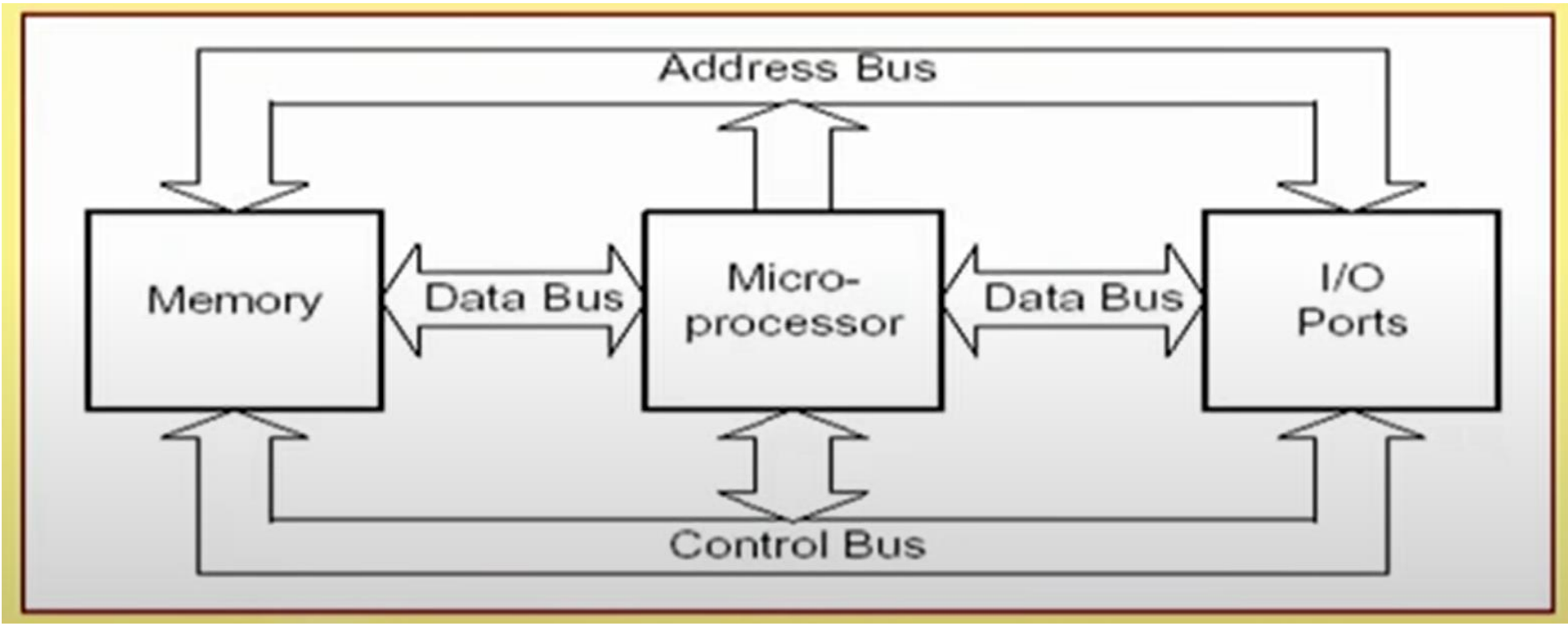
- A CPU fabricated on a single chip
  - Consists of a set of registers to store temporary data
  - Consists of an arithmetic logic unit (ALU)
  - Some mechanism to interface external devices (memory and I/O) through busses (address, data and control)
  - Consists of a control unit (pointer) that synchronizes the operation

Microprocessor architecture



What is microcomputer

- A computer that is built using a microprocessor

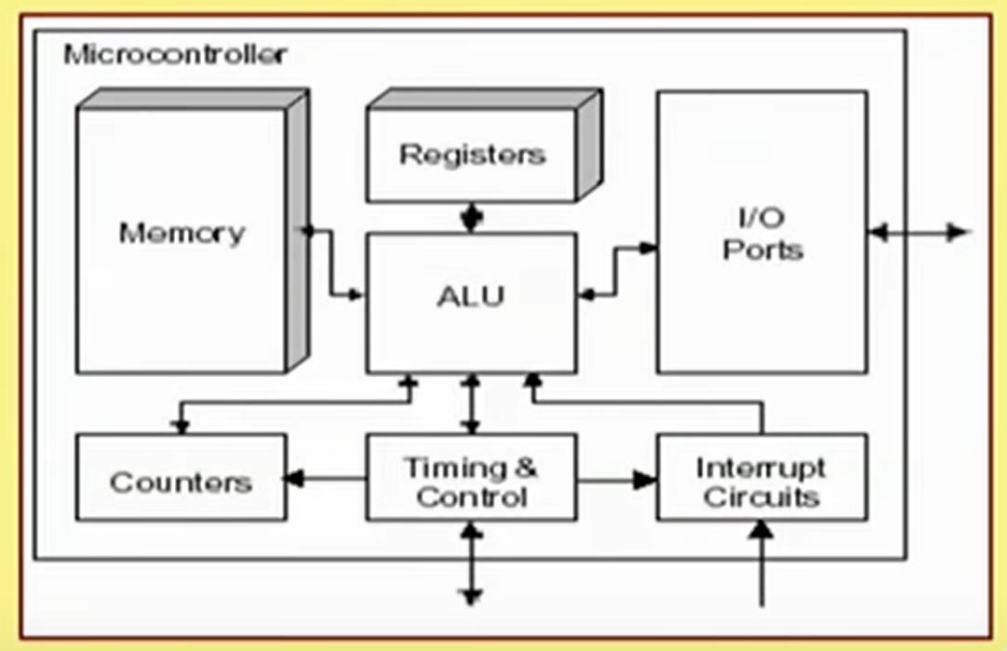


What is microcomputer

- Since a microprocess does not contain memory and I/O, we have to interface these separately to build a microcomputer
  - Too complex and expensive for very small and low-cost embedded systems

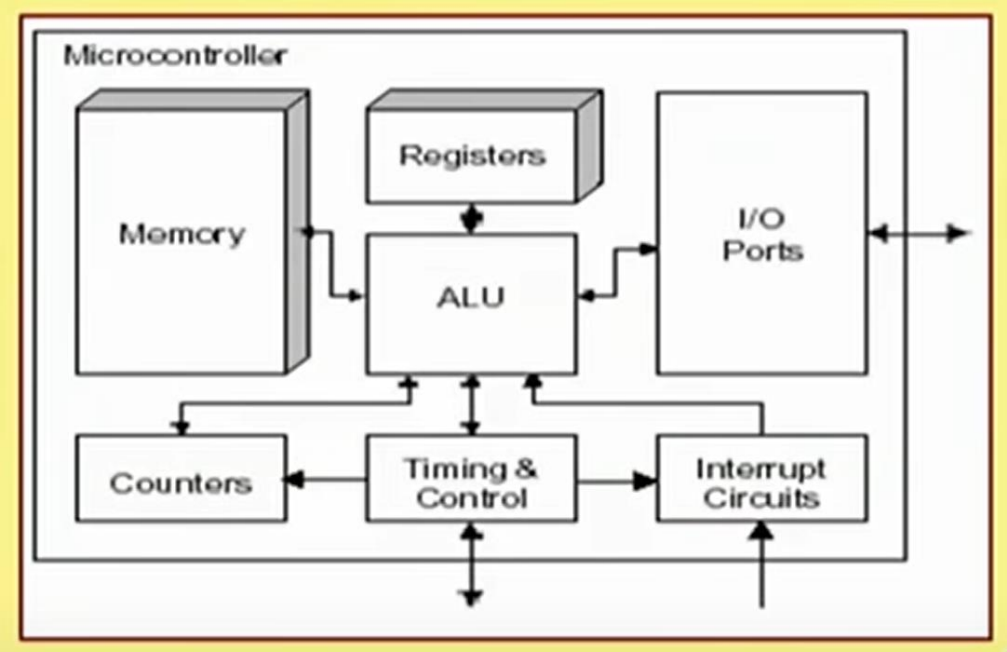
What is a Microcontroller

- It is basically a computer on a single chip
  - Very inexpensive, small, low power
  - Convenient for embedded system design

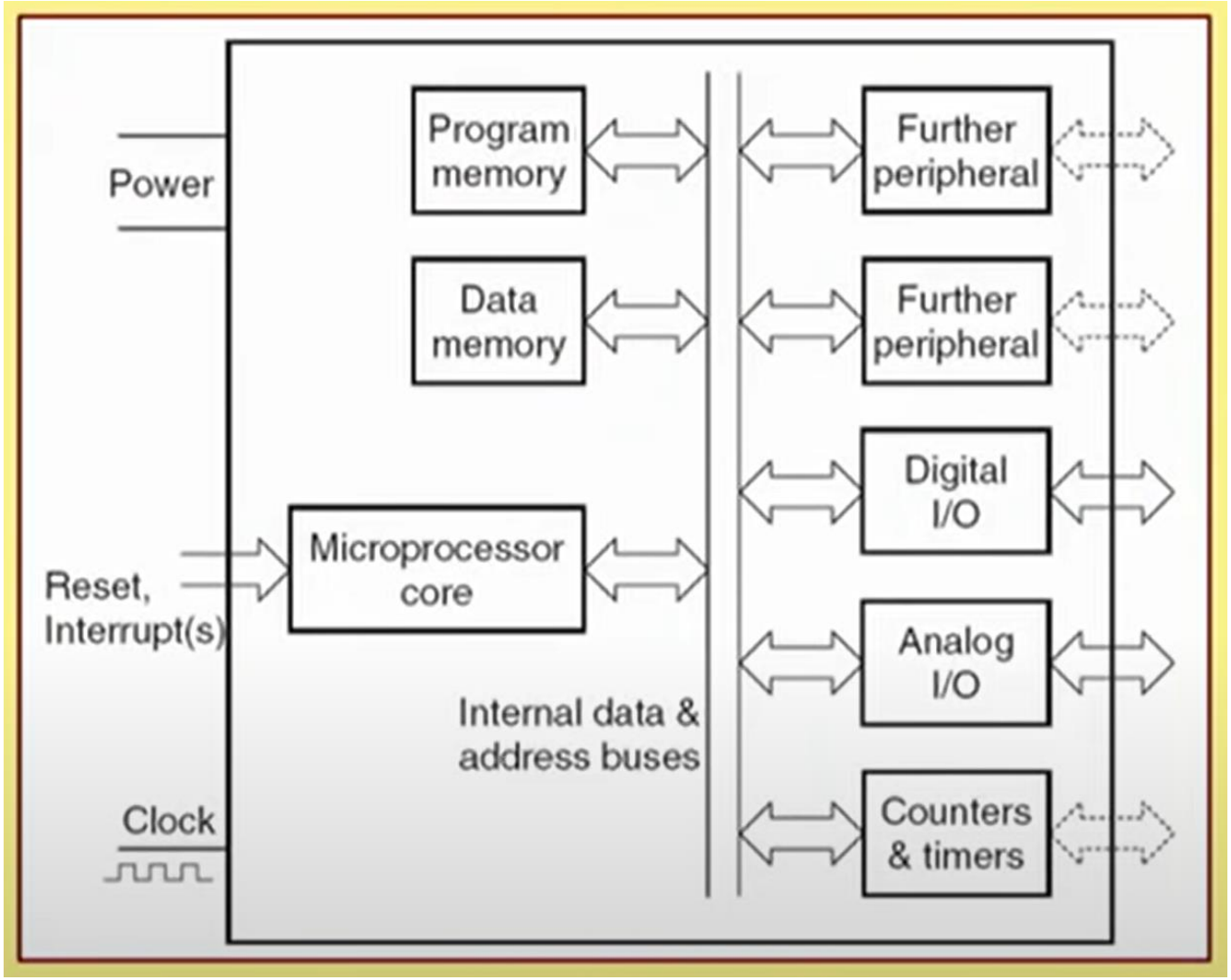


What is a Microcontroller

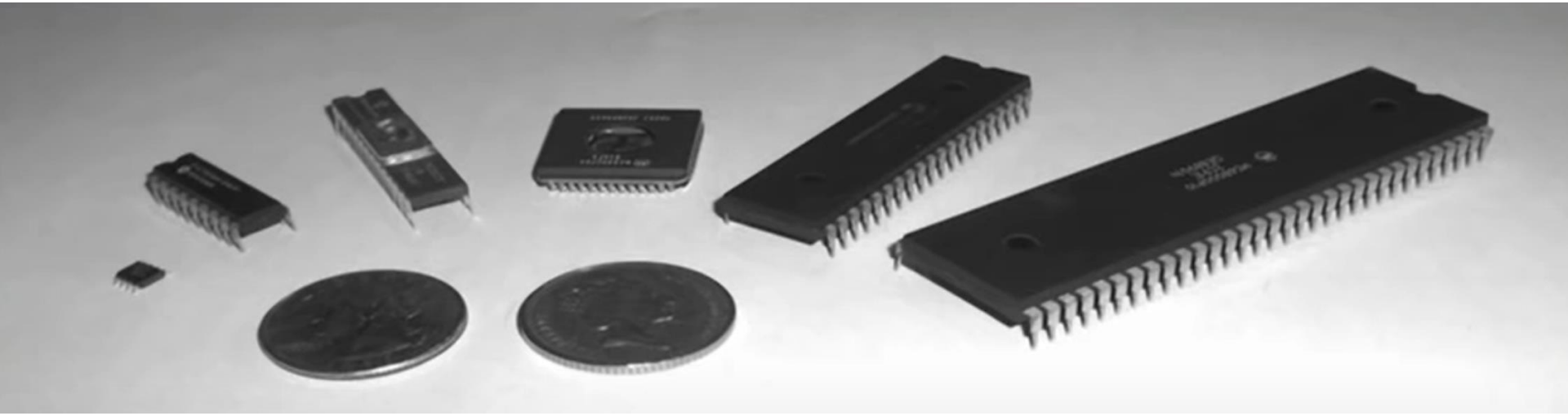
- It operates on data that are fed through it serial or parallel input ports, controlled by the software stored in on-chip memory



More detailed architecture



Microcontroller packaging



How Microcontrollers are different from PCs?

- When a PC executes a program, the program is in SSD/HDD into an allocated section of memory
  - Usually the program is loaded part by part to conserve memory space
  - There is a complicated operating system that handles all low-level operations

How Microcontrollers are different from PCs?

- In a microcontroller there is no disk to read from
  - On-chip ROM stores the program that is to be executed
  - Size of the ROM limits the maximum size of the program
  - **No operating system**

Where are Microcontrollers Used?

- Typically in applications where processing power is not critical
  - Modern day household has 50 such devices
- One third of the applications are in the office automation segment
- Rest one third in automotive and communication applications

Evolution of Microcontrollers

- Microcontrollers evolved from a microprocessor-based board-eleve design to a sing chip in the mid 1970's
- In the mid 1980's, microcontrollers got embedded into a larger ASIC
  - Microcontrollers are fabricated as a module inside a larger chip

Advantages of using Microcontrollers

- Fast and effective
- Low cost/Low power
- Compatibility
  - Opcodes and binaries are the same for all 80x51/AR/PIC variants