ECE 3120
Computer Systems

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- Today:
  - Basic Concepts
    - Computer Organization
    - Hardware
      - Processor
      - Memory
      - Input Devices
      - Output Devices

Computer Concepts

- Computer:
  - Hardware:
    - Processor: “brain”, CPU
      - Datapath: registers and ALU
      - Control unit: hardware instrucion logic.
    - Memory: place to store software programs and data
    - I/O devices: enter data/programs into the computer/display outputs
  - Software: programs
    - A program is a set of instructions that the computer hardware can execute.

Computer Organization

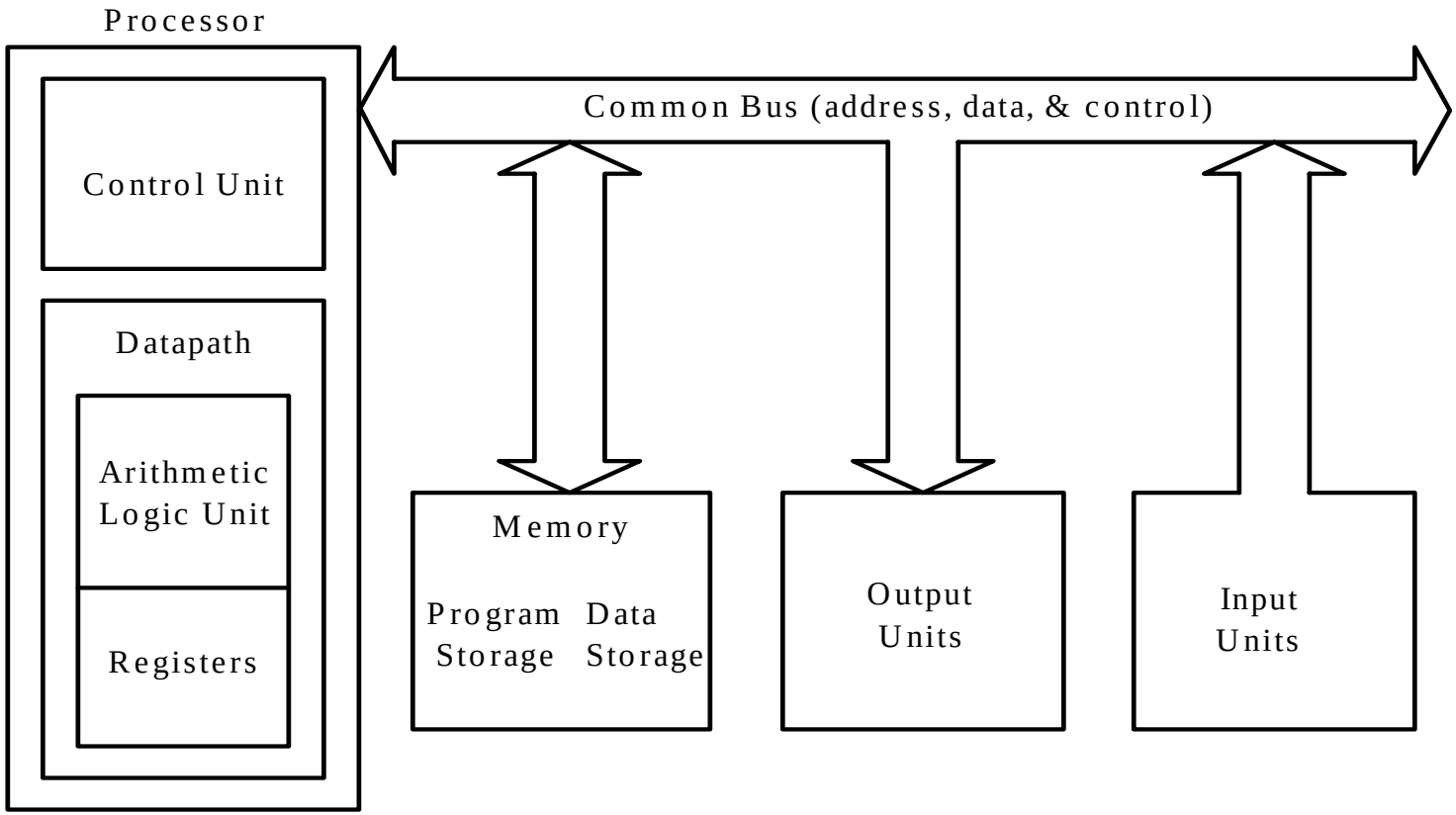


Figure 1.1 Computer Organization

Processor (Central Processing Unit)

- Datapath:
  - Register file: a register is a storage location within the CPU.
  - Arithmetic Logic Unit (ALU):perform all the arithmetic computations and logic evaluations.
- Control Unit:
  - Decodes and monitors the execution of instructions and coordinate the operations. The system clock synchronizes the activities of the CPU, which are measured by clock cycles. (GHz)
  - Maintain 2 registers:
    - PC: keeps track of the address of the next instruction to be executed
    - Status Register: flags the instruction execution result

Memory

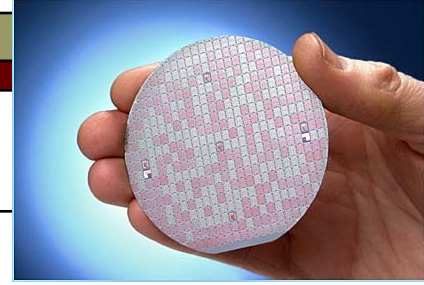
- Semiconductor memory, magnetic, optical memory.
- Semiconductor memory:
  - Random access memory (RAM):volatile
    - Dynamic RAM (DRAM): periodic refresh operations to maintain the stored information. Every a few milliseconds to over a hundred ms.
    - Static RAM (SRAM):no need to refresh. More transistors are used to hold one bit information.
  - Read-only memory (ROM): nonvolatile.
    - MROM: mask-programed ROM, programmed when being manufactured.
    - PROM: programmable ROM, one-time programmable ROM using PROM programmer/burner by end users.
    - EPROM: erasable PROM, strong ultraviolate light.erasable in bulk.
    - EEPROM: electrically EPROM, erased by elctrical signals and reprogrammed. Individual location.
    - Flash memory: take advantages of EPROM and EEPROM

I/O devices

- Input device
  - Allow users to enter data/programs into the computer so that computation can be performed.
  - Examples:

- Output device
  - Display results of computation so that users can read them and equipment can be controlled.
  - Examples:

Microprocessor



- A processor implemented on a single integrated circuit (IC). Peripheral chips are needed to construct a product. A microcomputer is a computer that uses a microprocessor as its CPU (such as today's desktop).
- Classifications: word length (number of bits that a microprocessor can manipulate in one operation).
  - 4-bit (intel 4004,1971), 8-bit, 16-bit, 32-bit, 64-bit.
- Limitations:
  - Requires external memory to execute programs;
  - Peripheral chips are needed to interface with I/O devices
  - Glue logic (decoders, buffers) is needed to interconnect external memory and peripheral interface chips with the microprocessor.

Microcontroller

- A computer implemented on a single VLSI chip. It contains everything a microprocessor contains plus some more components, such as:
  - Memory
  - Timer
  - ADC, DAC
  - DMA controller
  - parallel I/O interface (parallel ports)
  - asynchronous serial I/O interface, synchronous serial I/O interface
  - DSP features.

Features of 68HCS12 microcontroller

- 16-bit CPU
- 64 KB memory space (also supports expanded memory up to 1 MB through a 16-KB window)
- 0 KB to 4KB of EEPROM
- 2 KB to 14 KB of on-chip SRAM
- 32 KB to 512 KB flash memory
- Sophisticated timer functions that include: input capture, output compare, pulse accumulators, real-time interrupt, and COP timer
- Serial communication interfaces: SCI, SPI, CAN, BDLC
- Background debug mode (BDM)
- 10-bit A/D converter
- Instructions for supporting fuzzy logic function

Motivation for studying Microcontrollers!!

- **Application for Microcontrollers – Embedded Systems**

- **A product that uses one or more microcontrollers as controller (s). Also called embedded products.**
- **End users are interested in the functionality of the product, not the microcontroller itself.**
- **Cell phones, home security systems, and modern automobiles are examples of embedded products.**