COMPUTER ARCHITECTURE

2nd Year Computer science

Chapiter 2:

Main components of a computer

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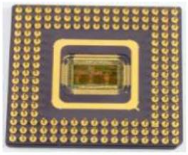
Computer components

There are **three** main components of a **Computer System**.

- ***Central Processing Unit (CPU):*** Also simply called as the microprocessor acts as the brain coordinating all activities within a computer.
- ***Memory:*** The program instructions and data are primarily stored.
- ***Input/output (I/O) Devices:*** Allow the computer to input information for processing and then output the results. I/O Devices are also known as computer peripherals.



- The integrated Circuit (IC) chip containing the CPU is called the ***microprocessor***.
- A microcomputer is a relatively smaller computer with a central processing unit (***CPU***) as a ***microprocessor***. A microcomputer is typically used as a personal computer (PC) which is smaller than a mainframe computer.

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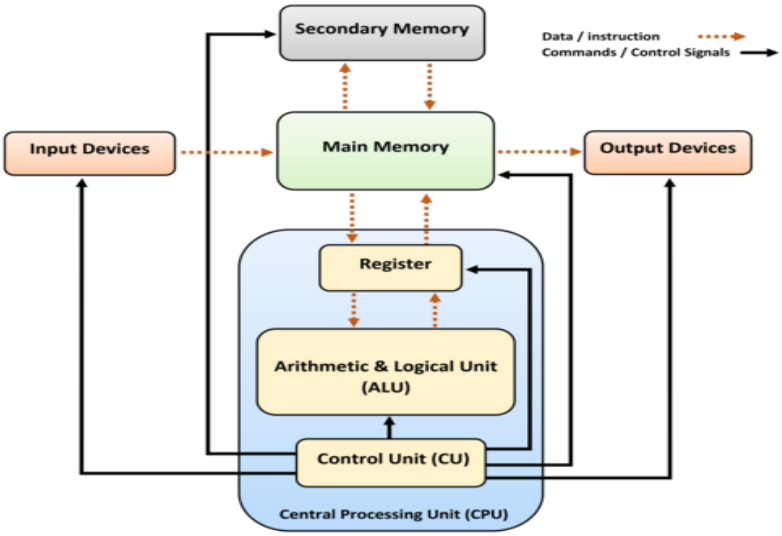
Computer components



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Computer components

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Computer components

There two types of memory used in microcomputers:

- ***RAM* (Random Access Memory/ Read-Write memory)** is used by the computer for the temporary storage of the programs that is running. Data is lost when the computer is turned off. So known as ***volatile*** memory.
- ***ROM* (Read Only Memory)** the information in ROM is permanent and not lost when the power is turned off. Therefore, it is called ***nonvolatile*** memory.

Note that RAM is sometimes referred as ***primary storage***, where magnetic /optical disks are called ***secondary storage***.

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Memory and Storage Devices

- Volatile Memory Devices
  - RAM = Random Access Memory
  - DRAM = Dynamic RAM
    - Dense but must be refreshed (typical choice for main memory)
  - SRAM: Static RAM
    - Faster but less dense than DRAM (typical choice for cache memory)

- Non-Volatile Storage Devices
  - Magnetic Disk
  - Flash Memory (Solid State Disk)
  - Optical Disk (CDROM, DVD)

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Units for Storage and Memory

Full Form	Units	Bytes
1 Bit	Binary Digit (0/1)	
1 Nibble	4 bits	
1 Byte	8 bits	
1 kilobyte(KB)	1024 byte	2^{10} bytes
1 Megabyte(MB)	1024 KB	2^{20} bytes
1 Gigabyte (GB)	1024 MB	2^{30} bytes
1 Terabyte(TB)	1024 GB	2^{40} bytes
1 Petabyte(PB)	1024 TB	2^{50} bytes
1 Exabyte(EB)	1024 PB	2^{60} bytes
1 Zettabyte(ZB)	1024 EB	2^{70} bytes
1 Yottabyte(YB)	1024 ZB	2^{80} bytes
1 Brontobyte	1024 YB	2^{90} bytes
1 Geopbyte	1024 Brontobyte	2^{100} bytes

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Computer components

The CPU is connected to memory and I/O devices through a strip of wires called a ***bus***. The bus inside a computer carries information from place to place. There are three types of busses:

1. ***Address Bus:*** The address bus is used to identify the memory location or I/O device the processor intends to communicate with. The width of the Address Bus rages from **20 bits (8086)** to **36 bits for (Pentium II).**
2. ***Data Bus:*** Data bus is used by the CPU to get data from / to send data to the memory or the I/O devices. The width of a microprocessor is used to classify the microprocessor. The size of data bus of Intel microprocessors vary between **8-bit (8085)** to **64-bit (Pentium).**
3. ***Control Bus:*** How can we tell if the address on the bus is memory address or an I/O device address? This is where the control bus comes in. Each time the processor outputs an address it also activates one of the four control bus signals: **Memory Read**, **Memory Write**, **I/O Read** and **I/O Write**.

The ***address and control bus*** contains output lines only, therefore it is ***unidirectional***, but the ***data bus*** is ***bidirectional***.

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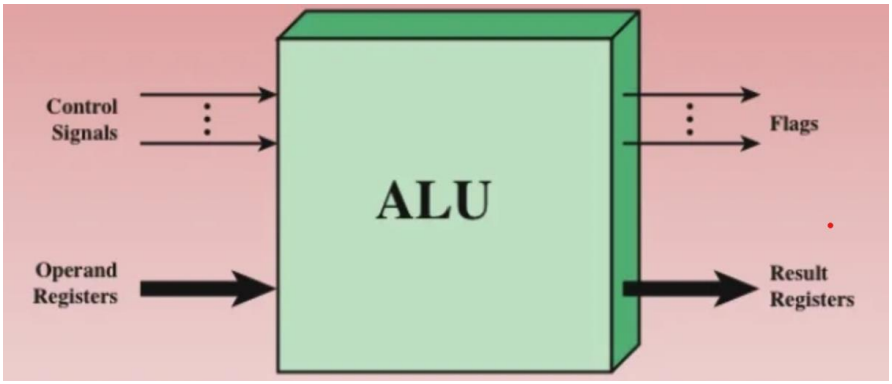
Arithmetic Logic Unit (ALU)



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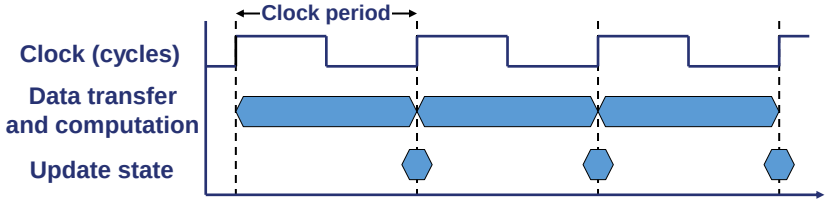
CPU Clocking



- Operation of digital hardware governed by a constant-rate clock
- Clock period: duration of a clock cycle
  - e.g., 250 ps = 0.25 ns = 250×10^{-12} s
- Clock frequency (rate): cycles per second
  - e.g., 4.0 GHz = 4000 MHz = 4.0×10^{9} Hz

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CPU Time

$$\text{CPU Time} = \frac{\text{Instructions}}{\text{Program}} \times \frac{\text{Clock cycles}}{\text{Instruction}} \times \frac{\text{Seconds}}{\text{Clock cycle}}$$

- Performance depends on
  - Algorithm: affects IC, possibly CPI
  - Programming language: affects IC, CPI
  - Compiler: affects IC, CPI
  - Instruction set architecture: affects IC, CPI, T_c

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Registers & Counter

Circuits that include flip-flops are usually classified by the function they perform

– Registers

– Counters

• **Register** is a group of flip-flops.

– Each flip-flop is capable of storing one bit of information.

– An n-bit register consists of a group of n flip-flops.

– Register is a group of binary cells suitable for holding binary information.

• A **counter** is essentially a register that goes through a predetermined sequence of states.

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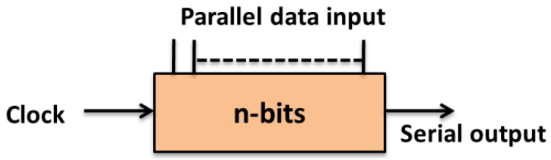
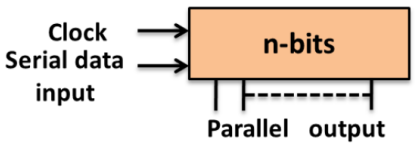
Types of registers

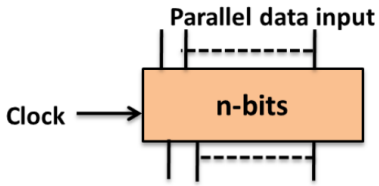
a) Serial in serial out (SISO)



c) Parallel in serial out (PISO)



b) Serial in parallel out (SIPO)



d) Parallel in parallel out (PIPO)

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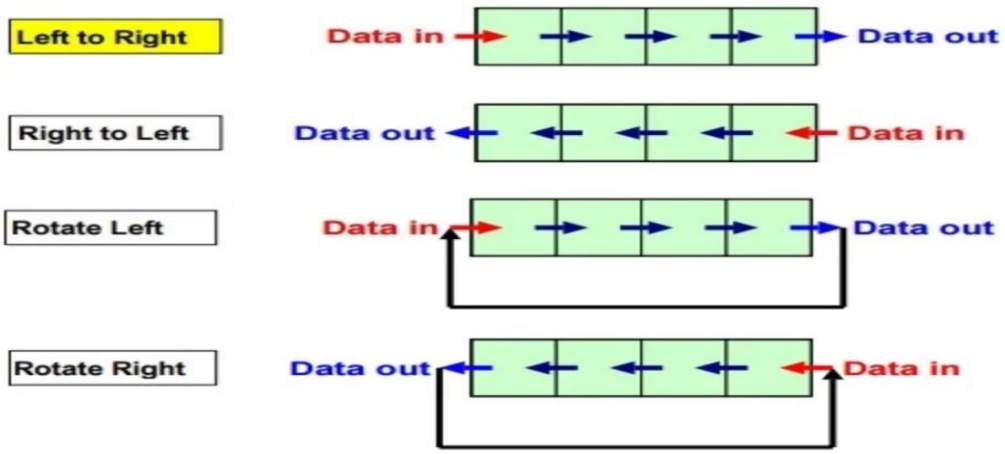
Types of shift registers



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Applications of registers

- **Shift Registers** are an important Flip-Flop configuration with a wide range of applications, including:
  - Computer and Data Communications
  - Serial and Parallel Communications
  - Multi-bit number storage
  - Sequencing
  - Basic arithmetic such as scaling (a serial shift to the left or right will change the value of a binary number a power of 2)
  - Logical opérations

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