

COMPUTER ORGANIZATION

AN OVERVIEW

© Copyright *Ashraf Kassim*.

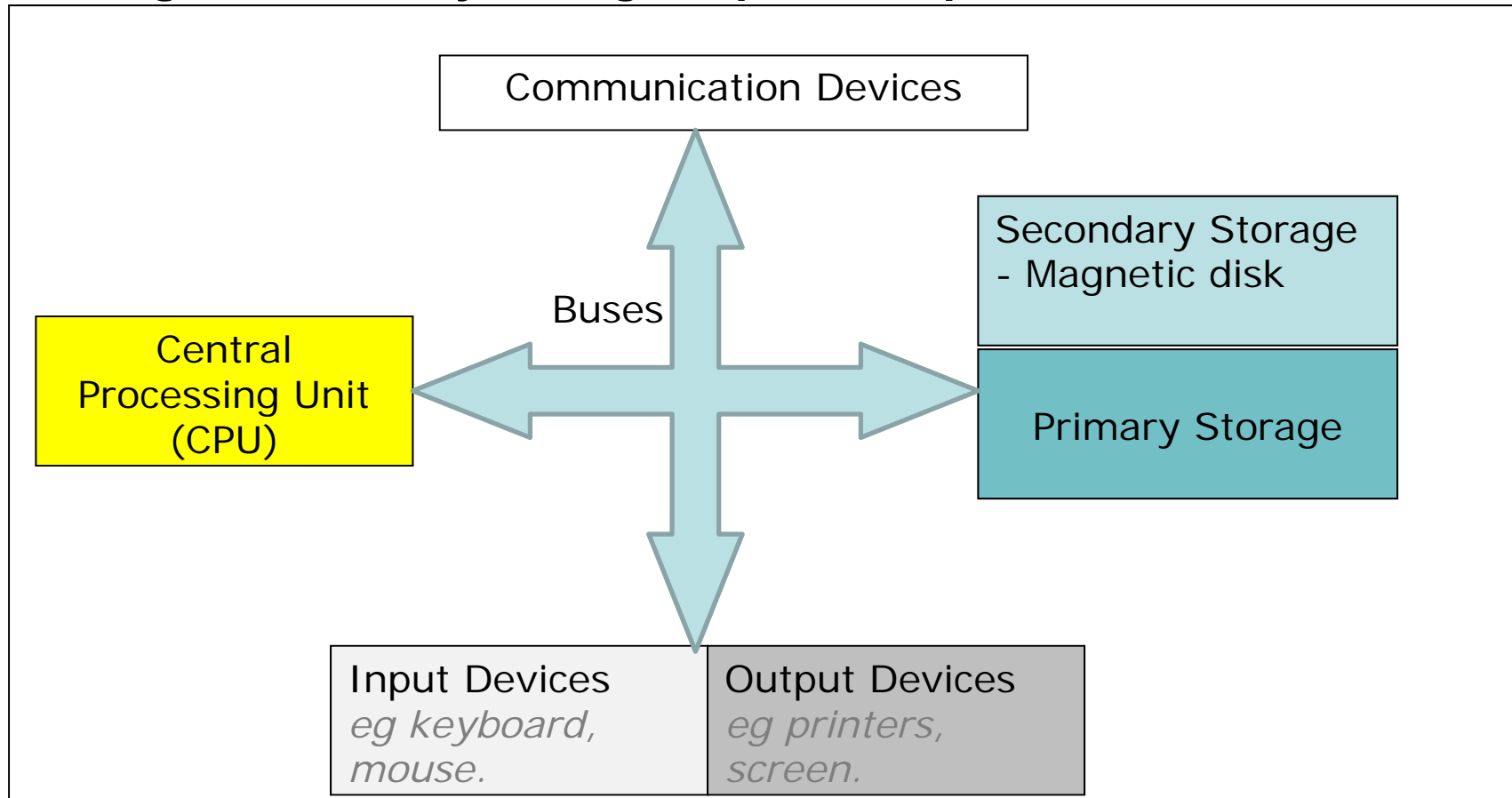
The Computer System

A **computer** is a device capable of performing computations & making logical decisions.

Computers process data under the control of sets of instructions (i.e., **computer programs**).

The Computer System

A **computer system** consists of **central processing unit** , **primary storage**, **secondary storage**, **input & output devices**:



The Computer System

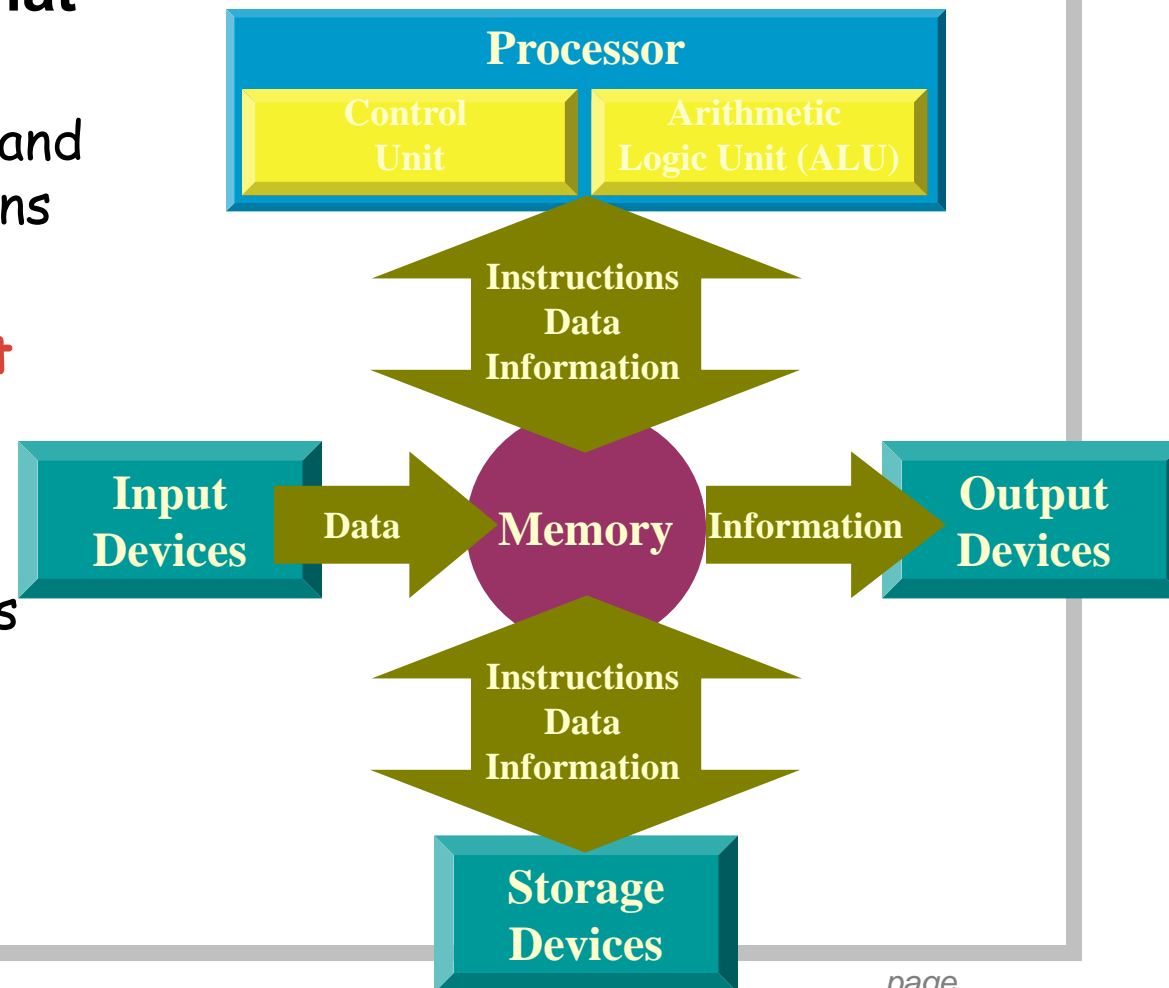
- **CPU**: manipulates raw data into more useful form and controls other parts of computer system.
- **Primary storage**: temporarily stores data & program instructions during processing
- **Secondary storage**: store data & programs when not being used in processing.
- **Input devices**: convert data & instructions into electronic form for input into computer.
- **Output devices**: convert electronic data produced by the computer system & display them.
- **Communication devices**: provide connections between the computer and communications networks
- **Buses**: circuitry paths for transmitting data & signals among parts of computer system.

The Central Processing Unit - CPU

➤ Interprets & carries out basic instructions that operate a computer

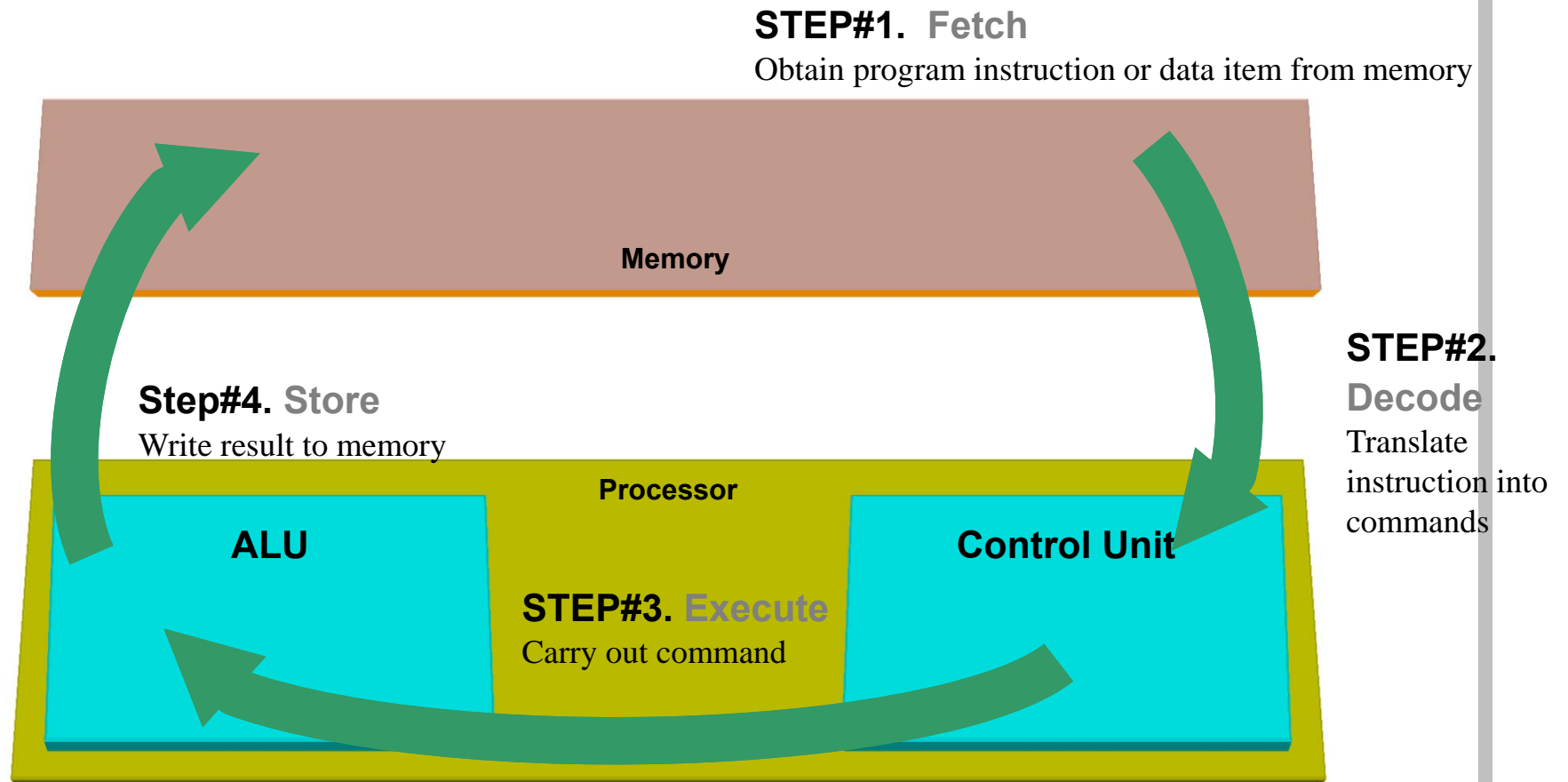
- **Control unit** directs and coordinates operations in computer
- **Arithmetic logic unit (ALU)** performs arithmetic, comparison, and logical operations

➤ Also called the **processor**



CPU - Machine Cycle

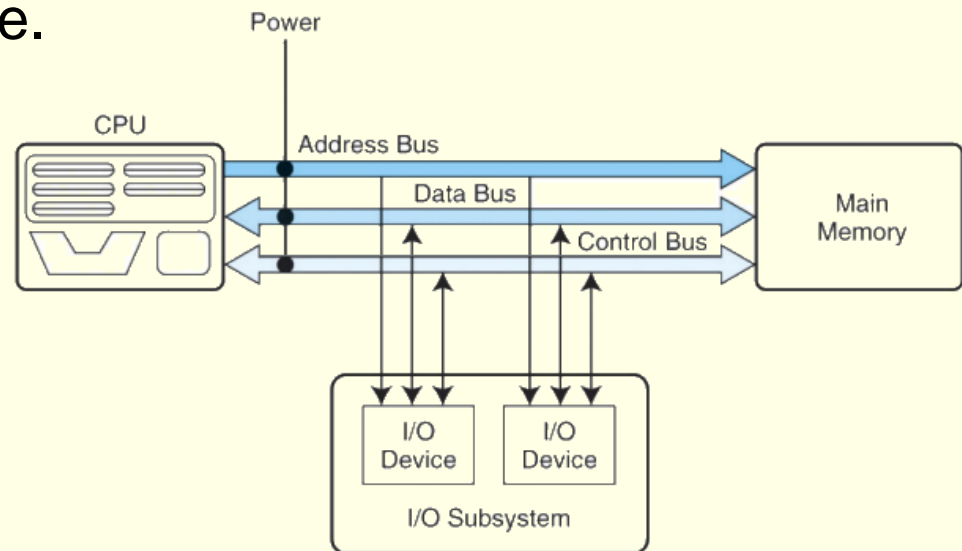
Four operations of the **CPU** comprise a machine cycle



Linking the CPU ...

Busses link CPU, primary storage & other devices in the computer system:

- **DATA BUS**: carries bi-directional data.
- **ADDRESS BUS**: signals that locate a given address/location in primary storage where data is to be read or written.
- **CONTROL BUS**: signals that specify whether to perform a read / write operation from/to the primary storage, an input device or an output device.



The Input / Output (I/O) Subsystem

A computer communicates with outside world through its **I / O** sub-system.

I / O devices connecting to CPU :

- can be **memory-mapped**; where these **I/O** devices behave like main memory from CPU's point of view.
- can be **instruction-based**, where the CPU has a specialized I/O instruction set for these devices.

Input devices: keyboard, mouse, touch-screens, microphones etc.

Output devices: screens, printers, plotters, speakers etc.

Memory Organization

Computer memory consists of a **linear array** of addressable storage cells (like registers)

Memory can be byte-addressable, or **word-addressable** (a word typically consists of two or more bytes)

Memory is constructed of RAM ICs:

- physical memory usually has more than 1 RAM IC
- if memory **word** size is 16 bits, a **4MBx16** RAM gives 4 megabytes of 16-bit memory locations.
- **4MB** can be expressed as $2^2 \times 2^{20} = 2^{22}$ **words**.
- memory locations are numbered 0 through $2^{22} - 1$.
- memory bus of this system requires ≥ 22 address lines

Memory Organization

Primary memory (also called main memory):

- stores all or part of program that is being executed.
- stores operating system (OS) programs that manage the operation of the computer.
- holds data that the program uses.

Data & program are placed in primary memory:

- *before processing*,
- ***between processing*** steps and
- ***after processing*** has ended prior to being returned to secondary storage or released as output.

Secondary Memory / Storage

Secondary storage is used for relatively **long-term storage** of data outside the CPU.

Secondary storage is **nonvolatile** and retains data even when computer is turned off.

Secondary storage technologies include:

- magnetic disks: floppy disks , hard disks
- optical disks: compact disks **CDs** use laser technology to store data at higher densities than magnetic disks
- magnetic tape: for secondary storage of large volumes of information; inexpensive but slow as data is sequentially stored.

Interrupts

Normal execution of a program is altered when an 'event' of higher-priority occurs.

CPU is alerted to such events through **interrupts**.

Interrupts can be triggered by I/O requests, arithmetic errors (e.g. division by zero), when an invalid instruction is encountered, etc.

Each **interrupt** is associated with a procedure that directs actions of **CPU** when an **interrupt** occurs.

Non-maskable interrupts are high-priority **interrupts** that cannot be ignored.