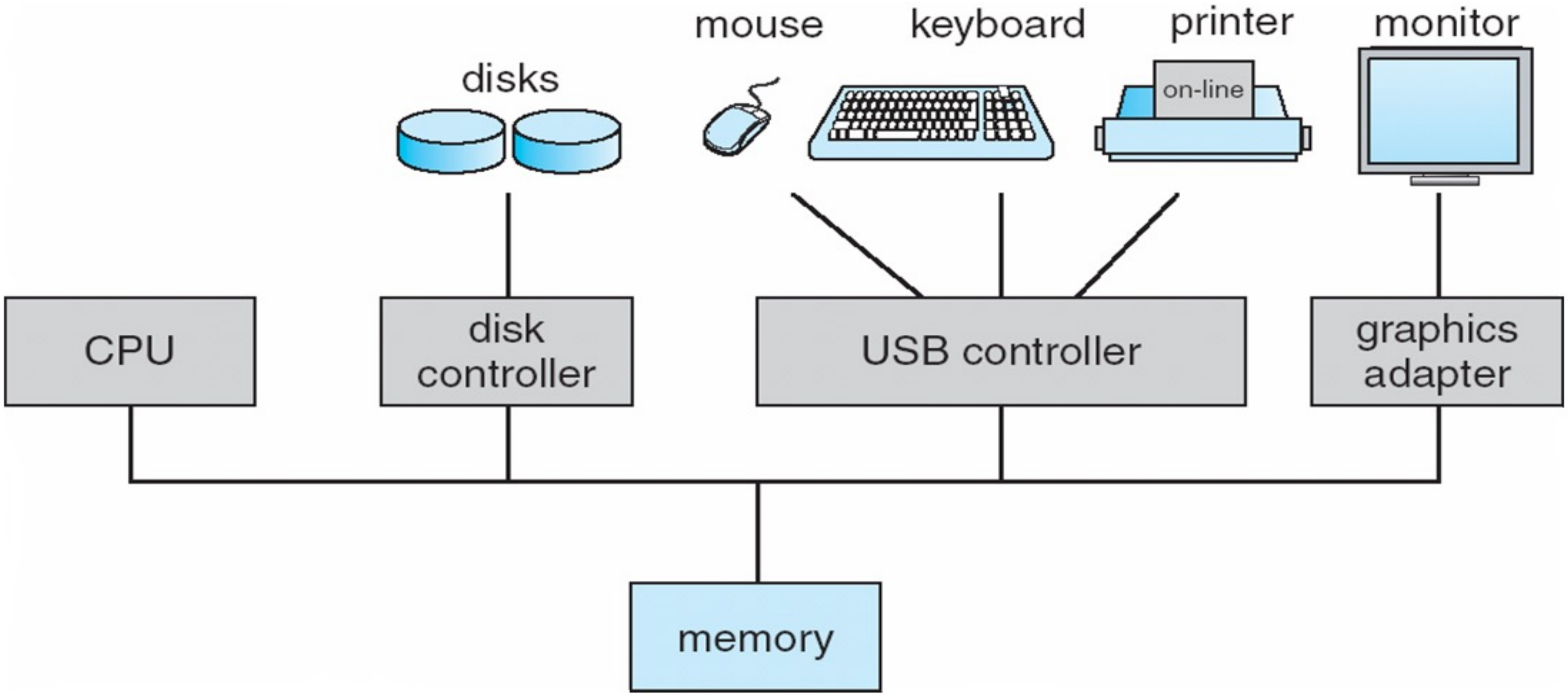
Computer Fundamentals

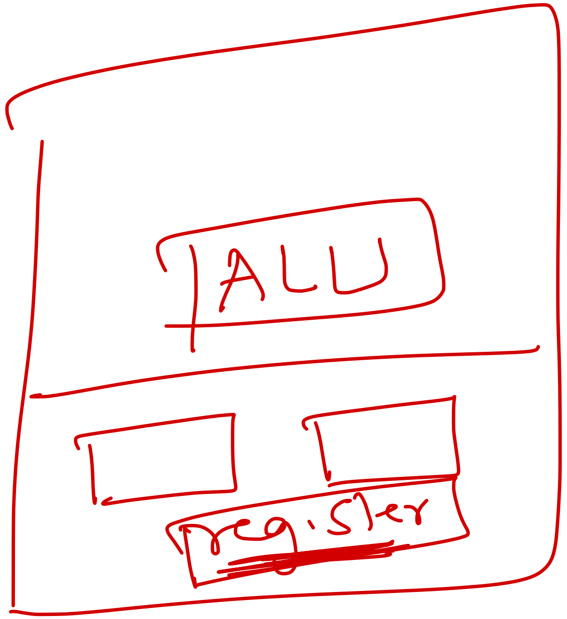
A Computer System



Computer Fundaments

Computer Structure

* CPU: Central Processing Unit
* RAM: Main memory
* Disk: Secondary storage
* IO Devices: Keyboard, Monitor, ...
* Bus: Set of wires connecting CPU to other peripherals
    * Address bus
    * Data bus
    * Control bus



Computer Fundaments

IO Device

- The Input unit allows programs and data to be entered into the computer.
    - e.g. Keyboard (primary), Mouse, Joystick, Touchpad, Touch pen, Scanner, Microphone, Webcam, Punch card, Bar code scanner, MICR scanner, Fingerprint, ...
- The Output unit allows the results of processing to be exported to the outside world or other devices or saved to be used later.
    - e.g. Monitor (primary), printer, plotter, Speakers, projector, ...

Computer System Components

1. **Hardware** – provides basic computing resources (CPU, Memory, I/O devices, Communication).
2. **Operating System** – controls and coordinates use of the hardware among various application programs for various users.
3. **System & Application Programs** – ways in which the system resources are used to solve computing problems of the users (Word processors, Compilers, Web browsers, Database systems, Video games).
4. **Users** – (People, Machines, other computers).

What happens when we start a computer?? (Booting Process)

- Hardware doesn’t know where the operating system resides and how to load it.
- **Bootstrap Program :**
  - Initial program to run a system
  - Locating and Loading OS Kernel in main memory
- Where it is stored ??? ROM

- If any storage device/partition contains one special program called as **"bootstrap program"** in its first sector i.e. in a boot sector then such a device/partition is referred as **bootable device/partition.**
  - e.g. hard disk drive, pen drive, CD/DVD

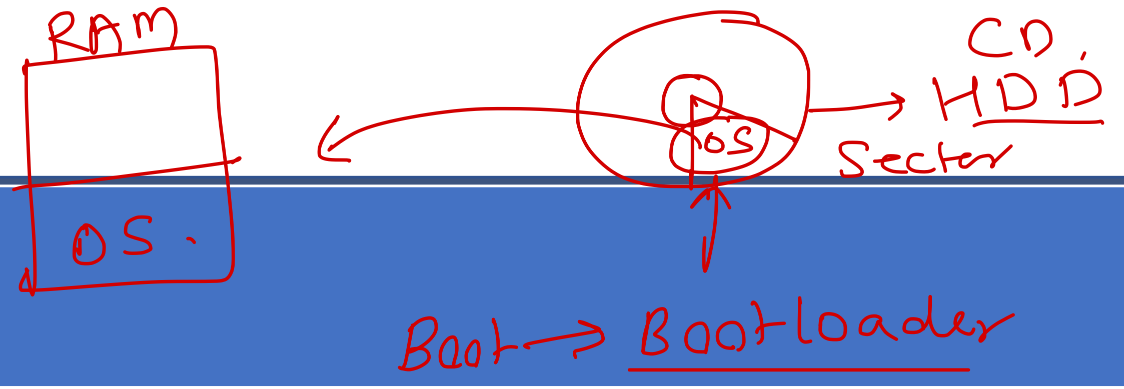
Steps of Booting

1. Machine Boot

ROM ,

- When we switch on the power current gets passed to the motherboard and one program gets invoked named as **"BIOS"** which is exists in the ROM memory on motherboard.
- BIOS -- Basic Input Output System -- which is **a micro-program.**
- A micro-program is a program which is smaller in size and can be stored into the memory with its all possible set of input values.
- first step of BIOS is **"POST" - Power On Self Test**, under POST BIOS checks whether all peripherals are connected properly or not and their working status.
- **"peripherals or peripheral devices"** -- devices which are connected to the motherboard externally are called as peripherals.
- after POST BIOS executes **"bootstrap loader",** bootstrap loader searches for available bootable devices and selects any one out of it as per the defined priorities.

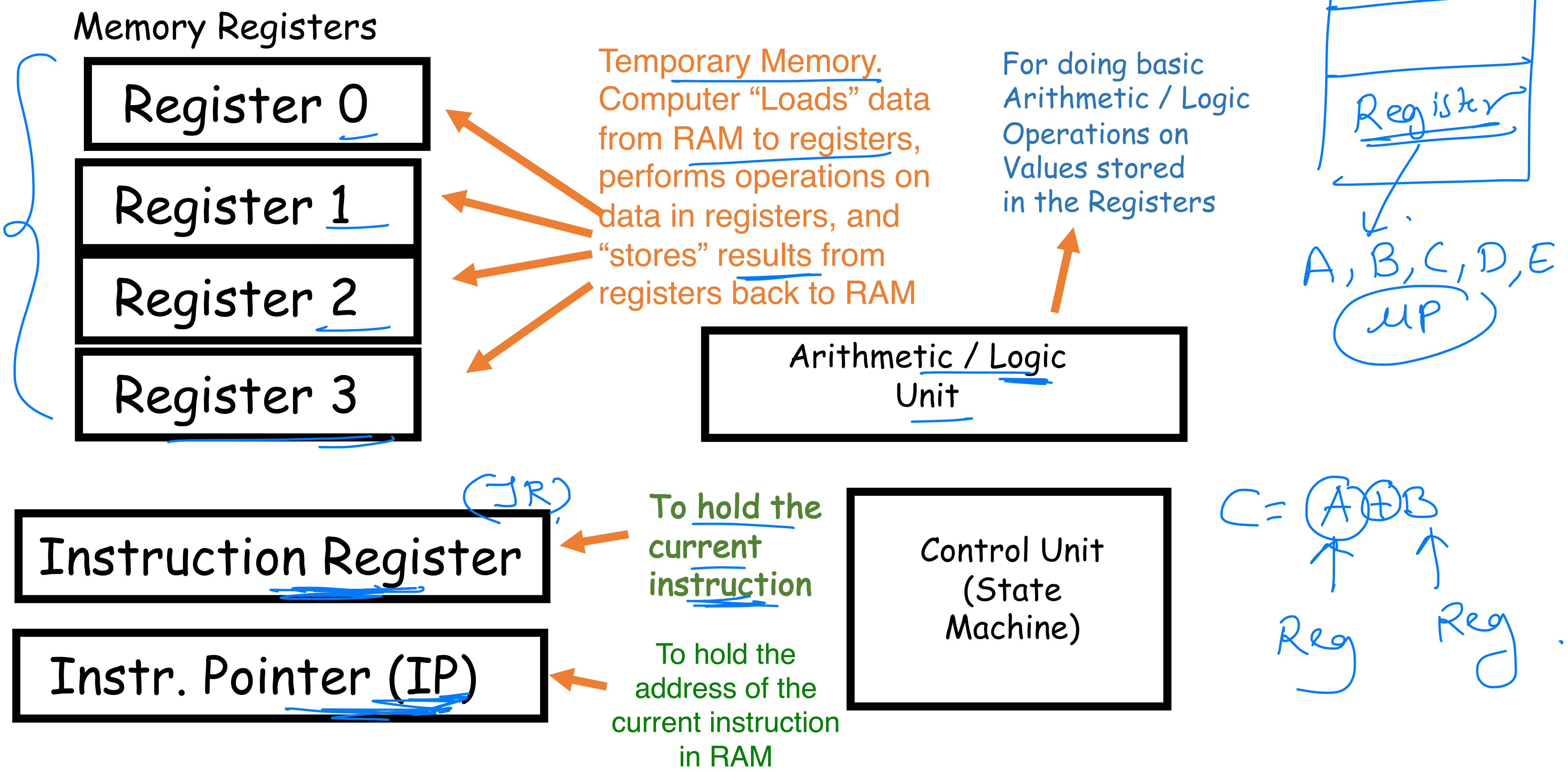
Steps of Booting Cont...



2.System boot:

- if hard disk drive got selected as a bootable device and if it contains multiple OS's have installed on it, then "**bootloader**" program gets executes.
- **Boot loader program** displays list of operating system installed onto the machine, so that user can select any one at a time from and it invokes bootstrap program of selected operating system.
- Bootstrap program locates the kernel and load it into the main memory.

CPU



Memory Registers

Register 0

Register 1

Register 2

Register 3

Temporary Memory. Computer "Loads" data from RAM to registers, performs operations on data in registers, and "stores" results from registers back to RAM

Arithmetic / Logic Unit

For doing basic Arithmetic / Logic Operations on Values stored in the Registers

Instruction Register

To hold the current instruction

Instr. Pointer (IP)

To hold the address of the current instruction in RAM

Control Unit (State Machine)

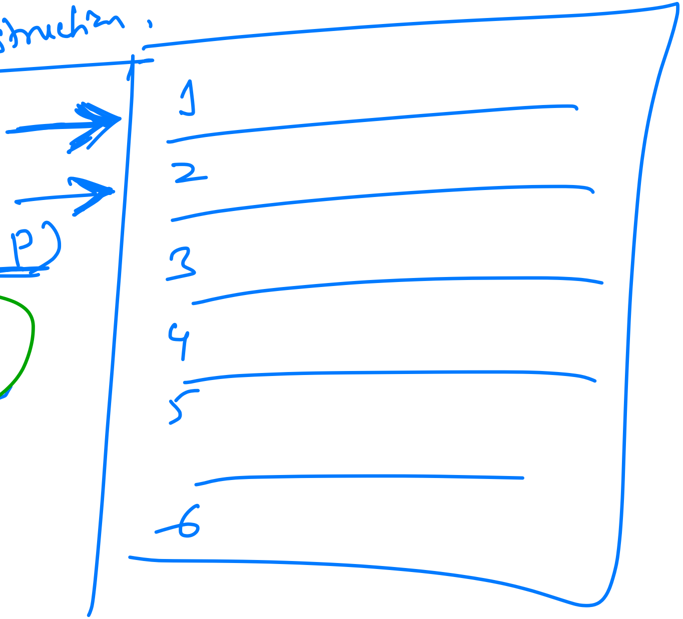
(CIR)

Current Instruction.

(IR)

Instruction Pointer (IP)

next instn execute.



① Fetch.

② decode.

③ Execution

Bus, CU, ALU, Memory

Bus

- It is a simplified way for many devices to communicate to each other.
- It is internal arrangement of computer system which includes design of the processor , memory and input/output units.

Control Unit

- Control is responsible for determining what action is to be performed on what data.
- controls all operations and it controls devices which are connected to the computer system by coordinating with device controllers.
- Fetch-Decode-Execute

ALU (Arithmetic Logic Unit)

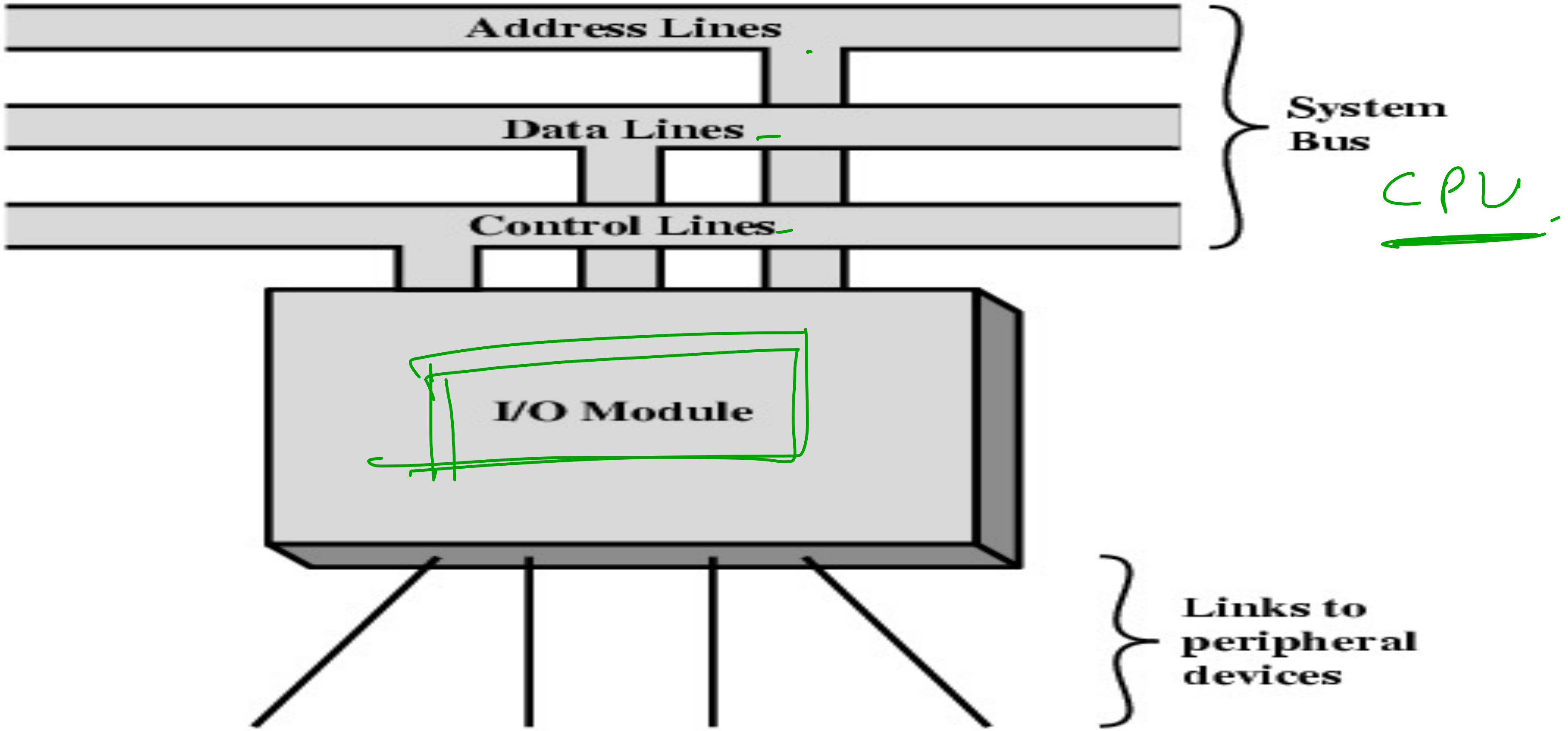
- ALU is mainly comprised of **logic gates**, circuits made from transistors that take inputs.
- ALU performs all arithmetic and logical operations.

Memory

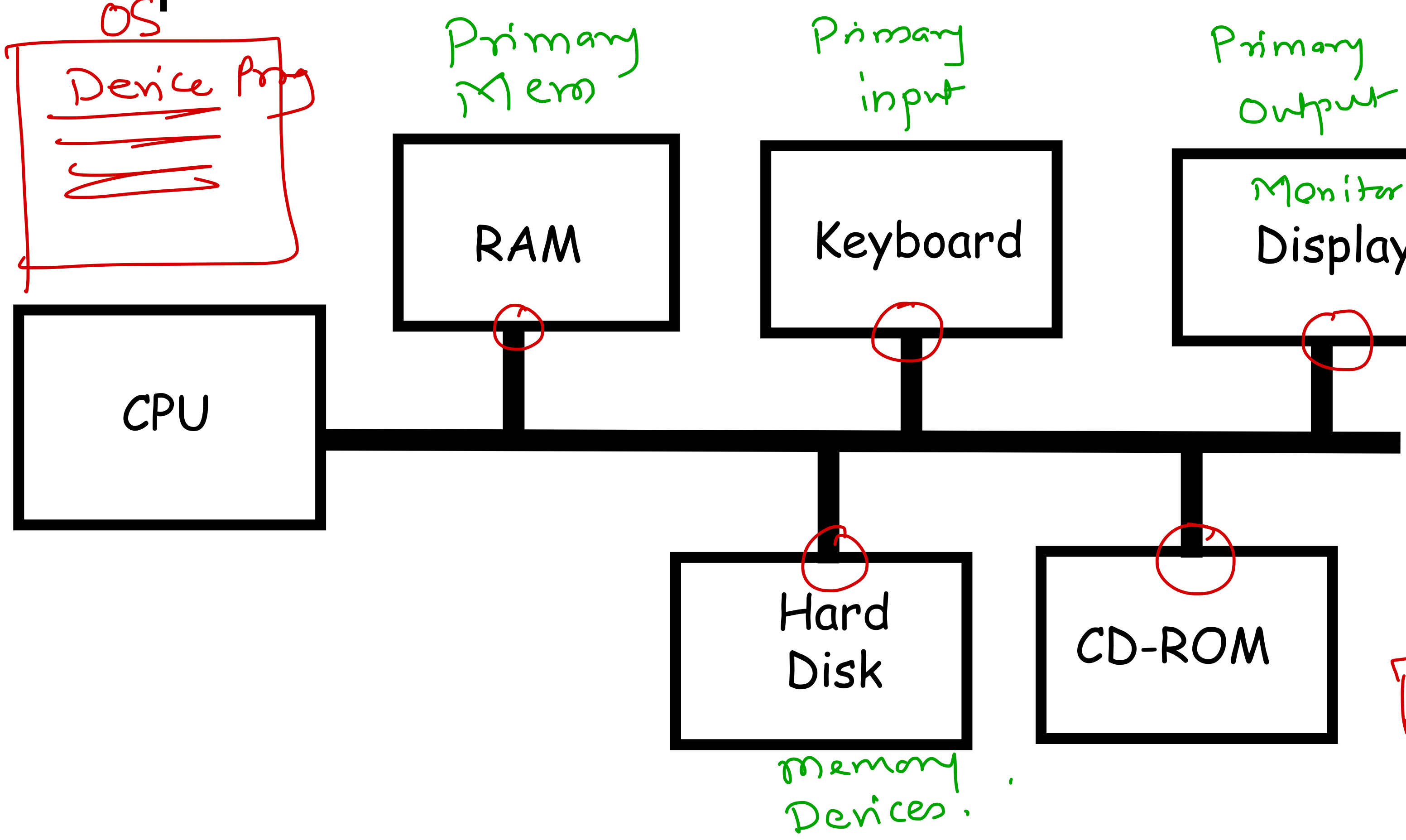
- Memory consists of circuits whose primary purpose is to **hold information**, but only temporarily.
- When you talk about the memory of a computer, most often you're talking about its RAM.

Input/Output

- The Input unit allows programs and data to be entered into the computer.
- The Output unit allows the results of processing to be exported to the outside world or other devices or saved to be used later.



Computer Fundamentals



Each IO device has its own internal dedicated processing unit called as IO controller/module

Device driver is a program within OS (part of os) that send/receive data to/from IO device controller and also handles interrupts send from the device

It is a system concept integrating software and hardware to specify the design of computing systems

Computer Fundaments

IO Module/Controller Functions

- Control & Timing
- CPU Communication
- Device Communication
- Data Buffering
- Error Detection

IO Module/Controller

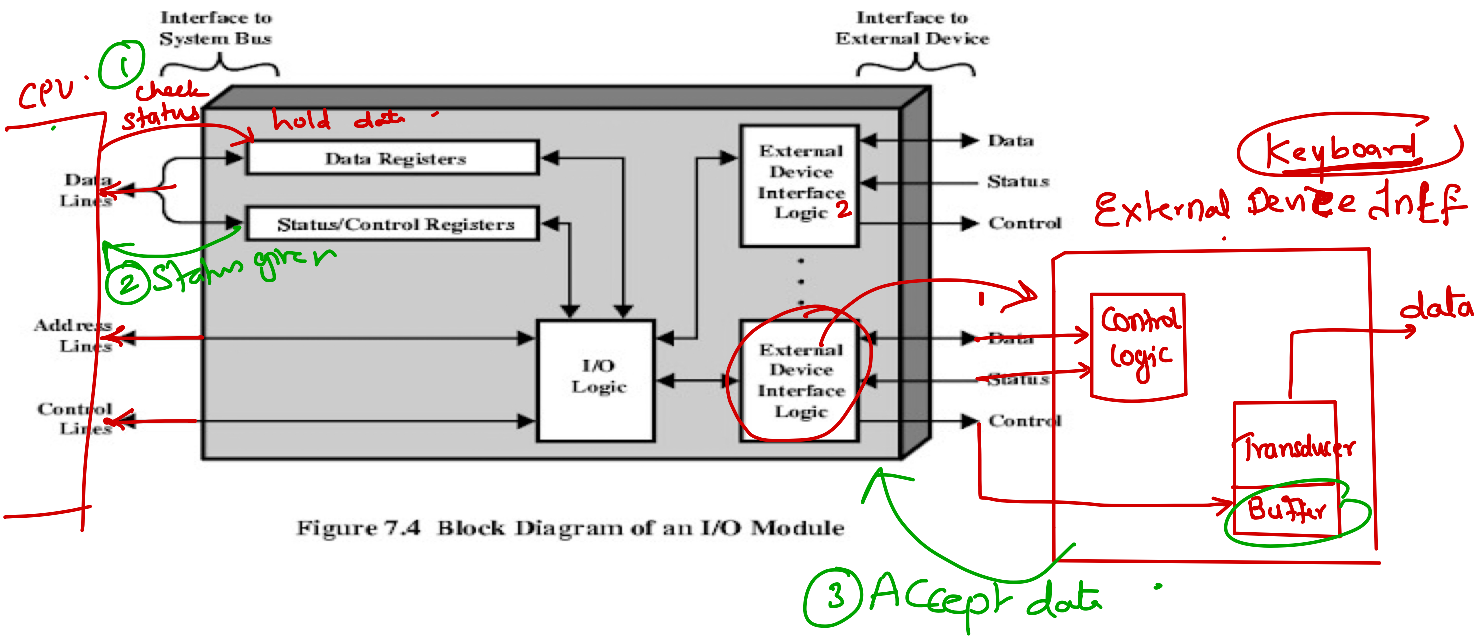


Figure 7.4 Block Diagram of an I/O Module

Computer Fundaments

IO Steps

- CPU checks I/O module device status
- I/O module returns status
- If ready, CPU requests data transfer
- I/O module gets data from device
- I/O module transfers data to CPU

Computer Fundaments

Device Interface Components

- * The control logic is the I/O module's interface to the device
- * The data channel passes the collected data from or the data to be output to the device. On the opposite end is the I/O module, but eventually it is the processor.
- * The transducer acts as a converter between the digital data of the I/O module and the signals of the outside world.
- * Keyboard converts the motion of the key into data representing the key pressed or released
- Temperature sensor converts the amount of heat into a digital value
- * Disk drive converts data to electronic signals for controlling the read/write head

Computer Fundaments

IO Techniques

- Communication between memory and IO devices.
- IO Techniques
  - Programmed IO
  - Interrupt-driven IO
  - Direct Memory Access

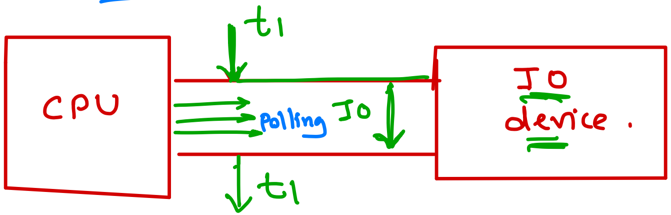
Programmed IO

- CPU waits for IO operations to be completed. This is also called "Polling".
- As CPU is faster, so CPU time is wasted.
- When OS/program waits for the IO to be completed, it is called a "Synchronous IO".

Interrupt driven IO

- CPU issues a command, and proceeds for its work until interrupted by IO device.
- Better utilization of CPU time.
- Since OS does not wait for the IO completion, it is called an "Asynchronous IO".

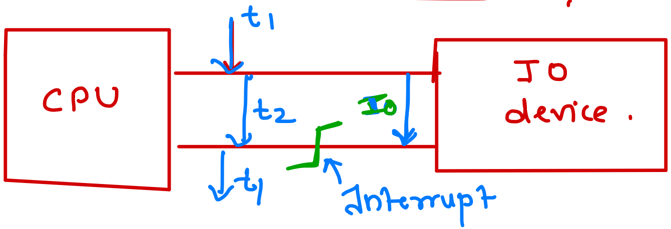
① Programmed I/O.



① CPU Keep checking Status of IO device if IO is completed this is called as "Polling" or "Programmed IO"

② OS is waiting for IO to complete, then it is called "synchronous IO"

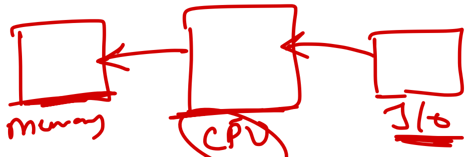
② Interrupt-driver IO.



① CPU assign IO task to IO device and begin execution of another program (as scheduled by OS)
When IO is done, the device (controller) Send signal (interrupt) to CPU. Then CPU resume the earlier paused task (as per sched by OS)

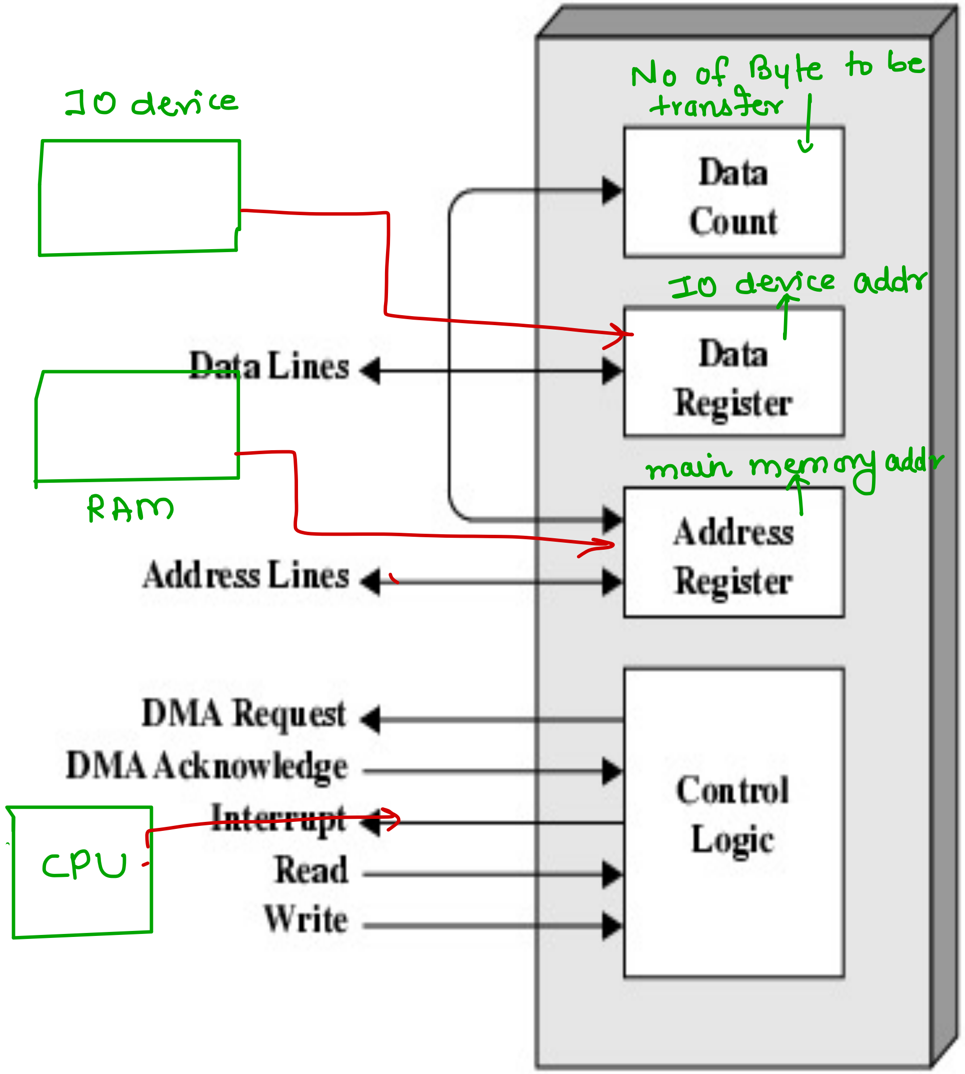
② OS is not waiting for IO to complete, instead schedules another task on CPU. This IO is called "asynchronous IO"

Direct Memory Access



- Interrupt driven and programmed I/O require active CPU intervention
  - Transfer rate is limited
  - CPU is tied up
- DMA Operations:
  - When the processor wishes read or send a block of data, it issues a command to the DMA module by sending some information to DMA module.
  - The information includes:
    - read or write command, sending **through read and write control lines**.
    - number of words to be read or written, communicated on the **data lines** and stored in the **data count register.**
    - starting location in memory to read from or write to, communicated on data lines and stored in the **address register**.
    - **address of the I/O device** involved, communicated on the **data lines**.

    When the transfer is complete, the DMA module sends an interrupt signal to the processor to inform that it has finish using the system bus



Thank You