Unit - I
Introduction

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* Concept of computer organization & Architecture

1) Computer Architecture :

- Computer architecture refers to those attributes of a system visible to a programmer or those attributes that have a direct impact on the logical execution of a program.
- Examples of architectural attributes include the instruction set, the no. of bits used to represents various data types (eg. numbers, characters), I/O mechanisms & techniques for addressing memory.

2) Computer organization :

- Computer organization refers to the operational units and their interconnections that realize the architectural specification.
- Organizational attributes includes those hardware details transparent to the programmer, such as- control signals, interfaces between the computer & peripherals & the memory technology used.
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- The distinction between architecture and organization has been an important one.
- Many computer manufacturers offers a family of computer models, all with the same architecture but with difference in organization.

* Difference bet^n Computer Architecture & Organization.

- Computer architecture is a functional description of requirements and design implementation for the various parts of a computer.
- It deals with the functional behavior of computer systems.

- It comes before the computer organization while designing a computer.

- Computer organization comes after the decision of computer architecture first.
- CO is how operational attributes are linked together & contribute to realizing the architectural specification.
- CO deals with a structural relationship.

Computer Architecture	Computer Organization
1) Architecture describes what the computer does.	1) The organization describes how it does it.
2) It deals with the functional behaviour of computer system.	2) It deals with structural relationship.
3) It deals with high level design issues. eg. system, computer.	3) It deals with low level design issues. eg. logic design, ckt design
4) Architecture indicates its hardware.	4) Organization indicates its performance.
5) As a programmer you can view architecture as a series of instructions, addressing modes & registers.	5) The implementation of the architecture is called organization.
6) For designing a computer its architecture fixed first.	6) For designing a computer its organization is decided after its architecture.

7) computer Architecture is also called instruction set Architecture (ISA)	7) computer organization is frequently called micro-architecture.
8) It makes the computer's hardware visible.	8) It offers details on how well the computer Perform.
9) Architecture coordinates the hardware & software of the system.	9) computer organization handles the segments of the network in a system.
10) The software developer is aware of it. ex: Intel and AMD created the x86. Processor.	10) It escapes the software Programmer's detection.
11) It Acts as interface bet" hardware & software.	11) ⇒ It deals with the components of a computer and the interconnection of components.

* Computer system fundamental units.

- In computer organization and architecture, the computer system can be classified into no. of functional units.
- This classification is based on the specific function performed in the computer system.
- The basic functional units or operational units of computer system include following units.

1) Input or Unit
2) Central processing Unit (CPU)
3) Control Unit (CU)

4) Arithmetic And Logic Unit (ALU)
5) Output unit.

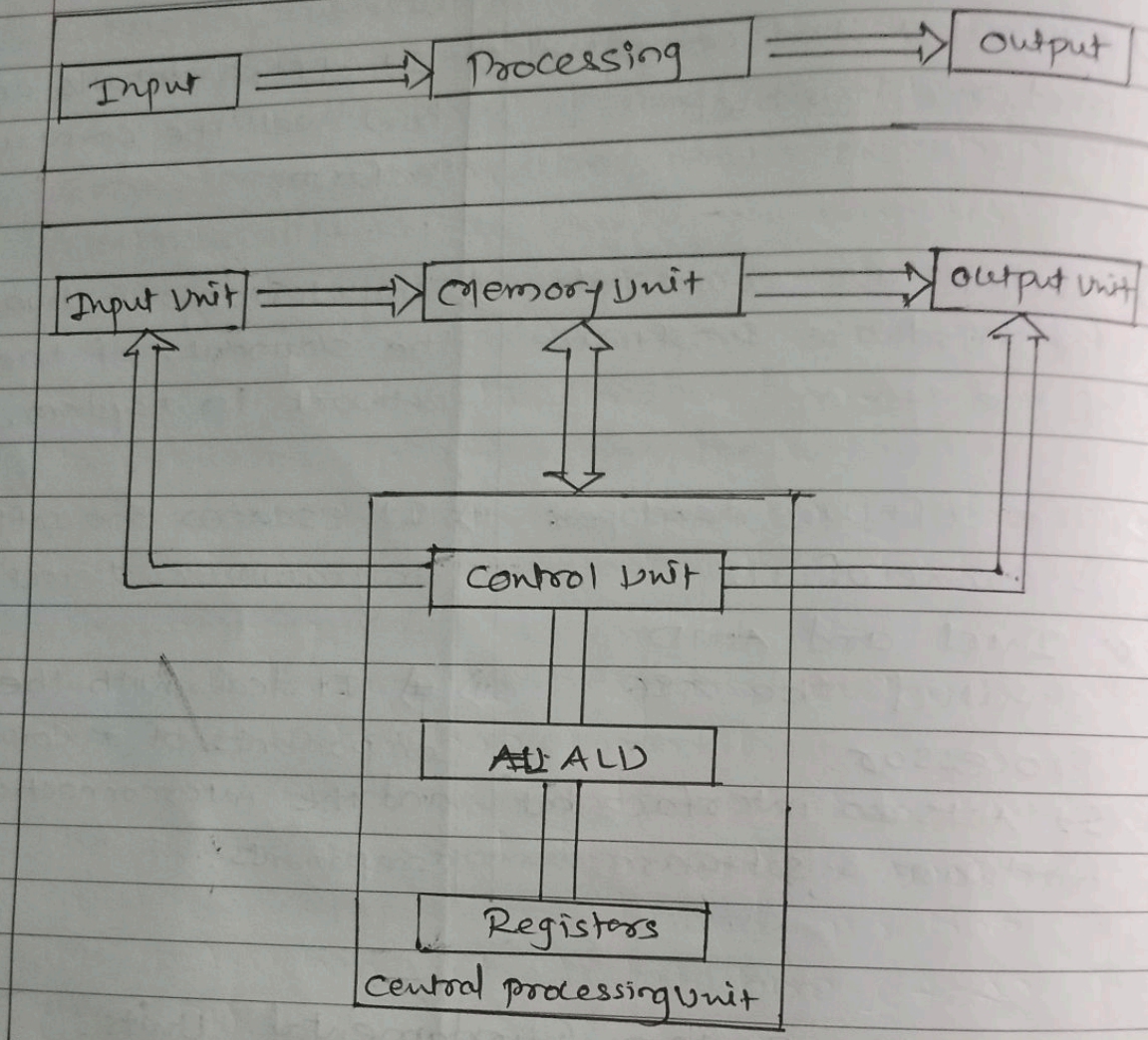


Fig @ Computer System Block Diagram

1) Input Unit :
- The main function of the input unit is to provide the data that will be operated by the CPU as per the program instructions.
- The most commonly used input devices for any general purpose computer system include keyboard and mouse.
- However, computer can also accept the input

from other input devices such as camera, scanner & mike.

- The computer system can accept the input from number of input devices such as keyboard, scanner, camera, mouse or any other input devices connected to the computer system.

eg: mouse, keyboard, camera, joystick, mike, scanner touch screen, USB flash drive.

2) Central processing unit :

- The central Processing Unit (CPU) is said to be the brain of the computer system.
- It is the CPU that provides the processing power to the computer.
- The CPU internally consists of three important units.
- These three units are control unit, Arithmetic and logic Unit, & memory unit.
- These three units together are referred as CPU.
- The main function of the CPU is to execute the computer program.
- The CPU executes the program by fetching Program instruction one by one from the main memory (RAM).
- The control Unit of the CPU decodes these instructions and performs the desired arithmetic and logical operations.
- The CPU executes the program instruction by repetitively performing the instruction cycle.
- The instruction cycle consist of four steps that include fetch, Decode, Execute & store.

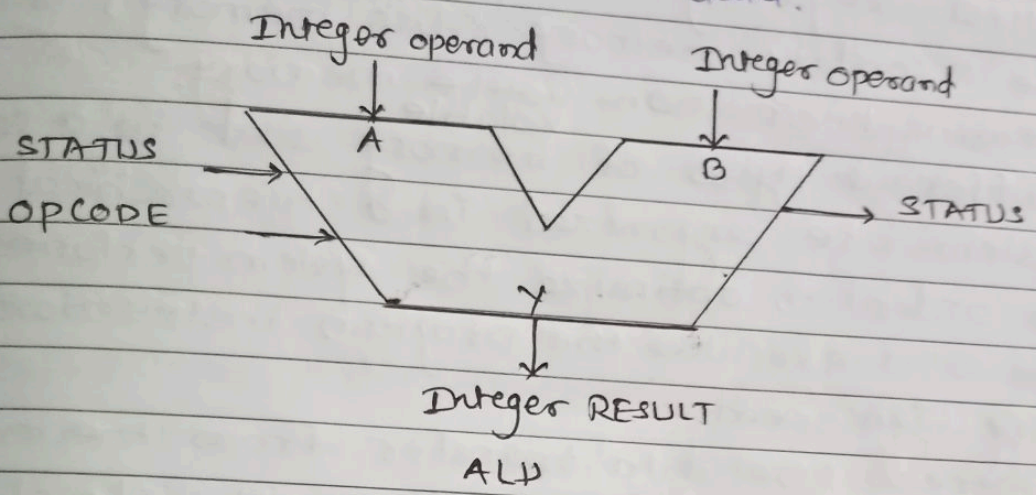
3) Control Unit :

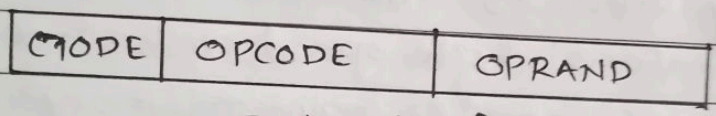
- The control unit (CU) is an important component of the central processing unit.
- The control unit of the CPU is responsible to control the working of all the hardware components connected to the system.
- In other words, the main function of the control unit is to direct the various operations performed by the computer system.
- The control units transmit the control signals that directs the hardware components to perform specific operations.
- The control unit of the CPU is also responsible to decode the program instructions fetched from the memory.
- The CU decodes the program instruction as per the instruction format.
- The CU after the decode operation directs the arithmetic and logic unit (ALU) of the CPU to perform the desired operation as per the Instruction set Architecture (ISA) of the CPU.

4) Arithmetic And Logic Unit (ALU) :

- The ALU is the mathematical brain of the computer placed inside the processor chip (central processing unit).
- The ALU essentially performs all the arithmetic & the logic operations performed by the CPU.
- It is the ALU that actually operates on the data.

- The CPU initiates the program execution by fetching the program instructions from the main memory (RAM).
- The control unit of the CPU decodes the instruction & directs the ALU to perform the desired operation on the data.





Instruction format

Fig. ⑥ central processing unit Arithmetic logic unit

- The ALU is an essential fundamental component of many digital computing circuits and also for all central processing unit CPU.
- In order to operate on the data, the ALU perform three types of operations.
- The ALU operation include arithmetic, logical & shift operations.

* Memory Unit :

- The main function of the memory unit is to store the data.
- The computer systems memory unit consist of

different types of memory.

- The computer system memory can be grouped into two basic types that is primary and secondary memory.
- The primary memory (main memory RAM) is called temporary or volatile memory.
- The secondary memory (disk memory) is called permanent or non-volatile memory.
- Different types of memory used in a computer system are organized in a hierarchical order in order to optimize the system performance.
- The CPU executes the program instructions at very high speed.
- Whereas the data transfer from the main memory RAM to the CPU is relatively slow.
- And therefore, high speed cache memory is placed between the CPU & main memory RAM.
- The CPU stores the frequently used data into the cache memory that can be accessed at high speed as compared to the RAM.

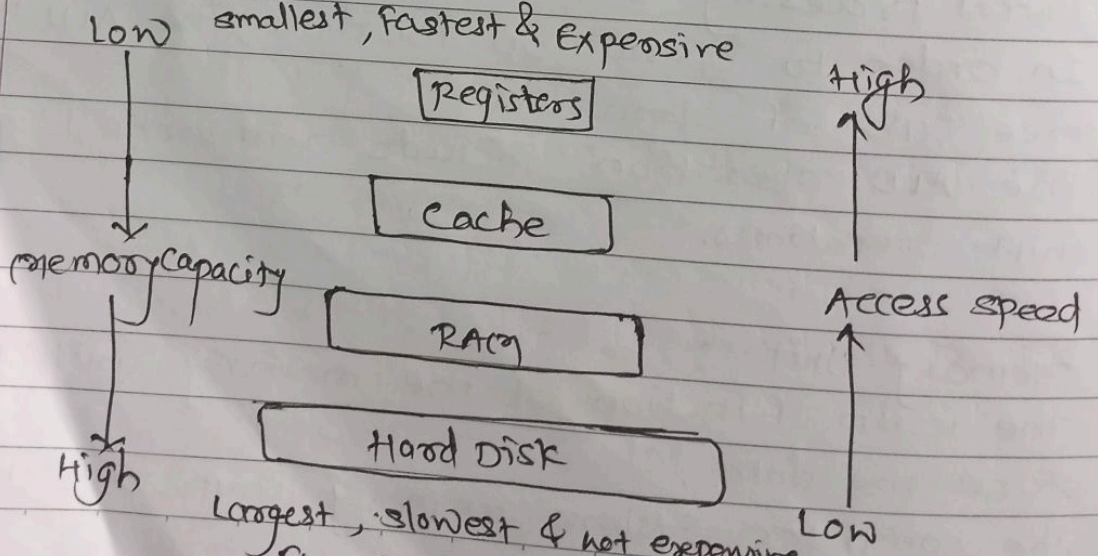


Fig. © Computer memory Hierarchy

- The CPU also makes use of another very high speed memory called CPU register built right inside the processor chip.
- The processor micro-architecture consists of no. of very high speed internal memory inside the CPU called registers.
- The processor internally use different types of registers at different stages of the instruction cycle during the program execution.

5) Output Unit :

- The main function of the output unit is to present the data to the user that is processed by the CPU as per the program instructions.
- The most commonly used output devices for any general purpose computer system include display monitor, speaker and printer.
- However, computer can also send the output to other output devices such as projector, speaker and disk memory.

eg- monitor, Headphone, speakers, External hard drive, Printer, plotter, scanner, projector.

Computer function:

- There are four functions of a computer.

1) Data input
2) Data processing
3) Information output
4) Data and information storage.

1) Data input:

- Every computer is designed with data input as a first function, an activity which is accomplished via input devices.
- Data entry is done manually, automatically or both,
- Manual input is done via add-on peripherals like the keyboard, mouse & stylus.
- Input can also be accomplished via vocal dictation applications & body gestures peripherals like kinect & biometric devices.
- Data input is also done using secondary storage media and networking interface.
- Word processing software is designed to input basic alphanumerical data, while a photo editing application is used to input & manipulate images.
- This data may be entered into a database, spreadsheet or other forms of a computerized work area.
- Automated applications & robotics can also be used to intelligently feed data into the computer on station or remote remotely.

2) Data processing :

- Data processing is the core function of a computer. Processing involves manipulation of raw data into before converting it into meaningful information.
- Usually, data is in raw form, and will thus undergo processing before dissemination for user consumption.
- The 'brain' of the computer where data is processed is referred to as the microprocessor.
- It is also commonly known as the central processing unit (CPU) or accelerated processing unit (APU).
- Besides the microprocessor, the dynamic random access memory (DRAM) & static random access memory (SRAM) are integral parts of data processing.
- Data entered via input devices is stored temporarily in DRAM, then transferred to SRAM from where the microprocessor manipulates it.

3) Information output :

- When raw data has been manipulated by the microprocessor the outcome is meant to be disseminated for useful purpose.
- The output is thus referred to as information & is ~~beni~~ beneficial to the computer user.
- Processed data or 'information can be,
  - viewed as alphanumeric, images and video via a display hardware.
  - listened to as audio files by use of a speaker.
  - Printed as hard copy output onto paper.
  - Printed as 3D models.

4) Data and Information storage :

- The fourth and equally very important function

of a computer is data & information storage.

- A computer can store information internally & externally.
- The hard disk drive (HDD) and solid-state disk drive (SSD) are internal storage device & serve to protect & house all data and information on a computer.
- External storage is achieved through accessories that attach esternally to the computer.
- They includes external drives and optical disks.

CPU structure & function :

Interconnection structure :

- A computer consists of a set of components or modules of three basic types (processor, memory, I/O) that communicate with each other.
- In effect, a computer is a network of basic modules.
- Thus, there must be paths for connecting the modules.
- The collection of paths connecting the various modules is called the interconnection structure.
- The design of this structure will depend on the exchanges that must be made among modules.
- Fig. (b) suggests the types of exchanges that are needed by indicating the major forms of input and output for each module type.

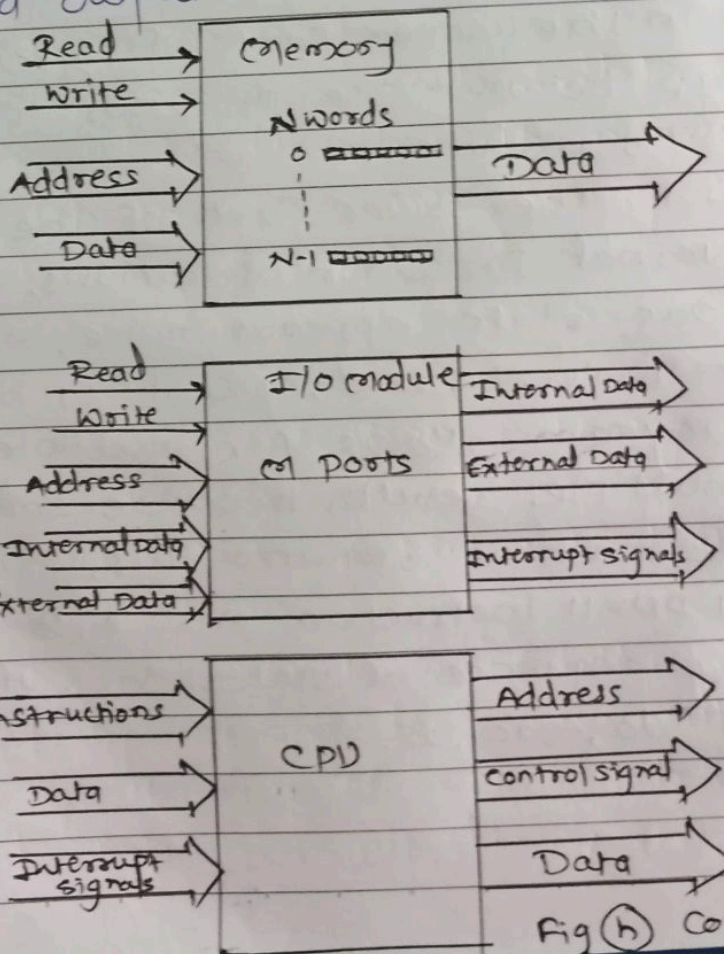


Fig (b) Computer modules

1) Memory :
- Typically, a memory module will consist of N words of equal length.
- Each word is assigned a unique numerical address (0, 1, ---, N-1).
- A word of data can be read from or written into the memory.
- The nature of the operation is indicated by read and write control signals.
- The location for the operation is specified by an address.

2) I/O module :
- From an internal point of view, I/O is functionally similar to memory.
- There are two operations read and write.
- Further, an I/O module may control more than one external device.
- We can refer to each of the interfaces to an external device as a port & give each a unique address (eg. 0, 1, ---, m-1)
- In addition, there are external data paths for the input and output of data with an external device.
- Finally, an I/O module can be able to send interrupt signals to the processor.

3) Processor :
The processor reads in instructions and data, writes out data after processing, & uses control signals to control the overall operation of the system. It is also receives interrupt signals.

- The preceding list defines the data to be exchanged.
- The interconnection structure must support the following type of transfer.

① Memory to processor :
The processor reads an instruction or a unit of data from memory.

② Processor to memory :
The processor writes a unit of data to memory.

③ I/O to processor :
The processor reads data from an I/O device via an I/O module.

④ Processor to I/O :
The processor ~~reads~~ sends data to the I/O device.

⑤ I/O to or from memory :
for these two cases, an I/O module is allowed to exchange data directly with memory, without going through the processor, using direct memory access (DMA).

* Bus Interconnection :

- A bus is a communication pathway connecting two or more devices.
- A key characteristics of bus is that it is a shared transmission medium.
- multiple devices connect to the bus and a signle transmitted by any one device is available for reception by all other devices attached to the bus.
- If two devices transmit during the same time

period, their signals will overlap & become garbled.
- Thus, only one device at a time can successfully transmit.
- Typically, a bus consists of multiple communication pathways or lines, Each line is capable of transmitting signals representing binary 1 & binary 0.

* Bus structure :
- It consists of typically 50 to 100 separate lines.
- Each line is assigned a particular line or function.
- Bus lines are classified into three functional groups:

① Data Bus :
- consists of 8, 16, 32 or more parallel signal lines.
- The data bus lines are bidirectional
- This means CPU can read data on these lines from memory or from port, as well as send data out on these lines to a memory location or to a port.
- Data bus is connected in parallel to all peripherals.
- Communication is activated by output enable ~~these~~ pulse to peripherals.
- The no. of lines of data bus referred to as the Width of the data bus. Because each line can carry one bit at a time, the no. of lines determines how many bits can be transferred at a time.
- The width of the data bus is a key factor in determining overall system performance.
- If the data bus is 32 bits wide & each instruction is 64 bits long, then the processor must access the memory module twice during each instruction cycle.

② Address Bus :

- The address lines are used to designate the source or destination of the data on the data bus.
- For example, if the processor wishes to read a word (8, 16 or 32 bit) of data from memory, it puts the address of the desired word on the address lines.
- The width of the address bus determines the maximum possible memory capacity of the system.
- The address lines are used to address I/O ports.

③ Control Bus :

- The control bus regulates the activity on the bus.
- The CPU sends control signals on the control bus to enable the output of addressed memory devices or port devices.
- Control signals transmit both command and timing information among system modules.
- Timing signals indicates the validity of data and address information.
- Command signals specify operations to be performed.
- Typical control bus signals are -

a) Memory Write :
Causes the data on the bus to be written into the addressed location.

b) Memory Read :
Causes data from the addressed location to be placed on the bus.

c) I/O Write :

causes data on the bus to be output to the addressed I/O Port.

d) I/O Read :
- causes data from the addressed I/O port to be placed on the bus.

e) Transfer ACK :
- Indicate that data have been accepted from or placed on the bus.

f) Bus request :
Indicates that a module needs to gain control of the bus.

g) Bus grant :
Indicates that a requesting module has been granted control of the bus

h) Interrupt request :
Indicates that an interrupt is pending.

i) Interrupt ACK :
Acknowledges that the pending interrupt has been recognized.

j) Clock :
Is used to synchronize operations.

k) Reset :
~~Initialli~~ Initializes all modules.

The operation of the bus is as follows:

- If one module wishes to send data to another, it must do two things -

1) obtain the use of the bus &
2) Transfer data via the bus. If one module wishes to request data from another modules.

It must -

1) obtain the use of the bus &
2) transfer a request to the other module over the approprite control & address lines.

- It must then wait for that second module to send the data.