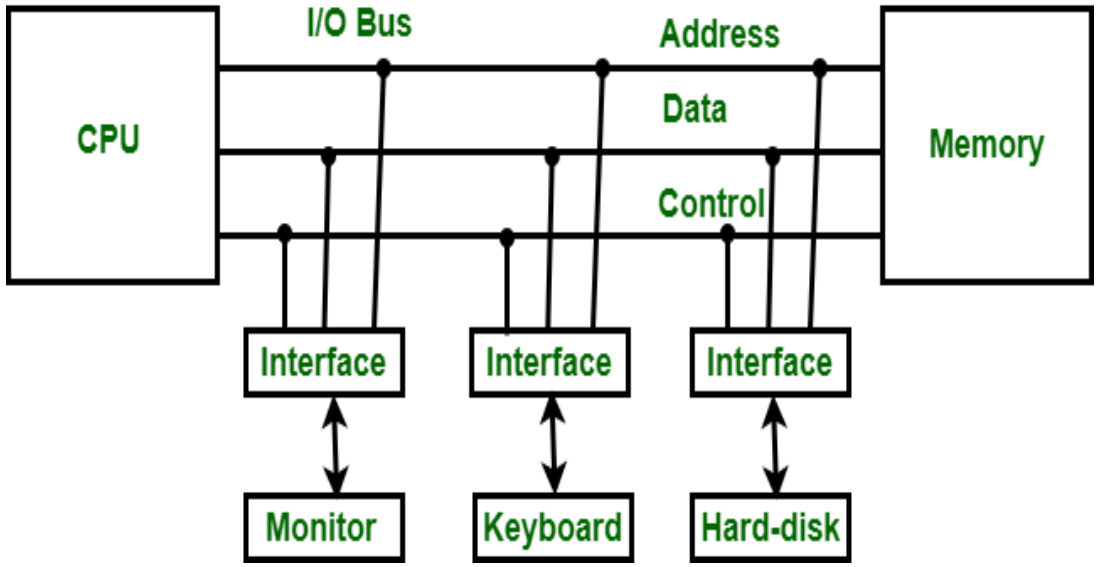
Computer System Architecture
UNIT – 5
Input - Output System

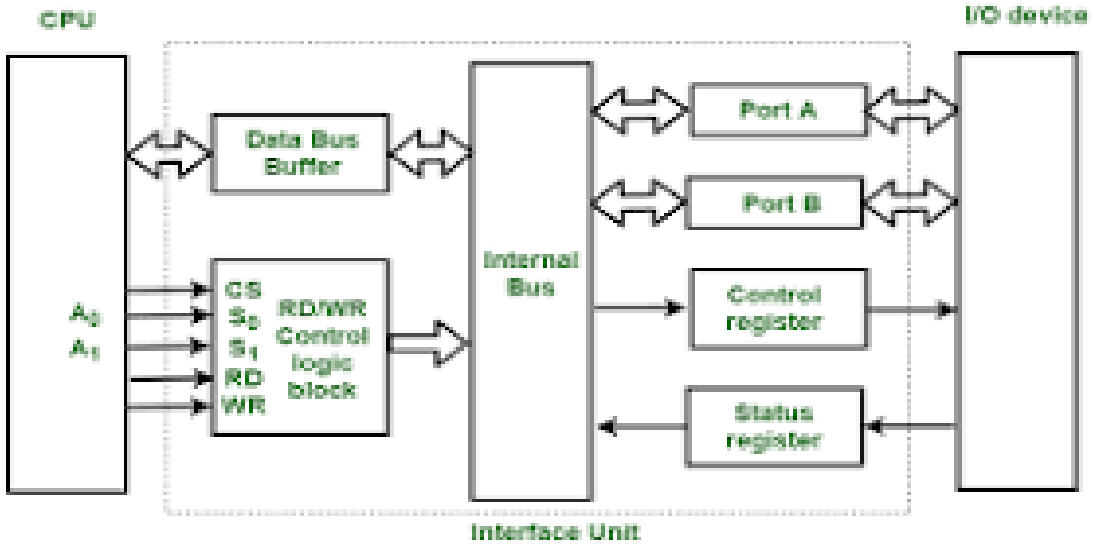
Syllabus

- Input - Output Interface
- Modes of Data transfer
- Programmed I/O Transfer
- Interrupt driven I/O
- DMA
- I/O Processor

Input - Output Interface

- Input-Output Interface helps in transferring of information between the internal storage devices i.e. memory and the external peripheral device.
- Input-Output devices are peripheral devices which provide input and output for the computer.
- For Example:
  - A keyboard and mouse provide Input to the computer are called input devices
  - A monitor and printer that provide output from the computer are called output devices





Modes of Data transfer

- The binary information that is received from an external device is usually stored in the memory unit.
- The information that is transferred from the CPU to the external device is originated from the memory unit.
- CPU merely processes the information but the source and target is always the memory unit.
- Data transfer between CPU and the I/O devices may be done in different modes.
- Data transfer to and from the peripherals may be done in any of the three possible ways
  - Programmed I/O.
  - Interrupt driven I/O.
  - Direct memory access(DMA).

Programmed I/O Transfer

- It is initiated by an (I/O) instruction in the program.
- Usually the transfer is from a CPU register and memory.
- Requires constant monitoring of the peripheral devices by the CPU .
- Example:
  - I/O device does not have direct access to the memory unit.
  - A transfer from I/O device to memory requires the execution of several instructions by the CPU, including
    - an input instruction to transfer the data from device to the CPU
    - and store instruction to transfer the data from CPU to memory.
  - CPU stays in the program loop until the I/O unit indicates that it is ready for data transfer.
  - This is a time consuming process since it needlessly keeps the CPU busy.
  - This situation can be avoided by using an interrupt facility.

Interrupt driven I/O

- In Programmed I/O, we saw the CPU is kept busy unnecessarily.
- This situation can be avoided by using an interrupt driven method for data transfer.
- By using interrupt facility and special commands to inform the interface to issue an interrupt request signal whenever data is available from any device.
- In the meantime the CPU can proceed for any other program execution.
- The interface meanwhile keeps monitoring the device.
- Whenever it is determined that the device is ready for data transfer it initiates an interrupt request signal to the computer.
- Upon detection of an external interrupt signal,
  - the CPU stops momentarily the task that it was already performing,
  - branches to the service program to process the I/O transfer,
  - and then return to the task it was originally performing.

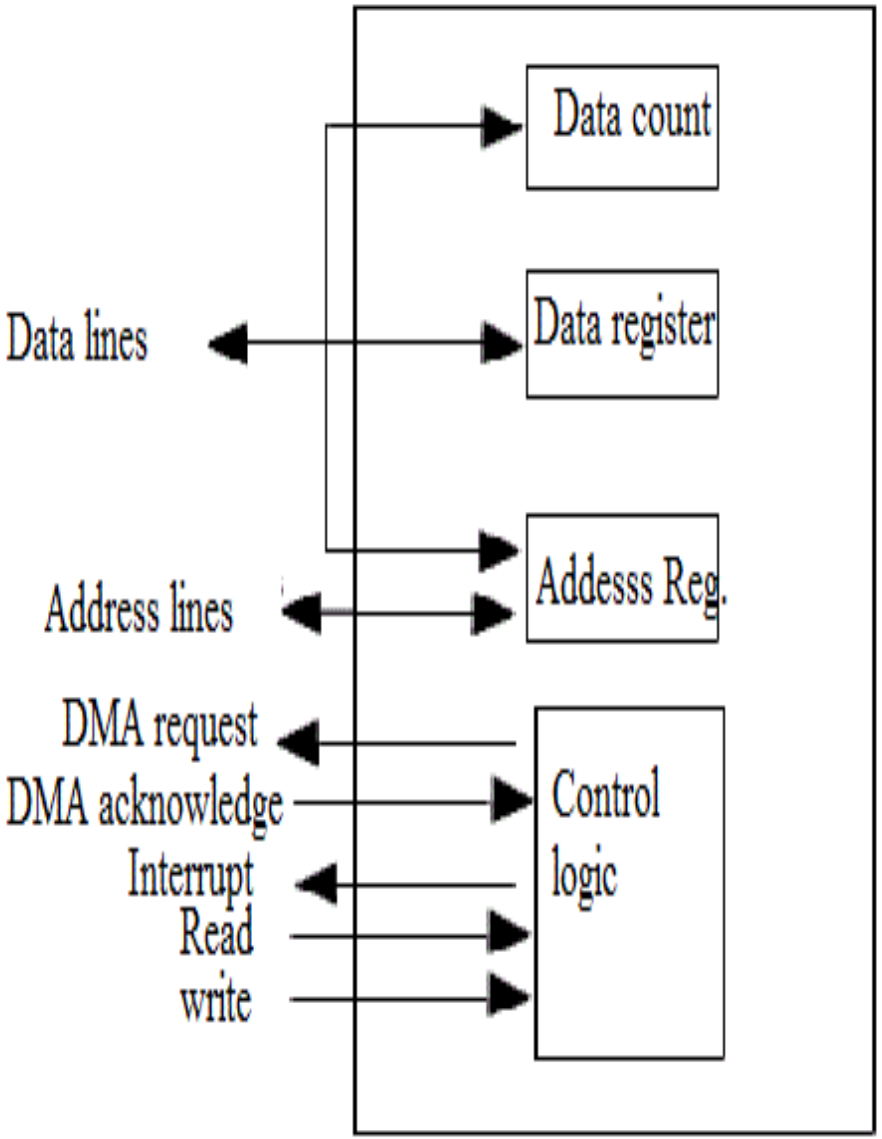
Interrupt driven I/O

- Note: Both the methods programmed I/O and Interrupt-driven I/O require the active intervention of the processor to transfer data between memory and the I/O module, and any data transfer must transverse a path through the processor.
- Thus both these forms of I/O suffer from two inherent drawbacks.
  - The I/O transfer rate is limited by the speed with which the processor can test and service a device.
  - The processor is tied up in managing an I/O transfer; a number of instructions must be executed for each I/O transfer.

DMA

Direct Memory Access

- The data transfer between a fast storage media such as magnetic disk and memory unit is limited by the speed of the CPU.
- Thus we can allow the peripherals directly communicate with each other using the memory buses, removing the intervention of the CPU.
- This type of data transfer technique is known as DMA or direct memory access.
- During DMA, the CPU is idle and it has no control over the memory buses.
- The DMA controller takes over the buses to manage the transfer directly between the I/O devices and the memory unit.



DMA

- DMA transfers are performed by a control circuit associated with the I/O device and this circuit is referred as DMA controller.
- With the help of Read or Write control line ,a specific operation is requested.
- I/o device which wants to send data ,DMA sends a HOLD signal to CPU on receiving HOLD signal it sends a HOLD ACK to the i/o device indicating that it has received it.
- The address of the I/O device and the starting location in memory need to be Read/Write is communicated on the address line and stored by the DMA module in the address register.
- The number of words to be transferred is communicated on the data lines and stored in the data counter register.
- On the completion of the transfer of data DMA module sends an interrupt signal to the processor.

DMA

DMA data transfer scheme are of following two types:

- Burst mode

  This is the most common type of DMA used .In this mode I/o device withdraws the DMA request only after all data bytes are transferred.

- Cycle stealing

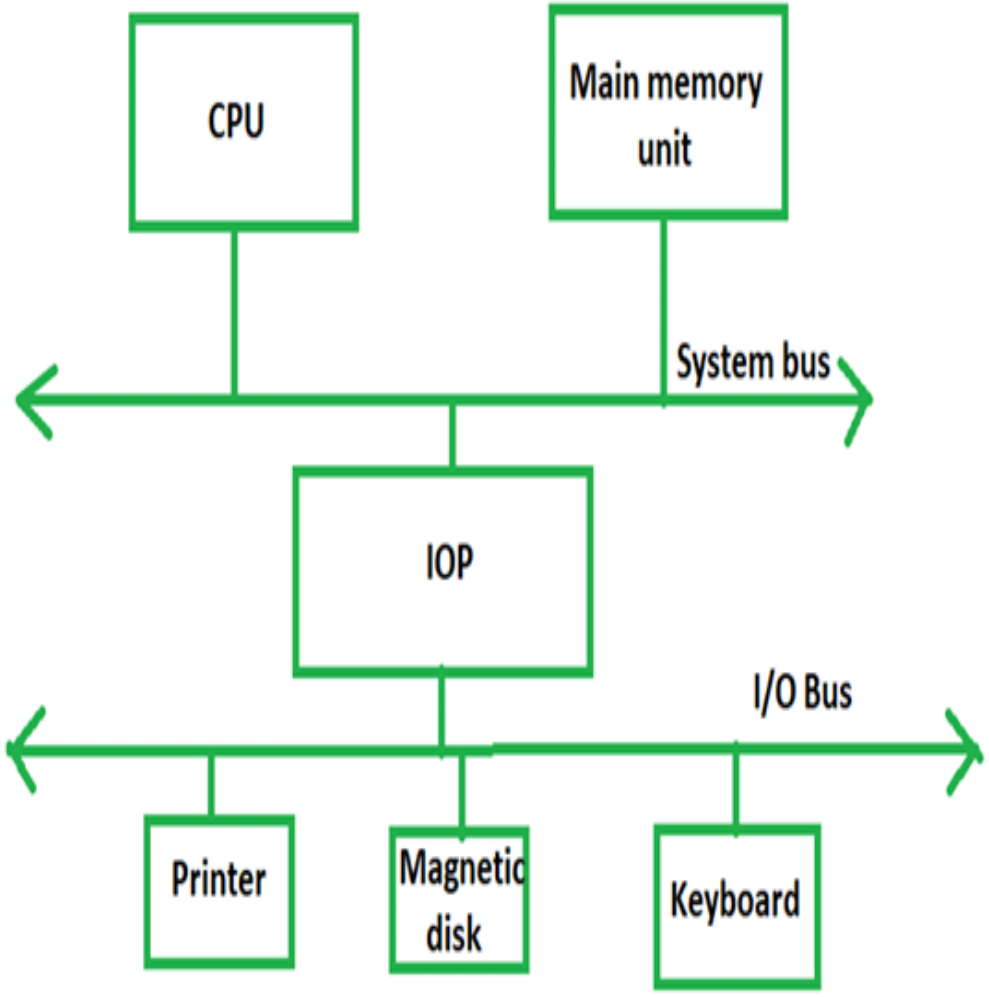
  In this mode a block of data is transfered by a sequence of DMA cycle. Here the I/O device withdraws DMA request after transferring one or several byte.

I/O Processor

- The DMA mode of data transfer reduces CPU's overhead in handling I/O operations. It also allows parallelism in CPU and I/O operations.
- Such parallelism is necessary to avoid wastage of valuable CPU time while handling I/O devices whose speeds are much slower as compared to CPU.
- The concept of DMA operation can be extended to relieve the CPU further from getting involved with the execution of I/O operations.
- This gives rises to the development of special purpose processor called Input-Output Processor (IOP) or IO channel.
- IOP is just like a CPU that handles the details of I/O operations.
- It is more equipped with facilities than those are available in typical DMA controller.
- The IOP can fetch and execute its own instructions that are specifically designed to characterize I/O transfers.
- In addition to the I/O – related tasks, it can perform other processing tasks like arithmetic, logic, branching and code translation.
- Main memory unit takes pivotal role. It communicates with processor by means of DMA.

I/O Processor

- The Input Output Processor is a specialized processor which loads and stores data into memory along with the execution of I/O instructions.
- It acts as an interface between system and devices.
- It involves a sequence of events to executing I/O operations and then store the results into the memory.
- Advantages:
  - The I/O devices can directly access the main memory without the intervention by the processor in I/O processor based systems.
  - It is used to address the problems that arises in Direct memory access method.



Input-Output Processor

Important Questions

- Explain various data transfer modes.
- Explain Programmed I/O
- Explain Interrupt Driven I/O
- Explain Direct Memory Access (DMA)
- Describe I/O interface with block diagram.
- Explain various DMA data transfer schemes.
- Describe Burst mode
- Describe Cycle stealing
- Explain the need of I/O processor.
- Describe I/O processor functionality with block diagram.