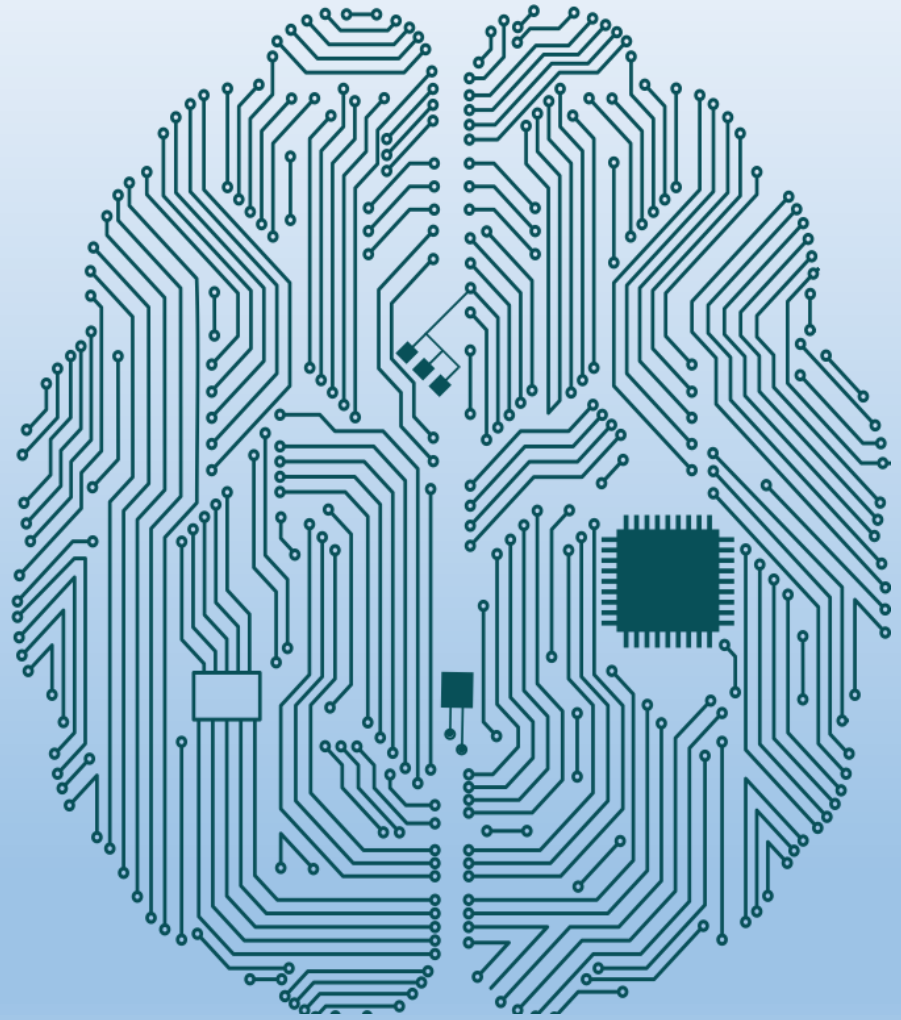


Input-Output Organization

Unit - V

Topics to be Covered

- Input-Output Interface
- Programmed I/O and Interrupt Initiated I/O
- CPU-IOP Communicatinon

I/O & Peripherals

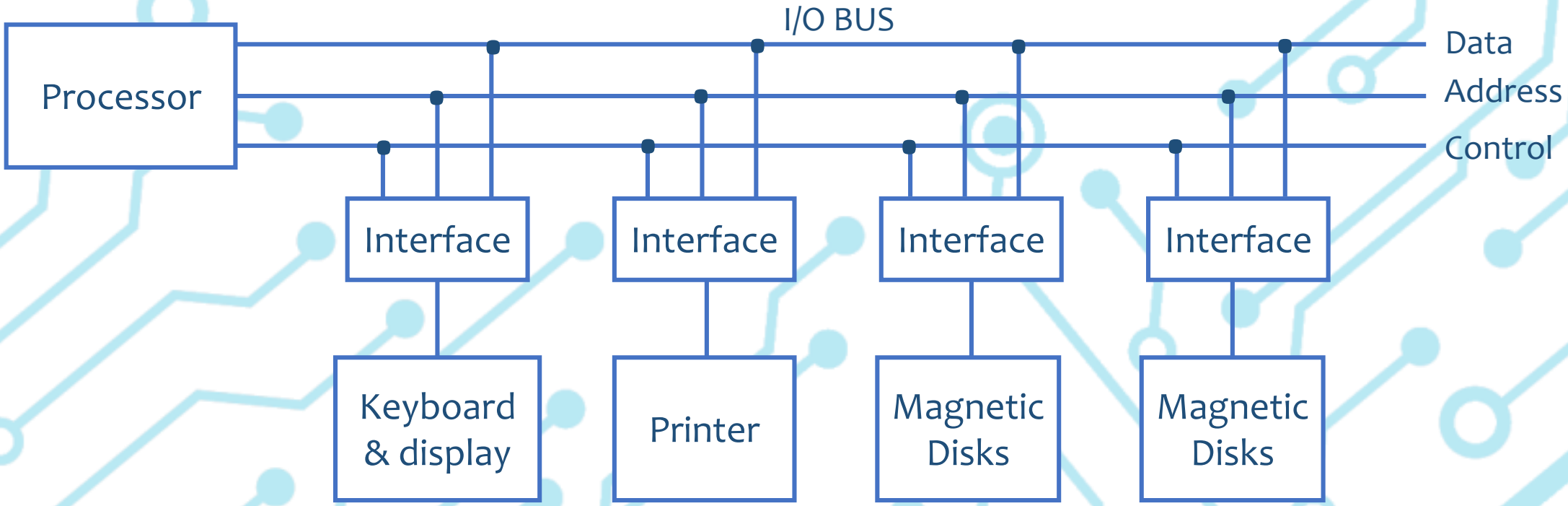
- The input–output subsystem of a computer, referred to as I/O, provides an efficient mode of communication between the central system and the outside environment.
- Programs and data must be entered into computer memory for processing and results obtained from computations must be recorded or displayed for the user.
- A computer serves no useful purpose without the ability to receive information from an outside source and to transmit results in a meaningful form.
- Input or output devices attached to the computer are also called **peripherals**.

Input – Output Interface

- Input–output interface provides a method for transferring information between internal storage and external I/O devices.
- Peripherals connected to a computer need special communication links for interfacing them with the central processing unit.
- The purpose of the communication link is to resolve the differences that exist between the central computer and each peripheral.
- Major Differences Include:
  - Peripherals are **electromechanical and electromagnetic** devices and their **manner of operation is different** from the operation of the CPU and memory, which are electronic devices. Therefore, a **conversion** of signal values may be required.
  - The **data transfer rate** of peripherals is **usually slower** than the transfer rate of the CPU, and consequently, a **synchronization** mechanism may be needed.
  - **Data codes and formats** in peripherals **differ** from the word format in the CPU and memory.
  - The **operating modes** of peripherals are **different** from each other and each must be controlled so as not to disturb the operation of other peripherals connected to the CPU.

Input – Output Interface

- These components are called interface units because they interface between the processor bus and the peripheral device.
- The word “Interface” is a general term for the point of contact between two parts of a system.



Input – Output Interface

- The function code is referred to as an I/O command and is in essence an instruction that is executed in the interface and its attached peripheral unit. The interpretation of the command depends on the peripheral that the processor is addressing.
- There are four types of commands that an interface may receive.
  - Control: issued to activate the peripheral device and to inform it what to do
  - Status: issued to test various status conditions in the interface and the peripheral.
  - Data Output: causes the interface to respond by transferring data from the bus into one of its registers.
  - Data Input: the interface receives an item of data from the peripheral and places it in its buffer register. The processor checks if data are available by means of a status command and then issues a data input command.

I/O Mapping Techniques

- Isolated I/O: In the isolated I/O configuration, the CPU has distinct input and output instructions, and each of these instructions is associated with the address of an interface register.
- Memory Mapped I/O: The computer treats an interface register as being part of the memory system, hence no requirement of distinct input output instructions

Isolated I/O v/s Memory Mapped I/O

Criteria	Isolated I/O	Memory Mapped I/O
Addressing	I/O devices are assigned distinct addresses.	I/O devices share memory addresses.
Address Range	Has a separate address range.	Shares the same address range as system memory.
Control	Requires separate control signals for I/O operations.	Uses standard memory read and write instructions.
Complexity	Generally simpler to implement.	Can be more complex due to address conflicts.
Hardware Mapping	Requires external hardware to decode I/O addresses.	Address decoding is often handled by the system bus.
Data Transfer	Typically slower due to separate control signals.	Faster data transfer as it leverages standard memory operations.
Protection	Offers better isolation and protection of I/O devices.	May have fewer protection mechanisms for I/O devices.
Usage	Commonly used in microcontroller-based systems.	Common in computer systems and microprocessors.

Modes of Data Transfer

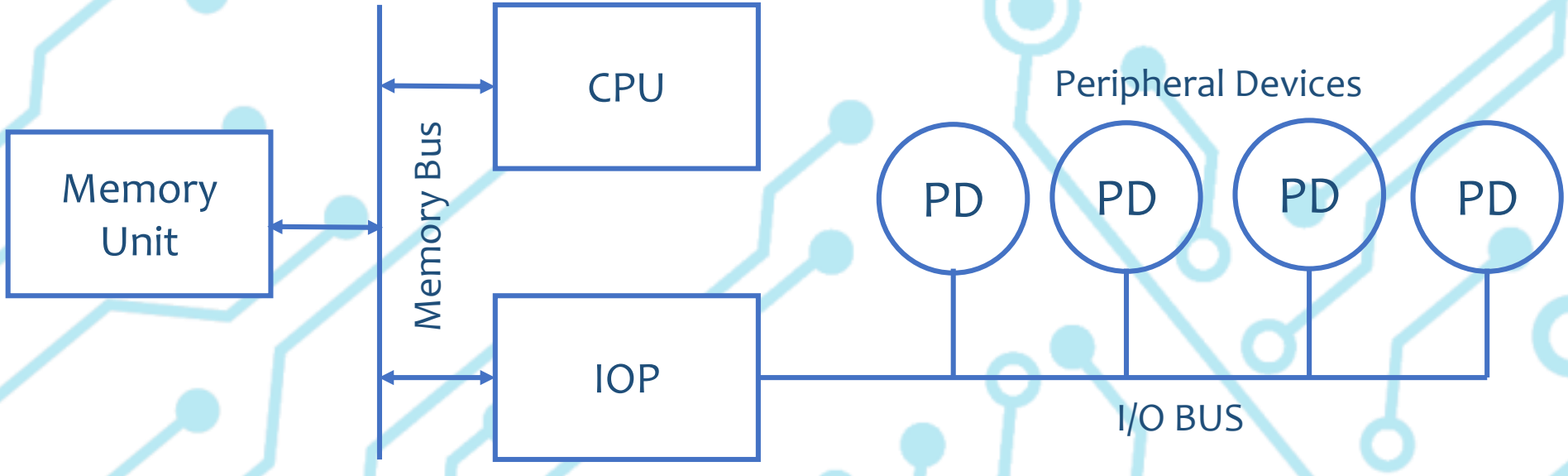
- Data transfer between the central computer and I/O devices may be handled in a variety of modes. Some modes use the CPU as an intermediate path; others transfer the data directly to and from the memory unit.
  - Programmed I/O
    - Programmed I/O operations are the result of I/O instructions written in the computer program. Each data item transfer is initiated by an instruction in the program.
  - Interrupted I/O
    - Programmed I/O wastes CPU cycles waiting for the input to arrive in a loop, this can make CPU needlessly busy.
    - This can be avoided using a technique where an interface interrupts the CPU when the input is arrived, meanwhile CPU can execute another program.
  - Direct Memory Access (DMA):
    - In DMA, the interface transfers data into and out of the memory unit through the memory bus. The CPU initiates the transfer by supplying the interface with the starting address and the number of words needed to be transferred and then proceeds to execute other tasks.

Programmed I/O v/s Interrupted I/O

Criteria	Programmed I/O	Interrupted I/O
Control	CPU is responsible for polling I/O device status and data transfer.	I/O device informs CPU when it's ready for data transfer via an interrupt.
CPU Utilization	CPU is continuously involved in polling, leading to lower CPU utilization.	CPU is free for other tasks when waiting for interrupts, leading to higher CPU utilization.
Latency	Can introduce latency as CPU may not immediately respond to I/O device readiness.	Typically lower latency as the CPU is notified as soon as the I/O device is ready.
Efficiency	Less efficient in terms of CPU utilization.	More efficient as CPU can perform other tasks while waiting for I/O device.
Complexity	Simpler in terms of hardware and software.	Can be more complex due to interrupt handling mechanisms.
Programming Effort	Requires more effort to manage polling loops and timing.	Easier to program as CPU is interrupted when I/O device is ready.
Applications	Suitable for simple I/O devices and applications.	Commonly used in complex, multitasking systems.

CPU – IOP Communication

- Many computers combine the interface logic with the requirements for direct memory access into one unit and call it an I/O processor (IOP).
- The IOP can handle many peripherals through a DMA and interrupt facility.
- In such a system, the computer is divided into three separate modules: the memory unit, the CPU, and the IOP.



CPU – IOP Communication