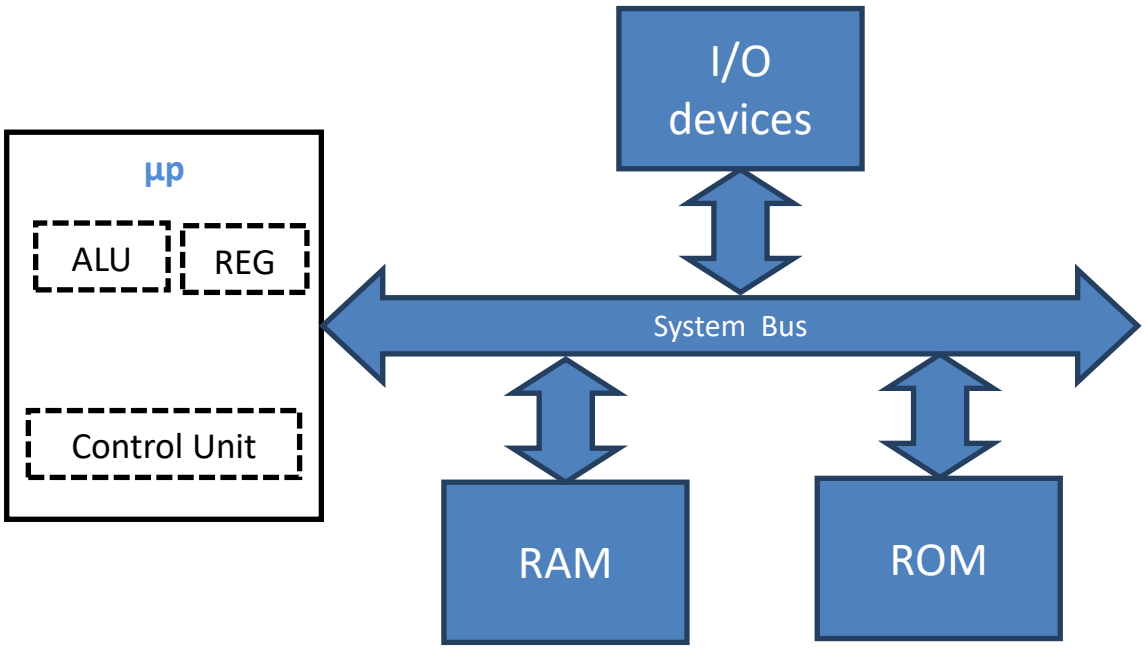
A Microprocessor System

Microprocessor has limited location to store information inside it. So, ROM and RAM chips are connected externally to store program and data respectively. A Microprocessor system requires IO ports to communicate with the external world. All these are connected to the microprocessor through the system bus. It is shown in the figure below.



So, a simple microprocessor system has:

1. **ROM:** ROM are non-volatile memory chips. So, ROM is used to store programs. The memory is normally used to read information.
2. **RAM**: RAM is volatile and information can be read or written to it. So, used to store data.
3. **Input devices** are used to read information from the real world. Transducer, Keyboard, Mouse, Scanner etc. are example of input devices.
4. **Output devices** used to display, record or print information. For example, LED, 7-segment display, CRT, Printer, Plotter etc. are output devices.

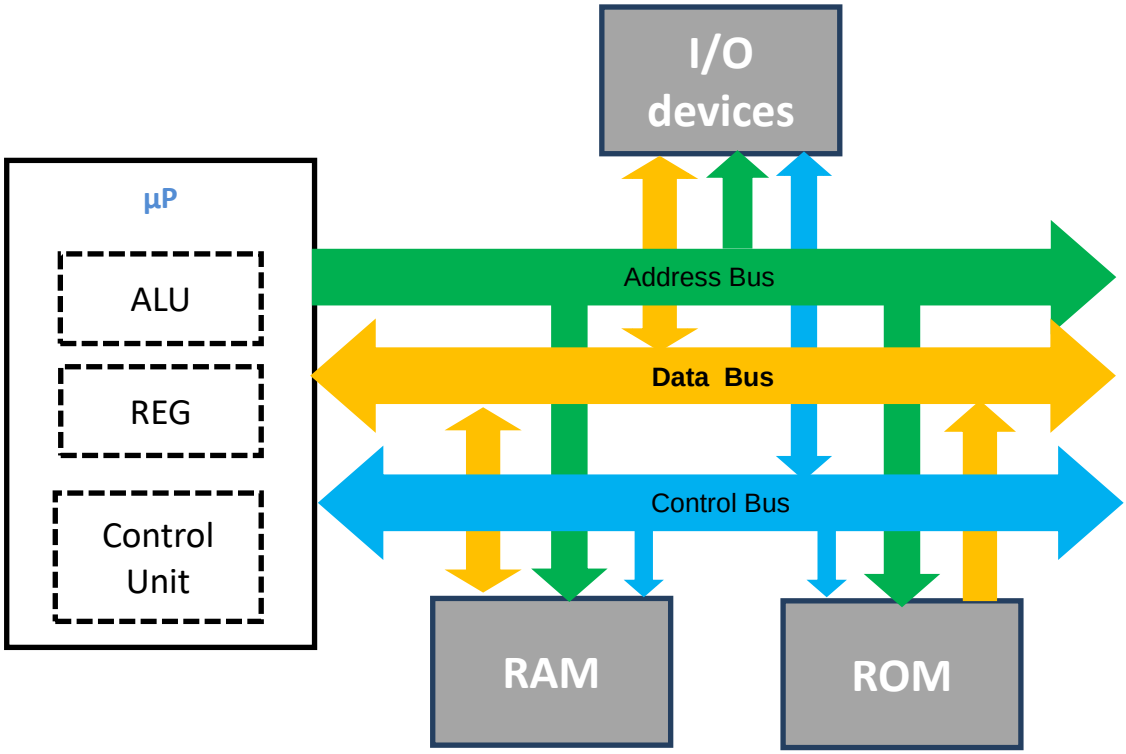
Please note IO devices (input/output devices) are generally slower than memory.

Note: ROM is non-volatile (i.e. information is not lost when power is removed. The information can be retrieved when power resumes) in nature. To avoid the loss of program (set of instructions) when power is not connected, it is stored in ROM. Data are not fixed and varies with time. So, data are stored in RAM, that are volatile (i.e. information stored is lost when power is removed) in nature.

BUS: Bus are a group of lines used for common purpose.

The system bus consists of

1. **Data Bus**: The microprocessor read the instruction from ROM using the data bus. It is also used by the processor to send and receive data to and from different devices. As data flows in both the direction it is bidirectional.
2. **Address Bus**: Microprocessor sends address through this line to select a memory location to read the instruction or data. Microprocessor also used these lines to send address to select the desired input/output (IO) for data transfer. As the address is generated by microprocessor only, it is unidirectional.
3. **Control Bus**: The control bus is used for transmitting and receiving control signals between the processor and various devices. A control signal may flow from processor to an external device or from an external device to processor,



Please note that address bus is unidirectional, but data bus is bidirectional. Address flows from microprocessor to memory or I/O devices, but in data bus data flows in any direction. When data flows from µP to external device it is called output or write operation. When data flow to the µP it is called input or read operation. So, we have 4 different cases:

1. Memory Read: Data flows from Memory (ROM or RAM) to µP.
2. Memory Write: Data flows from µP to RAM.
3. I/O Read: Data flows from I/O devices to µP.
4. I/O Write: Data flows from µP to I/O devices.

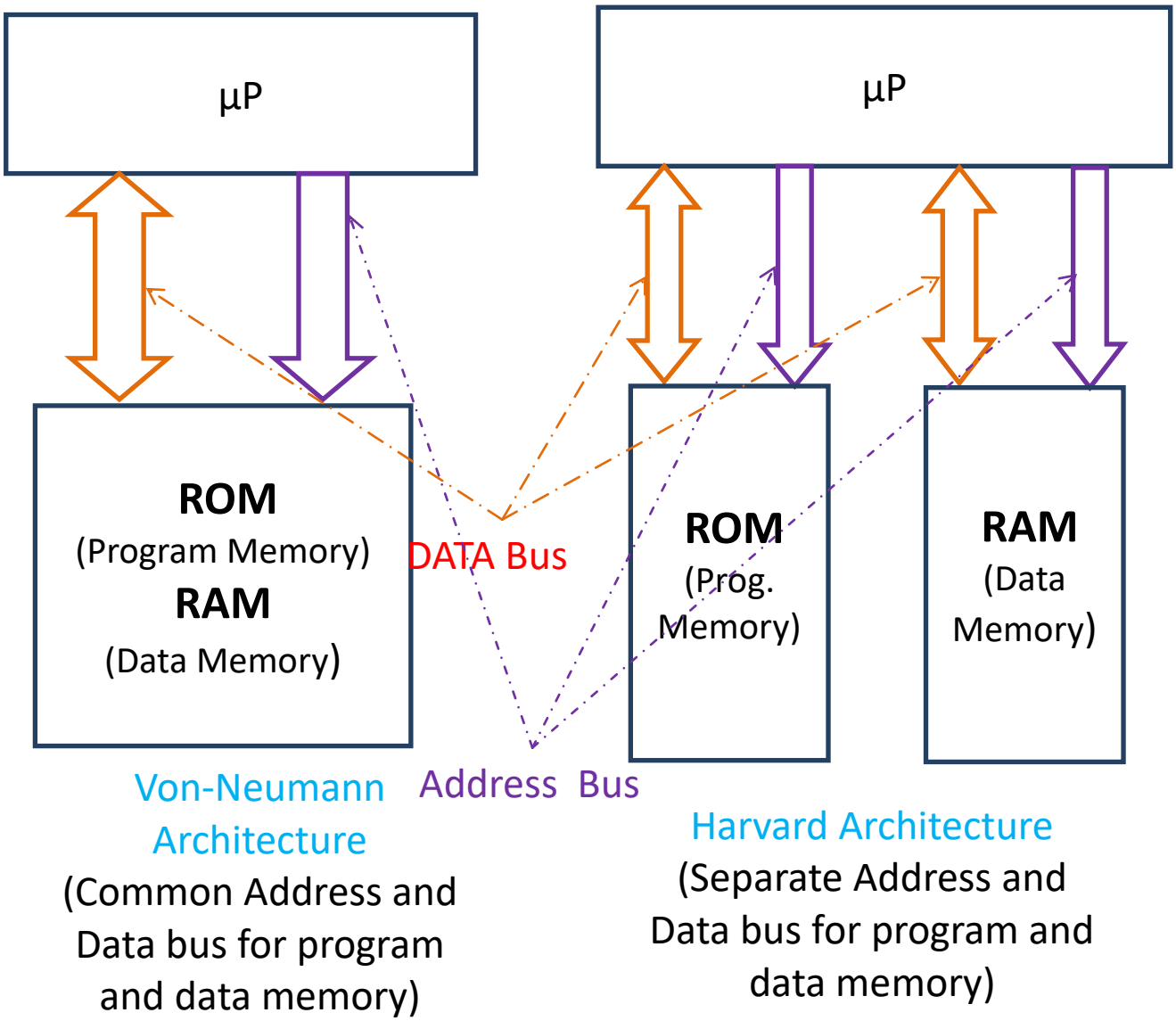
Architecture of Microprocessor System

Von-Neumann and Harvard Architecture:

Two types of architecture are used to connect the Memory. These are

1. Von-Neumann Architecture
2. Harvard Architecture

The architecture is shown in diagram below.



Von-Neumann Architecture

- Uses single memory spaces.
- Single shared bus for program and data memory. So requires a smaller number of pins.
- Design of control unit is simple in comparison to Harvard architecture.
    - So Cheaper.
- Either code or data can be transferred at a time. Simultaneous transfer of program code and data is not possible.
    - Hence, slower data transfer.

Harvard Architecture

- Instruction and data memory have separate memory spaces.
    - Separate data and address bus for program and data memory.
        - Allows different bus width for data and program memory.
- Data and Code (Program) memory can be accessed simultaneously.
    - So, execution speed is high
- Design of control unit is complex.
    - This makes the system costlier
- More pins are required for interfacing external memory.