Chapter-3

Central Processing Unit

3.1 CPU structure and Function

- The part of the computer that performs the bulk of data processing operations is called the Central Processing Unit (CPU) and is the central component of a digital computer.
- Its purpose is to interpret instruction cycles received from memory and perform arithmetic, logic and control operations with data stored in internal register, memory words and I/O interface units.
- A CPU is usually divided into two parts namely processor unit (Register Unit and Arithmetic Logic Unit) and control unit.

Processor Unit:

- The processor unit consists of arithmetic unit, logic unit, a number of registers and internal buses that provides data path for transfer of information between register and arithmetic logic unit.
- The block diagram of processor unit is shown in figure below where all registers are connected through common buses.
- The registers communicate each other not only for direct data transfer but also while performing various micro-operations.

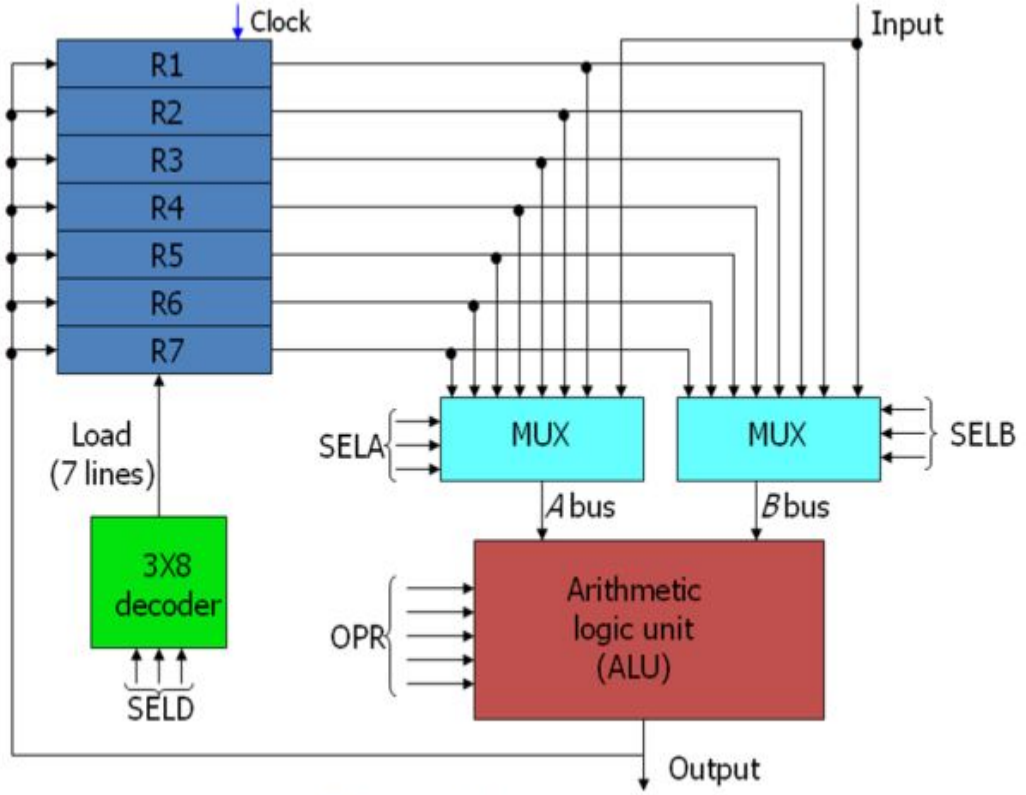


Fig: Processor Unit

Control unit:

- The control unit is the heart of CPU.
- It consists of a program counter, instruction register, timing and control logic.
- The control logic may be either hardwired or micro-programmed.
- The control unit decides what the instructions mean and directs the necessary data to be moved from memory to ALU.
- Control unit must communicate with both ALU and main memory and coordinates all activities of processor unit, peripheral devices and storage devices
- Control unit must have inputs that allow determining the state of system and outputs that allow controlling the behavior of system.

The input to control unit are:

- **Flag:** flags are headed to determine the status of processor and outcome of previous ALU operation.
- **Clock:** All micro-operations are performed within each clock pulse. This clock pulse is also called as processor cycle time or clock cycle time.
- **Instruction Register:** The op-code of instruction determines which micro-operation to perform during execution cycle.
- **Control signal from control bus:** The control bus portion of system bus provides interrupt, acknowledgement signals to control unit

The outputs from control unit are:

- **Control signal within processor:** These signals causes data transfer between registers, activate ALU functions.
- **Control signal to control bus:** These are signals to memory and I/O module. All these control signals are applied directly as binary inputs to individual logic gate.

Fig: Control unit

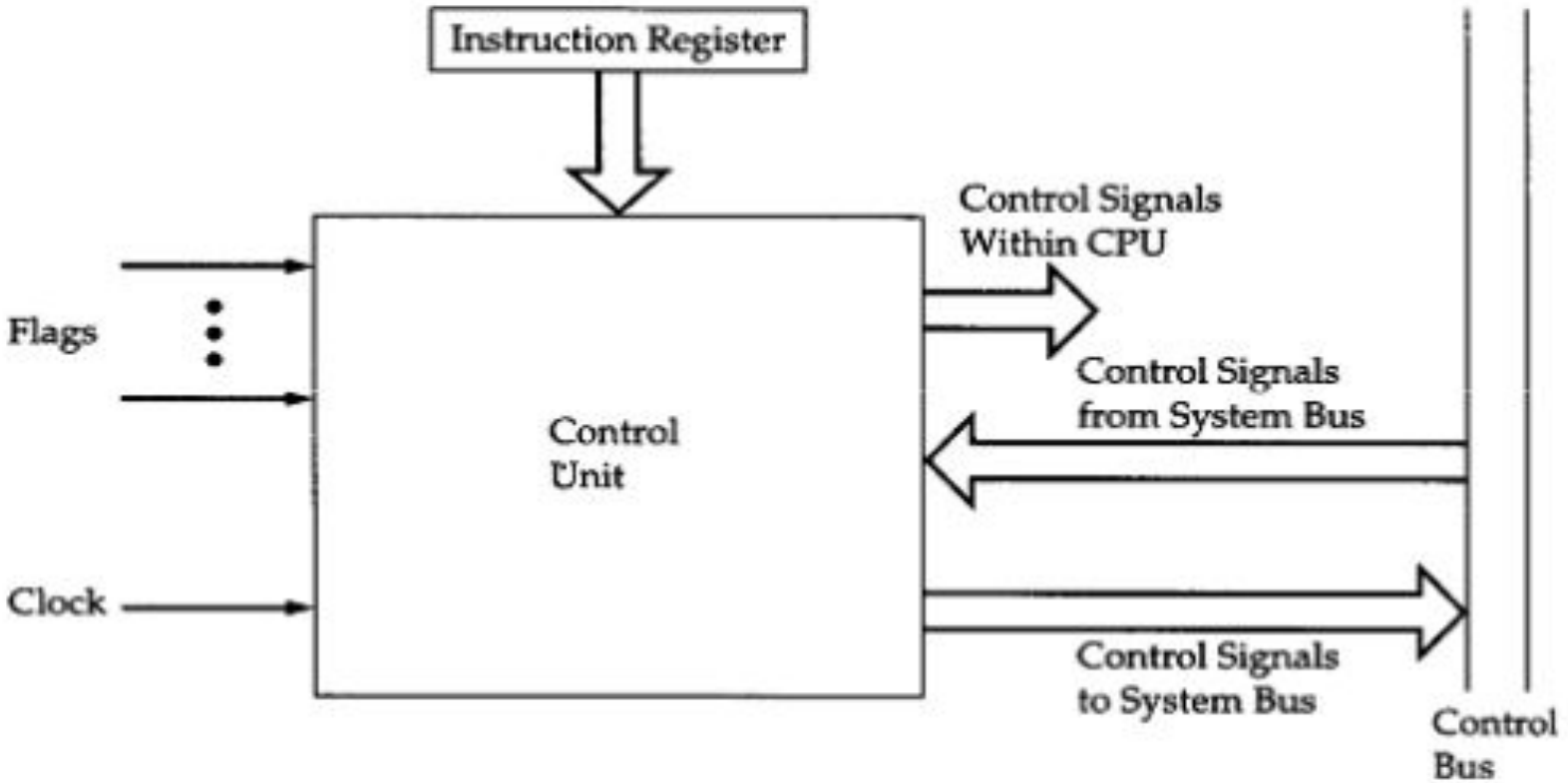
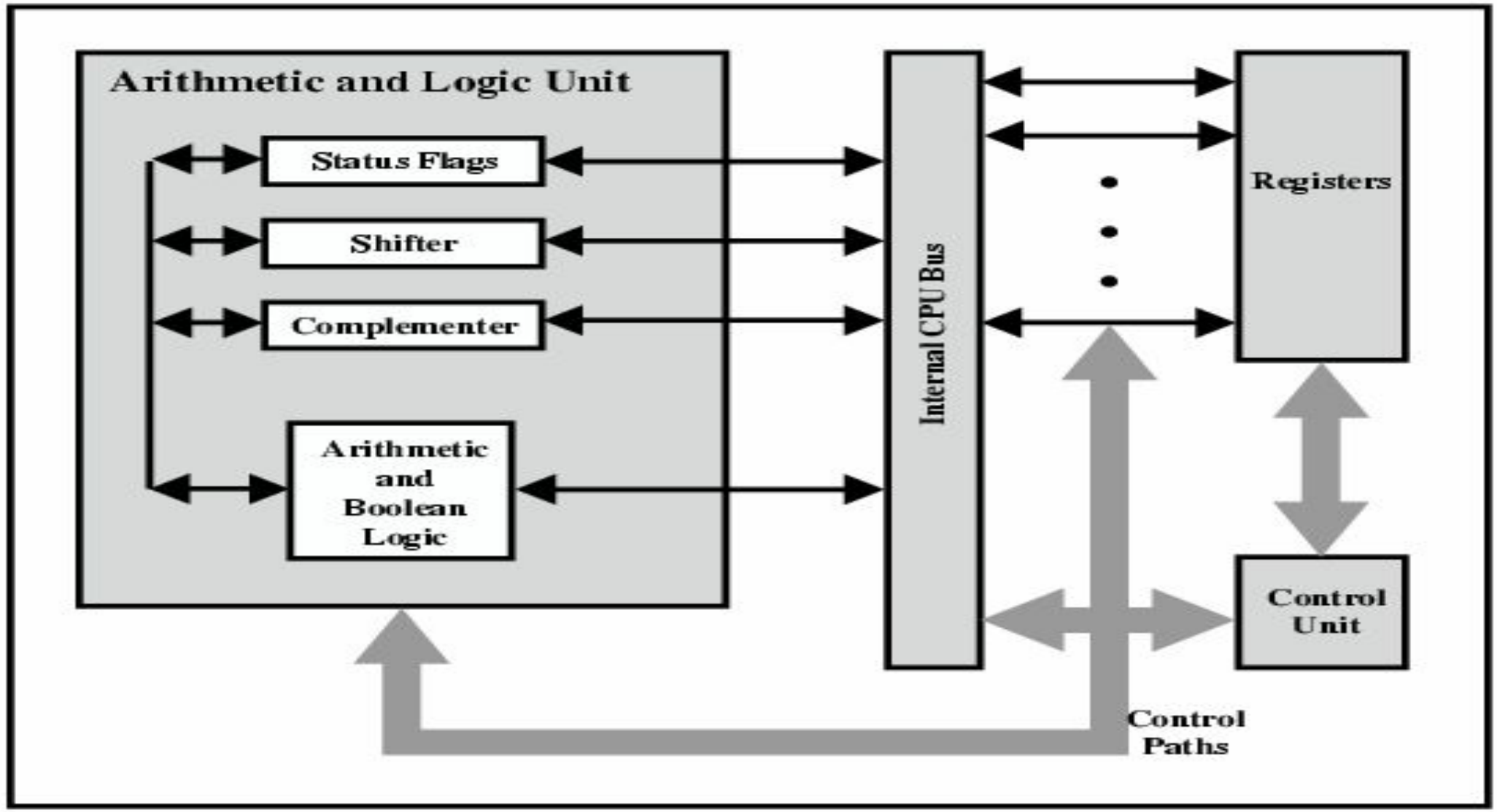


Fig: Control Unit

3.1 CPU Structure and Function

1. Processor Organization

- To understand the organization of the CPU, let us consider the requirements placed on the CPU, the things that it must do:
- **Fetch instruction:** The CPU reads an instruction from memory.
- **Interpret instruction:** The instruction is decoded to determine what action is required.
- **Fetch data:** The execution of an instruction may require reading data from memory or an I/O module.
- **Process data:** The execution of an instruction may require performing some arithmetic or logical operation on data.
- **Write data:** The results of an execution may require writing data to memory or an I/O module.


Arithmetic and Logic Unit
Status Flags
Shifter
Complementer
Arithmetic and Boolean Logic
Internal CPU Bus
Registers
Control Unit
Control Paths

2. Register Organization

- To do these things, it should be clear that the CPU needs to store some data temporarily.
- It must remember the location of the last instruction so that it can know where to get the next instruction.
- It needs to store instructions and data temporarily while an instruction is being executed. In other words, the CPU needs a small internal memory.
- A minimal internal memory, consisting of a set of storage locations, called registers.

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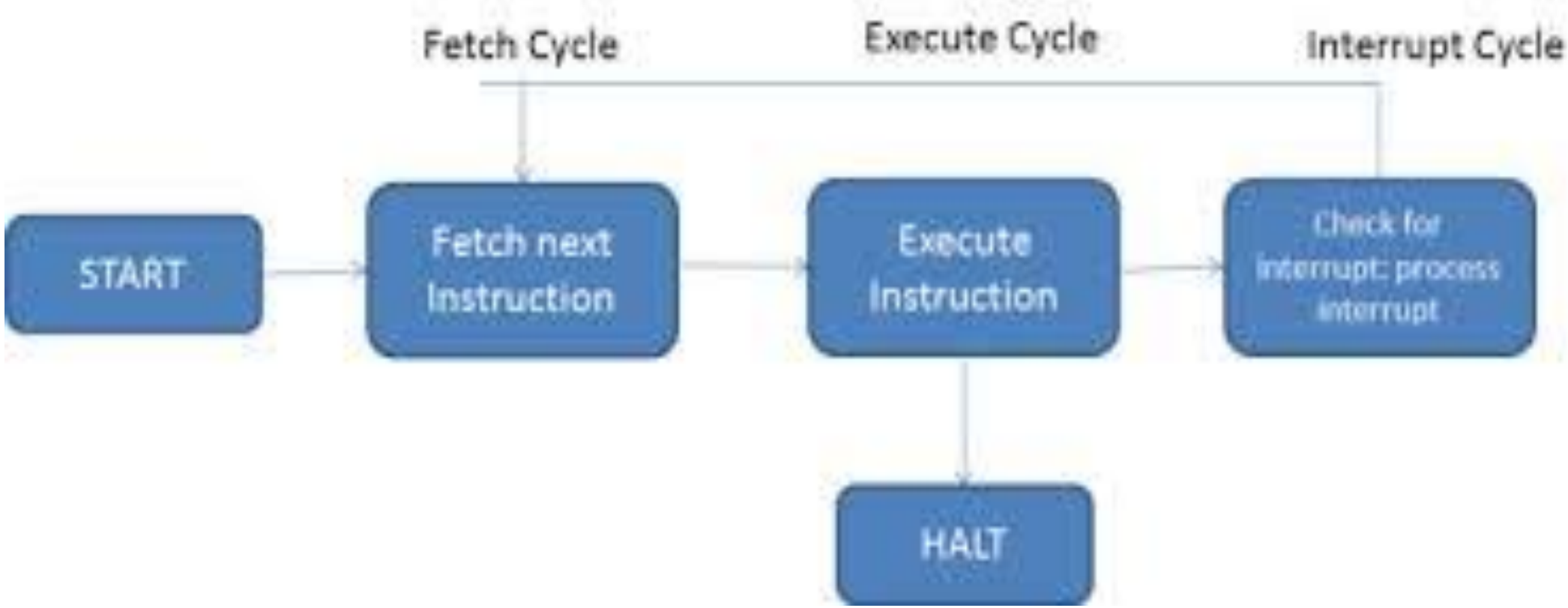
- Within the CPU, there is a set of registers that function as a level of memory above main memory and cache in the hierarchy. The registers in the CPU perform two roles:
- **User-visible registers:** These enable the machine- or assembly-language programmer to minimize main memory references by optimizing use of registers.
- **Control and status registers:** These are used by the control unit to control the operation of the CPU and by privileged, operating system programs to control the execution of programs.

3. Instruction Cycle

- The instruction cycle includes the following sub-cycles:
- **Fetch:** Read the next instruction from memory into the CPU.
- **Execute**: Interpret the opcode and perform the indicated operation.
- **Interrupt:** If interrupts are enabled and an interrupt has occurred, save the current process state and service the interrupt.

Fig: Instruction Cycles



3.2 Arithmetic and Logic Unit