BASIC OPERATIONAL CONCEPTS

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- **Program:**
  - Consists of a list of instructions to perform a given task.
  - It is stored in memory.
  - Individual instructions are brought from memory into processor.
  - Processor executes the specified operations.
  - Data to be used as operands are also stored in memory.

BASIC OPERATIONAL CONCEPTS CONT..

- **Example instruction:**
  - **Add LOCA, RO** // RO = [LOCA] + [RO]
- Steps required to execute a instruction:
  1. Instruction is fetched from memory into processor.
  2. Operand at memory location LOCA is fetched and added to contents of RO.
  3. Resulting sum is stored in register RO.
- This Add instruction combines a memory access operation with an ALU operation.
- Original contents of location LOCA are preserved.
- RO are overwritten.

BASIC OPERATIONAL CONCEPTS CONT..

- In many modern computers, memory access operation and ALU operation are performed by separate instructions for performance reasons.
- **Example:**
  - Load LOCA, R1 // transfers contents of LOCA into R1
  - Add R1, RO // adds R1 and RO and places sum into RO
  - It destroys the former contents of R1 and RO, whereas original contents of LOCA are preserved.

Connection Between Processor and Memory

- Processor contains a number of registers used for several different purposes.
    1. Instruction register (IR)
    2. Program counter (PC)
    3. Memory address register (MAR)
    4. Memory data register (MDR)
    5. General-purpose register (R0 – Rn-1)

Connection Between Processor and Memory Cont..

- **Instruction register (IR)**
  - Holds instruction that is currently being executed.
  - Its output is available to control circuits.
  - Control circuits
    - It generates timing signals that control the various processing elements involved in executing the instruction.
- **Program counter (PC)**
  - It is another specialized register.
  - It keeps track of the execution of a program.
  - It contains memory address of next instruction to be fetched and executed.
  - During execution of an instruction, contents of PC are updated.

Connection Between Processor and Memory Cont..

- Finally, two registers facilitate communication with the memory.
- **Memory address register (MAR)**
  - Holds the address of the location to be accessed.
- **Memory data register (MDR)**
  - Contains the data to be written into or read out of the addressed location.

Operating Steps: Move Data Between Memory and Processor

- Programs reside in memory.
- Execution starts when PC is set to point to first instruction.
- Contents of PC are transferred to MAR and a Read control signal is sent to memory.
- First instruction is read out of memory and loaded into MDR.
- Next, contents of MDR are transferred to IR.
- At this point, instruction is ready to be decoded and executed.
- If instruction involves an operation to be performed by ALU, it is necessary to obtain required operands.
- If an operand resides in memory (or in a general-purpose register), it has to be fetched by sending its address to MAR and initiating a Read cycle.

Operating Steps: Move Data Between Memory and Processor

- When operand has been read from memory into MDR, it is transferred from MDR to ALU.
- After one or more operands are fetched in this way, ALU can perform desired operation.
- If result is to be stored in memory, then result is sent to MDR.
- Address of the location where result is to be stored is sent to the MAR, and a Write cycle is initiated.
- At some point during the execution of the current instruction, the contents of the PC are incremented so that the PC points to the next instruction to be executed.
- Thus, as soon as execution of current instruction is completed, a new instruction fetch may be started.

Move Data Between Processor and I/O devices

- Computer accepts data from input devices and sends data to output devices.
- Thus, some machine instructions with the ability to handle I/O transfers are provided.

Interrupt Processing

- Interrupt is a request from an I/O device for service by the processor.
- If some device requires urgent service then it raises an interrupt signal.
- In order to deal with the situation immediately, normal execution of current program must be interrupted.
- Processor provides the requested service by executing an appropriate interrupt-service routine.
- This diversions may alter the internal state of the processor.
- Processor state must be saved in memory locations before servicing the interrupt.
- Normally, contents of PC, general registers, and some control information are stored in memory.
- When interrupt-service routine is completed, state of processor is restored so that interrupted program may continue.