BASIC OPERATIONAL CONCEPTS

Chapter #3 ; Lecture # 5, Week # 3

What is the basic Operation of Computer?

- **To execute a program/ command/ set of instructions:**

- The primary function of a computer system is to execute a program, sequence of instructions. These instructions are stored in computer memory.
- These instructions are executed to process data which are already loaded in the computer memory through some input devices.
- After processing the data, the result is either stored in the memory for further reference, or it is sent to the outside world through some output port.

How is it done ?

- To perform the execution of an instruction, in addition to the arithmetic logic unit, and control unit, the processor contains a number of registers used for temporary storage of data and some special function registers.
- For now, lets take an example of a simple instruction execution in the next slide.

- **For example, a processor includes an instruction, expressed symbolically as ADD A,B; that stores the sum of the contents of memory locations B and A into memory location A. A single instruction cycle with the following steps occurs:**

- Fetch the ADD instruction.
- Read the contents of memory location A into the processor.
- Read the contents of memory location B into the processor.
- In order that the contents of A are not lost, the processor must have at least two registers for storing memory values, rather than a single accumulator.
- Add the two values.
- Write the result from the processor to memory location A.

Operating steps

1. Programs reside in the memory & usually get these through the I/P unit.
2. Execution of the program starts when the PC is set to point at the first instruction of the program.
3. Contents of PC are transferred to MAR and a Read Control Signal is sent to the memory.
4. After the time required to access the memory elapses, the address word is read out of the memory and loaded into the MDR.
5. Now contents of MDR are transferred to the IR & now the instruction is ready to be decoded and executed.
6. If the instruction involves an operation by the ALU, it is necessary to obtain the required operands.

Operating steps

7. An operand in the memory is fetched by sending its address to MAR & Initiating a read cycle.
8. When the operand has been read from the memory to the MDR, it is transferred from MDR to the ALU.
9. After one or two such repeated cycles, the ALU can perform the desired operation.
10. If the result of this operation is to be stored in the memory, the result is sent to MDR.
11. Address of location where the result is stored is sent to MAR & a write cycle is initiated.
12. The contents of PC are incremented so that PC points to the next instruction that is to be executed.

Analyzing how Processor and Memory are Connected

- **Processors have various registers to perform various functions :-**
- **Program Counter** :- It contains the memory address of next instruction to be fetched.
- **Instruction Register**:- It holds the instruction which is currently being executed.
- **MDR** :- It facilities communication with memory. It contains the data to be written into or read out of the addressed location.
- **MAR** :- It holds the address of the location that is to be accessed
- There are **'n' general purpose registers** that is R0 to Rn-1

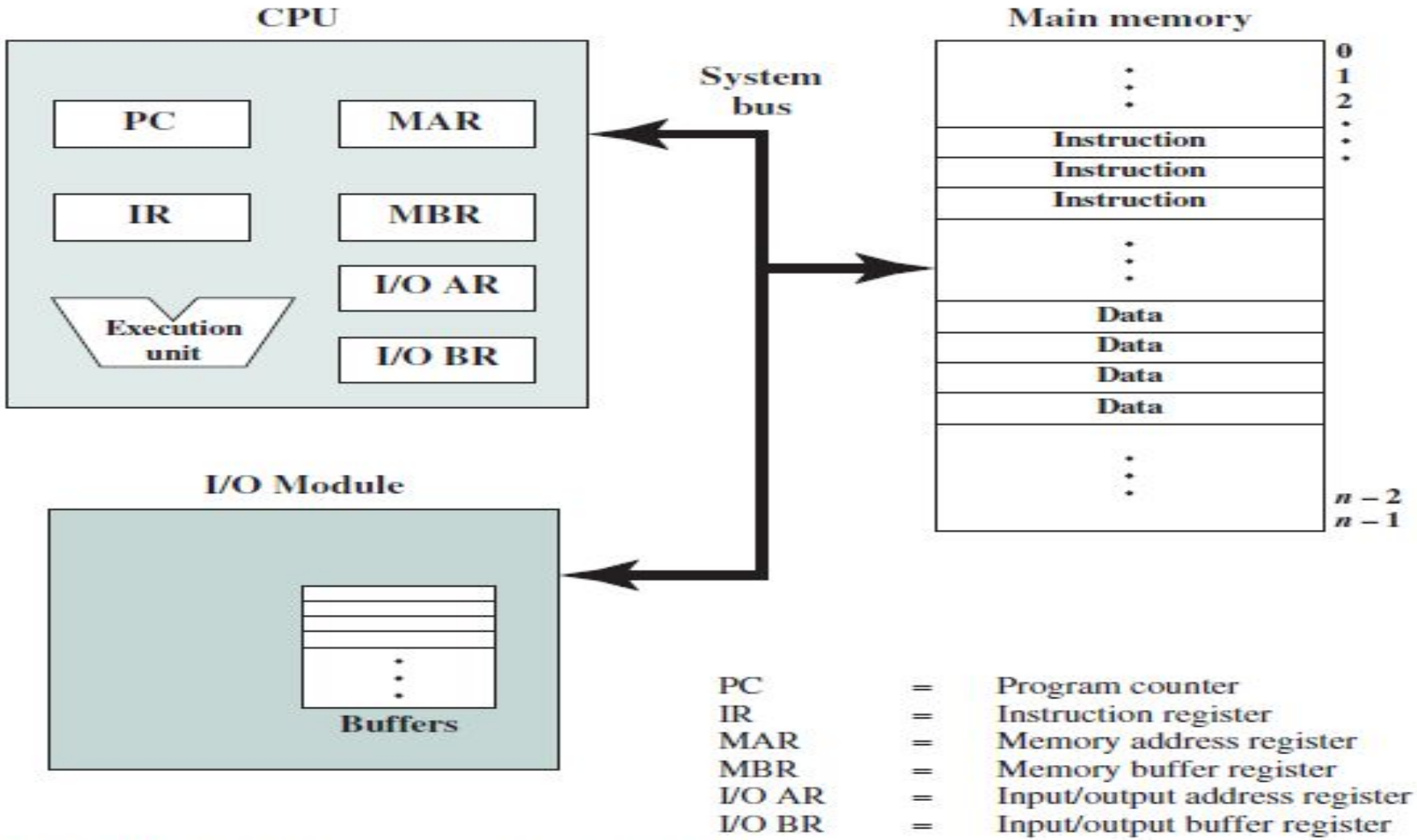


Figure 3.2 Computer Components: Top-Level View

- The **PC** is one of the most critical registers in CPU.
- The Program counter monitors the execution of instructions. It keeps track on which instruction is being executed and what the next instruction will be.

- The instruction register **IR** is used to hold the instruction that is currently being executed.
- The contents of IR are available to the control unit, which generate the timing signals that control, the various processing elements involved in executing the instruction.
- The two registers **MAR** and **MDR** are used to handle the data transfer between the main memory and the processor.

Working Explanation

- A **PC** is set to point to the first instruction of the program.
- The contents of the **PC** are transferred to the **MAR** and a Read control signal is sent to the memory.
- The addressed word is fetched from the location which is mentioned in the **MAR** and loaded into **MDR**.

Bus Structures and Operation

Buses

- A bus is a shared communication link, which uses one set of wires to connect multiple subsystems.
- The two major advantages of the bus organization are versatility and low cost.
- Most modern computers use single bus arrangement for connecting I/O devices to CPU & Memory.
- The bus enables all the devices connected to it to exchange information.

Buses

- Bus consists of 3 set of lines : *Address, Data, Control*
- Processor places a particular address (unique for an I/O Dev.) on address lines.
- Device which recognizes this address responds to the commands issued on the Control lines.
- Processor requests for either Read / Write.
- The data will be placed on Data lines.

Data Bus

- Carries data
  - Remember that there is no difference between "data" and "instruction" at this level
- Width is a key determinant of performance
  - 8, 16, 32, 64 bit

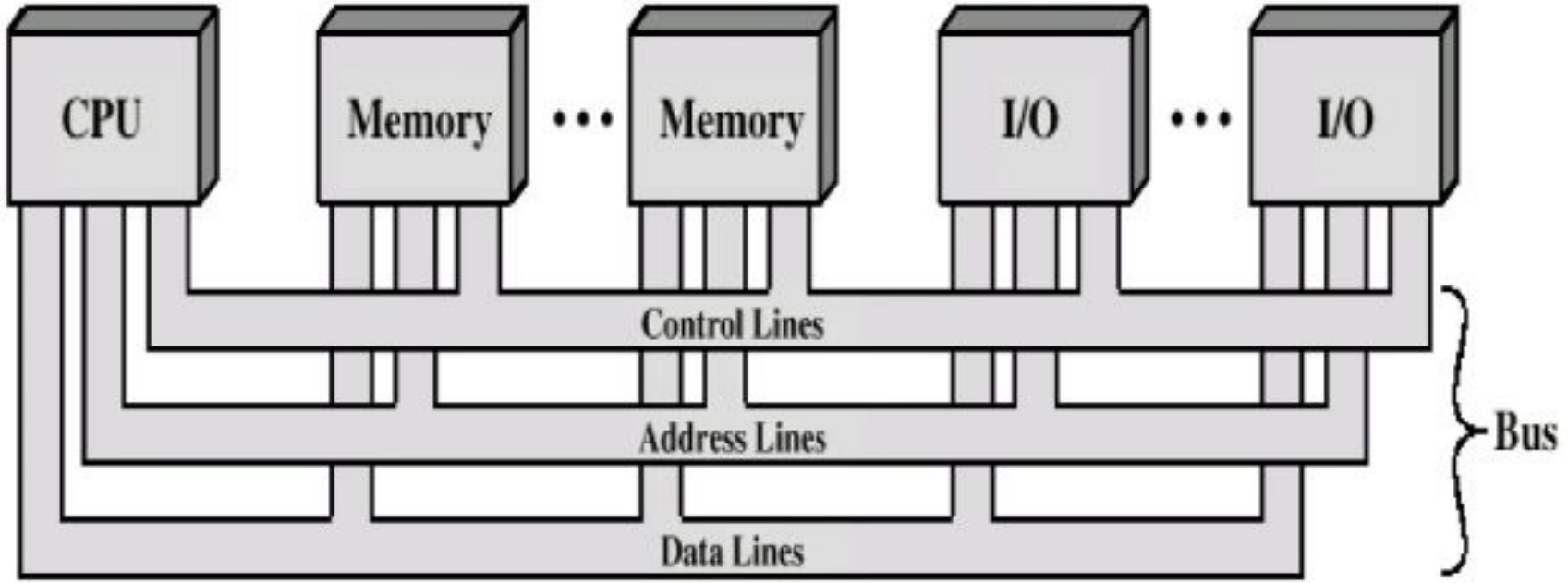
Address bus

- Identify the source or destination of data
- e.g. CPU needs to read an instruction (data) from a given location in memory
- Bus width determines maximum memory capacity of system
  - e.g. 8080 has 16 bit address bus giving 64k address space

Control Bus

- Control and timing information
  - Memory read/write signal
  - Interrupt request
  - Clock signals
  - Reset
  - Bus request / bus grant
  - Transfer ACK
  - I/O read and I/O write

Bus Interconnection Scheme



Big and Yellow?

- What do buses look like?
  - Parallel lines on circuit boards
  - Ribbon cables