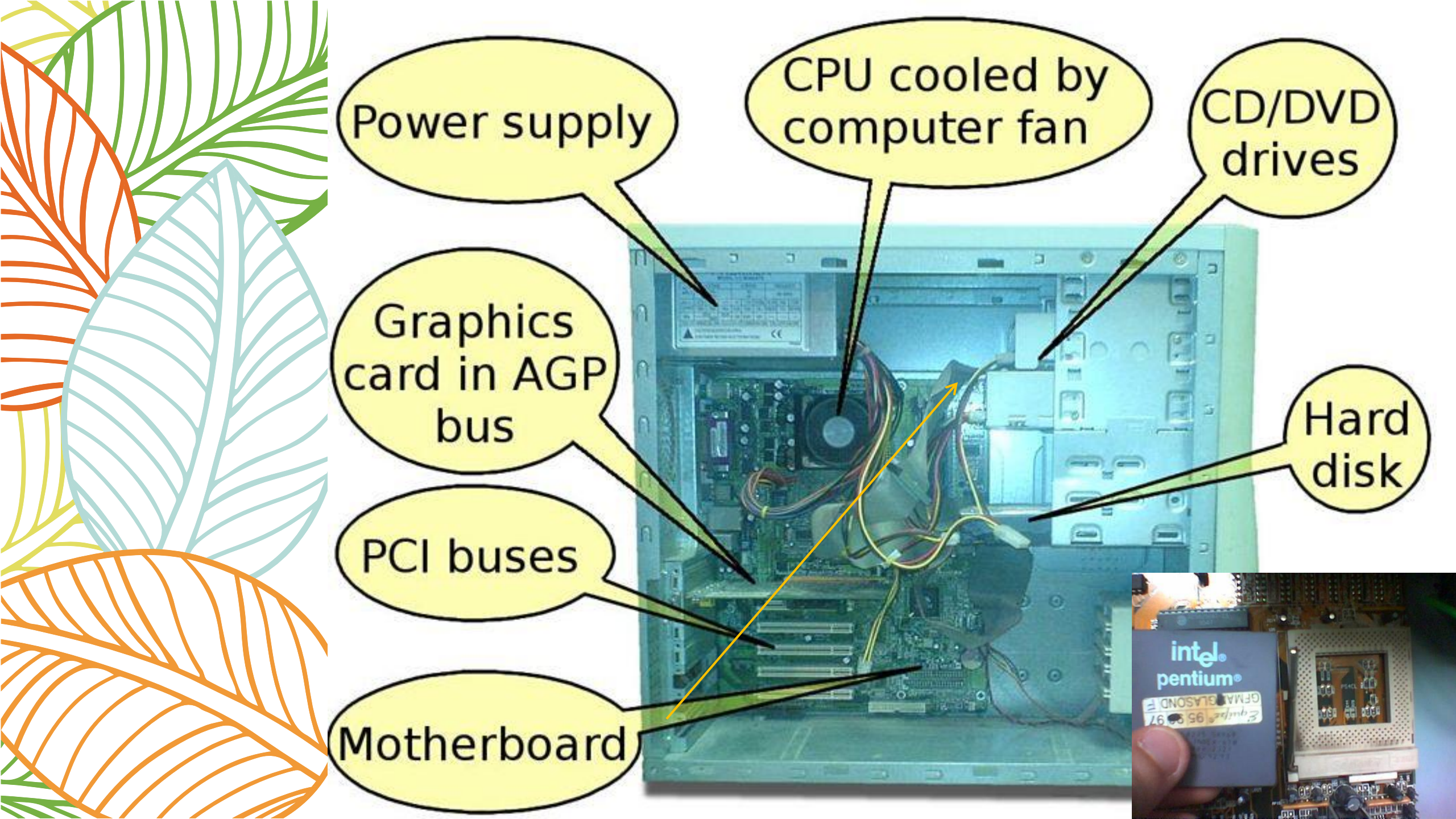
Architecture of Microprocessors
Case Study: 8085


Power supply
CPU cooled by computer fan
CD/DVD drives
Graphics card in AGP bus
Hard disk
PCI buses
Motherboard
intel
pentium

8251 (USART)

8255 (Parallel interface)

CPU

ALU

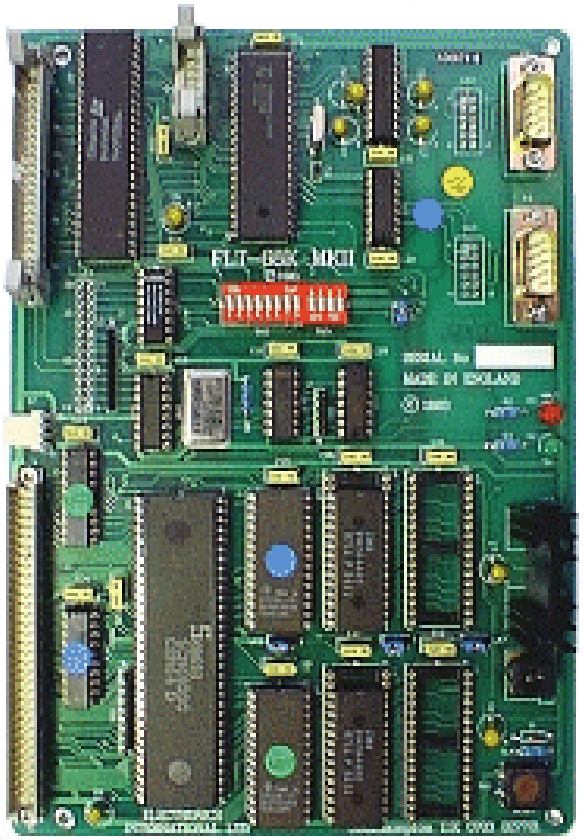
CU

MICROPROCESSOR

8085/8086

8257 (DMA Controller)

8254 (Timer)

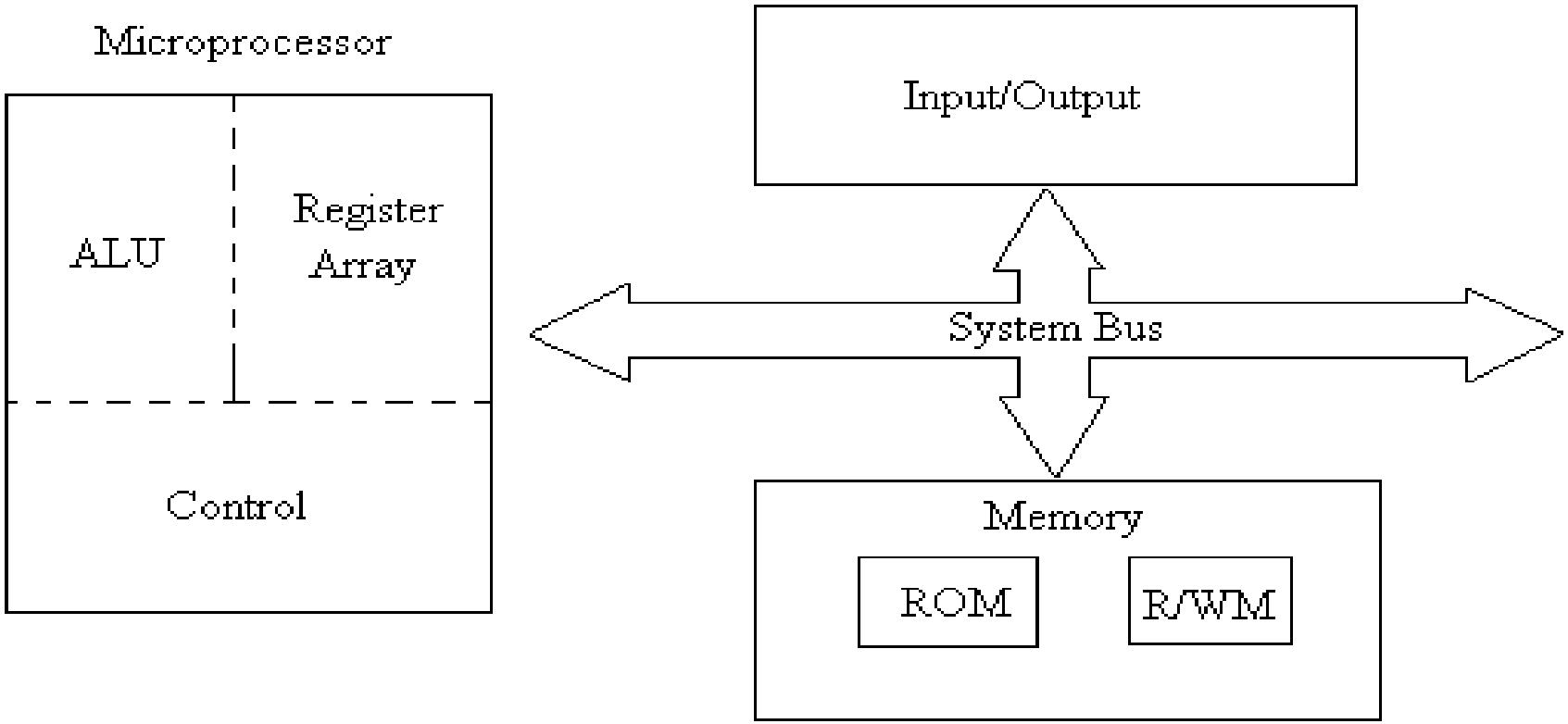


MICROPROCESSOR Based Development Board

What is a Microprocessor Based System?

- **Microcomputer is a microprocessor based system.**
- **Includes :**
  - **Microprocessor**
  - **Input/Output**
  - **Memory**
- **Components are connected through a communication path called a bus**
- **How we can differentiate microcomputer and a microprocessor?**
  - uP is one component of the microcomputer
  - The CPU functions of the microcomputer are performed by the uP
- **The term peripherals is used for I/O devices.**

uP based System Architecture with Bus Architecture



What is a microprocessor?

- **Microprocessor :-**
  - multipurpose,
  - programmable,
  - clock driven,
  - register-based electronic device
  - that reads binary instruction from a storage device called memory,
  - accepts binary data as input and
  - process data according to the instructions, and
  - provides results as output.
- Manufactured by using LSI or VLSI
- Microprocessor operation is similar to human brain
- **How we can differentiate CPU & uP ?**
- CPU is implemented on one or more circuit boards to perform the computing functions
- uP is similar to CPU
- uP - CPU on a single chip

Main 3 segments of uP

- **ALU :-** This area of uP will perform various computing functions such as arithmetic operations (Addition & Subtraction) and logic operations (AND/OR/EXOR)

- **Register Array :-** This area of uP consists of various register; B,C,D,E,H & L. Store data temporarily during execution of a program and are accessible to the user through instruction

- **Control Unit :-** Provides necessary timing and control signals to all the operations. Controls the flow of data b/w uP and memory and peripherals.

Memory

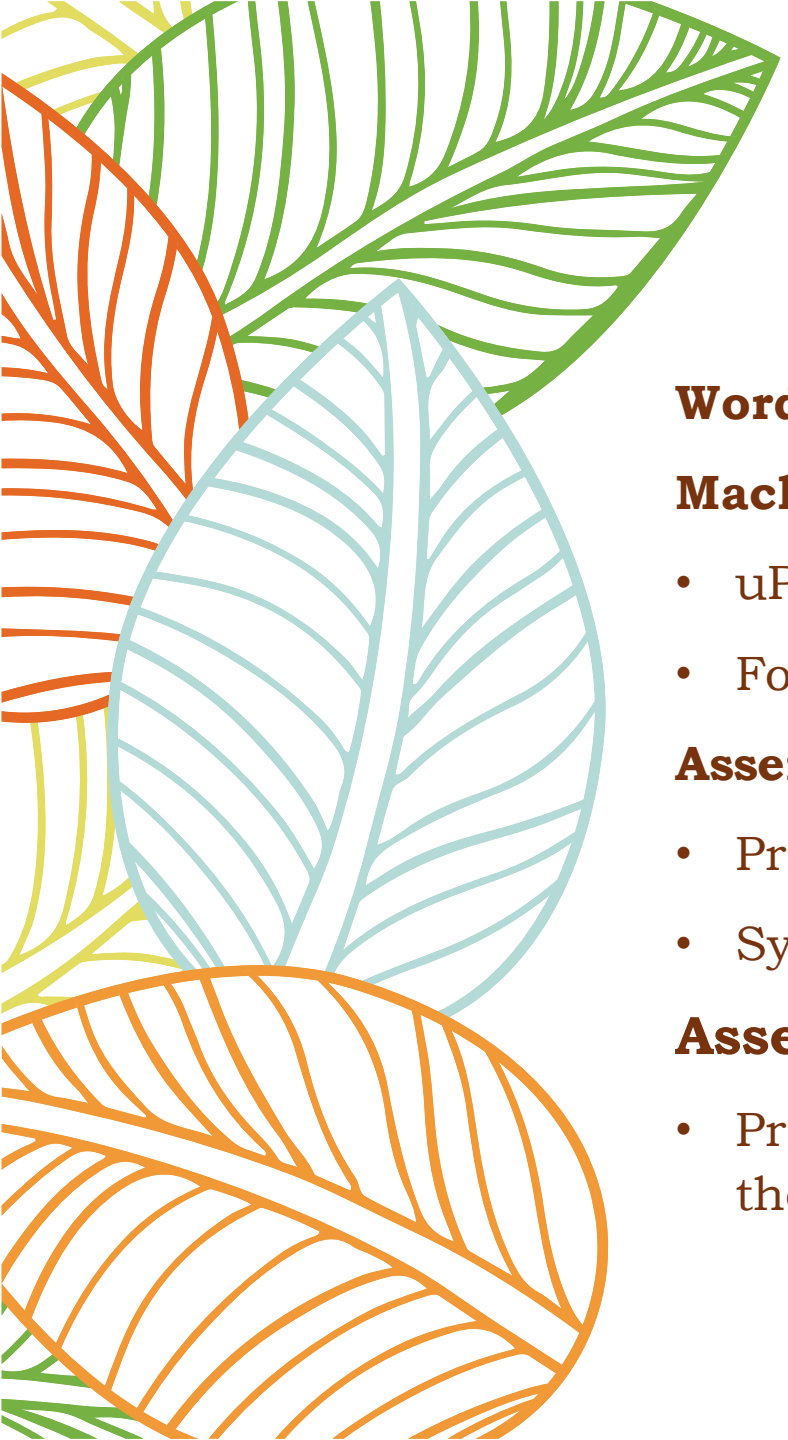
- Memory stores binary information as instruction and data
- 2 sections
  - **Read only Memory (ROM)**
    - Program in ROM can only be read, not altered.
    - Store programs that don't need alteration
  - **Read/Write Memory (RAM)**
    - User Memory
    - Stores user program & data
    - Information stored can be easily read and altered
- **Consider the monitor program, generally stored in ROM**
  - This program interprets the information entered through a keyboard and provides equivalent binary to the uP.
  - The monitor programs monitors the Hex Key and stores data in R/W memory

Input/ Output & System Bus

- **Input/Output :-**
- Also known as peripherals
- Communicating with the outside world through I/O
- Inputs devices :- keyboard, switches, ADC
    - Transfer binary information from outside world to the uP
- Output devices:- LED, CRT, Video screen (monitor), XY Plotter, Magnetic Tape, DAC
    - Transfer data from uP to the outside world
- **System Bus:-**
- Communication path between the uP and peripherals
- Bus - Group of wires to carry bits
- All peripherals share the same bus
- uP communicates with only one peripheral at a time
- Timing is provided by the CU of the uP.

How does a uP works?

- **Fetch, Decode, Execute**
  - uP fetches the first instruction from the memory
  - Decodes it
  - Execute the instruction
- Uses the system bus to fetch the instruction and data from the memory in the entire process
- Uses registers to store data temporarily
- Performs the computing function in the ALU
- Sends out the result in binary using the same bus lines to the o/p.



Terminology

Word :- No: of bits uP recognizes and process at a time

Machine Language:-

- uP communicates and operates in 0's & 1's
- For communication, give the instruction in binary language

Assembly language

- Programmer writes the program in words
- Symbolic code for each instruction, called mnemonics

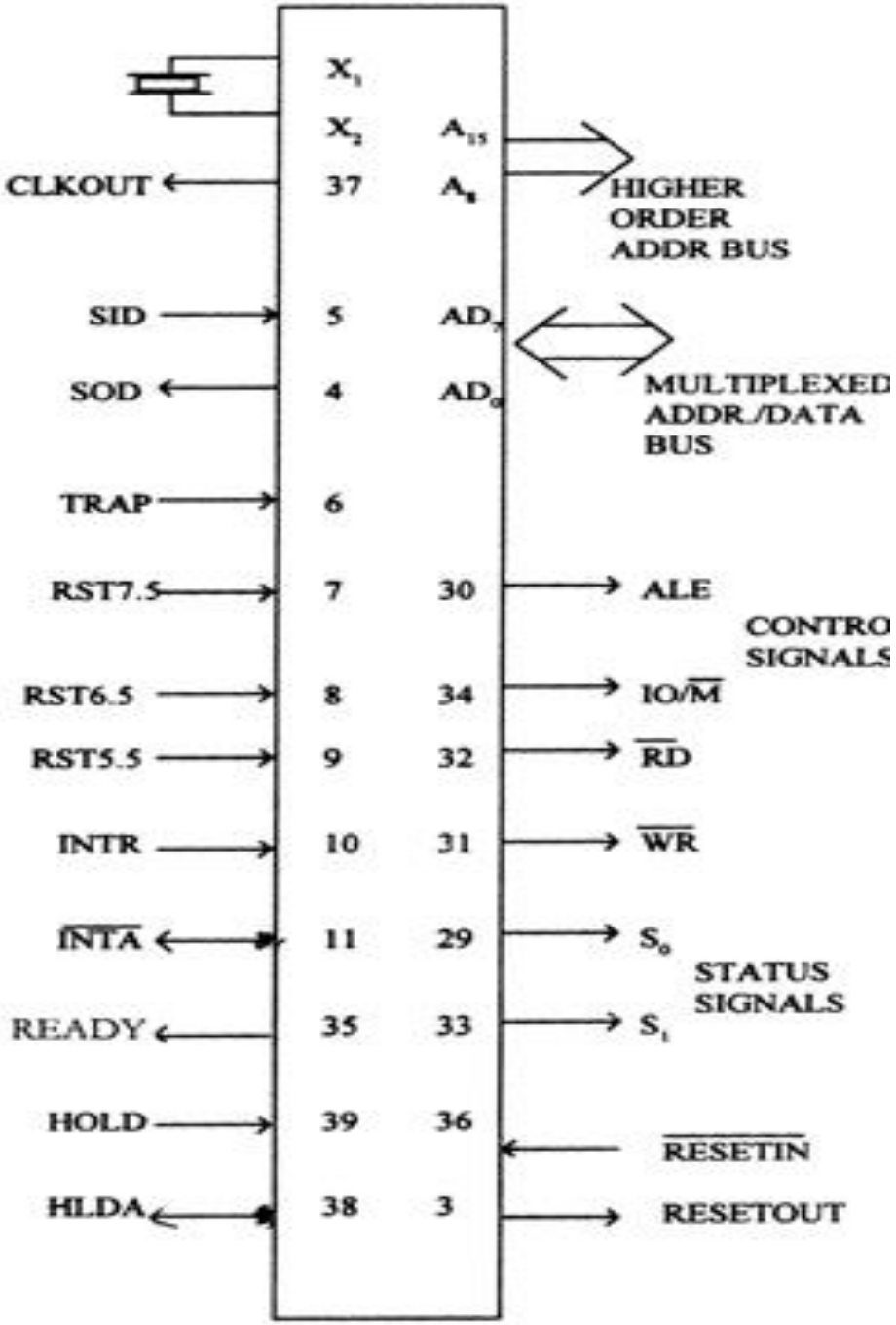
Assembler :-

- Program that translates the mnemonics entered from the keyboard into the corresponding binary machine codes of the uP

INTEL 8085-Features

- It is an 8 bit general purpose microprocessor.
- It is a single chip N-MOS device with 40 pins.
- Capable for addressing 64K of memory
- It has multiplexed address and data bus.(AD0-AD7).
- It works on 5 Volt dc power supply.
- The maximum clock frequency is 3 MHz - (8085A-5MHz)
- It provides 74 instructions with 5 different addressing modes.

- **Signals can be classified into 6 groups**:
  - Address Bus
  - Data Bus
  - Control and Status signals
  - Power supply and frequency signals
  - Externally initiated signals
  - Serial I/O ports



- **Address Bus**
  - 16 address lines
  - A15 – A8 & AD7 – AD0
  - A15 – A8 are unidirectional, called high order address
  - AD7 – AD0 for dual purpose

- **Multiplexed Address/Data Bus**
  - AD7-AD0 are bidirectional
  - Low order address bus or data bus
  - Earlier part of cycle, acts as low order address bus
  - Later part, acts as data bus

- **Control & Status Signal**
  - 2 control signals (RD & WR)
  - 3 Status signals (IO/M, S1 & S0)
  - 1 Special Signal (ALE)

- **Externally Initiated Signals**
  - Includes 5 Interrupt signals
  - INTR, INTA, RST 7.5, RST 6.5, RST 5.5, TRAP
  - 3 DMA (Direct memory Access) Controller signals
  - HOLD, HLDA, READY
  - RESET IN
  - RESET OUT

- **Power Supply and Clock Frequency**
  - Vcc - +5V power supply
  - Vss – Ground Reference
  - X1and X2 are the inputs from the crystal or clock generating circuit.
  - The frequency is internally divided by 2.
  - So, to run the microprocessor at 3 MHz, a clock running at 6 MHz should be connected to the X1 and X2 pins. (Crystal of 6MHz frequency should be connected)
  - CLK OUT – Clock Output
  - An output clock pin to drive the clock of the rest of the system.

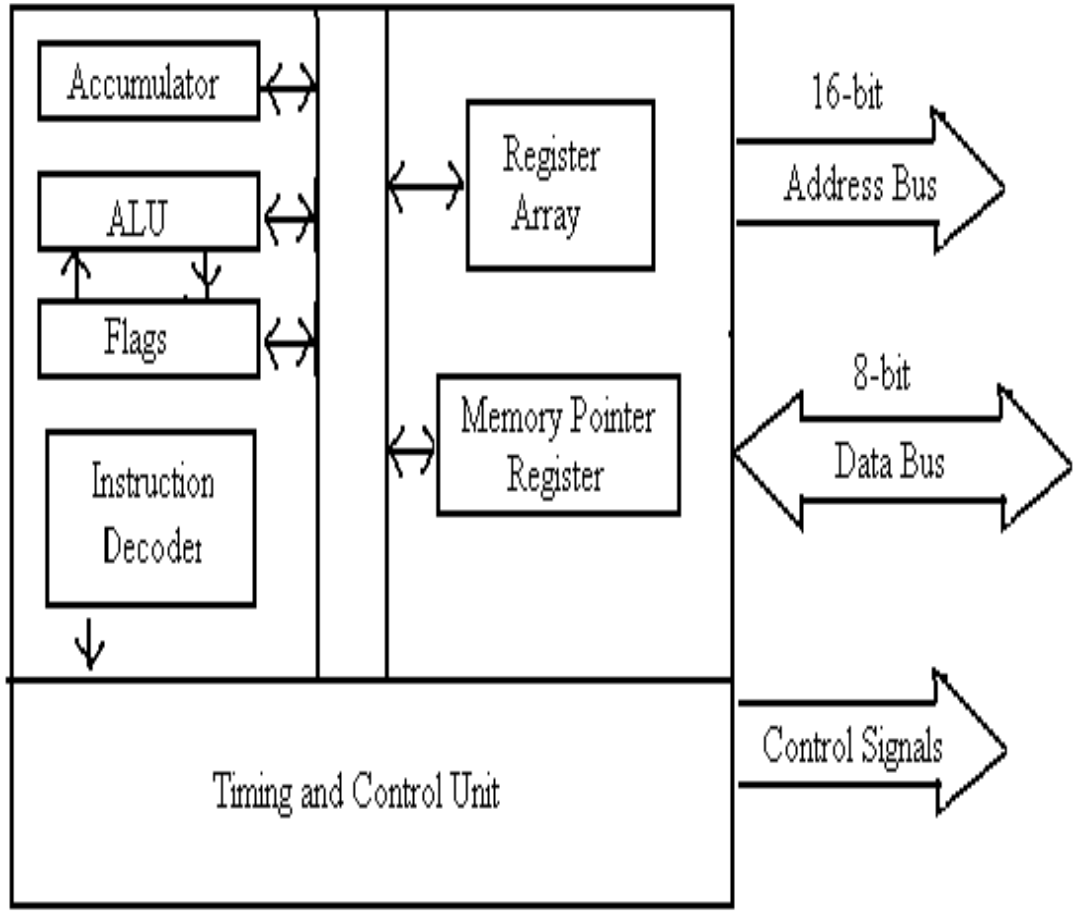
- **Serial I/O Ports**
  - SID – Serial Input Transmission
  - SOD – Serial Output Transmission

8085 Models

- Hardware Model (physical electronics components)
- Programming Model (information needed to write program)

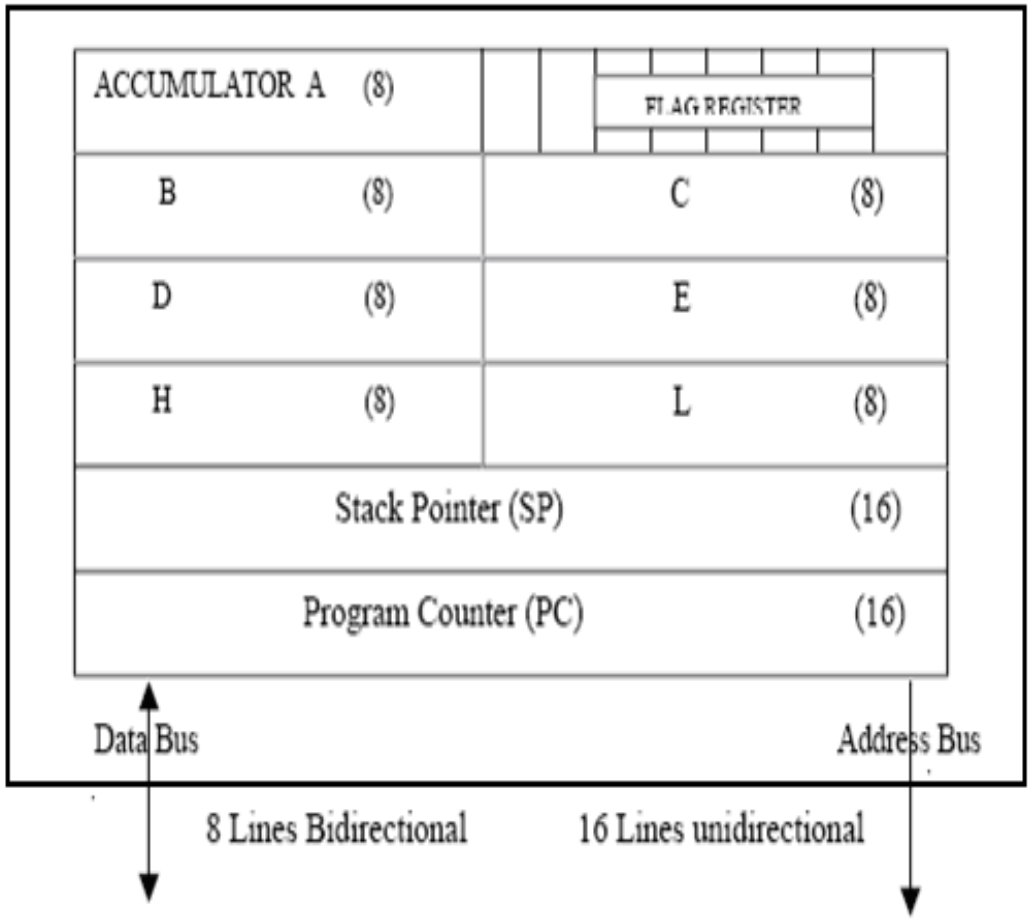
8085 Hardware Model

- **2 major segments**
  - **Segment 1**
    - ALU
    - 8-bit Accumulator
    - Instruction Decoder
    - Flags
  - **Segment 2**
    - 8-bit & 16 bit Register



8085 Programming Model

- Includes some segments of ALU and registers
- Includes information critical for writing assembly language
- 6 GPR
- 1 Accumulator
- 1 Flag register
- 16- bit Program Counter
- 16-bit Stack Pointer



Program Counter

- 16 –bit register hold memory address
- PC is used to sequence the execution of the instruction
- Function of PC is to point to the memory address from which the next byte is to be fetched
- When a byte (machine code) is being fetched, the program counter is incremented by one to point to the next memory location

Stack Pointer

- 16-bit register used as a memory pointer
- It points to a memory location in R/W memory, called the stack
- The beginning of the stack is defined by loading 16-bit address in the stack pointer.
- The stack is the sequence of memory locations defined by the programmer.
- The stack is used to save the content of a register during the execution of the program.

8085 Architecture

- ALU
- Timing & Control Unit
- Instruction Register and Decoder
- Register Array
- Interrupt Control
- Serial I/O Control

8085 ARCHITECTURE

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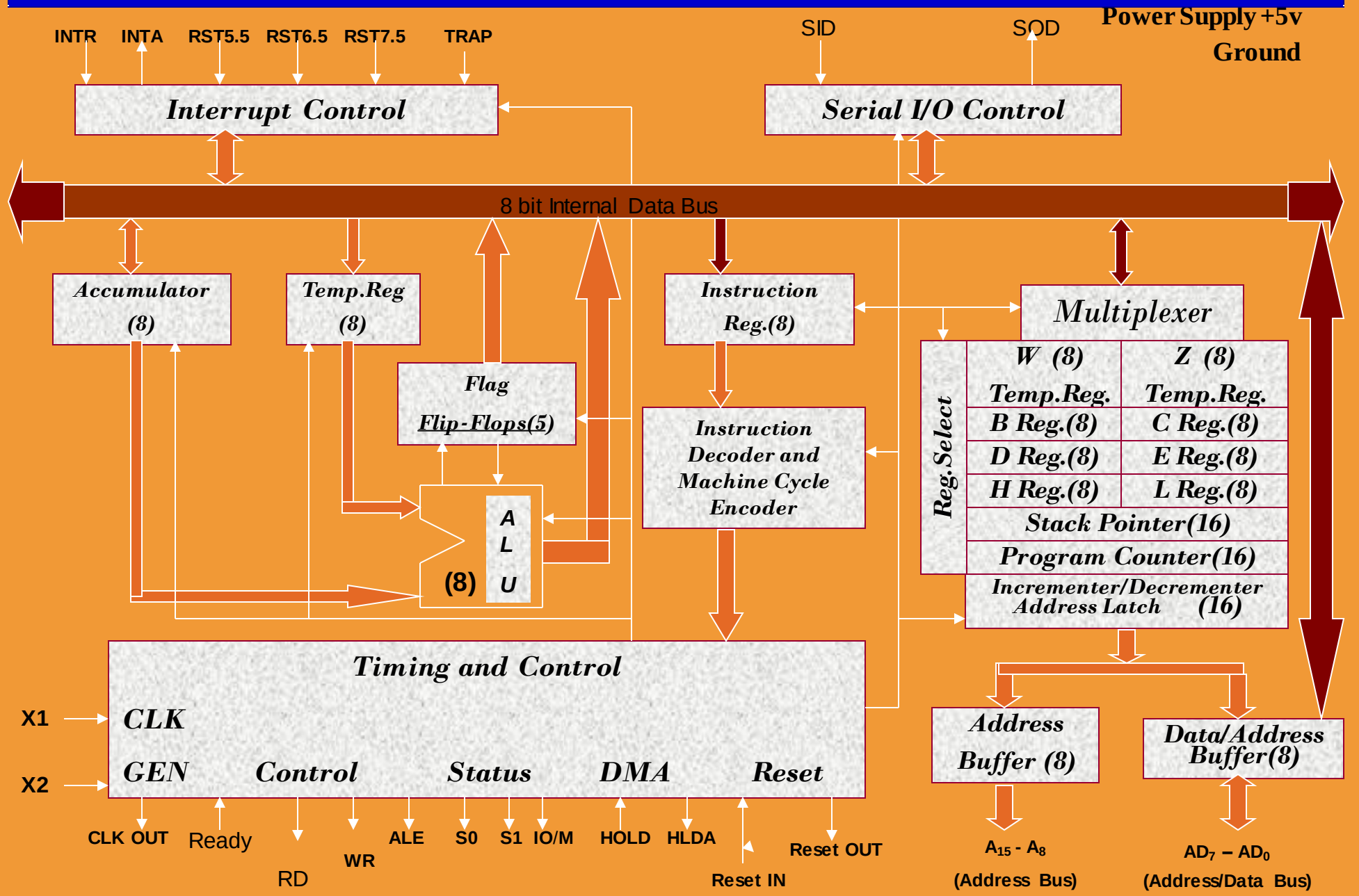
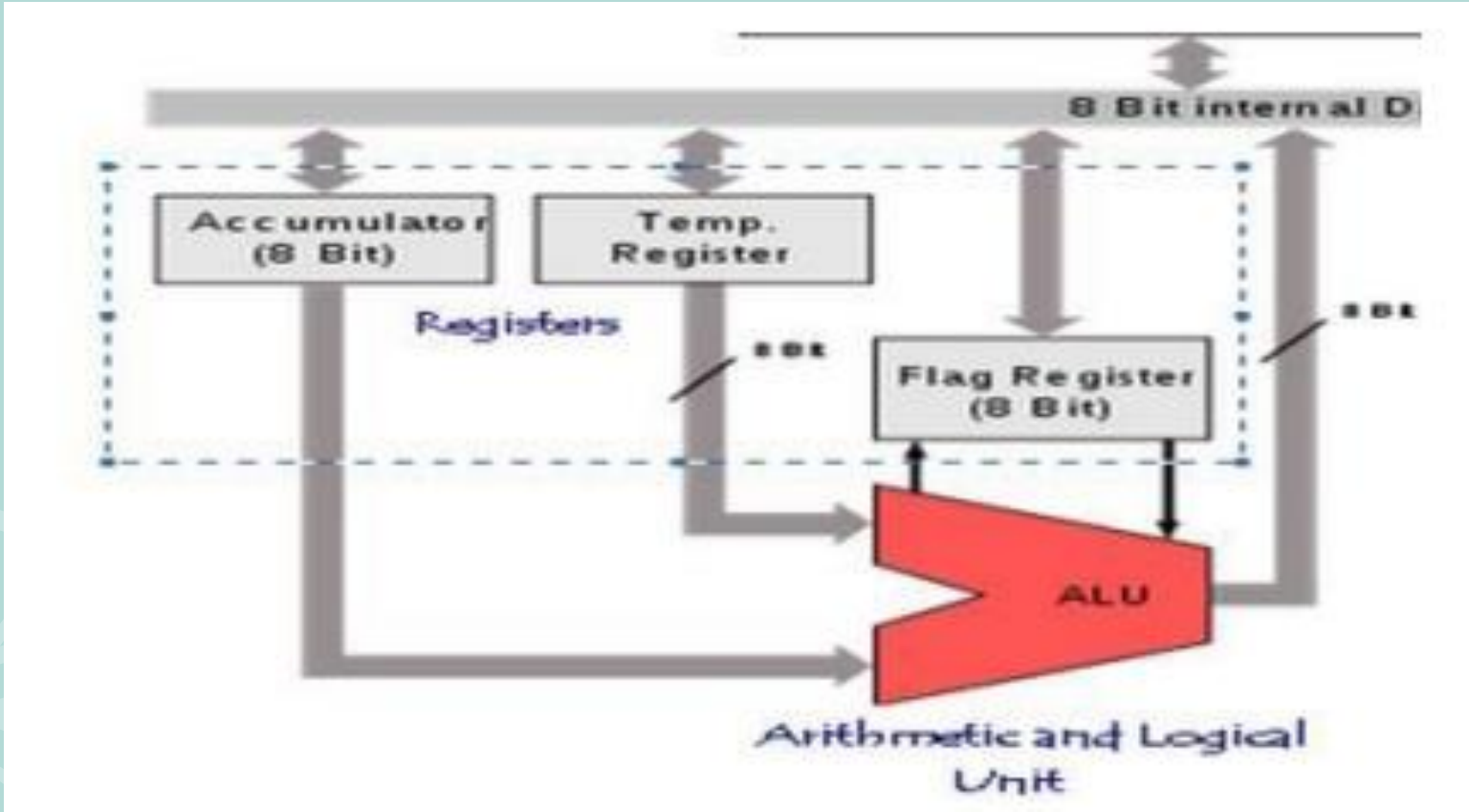


ALU (ARITHMETIC AND LOGICAL UNIT)

- It is referred to be as ALU which acts as a backbone for any arithmetic and logical operation as addition, subtraction, division, multiplication, AND, OR, NOT etc.
- Once the operation is performed, the result will be stored in accumulator, which is again a register.

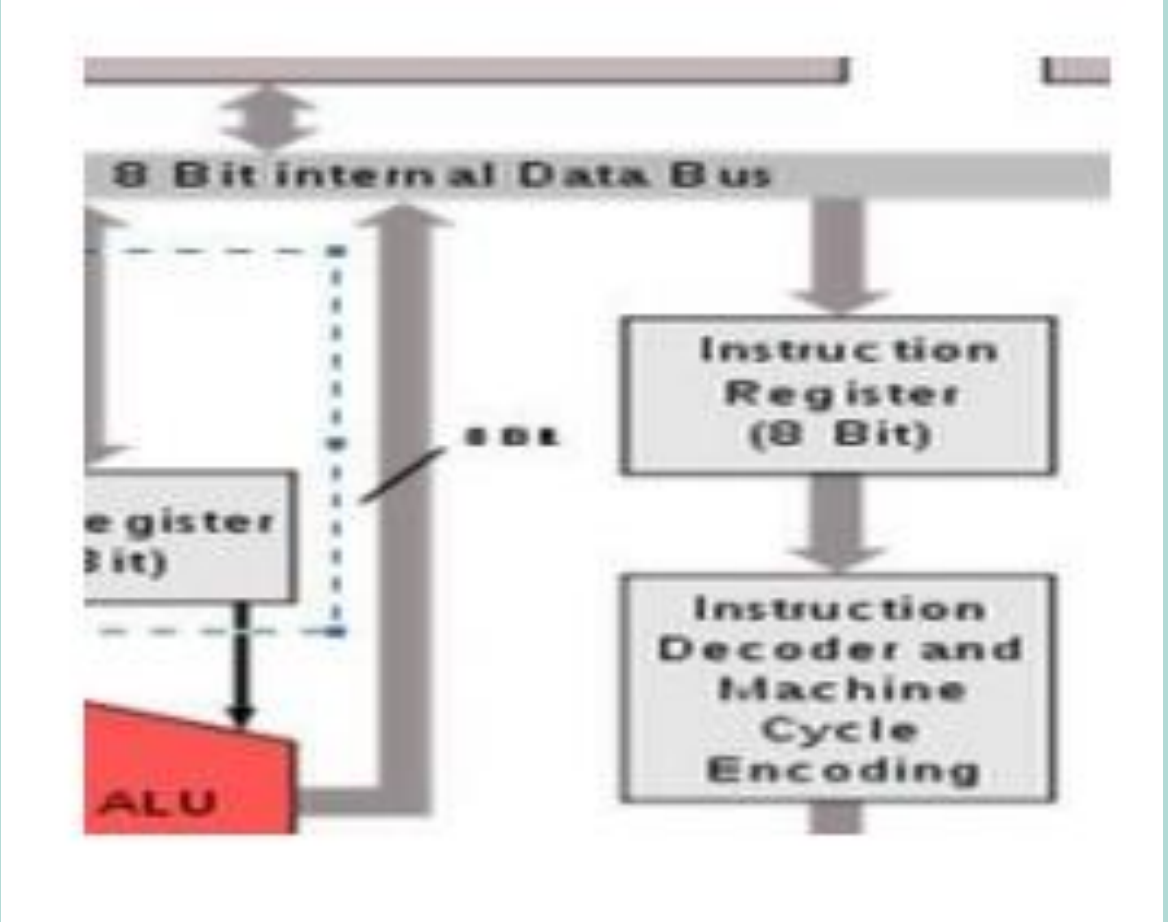


Timing and Control Unit

- Synchronizes all the uP operation with the clock
- Generates control signal necessary for the communication between uP and peripherals

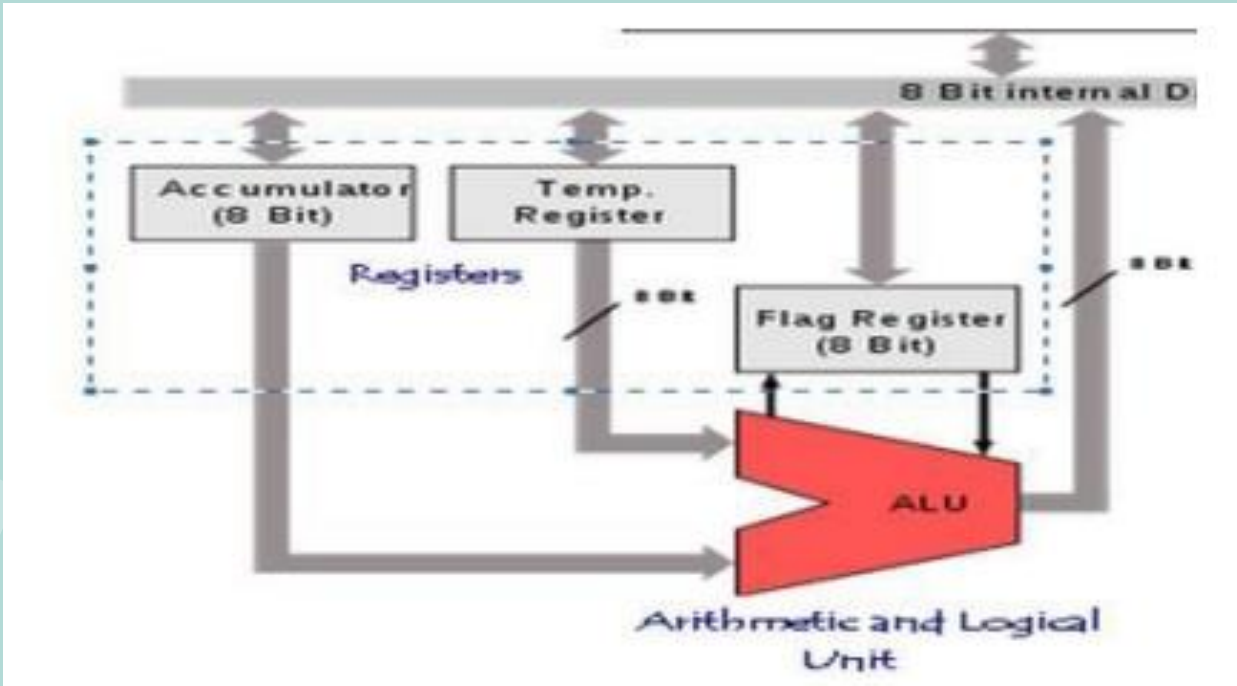
Instruction Register and Decoder

- Instruction register is a temporary storage area for the current instruction before it is being executed.
- Instruction fetched from memory is loaded into IR
- Decoder decodes the instruction & establishes the sequence of events to follow
- Not programmable & cannot accessed through any instruction
- Decoded instruction will be then moved to the next stage

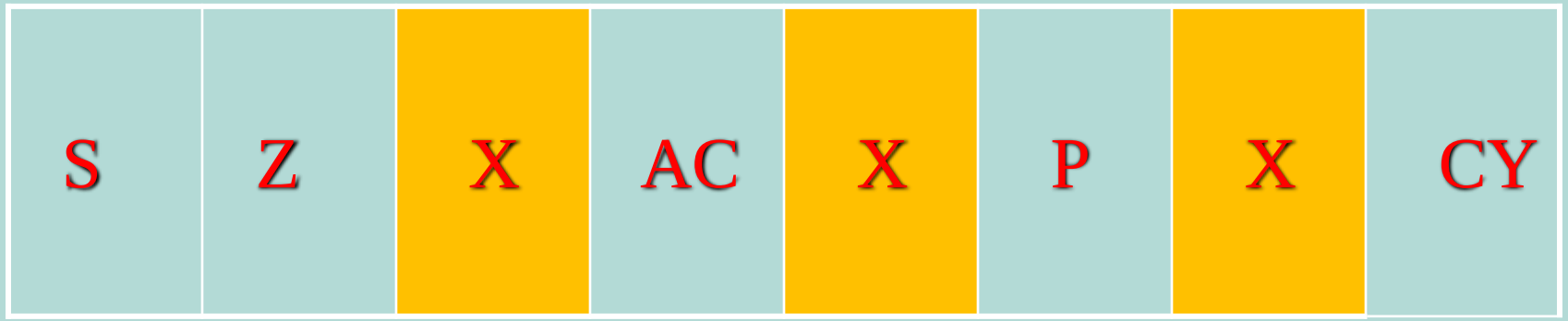


ACCUMULATOR

- Most important component of the entire Mu-P. 8 bit register.
- It is inevitable in all the arithmetic and logical operations since the result is going to be stored in thisregister.
- It is represented by the character A.
- When there is a new 8 bit data entering, the previously stored data will get automatically over written.
- Any operation that is happening will happen through Accumulator register only.
- Without Accumulator, Nothing would happen

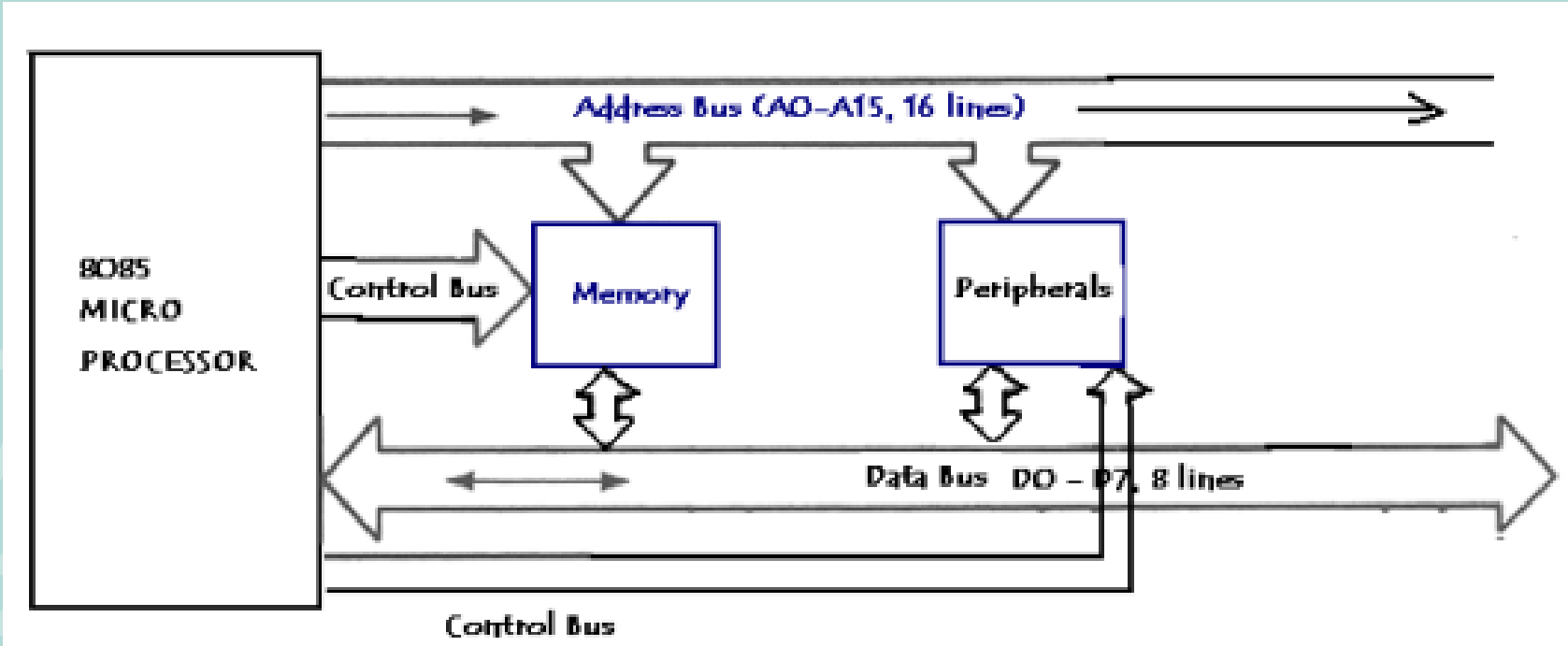


Flag Register



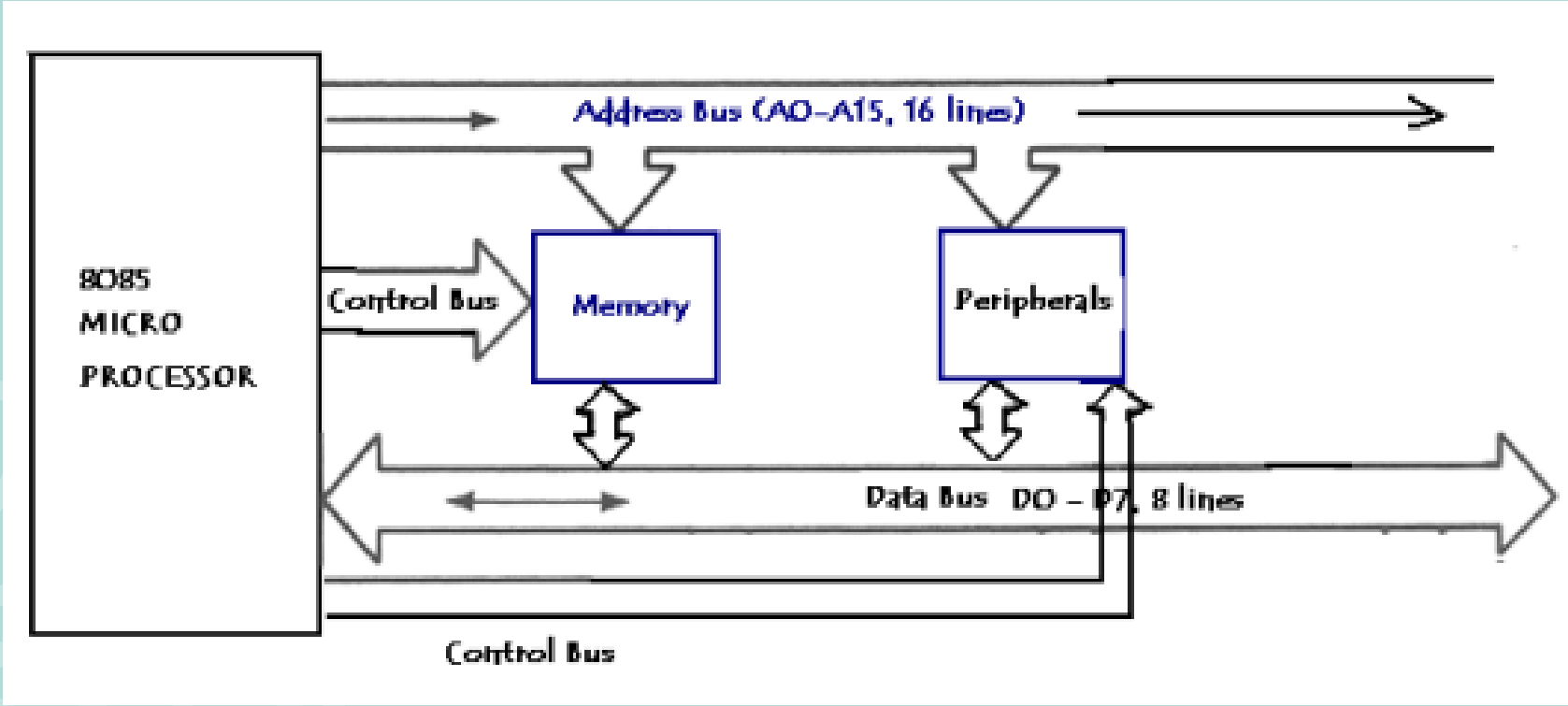
BUS STRUCTURE IN 8085

- What a bus is?
- A bus is as simple as the bus that people travel with. What is it meant for?
- It takes people and freight from a place to another.
- Same is the case here with microprocessor.
- Microprocessor often needs to send lot of control signals, data etc. to the peripherals and devices connected to it.
- All those are carried via the bus. In short it is the medium.



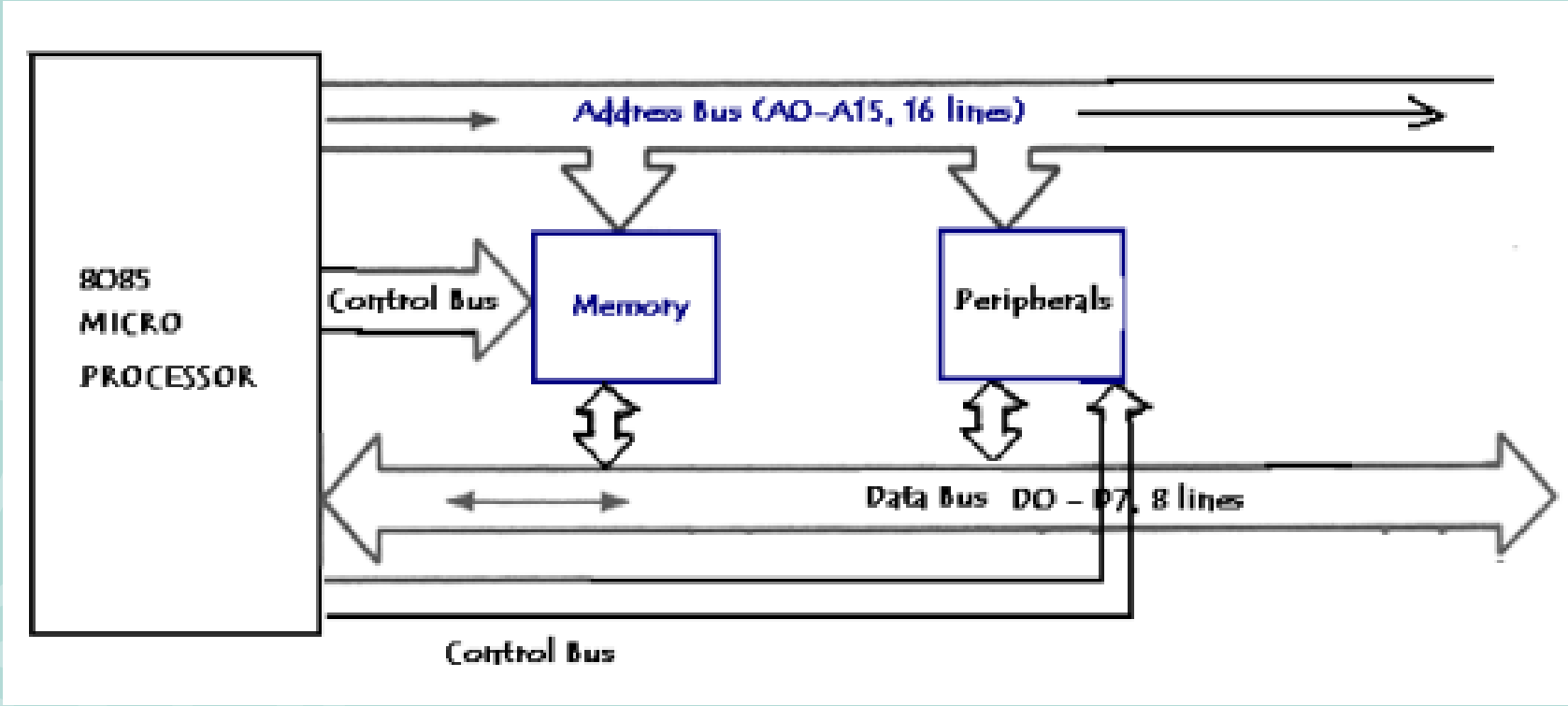
Address Bus

- Address bus
- As the name indicates it is used to carry the address.
- 8085 has 16 address lines which means it can have 2^16 = 65536bytes memory locations.
- The address bus will be mainly used to recognize a memory location or a connected peripheral.
- Postman basically delivers the letters using address. Likewise it is mandatory to have the identity for the memory locations and it is referred to be as an address.
- Address bus is always unidirectional. The communication happens from microprocessor to the peripherals



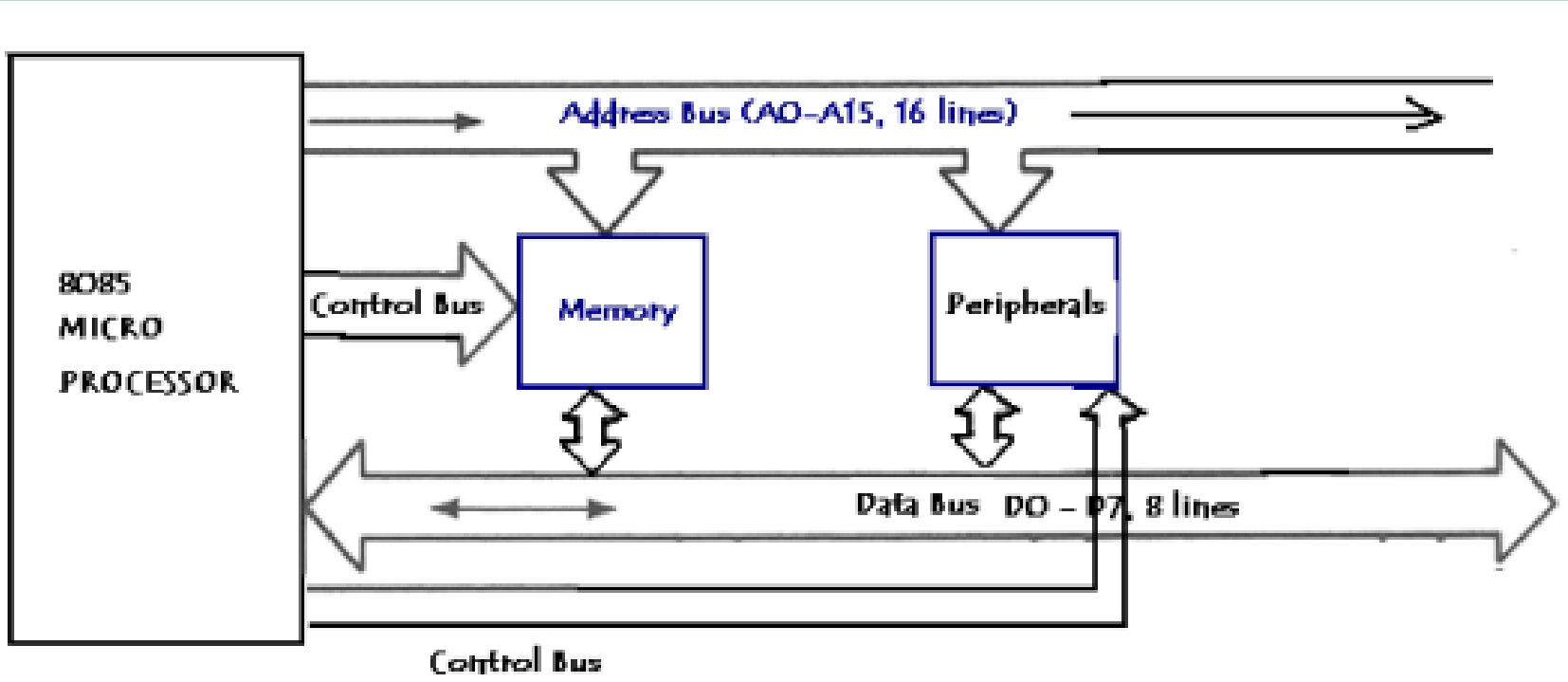
Data Bus

- Data bus
- This is bidirectional wires which carries data from to Microprocessor.
- Any information that gets in or goes out of Microprocessor is through the data bus only.
- There are 8 data lines from D0 to D7 as and this is the reason why we call it an 8 bit processor.
- Data bus is used to carry the instructions, results of the operations etc. to the peripherals and memory unit.
- When we quote that it is an 8 bit processor, it implies that the large data chunk has to be broken into smaller ones of up to 255 (o to 255, 28)



Control Bus

- Control bus
- All the controlling actions are carried out through these lines.
- It can be unidirectional or bidirectional.
- The control signals will intimate the microprocessor on where to read or where to write.
- Many control signals are available with 8085.
- All of them are discussed in detail when the pin description of 8085 is handled. Reader has to wait till then.



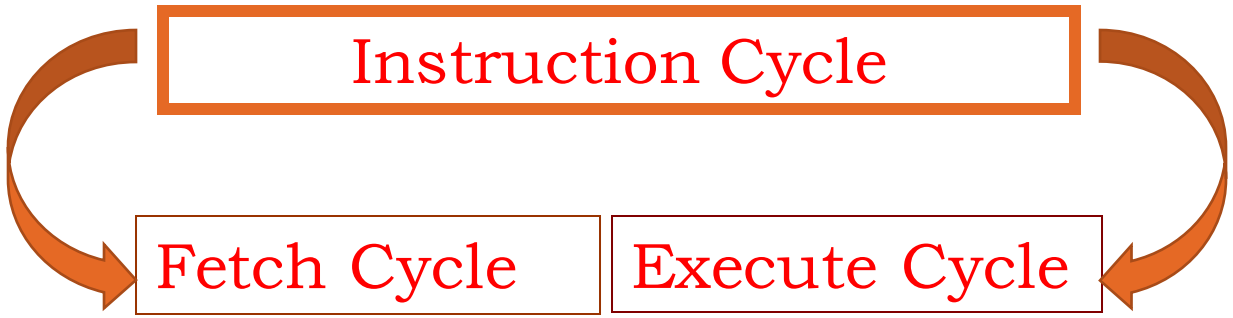
Processor Cycles

Instruction Cycle:

- The sequence of operations that a processor has to carry out while executing the instruction is called instruction cycle.

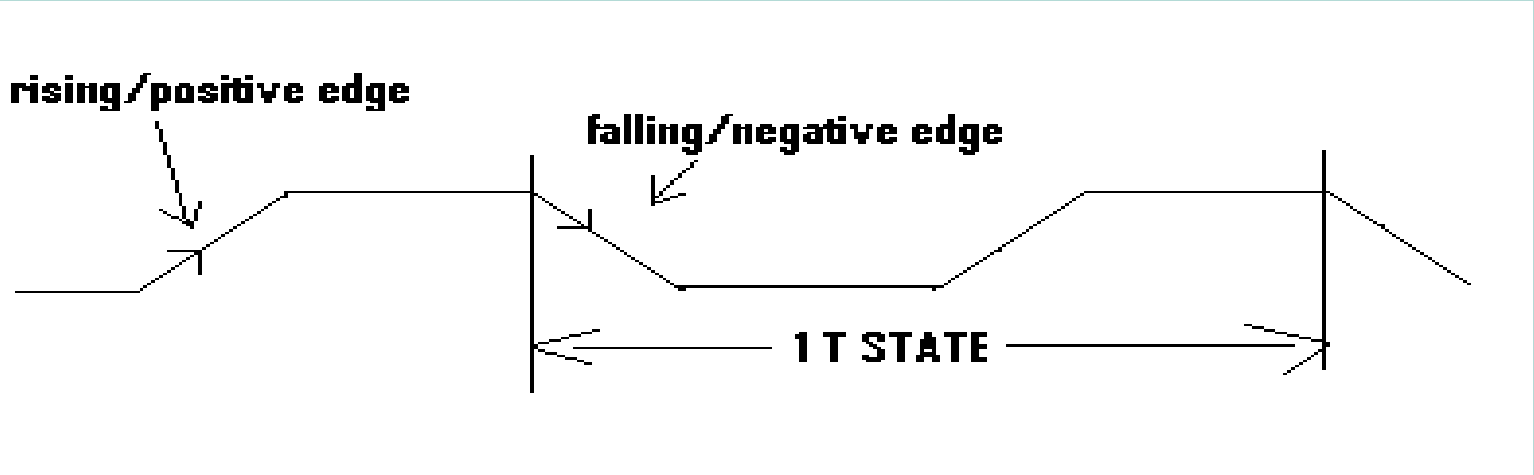
Machine Cycle:

- Each instruction cycle of a processor consist of a number of basic operations called machine cycles or processor cycles.



T States

- The time taken by the processor to execute a machine cycle is expressed in T - States.
- One T – state is equal to the time period of the internal clock signal of the processor.
- The T- state starts at the falling edge of a clock.



Thank You

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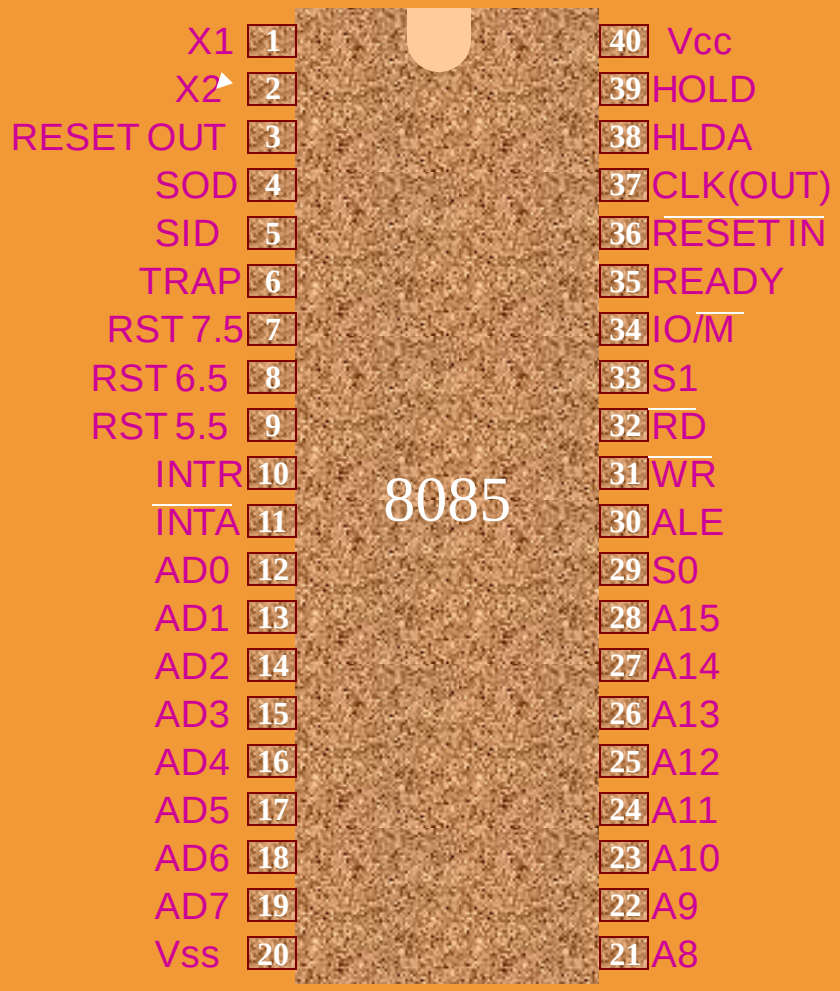
PIN DIAGRAM



S1	S0	
O	O	HALT
0	1	WRITE
1	0	READ
1	1	FETCH