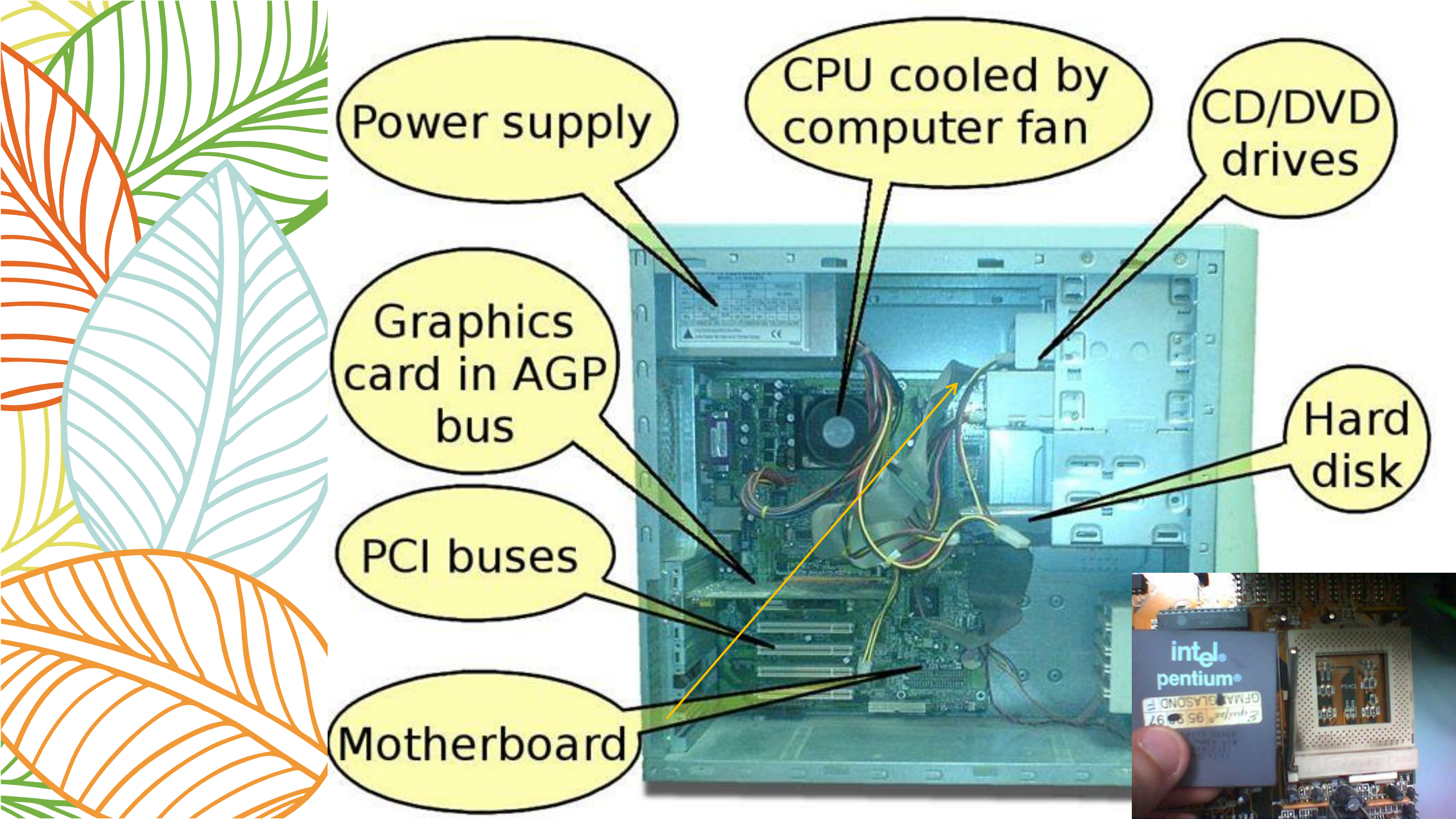
Architecture of Microprocessors
Case Study: 8085


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

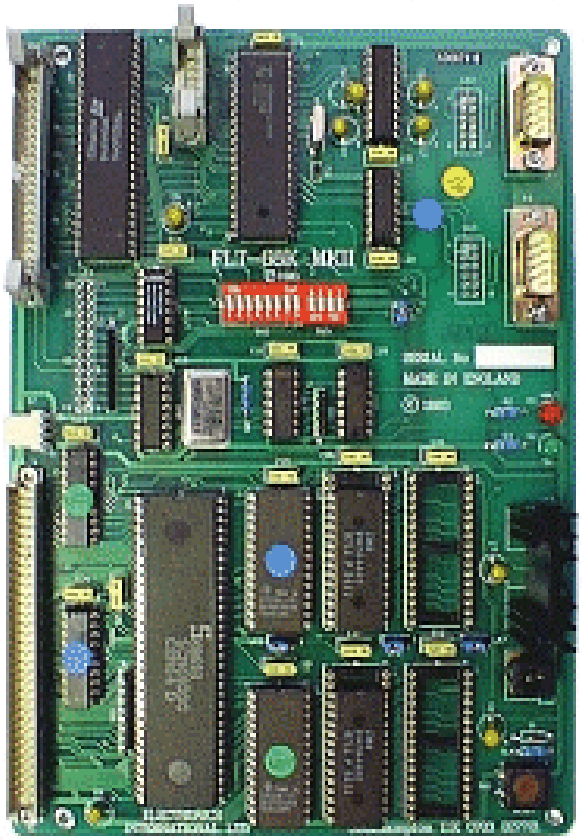
CU

MICROPROCESSOR

8085/8086

8257 (DMA Controller)

8254 (Timer)

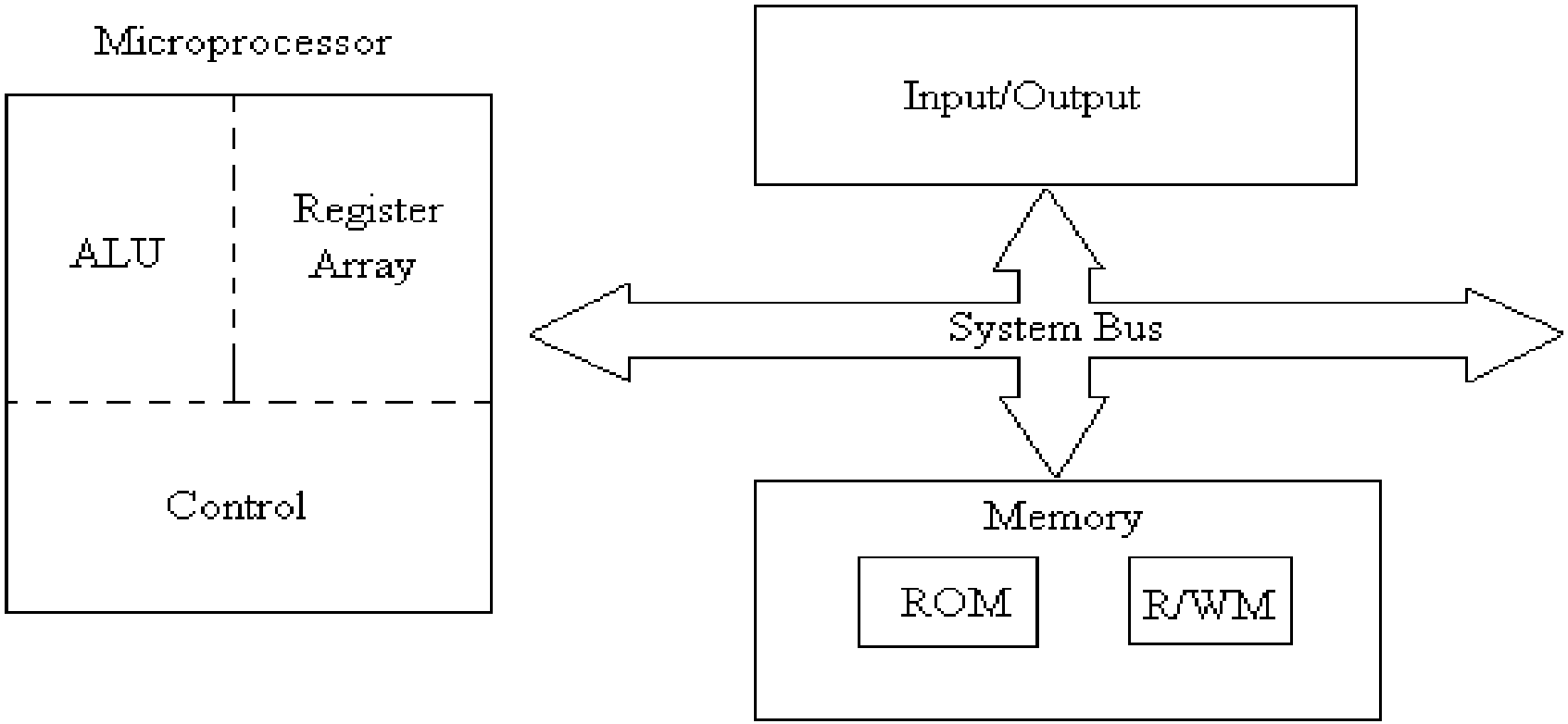


MICROPROCESSOR Based Development Board

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

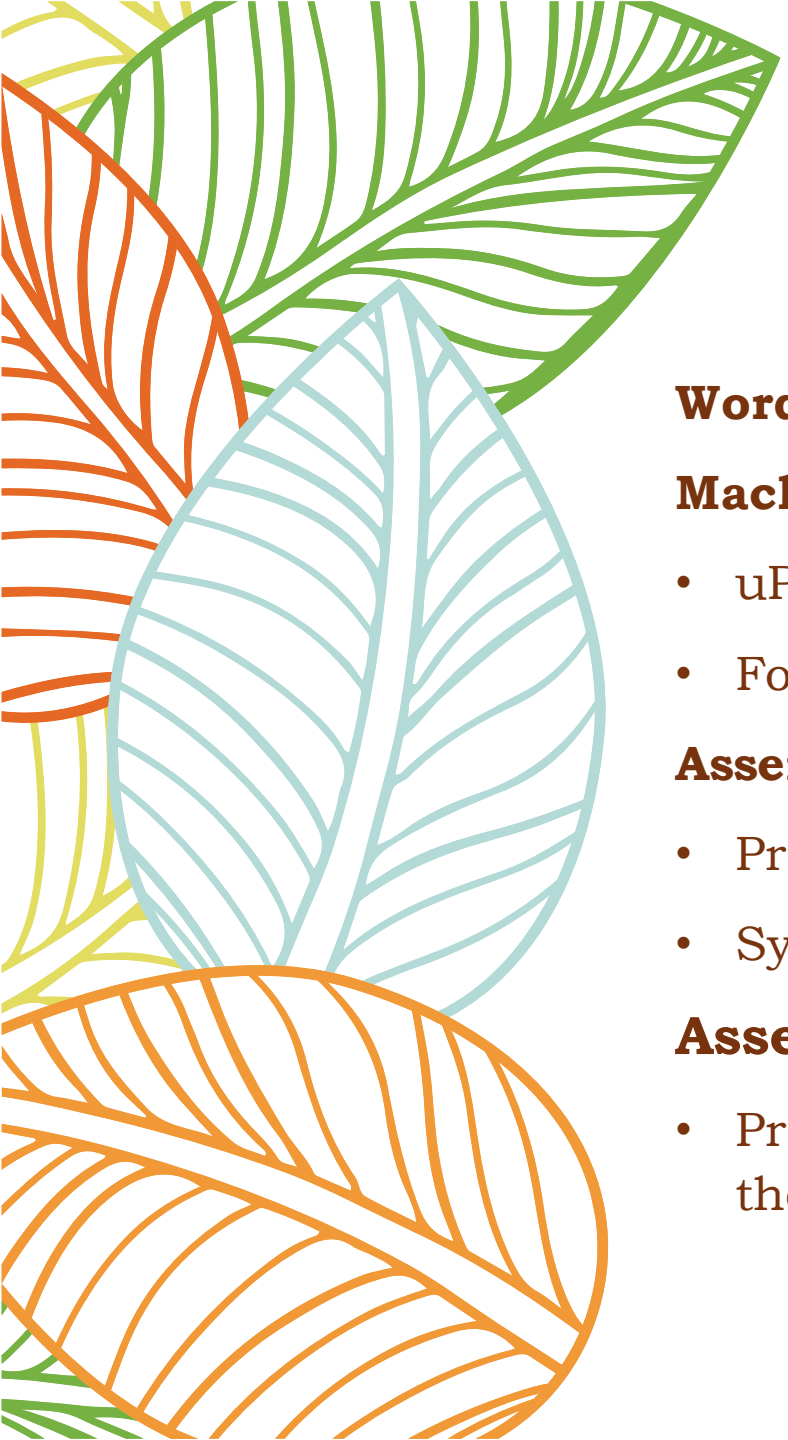
- Memory stores binary information as instruction and data
- 2 sections
  - **Read only Memory (ROM)**
    - Program in ROM can only be read, not altered.
    - Store programs that don't need alteration
  - **Read/Write Memory (RAM)**
    - User Memory
    - Stores user program & data
    - Information 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

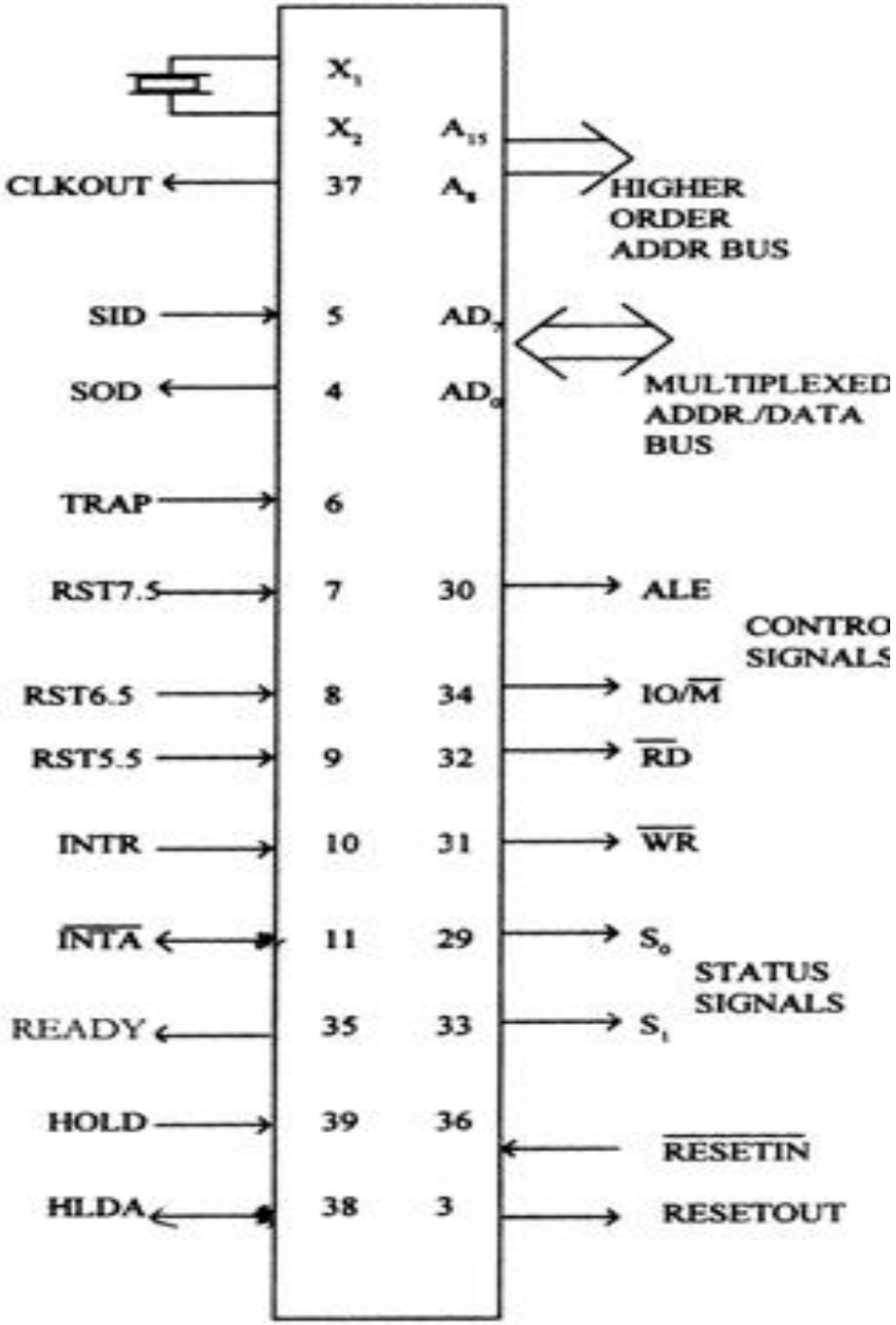
Assembler :-

- 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, they carry both address bits and data bits

- **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.

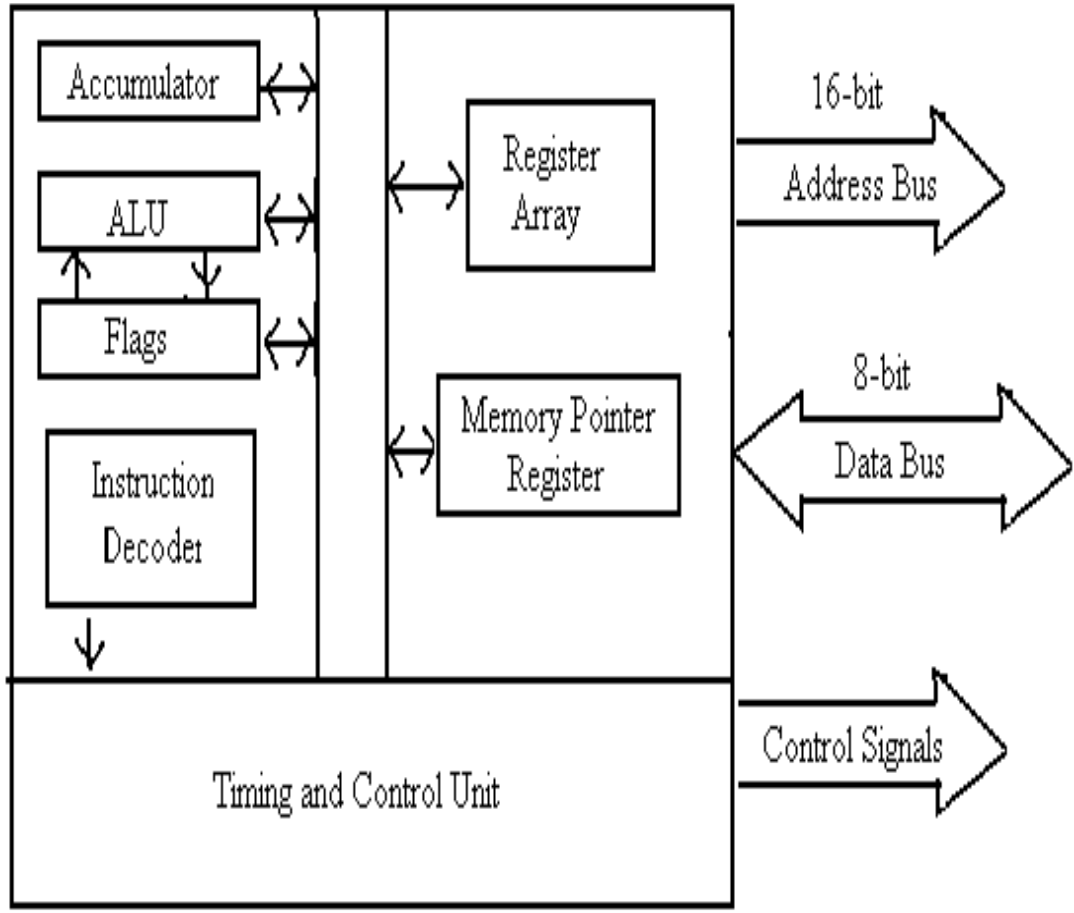
- **Serial I/O Ports**
  - SID – Serial Input Transmission
  - SOD – Serial Output Transmission

8085 Models

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

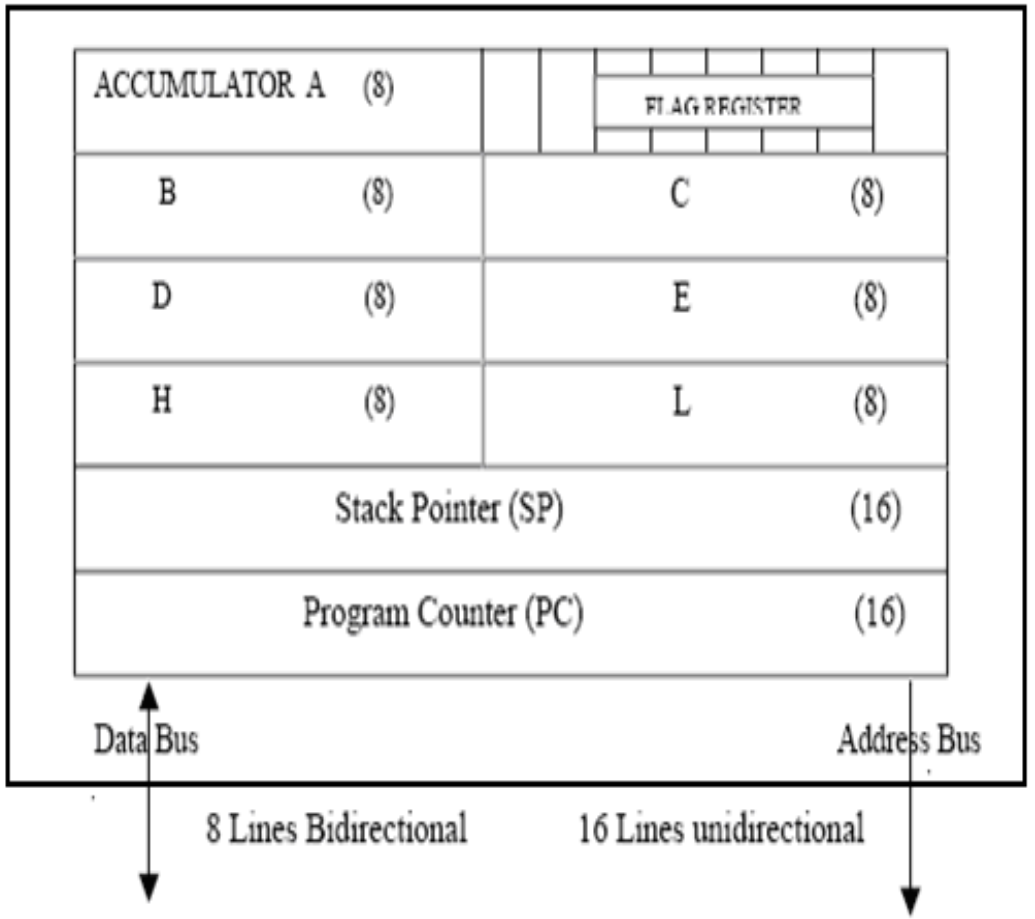
8085 Hardware Model

- **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 (General Purpose Registers)
- 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

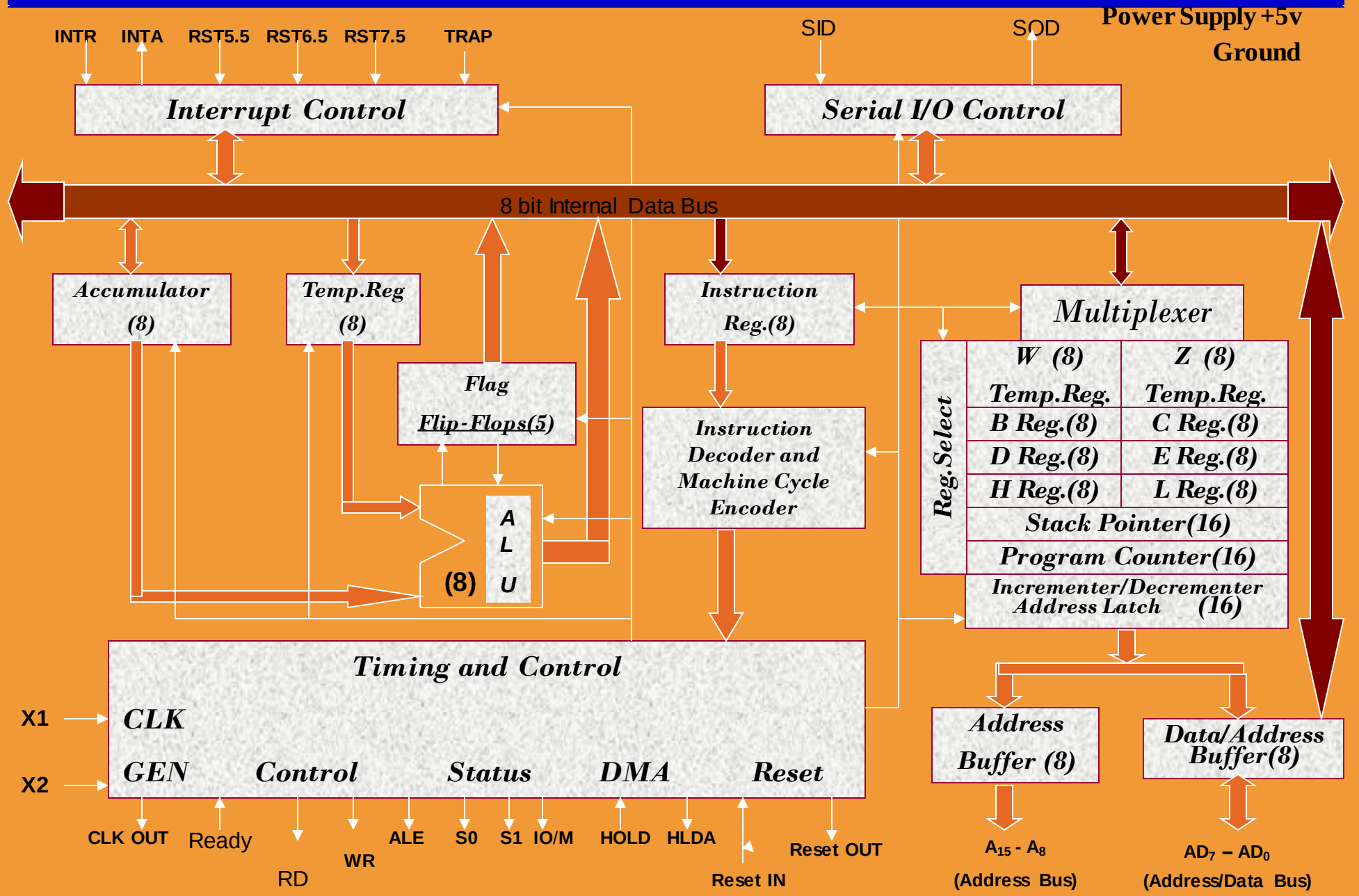
- 16-bit register used as a memory pointer
- It points to a memory location in R/W memory, called the stack
- The beginning of the stack is defined by loading 16-bit address in the stack pointer.
- The stack is the sequence of memory locations defined by the programmer.
- The stack is used to save the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

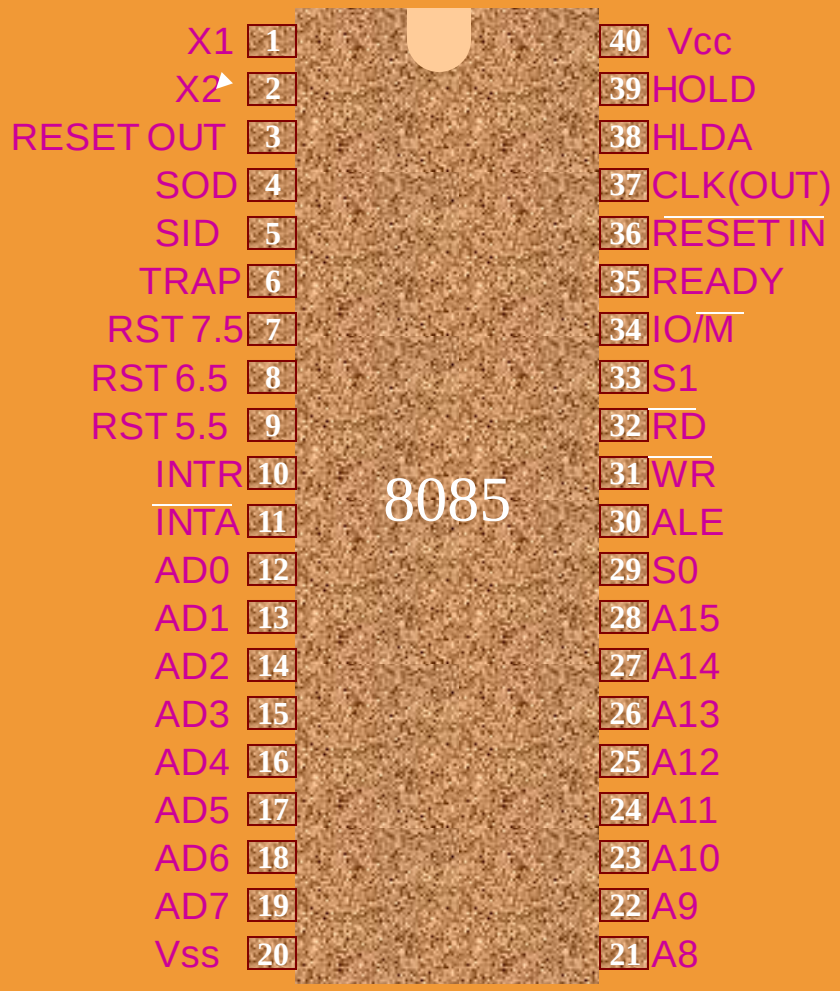
8085 ARCHITECTURE

Aum Amriteswaryai Namah:



Aum Amriteswaryai Namah:

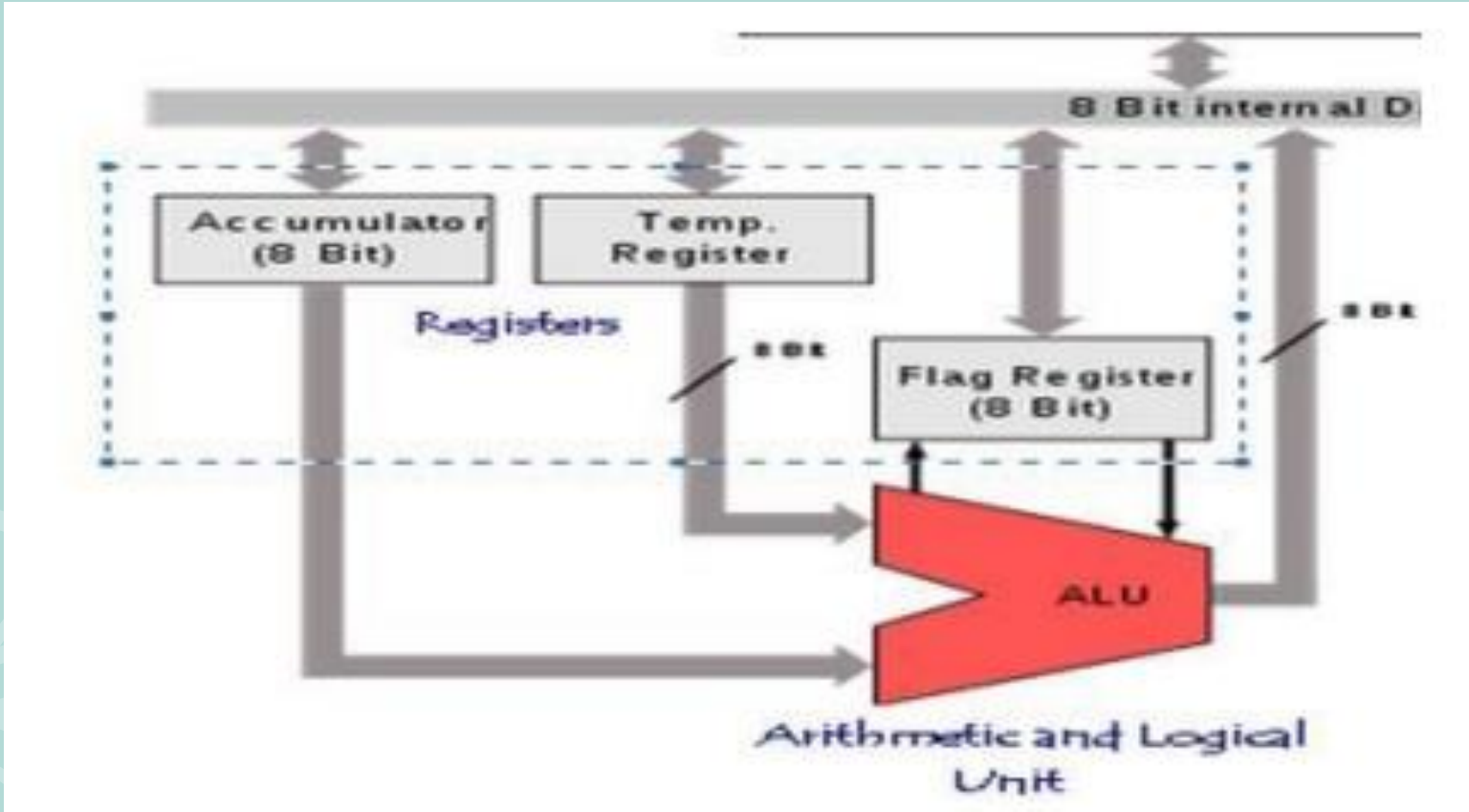
PIN DIAGRAM



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

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.

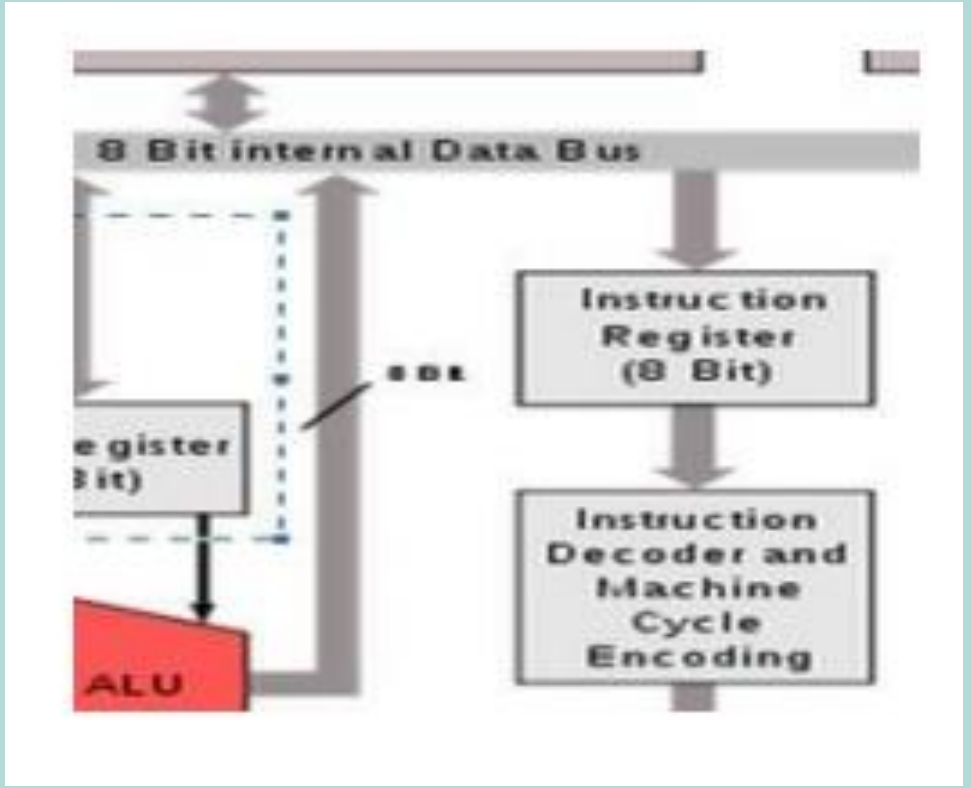


Timing and Control Unit

- Synchronizes all the uP operations with the clock
- Generates control signal necessary for the communication between uP and peripherals
- Two pins HOLD and HLDA used for DMA(Direct Memory Access). DMA controller sends a request by making Bus request control line high. CPU has received the HOLD request. HLDA will set high and in the next clock cycle after processing the data HLDA become low after HOLD signal is removed.

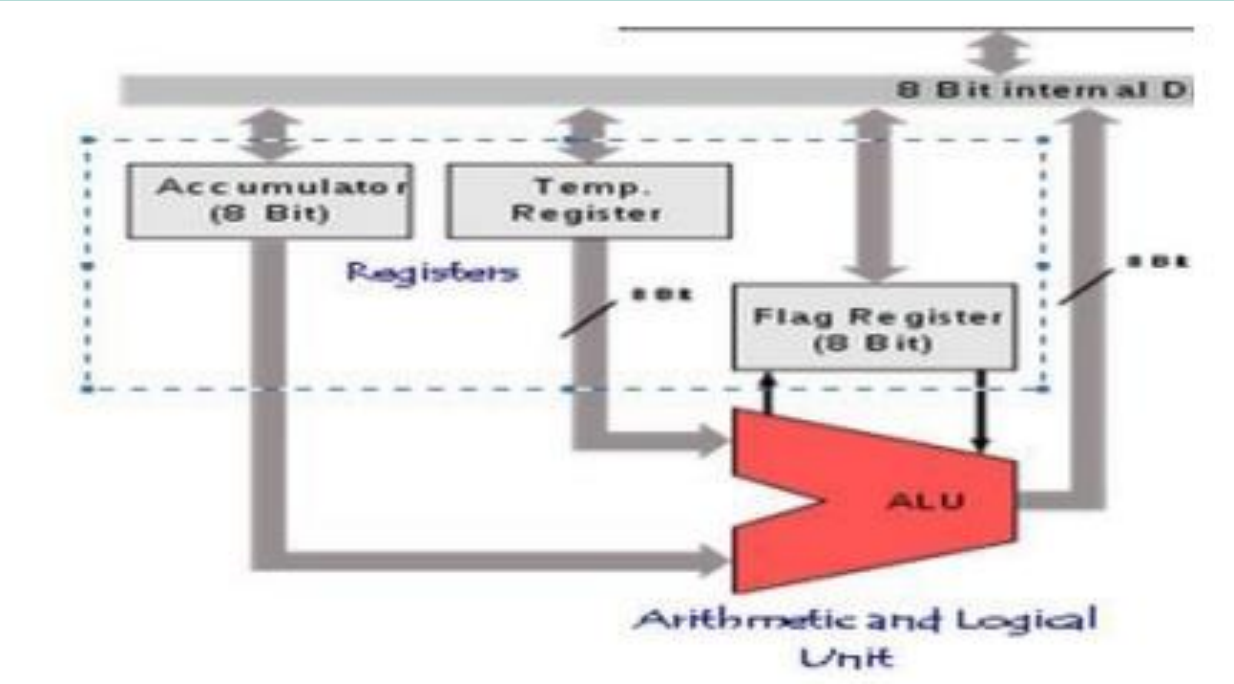
Instruction Register and Decoder

- 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

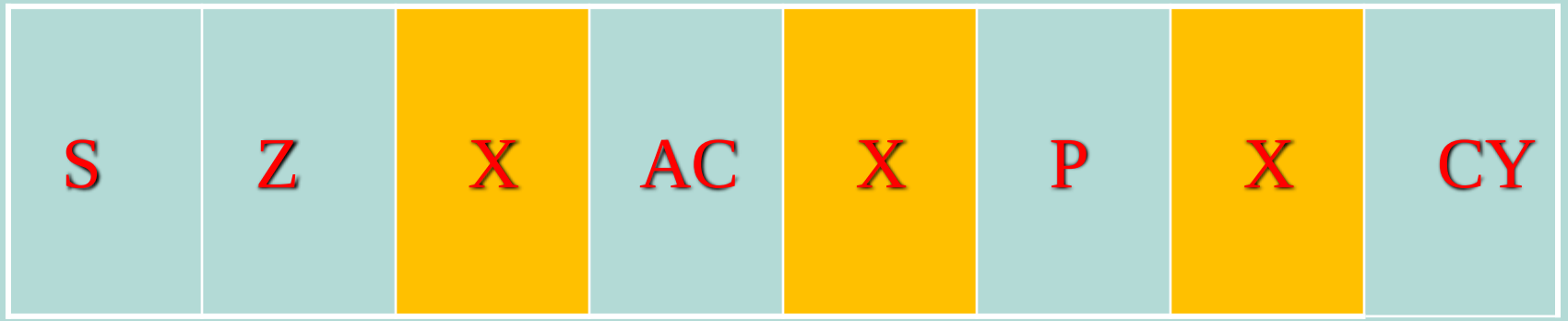


ACCUMULATOR

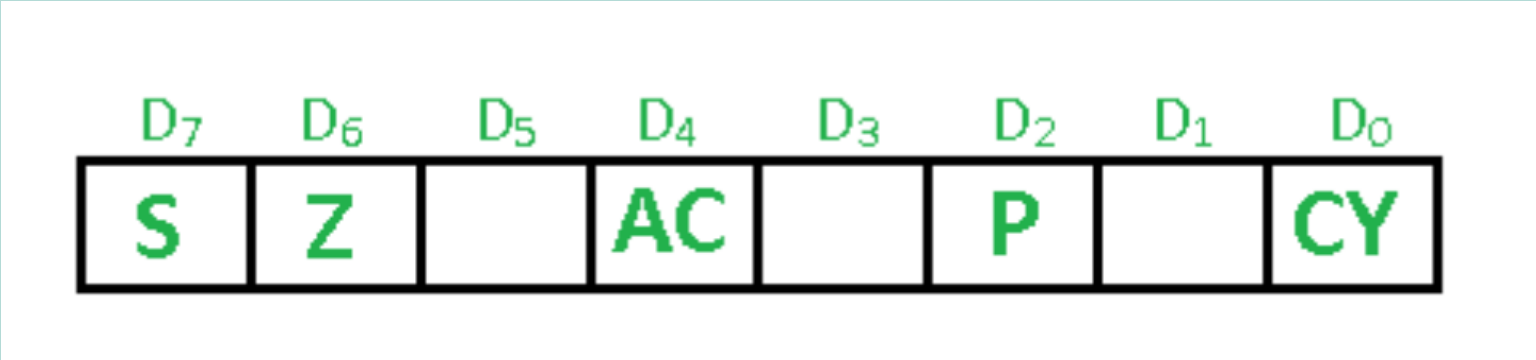
- Most important component of the entire Mu-P. 8 bit register.
- It is inevitable in all the arithmetic and logical operations since the result is going to be stored in this register.
- It is represented by the character A.
- When there is a new 8 bit data entering, the previously stored data will get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



Program Status Word Register (PSW) - Flag Register



Flag Register



S – Sign Flag, if S = 0 then the number is positive if S= 1 then the number is negative

Z – Zero Flag - if the ALU operation result becomes 0 then Z set to 1, if Z=0 then the operation will continue

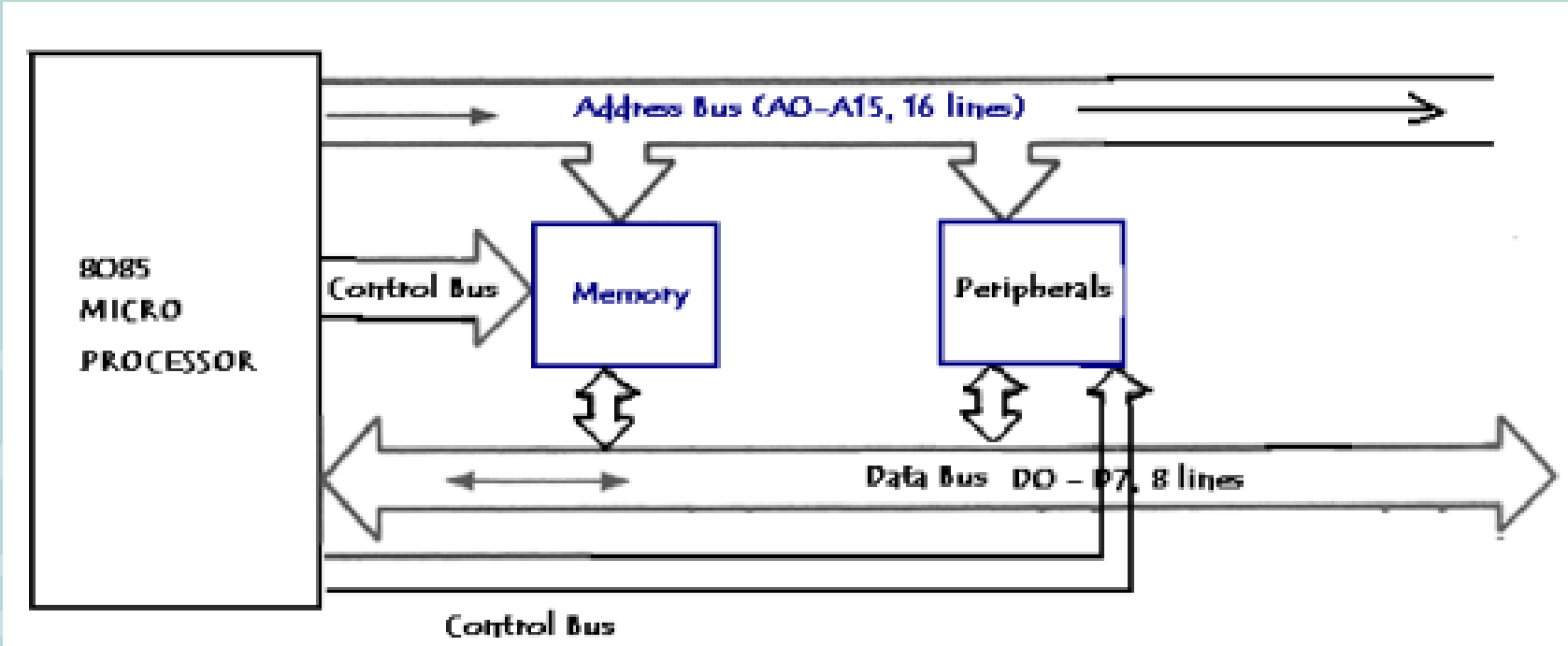
AC – Auxiliary Carry Flag – to detect if there was a carry from 3rd bit to 4th bit during addition or subtraction – if AC = 1 carry is present else AC = 0

P – Parity Flag – if P = 1 then the accumulator is having even number of One's (even parity) of else P= 0 (odd parity)

C – Carry Flag – If C = 0 then no carry else C=1 detect a carry after the addition or subtraction process

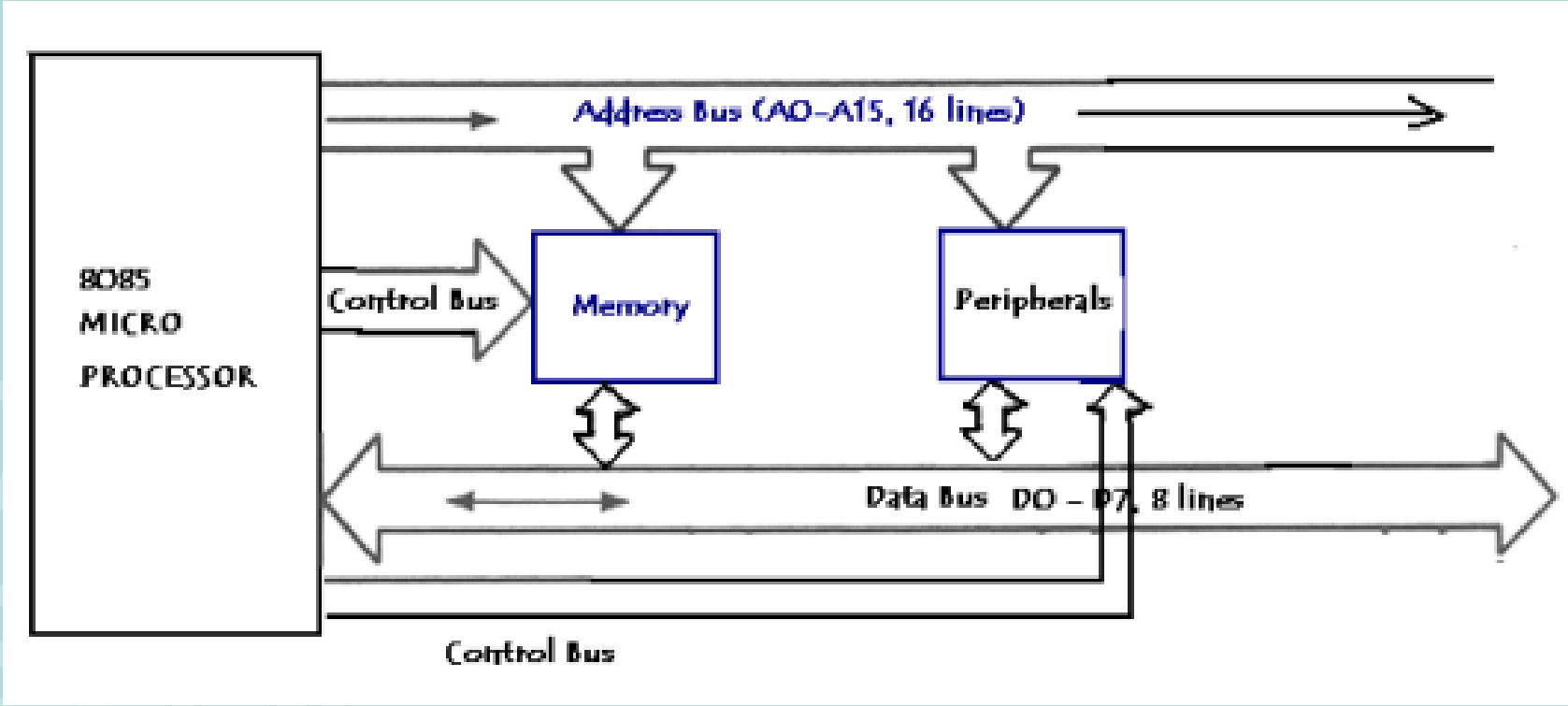
BUS STRUCTURE IN 8085

- 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.



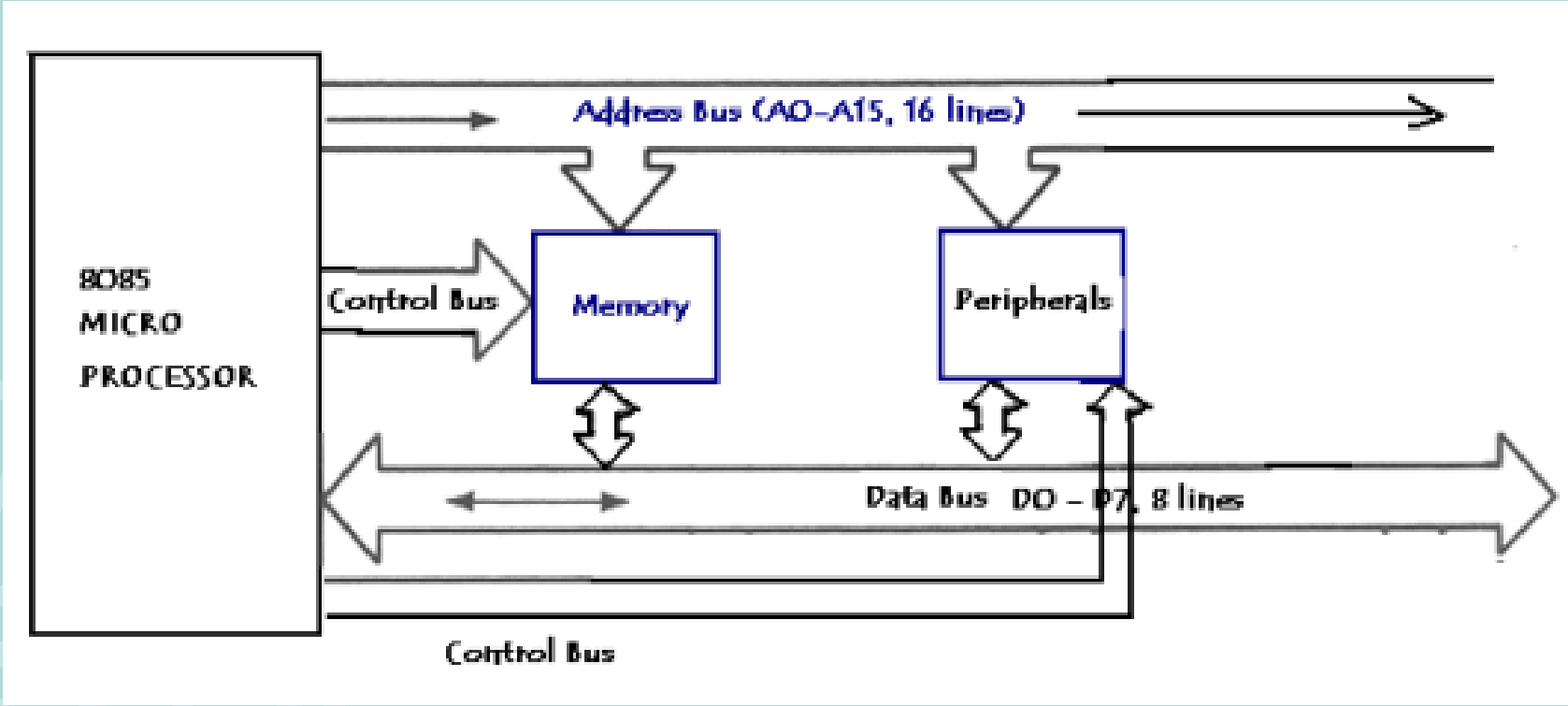
Address Bus

- 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



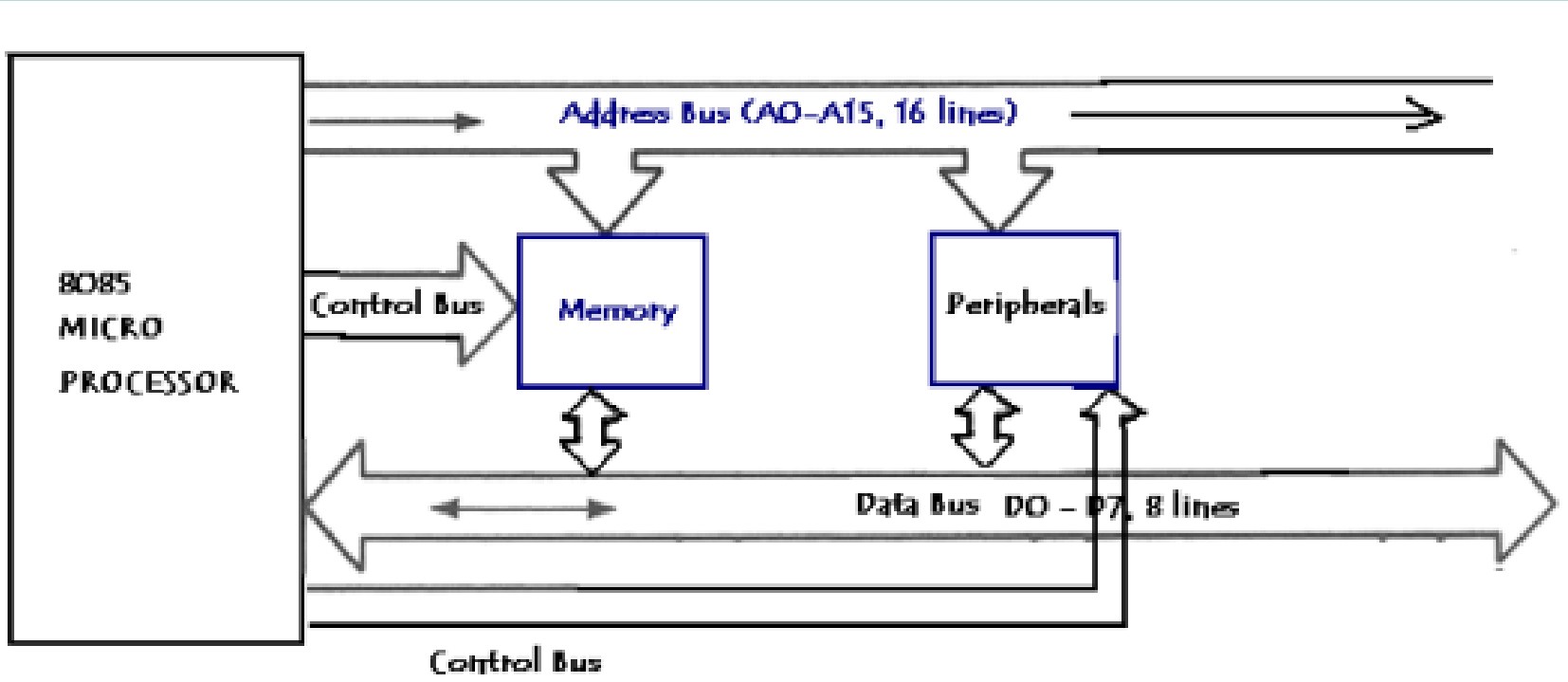
Data Bus

- 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.



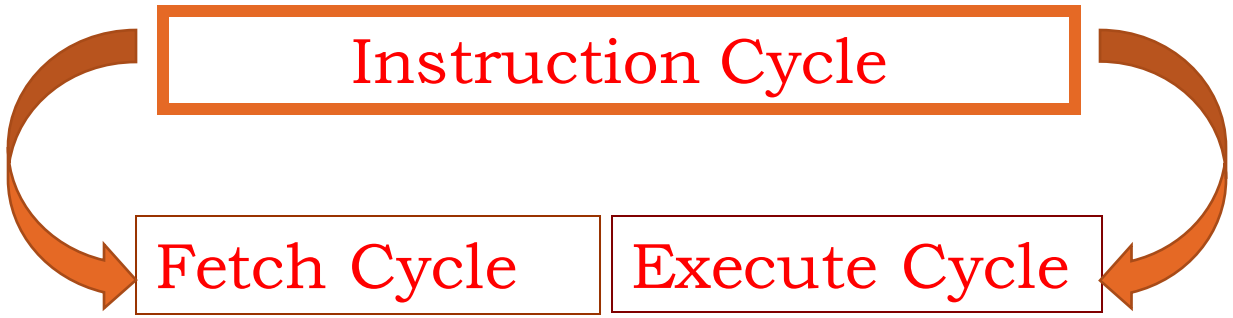
Processor Cycles

Instruction Cycle:

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

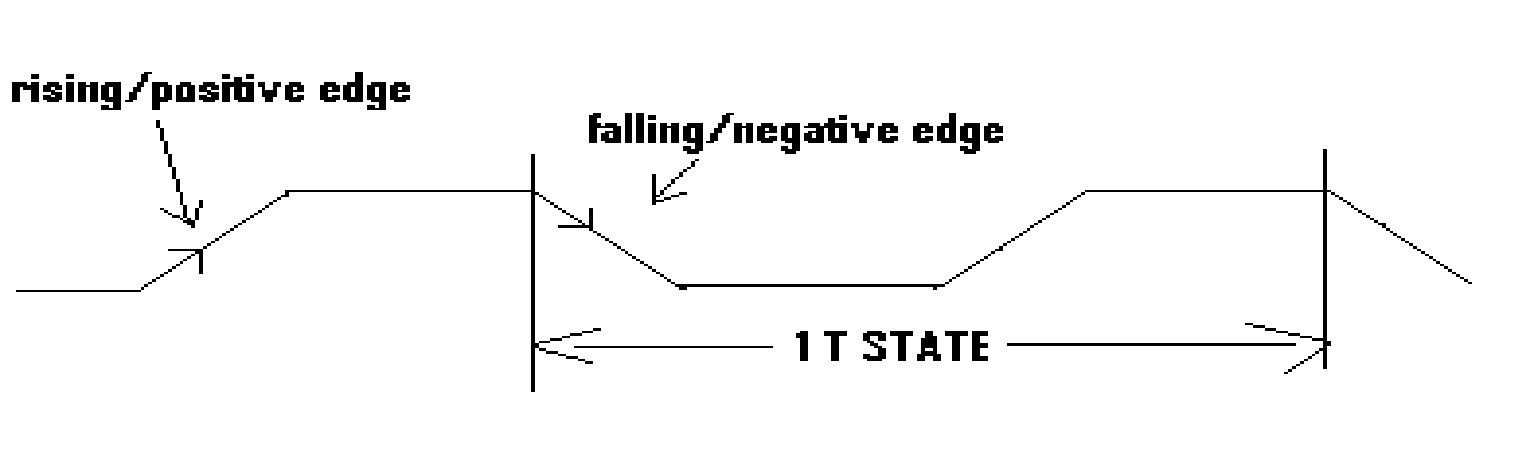
Machine Cycle:

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



T States

- The time required by the processor to complete an operation is called machine cycle and 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 pulse and to the falling edge of the next clock pulse.



Thank You