MICROPROCESSOR AND ASSEMBLY LANGUAGE
CSE 311
TOPIC: MEMORY SEGMENTATION

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8086 MEMORY

- In memory, data is stored as bytes.
- Each byte has a specific address.
- Intel 8086 has 20 lines address bus.
- With 20 address lines, the memory that can be addressed is 2^{20} bytes.
- 2^{20} = 1,048,576 bytes (1 MB).
- 8086 can access memory with address ranging from 00000 H to FFFFF H.

MEMORY CAPACITY

- 8086 memory capacity is 1 MB
- Capacity can be defined as,
- = No of bytes*size
- For 20-bit address lines it is 2^{20}
- Thus total capacity

  2^{20} *1 byte = 1 MB
- Thus physical address is 20-bit, as all registers are 16-bit, so 8086 generates a 32-bit logical address combination.
- 16-bit segment : 16-bit offset
- 16-bit segment value is given by appropriate segment register. Actually the upper 16-bit of a segment starting address is given by a segment register.
- And 16-bit offset is the displacement of data from segment base.

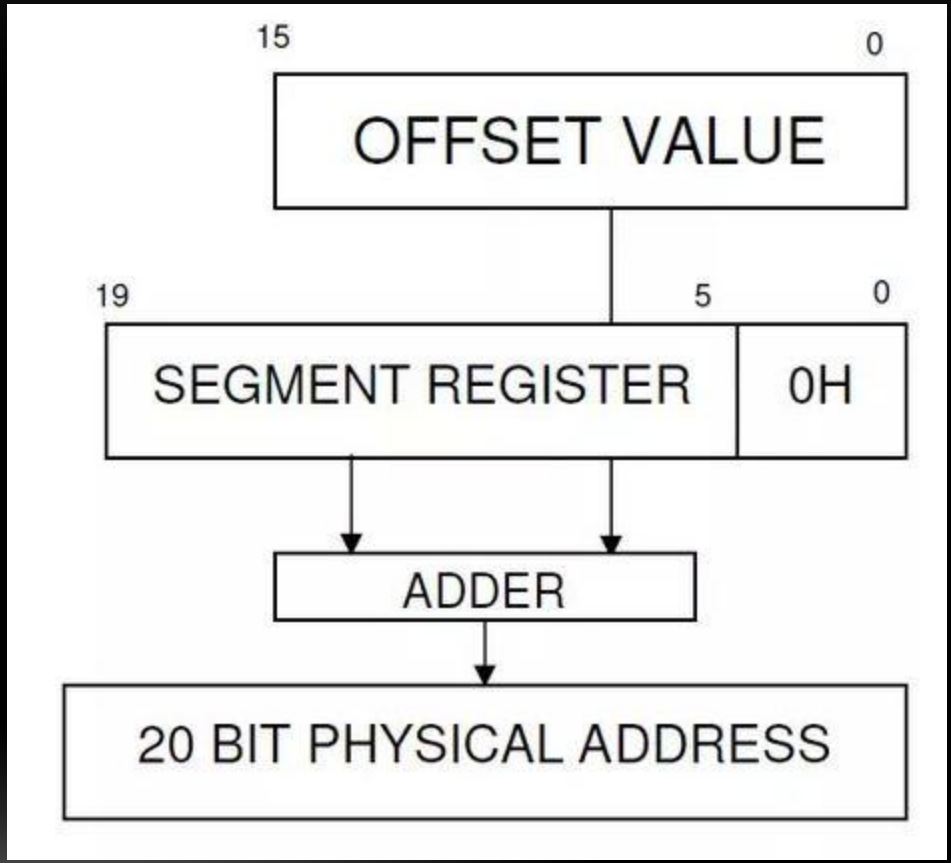
MEMORY SEGMENTATION

- The process of dividing memory into logical blocks is called **Segmentation.**
- According to this the total memory size is divided into segments of various sizes.
- A segment is just a logical area in memory.

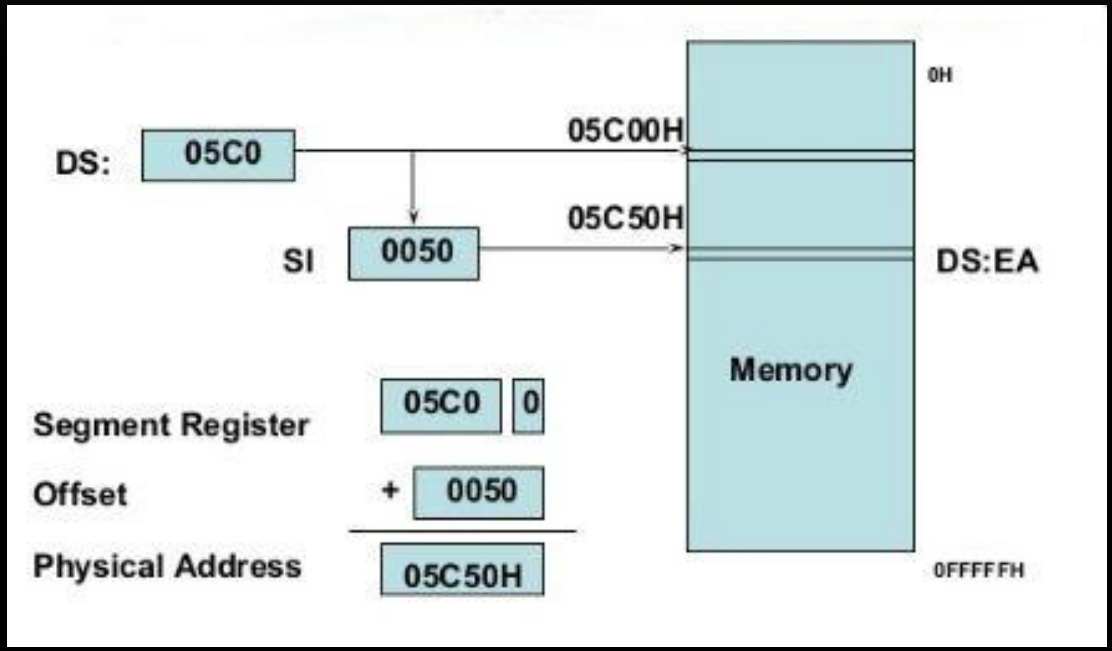
PHYSICAL ADDRESS CALCULATION

Segment value is 4-bit left shifted then added with offset.

A segment offset may range from 0000H to FFFFH.



AN EXAMPLE OF PROCEDURE



FINDING THE STARTING AND ENDING ADDRESSES

Segment Register	Starting Address	Ending Address
2000H	20000H	2FFFFH
2001H	20010H	3000FH
2100H	21000H	30FFFH
AB00H	AB000H	BAFFFH
1234H	12340H	2233FH

ADVANTAGES OF SEGMENTATION

i. Managing memory efficiently
ii. keeping different data in different address spaces. E.g. data, code, stack
iii. Searching easy and fast.
iv. Faster access and thus execution.
v. Helps and improves multiprogramming
vi. Possible to access 1 MB memory using 16-bit structure.

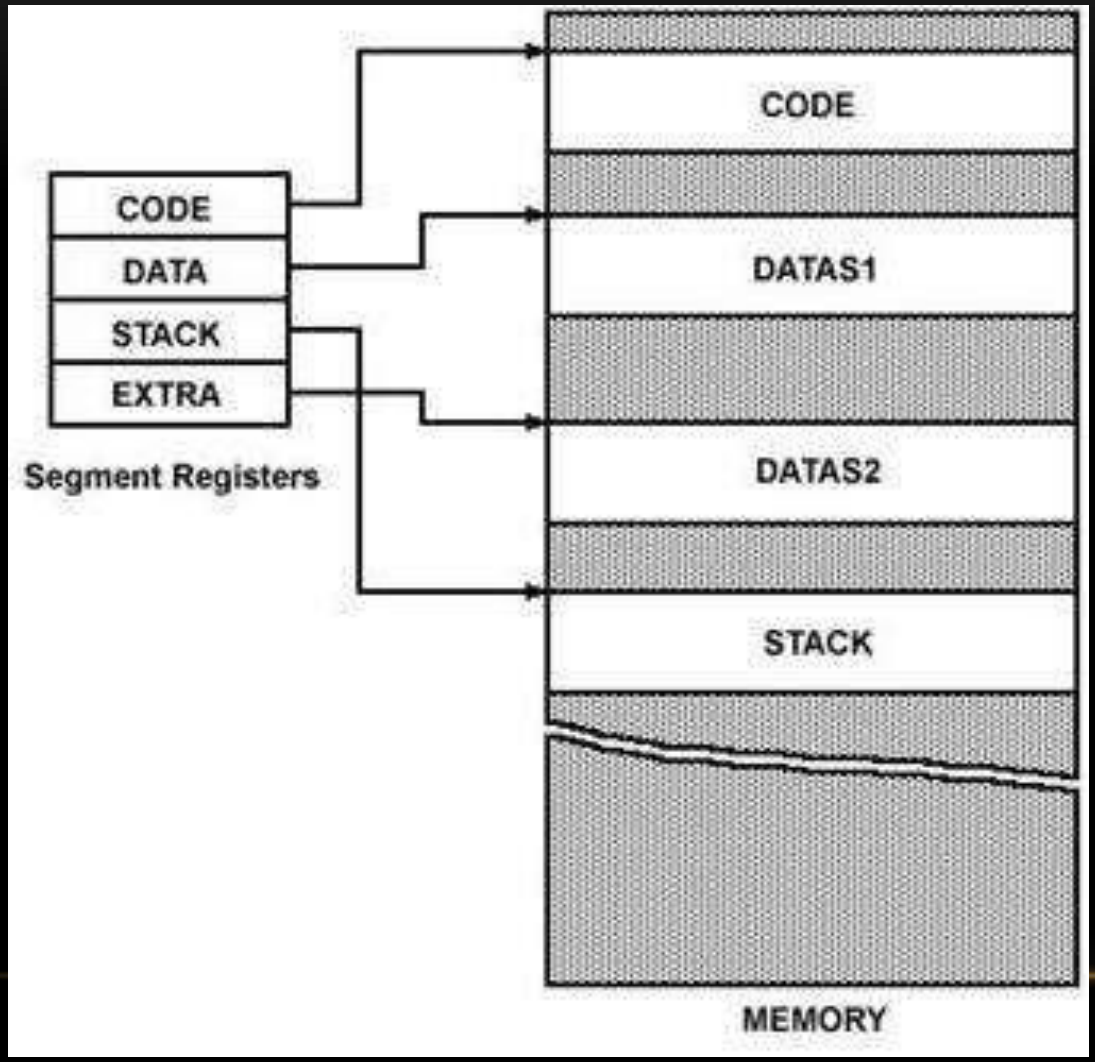
MEMORY SEGMENTATION

- In 8086, memory has four different types of segments.
- These are:
  - Code Segment
  - Data Segment
  - Stack Segment
  - Extra Segment

SEGMENT REGISTERS

- Each of these segments are addressed by an address stored in corresponding segment register.
- These registers are 16-bit in size.
- Each register stores the base address (starting address) of the corresponding segment.
- Because the segment registers cannot store 20 bits, they only store the upper 16 bits.

SEGMENT REGISTERS



EXAMPLE

- The 20-bit address of a byte is called its **Physical Address**.
- But, it is specified as a **Logical Address**.
- Logical address is in the form of:

Base Address : Offset

- Offset is the displacement of the memory location from the starting location of the segment.

EXAMPLE

- The value of Data Segment Register (DS) is 2222 H.
- To convert this 16-bit address into 20-bit, the BIU appends 0H to the LSBs of the address.
- After appending, the starting address of the Data Segment becomes 22220H.

EXAMPLE

- If the data at any location has a logical address specified as:

  2222 H : 0016 H

- Then, the number 0016 H is the offset.
- 2222 H is the value of DS.

EXAMPLE (CONTD.)

- To calculate the effective address of the memory, BIU uses the following formula:
  - Effective Address = Starting Address of Segment + Offset
- To find the starting address of the segment, BIU appends the contents of Segment Register with 0H.
- Then, it adds offset to it.

EXAMPLE (CONTD.)

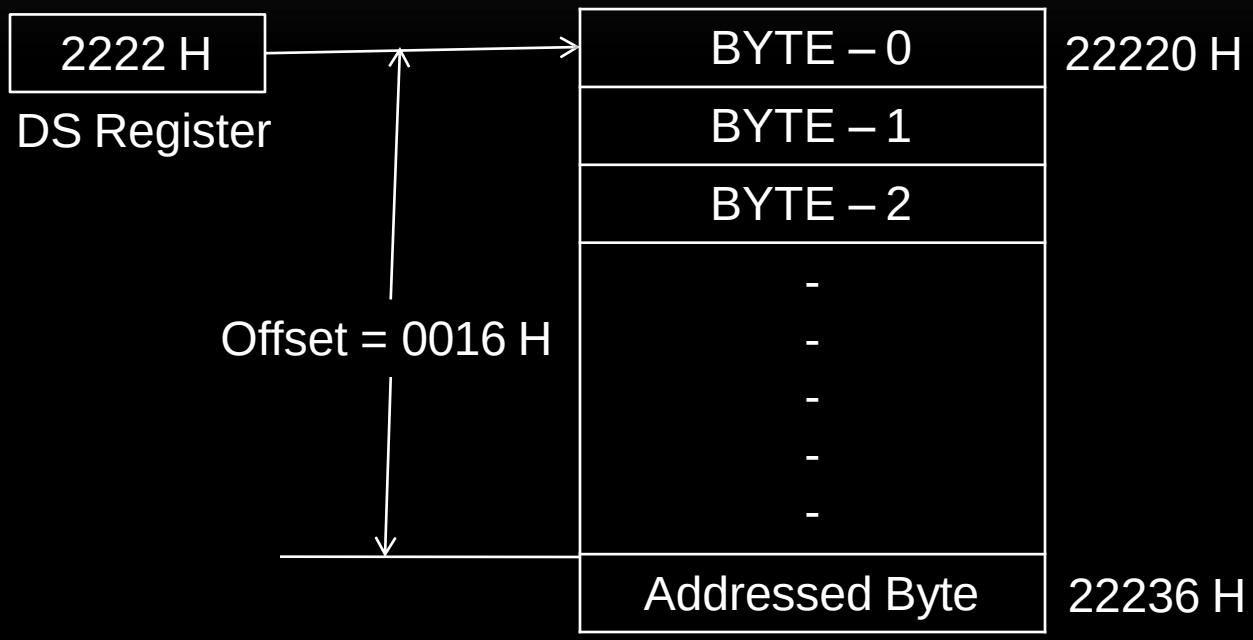
- Therefore:
- EA= 22220 H

  + 0016 H

  ——— .

  22236 H

EXAMPLE (CONTD.)



MAX. SIZE OF SEGMENT

- All offsets are limited to 16-bits.
- It means that the maximum size possible for segment is $2^{16} = 65,535$ bytes (64 KB).
- The offset of the first location within the segment is 0000 H.
- The offset of the last location in the segment is FFFF H.

WHERE TO LOOK FOR THE OFFSET

Segment	Offset Registers	Function
CS	IP	Address of the next instruction
DS	BX, DI, SI	Address of data
SS	SP, BP	Address in the stack
ES	DI	Address of destination data (for string operations)

QUESTION

- The contents of the following registers are:
  - CS = 1111 H
  - DS = 3333 H
  - SS = 2526 H
  - IP = 1232 H
  - SP = 1100 H
  - DI = 0020 H
- Calculate the corresponding physical addresses for the address bytes in CS, DS and SS.

SOLUTION

1. CS = 1111 H

- The base address of the code segment is 11110 H.
- Effective address of memory is given by 11110H + 1232H = 12342H.

2. DS = 3333 H

- The base address of the data segment is 33330 H.
- Effective address of memory is given by 33330H + 0020H = 33350H.

3. SS = 2526 H

- The base address of the stack segment is 25260 H.
- Effective address of memory is given by 25260H + 1100H = 26350H.