8086 assembler tutorial for beginners (part 9)

The Stack

Stack is an area of memory for keeping temporary data. Stack is used by **CALL** instruction to keep return address for procedure, **RET** instruction gets this value from the stack and returns to that offset. Quite the same thing happens when **INT** instruction calls an interrupt, it stores in stack flag register, code segment and offset. **IRET** instruction is used to return from interrupt call.

We can also use the stack to keep any other data,
there are two instructions that work with the stack:

PUSH - stores 16 bit value in the stack.

POP - gets 16 bit value from the stack.

Syntax for **PUSH** instruction:

```
PUSH REG
PUSH SREG
PUSH memory
PUSH immediate
```

REG: AX, BX, CX, DX, DI, SI, BP, SP.

SREG: DS, ES, SS, CS.

memory: [BX], [BX+SI+7], 16 bit variable, etc...

immediate: 5, -24, 3Fh, 10001101b, etc...

Syntax for **POP** instruction:

```
POP REG
POP SREG
POP memory
```

REG: AX, BX, CX, DX, DI, SI, BP, SP.

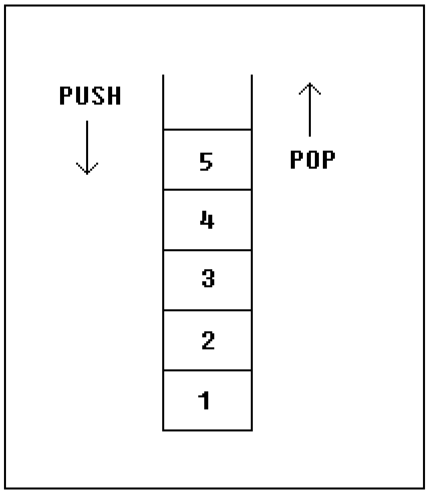
SREG: DS, ES, SS, (except CS).

memory: [BX], [BX+SI+7], 16 bit variable, etc...

Notes:

- **PUSH** and **POP** work with 16 bit values only!
- Note: **PUSH immediate** works only on 80186 CPU and later!

The stack uses **LIFO** (Last In First Out) algorithm,
this means that if we push these values one by one into the stack:
1, 2, 3, 4, 5
the first value that we will get on pop will be **5**, then **4**, **3**, **2**, and only then **1**.



It is very important to do equal number of **PUSH**s and **POP**s, otherwise the stack maybe corrupted and it will be impossible to return to operating system. As you already know we use **RET** instruction to return to operating system, so when program starts there is a return address in stack (generally it's 0000h).

PUSH and **POP** instruction are especially useful because we don't have too much registers to operate with, so here is a trick:

- Store original value of the register in stack (using **PUSH**).
- Use the register for any purpose.
- Restore the original value of the register from stack (using **POP**).

Here is an example:

```
ORG    100h

MOV    AX, 1234h
PUSH   AX          ; store value of AX in stack.

MOV    AX, 5678h   ; modify the AX value.

POP    AX          ; restore the original value of AX.

RET

END
```

Another use of the stack is for exchanging the values,
here is an example:

```
ORG    100h

MOV    AX, 1212h   ; store 1212h in AX.
MOV    BX, 3434h   ; store 3434h in BX


PUSH   AX          ; store value of AX in stack.
PUSH   BX          ; store value of BX in stack.

POP    AX          ; set AX to original value of BX.
POP    BX          ; set BX to original value of AX.

RET

END
```

The exchange happens because stack uses **LIFO** (Last In First Out) algorithm, so when we push **1212h** and then **3434h**, on pop we will first get **3434h** and only after it **1212h**.

The stack memory area is set by **SS** (Stack Segment) register, and **SP** (Stack Pointer) register. Generally operating system sets values of these registers on program start.

"**PUSH *source***" instruction does the following:

- Subtract **2** from **SP** register.
- Write the value of ***source*** to the address **SS:SP**.

"**POP *destination***" instruction does the following:

- Write the value at the address **SS:SP** to ***destination***.
- Add **2** to **SP** register.

The current address pointed by **SS:SP** is called **the top of the stack**.

For **COM** files stack segment is generally the code segment, and stack pointer is set to value of **0FFFEh**. At the address **SS:0FFFEh** stored a return address for **RET** instruction that is executed in the end of the program.

You can visually see the stack operation by clicking on [**Stack**] button on emulator window. The top of the stack is marked with "**<**" sign.

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