Data Movement Instructions

Intel Assembly

Data Movement Instruction:

- mov (covered already)
- push, pop
- lea (mov and offset)
- lds, les, lfs, lgs, lss
- movs, lods, stos
- ins, outs
- xchg, xlat
- lahf, sahf (not covered)
- in, out
- movsx, movzx
- bswap
- cmov

Stack Instructions

There are six forms of the ***push*** and ***pop*** instructions.

Register, memory (memory-to-memory copy), immediate, segment register, flags, and all registers

push:

The source of the data may be:

Any 16- or 32-bit register, immediate data, any segment register, any word or doubleword of memory data

pushad pushes **eax**, **ecx**, **edx**, **ebx**, **esp**, **ebp**, **edi** and **esi** where the value of **esp** saved on the stack is its value before the ***pushad***.

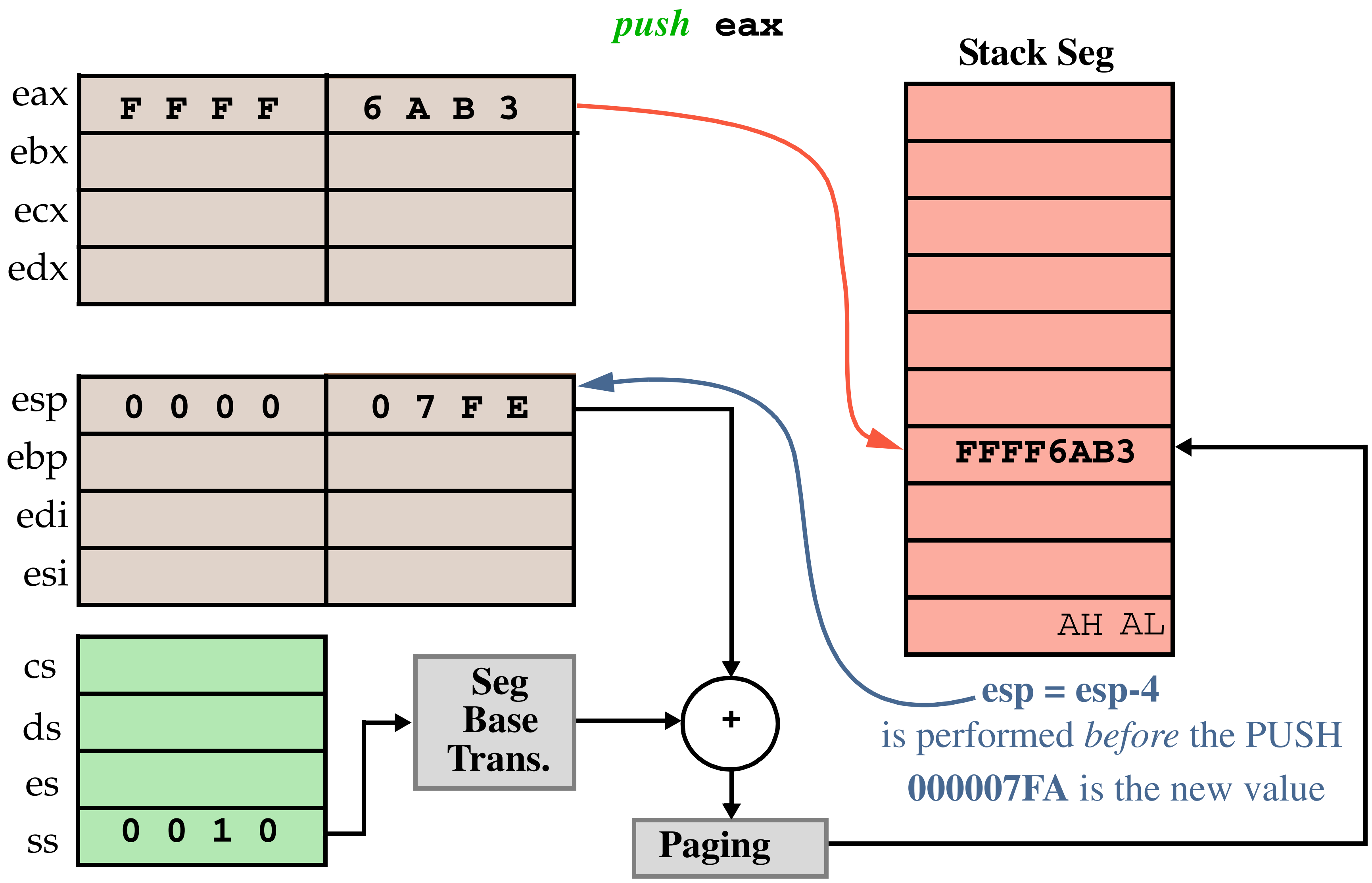
pop:

The source of the data may be:

Any 16- or 32-bit register, any segment register (except for **cs**), any word or doubleword of memory data.

Stack Instructions

push:



esp = esp-4
is performed *before* the PUSH
000007FA is the new value

Address Loading Instructions

Load-Effective Address.

- ***lea***:

  Loads any 32-bit register with the address of the data, as determined by the instruction addressing mode.

- ***lds*** and ***les***:

  Load a 32-bit offset address and then **ds** or **es** from a 48-bit memory location.

- ***lfs***, ***lgs*** and ***lss*** (80386 and up):

  Load any 32-bit offset address and then **fs**, **gs** or **ss** from a 48-bit memory location.

```
lea  eax,[ebx+ecx*4+100]  ;Loads eax with computed address.
lds    edi, LIST          ;Loads edi and ds.
lfs    esi, DATA1         ;Loads esi and fs.
```

NOTE: *lea* calculates the **ADDRESS** given by the right arg and stores it in the left arg!

Address Loading Instructions

Load-Effective Address.

lea versus ***mov***:

```
lea  ebx, [edi]    ;Load the contents of edi into ebx.  (1)
mov  ebx, [edi]    ;Load the value at edi into ebx.     (2)
mov  ebx, edi      ;Move the contents of edi into ebx.  (3)
```

1 and 3 are equivalent.

So what are the differences?

- 3 is faster than 1 and is preferred.
- However, ***mov*** only works with single args and cannot be used with *LIST*[**edi**].
- ***lea*** can take any address, e.g., ***lea*** **esi**, [**ebx** + **edi**].

String Operations

movs, lods, stos, ins, outs

Allow data transfers of a byte, a word or a double word, or if repeated, a block of each of these.

The *D* flag-bit (direction), **esi** and **edi** are implicitly used.

- *D = 0*: Auto increment **edi** and **esi**.

  Use ***cld*** instruction to clear this flag.
- *D = 1*: Auto decrement **edi** and **esi**.

  Use ***std*** instruction to set it.

edi:

Accesses data in the extra segment. Can NOT override.

esi:

Accesses data in the data segment. Can be overridden with segment override prefix.

String Operations

lods:

Loads **al**, **ax** or **eax** with data stored at the data segment (or extra segment) + offset given by **esi**.

esi is incremented or decremented afterwards:

```
lodsb                  ;al=ds:[esi]; esi=esi+/-1
lodsd                  ;eax=ds:[esi]; esi=esi+/-4
es lodsb DATA1         ;Override ds.
```

stosb:

Stores **al**, **ax** or **eax** to the extra segment (es) + offset given by **edi**. es cannot be over-ridden.

edi is incremented or decremented afterwards:

```
stosb                  ;es:[edi]=al; edi=edi+/-1
stosd                  ;es:[edi]=eax; edi=edi+/-4
```

String Operations

rep prefix:

Executes the instruction **ecx** times.

```
mov  edi, 0                 ;Offset 0.
mov  ecx, 25*80             ;Load count.
mov  eax, 0720H             ;Load value to write.
rep  stosw
```

NOTE: ***rep*** does not make sense with the ***lodsb*** instruction.

movs:

Moves a byte, word or doubleword from data segment and offset **esi** to extra segment and offset **edi**.

Increments/decrements both **edi** and **esi**:

```
movsb        ;es:[edi]=ds:[esi]; edi+/-=1; esi+/-=1
movsd        ;es:[edi]=ds:[esi]; edi+/-=4; esi+/-=4
```

String Operations and Exchange

ins/outs:

Transfers a byte, word or doubleword of data from/to an I/O device into/out of the extra/data segment + offset **edi/esi**, respectively.

The I/O address is stored in the **edx** register.

```
insb         ;es:[edi]=[edx]; edi+/-=1
insd         ;es:[edi]=[edx]; edi+/-=4
insw         ;es:[edi]=[edx]; edi+/-=2; esi+/-=2
outsb        ;[edx]=ds:[esi]; esi=esi+/-1
```

xchg:

Exchanges the contents of a register with the contents of any other register or memory location.

It can NOT exchange segment registers or memory-to-memory data.

Byte, word and doublewords can be exchanged using any addressing mode (except immediate, of course).

```
xchg edx, esi     ;Exchange edx and esi
```

Miscellaneous Data Transfer Operations

movsx and ***movzx*** (80386 and up only):

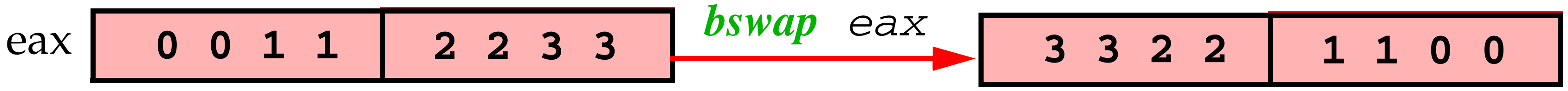
Move-and-sign-extend and Move-and-zero-extend:

```
movsx  cx, bl          ;Sign-extends bl into cx
movzx  eax, DATA2      ;Zero extends word at DATA2 in eax.
```

bswap (80486 and up only):

Swaps the first byte with the forth, and the second byte with the third.

Used to convert between little endian and big endian:



cmov (Pentium and up only):

These instructions move data only if a condition is true.

Conditions are set by a previous instruction and include *Carry*, *Zero*, *Sign*, *Overflow* and *Parity*:

```
cmovz eax, ebx  ;Move if Zero flag is set else do nothing.
```

There are many variations of this instruction (see intel instructions doc or text).

Assembler Directives

Segment Override Prefix:

Allows the programmer to override the default segment.

```
es outsb
es cmpsb
```

Procedure Calls

```
push args...               ;Push the arguments on stack.
call procedure_name        ;Call the procedure
add  esp, #                ;Restore the stack pointer.
```