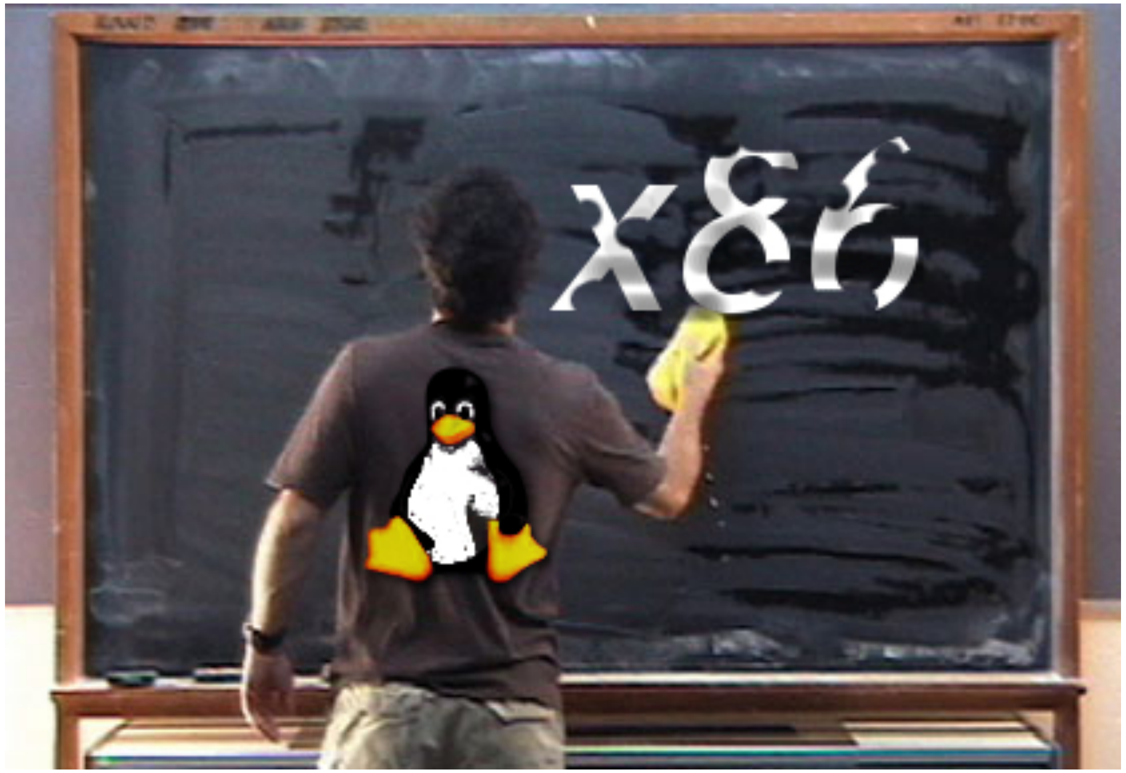
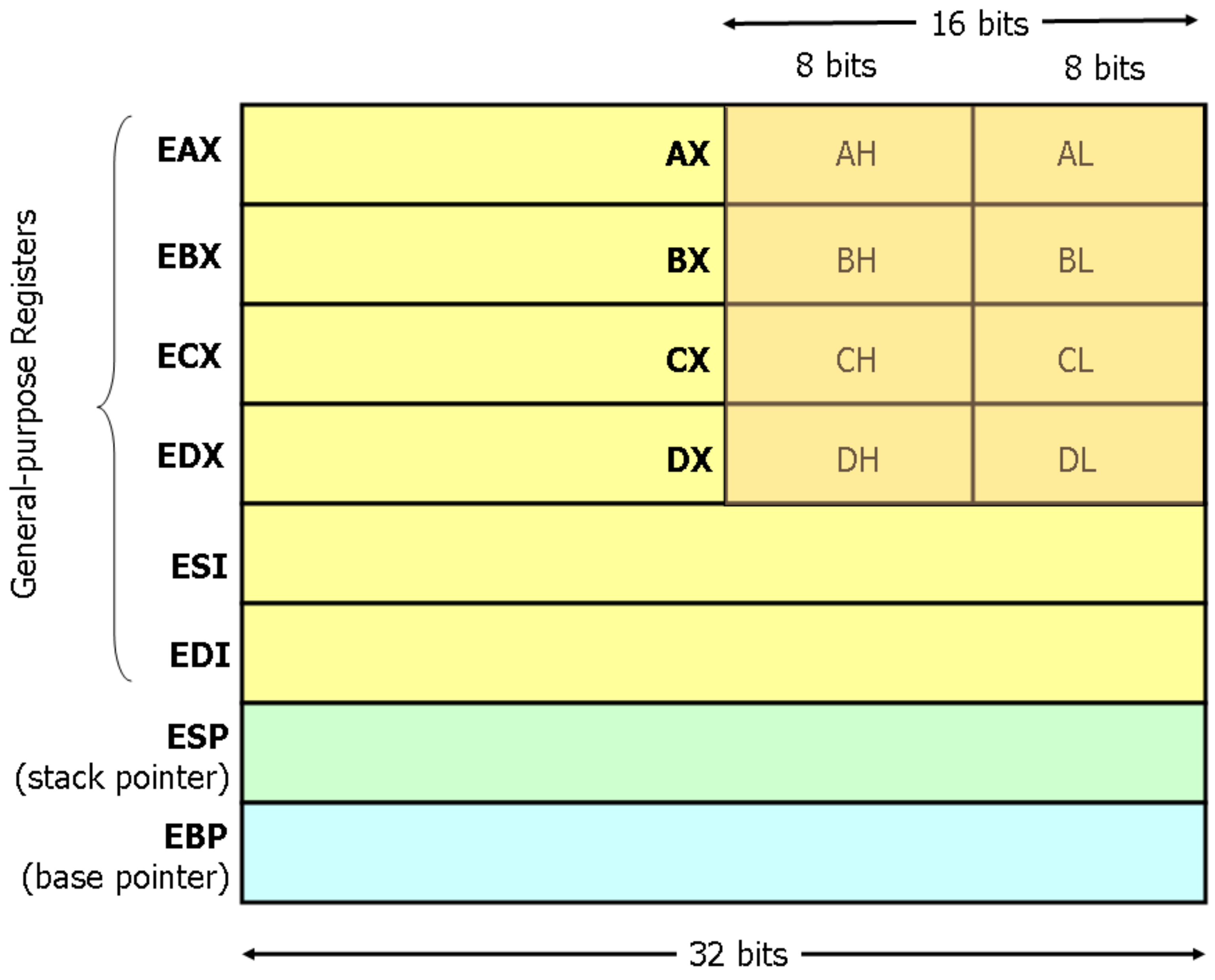
x86 Assembly Programming under Linux




16 bits
8 bits
8 bits
General-purpose Registers
EAX
AX
AH
AL
EBX
BX
BH
BL
ECX
CX
CH
CL
EDX
DX
DH
DL
ESI
EDI
ESP
(stack pointer)
EBP
(base pointer)
32 bits

Data Movement Instructions

mov — Move
push — Push stack
pop — Pop stack
lea — Load effective address

Control Flow Instructions

jmp — Jump
cmp — Compare
j*condition* — Conditional Jump
call, **ret** — Subroutine call and return

Arithmetic and Logic Instructions

add — Integer Addition
sub — Integer Subtraction
inc, **dec** — Increment, Decrement
mul — Integer Multiplication
div — Integer Division
and, **or**, **xor** — Bitwise Logical And, Or and Xor
not — Bitwise Logical Not
neg — Negate
shl, **shr** — Shift Left, Shift Right

min.s

```
.section .data                # start of data section
a:     .long 42               # variable a
b:     .long 53               # variable b
m:     .long 0                # variable m

.section .text                # start of text section
.globl _start                 # _start is a global symbol
                              # specifying the program start
_start:
       movl a, %eax
       movl b, %ebx
       cmpl %ebx, %eax        # compare a with b
       jle if                 # if (a <= b)
       jmp else
if:    movl %eax, m           #     m = a
       jmp endif              # else
else:  movl %ebx, m           #     m = b
endif: movl m, %ebx
       movl $1, %eax
       int $0x80              # exit(m)
```

Assemble:

```
as -o min.o min.s
```

Link:

```
ld -o min min.o
```

Execute:

```
./min
```

Print the result:

```
echo $?
```

min.c

```
int min(int a, int b) {
    int m;
    if (a < b)
        m = a;
    else
        m = b;
    return m;
}
```

Generate assembly code for the C code:

```
   gcc –S -m32 min.c
```

This generates `min.s`

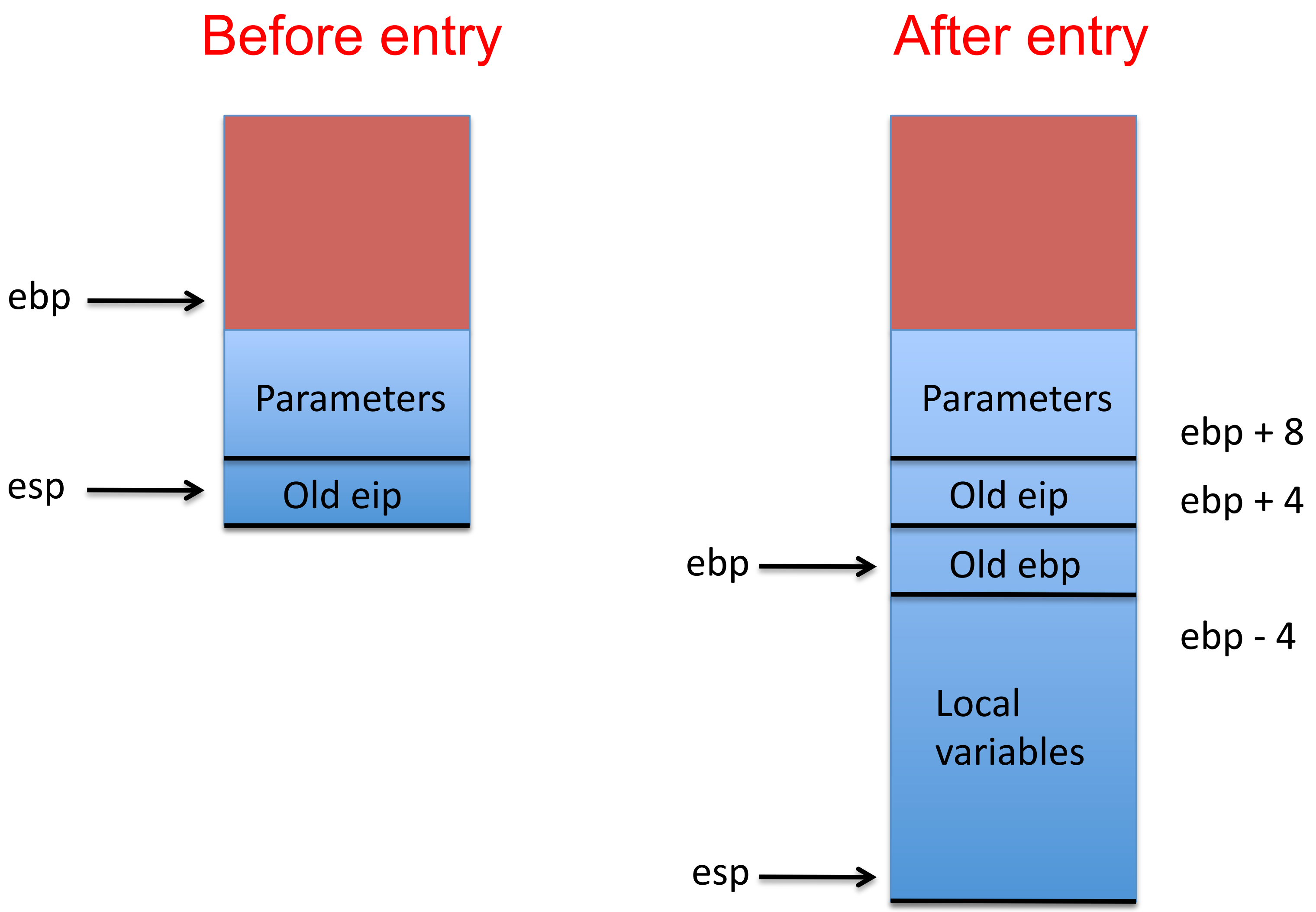
Show the assembly code:

```
   cat min.s
```

or

```
   gedit min.s
```

Stack frame


Before entry
ebp
esp
Parameters
Old eip
After entry
Parameters
Old eip
Old ebp
Local variables
ebp
esp
ebp + 8
ebp + 4
ebp - 4

Call
`min(2, 3)`

```
pushl $3
pushl $2
call  min
addl $8, %esp
```

```
        .file   "min.c"
        .text
        .globl  min
        .type   min, @function
min:
        pushl   %ebp
        movl    %esp, %ebp
        subl    $16, %esp
        movl    8(%ebp), %eax
        cmpl    12(%ebp), %eax
        jge     .L2
        movl    8(%ebp), %eax
        movl    %eax, -4(%ebp)
        jmp     .L3
.L2:
        movl    12(%ebp), %eax
        movl    %eax, -4(%ebp)
.L3:
        movl    -4(%ebp), %eax
        leave
        ret
```

Debugging information has been left out

`leave` equivalent to

```
movl %ebp, %esp
popl %ebp
```

Generate optimized assembly code:

```
gcc -O -S -m32 min.c
```

Show the assembly code:

```
cat min.s
```

Optimized code

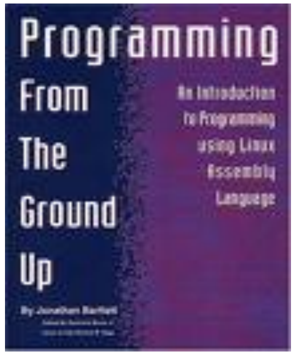
```
        .file   "min.c"
        .text
        .globl min
        .type   min, @function
min:
        movl    4(%ebp), %eax
        movl    8(%ebp), %edx
        cmpl    %edx, %eax
        cmovle  %edx, %eax
        ret
```

More about x86 assembly programming

The book

“Programming from the Ground Up”
by Jonathan Bartlett

may be downloaded via the webpage of the course


Programming
From
The
Ground
Up
An Introduction to Programming using Linux Assembly Language
By Jonathan Bartlett