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## 1 OS Development quick notes

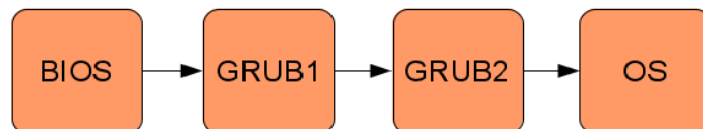
Quick notes I'll take while reading **The little book about OS Dev**.

### 1.1 Resources used

- The little book about os dev
- Makigas: construyendo un sistema operativo (youtube)
- [wiki.osdev.org](http://wiki.osdev.org)
- Andreas Kling code tour videos

### 1.2 Basics

#### 1.2.1 Booting



When the computer boots up, first it loads the **POST** to check that all the hardware is healthy and able to work, if it fails, normally is when

the "beeps" from the speaker gives information about what could be failing. After this, it starts the BIOS ( or on modern days, UEFI), this is basically the firmware, a program that (normally) is located on a ROM in the motherboard responsible for initializing devices such as memory, searches for bootable devices (hard disk, dvd, ...) and then it passes the control to the bootloader, the bootloader is responsible for loading the actual operating system.

#### 1. BIOS

On BIOS firmwares, it loads the bootloader from the first sector in the MBR (Master Boot Record) of a bootable device

#### 2. UEFI

On UEFI firmwares, the bootloader is loaded from the **EFI** partition (EFI System Partition).

A bootloader is a lowlevel complex program, while I could create one from scratch I for now will prefer to use a standard bootloader such as GRUB

### 1.3 Loader

The first "OS" example that the book shows to compile is a simple one that simply will load 0xCAFEBADE into register **eax**.

To do this, it writes assembly code (we can't use C without a stack set up)

```
global loader ; entry symbol for the program to load
; constants definitions
MAGIC_NUMBER equ 0x1BADB002 ; This is the required header parameters used for
FLAGS equ 0x0
CHECKSUM equ -MAGIC_NUMBER

section .text:
align 4 ; align variables into memory locations that are divisible by 4, this

; variable definitions
dd MAGIC_NUMBER
dd FLAGS
dd CHECKSUM
```

```

loader:
    mov eax, 0xCAFEBAFE

.loop:
    jmp .loop

```

In this assembly code we just define the correct header so it can be used by the standard multiboot specification.

This is then compiled into a 32bit ELF object file

```
nasm -f elf32 loader.s
```

And finally linked to have an executable file.

```

ENTRY(loader) /* the name of the entry label */
SECTIONS {
    . = 0x00100000; /* the code should be loaded at 1 MB */
    .text ALIGN (0x1000) : /* align at 4 KB */
    {
        *(.text) /* all text sections from all files */
    }
    .rodata ALIGN (0x1000) : /* align at 4 KB */
    {
        *(.rodata*) /* all read-only data sections from all files */
    }
    .data ALIGN (0x1000) : /* align at 4 KB */
    {
        *(.data) /* all data sections from all files */
    }
    .bss ALIGN (0x1000) : /* align at 4 KB */
    {
        *(COMMON) /* all COMMON sections from all files */
        *(.bss) /* all bss sections from all files */
    }
}

```

Then we link the object file compiled before with the link script so we can generate an executable.

```
ld -T link.ld -melf_i386 loader.o -o kernel.elf
```

Now I have an executable elf file, **kernel.elf**, this is the kernel to be loaded, we need a bootloader to execute this, in the book they show how to make an ISO that GRUB can boot, that's what I did to test, however, Andreas Kling, author of SerenityOS, showed how to make QEMU work as it's own bootloader, by passing the **-kernel** parameter in the CLI, that saved me some time, I won't need to create an ISO each time I want to test the OS.

```
qemu-system-i386 -d cpu -kernel kernel.elf
```

The **-d** option just indicates what I will want to show in the debug logs, with indicating **cpu** I can see a list of the registers.

So after booting, I can see that the **eax** register is correctly set to **0xBADC0FFE**

```
CCS=00000004 CCD=00950000 CCO=EFLAGS
EFER=0000000000000000
EAX=badc0ffe EBX=00009500 ECX=0010000c EDX=00010511
ESI=00000000 EDI=00001000 EBP=00000000 ESP=00006f08
EIP=00100011 EFL=00000006 [----P-] CPL=0 II=0 A20=1 SMM=0 HLT=0
ES =0010 00000000 ffffffff 00cf9300 DPL=0 DS [-WA]
CS =0008 00000000 ffffffff 00cf9a00 DPL=0 CS32 [-R-]
SS =0010 00000000 ffffffff 00cf9300 DPL=0 DS [-WA]
DS =0010 00000000 ffffffff 00cf9300 DPL=0 DS [-WA]
FS =0010 00000000 ffffffff 00cf9300 DPL=0 DS [-WA]
GS =0010 00000000 ffffffff 00cf9300 DPL=0 DS [-WA]
LDT=0000 00000000 0000ffff 00008200 DPL=0 LDT
TR =0000 00000000 0000ffff 00008b00 DPL=0 TSS32-busy
GDT= 000cb2b4 00000027
IDT= 00000000 000003ff
CR0=00000011 CR2=00000000 CR3=00000000 CR4=00000000
DR0=00000000 DR1=00000000 DR2=00000000 DR3=00000000
DR6=ffff0ff0 DR7=00000400
CCS=00000004 CCD=00950000 CCO=EFLAGS
EFER=0000000000000000
```



### 1.3.1 Getting to C

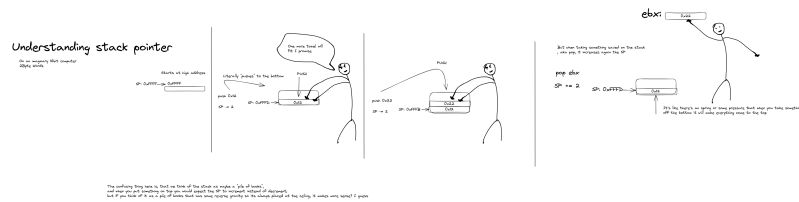
We don't want to use assembly all the time unless you have some kind of kink, so we will set up the correct environment to use C instead, for this we need to set up a memory **stack** which C will use.

To do this, we need to change where the **esp** register points to, but we can't just randomly use any address (we could, but it's a risk), what we can

do is to reserve some memory space by declaring data in the .bss section of our ELF file (If compiling to an ELF, in other way I guess you would need to do some hacky thing in the loader logic?)

## 1. How the stack pointer works

:ID: cd0b55c9-a642-4bf7-bb04-9b7764bceb68



draw: [https://excalidraw.com/#json=oV1i0TDce\\_1U9P0qcz8Kq,\\_89CUPrnoM7dZX3rNo0jxg](https://excalidraw.com/#json=oV1i0TDce_1U9P0qcz8Kq,_89CUPrnoM7dZX3rNo0jxg)

**IMPORTANT NOTE:** While in the drawing the values in the stack "disappear" from the stack when reading them with **pop**, in reality when you use pop the stack pointer is modified, but the data in the stack is **NOT** removed, it will still be there.

Example given by allison on the osdev discord guild:

	A	B	C	D	E	F	G	H	I	J	K	L	P
1	address	nothing on stack			push 0x12		push 0x34		push 0x56		pop		
2													
3	512 200			<-SP									
4	511 1FF				0x12	<-SP	0x12		0x12		0x12		
5	510 1FE						0x34	<-SP	0x34		0x34	<-SP	
6	509 1FD								0x56	<-SP			
7	508 1FC												
8	507 1FB												
9	506 1FA												
10	505 1F9												
11	504 1F8												
12	503 1F7												
13													

## 2 Assembly notes

I know some basic assembly, so I will take notes of those instructions, directives or whatever I don't know so I can remember it correctly

### 2.1 DD

The **dd** (defined double word, a word normally is 2 Bytes, so double is 4) is used to define a variable as a 4Byte value.

## 2.2 EQU

**\*equ** directive is used to define constant values, for example

```
ZERO equ 0x0 ; will declare ZERO as 0x0
```