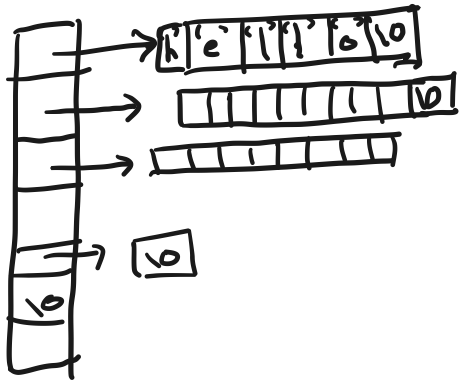
- [x] A. Last time
- [x] B. Today's class
- [x] C. Binaries + loading (assuming static linking)
- [x] D. From power-up to terminal
  - [x] Step 1: power up
  - [x] Step 2: firmware
  - [x] Step 3: OS bootloader
  - [x] Step 4: kernel
  - [x] Step 5: init(8)
  - [x] Step 6: login(1)
- [x] E. Remarks and observations

Binaries/loading

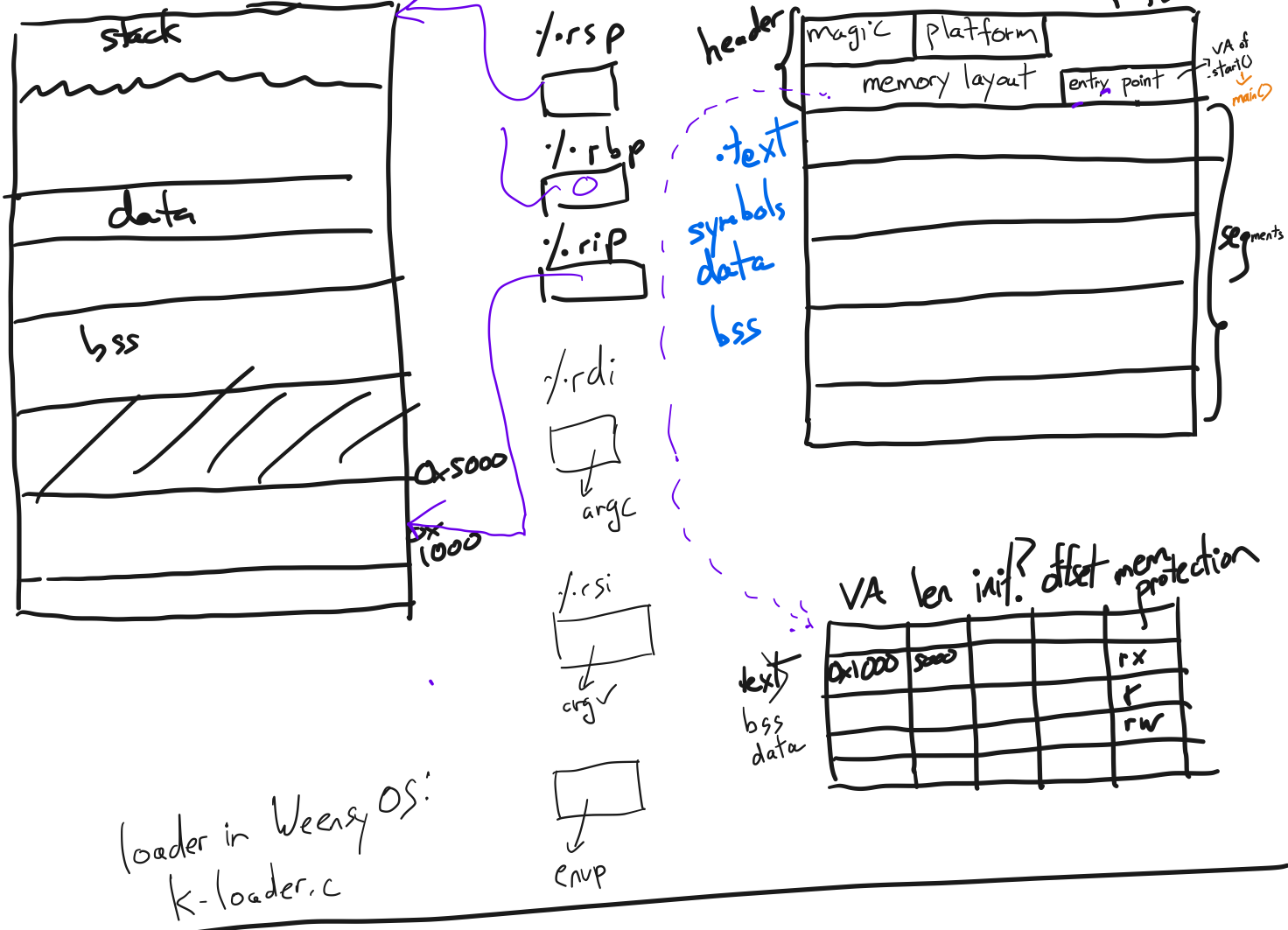
What happens when this code executes?

```
{
  ...
  char* new_argv[];
  char* new_envp[];
  //...
  // initialize argv and envp
  //----

  if (fork() == 0)
      execve("hello", new_argv, new_envp);

}
```




```
$ gcc hello.c -o hello
$ ls
  hello
$ ./hello
```

executable file (ELF / PE)



loader in Weensy OS:
k-loader.c

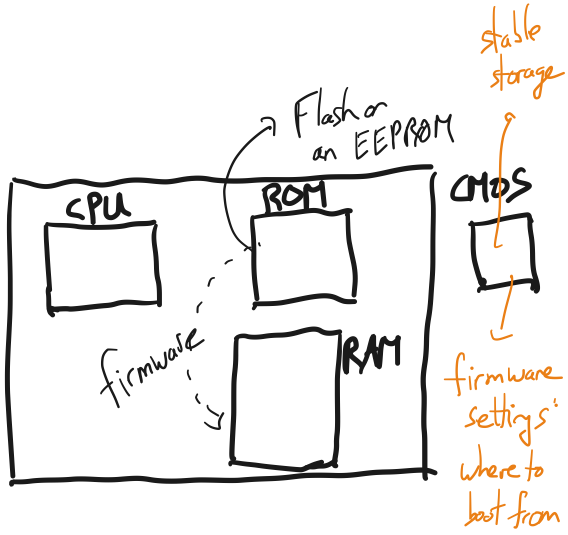
Step 1: power up

regs zeroed out

ctl. regs get defaults

real mode: 8086
- no paging
- 1 MB of phys mem

processor hard-wired:
- copy from ROM → RAM
- jump to known offset



Step 2: Firmware

UEFI or BIOS

time for the boot process

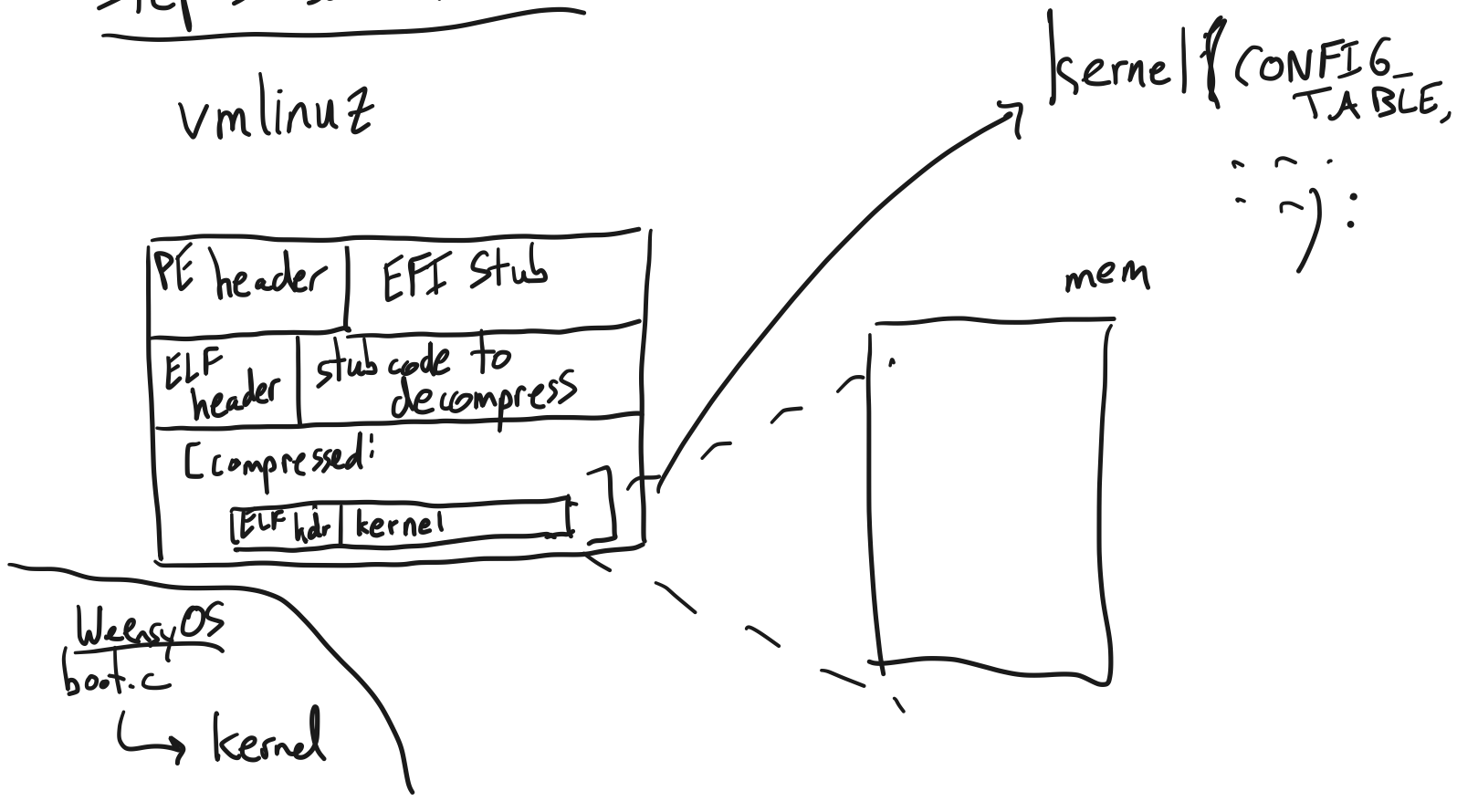
initialize hardware + provide a runtime [illegible])

Core: read → long mode (64-bits, paging)
create an identity-mapped pg table
create an initial IDT
initialize other processor structures
set ctl registers

Peripherals/devices: Initialize (UEFI has drivers)
↳ Disk, USB, Display, Keyboard, Mouse, NIC
Device Tree initialization (≡ CONFIGURATION_TABLE)
Mount VFAT partition → /EFI
Load + execute bootloader

Step 3: boot loader

vmlinuz



Step 4: kernel

Initialize the system:
- moving away from identity-mapped space
- rewrite the interrupt descriptor table (IDT)
- load + configure device drivers
- mount the device that will contain '/'
  - root device
  - [fsck would run here, if FS using fsck]

After initialization, kernel forks and exec init(8).

Step 5: init

$ man 8 init

Init: PID 1

Most distributions: systemd

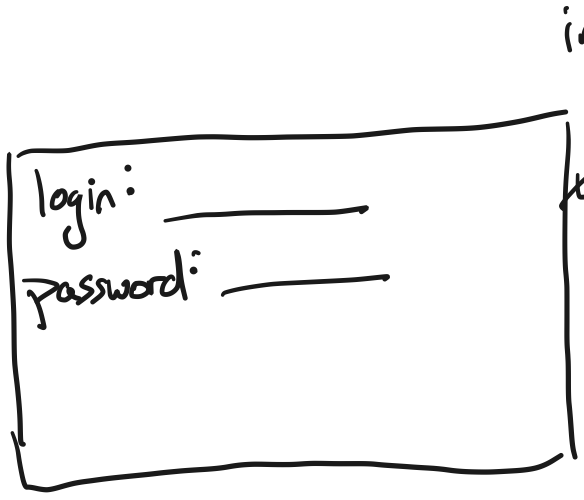
Executes as superuser aka root

(a) Finish initializing the system
(b) Launch the login manager
(c) Relaunch " " when users log out

(a): network: DHCP
graphics: set display resolution (GPU)
power mgmt settings

some of the initial services bind to ports 1...1024.
"tcpserve"

(b):



$ man 1 login

Step 6: login

login runs as root

$ login
<error>

/etc/passwd
/etc/shadow

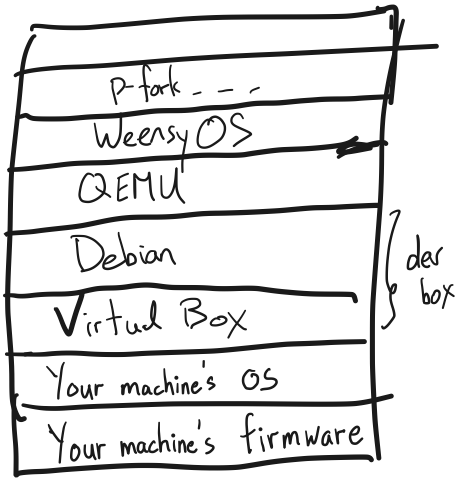
if match:
fork a new process
parent waits using waitpid().
child:
setuid(2)

$ man 2 setuid

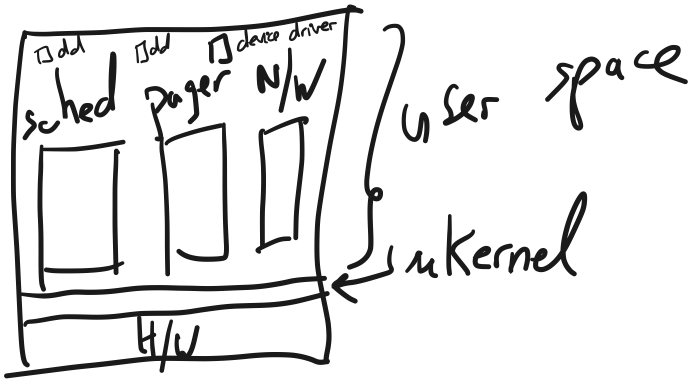
setgid
change directory to user's home directory
look up which shell is user's default
exec() that shell

E. Remarks + observations

- multiple OS-like things



- monolithic vs. microkernels



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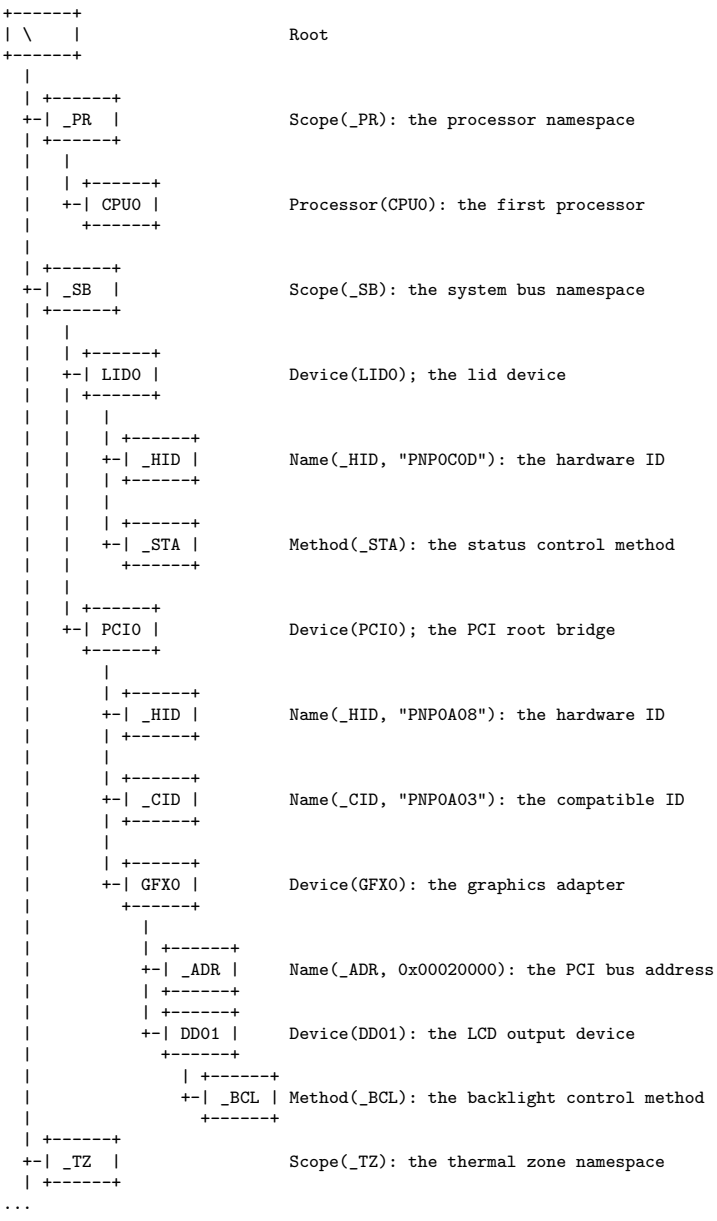
Example Device Tree



Credit: Copied and modified from: https://www.kernel.org/doc/html/latest/firmware-guide/acpi/namespace.html.