CS3510
Operating Systems

OS Boot Process

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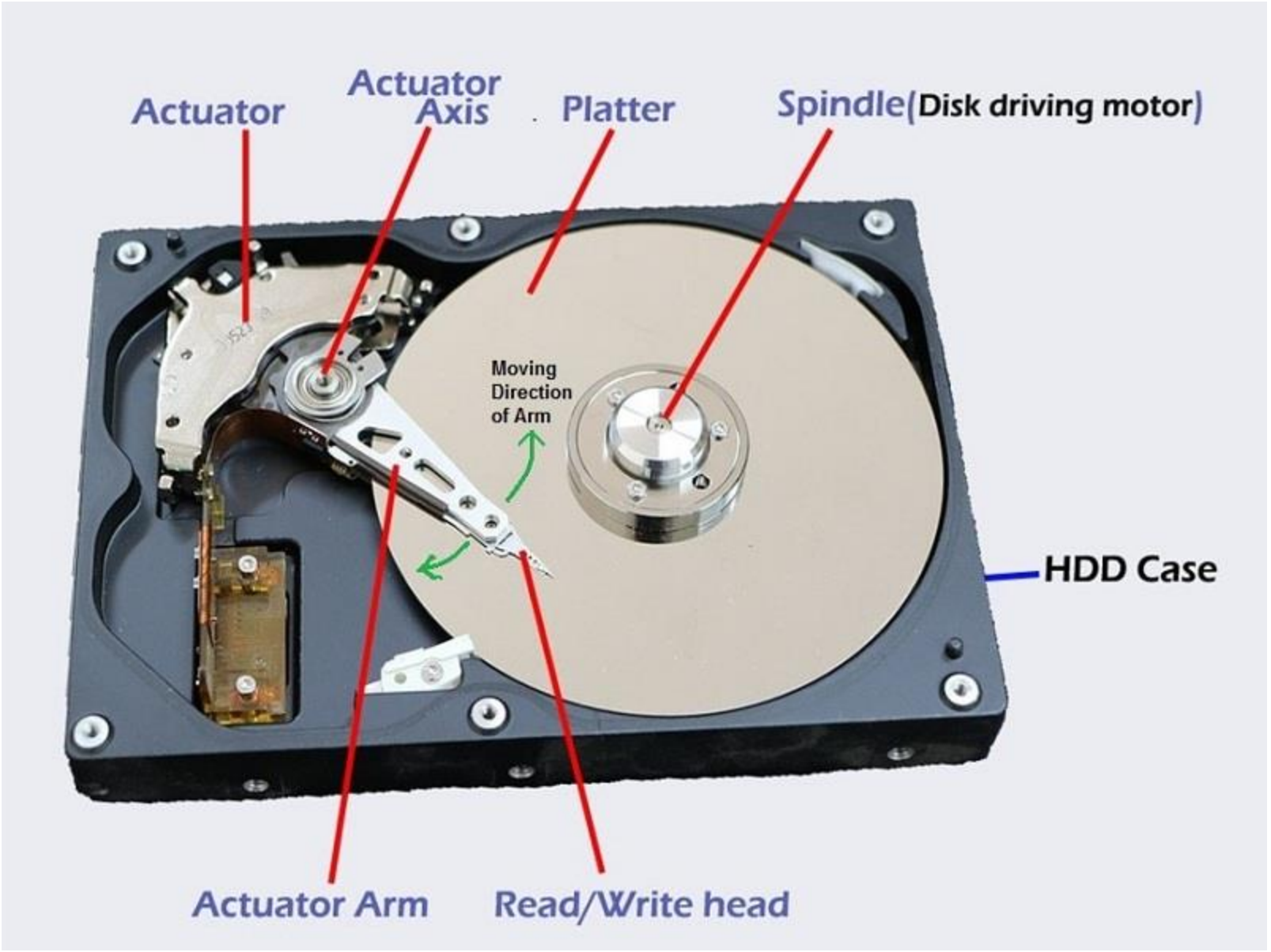
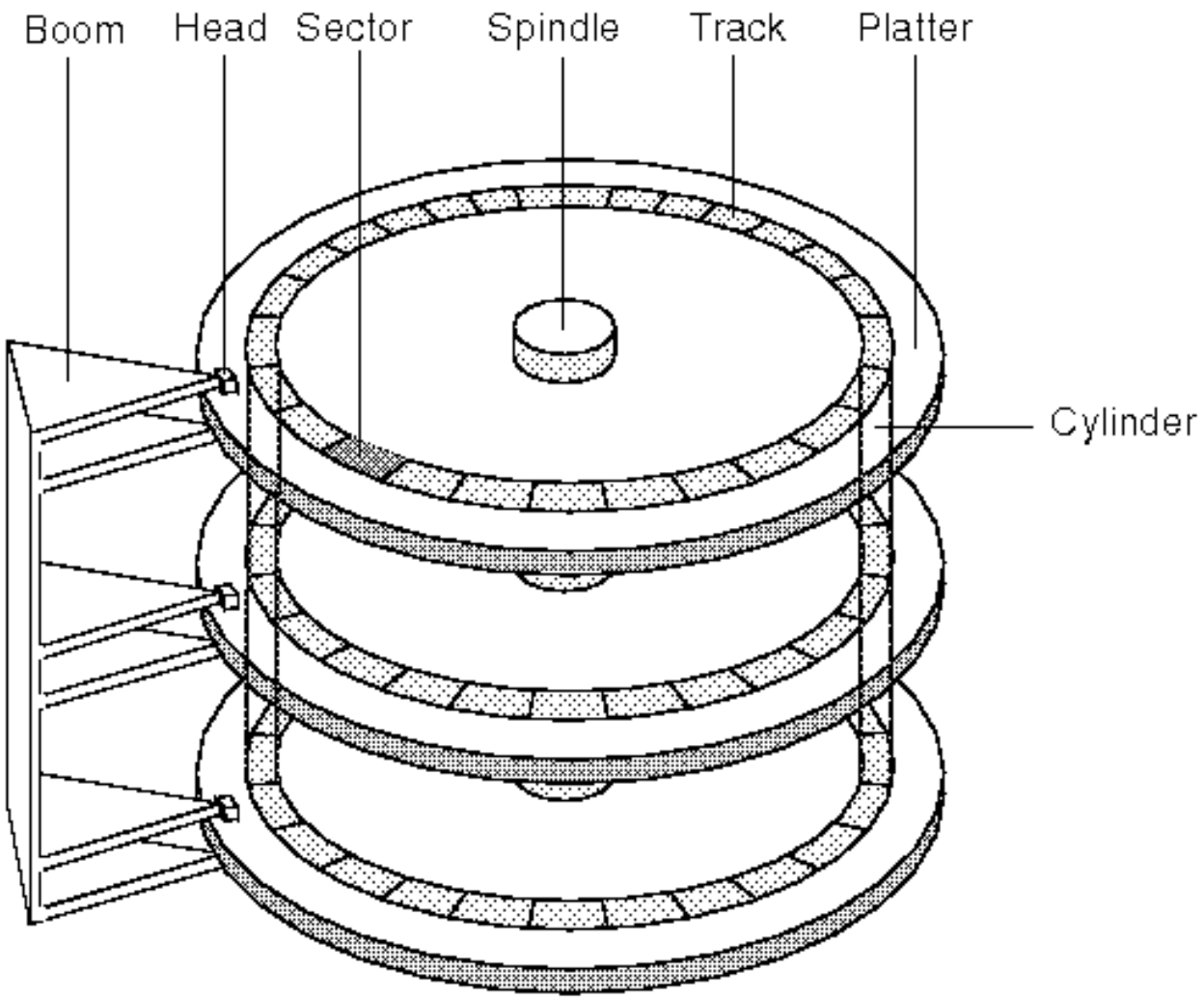
Hard Disk

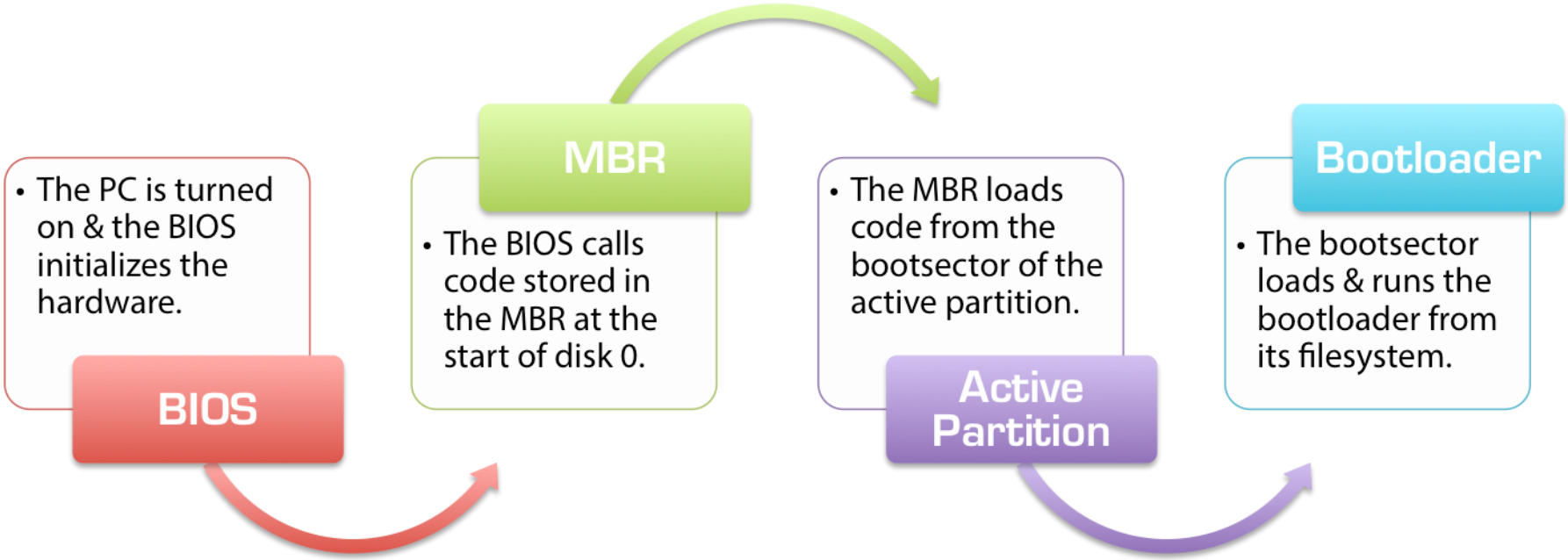

Actuator
Actuator Axis
Platter
Spindle(Disk driving motor)
Moving Direction of Arm
HDD Case
Actuator Arm
Read/Write head

HDD Components



On hard drives and floppies, each sector can hold 512 bytes of data.
Disk Block: a group of 1 or more sectors OS can refer at a time.

BIOS/MBR Boot Process



Credits: NeoSmart Tech

How do you start the OS?

- Your computer has a very simple program pre-loaded in a special ROM (EEPROM) aka firmware:
  - The Basic Input/Output Subsystem (BIOS)
  - Other names: System BIOS, ROM BIOS, PC BIOS
- When the machine boots, CPU first runs the BIOS
  - The lowest level s/w that interfaces with hardware: read KB, write to display, disk I/O, etc
  - It checks which I/O devices (inc. disks) present and whether basic I/O devices working correctly by scanning PCIe/PCI buses (known as POST: Power-On Self Test phase)
  - Configures/initializes basic I/O devices present
  - Then determines boot device (list of boot devices is stored in CMOS memory, in some order)

How do you start the OS?

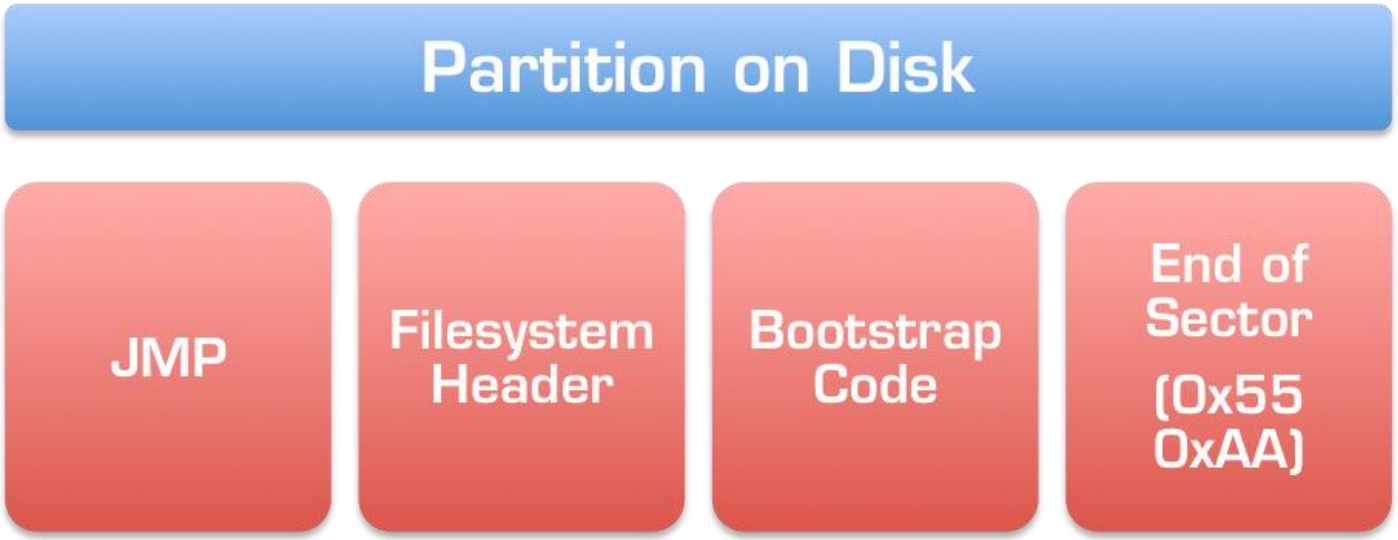
- The BIOS, in turn, loads a "small" OS executable (boot loader-1) aka MBR
  - From hard disk, CD-ROM, or Flash which is located in 1st sector of the bootable disk. Eg. /dev/hda, or /dev/sda
    - » MBR (boot loader-1) is written in a small, special-purpose file system that the BIOS does understand
  - Then transfers control to a standard start address in this MBR image of size 512 Bytes!
  - MBR loads and starts the "big" version of OS (real boot loader from active partition specified in partition table)
    - This multi-stage mechanism is used so that BIOS won't need to understand the file system implemented by the "big" OS kernel
    - File systems are complex data structures and different kernels implement them in different ways (FAT32/NTFS/ext2/ext3)

MBR

Only one partition can be marked as active at a time

Credits: NeoSmart Tech

Active/Boot Partition on Disk



- This is all packed into the first sector (512 Bytes) of the partition
- CPU follows the JMP instruction and executes Bootstrap Code

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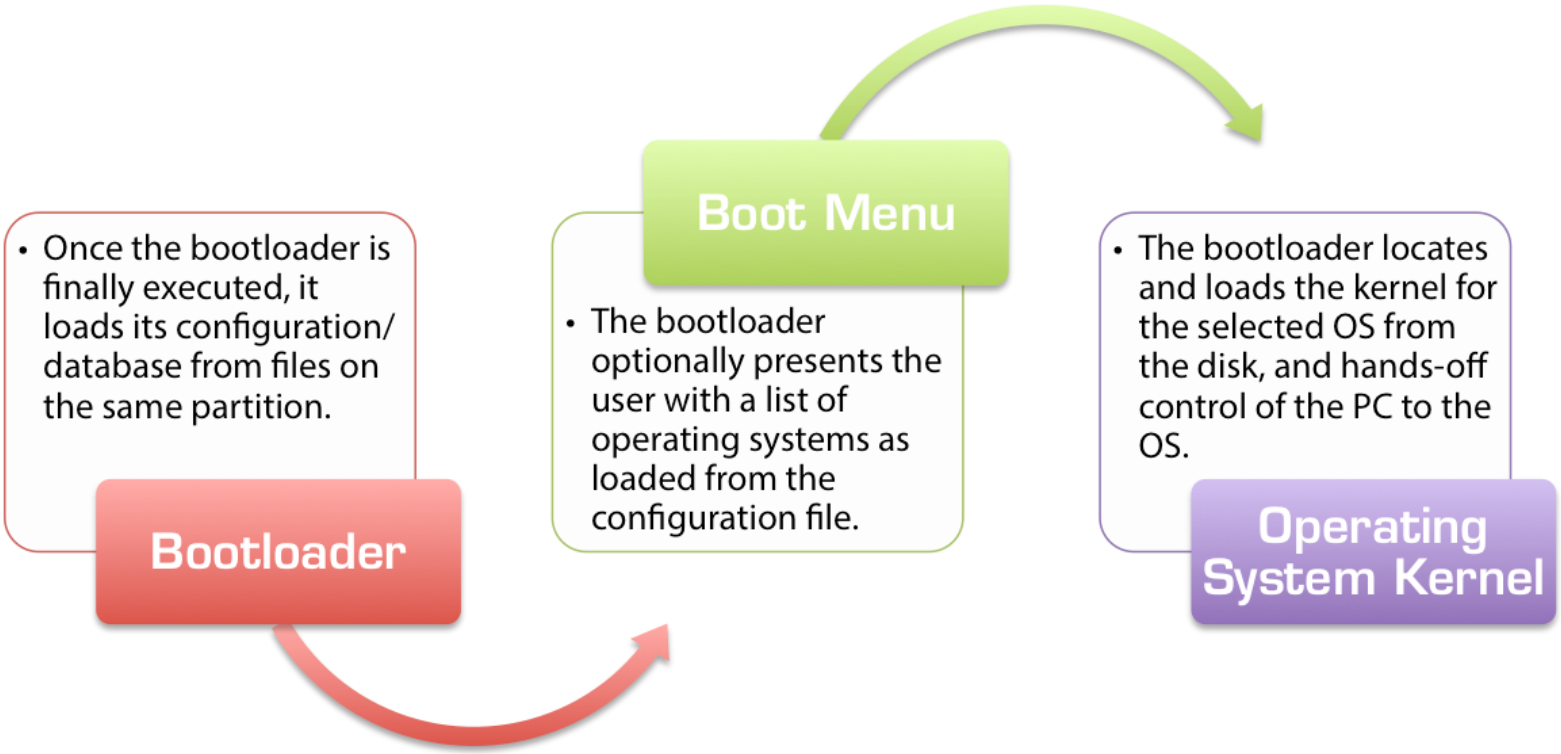
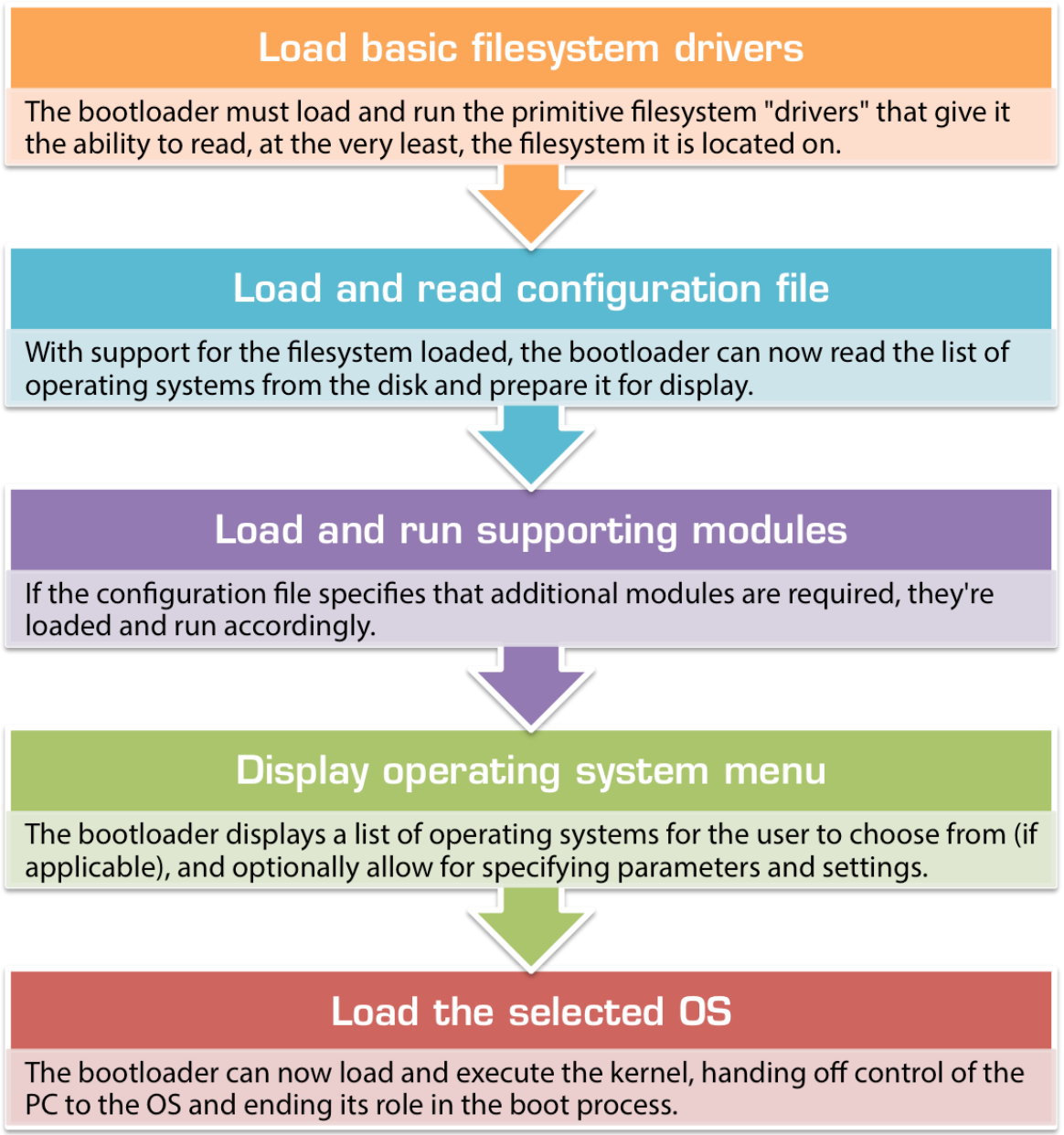
Real Boot Loader



Credits: NeoSmart Tech

Typical Job of Boot Loader



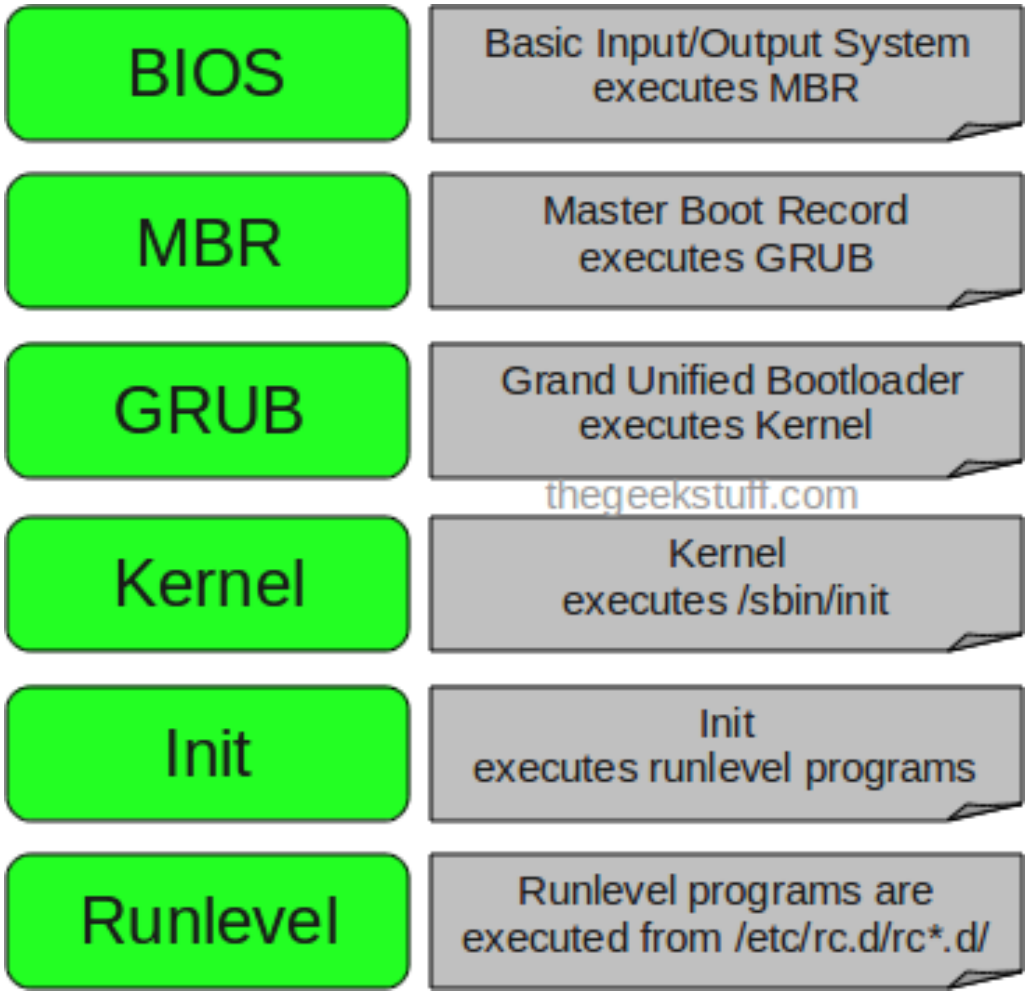
GRUB

- GRUB: Grand Unified Bootloader used in Linux
- GRUB has the knowledge of the filesystem unlike older LILO (LInux LOader)
- Grub config file is at PATH: /boot/grub/grub.conf (or menu.lst)
- GRUB just loads & executes Kernel and initrd images

```
#boot=/dev/sda
default=0
timeout=5
splashimage=(hd0,0)/boot/grub/splash.xpm.gz
hiddenmenu
title CentOS (2.6.18-194.el5PAE)
          root (hd0,0)
          kernel /boot/vmlinuz-2.6.18-194.el5PAE ro root=LABEL=/
          initrd /boot/initrd-2.6.18-194.el5PAE.img
```

- initrd stands for Initial RAM Disk which is used by kernel as temp file system which has essential drivers inside to access disk and other hardware
- Kernel mounts root filesystem /
- Kernel executes /sbin/init user-space program (PID=1)

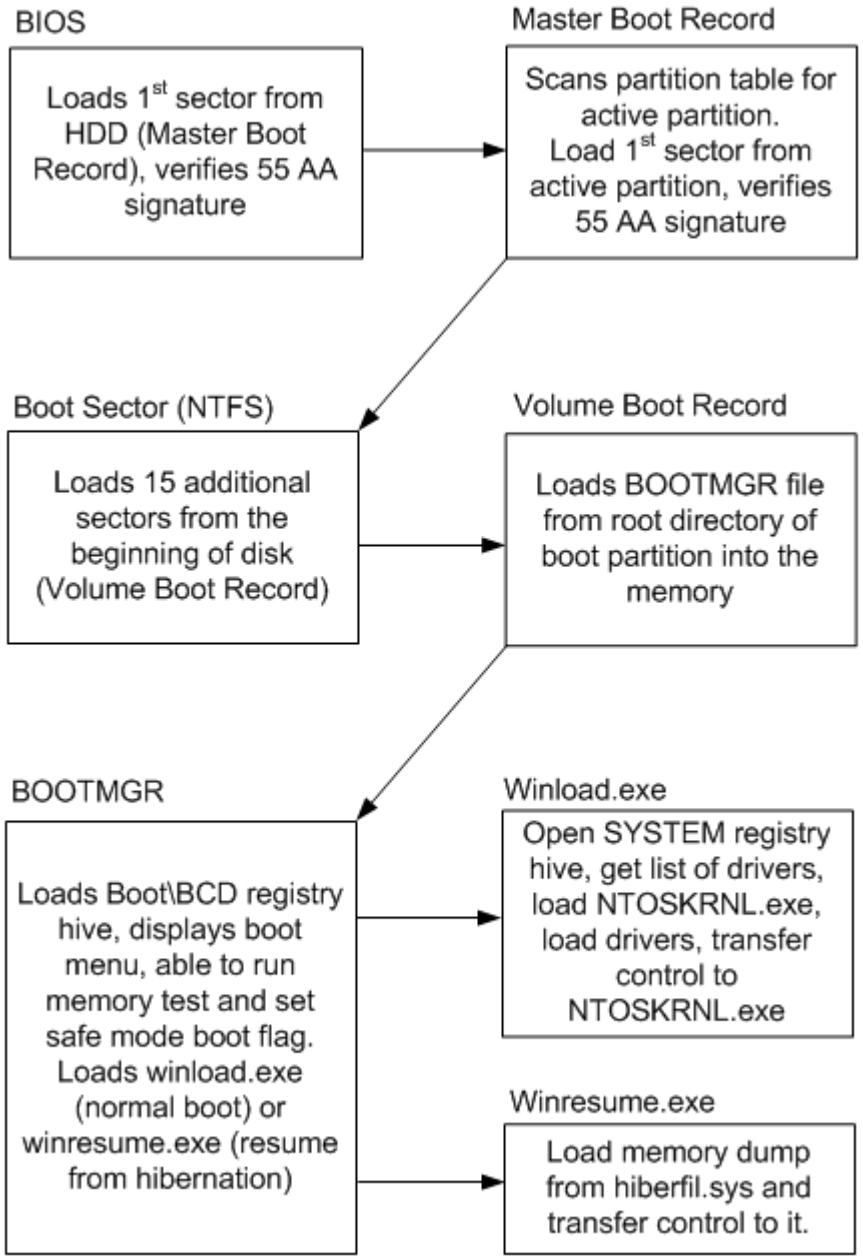
How do you start Linux OS?



man update-rc.d

Source: http://www.thegeekstuff.com/2011/02/linux-boot-process/
Video: http://www.youtube.com/watch?v=mHB0Z-HUauo

How do you start Windows OS?



Comparison of Boot Loaders

NTLDR	BOOTMGR	GRUB(2)
• NTLDR is the default bootloader for Windows NT, 2000, and XP. • BOOT.INI on the active partition contains the list of operating systems and their locations. • NTDETECT.COM is a helper program that runs to detect hardware and identify devices.	• BOOTMGR is the new Windows and is used on Windows Vista, 7, 8, and 10. • The list of operating systems is now read from the BCD file in the BOOT directory on the active partition. • BOOTMGR is self-contained, and does not need any helper programs or routines.	• GRUB is the most-popular bootloader for Linux, though it can boot numerous other OSes as well. • Its boot settings are stored in a file usually called grub.cfg (GRUB2) or menu.lst (GRUB). • GRUB is a modular bootloader, that can load additional modules from disk.

Credits: NeoSmart Tech

Troubleshooting Bootloaders

- EasyBCD: An easy-to-use utility that allows you to set up and configure a dual-boot or multi-boot between Windows, Linux, Mac, FreeBSD, etc

- Super GRUB2 Disk: A bootable GRUB2 disk that can be used to boot into Linux when your GRUB or GRUB2 is misconfigured or malfunctioning

Some interesting queries?

- How does boot process work in dual-boot m/cs like Windows 10 and Ubuntu?
- How does boot process work in Android/iOS?
- Why you need to typically install Windows first and then Linux?
- How about Mac and Linux dual-boot system?
- Why kernel is kept in compressed form in HDD/SSD?
- What is the use of Live-CD, Live USB?
- Secure boot, (Unified Extensible Firmware Interface) UEFI/GPT (GUID Partition Table) boot process in place of BIOS/MBR boot process
- Many many many more …
  - Refer Reading List at the end to find answers!

Administration

- Proctored Quiz-1 on Nov 5th at 12:30pm
- GL platform
- Syllabus: L1-L4

Reading and Viewing Assignments

- http://www.ibm.com/developerworks/library/l-linuxboot/
- https://www.linuxbabe.com/desktop-linux/legacy-bios-vs-uefi-bios
- http://thestarman.narod.ru/asm/mbr/
- http://en.wikipedia.org/wiki/GNU_GRUB & https://www.gnu.org/software/grub/manual/grub/
- http://www.dedoimedo.com/computers/grub-2.html
- http://ubuntuguide.org/wiki/Multiple_OS_Installation

http://en.wikipedia.org/wiki/Master_boot_record

- https://en.wikipedia.org/wiki/Unified_Extensible_Firmware_Interface

* Professor Messer's Linux+ Training:
http://www.youtube.com/playlist?list=PLCDA423AB5CEC8FDB

http://www.youtube.com/watch?v=6eTi2qu4Fb0&feature=c4-overview&list=UUkefXKtInZ9PLsoGRtml2FQ