Booting Up and Shutting Down

Booting Up

- Starting up a computer
  - Load kernel into memory and execute it.
    (1) BIOS load and run the MBR (Master Boot Record)
    (2) MBR searches for the bootable slice (partition) on the disk and then run the code on the slice to load OS.
    (3) kernel is loaded into memory, and then probing, initialization, init process.

- MBR
  - http://en.wikipedia.org/wiki/Master_boot_record
- FreeBSD Handbook
  - http://www.freebsd.org/doc/en/books/handbook/boot.html

MBR – Master Boot Record

- First 512 bytes of disk, outside the FreeBSD area, last 2 Bytes are 0x55AA
  - Corresponding copy in FreeBSD is /boot/boot0 or /boot/mbr

```
nctucs [~] -wangth- ls -l /boot/boot0
-r--r--r--  1 root  Wheel  512 Nov 12  2014 /boot/boot0
nctucs [~] -wangth- ls -l /boot/mbr
-r--r--r--  1 root  Wheel  512 Nov 12  2014 /boot/mbr
```

```
nctucs [~] -wangth- xxd /boot/mbr
00000000: fc31 c08e c08e d88e d0bc 007c be1a 7cbf  .1.........|..|.
00000010: 1a06 b9e6 01f3 a4e9 008a 31f6 bbbe 07b1  ..........1.....
…
…
…
000001d0: 0000 0000 0000 0000 0000 0000 0000 0000  ................
000001e0: 0000 0000 0000 0000 0000 0000 0000 0000  ................
000001f0: 0000 0000 0000 0000 0000 0000 0000 55aa  ..............U.
```

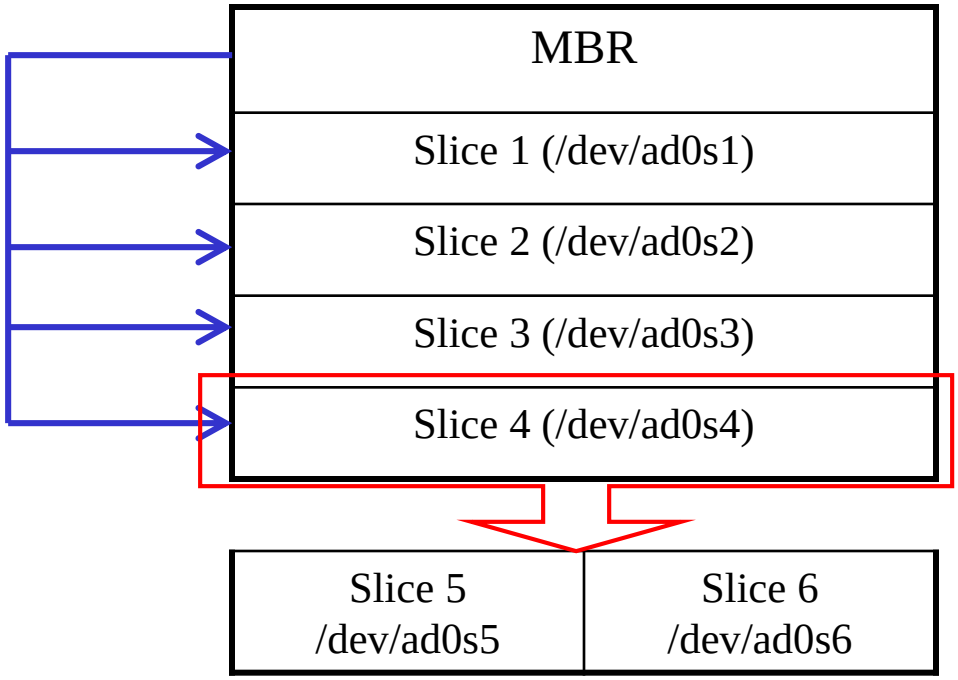
MBR – Master Boot Record

- Responsible to find the boot code on the boot sector of bootable slice.

Fig. boot0 Screenshot

```
F1 Win
F2 FreeBSD

Default: F2
```



Boot Stage One and Stage Two

- boot1 and boot2 (/boot/boot1 + /boot/boot2 = /boot/boot)
  - Members of booting chain
  - Used to run the loader.
  - As MBR, boot1 and boot2 are outside the FreeBSD, and the copy of these two are
    - /boot/boot1
    - /boot/boot2

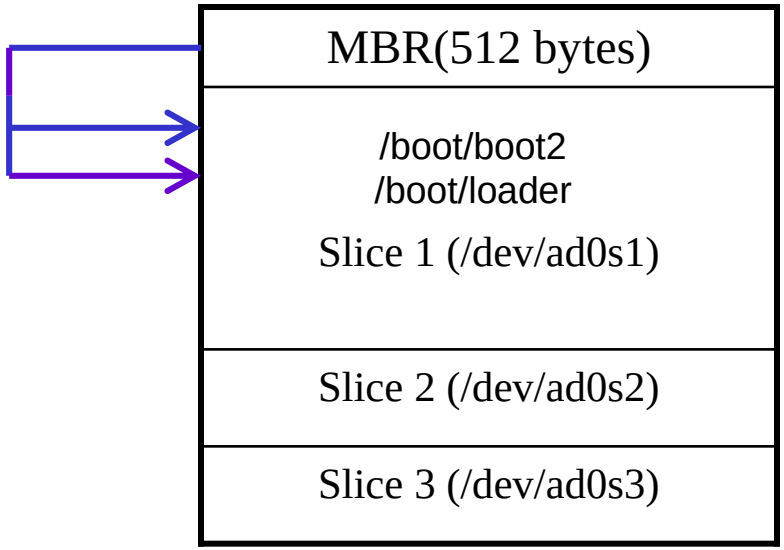


Fig. boot2 Screenshot

```
>> FreeBSD/i386 BOOT
Default: 0:ad(0,a)/boot/loader
boot:
```

Boot Stage Three

Boot Stage Three: The loader

- Provide a user-friendly interface to configure booting choice.
- /boot/loader
  - /boot/loader.rc use processing commands in /boot/loader.4th to manipulate loader.conf
  - Wait for 10 seconds then autoboot

```
/boot/default/loader.conf
```

Default loader behavior

```
/boot/loader.conf
autoboot_delay="10"
password="ooxx"
```

User-defined loader behavior

Files in /boot/

- /boot/mbr (Standard)
  - Simplified version of boot0, blindly boot the partition marked active
- /boot/boot0 (BootMgr)
  - bootmanager
- /boot/boot{1,2}
  - boot1 is very simple, since it can only be 512 bytes in size, and knows just enough about the FreeBSD bsdlabel, which stores information about the slice, to find and execute boot2. /boot/boot2
  - boot2 is slightly more sophisticated, and understands the FreeBSD file system enough to find files on it, and can provide a simple interface to choose the kernel or loader to run /boot/loader
- /boot/loader
  - load the kernel from disk
- /boot/kernel/kernel

MBR recover

- If MBR is overwritten by MS (or others), and you want to replace it with FreeBSD MBR:
  - Boot with CD or Floppy
  - % fdisk -B -b /boot/boot0 ad0

  or
  - % boot0cfg -B /dev/ad0
- If you want to replace it with MS MBR
  - Boot with DOS floppy
  - C:\fdisk /mbr

-B means reinitialize the boot code contained in sector 0 of the disk

-b is used to specify the boot code

Boot in single user mode

OS	command
FreeBSD	Interrupt the boot loader and type "boot -s" Or type "2" in the menu
Linux	LILO: linux single
Solaris	Press "STOP" and "a" to enter the boot PROM and Press "boot -s"

Insecure single user mode

- Single user mode requires no password by default
- When the physical security to the console is considerable,
  - Set console to be insecure in /etc/ttys

```
# name  getty                 type    status      comments
#
# If console is marked "insecure", then init will ask for the root password
# when going to single-user mode.
# console none                  unknown off secure
console none                  unknown off insecure
```

Multibooting (1)

- FreeBSD
  - FreeBSD's boot loader will try to detect bootable partitions
  - You can also declare the bootable partitions explicitly with boot0cfg
    - % boot0cfg -B -m 0x7 ad0

-m means mask

Specify slices to be enabled/disabled,

ex. 0x7 means 0111,boot menu will detect slice1~3 to show the options

Multibooting (2)

- Linux
  - Using lilo or GRUB

```
default 0
timeout 30
fallback 1

# For booting GNU/Linux
    title  GNU/Linux
    kernel (hd1,0)/vmlinuz root=/dev/hdb1
# For booting FreeBSD
    title  FreeBSD
    root   (hd0,2,a)
    kernel /boot/loader
# For booting Windows NT or Windows95
    title Windows NT / Windows 95 boot menu
    root        (hd0,0)
    makeactive
    chainloader +1
```

Steps in the boot process

- Loading and initialization of the kernel
- Device detection and configuration
- Creation of spontaneous system processes
- Operator intervention
- Execution of system startup scripts
- Multiuser operation

Steps in the boot process – Kernel initialization

- Get kernel image into memory to be executed
- Perform memory test
  - Allocate kernel's internal data structures

OS	Kernel image path
FreeBSD	/boot/kernel/kernel
Linux	/boot/vmlinuz
Solaris	/kernel/genunix
SunOS	/vmunix

Steps in the boot process – Hardware configuration

- Devices specified in kernel configuration file
  - Kernel will try to locate and initialize it
- Devices not specified in kernel configuration file
  - Kernel tries to determine the other information by probing the bus
    - If the driver is missing or not responsible to the probe, device is disabled
  - We can load kernel module to support this device.
    - kldload, kldstat, kldunload
    - /boot/kernel/*.ko

/boot/loader.conf

```
if_em_load="YES"
vboxdrv_load="YES"
vboxnet_enable="YES"
```

Steps in the boot process – System Processes

- Spontaneous process
  - Not created by the normal UNIX fork mechanism

OS	Pid 0	Pid 1	Pid 2 and more
FreeBSD	kernel	init	g_event
Linux	-	init	kthreadd, kflushed,kupdate Kpiod,kswapd
SunOS	sched	init	pageout

Steps in the boot process – Operator intervention

- Manual boot only (boot into single)
  - Only the root partition is mounted and mounted as read only
    - mount -u /
    - mount -a -t ufs
    - swapon -a

---

mount -u indicates that the status of an already mounted file system should be changed

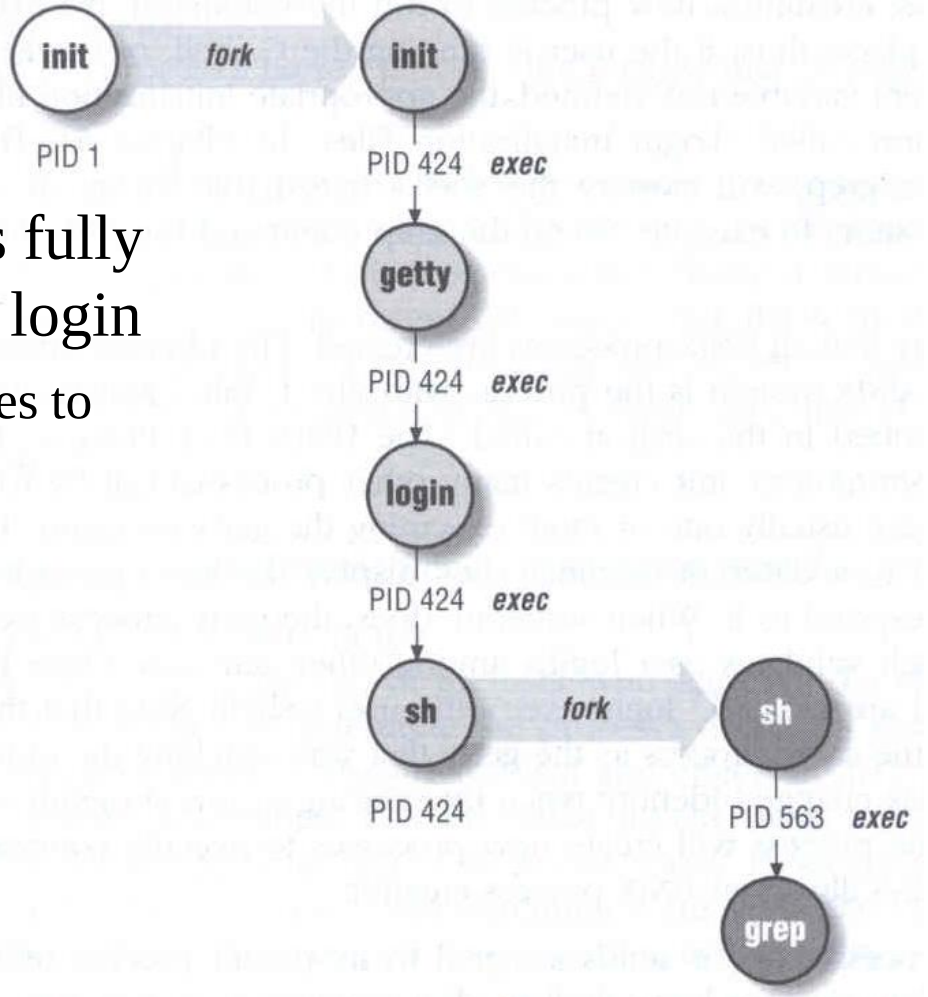
mount -a -t means mount all ufs file systems

Steps in the boot process – Execution of startup scripts

- The startup scripts are selected and run by **init**
- Typical works are:
  - Setting the name of the computer
  - Setting the time zone
  - Checking the disk with fsck
  - Mounting the system's disks
  - Removing files from /tmp directory
  - Configuring network interface
  - Starting up daemons and network services

Steps in the boot process – multiuser operator

- From now on, the system is fully operational, but no one can login
  - init will spawn getty processes to listen for login



FreeBSD startup scripts

- init will run /etc/rc
- /etc/rc will reads the following configuration
  - /etc/defaults/rc.conf
  - /etc/rc.conf
  - /etc/rc.d
- Manual: rc(8)

Ways to shut down or reboot

- Turning off the power ← Please Don't !
- Using the shutdown command
  - Using the halt and reboot command
    - halt = shutdown -h
    - reboot = shutdown -r
- Sending init a TERM signal
  - kill -TERM 1
  - Using telinit to change init's level
  - Killing init

Ways to shut down or reboot – shutdown command

OS	Pathname	Time	R	H	S	F
FreeBSD	/sbin/shutdown	time	-r	-h		
Linux	/sbin/shutdown	time	-r	-h		
Solaris	/usr/sbin/shutdown	-g*secs*	-i6	-i0	-is	
SunOS	/usr/sbin/shutdown	+mins	-r	-h		-f

R=Reboot, H=Halt, S=Enter Single user mode, F=Skip fsck

time format can be

+m

hh:mm ➔linux

yymmddhhmm ➔ FreeBSD

Poweroff ?

- In Linux,
  - You can use “poweroff” to shutdown the system and turn the power off.
- ACPI / APM
  - Advanced Configuration and Power Management
  - Advanced Power Management
- In FreeBSD,

  (1) Try “shutdown -p now”

  (2) Compile this into kernel

  device apm0 at nexus?flag 0x20

  (3) Rebuild the kernel

  (4) Edit /etc/rc.conf

  apm_enable="YES"

  apmd_enable="YES"

  (5) Reboot

  (6) Try “shtudown -p now”

Appendix

System-V

Startup Scripts

- SystemV-style startup scripts
  - sun, linux
  - /etc/init.d/
  - /etc/rc.d/rc*n*.d/
  - Each script is responsible for one daemon or one aspect of system.

Example: sshd in SunOS

```
case "$1" in
'start')
        if [ -x /usr/local/sbin/sshd ]; then
                echo "Starting the secure shell daemon"
                /usr/local/sbin/sshd &
        fi
        ;;

'stop')
        echo "Stopping the secure shell daemon "
        pkill -TERM sshd
        ;;
*)
        echo "Usage: /etc/init.d/sshd { start | stop }"
        ;;
esac
exit 0
```

Startup Scripts – SystemV-style startup scripts (1)

- Run-level
  - /etc/inittab
  - init follow the inittab from level 0 to level k

Example: inittab in sun1

Run Level	Startup scripts	Meaning
0	/etc/rc.d/rc0.d/	Halt
1	/etc/rc.d/rc1.d/	Single User Mode
2	/etc/rc.d/rc2.d/	Multiuser without NFS
3	/etc/rc.d/rc3.d/	Full multiuser mode
4	/etc/rc.d/rc4.d/	Unused
5	/etc/rc.d/rc5.d/	X11
6	/etc/rc.d/rc6.d/	reboot

Startup Scripts – SystemV-style startup scripts (2)

- /etc/rc.d/rc*n*.d/
  - When init transitions from lower run level to higher one,
    - it runs all the scripts that start with "S" in ascending order with "start" argument
  - When init transitions from high run level to lower one,
    - it runs all the scripts that start with "K" in descending order with "stop" argument

```
[tytsai@linux5 /etc]$ cd rc.d
[tytsai@linux5 rc.d]$ ls
init.d  rc0.d  rc2.d  rc4.d  rc6.d     rc.sysinit
rc      rc1.d  rc3.d  rc5.d  rc.local
[tytsai@linux5 rc.d]$ cd rc2.d
[tytsai@linux5 rc2.d]$ ls
K03rhnsd       K24irda           K50xinetd  K86nfslock    S17keytable  S85gpm
K05atd         K28amd            K65identd  K87portmap    S20random    S90crond
K05saslauthd   K30spamassassin   K73ypbind  K95firstboot  S24pcmcia    S90xfs
K12cWnn        K34yppasswdd      K74nscd    K95kudzu      S26apmd      S95anacron
K12tWnn        K35winbind        K74ntpd    S08iptables   S28autofs    S99local
K20nfs         K44rawdevices     K74ypserv  S09isdn       S55sshd      S99squid
K20rstatd      K50snmpd          K74ypxfrd  S10network    S60lpd
K20rusersd     K50snmptrapd      K75netfs   S12syslog     S80sendmail
[tytsai@linux5 rc2.d]$
```

Startup Scripts – SystemV-style startup scripts (3)

- If you write a daemon and want init to start/stop it,
  - write a script and put in /etc/init.d
  - make suitable symbolic link in rc*n*.d
    - **ln –s /etc/init.d/initiald /etc/rc2.d/S61initiald**
    - **ln –s /etc/init.d/initiald /etc/rc0.d/K33initiald**

Startup Scripts – SystemV-style startup scripts (4)

- In linux
  - /etc/sysconfig/ contain config data used by startup scripts
  - Ex:
    - network
      - Set global network option (hostname, gateway, ..)
        - HOSTNAME=linux5
        - GATEWAY=140.113.209.254
    - network-scripts/
      - Contain accessory scripts and network config file
      - EX: ifcfg-eth0
        - DEVICE=eth0
        - BROADCAST=140.113.209.255
        - IPADDR=140.113.209.145
        - NETMASK=255.255.255.0
        - ONBOOT=yes

Ways to shut down or reboot – telinit

- Only for SystemV systems
  - Linux, Solaris
    - % telinit 1