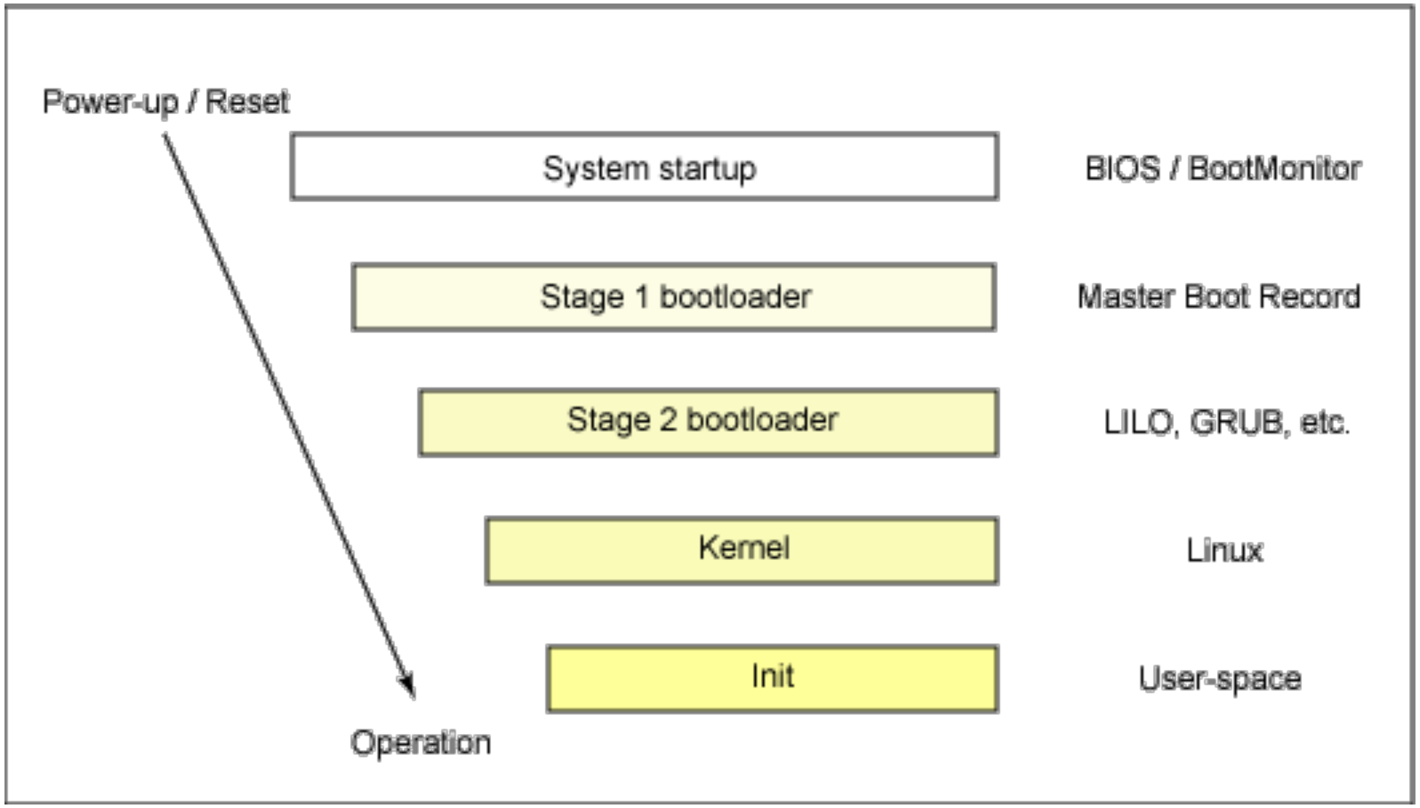
SYSTEM ADMINISTRATION BOOTING AND SHUTTING DOWN

UNIX Programming 2014 Fall by Euiseong Seo

Bootstrapping

- Starting up a computer
- Boot time is especially vulnerable
  - Misconfiguration, missing or unreliable equipment and damaged filesystems result in boot failure
- Understanding booting procedure is essential for UNIX programmers and administrators

Basic Procedure



* From Inside the Linux boot process, IBM

Steps to Boot

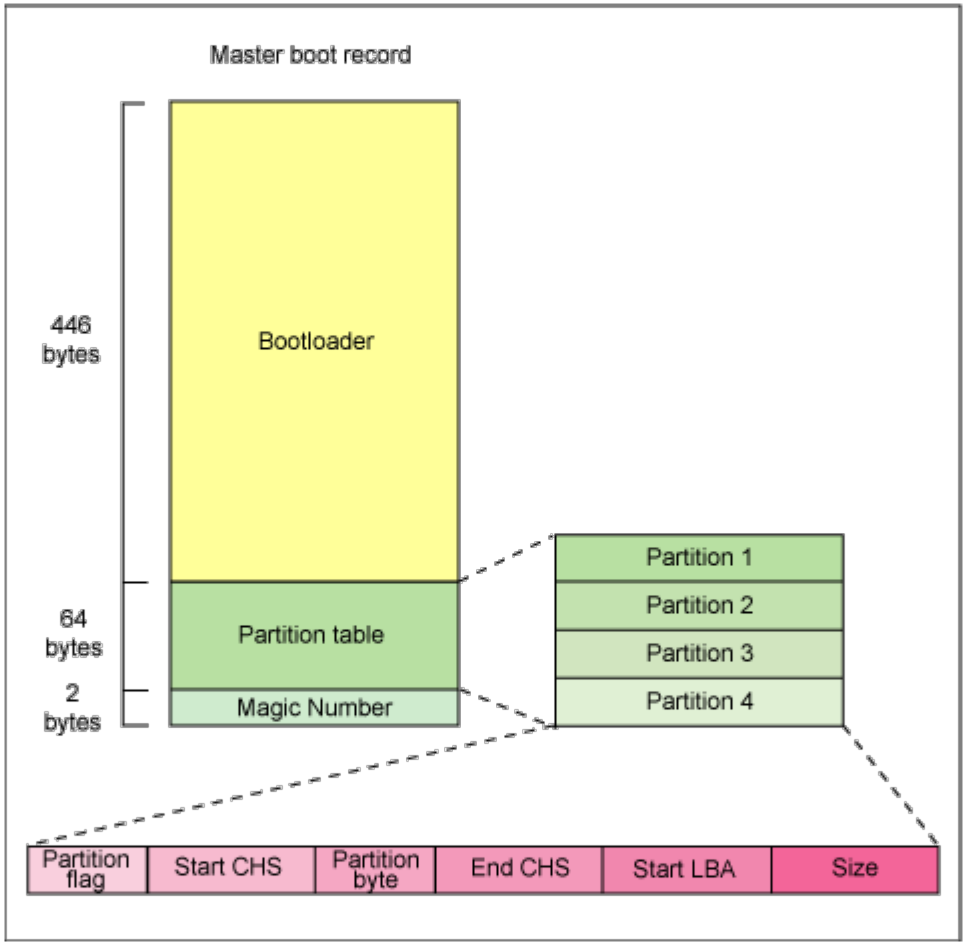
1. Reading of the boot loader from the master boot record
2. Loading and initialization of the kernel
3. Device detection and configuration
4. Creation of kernel process
5. Administrator intervention (single-user mode only)
6. Execution of system startup scripts

BIOS

- When a machine boots,
  it begins by executing code stored in ROM
  - BIOS (Basic Input/Output System)
- BIOS
  - Knows about some of devices on motherboard
  - Conducts POST (Power-on Self Test)
  - Provides services to OS later
- Boot device order is normally user-configurable
  - MBR of a boot device will be loaded by BIOS
- MBR (master boot record)
  - First sector of a boot device (Sec. 1 of Cyl. 0, Head 0)
  - 512 byte long

Boot Loader

- First 446 bytes
  - Primary boot loader
  - Executable text
  - Error message text
- Next 64 bytes
  - Partition table
  - For up to 4 partitions
  - 16 bytes each
- Last 2 bytes
  - Magic 0XAA55



Anatomy of the MBR

* From Inside the Linux boot process, IBM

Boot Loader

- Primary boot loader
  - To find and load the secondary boot loader (stage 2)
  - Looking through partition table to find an active one
  - Secondary boot loader is located in the boot record of the active partition
- Secondary boot loader (kernel loader)
  - To load the kernel image and optional *initrd*, an initial RAM disk
  - This style is called chain-loading
- Kernel image
  - Compressed kernel + setup code
  - Context will be switched to the setup code after loading

GRUB

- GRUB
  - De-facto standard boot loader set
  - 3 stage boot loader (MBR->PBR->Filesystem)
- Grub configuration file is located in /boot/grub
- Grub loads the configuration file at every boot
  - To allow dynamic changes
- Example *grub.cfg*

```
default=0
timeout=10 splashimage=(hd0,0)/boot/grub/splash.xpm.gz
title Red Hat Enterprise Linux Server (2.6.18-92.1.10.el5)
root (hd0,0)
kernel /vmlinuz-2.6.18-92.1.10.el5 ro root=LABEL=/
title Windows XP
rootnoverify (hd0,0)
chainloader +1
```

Kernel Initialization

- HW initialization
  - Peripheral device initialization
  - Device drivers for peripherals are stored in *initrd*
- Kernel parameters
  - Command line arguments to the kernel
  - Boot loader passes them to the kernel during boot up
  - Example
    - /boot/vmlinuz root=/dev/sda1 mem=256MB
  - See https://www.kernel.org/doc/Documentation/kernel-parameters.txt for more information

Init and Run Levels

- *Init*
  - The first process that a kernel creates
  - Root or parent process of all processes
  - Traditionally, */sbin/init*
  - Executes shell scripts corresponding to the run level
- Run level
  - System operation mode
    - Safe/Safe with network/Command prompt/Normal in Windows systems
  - /etc/rc*.d/ contains shell scripts to run at each run level
    - Eg) Shell scripts in /etc/rc1.d/ will be executed during boot up at run level 1

Init and Run Levels

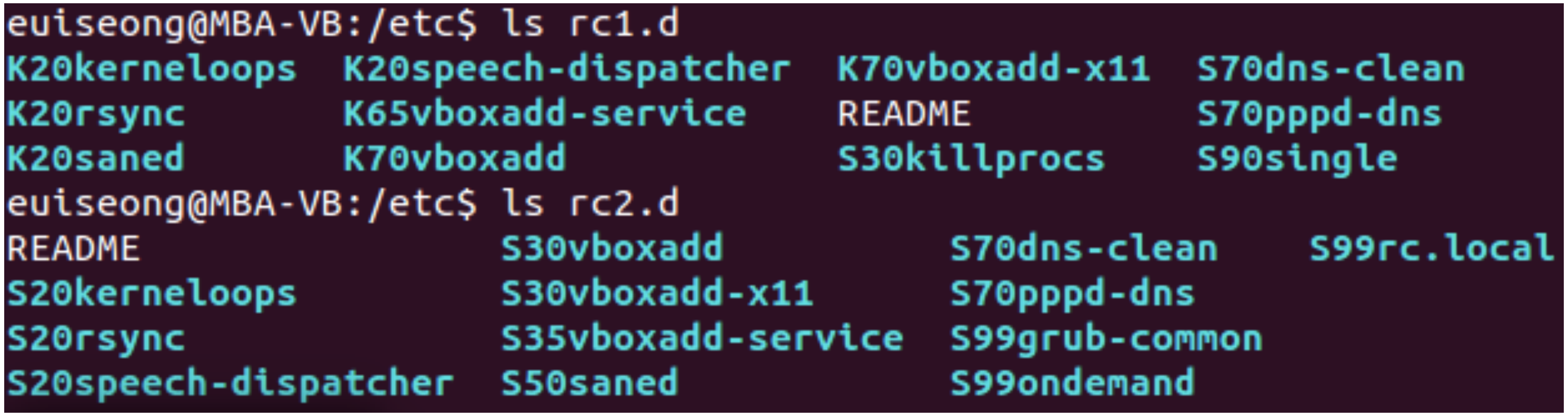
- Ubuntu run level definition
  - 0: Halt
  - 1: Single-user mode
  - 2: GUI multi-user mode with networking
  - 3-5: Undefined but configured the same as level 2
  - 6: Reboot
- Default run level is defined in /etc/init/rc-sysinit.conf
- Check runlevel
  - *runlevel*
- Change runlevel
  - *telinit N*
  - *init N*
- How can we change the run level during boot up?

Creation of Kernel Processes

- Some processes are not forked by init, but by kernel
- Kernel processes
  - In charge of important kernel-internal tasks
  - Identifiable by the brackets around their names in *ps*
  - You can't kill these processes
- Some common kernel processes
  - kjournald
    - Commits filesystem journal updates to disk
  - kswapd
    - Swaps processes when physical memory is low

Startup Scripts

- Scripts in rc*.d

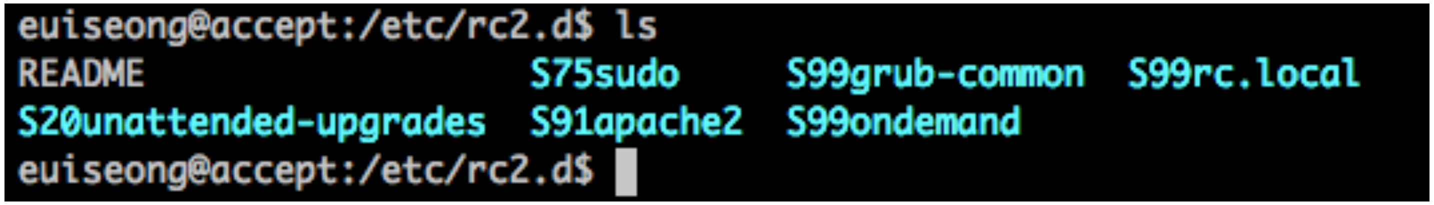


```
euiseong@MBA-VB:/etc$ ls rc1.d
K20kerneloops  K20speech-dispatcher  K70vboxadd-x11  S70dns-clean
K20rsync       K65vboxadd-service    README          S70pppd-dns
K20saned       K70vboxadd            S30killprocs    S90single
euiseong@MBA-VB:/etc$ ls rc2.d
README                S30vboxadd          S70dns-clean    S99rc.local
S20kerneloops         S30vboxadd-x11      S70pppd-dns
S20rsync              S35vboxadd-service  S99grub-common
S20speech-dispatcher  S50saned            S99ondemand
```

  - Symbolic links to the scripts in /etc/init.d/
  - S*nn* means the service should be started with the priority of nn (the smaller, the faster)
  - Knn menas the service should be stopped with the priority of nn

Startup Scripts

- Another example



```
euiseong@accept:/etc/rc2.d$ ls
README                      S75sudo      S99grub-common   S99rc.local
S20unattended-upgrades     S91apache2   S99ondemand
euiseong@accept:/etc/rc2.d$ 
```

- When you want start a service defined in /etc/init.d at the current level, just create a symbolic link in the rc directory in the form of *SnnServiceName*
- Quiz
  - If you want to make your system back up all temporary files in /tmp to a backup file, of which name is tmp-YYYY-MM-DD, in /backup/ after every boot up, how can you accomplish this?

Boot Process Completion

- System is fully functional after executing start up scripts in the `rc` directory
- init process stays and manages system run level

Rebooting and Shutting Down

- When your Windows system gets unresponsive or unstable, what is your first solution?
  - Blind rebooting is less effective in UNIX systems (Why?)
- Rebooting must be done gently not to corrupt filesystems and databases
- shutdown *[OPTION] TIME [message]*
  - The most gentle way to shut down or reboot
  - -h: halt after TIME
  - -p: halt and power down after TIME
  - -r: reboot after TIME
  - -k: just print out message and disable following logins