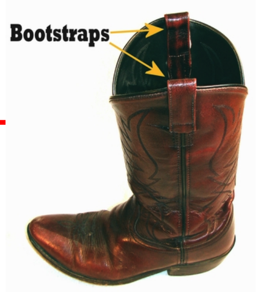
CSE 265: System and Network Administration

- System startup and shutdown
  - Bootstrapping
  - Booting PCs
  - Boot loaders
  - Booting into single user mode
  - Startup scripts
  - Rebooting and shutting down

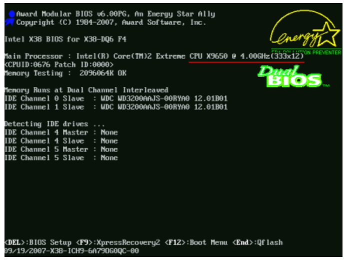
Bootstrapping

i.e., starting the computer



- System is particularly vulnerable
- Steps in boot process
  - *Execution of boot code in ROM*
  - Loading and initialization of kernel
  - Device detection and configuration
  - Creation of spontaneous system processes
  - Operator intervention (manual boot only)
  - **Execution of system startup scripts**
  - Multiuser operation

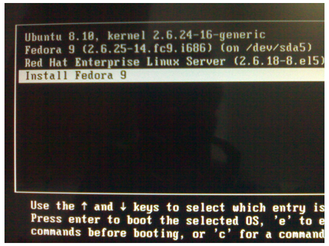
Booting PCs



```
Award Modular BIOS v6.00PG, An Energy Star Ally
Copyright (C) 1984-2007, Award Software, Inc.

Intel X38 BIOS for X38-DQ6 F4

Main Processor : Intel(R) Core(TM)2 Extreme CPU X9650 @ 4.00GHz(333x12)
<CPUID:0676 Patch ID:0000>
Memory Testing :  2096064K OK

Memory Runs at Dual Channel Interleaved
IDE Channel 0 Slave  : WDC WD3200AAJS-00RYA0 12.01B01
IDE Channel 1 Slave  : WDC WD3200AAJS-00RYA0 12.01B01

Detecting IDE drives ...
IDE Channel 4 Master : None
IDE Channel 4 Slave  : None
IDE Channel 5 Master : None
IDE Channel 5 Slave  : None

<DEL>:BIOS Setup <F9>:XpressRecovery2 <F12>:Boot Menu <End>:Qflash
09/19/2007-X38-ICH9-6A79OG0QC-00
```

- PC starts by executing code in ROM (the BIOS)
  - Usually BIOS has a configuration mode with special keypress during boot
  - Tries to load first 512B of the boot disk – the Master Boot Record
  - MBR contains program to specify which partition from which to load the secondary boot program (the “boot loader”)

Boot loaders

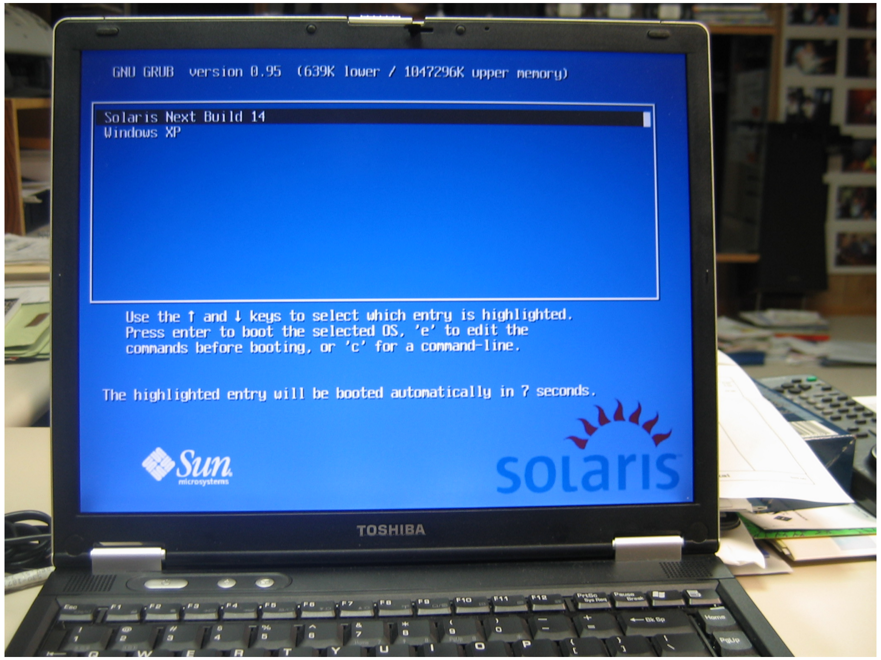


```
Ubuntu 8.10, kernel 2.6.24-16-generic
Fedora 9 (2.6.25-14.fc9.i686) (on /dev/sda5)
Red Hat Enterprise Linux Server (2.6.18-8.el5)
Install Fedora 9

Use the ↑ and ↓ keys to select which entry is
Press enter to boot the selected OS, 'e' to e
commands before booting, or 'c' for a command
```

- Load and start the kernel
  - Could be one of many kernels or OSes!
  - MBR set to load the master boot loader
  - Each disk partition can have its own second stage loader
- LILO is an older Linux boot loader
- GRUB is the modern Linux boot loader
  - Supports most OSes, not just Linux

Hardware configuration

- Kernel examines system environment
- Tries to locate and initialize every device that it is supposed to have
- Hardware configuration info in kernel is often underspecified
  - Probes buses for devices and asks drivers for info (i.e., which interrupt, which PCI address, etc.)
- Drivers can sometimes be added later



```
GNU GRUB  version 0.95  (639K lower / 1047296K upper memory)

Solaris Next Build 14
Windows XP

Use the ↑ and ↓ keys to select which entry is highlighted.
Press enter to boot the selected OS, 'e' to edit the
commands before booting, or 'c' for a command-line.

The highlighted entry will be booted automatically in 7 seconds.
```

Operator intervention (manual booting)

- Kernel tells **init** if single-user mode is desired
- Typically requests root password
- Single-user shell is similar to normal shell
  - Often fewer disk partitions mounted (such as root partition only)
    - Other partitions must be mounted by hand if needed
  - Daemons typically not running
  - Can run **fsck** if needed to repair filesystems
- When you exit, system attempts to boot into multi-user mode

Example multi-boot laptop GRUB

```
# grub.conf generated by anaconda
#
# Note that you do not have to rerun grub after making changes
#   to this file
# NOTICE:  You have a /boot partition.  This means that
#          all kernel and initrd paths are relative to /boot/, eg.
#          root (hd0,2)
#          kernel /vmlinuz-version ro root=/dev/hda6
#          initrd /initrd-version.img
#boot=/dev/hda
default=1
timeout=10
splashimage=(hd0,2)/grub/splash.xpm.gz
title Red Hat Linux (2.4.20-8)
        root (hd0,2)
        kernel /vmlinuz-2.4.20-8 ro root=LABEL=/
        initrd /initrd-2.4.20-8.img
title Microsoft XP
        rootnoverify (hd0,1)
        chainloader +1
```

Multiuser operation

- After initialization scripts run, system is fully operational, except that no one can log in
- init spawns
  - getty processes that listen on terminals (including console)
  - graphical login such as xdm or gdm if configured
- init later responsible for moving from one runlevel to the next

Booting into single user mode

- Need to modify a GRUB entry to include the keyword single, e.g.,

```
title Red Hat Linux (2.4.9-21) single user mode
    root (hd0,0)
    kernel /vmlinuz-2.4.9-21 ro root=/dev/hda6 single
    initrd /initrd-2.4.9-21.img
```

- Can be done at run-time
- Better is to set up a single-user mode entry ahead

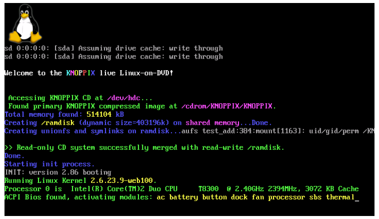
"Spontaneous" system processes

- Not created via usual fork mechanism
- init is always process 1
- Plus special memory and kernel processes
  - kflushd, kupdate, kpiod, kswapd
  - Not really processes (portions of kernel)
- Everything else (other processes) are started via init

Optionally view such processes with "ps -aux | more"

Startup scripts

- At the end of single user mode, init executes system startup scripts
- Typical tasks:
  - Setting name of computer
  - Setting the time zone
  - Checking the disks with fsck
  - Mounting the system disks
  - Removing old files from /tmp
  - Configuring network interfaces
  - Starting daemons and network services



```
sd 0:0:0:0: [sda] Assuming drive cache: write through
sd 0:0:0:0: [sda] Assuming drive cache: write through

Welcome to the KNOPPIX live Linux-on-DVD!


 Accessing KNOPPIX CD at /dev/hdc...
 Found primary KNOPPIX compressed image at /cdrom/KNOPPIX/KNOPPIX.
Total memory found: 514104 kB
Creating /ramdisk (dynamic size=403196k) on shared memory...Done.
Creating unionfs and symlinks on ramdisk...aufs test_add:384:mount[1163]: uid/gid/perm /KN

>> Read-only CD system successfully merged with read-write /ramdisk.
Done.
Starting init process.
INIT: version 2.86 booting
Running Linux Kernel 2.6.23.9-web100.
Processor 0 is  Intel(R) Core(TM)2 Duo CPU     T8300  @ 2.40GHz 2394MHz, 3072 KB Cache
ACPI Bios found, activating modules: ac battery button dock fan processor sbs thermal_
```

/etc/sysconfig

- Additional scripts and configuration for Red Hat
- Stores networking configuration
  - /etc/sysconfig/network-scripts/ifcfg-ethX
- Scripts can be used to individually start or stop network interfaces
  - /etc/sysconfig/network-scripts/ifdown eth0
  - /etc/sysconfig/network-scripts/ifup eth0

init and run levels

- Seven run levels defined
  - 0 is for system shut down
  - 1 or S is single user mode
  - 2-5 are multi-user levels
    - In RH/Fedora, 3 is networked multi-user, 5 is X-windows
  - 6 is the reboot level
- /etc/inittab specifies what init has to do in each level
- During booting, system goes from 0 to default run level (in /etc/inittab), and calls /etc/rc.d/rc for each change

Optionally view /etc/inittab

Rebooting and shutting down

- Not needed as often as in consumer OSes
  - Needed for
    - Adding or removing hardware
    - Change to boot configuration
      - Including new kernel
    - System really wedged
  - Ways to reboot or shutdown
    - Use the **shutdown** command
    - Use the **halt** and **reboot** commands
    - Use **telinit** to change init's run level
    - Use **poweroff** to tell system to turn off (missing from USLAH)
    - Use hardware reset switch or turn off power (last resort!)

init and rc scripts

- Startup scripts live in /etc/init.d/ (linked to /etc/rc.d/init.d/)
- Each script starts, stops, restarts some service
- /etc/rc.d/rc knows to look in /etc/rc.d/ where there is a subdirectory for each runlevel
  - Symbolic links are made to the actual script in /etc/init.d/ within each subdirectory for the services appropriate for that level, e.g.
    - ln -s /etc/init.d/sshd /etc/rc3.d/S99sshd
- Script names indicate order of Start or Kill

Halt; reboot

- halt
  - called by **shutdown -h**
  - logs the shutdown
  - kills non-essential processes
  - executes sync
    - waits for filesystem to finish writes
    - puts IDE drives in standby mode (flushing write caches)
  - halts the kernel
- reboot
  - called by **shutdown -r**
  - similar to halt, but tells kernel to reboot system

Turning off power

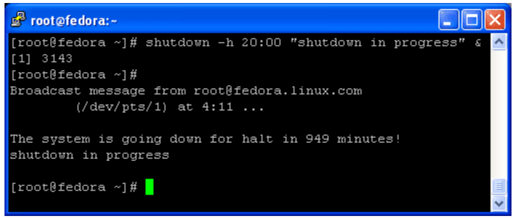
- Turning off power can cause data loss and leave filesystem in an inconsistent state
  - Linux (and other modern OS) filesystems buffer changes in memory, and only sporadically write them back to disk
    - Makes disk I/O faster, but more sensitive to loss
- Uninterrupted power is important
- Sometimes it is necessary to remove power
  - Flood, fire, etc.

telinint; poweroff

- telinit
  - Directs init to go to a specific run level
    - telinit 1 – takes system to single-user mode
- poweroff
  - Identical to halt, but adds request to power management system to turn off system's power

shutdown

- shutdown command is safest, considerate, and most thorough to halt, reboot, or change to single user mode
- shutdown can wait before bringing down system
- sends warning messages (like **wall**) to logged-in users
  - should explain why, and when it is coming back



```
[root@fedora ~]# shutdown -h 20:00 "shutdown in progress" &
[1] 3143
[root@fedora ~]#
Broadcast message from root@fedora.linux.com
        (/dev/pts/1) at 4:11 ...

The system is going down for halt in 949 minutes!
shutdown in progress

[root@fedora ~]#
```

- Can specify whether to halt, or reboot:
  - shutdown -r +15 “Rebooting to fix NFS”