The Linux Boot Process

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Overview

- BIOS
- Disk Geometry and Partitioning
- Boot Loader
- Kernel
- User Space Initialization
BIOS

• Classic
  – Initialize Hardware
  – Set the clock
  – Enable/Disable Components
    • User Interface – Usually Text Mode
  – Load Boot Sector
    • CPU Real Mode
BIOS

- Unified Extensible Firmware Interface (UEFI)
  - Legacy support for BIOS
  - Intel initiated (Itanium 64-bit motivation)
  - Multi-architecture (x86, x86_64, ARM)
  - Ability to boot from > 2T drives
  - Network capability
  - Maintain OS queryable data
Unified Extensible Firmware Interface (UEFI)
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Disk Geometry and Partitioning

- Traditional Disk Drives
  - 512 Byte Sectors
  - Cylinder/Track/Head
    - 63 Sectors/Track
  - 512 B Sectors + 32-bit Partition Table
    = $2^{41}$ bytes = 2 TiB
Disk Geometry and Partitioning

What's wrong with this picture?
Disk Geometry and Partitioning

- Disk Drives > 2TiB
  - GUID Partition Table (GPT)
  - 4K Sectors (512 B sector emulation)
    - Write Issues
  - Partitions should be at 1 MiB boundaries
    - parted
    - gdisk
    - fdisk (coming soon)
- GPT support required in kernel
- Needs GRUB2 for booting
<table>
<thead>
<tr>
<th>Basic MBR Disk</th>
<th>Basic GPT Disk</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Master Boot Code</strong></td>
<td><strong>Master Boot Code</strong></td>
</tr>
<tr>
<td><strong>1st Partition Table Entry</strong></td>
<td><strong>1st Partition Table Entry</strong></td>
</tr>
<tr>
<td><strong>2nd Partition Table Entry</strong></td>
<td><strong>2nd Partition Table Entry</strong></td>
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<tr>
<td><strong>3rd Partition Table Entry</strong></td>
<td><strong>3rd Partition Table Entry</strong></td>
</tr>
<tr>
<td><strong>4th Partition Table Entry</strong></td>
<td><strong>4th Partition Table Entry</strong></td>
</tr>
<tr>
<td><strong>0x55 AA</strong></td>
<td><strong>0x55 AA</strong></td>
</tr>
<tr>
<td><strong>Primary Partition (C:)</strong></td>
<td><strong>Primary GUID Partition Table Header</strong></td>
</tr>
<tr>
<td><strong>Primary Partition (E:)</strong></td>
<td><strong>GUID Partition Entry 1</strong></td>
</tr>
<tr>
<td><strong>Primary Partition (F:)</strong></td>
<td><strong>GUID Partition Entry 2</strong></td>
</tr>
<tr>
<td><strong>Primary Partition (F:)</strong></td>
<td><strong>GUID Partition Entry n</strong></td>
</tr>
<tr>
<td><strong>Logical Drive (G:)</strong></td>
<td><strong>GUID Partition Entry 128</strong></td>
</tr>
<tr>
<td><strong>Logical Drive (H:)</strong></td>
<td><strong>Primary Partition (E:)</strong></td>
</tr>
<tr>
<td><strong>Logical Drive n</strong></td>
<td><strong>Primary Partition n</strong></td>
</tr>
<tr>
<td><strong>GUID Partition Entry 1</strong></td>
<td><strong>GUID Partition Entry 1</strong></td>
</tr>
<tr>
<td><strong>GUID Partition Entry 2</strong></td>
<td><strong>GUID Partition Entry 2</strong></td>
</tr>
<tr>
<td><strong>GUID Partition Entry n</strong></td>
<td><strong>GUID Partition Entry n</strong></td>
</tr>
<tr>
<td><strong>GUID Partition Entry 128</strong></td>
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</tr>
<tr>
<td><strong>Backup GUID Partition Table Header</strong></td>
<td></td>
</tr>
</tbody>
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Boot Loader

- Legacy Loaders
  - 32-bit only

- GRUB2
  - Supports classic BIOS and UEFI
  - Support GPT
    - Needs BIOS Boot Partition
  - Install Issues
# Begin /boot/grub/grub.cfg

set default=0
set timeout=5
insmod ext2

# /dev/sda2
set root=(hd0,2)

menuentry "GNU/Linux, Linux 3.6-lfs-SVN-20121002" {
    linux /boot/vmlinux-3.6-lfs-SVN-20121002 root=/dev/sda2 ro
}
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Linux Kernel

- Decompress itself
- Initialize memory and internal data structures
- Initialize built-in drivers
- Checks for initrd
- Mounts root file system
- Runs /sbin/init
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User Space Initialization

- sysvinit
  - /etc/inittab
  - Series of scripts
    - Mout virtual file systems (/proc, /sys, etc)
    - Start udev
    - Set up swap
    - Check/mount file systems
    - Load modules
    - Start other services (initialize network, syslog, cron, ntpd, sshd, apache, etc)
    - Start atgetty (login prompt)
User Space Initialization

- systemd
  - Complex set of executables
  - Parallel execution of startup processes
  - Automount
  - Quotas
  - Auditing
  - sysv compatibility
  - Complex management
    - Binary logs
Discussion