Bootloaders and GRUB

A boot loader is a small program that is executed by the computer's BIOS or UEFI firmware at startup, and is responsible for loading the operating system into memory and starting the boot process.

GRUB (GRand Unified Bootloader) is the default boot loader for many Linux distributions, including Red Hat Enterprise Linux (RHEL). GRUB allows you to choose between multiple operating systems installed on the same machine, and provides a menu-based interface for selecting the operating system to boot.

GRUB is also capable of loading a variety of different file systems and can be used to boot other operating systems, such as Windows or macOS.

GRUB is configured using the **/boot/grub/grub.cfg** file, which contains a list of menu entries, each of which specifies the settings and parameters for booting a specific operating system. The grub.cfg file can be edited manually, but it is generally recommended to use the **grub2-mkconfig** command to regenerate the configuration file, as this will ensure that the file is updated with the latest information about the installed operating systems.

In addition to the menu-based interface, GRUB also provides a command-line interface for advanced users, which allows you to troubleshoot boot issues and perform other advanced tasks.

It's available in the /boot/grub/grub.conf file. The following is a detailed analysis of a typical version of that configuration file. Some of the details, especially as related to the kernel command, is not necessary.

```
# 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 (hd0,0)
# kernel /vmlinuz-version ro root=/dev/vda2
# initrd /initrd-[generic-]version.img
# boot=/dev/vda
```

The commented "NOTICE" in the configuration file appears when there's a separate partition for the /boot directory. The last commented line indicates the hard drive with the MBR—in this case, /dev/vda.

```
default=0
```

GRUB configuration options are organized in stanzas. The default=0 may be slightly confusing, as it points to the first available stanza. A default=1 would point to a second stanza; a default=2 would point to a third stanza, and so on, if included in the configuration file.

```
timeout=5
```

In other words, if nothing is done in the five seconds specified by the timeout=5 directive, GRUB automatically runs the commands in the first stanza.

```
splashimage=(hd0,0)/grub/splash.xpm.gz
```

The splashimage is the screen presented with the GRUB menu. Strangely enough, it's a black screen.

Hiddenmenu

The hiddenmenu option does not display the menu automatically; instead, it displays the "Booting Red Hat Enterprise Linux" message described earlier. The directives that follow are the first stanza; additional stanzas are commonly shown for different versions of the kernel or even different operating systems such as Microsoft Windows.

title Red Hat Enterprise Linux (2.6.32-71.el6.x86_64)

The title directive displays the option shown in the GRUB menu.

        root (hd0,0)

Now this is really weird—there are two definitions for the word root in this file. First, the /boot directory in the GRUB configuration file is associated with root, in this case, root(hd0,0).

        root=UUID=somelonghexadecimalnumber

The UUID is an acronym for the universally unique identifier. It's a 128-bit number, expressed in hexadecimal (base 16) format. It's a unique number generated for each volume configured on RHEL 6. While you could use the LABEL directive from RHEL 5 or even the device file associated with the top-level root directory (/) volume, the UUID is the new default standard for RHEL 6 in the GRUB configuration file as well as the /etc/fstab.

The root(hd0,0) directive uses numbers starting with 0. In other words, this directive points to the first partition on the first hard drive. The /boot directory is mounted on this partition. If it were the fifth partition on the first hard drive, for example, this directive would read root(hd0,4).

The timeout=5 directive specifies the time, in seconds, before GRUB automatically boots the default operating system. The splashimage directive locates the graphical GRUB screen. In this case, you can find it on the first partition of the first hard drive, in the /grub/splash.xpm.gz file. It happens to configure a black background. As (hd0,0) has been previously defined as the /boot directory, you can find the splash screen file in /boot/grub/splash.xpm.gz.

Different run levels in linux:

In Linux, run levels are used to determine the system state and the services that are available. The different run levels are:

1. Halt: Shuts down the system.

2. Single User Mode: Boots the system into a single user mode, with minimal services and a root shell prompt. This mode is used for system maintenance and recovery.

3. Multi-User Mode (without Networking): Boots the system into multi-user mode, with minimal services and no network access.

4. Multi-User Mode (with Networking): Boots the system into multi-user mode, with standard services and network access.

5. Unused: This run level is unused by most systems.

6. X11: Boots the system into multi-user mode, with standard services and network access, and starts the X11 windowing system.

7. Reboot: Reboots the system.

Runlevel	Systemd Description
0	poweroff.target
1	rescue.target
2	multi-user.target
3	multi-user.target
4	multi-user.target
5	graphical.target
6	reboot.target

Each run level is defined by the services that are started and stopped, as well as the state of the system and the available network services. The default run level is usually determined by the system administrator, and can be changed by modifying the boot configuration. The system can be switched to another run level by using the **init** or **telinit** command, followed by the desired run level number.

In Red Hat Enterprise Linux 6 (RHEL6), the files related to run levels are:

1.   **/etc/inittab**: This file is the configuration file for the **init** process, which is the first process started at boot time. It specifies the default run level and the action to be taken when the system enters a new run level.

2. **/etc/rc.d/rc.sysinit**: This file is executed at the beginning of the boot process, and is responsible for setting up the system environment and preparing the system for the boot process.

3. **/etc/rc.d/rcX.d/**: These directories (where X is the run level number) contain symbolic links to the scripts in the **/etc/init.d/** directory that are started or stopped when the system enters or leaves the corresponding run level. The scripts in these directories are executed in numerical order, based on the priority specified in the name of the script.

4. **/etc/init.d/**: This directory contains the scripts that are used to start and stop services in the system. The scripts in this directory are executed by the **/etc/rc.d/rcX.d/** directories when the system enters or leaves the corresponding run level.

In RHEL6, the **systemd** init system is used to manage the boot process and system services, which replaces the older **init** process used in previous versions of Linux. However, the run level concept still exists in **systemd** and is used to determine the state of the system and the services that are available.