

Version : **2021.01**

Updated : 2021/11/01 15:52

LCE510 - System Startup and Shutdown

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System Startup

Boot Loader

The most commonly used boot loader is called **GRUB (Grand Unified Boot Loader)**, however historically there have been others:

- LILO (**L**inux **L**oader)
- SysLinux
- LoadLin
- ...

BIOS Systems

The Boot Loader is generally placed in the MBR (**M**aster **B**oot **R**ecord) of the disk on which the system to-be-booted resides. The MBR format is as follows:

- 446 bytes occupied by the boot loader,
 - 64 bytes for the Partition Table. In other words 16 bytes per primary partition,
 - 2 bytes with a fixed hexadecimal value of **AA55**.
-



Important - Note that you can also install the boot loader in what is known as the **PBR** (**P**artition **B**oot **R**ecord).

EFI Systems

Since 2011, the BIOS is being steadily replaced by **UEFI** (**U**nified **E**xtensible **F**irmware **I**nterface). Systems using a CPU other than the x86 or the x86-64 use non-BIOS software such as **OpenFirmware** or **EFI**.

EFI relies on boot loaders stored in a disk partition called the **EFI System Partition** or **ESP**. This partition is normally mounted by Linux at **/boot/efi**. The boot loaders reside in files having a .efi extension stored in subdirectories named after the OS to be booted.

The EFI firmware includes a boot manager that enables you to choose which OS to boot. In order for EFI to work each boot loader must be registered with the firmware.

GRUB 2

GRUB 2 is a complete rewrite of GRUB LEGACY.

GRUB 2 is modular in design.

The **/boot/grub/grub.cfg** File

Grub2 reads its entries from the **/boot/grub/grub.cfg** file:

```
<code>
[root@centos8 ~]# cat /boot/grub2/grub.cfg
#
```

```
# DO NOT EDIT THIS FILE
#
# It is automatically generated by grub2-mkconfig using templates
# from /etc/grub.d and settings from /etc/default/grub
#

### BEGIN /etc/grub.d/00_header ###
set pager=1

if [ -f ${config_directory}/grubenv ]; then
  load_env -f ${config_directory}/grubenv
elif [ -s $prefix/grubenv ]; then
  load_env
fi
if [ "${next_entry}" ] ; then
  set default="${next_entry}"
  set next_entry=
  save_env next_entry
  set boot_once=true
else
  set default="${saved_entry}"
fi

if [ x"${feature_menuentry_id}" = xy ]; then
  menuentry_id_option="--id"
else
  menuentry_id_option=""
fi

export menuentry_id_option

if [ "${prev_saved_entry}" ]; then
  set saved_entry="${prev_saved_entry}"
  save_env saved_entry
```

```
set prev_saved_entry=
save_env prev_saved_entry
set boot_once=true
fi

function savedefault {
    if [ -z "${boot_once}" ]; then
        saved_entry="${chosen}"
        save_env saved_entry
    fi
}

function load_video {
    if [ x$feature_all_video_module = xy ]; then
        insmod all_video
    else
        insmod efi_gop
        insmod efi_uga
        insmod ieee1275_fb
        insmod vbe
        insmod vga
        insmod video_bochs
        insmod video_cirrus
    fi
}

terminal_output console
if [ x$feature_timeout_style = xy ] ; then
    set timeout_style=menu
    set timeout=5
# Fallback normal timeout code in case the timeout_style feature is
# unavailable.
else
    set timeout=5
fi
```

```
fi
### END /etc/grub.d/00_header ###

### BEGIN /etc/grub.d/00_tuned ###
set tuned_params=""
set tuned_initrd=""
### END /etc/grub.d/00_tuned ###

### BEGIN /etc/grub.d/01_menu_auto_hide ###
if [ "${boot_success}" = "1" -o "${boot_indeterminate}" = "1" ]; then
    set last_boot_ok=1
else
    set last_boot_ok=0
fi

# Reset boot_indeterminate after a successful boot
if [ "${boot_success}" = "1" ] ; then
    set boot_indeterminate=0
# Avoid boot_indeterminate causing the menu to be hidden more than once
elif [ "${boot_indeterminate}" = "1" ]; then
    set boot_indeterminate=2
fi
set boot_success=0
save_env boot_success boot_indeterminate

if [ x$feature_timeout_style = xy ] ; then
    if [ "${menu_show_once}" ]; then
        unset menu_show_once
        save_env menu_show_once
        set timeout_style=menu
        set timeout=60
    elif [ "${menu_auto_hide}" -a "${last_boot_ok}" = "1" ]; then
        set orig_timeout_style=${timeout_style}
        set orig_timeout=${timeout}
```

```
if [ "${fastboot}" = "1" ]; then
    # timeout_style=menu + timeout=0 avoids the countdown code keypress check
    set timeout_style=menu
    set timeout=0
else
    set timeout_style=hidden
    set timeout=1
fi
fi
fi
### END /etc/grub.d/01_menu_auto_hide ###

### BEGIN /etc/grub.d/01_users ###
if [ -f ${prefix}/user.cfg ]; then
    source ${prefix}/user.cfg
    if [ -n "${GRUB2_PASSWORD}" ]; then
        set superusers="root"
        export superusers
        password_pbkdf2 root ${GRUB2_PASSWORD}
    fi
fi
### END /etc/grub.d/01_users ###

### BEGIN /etc/grub.d/10_linux ###
insmod part_msdos
insmod ext2
set root='hd0,msdos1'
if [ x${feature_platform_search_hint} = xy ]; then
    search --no-floppy --fs-uuid --set=root --hint-bios=hd0,msdos1 --hint-efi=hd0,msdos1 --hint-baremetal=ahci0,msdos1 --hint='hd0,msdos1' 2ae4c035-9244-458c-82c5-a49ae169cdb6
else
    search --no-floppy --fs-uuid --set=root 2ae4c035-9244-458c-82c5-a49ae169cdb6
fi
insmod part_msdos
```

```
insmod ext2
set boot='hd0,msdos1'
if [ x$feature_platform_search_hint = xy ]; then
    search --no-floppy --fs-uuid --set=boot --hint-bios=hd0,msdos1 --hint-efi=hd0,msdos1 --hint-baremetal=ahci0,msdos1 --hint='hd0,msdos1' 2ae4c035-9244-458c-82c5-a49ae169cdb6
else
    search --no-floppy --fs-uuid --set=boot 2ae4c035-9244-458c-82c5-a49ae169cdb6
fi

# This section was generated by a script. Do not modify the generated file - all changes
# will be lost the next time file is regenerated. Instead edit the BootLoaderSpec files.
#
# The blscfg command parses the BootLoaderSpec files stored in /boot/loader/entries and
# populates the boot menu. Please refer to the Boot Loader Specification documentation
# for the files format: https://www.freedesktop.org/wiki/Specifications/BootLoaderSpec/.

set default_kernels="root=UUID=4c0cc28c-0d59-45be-bd73-d292b80be33c ro crashkernel=auto resume=UUID=c8bb3f47-d67f-4b21-b781-766899dc83d4 rhgb quiet "

insmod blscfg
blscfg
### END /etc/grub.d/10_linux ###

### BEGIN /etc/grub.d/20_linux_xen ###
### END /etc/grub.d/20_linux_xen ###

### BEGIN /etc/grub.d/20_ppc_terminfo ###
### END /etc/grub.d/20_ppc_terminfo ###

### BEGIN /etc/grub.d/30_os-prober ###
### END /etc/grub.d/30_os-prober ###

### BEGIN /etc/grub.d/30_uefi-firmware ###
### END /etc/grub.d/30_uefi-firmware ###
```

```
### BEGIN /etc/grub.d/40_custom ###
# This file provides an easy way to add custom menu entries.  Simply type the
# menu entries you want to add after this comment.  Be careful not to change
# the 'exec tail' line above.
### END /etc/grub.d/40_custom ###

### BEGIN /etc/grub.d/41_custom ###
if [ -f ${config_directory}/custom.cfg ]; then
    source ${config_directory}/custom.cfg
elif [ -z "${config_directory}" -a -f $prefix/custom.cfg ]; then
    source $prefix/custom.cfg;
fi
### END /etc/grub.d/41_custom ###
</file>
```

==The /etc/default/grub file==

This file contains the default global configuration for GRUB 2:

<code>

```
[root@centos8 ~]# cat /etc/default/grub
GRUB_TIMEOUT=5
GRUB_DISTRIBUTOR="$(sed 's, release .*$,,g' /etc/system-release)"
GRUB_DEFAULT=saved
GRUB_DISABLE_SUBMENU=true
GRUB_TERMINAL_OUTPUT="console"
GRUB_CMDLINE_LINUX="crashkernel=auto resume=UUID=c8bb3f47-d67f-4b21-b781-766899dc83d4 rhgb quiet"
GRUB_DISABLE_RECOVERY="true"
GRUB_ENABLE_BLSCFG=true
```



Important : Any change made to this file requires the execution of the **grub2-mkconfig** command in order for the changes to become effective.

The most important directives in the above file are as follows:

Directive	Description
GRUB_TIMEOUT	Indicates the time to wait for user input prior to booting the default OS
GRUB_DISTRIBUTOR	Set by distributors of GRUB to their identifying name. This is used to generate more informative menu entry titles.
GRUB_DEFAULT	Indicates the default OS to boot. A value of 0 indicates the OS referenced by the first stanza commencing with the menuentry keyword
GRUB_CMDLINE_LINUX	Command-line arguments to add to menu entries for the Linux kernel.

Files in the /etc/grub.d directory

The files in this directory are executed in a numerical order and are used to build the stanzas in the **/boot/grub/grub.cfg** file:

```
[root@centos8 ~]# ls -l /etc/grub.d
total 92
-rwxr-xr-x. 1 root root  8958 Mar  2 15:51 00_header
-rwxr-xr-x. 1 root root  1043 Jun 15 2020 00_tuned
-rwxr-xr-x. 1 root root   232 Mar  2 15:51 01_users
-rwxr-xr-x. 1 root root   832 Mar  2 15:51 08_fallback_counting
-rwxr-xr-x. 1 root root 14088 Mar  2 15:51 10_linux
-rwxr-xr-x. 1 root root   830 Mar  2 15:51 10_reset_boot_success
-rwxr-xr-x. 1 root root   889 Mar  2 15:51 12_menu_auto_hide
-rwxr-xr-x. 1 root root 11696 Mar  2 15:51 20_linux_xen
-rwxr-xr-x. 1 root root  2559 Mar  2 15:51 20_ppc_terminfo
-rwxr-xr-x. 1 root root 10670 Mar  2 15:51 30_os-prober
-rwxr-xr-x. 1 root root  1412 Mar  2 15:51 30_uefi-firmware
-rwxr-xr-x. 1 root root   214 Mar  2 15:51 40_custom
-rwxr-xr-x. 1 root root   216 Mar  2 15:51 41_custom
-rw-r--r--. 1 root root   483 Mar  2 15:51 README
```

Initramfs

The **Initramfs** *INITial Ram File System* file is a minimal system image which is initialised upon system boot.

The file format is **cramFS** that is to say archived using **cpio** and compressed with **gzip**.

```
[root@centos8 ~]# cp /boot/initramfs-4.18.0-240.22.1.el8_3.x86_64.img /tmp/custom
[root@centos8 ~]# cd /tmp
[root@centos8 tmp]# ls
cpio.list
custom
dateref
incremental.tar
mbr.save
systemd-private-9af7a2f7444849578f55b306bfd9f820-chronyd.service-iQiNzF
tblpart.save
test.cpio
test.print
test.tar
tmp.iso
vg0_backup

[root@centos8 tmp]# mv custom custom.gz

[root@centos8 tmp]# gunzip custom.gz

[root@centos8 tmp]# mkdir initramfs

[root@centos8 tmp]# cd initramfs

[root@centos8 initramfs]# cpio -cid -I ../custom
216 blocks
[root@centos8 initramfs]# ls
```

```
bin dev etc init lib lib64 proc root run sbin shutdown sys sysroot tmp usr var
```

To examine the current image, you need to use the **lsinitrd** command:

```
[root@centos8 tmp]# lsinitrd custom | more
Image: custom: 25M
=====
Early CPIO image
=====
drwxr-xr-x  3 root    root          0 Feb 22 10:57 .
-rw-r--r--  1 root    root          2 Feb 22 10:57 early_cpio
drwxr-xr-x  3 root    root          0 Feb 22 10:57 kernel
drwxr-xr-x  3 root    root          0 Feb 22 10:57 kernel/x86
drwxr-xr-x  2 root    root          0 Feb 22 10:57 kernel/x86/microcode
-rw-r--r--  1 root    root       109568 Feb 22 10:57 kernel/x86/microcode/GenuineIntel.bin
=====
Version: dracut-049-95.git20200804.el8_3.4

Arguments: -f --kver '4.18.0-240.22.1.el8_3.x86_64'

dracut modules:
bash
systemd
systemd-initrd
nss-softokn
rngd
i18n
network-legacy
network
ifcfg
drm
plymouth
prefixdevname
kernel-modules
```

```

kernel-modules-extra
kernel-network-modules
resume
rootfs-block
terminfo
udev-rules
biosdevname
dracut-systemd
usrmount
base
fs-lib
memstrack
microcode_ctl-fw_dir_override
shutdown

```

```

=====
drwxr-xr-x 12 root    root          0 Feb 22 10:57 .
crw-r--r--  1 root    root          5,  1 Feb 22 10:57 dev/console
crw-r--r--  1 root    root          1, 11 Feb 22 10:57 dev/kmsg
crw-r--r--  1 root    root          1,  3 Feb 22 10:57 dev/null
crw-r--r--  1 root    root          1,  8 Feb 22 10:57 dev/random
crw-r--r--  1 root    root          1,  9 Feb 22 10:57 dev/urandom
lrwxrwxrwx  1 root    root          7 Feb 22 10:57 bin -> usr/bin
drwxr-xr-x  2 root    root          0 Feb 22 10:57 dev
drwxr-xr-x 11 root    root          0 Feb 22 10:57 etc
-rw-r--r--  1 root    root          30 Nov 10  2020 etc/centos-release
drwxr-xr-x  2 root    root          0 Feb 22 10:57 etc/cmdline.d
drwxr-xr-x  2 root    root          0 Feb 22 10:57 etc/conf.d
-rw-r--r--  1 root    root         124 Feb 22 10:57 etc/conf.d/systemd.conf
--More--

```

The init Script

RHEL/CentOS 8 uses **systemd**. For this reason the init script is a soft link to **/usr/lib/systemd/systemd** :

```
[root@centos8 tmp]# lsinitrd custom | grep usr/lib/systemd/systemd | grep init
lrwxrwxrwx  1 root    root      23 Feb 22 10:57 init -> usr/lib/systemd/systemd
```

Kernel Booting Process

The Kernel Booting Process is divided into 6 stages:

Stage	Description
Kernel loader loading, setup and configuration	In this step, the bootsect.s file is loaded into the memory by the BIOS. When the bootsect.s file sets up, it loads the rest of the kernel into the memory.
Parameter setup and switch to 32-bit mode	When the kernel has been loaded, the boot.s file sets up a temporary IDT and GDT and handles the switch to 32-bit mode.
Kernel decompression	The head.s file decompresses the kernel.
Kernel setup	After the kernel is decompressed, the real GDT and IDT are created by the head.s (second file).
Kernel and memory initialisation	In this step, the kernel sets up all memory constraints and virtual memory is completely set up.
Init process creation	In the final step of booting, the init process is created, which switches a Linux computer to different runlevels.

The **init_post()** function then tries to execute one of the following in the order shown:

- /sbin/init ==> /usr/sbin/init ==> /usr/lib/systemd/systemd
- /etc/init
- /bin/init
- /bin/sh ==> /bin/bash ==> /usr/bin/bash

An error at this stage results in a **Kernel Panic**.

Systemd

Systemd uses Units and Targets. A unit can be:

- **.automount**
- **.device**
- **.mount**
- **.path**
- **.service**
- **.scope**
- **.slice**
- **.snapshot**
- **.socket**
- **.swap**
- **.timer**
- **.target**

Examples of Targets are:

- **halt.target**
- **poweroff.target**
- **shutdown.target**
- **rescue.target**
- **emergency.target**
- **multi-user.target**
- **graphical.target**
- **hibernate.target**
- **reboot.target**

Systemd uses Targets in a similar way to the use of run-levels by **SysVinit**. To facilitate the transition to Systemd, certain Targets are soft links:

```
[root@centos8 ~]# ls -l /usr/lib/systemd/system/runlevel*
lrwxrwxrwx. 1 root root 15 Apr  7 16:55 /usr/lib/systemd/system/runlevel0.target -> poweroff.target
lrwxrwxrwx. 1 root root 13 Apr  7 16:55 /usr/lib/systemd/system/runlevel1.target -> rescue.target
lrwxrwxrwx. 1 root root 17 Apr  7 16:55 /usr/lib/systemd/system/runlevel2.target -> multi-user.target
lrwxrwxrwx. 1 root root 17 Apr  7 16:55 /usr/lib/systemd/system/runlevel3.target -> multi-user.target
lrwxrwxrwx. 1 root root 17 Apr  7 16:55 /usr/lib/systemd/system/runlevel4.target -> multi-user.target
lrwxrwxrwx. 1 root root 16 Apr  7 16:55 /usr/lib/systemd/system/runlevel5.target -> graphical.target
```

```
lrwxrwxrwx. 1 root root 13 Apr  7 16:55 /usr/lib/systemd/system/runlevel6.target -> reboot.target

/usr/lib/systemd/system/runlevel1.target.wants:
total 0

/usr/lib/systemd/system/runlevel2.target.wants:
total 0

/usr/lib/systemd/system/runlevel3.target.wants:
total 0

/usr/lib/systemd/system/runlevel4.target.wants:
total 0

/usr/lib/systemd/system/runlevel5.target.wants:
total 0
```

LAB #1 - The systemctl Command

To list unit files, use the **systemctl** command with the **list-units** sub-command:

```
[root@centos8 ~]# systemctl list-units
UNIT                                LOAD    ACTIVE SUB
DESCRIPTION
proc-sys-fs-binfmt_misc.automount  loaded active waiting
Arbitrary Executable File Formats File System Automount Point
sys-devices-pci0000:00-0000:00:01.1-ata2-host1-target1:0:0-1:0:0:0-block-sr0.device  loaded active plugged
CD-ROM
sys-devices-pci0000:00-0000:00:03.0-net-enp0s3.device  loaded active plugged
82540EM Gigabit Ethernet Controller (PRO/1000 MT Desktop Adapter)
sys-devices-pci0000:00-0000:00:05.0-sound-card0.device  loaded active plugged
82801AA AC'97 Audio Controller
sys-devices-pci0000:00-0000:00:0d.0-ata3-host2-target2:0:0-2:0:0:0-block-sda-sda1.device  loaded active plugged
```

```
VBOX_HARDDISK 1
sys-devices-pci0000:00-0000:00:0d.0-ata3-host2-target2:0:0-2:0:0:0-block-sda-sda2.device loaded active plugged
VBOX_HARDDISK 2
sys-devices-pci0000:00-0000:00:0d.0-ata3-host2-target2:0:0-2:0:0:0-block-sda-sda3.device loaded active plugged
VBOX_HARDDISK 3
sys-devices-pci0000:00-0000:00:0d.0-ata3-host2-target2:0:0-2:0:0:0-block-sda.device loaded active plugged
VBOX_HARDDISK
sys-devices-pci0000:00-0000:00:0d.0-ata4-host3-target3:0:0-3:0:0:0-block-sdb-sdb1.device loaded active plugged
VBOX_HARDDISK 1
sys-devices-pci0000:00-0000:00:0d.0-ata4-host3-target3:0:0-3:0:0:0-block-sdb-sdb10.device loaded active plugged
VBOX_HARDDISK 10
sys-devices-pci0000:00-0000:00:0d.0-ata4-host3-target3:0:0-3:0:0:0-block-sdb-sdb11.device loaded active plugged
VBOX_HARDDISK my_ext4
sys-devices-pci0000:00-0000:00:0d.0-ata4-host3-target3:0:0-3:0:0:0-block-sdb-sdb12.device loaded active plugged
VBOX_HARDDISK 12
sys-devices-pci0000:00-0000:00:0d.0-ata4-host3-target3:0:0-3:0:0:0-block-sdb-sdb2.device loaded active plugged
VBOX_HARDDISK 2
sys-devices-pci0000:00-0000:00:0d.0-ata4-host3-target3:0:0-3:0:0:0-block-sdb-sdb3.device loaded active plugged
VBOX_HARDDISK 3
sys-devices-pci0000:00-0000:00:0d.0-ata4-host3-target3:0:0-3:0:0:0-block-sdb-sdb4.device loaded active plugged
VBOX_HARDDISK 4
sys-devices-pci0000:00-0000:00:0d.0-ata4-host3-target3:0:0-3:0:0:0-block-sdb-sdb5.device loaded active plugged
VBOX_HARDDISK 5
sys-devices-pci0000:00-0000:00:0d.0-ata4-host3-target3:0:0-3:0:0:0-block-sdb-sdb6.device loaded active plugged
VBOX_HARDDISK 6
sys-devices-pci0000:00-0000:00:0d.0-ata4-host3-target3:0:0-3:0:0:0-block-sdb-sdb7.device loaded active plugged
VBOX_HARDDISK 7
sys-devices-pci0000:00-0000:00:0d.0-ata4-host3-target3:0:0-3:0:0:0-block-sdb-sdb8.device loaded active plugged
VBOX_HARDDISK 8
sys-devices-pci0000:00-0000:00:0d.0-ata4-host3-target3:0:0-3:0:0:0-block-sdb-sdb9.device loaded active plugged
VBOX_HARDDISK 9
sys-devices-pci0000:00-0000:00:0d.0-ata4-host3-target3:0:0-3:0:0:0-block-sdb.device loaded active plugged
VBOX_HARDDISK
sys-devices-platform-serial8250-tty-ttyS0.device loaded active plugged
```


Kernel Configuration File System	
sys-kernel-debug.mount	loaded active mounted
Kernel Debug File System	
sys-kernel-tracing.mount	loaded active mounted
/sys/kernel/tracing	
var-lib-nfs-rpc_pipefs.mount	loaded active mounted
RPC Pipe File System	
cups.path	loaded active running
CUPS Scheduler	
systemd-ask-password-plymouth.path	loaded active waiting
Forward Password Requests to Plymouth Directory Watch	
systemd-ask-password-wall.path	loaded active waiting
Forward Password Requests to Wall Directory Watch	
init.scope	loaded active running
System and Service Manager	
session-96.scope	loaded active running
Session 96 of user trainee	
atd.service	loaded active running
Job spooling tools	
auditd.service	loaded active running
Security Auditing Service	
avahi-daemon.service	loaded active running
Avahi mDNS/DNS-SD Stack	
chronyd.service	loaded active running
NTP client/server	
crond.service	loaded active running
Command Scheduler	
cups.service	loaded active running
CUPS Scheduler	
dbus.service	loaded active running
D-Bus System Message Bus	
dracut-shutdown.service	loaded active exited
Restore /run/initramfs on shutdown	
firewalld.service	loaded active running

```
firewalld - dynamic firewall daemon
lines 1-57
```

To see inactive units, use the following command:

```
[root@centos8 ~]# systemctl list-units --all | grep inactive | more
● boot.automount
not-found inactive dead      boot.automount
  proc-fs-nfsd.mount
loaded    inactive dead      NFSD configuration filesystem
  proc-sys-fs-binfmt_misc.mount
loaded    inactive dead      Arbitrary Executable File Formats File System
  sys-fs-fuse-connections.mount
loaded    inactive dead      FUSE Control File System
● sysroot.mount
not-found inactive dead      sysroot.mount
  tmp.mount
loaded    inactive dead      Temporary Directory (/tmp)
  var-lib-machines.mount
loaded    inactive dead      Virtual Machine and Container Storage
  systemd-ask-password-console.path
loaded    inactive dead      Dispatch Password Requests to Console Directory Watch
● apparmor.service
not-found inactive dead      apparmor.service
  auth-rpcgss-module.service
loaded    inactive dead      Kernel Module supporting RPCSEC_GSS
  cpupower.service
loaded    inactive dead      Configure CPU power related settings
● display-manager.service
not-found inactive dead      display-manager.service
  dm-event.service
loaded    inactive dead      Device-mapper event daemon
  dnf-makecache.service
loaded    inactive dead      dnf makecache
```

```
dracut-cmdline.service
loaded inactive dead dracut cmdline hook
dracut-initqueue.service
loaded inactive dead dracut initqueue hook
dracut-mount.service
loaded inactive dead dracut mount hook
dracut-pre-mount.service
loaded inactive dead dracut pre-mount hook
dracut-pre-pivot.service
loaded inactive dead dracut pre-pivot and cleanup hook
dracut-pre-trigger.service
loaded inactive dead dracut pre-trigger hook
dracut-pre-udev.service
loaded inactive dead dracut pre-udev hook
ebtables.service
loaded inactive dead Ethernet Bridge Filtering tables
emergency.service
loaded inactive dead Emergency Shell
initrd-cleanup.service
loaded inactive dead Cleaning Up and Shutting Down Daemons
initrd-parse-etc.service
loaded inactive dead Reload Configuration from the Real Root
initrd-switch-root.service
loaded inactive dead Switch Root
initrd-udevadm-cleanup-db.service
loaded inactive dead Cleanup udevd DB
● ip6tables.service
not-found inactive dead ip6tables.service
● ipset.service
not-found inactive dead ipset.service
● iptables.service
not-found inactive dead iptables.service
iscsi-onboot.service
loaded inactive dead Special handling of early boot iSCSI sessions
```

```
iscsi.service
loaded inactive dead Login and scanning of iSCSI devices
iscsid.service
loaded inactive dead Open-iSCSI
iscsiuio.service
loaded inactive dead iSCSI UserSpace I/O driver
ldconfig.service
loaded inactive dead Rebuild Dynamic Linker Cache
libvirt-guests.service
loaded inactive dead Suspend/Resume Running libvirt Guests
libvirtd.service
loaded inactive dead Virtualization daemon
loadmodules.service
loaded inactive dead Load legacy module configuration
● lvm2-activation.service
not-found inactive dead lvm2-activation.service
lvm2-lvmpolld.service
loaded inactive dead LVM2 poll daemon
mdmonitor.service
loaded inactive dead Software RAID monitoring and management
microcode.service
loaded inactive dead Load CPU microcode update
● network.service
not-found inactive dead network.service
nfs-blkmap.service
loaded inactive dead pNFS block layout mapping daemon
nfs-convert.service
loaded inactive dead Preprocess NFS configuration conversion
nfs-idmapd.service
loaded inactive dead NFSv4 ID-name mapping service
nfs-mountd.service
loaded inactive dead NFS Mount Daemon
nfs-server.service
loaded inactive dead NFS server and services
```

```
nfs-utils.service
loaded inactive dead      NFS server and client services
nfsdclld.service
loaded inactive dead      NFSv4 Client Tracking Daemon
nftables.service
loaded inactive dead      Netfilter Tables
● ntpd.service
not-found inactive dead   ntpd.service
● ntpdate.service
not-found inactive dead   ntpdate.service
plymouth-switch-root.service
loaded inactive dead      Plymouth switch root service
rc-local.service
loaded inactive dead      /etc/rc.d/rc.local Compatibility
rescue.service
loaded inactive dead      Rescue Shell
rpc-gssd.service
loaded inactive dead      RPC security service for NFS client and server
--More--
```

The black dots above are white on the screen. These dots mean that the unit has not been found on the system. For example:

```
[root@centos8 ~]# systemctl status ntpd
Unit ntpd.service could not be found.
```

To see unit status data, use the following command:

```
[root@centos8 ~]# systemctl list-unit-files | more
UNIT FILE                                STATE
proc-sys-fs-binfmt_misc.automount       static
-.mount                                  generated
boot.mount                               generated
dev-hugepages.mount                     static
dev-mqueue.mount                         static
```

proc-fs-nfsd.mount	static
proc-sys-fs-binfmt_misc.mount	static
sys-fs-fuse-connections.mount	static
sys-kernel-config.mount	static
sys-kernel-debug.mount	static
tmp.mount	disabled
var-lib-machines.mount	static
var-lib-nfs-rpc_pipefs.mount	static
cups.path	enabled
systemd-ask-password-console.path	static
systemd-ask-password-plymouth.path	static
systemd-ask-password-wall.path	static
session-96.scope	transient
arp-ethers.service	disabled
atd.service	enabled
auditd.service	enabled
auth-rpcgss-module.service	static
autovt@.service	enabled
avahi-daemon.service	enabled
blk-availability.service	disabled
chrony-dnssrv@.service	static
chrony-wait.service	disabled
chronyd.service	enabled
cockpit-motd.service	static
cockpit-wsinstance-http-redirect.service	static
cockpit-wsinstance-http.service	static
cockpit-wsinstance-https-factory@.service	static
cockpit-wsinstance-https@.service	static
cockpit.service	static
console-getty.service	disabled
container-getty@.service	static
cpupower.service	disabled
crond.service	enabled
cups-browsed.service	disabled

```
cups.service enabled
dbus-org.fedoraproject.FirewallD1.service enabled
dbus-org.freedesktop.Avahi.service enabled
dbus-org.freedesktop.hostname1.service static
dbus-org.freedesktop.import1.service static
dbus-org.freedesktop.locale1.service static
dbus-org.freedesktop.login1.service static
dbus-org.freedesktop.machin1.service static
dbus-org.freedesktop.nm-dispatcher.service enabled
dbus-org.freedesktop.portable1.service static
dbus-org.freedesktop.timedat1.service enabled
dbus.service static
debug-shell.service disabled
dm-event.service static
dnf-makecache.service static
dnsmasq.service disabled
dracut-cmdline.service static
--More--
```

To see units of a specific type, use the **-t** switch:

```
[root@centos8 ~]# systemctl list-unit-files -t mount
UNIT FILE STATE
-.mount generated
boot.mount generated
dev-hugepages.mount static
dev-mqueue.mount static
proc-fs-nfsd.mount static
proc-sys-fs-binfmt_misc.mount static
sys-fs-fuse-connections.mount static
sys-kernel-config.mount static
sys-kernel-debug.mount static
tmp.mount disabled
var-lib-machines.mount static
```

```
var-lib-nfs-rpc_pipefs.mount static
```

```
12 unit files listed.
```

In the STATE column you can see the **static** and **generated** terms.

- STATE = static
 - This implies that only the system can stop and start the unit. Generally these are dependencies of other units.
- STATE = generated
 - This indicates that the file is generated automatically from the information in the **/etc/fstab** file when the system starts. In the case of a mount point, the binary responsible for this is **/lib/systemd/system-generators/systemd-fstab-generator** :

```
[root@centos8 ~]# ls -l /lib/systemd/system-generators/systemd-fstab-generator
-rwxr-xr-x. 1 root root 46096 Apr  7 16:56 /lib/systemd/system-generators/systemd-fstab-generator
```

Other binaries exist to automatically generate other types of unit files:

```
[root@centos8 ~]# ls -l /lib/systemd/system-generators
total 508
-rwxr-xr-x. 1 root root  504 Jan  4 11:25 kdump-dep-generator.sh
-r-xr-xr-x. 1 root root 134976 Aug 17  2020 lvm2-activation-generator
-rwxr-xr-x. 1 root root  67792 Jul 20  2020 nfs-server-generator
-rwxr-xr-x. 1 root root  38216 Jul 20  2020 rpc-pipefs-generator
-rwxr-xr-x. 1 root root   743 Apr 23  2020 selinux-autorelabel-generator.sh
-rwxr-xr-x. 1 root root  33504 Apr  7 16:56 systemd-cryptsetup-generator
-rwxr-xr-x. 1 root root  16648 Apr  7 16:56 systemd-debug-generator
-rwxr-xr-x. 1 root root  46096 Apr  7 16:56 systemd-fstab-generator
-rwxr-xr-x. 1 root root  17064 Apr  7 16:56 systemd-getty-generator
-rwxr-xr-x. 1 root root  29432 Apr  7 16:56 systemd-gpt-auto-generator
-rwxr-xr-x. 1 root root  12568 Apr  7 16:56 systemd-hibernate-resume-generator
-rwxr-xr-x. 1 root root  12368 Apr  7 16:56 systemd-rc-local-generator
-rwxr-xr-x. 1 root root  12408 Apr  7 16:56 systemd-system-update-generator
-rwxr-xr-x. 1 root root  33544 Apr  7 16:56 systemd-sysv-generator
```

```
-rwxr-xr-x. 1 root root 17024 Apr 7 16:56 systemd-veritysetup-generator
```

Command Line Switches

Command line switches of the **systemctl** command are as follows:

```
[root@centos8 ~]# systemctl --help
systemctl [OPTIONS...] {COMMAND} ...
```

Query or send control commands to the systemd manager.

```
-h --help           Show this help
  --version         Show package version
  --system          Connect to system manager
  --user            Connect to user service manager
-H --host=[USER@]HOST
                    Operate on remote host
-M --machine=CONTAINER
                    Operate on local container
-t --type=TYPE      List units of a particular type
  --state=STATE     List units with particular LOAD or SUB or ACTIVE state
-p --property=NAME Show only properties by this name
-a --all            Show all properties/all units currently in memory,
                    including dead/empty ones. To list all units installed on
                    the system, use the 'list-unit-files' command instead.
  --failed          Same as --state=failed
-l --full           Don't ellipsize unit names on output
-r --recursive      Show unit list of host and local containers
  --reverse         Show reverse dependencies with 'list-dependencies'
  --job-mode=MODE  Specify how to deal with already queued jobs, when
                    queueing a new job
  --show-types      When showing sockets, explicitly show their type
  --value           When showing properties, only print the value
```

```
-i --ignore-inhibitors      When shutting down or sleeping, ignore inhibitors
  --kill-who=WHO           Who to send signal to
-s --signal=SIGNAL         Which signal to send
  --now                    Start or stop unit in addition to enabling or disabling it
  --dry-run                Only print what would be done
-q --quiet                 Suppress output
  --wait                   For (re)start, wait until service stopped again
  --no-block               Do not wait until operation finished
  --no-wall                Don't send wall message before halt/power-off/reboot
  --no-reload              Don't reload daemon after en-/dis-abling unit files
  --no-legend              Do not print a legend (column headers and hints)
  --no-pager               Do not pipe output into a pager
  --no-ask-password        Do not ask for system passwords
  --global                 Enable/disable/mask unit files globally
  --runtime                Enable/disable/mask unit files temporarily until next
                          reboot
-f --force                 When enabling unit files, override existing symlinks
                          When shutting down, execute action immediately
  --preset-mode=           Apply only enable, only disable, or all presets
  --root=PATH              Enable/disable/mask unit files in the specified root
                          directory
-n --lines=INTEGER        Number of journal entries to show
-o --output=STRING         Change journal output mode (short, short-precise,
                          short-iso, short-iso-precise, short-full,
                          short-monotonic, short-unix,
                          verbose, export, json, json-pretty, json-sse, cat)
  --firmware-setup         Tell the firmware to show the setup menu on next boot
  --plain                  Print unit dependencies as a list instead of a tree
```

lines 1-57

LAB #2 - Configuration Files

2.1 - Default Configuration Files

These files can be found in the `/usr/lib/systemd/system` directory:

```
[root@centos8 ~]# pkg-config systemd --variable=systemdsystemunitdir
/usr/lib/systemd/system
```

```
[root@centos8 ~]# ls -l /usr/lib/systemd/system | more
total 1464
-rw-r--r--. 1 root root 275 Apr 26 2020 arp-ethers.service
-rw-r--r--. 1 root root 222 May 11 2019 atd.service
-rw-r--r--. 1 root root 1512 Apr 23 2020 auditd.service
-rw-r--r--. 1 root root 628 Jul 20 2020 auth-rpcgss-module.service
lrwxrwxrwx. 1 root root 14 Apr 7 16:55 autovt@.service -> getty@.service
-rw-r--r--. 1 root root 1044 Nov 16 2020 avahi-daemon.service
-rw-r--r--. 1 root root 870 Nov 16 2020 avahi-daemon.socket
-rw-r--r--. 1 root root 956 Apr 7 16:54 basic.target
drwxr-xr-x. 2 root root 6 Apr 7 16:55 basic.target.wants
-r--r--r--. 1 root root 408 Aug 17 2020 blk-availability.service
-rw-r--r--. 1 root root 419 Jun 22 2018 bluetooth.target
-rw-r--r--. 1 root root 455 Apr 7 16:54 boot-complete.target
-rw-r--r--. 1 root root 209 Nov 19 2019 chrony-dnssrv@.service
-rw-r--r--. 1 root root 138 Nov 19 2019 chrony-dnssrv@.timer
-rw-r--r--. 1 root root 491 Nov 19 2019 chronyd.service
-rw-r--r--. 1 root root 472 May 10 2019 chrony-wait.service
-rw-r--r--. 1 root root 222 Aug 24 2020 cockpit-motd.service
-rw-r--r--. 1 root root 835 Aug 24 2020 cockpit.service
-rw-r--r--. 1 root root 373 Aug 24 2020 cockpit.socket
-rw-r--r--. 1 root root 251 Aug 24 2020 cockpit-wsinstance-http-redirect.service
-rw-r--r--. 1 root root 233 Aug 24 2020 cockpit-wsinstance-http-redirect.socket
```

```
-rw-r--r--. 1 root root 221 Aug 24 2020 cockpit-wsinstance-http.service
-rw-r--r--. 1 root root 165 Aug 24 2020 cockpit-wsinstance-https-factory@.service
-rw-r--r--. 1 root root 244 Aug 24 2020 cockpit-wsinstance-https-factory.socket
-rw-r--r--. 1 root root 215 Aug 24 2020 cockpit-wsinstance-http.socket
-rw-r--r--. 1 root root 264 Aug 24 2020 cockpit-wsinstance-https@.service
-rw-r--r--. 1 root root 478 Aug 24 2020 cockpit-wsinstance-https@.socket
-rw-r--r--. 1 root root 1082 Apr 7 16:55 console-getty.service
-rw-r--r--. 1 root root 1263 Apr 7 16:55 container-getty@.service
-rw-r--r--. 1 root root 294 Apr 8 15:21 cpupower.service
-rw-r--r--. 1 root root 356 Nov 8 2019 crond.service
-rw-r--r--. 1 root root 465 Jun 22 2018 cryptsetup-pre.target
-rw-r--r--. 1 root root 412 Jun 22 2018 cryptsetup.target
lrwxrwxrwx. 1 root root 13 Apr 7 16:55 ctrl-alt-del.target -> reboot.target
-rw-r--r--. 1 root root 234 Oct 4 2017 cups-browsed.service
-r--r--r--. 1 root root 142 Jun 15 2020 cups.path
-r--r--r--. 1 root root 248 Jun 15 2020 cups.service
-r--r--r--. 1 root root 136 Jun 15 2020 cups.socket
lrwxrwxrwx. 1 root root 25 Apr 7 16:55 dbus-org.freedesktop.hostname1.service -> systemd-hostnamed.service
lrwxrwxrwx. 1 root root 23 Apr 7 16:55 dbus-org.freedesktop.import1.service -> systemd-importd.service
lrwxrwxrwx. 1 root root 23 Apr 7 16:55 dbus-org.freedesktop.locale1.service -> systemd-localed.service
lrwxrwxrwx. 1 root root 22 Apr 7 16:55 dbus-org.freedesktop.login1.service -> systemd-logind.service
lrwxrwxrwx. 1 root root 24 Apr 7 16:55 dbus-org.freedesktop.machine1.service -> systemd-machined.service
lrwxrwxrwx. 1 root root 25 Apr 7 16:55 dbus-org.freedesktop.portable1.service -> systemd-portabled.service
lrwxrwxrwx. 1 root root 25 Apr 7 16:55 dbus-org.freedesktop.timedate1.service -> systemd-timedated.service
-rw-r--r--. 1 root root 380 Apr 7 12:08 dbus.service
-rw-r--r--. 1 root root 102 Apr 7 12:08 dbus.socket
drwxr-xr-x. 2 root root 6 Apr 7 16:55 dbus.target.wants
-rw-r--r--. 1 root root 1084 Apr 7 16:55 debug-shell.service
lrwxrwxrwx. 1 root root 16 Apr 7 16:55 default.target -> graphical.target
drwxr-xr-x. 2 root root 6 Apr 7 16:55 default.target.wants
-rw-r--r--. 1 root root 750 Jun 22 2018 dev-hugepages.mount
-rw-r--r--. 1 root root 665 Jun 22 2018 dev-mqueue.mount
-r--r--r--. 1 root root 345 Aug 17 2020 dm-event.service
-r--r--r--. 1 root root 248 Aug 17 2020 dm-event.socket
```

```
-rw-r--r--. 1 root root 457 Jun 2 2020 dnf-makecache.service
--More--
```

Certain configuration files are dynamically created and placed in the **/run/systemd/system** directory to then be deleted upon system reboot:

```
[root@centos8 ~]# ls -l /run/systemd/system/
total 0
```

User created unit files must be placed in the **/usr/lib/systemd/user** directory:

```
[root@centos8 ~]# pkg-config systemd --variable=systemduserunitdir
/usr/lib/systemd/user
```



Important : This means that files in **/usr/lib/systemd/user** overload by files in **/run/systemd/system** which in turn overload files in **/usr/lib/systemd/system**.

Take the case of the **/usr/lib/systemd/system/sshd.service** file:

```
[root@centos8 ~]# cat /usr/lib/systemd/system/sshd.service
[Unit]
Description=OpenSSH server daemon
Documentation=man:sshd(8) man:sshd_config(5)
After=network.target sshd-keygen.target
Wants=sshd-keygen.target

[Service]
Type=notify
EnvironmentFile=-/etc/crypto-policies/back-ends/opensshserver.config
EnvironmentFile=-/etc/sysconfig/ssh
ExecStart=/usr/sbin/sshd -D $OPTIONS $CRYPTO_POLICY
ExecReload=/bin/kill -HUP $MAINPID
```

```
KillMode=process  
Restart=on-failure  
RestartSec=42s
```

```
[Install]  
WantedBy=multi-user.target
```

To see **all** of the values of the configuration directives, use **systemctl show** and specify the unit file:

```
[root@centos8 ~]# systemctl show sshd  
Type=notify  
Restart=on-failure  
NotifyAccess=main  
RestartUsec=42s  
TimeoutStartUsec=1min 30s  
TimeoutStopUsec=1min 30s  
RuntimeMaxUsec=infinity  
WatchdogUsec=0  
WatchdogTimestamp=Thu 2021-06-03 15:09:54 EDT  
WatchdogTimestampMonotonic=12502561  
PermissionsStartOnly=no  
RootDirectoryStartOnly=no  
RemainAfterExit=no  
GuessMainPID=yes  
MainPID=902  
ControlPID=0  
FileDescriptorStoreMax=0  
NFileDescriptorStore=0  
StatusErrno=0  
Result=success  
UID=[not set]  
GID=[not set]  
NRestarts=0  
ExecMainStartTimestamp=Thu 2021-06-03 15:09:54 EDT
```

```
ExecMainStartTimestampMonotonic=12446178
ExecMainExitTimestampMonotonic=0
ExecMainPID=902
ExecMainCode=0
ExecMainStatus=0
ExecStart={ path=/usr/sbin/sshd ; argv[]=/usr/sbin/sshd -D $OPTIONS $CRYPTO_POLICY ; ignore_errors=no ;
start_time=[n/a] ; stop_time=[n/a] ; pid=0 ; code=(null) ; status=0/0 }
ExecReload={ path=/bin/kill ; argv[]=/bin/kill -HUP $MAINPID ; ignore_errors=no ; start_time=[n/a] ;
stop_time=[n/a] ; pid=0 ; code=(null) ; status=0/0 }
Slice=system.slice
ControlGroup=/system.slice/sshd.service
MemoryCurrent=6270976
CPUUsageNSec=[not set]
EffectiveCPUs=
EffectiveMemoryNodes=
TasksCurrent=1
IPIngressBytes=18446744073709551615
IPIngressPackets=18446744073709551615
IPEgressBytes=18446744073709551615
IPEgressPackets=18446744073709551615
Delegate=no
CPUAccounting=no
CPUWeight=[not set]
StartupCPUWeight=[not set]
CPUShares=[not set]
StartupCPUShares=[not set]
CPUQuotaPerSecUSec=infinity
CPUQuotaPeriodUSec=infinity
AllowedCPUs=
AllowedMemoryNodes=
IOAccounting=no
IOWeight=[not set]
StartupIOWeight=[not set]
BlockIOAccounting=no
```

```
BlockIOWeight=[not set]
lines 1-57
```

To see unit dependencies, use the **systemctl list-dependencies** command and specify the unit:

```
[root@centos8 ~]# systemctl list-dependencies sshd.service
sshd.service
● └system.slice
● └sshd-keygen.target
●   └sshd-keygen@ecdsa.service
●   └sshd-keygen@ed25519.service
●   └sshd-keygen@rsa.service
● └sysinit.target
●   └dev-hugepages.mount
●   └dev-mqueue.mount
●   └dracut-shutdown.service
●   └import-state.service
●   └iscsi-onboot.service
●   └kmod-static-nodes.service
●   └ldconfig.service
●   └loadmodules.service
●   └lvm2-lvmpolld.socket
●   └lvm2-monitor.service
●   └nis-domainname.service
●   └plymouth-read-write.service
●   └plymouth-start.service
●   └proc-sys-fs-binfmt_misc.automount
●   └rngd.service
●   └selinux-autorelabel-mark.service
●   └sys-fs-fuse-connections.mount
●   └sys-kernel-config.mount
●   └sys-kernel-debug.mount
●   └systemd-ask-password-console.path
●   └systemd-binfmt.service
```

```
● |systemd-firstboot.service
● |systemd-hwdb-update.service
● |systemd-journal-catalog-update.service
● |systemd-journal-flush.service
● |systemd-journald.service
● |systemd-machine-id-commit.service
● |systemd-modules-load.service
● |systemd-random-seed.service
● |systemd-sysctl.service
● |systemd-sysusers.service
● |systemd-tmpfiles-setup-dev.service
● |systemd-tmpfiles-setup.service
● |systemd-udev-trigger.service
● |systemd-udevd.service
● |systemd-update-done.service
● |systemd-update-utmp.service
● |cryptsetup.target
● |local-fs.target
● |  |-- .mount
● |  |-- boot.mount
● |  |--systemd-remount-fs.service
● |  |--swap.target
● |  |--dev-disk-by\x2duuid-c8bb3f47\x2dd67f\x2d4b21\x2ddb781\x2d766899dc83d4.swap
```

2.2 - Overloading Default Configuration Files

Default configuration files can be overloaded by files in other directories:

```
[root@centos8 ~]# pkg-config systemd --variable=systemdsystemunitpath
/etc/systemd/system:/etc/systemd/system:/run/systemd/system:/usr/local/lib/systemd/system:/usr/lib/systemd/system
:/usr/lib/systemd/system:/lib/systemd/system
```

```
[root@centos8 ~]# ls -l /etc/systemd/system
```

```
total 4
drwxr-xr-x. 2 root root   31 May  8  2020 basic.target.wants
lrwxrwxrwx. 1 root root   41 May  8  2020 dbus-org.fedoraproject.FirewallD1.service ->
/usr/lib/systemd/system/firewalld.service
lrwxrwxrwx. 1 root root   44 Jun  3 14:02 dbus-org.freedesktop.Avahi.service -> /usr/lib/systemd/system/avahi-
daemon.service
lrwxrwxrwx. 1 root root   57 May  8  2020 dbus-org.freedesktop.nm-dispatcher.service ->
/usr/lib/systemd/system/NetworkManager-dispatcher.service
lrwxrwxrwx. 1 root root   41 May  8  2020 dbus-org.freedesktop.timedate1.service ->
/usr/lib/systemd/system/timedatex.service
lrwxrwxrwx. 1 root root   37 May  8  2020 default.target -> /lib/systemd/system/multi-user.target
drwxr-xr-x. 2 root root   32 May  8  2020 getty.target.wants
drwxr-xr-x. 2 root root 4096 Jun  3 14:02 multi-user.target.wants
drwxr-xr-x. 2 root root   48 May  8  2020 network-online.target.wants
drwxr-xr-x. 2 root root   33 Apr 19 12:07 nfs-blkmap.service.requires
drwxr-xr-x. 2 root root   33 Apr 19 12:07 nfs-idmapd.service.requires
drwxr-xr-x. 2 root root   33 Apr 19 12:07 nfs-mountd.service.requires
drwxr-xr-x. 2 root root   33 Apr 19 12:07 nfs-server.service.requires
drwxr-xr-x. 2 root root   26 Jun  3 14:02 printer.target.wants
drwxr-xr-x. 2 root root   52 Apr 19 12:07 remote-fs.target.wants
drwxr-xr-x. 2 root root   33 Apr 19 12:07 rpc-gssd.service.requires
drwxr-xr-x. 2 root root   33 Apr 19 12:07 rpc-statd-notify.service.requires
drwxr-xr-x. 2 root root   33 Apr 19 12:07 rpc-statd.service.requires
drwxr-xr-x. 2 root root  260 Jun  3 14:02 sockets.target.wants
drwxr-xr-x. 2 root root  235 Apr 19 12:07 sysinit.target.wants
lrwxrwxrwx. 1 root root   39 May  8  2020 syslog.service -> /usr/lib/systemd/system/rsyslog.service
lrwxrwxrwx. 1 root root   9 May 11  2019 systemd-timedated.service -> /dev/null
drwxr-xr-x. 2 root root   34 May  8  2020 timers.target.wants
```

LAB #3 - The systemd-analyze Command

To see the startup duration, use the following command:

```
[root@centos8 ~]# systemd-analyze
Startup finished in 1.665s (kernel) + 6.977s (initrd) + 8.458s (userspace) = 17.101s
multi-user.target reached after 5.528s in userspace
```

The **blame** sub-command is used to see which units are the slowest:

```
[root@centos8 ~]# systemd-analyze blame
4.080s dracut-initqueue.service
3.257s kdump.service
1.727s tuned.service
1.415s initrd-switch-root.service
1.393s NetworkManager-wait-online.service
1.116s systemd-machined.service
1.111s dracut-cmdline.service
850ms sssd.service
791ms vdo.service
713ms firewalld.service
622ms lvm2-monitor.service
605ms polkit.service
508ms chronyd.service
434ms avahi-daemon.service
426ms systemd-logind.service
417ms netcf-transaction.service
410ms dracut-pre-udev.service
295ms libvirtd.service
275ms dnf-makecache.service
243ms systemd-udev.service
221ms systemd-journald.service
196ms systemd-tmpfiles-setup.service
151ms dracut-pre-pivot.service
139ms sysroot.mount
139ms systemd-update-utmp-runlevel.service
122ms systemd-vconsole-setup.service
110ms lvm2-pvscan@8:25.service
```

```
98ms systemd-udev-trigger.service
82ms gssproxy.service
81ms cups.service
79ms initrd-parse-etc.service
77ms NetworkManager.service
72ms lvm2-pvscan@8:23.service
69ms systemd-user-sessions.service
68ms lvm2-pvscan@8:22.service
67ms unbound-anchor.service
66ms rsyslog.service
62ms boot.mount
56ms sshd.service
54ms smartd.service
54ms systemd-fsck@dev-disk-by\x2duuid-2ae4c035\x2d9244\x2d458c\x2d82c5\x2da49ae169cdb6.service
53ms user@1000.service
52ms auditd.service
51ms plymouth-quit.service
49ms rngd-wake-threshold.service
46ms import-state.service
46ms systemd-tmpfiles-setup-dev.service
43ms ksmtuned.service
42ms plymouth-quit-wait.service
42ms var-lib-nfs-rpc_pipefs.mount
42ms rpc-statd-notify.service
38ms plymouth-switch-root.service
37ms systemd-remount-fs.service
37ms plymouth-start.service
33ms dev-disk-by\x2duuid-c8bb3f47\x2dd67f\x2d4b21\x2ddb781\x2d766899dc83d4.swap
33ms systemd-tmpfiles-clean.service
31ms dev-hugepages.mount
```

lines 1-57

The **critical-chain** sub-command shows the startup process of a specific unit:

```
[root@centos8 ~]# systemd-analyze critical-chain sshd.service
The time after the unit is active or started is printed after the "@" character.
The time the unit takes to start is printed after the "+" character.

sshd.service +56ms
└─network.target @3.799s
   └─NetworkManager.service @3.719s +77ms
      └─network-pre.target @3.718s
         └─firewalld.service @3.004s +713ms
            └─polkit.service @2.397s +605ms
               └─basic.target @2.392s
                  └─sockets.target @2.392s
                     └─sssd-kcm.socket @2.391s
                        └─sysinit.target @2.379s
                           └─systemd-update-utmp.service @2.370s +8ms
                              └─auditd.service @2.317s +52ms
                                 └─systemd-tmpfiles-setup.service @2.118s +196ms
                                    └─import-state.service @2.070s +46ms
                                       └─local-fs.target @2.069s
                                          └─boot.mount @2.006s +62ms
                                             └─systemd-fsck@dev-disk-
by\x2duuid-2ae4c035\x2d9244\x2d458c\x2d82c5\x2da49ae169cdb6.service @1.943s +54ms
                                       └─local-fs-pre.target @1.942s
                                          └─lvm2-monitor.service @1.319s +622ms
                                             └─dm-event.socket @1.317s
                                                └─.mount
                                                   └─system.slice
                                                      └─.slice
```

Command Line Switches

Command line switches of the **systemd-analyze** command are as follows:

```
[root@centos7 ~]# systemd-analyze --help
systemd-analyze [OPTIONS...] {COMMAND} ...
```

Process systemd profiling information

```
-h --help           Show this help
--version          Show package version
--system          Connect to system manager
--user            Connect to user service manager
--order           When generating a dependency graph, show only order
--require         When generating a dependency graph, show only requirement
--from-pattern=GLOB, --to-pattern=GLOB
                  When generating a dependency graph, filter only origins
                  or destinations, respectively
--fuzz=TIMESPAN   When printing the tree of the critical chain, print also
                  services, which finished TIMESPAN earlier, than the
                  latest in the branch. The unit of TIMESPAN is seconds
                  unless specified with a different unit, i.e. 50ms
--no-pager        Do not pipe output into a pager
```

Commands:

```
time              Print time spent in the kernel before reaching userspace
blame             Print list of running units ordered by time to init
critical-chain    Print a tree of the time critical chain of units
plot             Output SVG graphic showing service initialization
dot              Output dependency graph in dot(1) format
set-log-level LEVEL Set logging threshold for systemd
dump             Output state serialization of service manager
```

LAB #4 - Targets

Each Target has a configuration file:

```
[root@centos8 ~]# cat /usr/lib/systemd/system/graphical.target
# SPDX-License-Identifier: LGPL-2.1+
#
# This file is part of systemd.
#
# systemd is free software; you can redistribute it and/or modify it
# under the terms of the GNU Lesser General Public License as published by
# the Free Software Foundation; either version 2.1 of the License, or
# (at your option) any later version.

[Unit]
Description=Graphical Interface
Documentation=man:systemd.special(7)
Requires=multi-user.target
Wants=display-manager.service
Conflicts=rescue.service rescue.target
After=multi-user.target rescue.service rescue.target display-manager.service
AllowIsolate=yes
```

4.1 - Checking the Target Dependencies

Target dependencies are shown by the **systemctl list-dependencies** command:

```
[root@centos8 ~]# systemctl list-dependencies multi-user.target
multi-user.target
● └atd.service
● └auditd.service
● └avahi-daemon.service
● └chronyd.service
● └crond.service
● └cups.path
● └cups.service
```

```
● |—dbus.service
● |—dnf-makecache.timer
● |—firewalld.service
● |—irqbalance.service
● |—kdump.service
● |—kvm.service
● |—ksmtuned.service
● |—libstoragemgmt.service
● |—libvirtd.service
● |—mcelog.service
● |—mdmonitor.service
● |—netcf-transaction.service
● |—NetworkManager.service
● |—plymouth-quit-wait.service
● |—plymouth-quit.service
● |—rpcbind.service
● |—rsyslog.service
● |—smartd.service
● |—sshd.service
● |—sssd.service
● |—systemd-ask-password-wall.path
● |—systemd-logind.service
● |—systemd-update-utmp-runlevel.service
● |—systemd-user-sessions.service
● |—tuned.service
● |—vdo.service
● |—basic.target
● | |— .mount
● | |—microcode.service
● | |—paths.target
● | |—slices.target
● | | |— .slice
● | | |—system.slice
● |—sockets.target
```



```
lrwxrwxrwx. 1 root root 38 May 8 2020 auditd.service -> /usr/lib/systemd/system/auditd.service
lrwxrwxrwx. 1 root root 44 Jun 3 14:02 avahi-daemon.service -> /usr/lib/systemd/system/avahi-daemon.service
lrwxrwxrwx. 1 root root 39 May 8 2020 chronyd.service -> /usr/lib/systemd/system/chronyd.service
lrwxrwxrwx. 1 root root 37 May 8 2020 crond.service -> /usr/lib/systemd/system/crond.service
lrwxrwxrwx. 1 root root 33 Jun 3 14:02 cups.path -> /usr/lib/systemd/system/cups.path
lrwxrwxrwx. 1 root root 36 Jun 3 14:02 cups.service -> /usr/lib/systemd/system/cups.service
lrwxrwxrwx. 1 root root 43 May 8 2020 dnf-makecache.timer -> /usr/lib/systemd/system/dnf-makecache.timer
lrwxrwxrwx. 1 root root 41 May 8 2020 firewalld.service -> /usr/lib/systemd/system/firewalld.service
lrwxrwxrwx. 1 root root 42 May 8 2020 irqbalance.service -> /usr/lib/systemd/system/irqbalance.service
lrwxrwxrwx. 1 root root 37 May 8 2020 kdump.service -> /usr/lib/systemd/system/kdump.service
lrwxrwxrwx. 1 root root 35 Apr 19 12:07 ksm.service -> /usr/lib/systemd/system/ksm.service
lrwxrwxrwx. 1 root root 40 Apr 19 12:07 ksmtuned.service -> /usr/lib/systemd/system/ksmtuned.service
lrwxrwxrwx. 1 root root 46 May 8 2020 libstoragemgmt.service -> /usr/lib/systemd/system/libstoragemgmt.service
lrwxrwxrwx. 1 root root 40 Apr 19 12:07 libvirtd.service -> /usr/lib/systemd/system/libvirtd.service
lrwxrwxrwx. 1 root root 38 May 8 2020 mcelog.service -> /usr/lib/systemd/system/mcelog.service
lrwxrwxrwx. 1 root root 41 May 8 2020 mdmonitor.service -> /usr/lib/systemd/system/mdmonitor.service
lrwxrwxrwx. 1 root root 49 Apr 19 12:07 netcf-transaction.service -> /usr/lib/systemd/system/netcf-transaction.service
lrwxrwxrwx. 1 root root 46 May 8 2020 NetworkManager.service -> /usr/lib/systemd/system/NetworkManager.service
lrwxrwxrwx. 1 root root 41 Apr 19 12:07 nfs-client.target -> /usr/lib/systemd/system/nfs-client.target
lrwxrwxrwx. 1 root root 40 May 8 2020 remote-fs.target -> /usr/lib/systemd/system/remote-fs.target
lrwxrwxrwx. 1 root root 39 Apr 19 12:07 rpcbind.service -> /usr/lib/systemd/system/rpcbind.service
lrwxrwxrwx. 1 root root 39 May 8 2020 rsyslog.service -> /usr/lib/systemd/system/rsyslog.service
lrwxrwxrwx. 1 root root 38 May 8 2020 smartd.service -> /usr/lib/systemd/system/smartd.service
lrwxrwxrwx. 1 root root 36 May 8 2020 sshd.service -> /usr/lib/systemd/system/sshd.service
lrwxrwxrwx. 1 root root 36 May 8 2020 sssd.service -> /usr/lib/systemd/system/sss.service
lrwxrwxrwx. 1 root root 37 May 8 2020 tuned.service -> /usr/lib/systemd/system/tuned.service
lrwxrwxrwx. 1 root root 35 May 8 2020 vdo.service -> /usr/lib/systemd/system/vdo.service
```

```
[root@centos8 ~]# ls -l /usr/lib/systemd/system/multi-user.target.wants
total 0
lrwxrwxrwx. 1 root root 15 Apr 7 12:08 dbus.service -> ../dbus.service
lrwxrwxrwx. 1 root root 15 Apr 7 16:55 getty.target -> ../getty.target
```

```
lrwxrwxrwx. 1 root root 29 Oct 6 2020 plymouth-quit-wait.service -> ../plymouth-quit-wait.service
lrwxrwxrwx. 1 root root 33 Apr 7 16:55 systemd-ask-password-wall.path -> ../systemd-ask-password-wall.path
lrwxrwxrwx. 1 root root 25 Apr 7 16:55 systemd-logind.service -> ../systemd-logind.service
lrwxrwxrwx. 1 root root 39 Apr 7 16:55 systemd-update-utmp-runlevel.service -> ../systemd-update-utmp-runlevel.service
lrwxrwxrwx. 1 root root 32 Apr 7 16:55 systemd-user-sessions.service -> ../systemd-user-sessions.service
```

4.2 - The Default Target

Checking the Default Target

To check the default target, use the **systemctl get-default** command:

```
[root@centos8 ~]# systemctl get-default
multi-user.target
```

The default target is in fact a symbolic link:

```
[root@centos8 ~]# ls -l /etc/systemd/system/default.target
lrwxrwxrwx. 1 root root 37 May 8 2020 /etc/systemd/system/default.target -> /lib/systemd/system/multi-user.target
```

Changing the Default Target

To change the default target for the **next** boot process, use the **systemctl set-default** command:

```
[root@centos8 ~]# systemctl set-default graphical.target
Removed /etc/systemd/system/default.target.
Created symlink /etc/systemd/system/default.target -> /usr/lib/systemd/system/graphical.target.
[root@centos8 ~]# ls -l /etc/systemd/system/default.target
```

```
lrwxrwxrwx. 1 root root 40 Jun  6 08:11 /etc/systemd/system/default.target ->
/usr/lib/systemd/system/graphical.target
[root@centos8 ~]# systemctl set-default multi-user.target
Removed /etc/systemd/system/default.target.
Created symlink /etc/systemd/system/default.target → /usr/lib/systemd/system/multi-user.target.
[root@centos8 ~]# ls -l /etc/systemd/system/default.target
lrwxrwxrwx. 1 root root 41 Jun  6 08:11 /etc/systemd/system/default.target -> /usr/lib/systemd/system/multi-
user.target
```

Changing the Default Target for the Current Session

This can be done by using the **systemctl isolate** command:

```
[root@centos8 ~]# systemctl isolate rescue
[root@centos8 ~]# systemctl list-units --type target | egrep "eme|res|gra|mul" | head -1
rescue.target          loaded active active Rescue Mode
[root@centos8 ~]# runlevel
3 1
[root@centos8 ~]# who -r
          run-level 1  2021-06-15 04:22                last=3
```

```
[root@centos8 ~]# systemctl isolate multi-user
[root@centos8 ~]# systemctl list-units --type target | egrep "eme|res|gra|mul" | head -1
multi-user.target     loaded active active Multi-User System
[root@centos8 ~]# runlevel
1 3
[root@centos8 ~]# who -r
          run-level 3  2021-06-15 04:24                last=1
```

LAB #5 - Managing Services

5.1 - Single Service Instances

Start by installing **httpd** :

```
[root@centos8 ~]# dnf install httpd
```

To obtain information about a specific service, use the **systemctl status** command:

```
[root@centos8 ~]# systemctl status httpd.service
● httpd.service - The Apache HTTP Server
  Loaded: loaded (/usr/lib/systemd/system/httpd.service; disabled; vendor preset: disabled)
  Active: inactive (dead)
  Docs: man:httpd.service(8)
```

In the above output you can see that the service is **disabled**. The status can have one of two values:

- **disabled.**
- **enabled.**

You can also check if a service is enabled with the **systemctl is-enabled** command:

```
[root@centos8 ~]# systemctl is-enabled httpd.service
disabled
```

To configure the status as **enabled**, use the **systemctl enable** command:

```
[root@centos8 ~]# systemctl enable httpd.service
Created symlink /etc/systemd/system/multi-user.target.wants/httpd.service →
/usr/lib/systemd/system/httpd.service.
```

```
[root@centos8 ~]# systemctl is-enabled httpd.service
enabled
```

```
[root@centos8 ~]# systemctl status httpd.service
● httpd.service - The Apache HTTP Server
  Loaded: loaded (/usr/lib/systemd/system/httpd.service; enabled; vendor preset: disabled)
  Active: inactive (dead)
  Docs: man:httpd.service(8)
```

In the above output, you can now see that the status is **inactive (dead)**. The status can have one of 7 values:

- **inactive (dead)**
- **active(running)**
- **active(exited)**
- **active(waiting)**
- **activating**
- **deactivating**
- **failed**

You can also check if a service is active with the **systemctl is-active** command:

```
[root@centos8 ~]# systemctl is-active httpd.service
inactive
```

To set the service to **active(running)**, use the following command:

```
[root@centos8 ~]# systemctl start httpd.service
```

Now check the service status:

```
[root@centos8 ~]# systemctl is-active httpd.service
active

[root@centos8 ~]# systemctl status httpd.service
● httpd.service - The Apache HTTP Server
  Loaded: loaded (/usr/lib/systemd/system/httpd.service; enabled; vendor preset: disabled)
  Active: active (running) since Sun 2021-06-06 15:33:06 EDT; 14s ago
```

```
Docs: man:httpd.service(8)
Main PID: 34382 (httpd)
Status: "Running, listening on: port 80"
Tasks: 213 (limit: 23719)
Memory: 36.3M
CGroup: /system.slice/httpd.service
├─34382 /usr/sbin/httpd -DFOREGROUND
├─34383 /usr/sbin/httpd -DFOREGROUND
├─34384 /usr/sbin/httpd -DFOREGROUND
├─34385 /usr/sbin/httpd -DFOREGROUND
└─34386 /usr/sbin/httpd -DFOREGROUND
```

```
Jun 06 15:33:05 centos8.ittraining.loc systemd[1]: Starting The Apache HTTP Server...
Jun 06 15:33:06 centos8.ittraining.loc systemd[1]: Started The Apache HTTP Server.
Jun 06 15:33:06 centos8.ittraining.loc httpd[34382]: Server configured, listening on: port 80
```

To stop a service use the following command:

```
[root@centos8 ~]# systemctl stop httpd.service
[root@centos8 ~]# systemctl status httpd.service
● httpd.service - The Apache HTTP Server
   Loaded: loaded (/usr/lib/systemd/system/httpd.service; enabled; vendor preset: disabled)
   Active: inactive (dead) since Sun 2021-06-06 23:58:04 EDT; 8s ago
     Docs: man:httpd.service(8)
  Process: 34382 ExecStart=/usr/sbin/httpd $OPTIONS -DFOREGROUND (code=exited, status=0/SUCCESS)
 Main PID: 34382 (code=exited, status=0/SUCCESS)
   Status: "Running, listening on: port 80"

Jun 06 15:33:05 centos8.ittraining.loc systemd[1]: Starting The Apache HTTP Server...
Jun 06 15:33:06 centos8.ittraining.loc systemd[1]: Started The Apache HTTP Server.
Jun 06 15:33:06 centos8.ittraining.loc httpd[34382]: Server configured, listening on: port 80
Jun 06 23:58:02 centos8.ittraining.loc systemd[1]: Stopping The Apache HTTP Server...
Jun 06 23:58:04 centos8.ittraining.loc systemd[1]: httpd.service: Succeeded.
```

```
Jun 06 23:58:04 centos8.ittraining.loc systemd[1]: Stopped The Apache HTTP Server.
```

To disable a service for the next boot sequence, use the **disable** sub-command:

```
[root@centos8 ~]# systemctl disable httpd.service
Removed /etc/systemd/system/multi-user.target.wants/httpd.service.
[root@centos8 ~]# systemctl status httpd.service
● httpd.service - The Apache HTTP Server
   Loaded: loaded (/usr/lib/systemd/system/httpd.service; disabled; vendor preset: disabled)
   Active: inactive (dead)
     Docs: man:httpd.service(8)

Jun 06 15:33:05 centos8.ittraining.loc systemd[1]: Starting The Apache HTTP Server...
Jun 06 15:33:06 centos8.ittraining.loc systemd[1]: Started The Apache HTTP Server.
Jun 06 15:33:06 centos8.ittraining.loc httpd[34382]: Server configured, listening on: port 80
Jun 06 23:58:02 centos8.ittraining.loc systemd[1]: Stopping The Apache HTTP Server...
Jun 06 23:58:04 centos8.ittraining.loc systemd[1]: httpd.service: Succeeded.
Jun 06 23:58:04 centos8.ittraining.loc systemd[1]: Stopped The Apache HTTP Server.
```

5.2 - Multiple Instance Services

Systemd permits the use of unit configuration file templates. In this way, multiple service instances can co-exist. A template can be recognised by its name which contains the @ character:

```
[root@centos8 ~]# cat /usr/lib/systemd/system/httpd@.service
# This is a template for httpd instances.
# See httpd@.service(8) for more information.

[Unit]
Description=The Apache HTTP Server
After=network.target remote-fs.target nss-lookup.target
Documentation=man:httpd@.service(8)
```

```
[Service]
Type=notify
Environment=LANG=C
Environment=HTTPD_INSTANCE=%i
ExecStartPre=/bin/mkdir -m 710 -p /run/httpd/instance-%i
ExecStartPre=/bin/chown root.apache /run/httpd/instance-%i
ExecStart=/usr/sbin/httpd $OPTIONS -DFOREGROUND -f conf/%i.conf
ExecReload=/usr/sbin/httpd $OPTIONS -k graceful -f conf/%i.conf
# Send SIGWINCH for graceful stop
KillSignal=SIGWINCH
KillMode=mixed
PrivateTmp=true

[Install]
WantedBy=multi-user.target
```

An instance created from this template must have a name of the following format:

```
httpd@<nom_instance>.service
```

In the configuration file you can see an **%i** which is called an **identifier**. Identifiers can be of two types - **escaped** where alphanumeric non-ASCII characters are replaced with C language **escapes** whilst the other type is **non-escaped**:

- **%n** : is replaced by the escaped or non-escaped name of the unit.
- **%N** : is replaced by unit's complete non-escaped name.
- **%p** : is replaced by the prefix - the part of the name before the **@** of an escaped unit.
- **%P** : is replaced by the prefix - part of the name before the **@** of a non-escaped unit.
- **%i** : is replaced by the part of the name after the **@** and before the **.** of an escaped unit.
- **%l** : is replaced by the part of the name after the **@** and before the **.** of a non-escaped unit.
- **%f** : is replaced by a **/** character followed by the prefix of the name of a non-escaped unit.
- **%c** : is replaced by unit's CGroup without **/sys/fs/cgroup/systemd/**.
- **%u** : is replaced by the name of the user responsible for the execution of the unit.
- **%U** : is replaced by the UID of the user responsible for the execution of the unit.
- **%H** : is replaced by the hostname of the system on which the unit is executed.

- %% : is replaced by % character.

Now create **two** copies of the `/usr/lib/systemd/system/httpd@.service` file:

```
[root@centos8 ~]# cp /usr/lib/systemd/system/httpd@.service /usr/lib/systemd/system/httpd@instance01.service
[root@centos8 ~]# cp /usr/lib/systemd/system/httpd@.service /usr/lib/systemd/system/httpd@instance02.service
```

Create **two** copies of the `/etc/httpd/conf/httpd.conf` file:

```
[root@centos8 ~]# cp /etc/httpd/conf/httpd.conf /etc/httpd/conf/instance01.conf
[root@centos8 ~]# cp /etc/httpd/conf/httpd.conf /etc/httpd/conf/instance02.conf
```

Change the value of the **Listen** directive and **add* the PidFile directive in the `/etc/httpd/conf/instance01.conf` file:** `[root@centos8 ~]# vi /etc/httpd/conf/instance01.conf` `[root@centos8 ~]# more /etc/httpd/conf/instance01.conf` **# This is the main Apache HTTP server configuration file. It contains the # configuration directives that give the server its instructions. # See <URL:<http://httpd.apache.org/docs/2.4/>> for detailed information. # In particular, see # <URL:<http://httpd.apache.org/docs/2.4/mod/directives.html>> # for a discussion of each configuration directive. # # See the httpd.conf(5) man page for more information on this configuration, # and httpd.service(8) on using and configuring the httpd service. # # Do NOT simply read the instructions in here without understanding # what they do. They're here only as hints or reminders. If you are unsure # consult the online docs. You have been warned. # # Configuration and logfile names: If the filenames you specify for many # of the server's control files begin with "/" (or "drive:/" for Win32), the # server will use that explicit path. If the filenames do *not* begin # with "/", the value of ServerRoot is prepended - so 'log/access_log' # with ServerRoot set to '/www' will be interpreted by the # server as '/www/log/access_log', where as '/log/access_log' will be # interpreted as '/log/access_log'. # # ServerRoot: The top of the directory tree under which the server's # configuration, error, and log files are kept. # # Do not add a slash at the end of the directory path. If you point # ServerRoot at a non-local disk, be sure to specify a local disk on the # Mutex directive, if file-based mutexes are used. If you wish to share the # same ServerRoot for multiple httpd daemons, you will need to change at # least PidFile. # ServerRoot "/etc/httpd" # # Listen: Allows you to bind Apache to specific IP addresses and/or # ports, instead of the default. See also the <VirtualHost> # directive. # # Change this to Listen on specific IP addresses as shown below to # prevent Apache from glomming onto all bound IP addresses. # #Listen 12.34.56.78:80 Listen 8008 PidFile /var/run/httpd/instance01.pid # # Dynamic Shared Object (DSO) Support # # To be able to use the functionality of a module which was built as a DSO you # have to place corresponding `LoadModule' lines at this location so the # directives contained in it are actually available _before_ they are used. # Statically compiled modules (those listed by `httpd -l') do not need # to be loaded here. # # Example: # LoadModule foo_module modules/mod_foo.so -More-(19%)** `</code>` **Change the value of the Listen directive and add* the PidFile directive in the `/etc/httpd/conf/instance02.conf` file:**

```
[root@centos8 ~]# vi /etc/httpd/conf/instance02.conf
[root@centos8 ~]# more /etc/httpd/conf/instance02.conf
#
# This is the main Apache HTTP server configuration file. It contains the
# configuration directives that give the server its instructions.
# See <URL:http://httpd.apache.org/docs/2.4/> for detailed information.
# In particular, see
# <URL:http://httpd.apache.org/docs/2.4/mod/directives.html>
# for a discussion of each configuration directive.
#
# See the httpd.conf(5) man page for more information on this configuration,
# and httpd.service(8) on using and configuring the httpd service.
#
# Do NOT simply read the instructions in here without understanding
# what they do. They're here only as hints or reminders. If you are unsure
# consult the online docs. You have been warned.
#
# Configuration and logfile names: If the filenames you specify for many
# of the server's control files begin with "/" (or "drive:/" for Win32), the
# server will use that explicit path. If the filenames do *not* begin
# with "/", the value of ServerRoot is prepended -- so 'log/access_log'
# with ServerRoot set to '/www' will be interpreted by the
# server as '/www/log/access_log', where as '/log/access_log' will be
# interpreted as '/log/access_log'.
#
# ServerRoot: The top of the directory tree under which the server's
# configuration, error, and log files are kept.
#
# Do not add a slash at the end of the directory path. If you point
# ServerRoot at a non-local disk, be sure to specify a local disk on the
# Mutex directive, if file-based mutexes are used. If you wish to share the
# same ServerRoot for multiple httpd daemons, you will need to change at
# least PidFile.
```

```
#
ServerRoot "/etc/httpd"

#
# Listen: Allows you to bind Apache to specific IP addresses and/or
# ports, instead of the default. See also the <VirtualHost>
# directive.
#
# Change this to Listen on specific IP addresses as shown below to
# prevent Apache from glomming onto all bound IP addresses.
#
#Listen 12.34.56.78:80
Listen 8009
PidFile /var/run/httpd/instance02.pid
#
# Dynamic Shared Object (DSO) Support
#
# To be able to use the functionality of a module which was built as a DSO you
# have to place corresponding `LoadModule' lines at this location so the
# directives contained in it are actually available _before_ they are used.
# Statically compiled modules (those listed by `httpd -l') do not need
# to be loaded here.
#
# Example:
# LoadModule foo_module modules/mod_foo.so
--More-- (19%)
```

Now start both services:

```
[root@centos8 ~]# systemctl start httpd@instance01.service
[root@centos8 ~]# systemctl status httpd@instance01.service
● httpd@instance01.service - The Apache HTTP Server
   Loaded: loaded (/usr/lib/systemd/system/httpd@instance01.service; disabled; vendor preset: disabled)
   Active: active (running) since Mon 2021-06-07 01:40:43 EDT; 7s ago
```

```
Docs: man:httpd@.service(8)
Process: 43854 ExecStartPre=/bin/chown root.apache /run/httpd/instance-instance01 (code=exited,
status=0/SUCCESS)
Process: 43852 ExecStartPre=/bin/mkdir -m 710 -p /run/httpd/instance-instance01 (code=exited, status=0/SUCCESS)
Main PID: 43856 (httpd)
Status: "Started, listening on: port 8008"
Tasks: 213 (limit: 23719)
Memory: 43.6M
CGroup: /system.slice/system-httpd.slice/httpd@instance01.service
├─43856 /usr/sbin/httpd -DFOREGROUND -f conf/instance01.conf
├─43857 /usr/sbin/httpd -DFOREGROUND -f conf/instance01.conf
├─43858 /usr/sbin/httpd -DFOREGROUND -f conf/instance01.conf
├─43859 /usr/sbin/httpd -DFOREGROUND -f conf/instance01.conf
└─43860 /usr/sbin/httpd -DFOREGROUND -f conf/instance01.conf

Jun 07 01:40:43 centos8.ittraining.loc systemd[1]: Starting The Apache HTTP Server...
Jun 07 01:40:43 centos8.ittraining.loc systemd[1]: Started The Apache HTTP Server.
Jun 07 01:40:43 centos8.ittraining.loc httpd[43856]: Server configured, listening on: port 8008
[root@centos8 ~]# systemctl start httpd@instance02.service
[root@centos8 ~]# systemctl status httpd@instance02.service
● httpd@instance02.service - The Apache HTTP Server
   Loaded: loaded (/usr/lib/systemd/system/httpd@instance02.service; disabled; vendor preset: disabled)
   Active: active (running) since Mon 2021-06-07 01:36:45 EDT; 4min 24s ago
     Docs: man:httpd@.service(8)
  Process: 43568 ExecStartPre=/bin/chown root.apache /run/httpd/instance-instance02 (code=exited,
status=0/SUCCESS)
  Process: 43566 ExecStartPre=/bin/mkdir -m 710 -p /run/httpd/instance-instance02 (code=exited, status=0/SUCCESS)
 Main PID: 43569 (httpd)
  Status: "Running, listening on: port 8009"
    Tasks: 213 (limit: 23719)
  Memory: 43.6M
  CGroup: /system.slice/system-httpd.slice/httpd@instance02.service
          ├─43569 /usr/sbin/httpd -DFOREGROUND -f conf/instance02.conf
          └─43571 /usr/sbin/httpd -DFOREGROUND -f conf/instance02.conf
```

```
├─43572 /usr/sbin/httpd -DFOREGROUND -f conf/instance02.conf
├─43573 /usr/sbin/httpd -DFOREGROUND -f conf/instance02.conf
└─43574 /usr/sbin/httpd -DFOREGROUND -f conf/instance02.conf
```

```
Jun 07 01:36:45 centos8.ittraining.loc systemd[1]: Starting The Apache HTTP Server...
Jun 07 01:36:45 centos8.ittraining.loc systemd[1]: Started The Apache HTTP Server.
Jun 07 01:36:45 centos8.ittraining.loc httpd[43569]: Server configured, listening on: port 8009
```

5.3 - Disallowing Modifications to a Service Status

It is possible to disallow modifications to a service status by using the **systemctl mask** command:

```
[root@centos8 ~]# systemctl status httpd.service
● httpd.service - The Apache HTTP Server
   Loaded: loaded (/usr/lib/systemd/system/httpd.service; disabled; vendor preset: disabled)
   Active: inactive (dead)
     Docs: man:httpd.service(8)

Jun 07 18:27:25 centos8.ittraining.loc httpd[58535]: Server configured, listening on: port 80
Jun 07 18:27:29 centos8.ittraining.loc systemd[1]: Stopping The Apache HTTP Server...
Jun 07 18:27:30 centos8.ittraining.loc systemd[1]: httpd.service: Succeeded.
Jun 07 18:27:30 centos8.ittraining.loc systemd[1]: Stopped The Apache HTTP Server.
Jun 07 18:27:32 centos8.ittraining.loc systemd[1]: Starting The Apache HTTP Server...
Jun 07 18:27:32 centos8.ittraining.loc systemd[1]: Started The Apache HTTP Server.
Jun 07 18:27:32 centos8.ittraining.loc httpd[58760]: Server configured, listening on: port 80
Jun 07 18:27:34 centos8.ittraining.loc systemd[1]: Stopping The Apache HTTP Server...
Jun 07 18:27:36 centos8.ittraining.loc systemd[1]: httpd.service: Succeeded.
Jun 07 18:27:36 centos8.ittraining.loc systemd[1]: Stopped The Apache HTTP Server.

[root@centos8 ~]# systemctl mask httpd.service
Created symlink /etc/systemd/system/httpd.service → /dev/null.

[root@centos8 ~]# systemctl enable httpd.service
```

```
Failed to enable unit: Unit file /etc/systemd/system/httpd.service is masked.
```

```
[root@centos8 ~]# systemctl start httpd.service
Failed to start httpd.service: Unit httpd.service is masked.
```

To once again allow modifications, use the **systemctl unmask** command:

```
[root@centos8 ~]# systemctl unmask httpd.service
Removed /etc/systemd/system/httpd.service.
```

```
[root@centos8 ~]# systemctl enable httpd.service
Created symlink /etc/systemd/system/multi-user.target.wants/httpd.service →
/usr/lib/systemd/system/httpd.service.
```

```
[root@centos8 ~]# systemctl start httpd.service
```

```
[root@centos8 ~]# systemctl status httpd.service
```

```
● httpd.service - The Apache HTTP Server
   Loaded: loaded (/usr/lib/systemd/system/httpd.service; enabled; vendor preset: disabled)
   Active: active (running) since Mon 2021-06-07 18:30:59 EDT; 5s ago
     Docs: man:httpd.service(8)
  Main PID: 59101 (httpd)
    Status: "Started, listening on: port 80"
   Tasks: 213 (limit: 23719)
  Memory: 39.4M
   CGroup: /system.slice/httpd.service
           └─59101 /usr/sbin/httpd -DFOREGROUND
             └─59102 /usr/sbin/httpd -DFOREGROUND
               └─59103 /usr/sbin/httpd -DFOREGROUND
                 └─59104 /usr/sbin/httpd -DFOREGROUND
                   └─59105 /usr/sbin/httpd -DFOREGROUND
```

```
Jun 07 18:30:59 centos8.ittraining.loc systemd[1]: Starting The Apache HTTP Server...
```

```
Jun 07 18:30:59 centos8.ittraining.loc systemd[1]: Started The Apache HTTP Server.
```

```
Jun 07 18:31:00 centos8.ittraining.loc httpd[59101]: Server configured, listening on: port 80
```

LAB #6 - System Shutdown

Using RHEL / CentOS 8 the **halt**, **poweroff**, **reboot** and **shutdown** commands are all soft links pointing to **/bin/systemctl** :

```
[root@centos8 ~]# ls -l /usr/sbin/shutdown /usr/sbin/halt /usr/sbin/poweroff /usr/sbin/reboot
lrwxrwxrwx. 1 root root 16 Apr  7 16:55 /usr/sbin/halt -> ../bin/systemctl
lrwxrwxrwx. 1 root root 16 Apr  7 16:55 /usr/sbin/poweroff -> ../bin/systemctl
lrwxrwxrwx. 1 root root 16 Apr  7 16:55 /usr/sbin/reboot -> ../bin/systemctl
lrwxrwxrwx. 1 root root 16 Apr  7 16:55 /usr/sbin/shutdown -> ../bin/systemctl
```

The correct way to use these four commands is now:

- systemctl halt
- systemctl poweroff
- systemctl reboot
- systemctl shutdown

However you can still use the **halt**, **poweroff**, **reboot** and **shutdown** commands without specifying systemctl.

6.1 - The shutdown Command

The shutdown command's procedure includes :

- informing all connected users that the machine will shutdown,
- stopping all started services,
- committing all data to disk,
- unmounting all mounted filesystems.

shutdown's command line switches are as follows:

```
[root@centos8 ~]# shutdown --help
shutdown [OPTIONS...] [TIME] [WALL...]
```

Shut down the system.

```
--help      Show this help
-H --halt    Halt the machine
-P --poweroff Power-off the machine
-r --reboot  Reboot the machine
-h          Equivalent to --poweroff, overridden by --halt
-k          Don't halt/power-off/reboot, just send warnings
--no-wall   Don't send wall message before halt/power-off/reboot
-c          Cancel a pending shutdown
```

The **time** argument can take several values:

Value	Description
hh:mm	The time at which to shutdown
+m	Shutdown the system in m minutes
now	Shutdown immediately



Important : If a shutdown is programmed for less than 5 minutes in the future any future connections are rejected, including those for root.

6.2 - The reboot command

This command calls the **shutdown -r** command.

reboot's command line switches are as follows:

```
[root@centos8 ~]# reboot --help
reboot [OPTIONS...] [ARG]
```

Reboot the system.

```
  --help      Show this help
  --halt      Halt the machine
-p --poweroff Switch off the machine
  --reboot    Reboot the machine
-f --force    Force immediate halt/power-off/reboot
-w --wtmp-only Don't halt/power-off/reboot, just write wtmp record
-d --no-wtmp  Don't write wtmp record
  --no-wall   Don't send wall message before halt/power-off/reboot
```

6.3 - The halt Command

This command calls the **shutdown -h** command.

halt's command line switches are as follows:

```
[root@centos8 ~]# halt --help
halt [OPTIONS...]
```

Halt the system.

```
  --help      Show this help
  --halt      Halt the machine
-p --poweroff Switch off the machine
  --reboot    Reboot the machine
-f --force    Force immediate halt/power-off/reboot
-w --wtmp-only Don't halt/power-off/reboot, just write wtmp record
-d --no-wtmp  Don't write wtmp record
```

```
--no-wall    Don't send wall message before halt/power-off/reboot
```

6.4 - The poweroff Command

This command calls the **shutdown -hP** command.

halt's command line switches are as follows:

```
[root@centos8 ~]# poweroff --help
poweroff [OPTIONS...]
```

Power off the system.

```
--help      Show this help
--halt      Halt the machine
-p --poweroff Switch off the machine
--reboot    Reboot the machine
-f --force   Force immediate halt/power-off/reboot
-w --wtmp-only Don't halt/power-off/reboot, just write wtmp record
-d --no-wtmp Don't write wtmp record
--no-wall   Don't send wall message before halt/power-off/reboot
```

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