

UCSD Embedded Linux Assignment 3

By

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Step 1. /sbin/init

```
raspberrypi.local - pi@raspberrypi: ~ VT
File Edit Setup Control Window Help

pi@raspberrypi:~$ ps aux
USER      PID %CPU %MEM    USZ    RSS TTY      STAT START   TIME COMMAND
root         1   0.5   0.2 33756   8788 ?        Ss   03:16   0:02 /sbin/init splash
root         2   0.0   0.0     0     0 ?        S    03:16   0:00 [kthreadd]
root         3   0.0   0.0     0     0 ?        I<   03:16   0:00 [rcu_gpl]
pi@raspberrypi:~$ ls -l /sbin/init
lrwxrwxrwx 1 root root 20 Sep 13  2022 /sbin/init -> /lib/systemd/systemd
pi@raspberrypi:~$
```

Step 2. pstree -p

 raspberrypi.local - pi@raspberrypi: ~ VT

File Edit Setup Control Window Help

[illegible]

Step 3. man systemd

```
raspberrypi.local - pi@raspberrypi: ~ VT
File Edit Setup Control Window Help
SYSTEMD(1)                                systemd                                SYSTEMD(1)
NAME
    systemd, init - systemd system and service manager

SYNOPSIS
    /lib/systemd/systemd [OPTIONS...]

    init [OPTIONS...] <COMMAND>

DESCRIPTION
    systemd is a system and service manager for Linux operating systems. When run as first process on boot (as PID 1), it acts as init system that brings up and maintains userspace services. Separate instances are started for logged-in users to start their services.

    systemd is usually not invoked directly by the user, but is installed as the /sbin/init symlink and started during early boot. The user manager instances are started automatically through the user@.service(5) service.

    For compatibility with SysV, if the binary is called as init and is not the first process on the machine (PID is not 1), it will execute telinit and pass all command line arguments unmodified. That means init and telinit are mostly equivalent when invoked from normal login sessions. See telinit(8) for more information.

    When run as a system instance, systemd interprets the configuration file system.conf and the files in system.conf.d directories; when run as a user instance, systemd interprets the configuration file user.conf and the files in user.conf.d directories. See systemd-system.conf(5) for more information.

CONCEPTS
    systemd provides a dependency system between various entities called "units" of 11 different types. Units encapsulate various objects that are relevant for system boot-up and maintenance. The majority of units are configured in unit configuration files, whose syntax and basic set of options is described in systemd.unit(5), however some are created automatically from other configuration, dynamically from system state or programmatically at runtime. Units may be "active" (meaning started, bound, plugged in, ..., depending on the unit type, see below), or "inactive" (meaning stopped, unbound, unplugged, ...), as well as in the process of being activated or deactivated, i.e. between the two states (these states are called "activating", "deactivating"). A special "failed" state is available as well, which is very similar to "inactive" and is entered when the service failed in some way (process returned error code on exit, or crashed, an operation timed out, or after too many restarts). If this state is entered, the cause will be logged, for later reference. Note that the various unit types may have a number of additional substates, which are mapped to the five generalized unit states described here.

    The following unit types are available:

    1. Service units, which start and control daemons and the processes they consist of. For details, see systemd.service(5).

    2. Socket units, which encapsulate local IPC or network sockets in the system, useful for socket-based activation. For details about socket units, see systemd.socket(5), for details on socket-based activation and other forms of activation, see daemon(?).

    3. Target units are useful to group units, or provide well-known synchronization points during boot-up, see
Manual page systemd(1) line 1 (press h for help or q to quit)
```

Step 4. man systemctl

```
raspberrypi.local - pi@raspberrypi: ~ VT
File Edit Setup Control Window Help
SYSTEMCTL<1>                                systemctl                                SYSTEMCTL<1>
NAME
systemctl - Control the systemd system and service manager

SYNOPSIS
systemctl [OPTIONS...] COMMAND [UNIT...]

DESCRIPTION
systemctl may be used to introspect and control the state of the "systemd" system and service manager. Please refer to systemd(1) for an introduction into the basic concepts and functionality this tool manages.

COMMANDS
The following commands are understood:

Unit Commands (Introspection and Modification)
list-units [PATTERN...]
List units that systemd currently has in memory. This includes units that are either referenced directly or through a dependency, units that are pinned by applications programmatically, or units that were active in the past and have failed. By default only units which are active, have pending jobs, or have failed are shown; this can be changed with option --all. If one or more PATTERNS are specified, only units matching one of them are shown. The units that are shown are additionally filtered by --type= and --state= if those options are specified.

Produces output similar to

UNIT                                LOAD    ACTIVE SUB    DESCRIPTION
sys-module-fuse.device             loaded active plugged /sys/module/fuse
-.mount                            loaded active mounted Root Mount
boot-efi.mount                     loaded active mounted /boot/efi
systemd-journald.service           loaded active running Journal Service
systemd-logind.service             loaded active running Login Service
? user@1000.service                loaded failed failed  User Manager for UID 1000
...
systemd-tmpfiles-clean.timer        loaded active waiting Daily Cleanup of Temporary Directories

LOAD    = Reflects whether the unit definition was properly loaded.
ACTIVE  = The high-level unit activation state, i.e. generalization of SUB.
SUB      = The low-level unit activation state, values depend on unit type.

123 loaded units listed. Pass --all to see loaded but inactive units, too.
To show all installed unit files use 'systemctl list-unit-files'.

The header and the last unit of a given type are underlined if the terminal supports that. A colored dot is shown next to services which were masked, not found, or otherwise failed.

The LOAD column shows the load state, one of loaded, not-found, bad-setting, error, masked. The ACTIVE column shows the general unit state, one of active, reloading, inactive, failed, activating, deactivating. The SUB column shows the unit-type-specific detailed state of the unit, possible values vary by unit type. The list of possible LOAD, ACTIVE, and SUB states is not constant and new systemd releases

Manual page systemctl(1) line 1 (press h for help or q to quit)
```

Step 5. /etc/systemd

```
raspberrypi.local - pi@raspberrypi: ~ VT
File Edit Setup Control Window Help
pi@raspberrypi:~$ ls /etc/systemd
journald.conf  network  pstore.conf  sleep.conf  system.conf  user
logind.conf    networkd.conf  resolved.conf  system  timesyncd.conf  user.conf
pi@raspberrypi:~$
```

Step 6. /etc/systemd/system.conf

```
raspberrypi.local - pi@raspberrypi: ~ VT
File Edit Setup Control Window Help
pi@raspberrypi:~$ cat /etc/systemd/system.conf
# 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.
#
# Entries in this file show the compile time defaults.
# You can change settings by editing this file.
# Defaults can be restored by simply deleting this file.
#
# See systemd-system.conf(5) for details.

[Manager]
#LogLevel=info
#LogTarget=journal-or-kmsg
#LogColor=yes
#LogLocation=no
#LogTime=no
#DumpCore=yes
#ShowStatus=yes
#CrashChangeUT=no
#CrashShell=no
#CrashReboot=no
#CtrlAltDelBurstAction=reboot-force
#CPUAffinity=1 2
#NUMAPolicy=default
#NUMAMask=
#RuntimeWatchdogSec=0
#RebootWatchdogSec=10min
#ShutdownWatchdogSec=10min
#KExecWatchdogSec=0
#WatchdogDevice=
#CapabilityBoundingSet=
#NoNewPrivileges=no
#SystemCallArchitectures=
#TimerSlackNSec=
#StatusUnitFormat=description
#DefaultTimerAccuracySec=1min
#DefaultStandardOutput=journal
#DefaultStandardError=inherit
#DefaultTimeoutStartSec=90s
#DefaultTimeoutStopSec=90s
#DefaultTimeoutAbortSec=
#DefaultRestartSec=100ms
#DefaultStartLimitIntervalSec=10s
#DefaultStartLimitBurst=5
#DefaultEnvironment=
#DefaultCPUAccounting=no
#DefaultIOAccounting=no
```

Step 7. /etc/systemd/system

```

T raspberrypi.local - pi@raspberrypi: ~ VT
File Edit Setup Control Window Help
pi@raspberrypi:~ $ ls /etc/systemd/system
bluetooth.target.wants      dhcpcd.service.d           printer.target.wants
dbus-fi.wi.wpa_supplicant1.service  display-manager.service    rc-local.service.d
dbus-org.bluez.service      getty.target.wants          reboot.target.wants
dbus-org.freedesktop.Avahi.service  getty@tty1.service.d       remote-fs.target.wants
dbus-org.freedesktop.ModemManager1.service  graphical.target.wants    sockets.target.wants
dbus-org.freedesktop.timesync1.service  halt.target.wants          sshd.service
default.target               multi-user.target.wants     sysinit.target.wants
default.target.wants         network-online.target.wants syslog.service
dev-serial1.device.wants     poweroff.target.wants      timers.target.wants
pi@raspberrypi:~ $
```


Step 8. man systemd.unit.

```
raspberrypi.local - pi@raspberrypi: ~ VT
File Edit Setup Control Window Help
SYSTEMD.UNIT<5>          systemd.unit          SYSTEMD.UNIT<5>
NAME
    systemd.unit - Unit configuration

SYNOPSIS
    service.service, socket.socket, device.device, mount.mount, automount.automount, swap.swap, target.target,
    path.path, timer.timer, slice.slice, scope.scope

    System Unit Search Path
    /etc/systemd/system.control/*
    /run/systemd/system.control/*
    /run/systemd/transient/*
    /run/systemd/generator.early/*
    /etc/systemd/system/*
    /etc/systemd/systemd.attached/*
    /run/systemd/system/*
    /run/systemd/systemd.attached/*
    /run/systemd/generator/*
    ...
    /lib/systemd/system/*
    /run/systemd/generator.late/*

    User Unit Search Path
    ~/.config/systemd/user.control/*
    $XDG_RUNTIME_DIR/systemd/user.control/*
    $XDG_RUNTIME_DIR/systemd/transient/*
    $XDG_RUNTIME_DIR/systemd/generator.early/*
    $XDG_CONFIG_HOME/systemd/user/*
    $XDG_CONFIG_DIRS/systemd/user/*
    /etc/systemd/user/*
    $XDG_RUNTIME_DIR/systemd/user/*
    /run/systemd/user/*
    $XDG_RUNTIME_DIR/systemd/generator/*
    $XDG_DATA_HOME/systemd/user/*
    $XDG_DATA_DIRS/systemd/user/*
    ...
    /usr/lib/systemd/user/*
    $XDG_RUNTIME_DIR/systemd/generator.late/*

DESCRIPTION
    A unit file is a plain text ini-style file that encodes information about a service, a socket, a device, a
    mount point, an automount point, a swap file or partition, a start-up target, a watched file system path, a
    timer controlled and supervised by systemd(1), a resource management slice or a group of externally created
    processes. See systemd.syntax(7) for a general description of the syntax.

    This man page lists the common configuration options of all the unit types. These options need to be
    configured in the [Unit] or [Install] sections of the unit files.

    In addition to the generic [Unit] and [Install] sections described here, each unit may have a type-specific
    Manual page systemd.unit<5> line 1 (press h for help or q to quit)
```

Step 9. systemctl

```
raspberrypi.local - pi@raspberrypi: ~ VT
File Edit Setup Control Window Help

UNIT                                LOAD    ACTIVE SUB
proc-sys-fs-binfmt_misc.automount  loaded active waiti
sys-devices-platform-emmc2bus-fe340000.mmc-mmc_host-mmc0-mmc0:aaaa-block-mmcblk0-mmcblk0p1.device loaded active plugg
sys-devices-platform-emmc2bus-fe340000.mmc-mmc_host-mmc0-mmc0:aaaa-block-mmcblk0-mmcblk0p2.device loaded active plugg
sys-devices-platform-emmc2bus-fe340000.mmc-mmc_host-mmc0-mmc0:aaaa-block-mmcblk0.device loaded active plugg
sys-devices-platform-scb-fd580000.ethernet-net-eth0.device loaded active plugg
sys-devices-platform-soc-fe00b840.mailbox-bcm2835_audio-sound-card0-controlC0.device loaded active plugg
sys-devices-platform-soc-fe201000.serial-tty-ttyAMA0-hci0.device loaded active plugg
sys-devices-platform-soc-fe201000.serial-tty-ttyAMA0.device loaded active plugg
sys-devices-platform-soc-fe215040.serial-tty-ttyS0.device loaded active plugg
sys-devices-platform-soc-fe300000.mmcnr-mmc_host-mmc1-mmc1:0001-mmc1:0001:1-net-wlan0.device loaded active plugg
sys-devices-platform-soc-fef00700.hdmi-sound-card1-controlC1.device loaded active plugg
sys-devices-platform-soc-fef05700.hdmi-sound-card2-controlC2.device loaded active plugg
sys-devices-virtual-block-ram0.device loaded active plugg
sys-devices-virtual-block-ram1.device loaded active plugg
sys-devices-virtual-block-ram10.device loaded active plugg
sys-devices-virtual-block-ram11.device loaded active plugg
sys-devices-virtual-block-ram12.device loaded active plugg
sys-devices-virtual-block-ram13.device loaded active plugg
sys-devices-virtual-block-ram14.device loaded active plugg
sys-devices-virtual-block-ram15.device loaded active plugg
sys-devices-virtual-block-ram2.device loaded active plugg
sys-devices-virtual-block-ram3.device loaded active plugg
sys-devices-virtual-block-ram4.device loaded active plugg
sys-devices-virtual-block-ram5.device loaded active plugg
sys-devices-virtual-block-ram6.device loaded active plugg
sys-devices-virtual-block-ram7.device loaded active plugg
sys-devices-virtual-block-ram8.device loaded active plugg
sys-devices-virtual-block-ram9.device loaded active plugg
sys-devices-virtual-misc-rfkill.device loaded active plugg
sys-devices-virtual-tty-ttyprintk.device loaded active plugg
sys-module-configfs.device loaded active plugg
sys-module-fuse.device loaded active plugg
sys-subsystem-bluetooth-devices-hci0.device loaded active plugg
sys-subsystem-net-devices-eth0.device loaded active plugg
sys-subsystem-net-devices-wlan0.device loaded active plugg
-.mount loaded active mount
boot.mount loaded active mount
dev-mqueue.mount loaded active mount
run-rpc_pipefs.mount loaded active mount
run-user-1000-gvfs.mount loaded active mount
run-user-1000.mount loaded active mount
sys-fs-fuse-connections.mount loaded active mount
sys-kernel-config.mount loaded active mount
sys-kernel-debug.mount loaded active mount
sys-kernel-tracing.mount loaded active mount
cups.path loaded active runni
systemd-ask-password-plymouth.path loaded active waiti
systemd-ask-password-wall.path loaded active waiti
init.scope loaded active runni
lines 1-50
```

Step 10. systemctl status

```
raspberrypi.local - pi@raspberrypi: ~ VT
File Edit Setup Control Window Help
? raspberrypi
  State: running
  Jobs: 0 queued
  Failed: 0 units
  Since: Thu 1970-01-01 01:00:02 BST; 53 years 4 months ago
  CGroup: /
    user.slice
      user-1000.slice
        user@1000.service
          app.slice
            gvfs-goa-volume-monitor.service
              881 /usr/libexec/gvfs-goa-volume-monitor
            pulseaudio.service
              644 /usr/bin/pulseaudio --daemonize=no --log-target=journal
            gvfs-daemon.service
              748 /usr/libexec/gvfsd
              762 /usr/libexec/gvfsd-fuse /run/user/1000/gvfs -f
              923 /usr/libexec/gvfsd-trash --spawner :1.7 /org/gtk/gvfs/exec_spaw/0
            gvfs-udisks2-volume-monitor.service
              848 /usr/libexec/gvfs-udisks2-volume-monitor
            gvfs-gphoto2-volume-monitor.service
              869 /usr/libexec/gvfs-gphoto2-volume-monitor
            pipewire.service
              643 /usr/bin/pipewire
              666 /usr/bin/pipewire-media-session
            dbus.service
              657 /usr/bin/dbus-daemon --session --address=systemd: --nofork --nopidfile --systemd-acti
            gvfs-mtp-volume-monitor.service
              895 /usr/libexec/gvfs-mtp-volume-monitor
            gvfs-afc-volume-monitor.service
              899 /usr/libexec/gvfs-afc-volume-monitor
          init.scope
            628 /lib/systemd/systemd --user
            629 <sd-pam>
        session-3.scope
          589 /bin/login -f
          742 -bash
        session-4.scope
          1066 sshd: pi [privl
          1072 sshd: pi@pts/0
          1073 -bash
          1233 systemctl status
          1234 pager
        session-1.scope
          623 lightdm --session-child 14 17
          645 /usr/bin/lxsession -s LXDE-pi -e LXDE -w openbox-lxde-pi
          706 /usr/bin/ssh-agent x-session-manager
          772 openbox --config-file /home/pi/.config/openbox/lxde-pi-rc.xml
          773 lxpolkit
          776 lxpanel --profile LXDE-pi
lines 1-50
```

Step 11. systemctl status bluetooth

```
raspberrypi.local - pi@raspberrypi: ~ VT
File Edit Setup Control Window Help
? bluetooth.service - Bluetooth service
   Loaded: loaded (/lib/systemd/system/bluetooth.service; enabled; vendor preset: enabled)
   Active: active (running) since Wed 2023-05-03 03:17:13 BST; 41min ago
     Docs: man:bluetoothd(8)
  Main PID: 894 (bluetoothd)
   Status: "Running"
    Tasks: 1 (limit: 3873)
     CPU: 77ms
    CGroup: /system.slice/bluetooth.service
            └─894 /usr/libexec/bluetooth/bluetoothd

May 03 03:17:13 raspberrypi systemd[1]: Starting Bluetooth service...
May 03 03:17:13 raspberrypi bluetoothd[894]: Bluetooth daemon 5.55
May 03 03:17:13 raspberrypi systemd[1]: Started Bluetooth service.
May 03 03:17:13 raspberrypi bluetoothd[894]: Starting SDP server
May 03 03:17:13 raspberrypi bluetoothd[894]: Bluetooth management interface 1.22 initialized
May 03 03:17:13 raspberrypi bluetoothd[894]: profiles/sap/server.c:sap_server_register() Sap driver initialization fail
May 03 03:17:13 raspberrypi bluetoothd[894]: sap-server: Operation not permitted (1)
May 03 03:17:13 raspberrypi bluetoothd[894]: Endpoint registered: sender=:1.28 path=/MediaEndpoint/A2DPSink/sbc
May 03 03:17:13 raspberrypi bluetoothd[894]: Endpoint registered: sender=:1.28 path=/MediaEndpoint/A2DPSource/sbc
May 03 03:17:13 raspberrypi bluetoothd[894]: Failed to set privacy: Rejected (0x0b)
```

Step 12. systemctl show

```
raspberrypi.local - pi@raspberrypi: ~ VT
File Edit Setup Control Window Help
Version=247.3-7+rpil+deb11u1
Features=+PAM +AUDIT +SELINUX +IMA +APPARMOR +SMACK +SYSVINIT +UTMP +LIBCRYPTSETUP +GCRYPT +GNUTLS +ACL +XZ +LZ
Architecture=arm64
FirmwareTimestampMonotonic=0
LoaderTimestampMonotonic=0
KernelTimestamp=Thu 1970-01-01 01:00:00 BST
KernelTimestampMonotonic=0
InitRDTimestampMonotonic=0
UserspaceTimestamp=Thu 1970-01-01 01:00:02 BST
UserspaceTimestampMonotonic=2234975
FinishTimestamp=Wed 2023-05-03 03:17:13 BST
FinishTimestampMonotonic=16036103
SecurityStartTimestamp=Thu 1970-01-01 01:00:02 BST
SecurityStartTimestampMonotonic=2256415
SecurityFinishTimestamp=Thu 1970-01-01 01:00:02 BST
SecurityFinishTimestampMonotonic=2262761
GeneratorsStartTimestamp=Tue 2022-09-13 02:58:38 BST
GeneratorsStartTimestampMonotonic=2576424
GeneratorsFinishTimestamp=Tue 2022-09-13 02:58:38 BST
GeneratorsFinishTimestampMonotonic=2800614
UnitsLoadStartTimestamp=Tue 2022-09-13 02:58:38 BST
UnitsLoadStartTimestampMonotonic=2800641
UnitsLoadFinishTimestamp=Tue 2022-09-13 02:58:38 BST
UnitsLoadFinishTimestampMonotonic=2871062
InitRDSecurityStartTimestampMonotonic=0
InitRDSecurityFinishTimestampMonotonic=0
InitRDGeneratorsStartTimestampMonotonic=0
InitRDGeneratorsFinishTimestampMonotonic=0
InitRDUnitsLoadStartTimestampMonotonic=0
InitRDUnitsLoadFinishTimestampMonotonic=0
LogLevel=info
LogTarget=journal-or-kmsg
NNames=298
NFailedUnits=0
```

Step 13. systemctl show bluetooth

```
raspberrypi.local - pi@raspberrypi: ~ VT
File Edit Setup Control Window Help
Type=dbus
Restart=no
NotifyAccess=main
RestartUsec=100ms
TimeoutStartUsec=1min 30s
TimeoutStopUsec=1min 30s
TimeoutAbortUsec=1min 30s
TimeoutStartFailureMode=terminate
TimeoutStopFailureMode=terminate
RuntimeMaxUsec=infinity
WatchdogUsec=0
WatchdogTimestampMonotonic=0
RootDirectoryStartOnly=no
RemainAfterExit=no
GuessMainPID=yes
MainPID=894
ControlPID=0
BusName=org.bluez
FileDescriptorStoreMax=0
NFileDescriptorStore=0
StatusText=Running
StatusErrno=0
Result=success
ReloadResult=success
CleanResult=success
UID=[not set]
GID=[not set]
NRestarts=0
OOMPolicy=stop
ExecMainStartTimestamp=Wed 2023-05-03 03:17:13 BST
ExecMainStartTimestampMonotonic=15940354
ExecMainExitTimestampMonotonic=0
ExecMainPID=894
ExecMainCode=0
lines 1-34
```

Step 14. systemctl cat bluetooth

```
raspberrypi.local - pi@raspberrypi: ~ VT
File Edit Setup Control Window Help
pi@raspberrypi:~ $ systemctl cat bluetooth
# /lib/systemd/system/bluetooth.service
[Unit]
Description=Bluetooth service
Documentation=man:bluetoothd(8)
ConditionPathIsDirectory=/sys/class/bluetooth

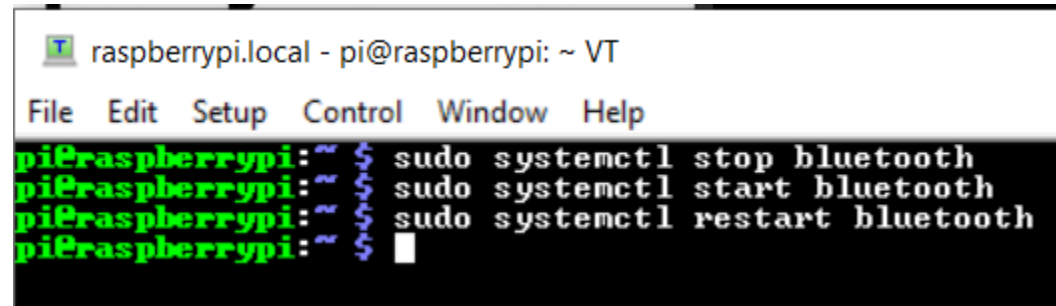
[Service]
Type=dbus
BusName=org.bluez
ExecStart=/usr/libexec/bluetooth/bluetoothd
NotifyAccess=main
#WatchdogSec=10
#Restart=on-failure
CapabilityBoundingSet=CAP_NET_ADMIN CAP_NET_BIND_SERVICE
LimitNPROC=1
ProtectHome=true
ProtectSystem=full

[Install]
WantedBy=bluetooth.target
Alias=dbus-org.bluez.service
pi@raspberrypi:~ $
```


Step 15. systemctl list-dependencies bluetooth

```
raspberrypi.local - pi@raspberrypi: ~ VT
File Edit Setup Control Window Help
bluetooth.service
?  | dbus.socket
?  | | system.slice
?  | | | sysinit.target
?  | | | | dev-hugepages.mount
?  | | | | dev-mqueue.mount
?  | | | | fake-hwclock.service
?  | | | | keyboard-setup.service
?  | | | | kmod-static-nodes.service
?  | | | | plymouth-read-write.service
?  | | | | plymouth-start.service
?  | | | | proc-sys-fs-binfmt_misc.automount
?  | | | | sys-fs-fuse-connections.mount
?  | | | | sys-kernel-config.mount
?  | | | | sys-kernel-debug.mount
?  | | | | sys-kernel-tracing.mount
?  | | | | systemd-ask-password-console.path
?  | | | | systemd-binfmt.service
?  | | | | systemd-boot-system-token.service
?  | | | | systemd-hwdb-update.service
?  | | | | systemd-journal-flush.service
?  | | | | systemd-journald.service
?  | | | | systemd-machine-id-commit.service
?  | | | | systemd-modules-load.service
?  | | | | systemd-pstore.service
?  | | | | systemd-random-seed.service
?  | | | | systemd-sysctl.service
?  | | | | systemd-sysusers.service
?  | | | | systemd-timesyncd.service
?  | | | | systemd-tmpfiles-setup-dev.service
?  | | | | systemd-tmpfiles-setup.service
?  | | | | systemd-udev-trigger.service
?  | | | | systemd-udevd.service
?  | | | | systemd-update-utmp.service
```



Step 16. sudo systemctl start/stop/restart bluetooth



```
raspberrypi.local - pi@raspberrypi: ~ VT
File Edit Setup Control Window Help
pi@raspberrypi:~$ sudo systemctl stop bluetooth
pi@raspberrypi:~$ sudo systemctl start bluetooth
pi@raspberrypi:~$ sudo systemctl restart bluetooth
pi@raspberrypi:~$
```

A terminal window titled "raspberrypi.local - pi@raspberrypi: ~ VT" with a menu bar containing "File", "Edit", "Setup", "Control", "Window", and "Help". The terminal shows four lines of commands being executed: "sudo systemctl stop bluetooth", "sudo systemctl start bluetooth", "sudo systemctl restart bluetooth", and a final prompt "pi@raspberrypi:~\$".

Step 17. systemctl enable/disable bluetooth

 raspberrypi.local - pi@raspberrypi: ~ VT

File Edit Setup Control Window Help

```
pi@raspberrypi:~$ sudo systemctl enable bluetooth
Synchronizing state of bluetooth.service with SysV service script with /lib/systemd/systemd-sysv-install
Executing: /lib/systemd/systemd-sysv-install enable bluetooth
pi@raspberrypi:~$ sudo systemctl disable bluetooth
Synchronizing state of bluetooth.service with SysV service script with /lib/systemd/systemd-sysv-install
Executing: /lib/systemd/systemd-sysv-install disable bluetooth
Removed /etc/systemd/system/bluetooth.target.wants/bluetooth.service.
Removed /etc/systemd/system/dbus-org.bluez.service.
pi@raspberrypi:~$
```

Step 18. systemctl list-timers

```
pi@raspberrypi:~$ systemctl list-timers
NEXT LEFT LAST PASSED UNIT
Wed 2023-05-03 06:31:03 BST 2h 16min left Wed 2023-05-03 01:36:28 BST 2h 38min ago apt-daily-upgrade.timer
Wed 2023-05-03 06:39:23 BST 2h 24min left Wed 2023-05-03 01:36:28 BST 2h 38min ago apt-daily.timer
Thu 2023-05-04 00:00:00 BST 19h left Wed 2023-05-03 01:36:28 BST 2h 38min ago logrotate.timer
Thu 2023-05-04 00:00:00 BST 19h left Wed 2023-05-03 01:36:28 BST 2h 38min ago man-db.timer
Thu 2023-05-04 03:32:00 BST 23h left Wed 2023-05-03 03:32:00 BST 42min ago systemd-tmpfiles-clean.timer
Sun 2023-05-07 03:10:12 BST 3 days left Wed 2023-05-03 01:36:28 BST 2h 38min ago e2scrub_all.timer
Mon 2023-05-08 00:21:21 BST 4 days left Wed 2023-05-03 01:36:28 BST 2h 38min ago fstrim.timer

7 timers listed.
Pass --all to see loaded but inactive timers, too.
lines 1-11/11 (END)
```

Step 19. systemctl list-sockets

```
raspberrypi.local - pi@raspberrypi: ~ VT
File Edit Setup Control Window Help
pi@raspberrypi:~$ systemctl list-sockets
LISTEN                                UNIT                                ACTIVATES
/dev/rfkill                          systemd-rfkill.socket             systemd-rfkill.service
/run/avahi-daemon/socket              avahi-daemon.socket              avahi-daemon.service
/run/cups/cups.sock                   cups.socket                       cups.service
/run/dbus/system_bus_socket          dbus.socket                      dbus.service
/run/initctl                         systemd-initctl.socket           systemd-initctl.service
/run/systemd/fsck.progress            systemd-fsckd.socket             systemd-fsckd.service
/run/systemd/journal/dev-log         systemd-journald-dev-log.socket  systemd-journald.service
/run/systemd/journal/socket          systemd-journald.socket          systemd-journald.service
/run/systemd/journal/stdout          systemd-journald.socket          systemd-journald.service
/run/systemd/journal/syslog          syslog.socket                    rsyslog.service
/run/thd.socket                      triggerhappy.socket              triggerhappy.service
/run/udev/control                    systemd-udev-control.socket      systemd-udev.service
audit 1                             systemd-journald-audit.socket    systemd-journald.service
kobject-uevent 1                    systemd-udev-kernel.socket      systemd-udev.service

14 sockets listed.
Pass --all to see loaded but inactive sockets, too.
pi@raspberrypi:~$
```

Step 20. man journalctl

```
raspberrypi.local - pi@raspberrypi: ~ VT
File Edit Setup Control Window Help
JOURNALCTL<1> journalctl JOURNALCTL<1>
NAME
    journalctl - Query the systemd journal
SYNOPSIS
    journalctl [OPTIONS...] [MATCHES...]
DESCRIPTION
    journalctl may be used to query the contents of the systemd<1> journal as written by systemd-journald.service<8>.

    If called without parameters, it will show the full contents of the journal, starting with the oldest entry collected.

    If one or more match arguments are passed, the output is filtered accordingly. A match is in the format "FIELD=VALUE", e.g. "_SYSTEMD_UNIT=httpd.service", referring to the components of a structured journal entry. See systemd.journal-fields<7> for a list of well-known fields. If multiple matches are specified matching different fields, the log entries are filtered by both, i.e. the resulting output will show only entries matching all the specified matches of this kind. If two matches apply to the same field, then they are automatically matched as alternatives, i.e. the resulting output will show entries matching any of the specified matches for the same field. Finally, the character "+" may appear as a separate word between other terms on the command line. This causes all matches before and after to be combined in a disjunction (i.e. logical OR).

    It is also possible to filter the entries by specifying an absolute file path as an argument. The file path may be a file or a symbolic link and the file must exist at the time of the query. If a file path refers to an executable binary, an "_EXE=" match for the canonicalized binary path is added to the query. If a file path refers to an executable script, a "_COMM=" match for the script name is added to the query. If a file path refers to a device node, "_KERNEL_DEVICE=" matches for the kernel name of the device and for each of its ancestor devices is added to the query. Symbolic links are dereferenced, kernel names are synthesized, and parent devices are identified from the environment at the time of the query. In general, a device node is the best proxy for an actual device, as log entries do not usually contain fields that identify an actual device. For the resulting log entries to

Manual page journalctl<1> line 1 (press h for help or q to quit)
```

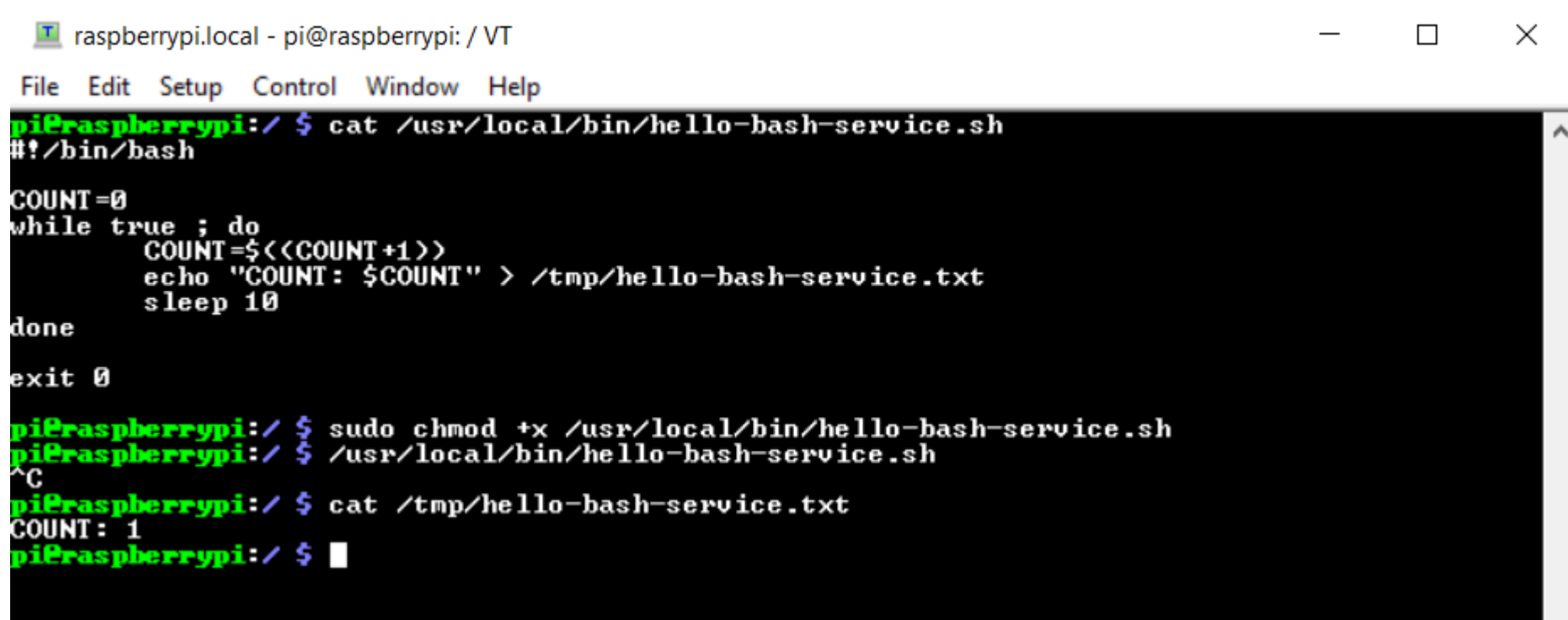
Step 21. journalctl

```
raspberrypi.local - pi@raspberrypi: ~ VT
File Edit Setup Control Window Help
-- Journal begins at Wed 2023-05-03 01:36:11 BST, ends at Wed 2023-05-03 04:14:10 BST. --
May 03 01:36:11 raspberrypi kernel: Booting Linux on physical CPU 0x0000000000 [0x410fd083]
May 03 01:36:11 raspberrypi kernel: Linux version 6.1.21-v8+ (dowd@buildbot) (aarch64-linux-gnu-gcc-8 (Ubuntu/Li
May 03 01:36:11 raspberrypi kernel: random: crng init done
May 03 01:36:11 raspberrypi kernel: Machine model: Raspberry Pi 4 Model B Rev 1.5
May 03 01:36:11 raspberrypi kernel: efi: UEFI not found.
May 03 01:36:11 raspberrypi kernel: Reserved memory: created CMA memory pool at 0x000000000ec00000, size 512 MiB
May 03 01:36:11 raspberrypi kernel: OF: reserved mem: initialized node linux,cma, compatible id shared-dma-pool
May 03 01:36:11 raspberrypi kernel: Zone ranges:
May 03 01:36:11 raspberrypi kernel:   DMA [mem 0x0000000000000000-0x000000003fffffff]
May 03 01:36:11 raspberrypi kernel:   DMA32 [mem 0x0000000040000000-0x00000000fbffffff]
May 03 01:36:11 raspberrypi kernel:   Normal empty
May 03 01:36:11 raspberrypi kernel: Movable zone start for each node
May 03 01:36:11 raspberrypi kernel: Early memory node ranges
May 03 01:36:11 raspberrypi kernel:   node 0: [mem 0x0000000000000000-0x000000003b3fffffff]
May 03 01:36:11 raspberrypi kernel:   node 0: [mem 0x0000000040000000-0x00000000fbffffff]
May 03 01:36:11 raspberrypi kernel: Initmem setup node 0 [mem 0x0000000000000000-0x00000000fbffffff]
May 03 01:36:11 raspberrypi kernel: On node 0, zone DMA32: 19456 pages in unavailable ranges
May 03 01:36:11 raspberrypi kernel: On node 0, zone DMA32: 16384 pages in unavailable ranges
May 03 01:36:11 raspberrypi kernel: percpu: Embedded 29 pages/cpu s78504 r8192 d32088 u118784
May 03 01:36:11 raspberrypi kernel: pcpu-alloc: s78504 r8192 d32088 u118784 alloc=29*4096
May 03 01:36:11 raspberrypi kernel: pcpu-alloc: [0] 0 [0] 1 [0] 2 [0] 3
May 03 01:36:11 raspberrypi kernel: Detected PIPT I-cache on CPU0
May 03 01:36:11 raspberrypi kernel: CPU features: detected: Spectre-v2
May 03 01:36:11 raspberrypi kernel: CPU features: detected: Spectre-v3a
May 03 01:36:11 raspberrypi kernel: CPU features: detected: Spectre-v4
May 03 01:36:11 raspberrypi kernel: CPU features: detected: Spectre-BHB
May 03 01:36:11 raspberrypi kernel: CPU features: kernel page table isolation forced ON by KASLR
May 03 01:36:11 raspberrypi kernel: CPU features: detected: Kernel page table isolation (KPTI)
May 03 01:36:11 raspberrypi kernel: CPU features: detected: ARM erratum 1742098
May 03 01:36:11 raspberrypi kernel: CPU features: detected: ARM errata 1165522, 1319367, or 1530923
May 03 01:36:11 raspberrypi kernel: alternatives: applying boot alternatives
May 03 01:36:11 raspberrypi kernel: Built 1 zonelists, mobility grouping on. Total pages: 996912
May 03 01:36:11 raspberrypi kernel: Kernel command line: coherent_pool=1M 8250.nr_uarts=0 snd_bcm2835.enable_be
lines 1-34
```

Step 22. journalctl --lines 20

```
raspberrypi.local - pi@raspberrypi: ~ VT
File Edit Setup Control Window Help
pi@raspberrypi:~$ journalctl --lines 20
-- Journal begins at Wed 2023-05-03 01:36:11 BST, ends at Wed 2023-05-03 04:17:05 BST. --
May 03 04:14:10 raspberrypi systemd[1]: /lib/systemd/system/plymouth-start.service:16: Unit configured to use K
May 03 04:14:10 raspberrypi sudo[1559]: pam_unix(sudo:session): session closed for user root
May 03 04:17:01 raspberrypi CRON[1633]: pam_unix(cron:session): session opened for user root(uid=0) by (uid=0)
May 03 04:17:01 raspberrypi CRON[1634]: (root) CMD ( cd / && run-parts --report /etc/cron.hourly)
May 03 04:17:01 raspberrypi CRON[1633]: pam_unix(cron:session): session closed for user root
May 03 04:17:05 raspberrypi rngd[531]: stats: bits received from HRNG source: 80064
May 03 04:17:05 raspberrypi rngd[531]: stats: bits sent to kernel pool: 30240
May 03 04:17:05 raspberrypi rngd[531]: stats: entropy added to kernel pool: 30240
May 03 04:17:05 raspberrypi rngd[531]: stats: FIPS 140-2 successes: 4
May 03 04:17:05 raspberrypi rngd[531]: stats: FIPS 140-2 failures: 0
May 03 04:17:05 raspberrypi rngd[531]: stats: FIPS 140-2(2001-10-10) Monobit: 0
May 03 04:17:05 raspberrypi rngd[531]: stats: FIPS 140-2(2001-10-10) Poker: 0
May 03 04:17:05 raspberrypi rngd[531]: stats: FIPS 140-2(2001-10-10) Runs: 0
May 03 04:17:05 raspberrypi rngd[531]: stats: FIPS 140-2(2001-10-10) Long run: 0
May 03 04:17:05 raspberrypi rngd[531]: stats: FIPS 140-2(2001-10-10) Continuous run: 0
May 03 04:17:05 raspberrypi rngd[531]: stats: HRNG source speed: (min=341.892; avg=443.915; max=543.214)Kibits/s
May 03 04:17:05 raspberrypi rngd[531]: stats: FIPS tests speed: (min=19.765; avg=24.236; max=29.617)Mibits/s
May 03 04:17:05 raspberrypi rngd[531]: stats: Lowest ready-buffers level: 2
May 03 04:17:05 raspberrypi rngd[531]: stats: Entropy starvations: 0
May 03 04:17:05 raspberrypi rngd[531]: stats: Time spent starving for entropy: (min=0; avg=0.000; max=0)us
lines 1-21/21 (END)
```


Step 23. Creating a “Hello World” Service - Part 1



```
raspberrypi.local - pi@raspberrypi: / VT
File Edit Setup Control Window Help
pi@raspberrypi:/$ cat /usr/local/bin/hello-bash-service.sh
#!/bin/bash

COUNT=0
while true ; do
    COUNT=$((COUNT+1))
    echo "COUNT: $COUNT" > /tmp/hello-bash-service.txt
    sleep 10
done

exit 0

pi@raspberrypi:/$ sudo chmod +x /usr/local/bin/hello-bash-service.sh
pi@raspberrypi:/$ /usr/local/bin/hello-bash-service.sh
^C
pi@raspberrypi:/$ cat /tmp/hello-bash-service.txt
COUNT: 1
pi@raspberrypi:/$
```


Step 24. Creating a "Hello World" Service - Part 2

```
raspberrypi.local - pi@raspberrypi: / VT
File Edit Setup Control Window Help
pi@raspberrypi:/$ ls /etc/systemd/system
dbus-fi.wl.wpa_supplicant1.service      multi-user.target.wants
dbus-org.freedesktop.Avahi.service       network-online.target.wants
dbus-org.freedesktop.ModemManager1.service poweroff.target.wants
dbus-org.freedesktop.timesync1.service   printer.target.wants
default.target                          rc-local.service.d
default.target.wants                    reboot.target.wants
dev-serial1.device.wants                remote-fs.target.wants
dhcpcd.service.d                        sockets.target.wants
display-manager.service                 sshd.service
getty.target.wants                      sysinit.target.wants
getty@tty1.service.d                   syslog.service
graphical.target.wants                  timers.target.wants
halt.target.wants
pi@raspberrypi:/$ sudo vim /etc/systemd/system/hello-bash-service
sudo: vim: command not found
pi@raspberrypi:/$ sudo nano /etc/systemd/system/hello-bash-service
pi@raspberrypi:/$ cat /etc/systemd/system/hello-bash-service.service
[UNIT]
Description=Hello World Service

[Service]
Type=simple
ExecStart=/usr/local/bin/hello-bash-service.sh

[Install]
WantedBy=multi-user.target
pi@raspberrypi:/$
```

Step 25. Creating a “Hello World” Service - Part 3

```
raspberrypi.local - pi@raspberrypi: / VT
File Edit Setup Control Window Help
pi@raspberrypi:/$ sudo systemctl daemon-reload
pi@raspberrypi:/$ sudo systemctl start hello-bash-service
pi@raspberrypi:/$ systemctl status hello-bash-service
? hello-bash-service.service
   Loaded: loaded (/etc/systemd/system/hello-bash-service.service; disabled; vendor prese
   Active: active (running) since Wed 2023-05-03 04:47:29 BST; 10s ago
   Main PID: 1825 (hello-bash-serv)
     Tasks: 2 (limit: 3873)
        CPU: 17ms
   CGroup: /system.slice/hello-bash-service.service
           └─1825 /bin/bash /usr/local/bin/hello-bash-service.sh
             └─1827 sleep 10

May 03 04:47:29 raspberrypi systemd[1]: Started hello-bash-service.service.
May 03 04:47:29 raspberrypi hello-bash-service.sh[1825]: /usr/local/bin/hello-bash-service.
May 03 04:47:39 raspberrypi hello-bash-service.sh[1825]: /usr/local/bin/hello-bash-service.
May 03 04:47:40 raspberrypi systemd[1]: /etc/systemd/system/hello-bash-service.service:1: l
lines 1-14/14 (END)
```

Step 26. Creating a “Hello World” Service - Part 4

```
pi@raspberrypi:~$ pstree
systemd--ModemManager--2*[<ModemManager>]
--agetty
--applet.py
--avahi-daemon--avahi-daemon
--bluetoothd
--cron
--cups-browsed--2*[<cups-browsed>]
--cupsd--5*[<dbus>]
--dbus-daemon
--dhcpcd
--hciattach
--hello-bash-serv--sleep
--lightdm--Xorg--<Xorg>
--lightdm--lightdm--lxsession--lxpanel--5*[<lxpanel>]
--lightdm--lightdm--lxsession--lxpolkit--2*[<lxpolkit>]
--lightdm--lightdm--lxsession--openbox
--lightdm--lightdm--lxsession--pcmanfm--2*[<pcmanfm>]
--lightdm--lightdm--lxsession--ssh-agent
--lightdm--lightdm--lxsession--2*[<lxsession>]
--lightdm--2*[<lightdm>]
--login--bash
--menu-cached--2*[<menu-cached>]
--packagekitd--2*[<packagekitd>]
--polkitd--2*[<polkitd>]
--rngd--3*[<rngd>]
--rsyslogd--3*[<rsyslogd>]
--rtkit-daemon--2*[<rtkit-daemon>]
--sh--zenity--2*[<zenity>]
--ssh-agent
--sshd--sshd--sshd--bash--hello-bash-serv--sleep
--systemd--<sd-pam>
--systemd--dbus-daemon
--systemd--gvfs-afc-volume--3*[<gvfs-afc-volume>]
--systemd--gvfs-goa-volume--2*[<gvfs-goa-volume>]
--systemd--gvfs-gphoto2-vo--2*[<gvfs-gphoto2-vo>]
--systemd--gvfs-mtp-volume--2*[<gvfs-mtp-volume>]
```

```
pi@raspberrypi:~$ cat /tmp/hello-bash-service.txt
COUNT: 1
pi@raspberrypi:~$ sudo systemctl stop hello-bash-service
pi@raspberrypi:~$ sudo systemctl status hello-bash-service
? hello-bash-service.service
   Loaded: loaded (/etc/systemd/system/hello-bash-service.service; disabled; vendor pres>
   Active: inactive (dead)

May 03 04:50:09 raspberrypi hello-bash-service.sh[1825]: /usr/local/bin/hello-bash-service>
May 03 04:50:19 raspberrypi hello-bash-service.sh[1825]: /usr/local/bin/hello-bash-service>
May 03 04:50:29 raspberrypi hello-bash-service.sh[1825]: /usr/local/bin/hello-bash-service>
May 03 04:50:37 raspberrypi systemd[1]: Stopping hello-bash-service.service...
May 03 04:50:37 raspberrypi systemd[1]: hello-bash-service.service: Succeeded.
May 03 04:50:37 raspberrypi systemd[1]: Stopped hello-bash-service.service.
May 03 04:50:37 raspberrypi systemd[1]: /etc/systemd/system/hello-bash-service.service:1: >
May 03 04:50:37 raspberrypi systemd[1]: /etc/systemd/system/hello-bash-service.service:1: >
May 03 04:50:37 raspberrypi systemd[1]: /etc/systemd/system/hello-bash-service.service:1: >
May 03 04:50:49 raspberrypi systemd[1]: /etc/systemd/system/hello-bash-service.service:1: >
May 03 04:50:49 raspberrypi systemd[1]: /etc/systemd/system/hello-bash-service.service:1: >
lines 1-14/14 (END)
```