06-1 Userspace Initialization - systemd

Chapter 6

Beagle 3.8

bone$ **cat /etc/init.d/README**

```
You are running a systemd-based OS where traditional init scripts have
been replaced by native systemd services files. Service files provide
very similar functionality to init scripts. To make use of service
files simply invoke "systemctl", which will output a list of all
currently running services (and other units). Use "systemctl
list-unit-files" to get a listing of all known unit files, including
stopped, disabled and masked ones. Use "systemctl start
foobar.service" and "systemctl stop foobar.service" to start or stop a
service, respectively. For further details, please refer to
systemctl(1).
```

Beagle 3.8 (cont)

bone$ **cat /etc/init.d/README**

```
Note that traditional init scripts continue to function on a systemd
system. An init script /etc/init.d/foobar is implicitly mapped
into a service unit foobar.service during system initialization.

Thank you!

Further reading:
        man:systemctl(1)
        man:systemd(1)
        http://0pointer.de/blog/projects/systemd-for-admins-3.html

http://www.freedesktop.org/wiki/Software/systemd/Incompatibilities
```

http://en.wikipedia.org/wiki/Systemd

systemd

- init.d is not used on the Bone
- systemd is used for user space initialization
- http://www.freedesktop.org/wiki/Software/systemd/
- Faster boot time by allowing initialization in parallel

systemd adoption of major Linux distributions

Linux distribution	Date added to software repository[a]	Enabled by default?	Can run without?	Date released as default
Android	N/A (not in repository)	N/A	Yes	N/A
Arch Linux	January 2012[40]	Yes	Yes, but unsupported[41]	October 2012[42]
CentOS	April 2014	Yes	No	April 2014 (7.14.04)
CoreOS	July 2013	Yes	?	October 2013 (v94.0.0)[43][44]
Debian	April 2012[45]	Yes	Yes	April 2015 (v8)[46]
Devuan	N/A (Inherited from Debian)	No	Yes	N/A
Fedora	November 2010 (v14)[47]	Yes	No	May 2011 (v15)
Gentoo Linux[b]	July 2011[48][50][51]	No	Yes	N/A
Mageia	January 2011 (v1.0)[52]	Yes	?	May 2012 (v2.0)[53]
openSUSE	March 2011 (v11.4)[54]	Yes	No	September 2012 (v12.2)[55]
Red Hat Enterprise Linux	June 2014 (v7.0)[56]	Yes	No	June 2014 (v7.0)
Slackware	N/A (not in repository)	N/A	Yes	N/A
SUSE Linux Enterprise Server	October 2014 (v12)	Yes	No	October 2014 (v12)
Ubuntu	April 2013 (v13.04)	Yes	Yes[57]	April 2015 (v15.04)

systemd-Outline

- Being an Admin
  - Monitoring boot up
  - cgroup
  - Stopping, starting, etc.
  - Boot time
- Running your own server

Bootup

- Much scrolls by during boot time

```
Starting kernel ...
76
77 Uncompressing Linux... done, booting the kernel.
78 [ 0.000000] Booting Linux on physical CPU 0x0
79 [ 0.000000] Initializing cgroup subsys cpu
80 [ 0.000000] Linux version 3.8.13-bone27 (yoder@ubuntu) (gcc version 4.7.3
20130328
(prerelease) (crosstool-NG linaro-1.13.1-4.7-2013.04-20130415 - Linaro GCC
2013.04) )
#1 SMP Thu Aug 29 19:57:17 EDT 2013
81 [ 0.000000] CPU: ARMv7 Processor [413fc082] revision 2 (ARMv7), cr=10c5387d
82 [ 0.000000] CPU: PIPT / VIPT nonaliasing data cache, VIPT aliasing instruction
cache
83 [ 0.000000] Machine: Generic AM33XX (Flattened Device Tree), model: TI AM335x
BeagleBone
```

- What if you miss something?

systemctl – Seeing what's running

- You can see the status of various processes using systemctl

systemctl

```
bone $ systemctl
UNIT                                    LOAD   ACTIVE SUB       DESCRIPTION
proc-sys-fs-binfmt_misc.automount       loaded active running   Arbitrary Executable File Formats Fi
sys-devices-platform-ocp-44e09000.serial-tty-ttyS0.device loaded active plugged   /sys/devices/pl
sys-devices-platform-ocp-47400000.usb-47401400.usb-musb\x2dhdrc.0.auto-gadget-net-usb0.device loa
sys-devices-platform-ocp-47400000.usb-47401c00.usb-musb\x2dhdrc.1.auto-usb1-1\x2d1-1\x2d1:1.1-sou
sys-devices-platform-ocp-48022000.serial-tty-ttyS1.device loaded active plugged   /sys/devices/pl
sys-devices-platform-ocp-48024000.serial-tty-ttyS2.device loaded active plugged   /sys/devices/pl
sys-devices-platform-ocp-48060000.mmc-mmc_host-mmc0-mmc0:b368-block-mmcblk0-mmcblk0p1.device load
sys-devices-platform-ocp-48060000.mmc-mmc_host-mmc0-mmc0:b368-block-mmcblk0.device loaded active
sys-devices-platform-ocp-481a8000.serial-tty-ttyS4.device loaded active plugged   /sys/devices/pl
sys-devices-platform-ocp-481cc000.can-net-can0.device loaded active plugged   /sys/devices/platfo
sys-devices-platform-ocp-481d0000.can-net-can1.device loaded active plugged   /sys/devices/platfo
sys-devices-platform-ocp-481d8000.mmc-mmc_host-mmc1-mmc1:0001-block-mmcblk1-mmcblk1boot0.device l
sys-devices-platform-ocp-481d8000.mmc-mmc_host-mmc1-mmc1:0001-block-mmcblk1-mmcblk1boot1.device l
sys-devices-platform-ocp-481d8000.mmc-mmc_host-mmc1-mmc1:0001-block-mmcblk1-mmcblk1p1.device load
sys-devices-platform-ocp-481d8000.mmc-mmc_host-mmc1-mmc1:0001-block-mmcblk1.device loaded active
sys-devices-platform-ocp-4a100000.ethernet-net-eth0.device loaded active plugged   /sys/devices/p
sys-devices-platform-serial8250-tty-ttyS3.device loaded active plugged   /sys/devices/platform/se
sys-devices-platform-serial8250-tty-ttyS5.device loaded active plugged   /sys/devices/platform/se
sys-devices-virtual-misc-rfkill.device loaded active plugged   /sys/devices/virtual/misc/rfkill
sys-devices-virtual-tty-ttyGS0.device loaded active plugged   /sys/devices/virtual/tty/ttyGS0
sys-module-configfs.device              loaded active plugged   /sys/module/configfs
sys-module-fuse.device                  loaded active plugged   /sys/module/fuse
sys-subsystem-net-devices-can0.device loaded active plugged   /sys/subsystem/net/devices/can0
```

systemctl

```
bone $ systemctl
UNIT                          LOAD   ACTIVE SUB       DESCRIPTION
bonescript-autorun.service    loaded active running   Bonescript autorun
bonescript.service            loaded active running   Bonescript server
cloud9.service                loaded active running   Cloud9 IDE
connman.service               loaded active running   Connection service
console-...em-start.service   loaded active exited    Console System Startup Logging
crond.service                 loaded active running   Periodic Command Scheduler
dbus.service                  loaded active running   D-Bus System Message Bus
dropbear....1:42389.service   loaded active running   SSH Per-Connection Server
gateone.service               loaded active running   GateOne daemon
gdm.service                   loaded active running   Gnome Display Manager
getty@tty1.service            loaded active running   Getty on tty1
leds.service                  loaded active exited    Angstrom LED config
mpd.service                   loaded failed failed    Music Player Daemon
ntpdate.service               loaded active exited    Network Time Service (one-shot ntpdate mode)
serial-getty@ttyGS0.service   loaded active running   Serial Getty on ttyGS0
serial-getty@ttyO0.service    loaded active running   Serial Getty on ttyO0
```

Systemctl status

```
bone$ systemctl status mpd.service
mpd.service - Music Player Daemon
               Loaded: loaded (/lib/systemd/system/mpd.service; enabled)
               Active: failed (Result: signal) since Mon 2000-01-03 12:44:01 EST; 13 years 9 months ago
              Process: 125 ExecStart=/usr/bin/mpd --no-daemon (code=killed, signal=ABRT)
               CGroup: name=systemd:/system/mpd.service
```

Systemctl status

```
bone$ systemctl status mpd.service
…

Jan 03 12:44:01 yoder-black-bone systemd[1]: mpd.service: main
process exited, code=killed, status=6/ABRT
Jan 03 12:44:01 yoder-black-bone systemd[1]: Unit mpd.service
entered failed state
Jan 03 12:44:10 yoder-black-bone mpd[125]: listen: bind to
'0.0.0.0:6600' failed: Address already in use (continuing
anyway, because binding to '[::]:6600' succeeded)
Jan 03 12:44:10 yoder-black-bone mpd[125]: output: No
"audio_output" defined in config file
Jan 03 12:44:10 yoder-black-bone mpd[125]: output: Attempt to
detect audio output device
Jan 03 12:44:10 yoder-black-bone mpd[125]: output: Attempting
to detect a alsa audio device
Jan 03 12:44:10 yoder-black-bone mpd[125]: ALSA lib
confmisc.c:768:(parse_card) cannot find card '0'
pa_threaded_mainloop_get_api(). Aborting.
```

cgroup - Which Service Owns Which Processes?

- One process can start other processes
- It's hard to tell which process runs what
- *Control groups* (cgroups) are groups of processes
- In systemd every process that is spawned is placed in a control group named after its service
- Makes it easier to track down problems

cgroup

```
bone$ systemd-cgls
Control group /:
-.slice
├─init.scope
│ └─1 /sbin/init
└─system.slice
  ├─cloud9.service
  │ ├─1543 /usr/bin/nodejs server.js --packed -w /var/lib/cloud9
  │ ├─1547 /root/.c9/node/bin/node /opt/cloud9/build/standalonebuild/node_modules/vfs-child/child
  │ ├─1563 /usr/bin/tmux -u2 -L cloud91.9 new -s devel_472 export ISOUTPUTPANE=0;bash -l ; set -q
  │ ├─1566 /usr/bin/tmux -u2 -L cloud91.9 new -s devel_472 export ISOUTPUTPANE=0;bash -l ; set -q
  │ ├─1567 bash -c export ISOUTPUTPANE=0;bash -l
  │ └─1568 bash -l
  ├─avahi-daemon.service
  │ ├─312 avahi-daemon: running [yoder-debian-bone.local
  │ └─327 avahi-daemon: chroot helpe
  ├─node-red.service
  │ ├─1507 /bin/bash - /usr/bin/node-red.sh
  │ └─1509 node-red
  ├─udhcpd.service
  │ └─1263 /usr/sbin/udhcpd -S
```

cgroup

```
bone$ systemd-cgls
…
 ├─dbus.service
 │ └─321 /usr/bin/dbus-daemon --system --address=systemd: --nofork --nopidfile --
systemd-activat
 ├─cron.service
 │ └─316 /usr/sbin/cron -f
 ├─wpa_supplicant.service
 │ └─700 /sbin/wpa_supplicant -u -s -O /run/wpa_supplicant
 ├─bonescript-autorun.service
 │ └─308 /usr/bin/nodejs autorun.js
 ├─system-serial\x2dgetty.slice
 │ ├─serial-getty@ttyS0.service
 │ │ ├─ 779 /bin/login --
 │ │ ├─1220 -bash
 │ │ ├─1599 tmux
 │ │ ├─1600 -bash
 │ │ └─1616 node ./clock.js
 │ └─serial-getty@ttyGS0.service
 │   └─1265 /sbin/agetty --keep-baud 115200 38400 9600 ttyGS0 vt220
```

cgroup

```
bone$ systemd-cgls
…
  ├─systemd-journald.service
  │ └─99 /lib/systemd/systemd-journald
  ├─bonescript.service
  │ └─6228 /usr/bin/nodejs /usr/local/lib/node_modules/bonescript/server.js
  ├─connman.service
  │ └─350 /usr/sbin/connmand -n
  ├─systemd-timesyncd.service
  │ └─200 /lib/systemd/systemd-timesyncd
  ├─ssh.service
  │ ├─ 506 /usr/sbin/sshd -D
  │ ├─1488 sshd: root@pts/0
  │ ├─1490 -bash
  │ ├─2342 sshd: root@pts/5
  │ ├─2348 -bash
  │ ├─6634 sshd: root@pts/4
  │ ├─6636 -bash
  │ ├─7790 git-credential-cache--daemon /root/.git-credential-cache/socket
  │ ├─8459 systemd-cgls
  │ └─8460 pager
```

cgroup

```
bone$ systemd-cgls
…
 ├─systemd-logind.service
  │ └─301 /lib/systemd/systemd-logind
  ├─system-getty.slice
  │ └─getty@tty1.service
  │   └─550 /sbin/agetty --noclear tty1 linux
  ├─systemd-udevd.service
  │ └─133 /lib/systemd/systemd-udevd
  ├─haveged.service
  │ └─376 /usr/sbin/haveged --Foreground --verbose=1 --write=1024
  └─rsyslog.service
    └─310 /usr/sbin/rsyslogd -n
```

Outline

- Being an Admin
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Managing

bone$ **systemctl status systemd-journald.service**

```
● systemd-journald.service - Journal Service
   Loaded: loaded (/lib/systemd/system/systemd-journald.service; static; vendor preset:
enabled)
   Active: active (running) since Fri 2016-09-30 16:49:36 EDT; 3 days ago
     Docs: man:systemd-journald.service(8)
           man:journald.conf(5)
 Main PID: 99 (systemd-journal)
   Status: "Processing requests..."
   CGroup: /system.slice/systemd-journald.service
           └─99 /lib/systemd/systemd-journald

Sep 30 16:49:35 yoder-debian-bone systemd-journald[99]: Runtime journal
(/run/log/journal/) is 3.
Sep 30 16:49:35 yoder-debian-bone systemd-journald[99]: Journal started
Warning: Journal has been rotated since unit was started. Log output is incomplete or
unavailable
```

Managing

bone$ **systemctl status systemd-journald.service**

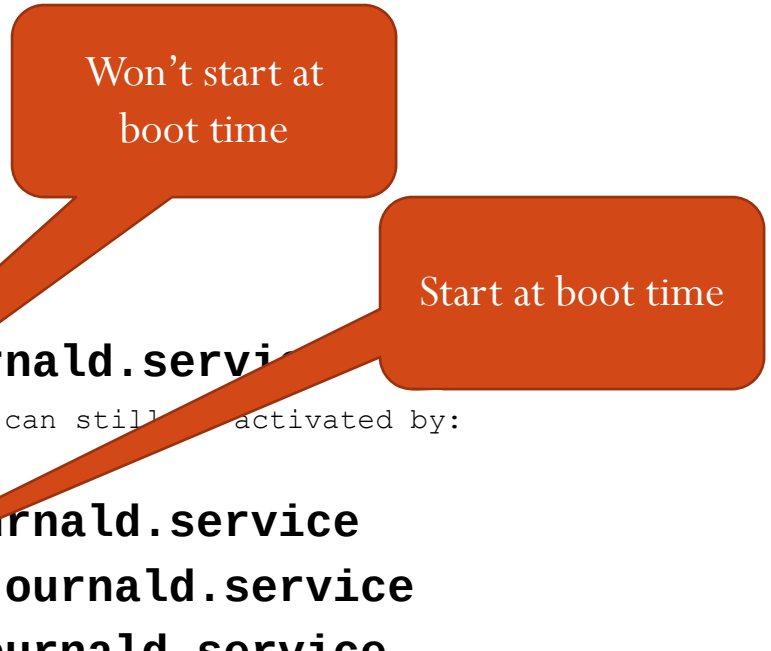
```
● systemd-journald.service - Journal Service
   Loaded: loaded (/lib/systemd/system/systemd-journald.service; static; vendor preset:
enabled)
   Active: active (running) since Thu 2016-11-03 13:16:44 EDT; 11 months 2 days ago
     Docs: man:systemd-journald.service(8)
           man:journald.conf(5)
 Main PID: 205 (systemd-journal)
   Status: "Processing requests..."
    Tasks: 1 (limit: 4915)
   CGroup: /system.slice/systemd-journald.service
           └─205 /lib/systemd/systemd-journald

Nov 03 13:16:44 bone-0834 systemd-journald[205]: Journal started
Nov 03 13:16:44 bone-0834 systemd-journald[205]: Runtime journal
(/run/log/journal/035732fb7bb3a80710a1e
Nov 03 13:16:45 bone-0834 systemd-journald[205]: Runtime journal
(/run/log/journal/035732fb7bb3a80710a1e
Warning: Journal has been rotated since unit was started. Log output is incomplete or
unavailable.
```

Managing

- Stop, start, disable, enable

```
bone$ systemctl stop systemd-journald.service
Warning: Stopping systemd-journald.service, but it can still be activated by:
  systemd-journald.socket
bone$ systemctl start systemd-journald.service
bone$ systemctl disable systemd-journald.service
bone$ systemctl enable systemd-journald.service
The unit files have no [Install] section. They are not meant to be enabled
using systemctl.
Possible reasons for having this kind of units are:
1) A unit may be statically enabled by being symlinked from another unit's
   .wants/ or .requires/ directory.
2) A unit's purpose may be to act as a helper for some other unit which has
   a requirement dependency on it.
3) A unit may be started when needed via activation (socket, path, timer,
   D-Bus, udev, scripted systemctl call, ...).
```



Outline

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Boot performance

```
bone$ systemd-analyze
Startup finished in 1079ms (kernel) + 14107ms (userspace) = 15186ms
bone$ systemd-analyze blame
  9797ms wicd.service
  4742ms apache2.service
  4321ms console-kit-daemon.service
  3525ms xrdp.service
  3479ms bootlogs.service
  3294ms ssh.service
  3037ms cron.service
  2923ms loadcpufreq.service
  2164ms upower.service
  1816ms avahi-daemon.service
  1765ms wpa_supplicant.service
  1736ms systemd-logind.service
  1614ms console-setup.service
  1548ms networking.service
  1348ms lightdm.service
  1297ms polkitd.service
  1262ms capemgr.service
  1250ms generic-boot-script.service
  1009ms rc.local.service 950ms keyboard-setup.service
   923ms udev-trigger.service
   833ms udhcpd.service
   739ms motd.service
   658ms alsa-utils.service
   613ms console-kit-log-system-start.service
   575ms cpufrequtils.service
   562ms udev.service
   510ms kbd.service
   429ms systemd-user-sessions.service
   402ms hostapd.service
   377ms screen-cleanup.service
   330ms saned.service
   327ms systemd-modules-load.service
   249ms systemd-tmpfiles-setup.service
   249ms hdparm.service
   241ms systemd-sysctl.service
   223ms run-lock.mount
```

Boot performance

```
bone$ systemd-analyze
Startup finished in 4.255s (kernel) + 46.241s (userspace) = 50.496s
bone$ systemd-analyze blame
          41.396s generic-board-startup.service
          14.166s dev-mmcblk0p1.device
           6.139s networking.service
           4.913s loadcpufreq.service
           2.178s systemd-udev-trigger.service
           1.884s wpa_supplicant.service
           1.677s systemd-logind.service
           1.496s alsa-restore.service
           1.312s rsyslog.service
           1.033s connman.service
            896ms capemgr.service
            752ms rc-local.service
            736ms hostapd.service
            732ms systemd-user-sessions.service
            629ms systemd-journald.service
            592ms hdparm.service
            573ms avahi-daemon.service
            405ms systemd-udevd.service
            400ms cpufrequtils.service
            372ms systemd-journal-flush.service
            592ms pppd-dns.service
            338ms systemd-update-utmp.service
            333ms systemd-tmpfiles-setup.service
            332ms kmod-static-nodes.service
            319ms sys-kernel-debug.mount
            316ms systemd-fsck-root.service
            251ms sys-kernel-config.mount
            248ms sys-fs-fuse-connections.mount
            242ms systemd-timesyncd.service
            223ms systemd-random-seed.service
            205ms systemd-modules-load.service
            203ms systemd-tmpfiles-setup-dev.service
            184ms systemd-sysctl.service
            183ms systemd-remount-fs.service
            173ms dev-mqueue.mount
            148ms udhcpd.service
            147ms systemd-tmpfiles-clean.service
            144ms proc-sys-fs-binfmt_misc.mount
            123ms systemd-update-utmp-runlevel.service
            106ms bb-wl18xx-bluetooth.service
```

Boot performance

```
bone$ systemd-analyze
Startup finished in 19.345s (kernel) + 46.280s (userspace) = 1min 5.626s
bone$ systemd-analyze blame
          39.173s bb-wl18xx-wlan0.service
          17.494s generic-board-startup.service
          16.508s dev-mmcblk0p1.device
           4.806s loadcpufreq.service
           4.507s networking.service
           4.302s apt-daily.service
           3.740s apache2.service
           3.114s systemd-udev-trigger.service
           2.983s apt-daily-upgrade.service
           2.458s bb-wl18xx-bluetooth.service
           2.338s connman.service
           1.950s udhcpd.service
           1.841s systemd-logind.service
           1.417s capemgr.service
           1.336s avahi-daemon.service
           1.324s ssh.service
           1.071s cpufrequtils.service
           1.053s systemd-journald.service
           1.010s systemd-user-sessions.service
            884ms rsyslog.service
            876ms systemd-modules-load.service
            772ms hostapd.service
            740ms systemd-random-seed.service
            701ms dnsmasq.service
            688ms kmod-static-nodes.service
            683ms wpa_supplicant.service
            660ms systemd-timesyncd.service
            652ms systemd-udevd.service
            650ms dev-mqueue.mount
            645ms systemd-tmpfiles-setup-dev.service
            525ms sys-kernel-debug.mount
            452ms systemd-journal-flush.service
            409ms sys-fs-fuse-connections.mount
            380ms systemd-tmpfiles-setup.service
            367ms systemd-update-utmp.service
            366ms systemd-sysctl.service
            361ms systemd-remount-fs.service
            234ms systemd-rfkill.service
            231ms bluetooth.service
            194ms sys-kernel-config.mount
            153ms systemd-tmpfiles-clean.service
            138ms systemd-update-utmp-runlevel.service
            117ms cloud9.service
```

Outline

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Autostarting a server

- For and example, let's use the server in

```
bone$ cd exercises/realtime
bone$ ./boneServer.js
 Listening on 9090
    info  - socket.io started
```

- How do you write your own service script?

Find a working script

```
bone$ systemctl | grep bone
bonescript-autorun.service  loaded active running   Bonescript autorun
bonescript.service          loaded active running   Bonescript server
bonescript.socket           loaded active running   bonescript.socket
```

- I see a couple of bonescript servers that look promising.

```
bone$ systemctl status bonescript
bonescript.service - Bonescript server
   Loaded: loaded (/lib/systemd/system/bonescript.service; static)
   Active: active (running) since Sun 2000-01-09 15:07:55 EST; 13 years 9 months ago
   Main PID: 357 (node)
         CGroup: name=systemd:/system/bonescript.service
            `-357 /usr/bin/node server.js

Jan 09 15:07:55 yoder-black-bone systemd[1]: Starting Bonescript server...
Jan 09 15:08:04 yoder-black-bone bonescript[357]: [35B blob data]
Jan 09 15:08:05 yoder-black-bone bonescript[357]: - - - [Sun, 09 Jan 2000 20:...
```

Copy

```
bone$ cp /lib/systemd/system/bonescript.service boneServer.service
bone$ cat boneServer.service
[Unit]
Description=Bonescript server

[Service]
WorkingDirectory=/usr/lib/node_modules/bonescript
ExecStart=/usr/bin/node server.js
SyslogIdentifier=bonescript

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

Environment Variables

- Node.js also needs

```
bone$ echo $NODE_PATH
/usr/lib/node_modules
```

- You get to figure out how to set it

Install

```
bone$ cp boneServer.service /lib/systemd/system
```

- Start the server

```
bone$ systemctl start boneServer
```

- Point your browser to 192.168.7.2:9090 and see if it works.
- To make it work after rebooting

```
bone$ systemctl enable boneServer
```

```
ln -s '/lib/systemd/system/boneServer.service'
'/etc/systemd/system/multi-user.target.wants/boneServer.service‘
```

- Reboot and see if it worked