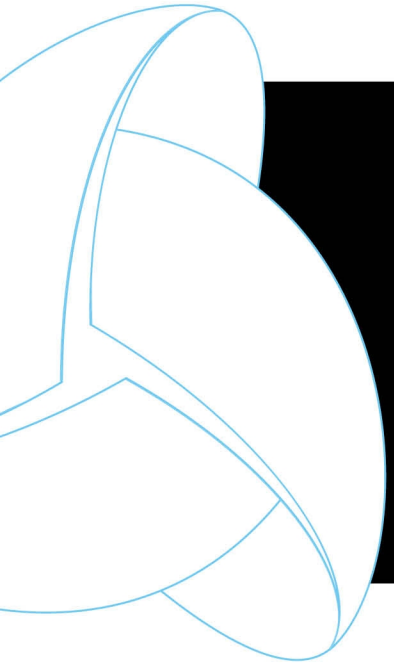

Timings of Init

Android Ramdisks
for the practical hacker

Big Android BBQ - October 2014

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Networking for a Better Tomorrow

DESIGN. BUILD. OPERATE.

Who Am I?

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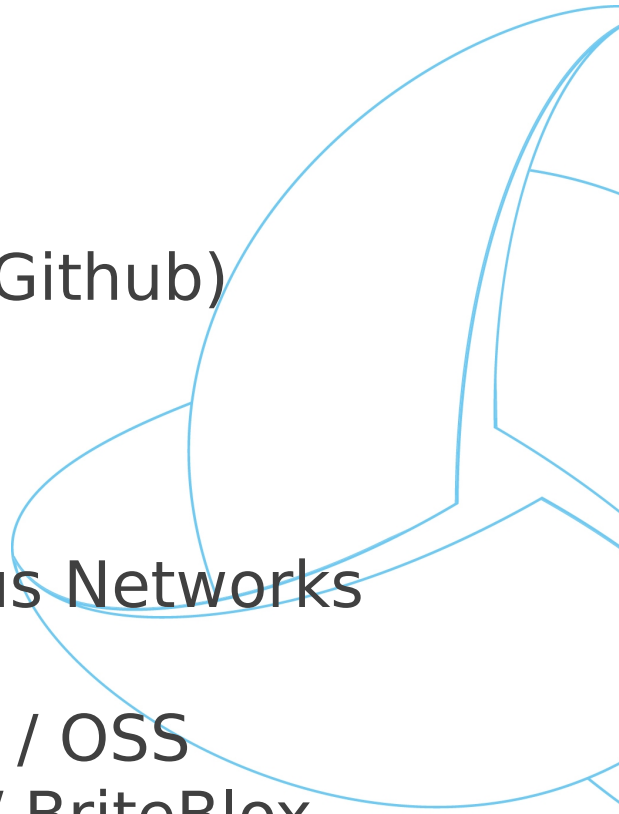
(Rootzwiki / XDA-developers / IRC / Github)

27 years old, soon to be 28 Yay!

Principal Software Engineer at Oceus Networks

Partner of OpenBrite LLC, an OSHW / OSS company, creators of the LEDgoes / BriteBlox product line



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What is it and where?

Boot Image or Recovery Image (boot.img / recovery.img) contains two pieces:

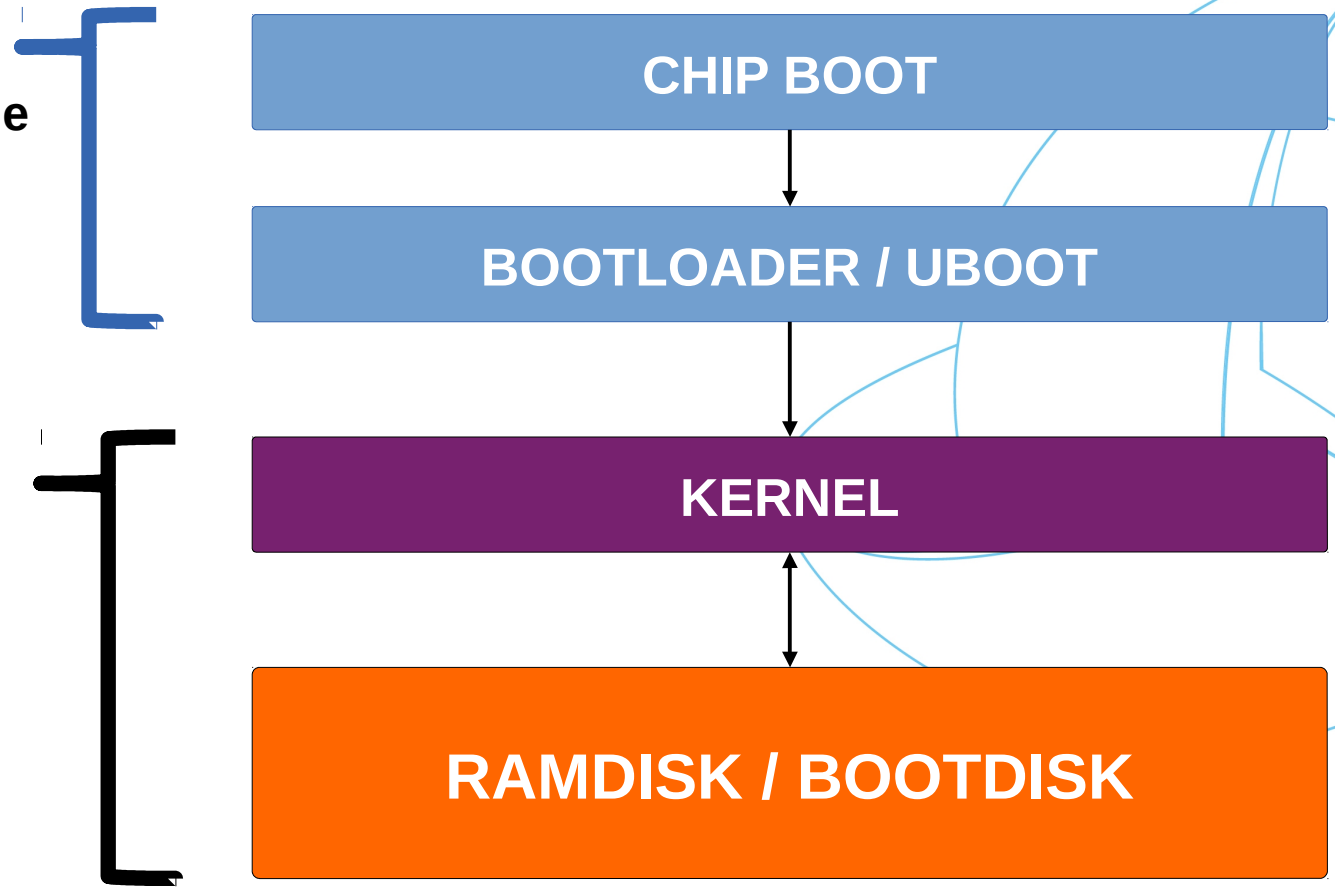
- Kernel (zImage)
- Ramdisk / Bootdisk / Rootdisk

Without it, the kernel doesn't know what to do or how to start the OS.

Ramdisk / Init in the Boot Sequence

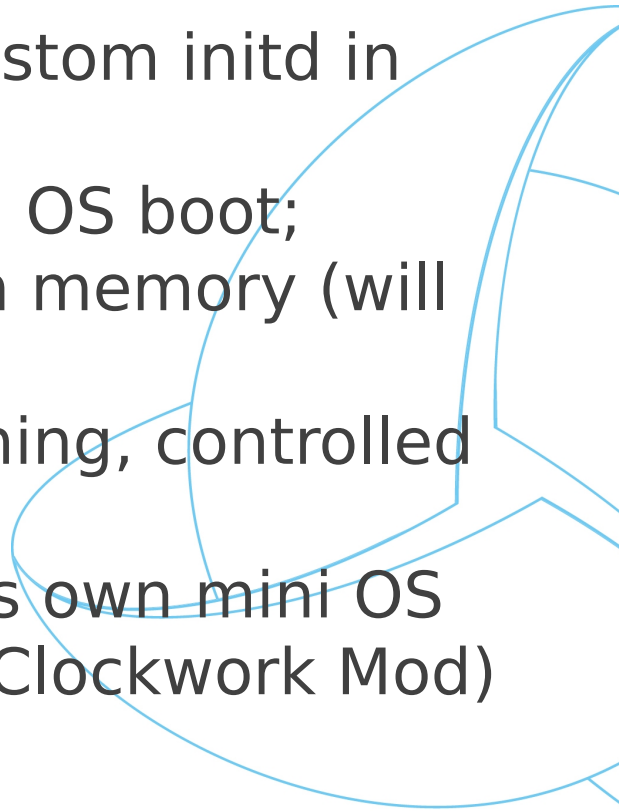
Chip Supplier and Vendor controlled code (usually)

$$$



Android vs. Linux Ramdisks

- Most Linux Distros use initrd (vs. custom initd in Android)
- Linux kills off its ramdisk after main OS boot;
- Android keeps the ramdisk active in memory (will appear in / at runtime)
- Android core services continue running, controlled by the init.rc scripts
- Android Ramdisk + Kernel makes its own mini OS (see Team Win Recovery Project or Clockwork Mod)



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storytime

FROM HELL !

*devil wears no pants

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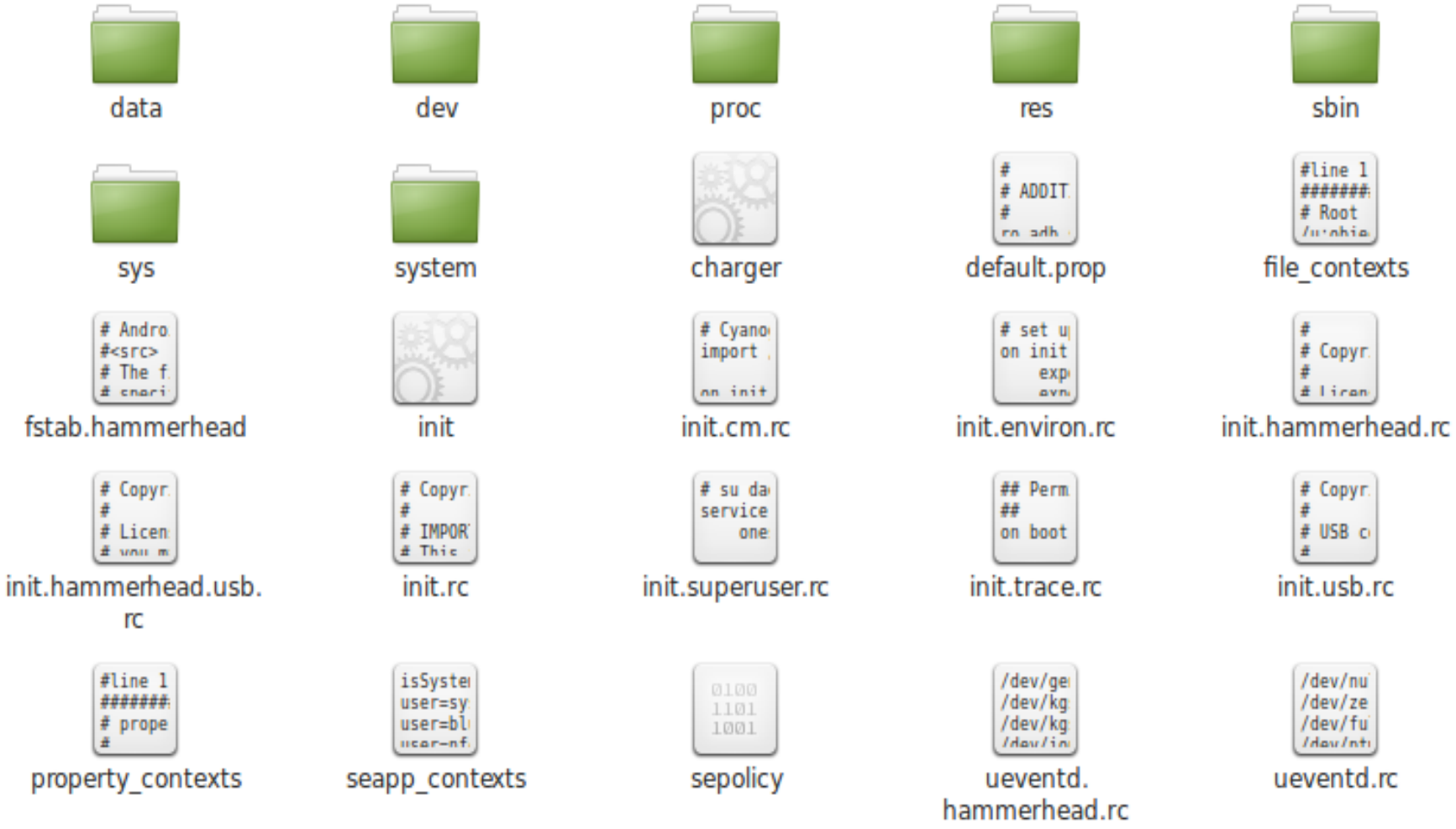
What was the Problem?

The current state of init.rc scripts did not account for larger encryption keys or decryption that would take longer.

This was a problem because the current state of initialization had the system and radios initializing separately with no checks. THIS IS NORMAL!

Fixing required lots of time and careful monitoring of kernel messages and such from the serial terminal

Nexus 5 Ramdisk Example (CM)



Key Init binary starts

- Init binary controls startup plus some other embedded functions like helping “vold” and in Android 4.3+, turning SEpolicy to “enforcing”. Vendors like Samsung and LG may incorporate custom initializations and checks prior to booting certain code.

- Init starts the basic init.rc file which includes the imports for the next stage “.rc” files. Upon import (which may be chained through multiple “.rc” files), it immediately has the same startup and capabilities as the base init.rc.

- How is this relevant? If having issues with init.rc or trouble finding something which is starting up, it might be in the Init binary and not in the runtime scripts.

Directories

- **SBIN** – Dedicated SBIN for binaries that may need to exist early in boot sequence or outside of the OS reach (usually executables)
- **BIN** – Maps and links to “/system/bin”. Good place to put .ko files for insmod and .sh files that shouldn't go in “/” of the ramdisk.
- **“/”** - Maps to “/” and contains init.rc files plus .sh files critical to bring-up (usually proprietary bits and radios). Most modern versions put this now in “/system/etc” in the normal system.img of the OS. In Android 4.3+, Sepolicy files used at startup are here (usually OK for most security as /system, boot-up, /proc, /dev, etc. files are what you care about at this point).

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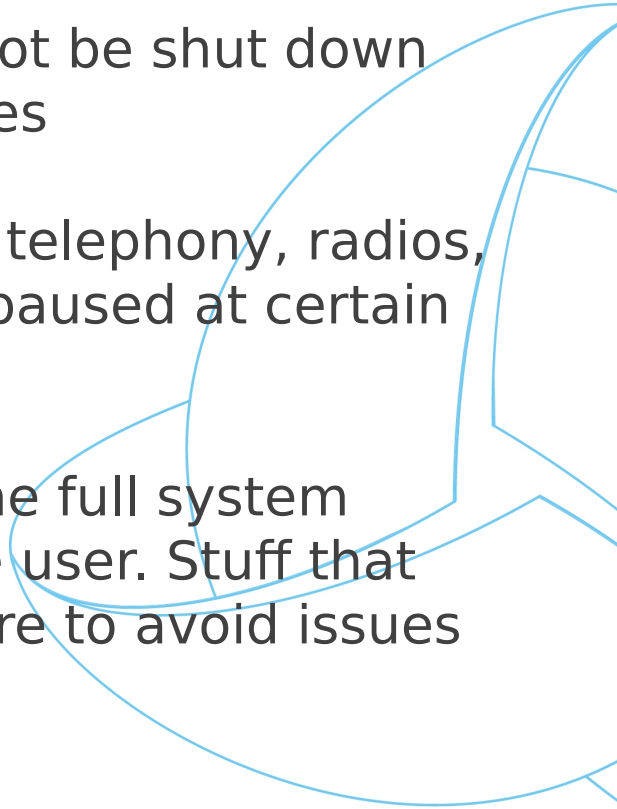
Basic Timing functions in init.rc

import – pulls in the other init.xxx.rc files that will be run/running to control startup
on early-init - start ueventd and any forks
on init - startup actions like /sys properties, partition mounts, and symlinks
on fs - partition mounts, chmod operations, yaffs handling in older devices
on post-fs - chmod and chown of proc and cache
on post-fs-data - permissions for sensors, radios, GPS, NFC, etc.
on boot - first actions (permissions for /sys and /dev files, setprops)
on post-boot - not normally used, but items that happen
on nonencrypted - data is mountable and things relying on /data can now begin startup once it is mounted.
on charger - starts the service for the charging binary

****encryption timings – next slide****
on property: - normal system properties as triggers. They can be used to start scripts, continue running scripts, binaries, or change port functions *(init.usb.rc files and adbd related services are good examples of this)*

Service classes of Init

- **class core** – Always started first and cannot be shut down without serious consequences in most cases
- **class main** – Responsible for services like telephony, radios, critical sensors. Many can be restarted or paused at certain times, but only if absolutely required
- **class late-start** – Happens right before the full system boots and starts becoming available to the user. Stuff that relies on /data will usually have to start here to avoid issues on encryption



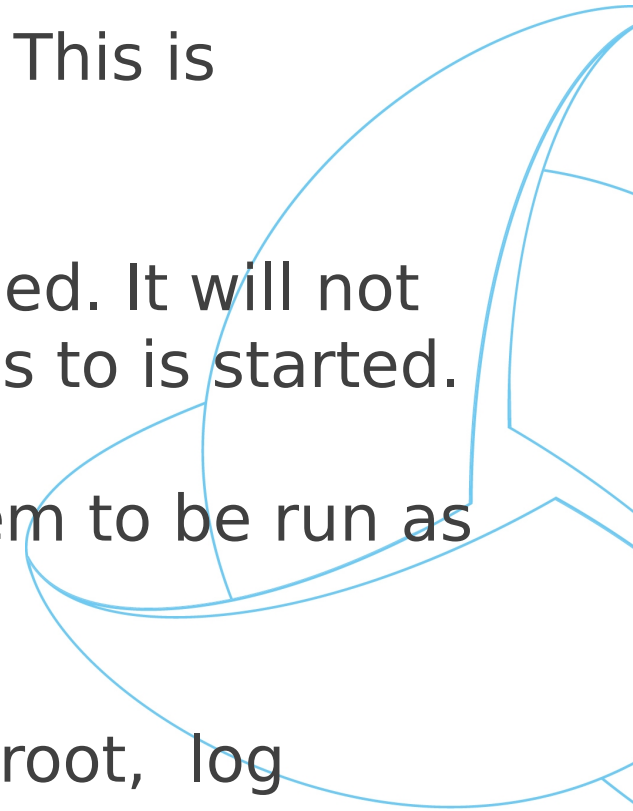
Service Properties of Init

oneshot - runs once and turns off. This is especially used for shell scripts.

disabled - only can be directly called. It will not be started when the class it belongs to is started.

user - uid such as root, shell, system to be run as or that it belongs to

group - gid, usually shell, system, root, log



Decryption and my friend Vold

- Encryption “on” property timings and recognition is controlled by vold and its interaction with the Init binary.
- After vold has done the mountings for system, boot, etc. then, init tells it to mount /data. Vold sees that /data is encrypted and then starts the decryption sequence
- Decryption in Android is somewhat unique, a fake /data partition is mounted and only class main and class core services are run during this time – more on that in later slides.
- That fake /data partition allows a “mini system boot” and a special mode to pop up asking for those keys. It then uses keystore and some functions to verify your pin/password, which then releases the encryption keys to be used for decryption. Most of the time, these are at the end of the data partition, but can be inside of media abstracted disks like in the Nexus devices.
- Vold gets the action and performs the decryption while the Init binary causes another small boot where some of class main gets restarted and a half-reboot occurs (see boot animation again, but shorter). Basically, restarting where “on nonencrypted” left off.

Encryption properties and Timings

USED IN DECRYPTION
ro.crypto.state = "encrypted" => was unable to mount data, now usually there is a system flag to indicate this in more modern android versions.
vold.decrypt = 1 => framework begins booting a tmpfs /data disk
CRYPTO_ENCRYPTION_IN_PROGRESS flag from cryptfs ran by vold = 0
"cryptfs cryptocomplete" result to vold command listener
"cryptfs checkpw" result to vold command listener
ro.crypto.fs_crypto_blkdev = 0 => success in decryption
vold.decrypt=trigger_reset_main => restarts all services in main
vold.post_fs_data_done = 0 => start post_fs-data
vold.decrypt=trigger_load_persist_props => loads props
vold.decrypt=trigger_post_fs_data => sets on post-fs-data
vold.post_fs_data_done = 1 => all is well on mounting the proper /data image
vold.decrypt=trigger_restart_framework => starts class main and late_start

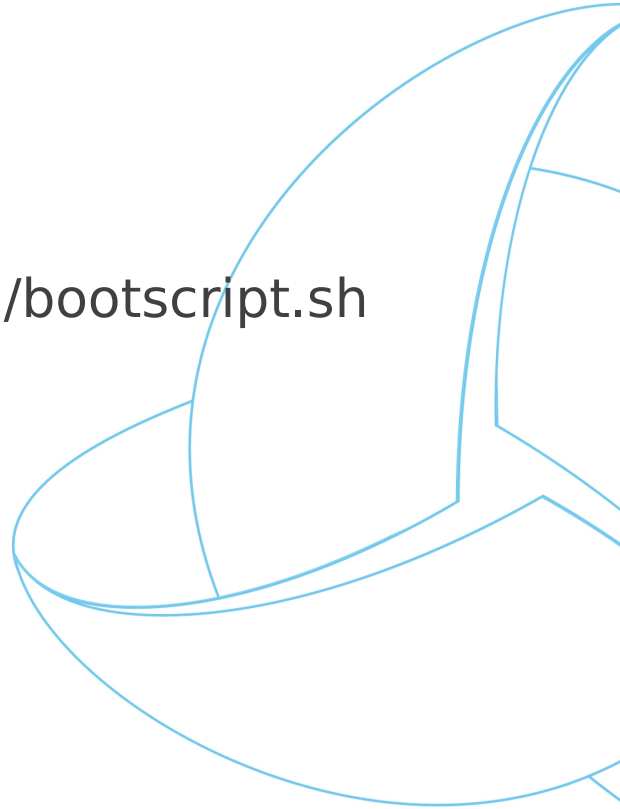
USED IN ENCRYPTION
vold.decrypt=trigger_shutdown_framework => reset class late_start and main unmounts /data
vold.decrypt=trigger_restart_min_framework => starts class main services
vold.encrypt_progress = 0 => starting to encrypt and CRYPT_ENCRYPTION_IN_PROGRESS 0x2
vold.encrypt_progress = 1 => encryption is done and system will be rebooted


DISREGARD CONVENTION
ACQUIRE CURRENCY

Run a Script on Boot

```
on property:dev.bootcomplete=1
        start bootstart

service bootstart /system/bin/sh /system/bin/bootscript.sh
        class late_start
        user root
        group root
        disabled
        oneshot
```



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Write your own init.rc

Top of init.cm.rc

```
import init.su.rc
```

Full init.superuser.rc

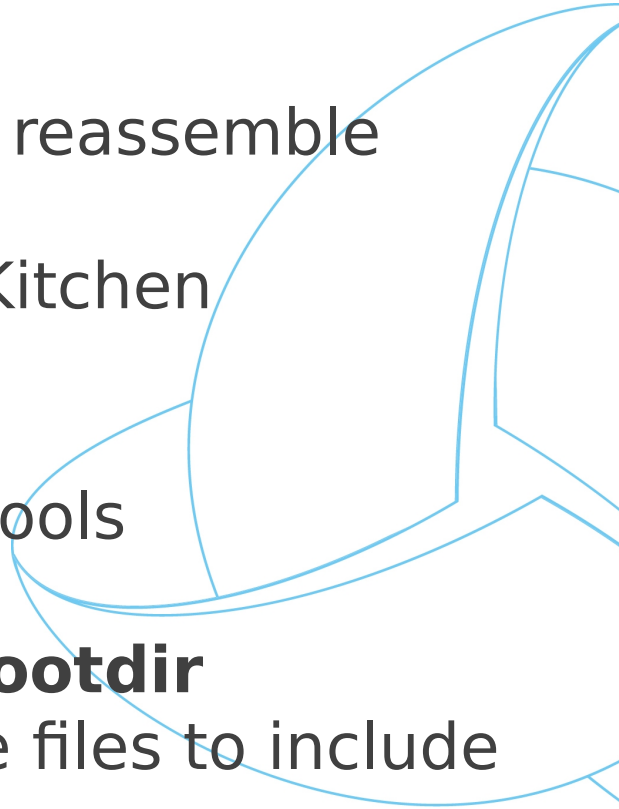
```
# su daemon
service su_daemon /system/xbin/su --daemon
    oneshot

on property:persist.sys.root_access=0
    stop su_daemon

on property:persist.sys.root_access=2
    stop su_daemon

on property:persist.sys.root_access=1
    start su_daemon

on property:persist.sys.root_access=3
    start su_daemon
```

Tools

Android Kitchen (linux)
Lots of tools, but has auto-split and reassemble with correct memory spots.
https://github.com/dsixda/Android-Kitchen

Perl and Python scripts (linux)
Check goo.im/devs/childofthehorn/tools

AOSP (tree) in /device/vendor/rootdir
Be sure to modify your ".mk" make files to include any new ".rc" files



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Special Thanks!!!

Dees Troy – Ethan
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source.android.com