



Replicant: Struggle for independence

Denis 'GNUtoo' Carikli

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Presentation structure:

- Introduction
 - Why caring about smartphones?
 - What is Replicant?
 - What is a smartphone?
 - Android architecture
- Replicant past struggles, successes and failures
 - Why Replicant is (still) not based on GNU/Linux?
 - Replicant creation and history
 - Replicant past struggles and phases
 - Current work and issues
- Parallel work
- References
- Time for Q/A (Hopefully)



Introduction



Why people have smartphones?

- Pressure to be reachable at all times?
- Mobile computing?
- Mobile banking?
- Cheap computer?
- Add your ideas here.



Main issues with smartphones

- Making smartphones destroys people (bad work conditions) and the planet (manufacturing).
- The network knows the smartphone location.
- Runs nonfree software.
- Unclear if empowers people or not (depends users freedom, use cases, etc).
- Add your issues here.





Solution:

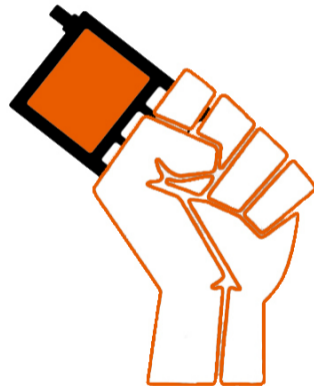
Not use smartphones at all
→ No need to fix the issue





Doesn't work?

- At least 2.7 billion people still using it, including people at risk like:[6]
 - Political activists
 - Journalists
 - etc
- Or indigenous people in Oxaca for their security





And yet:

- Making smartphones destroys people (bad work conditions) and the planet (manufacturing)
- The network knows the smartphone location
- Runs nonfree software



How to fix that?

- Destroy civilization, capitalism, etc? → Does that require smartphones that run free software in the first place?
- Destroy all factories? → Not my area of expertise. People also do depend on smartphones and that cannot work without big support from people.





Free software to advance in the right direction

- Making (smartphones and tablet) hardware work with free software. ← Part of this talk.

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ESSENTIAL FREEDOMS OF SOFTWARE



0 To run the software when ever you wish & for what ever purpose.



1 To study the source code & make modifications to the software.



2 To give or sell copies of the software to other people.



3 To give or sell copies of your modified versions of the software.

You have the 4 essential freedoms with other useful items that belong to you. Clothing, Food, Simple Electrical Devices. But most software companies do not want you to have these essential freedoms with software, running on your various devices. Taking away your control over your own devices.

SWITCH INSTEAD TO FREE SOFTWARE!

www.GNU.org



Other ways to help:

Political pressure:

- Practical right to repair, devices that last longer → Easier to support with free software.
- Against DRM: Corelation between DRM and the inability for users to completely control their device (can't change the nonfree bootloader, TrustZone OS, etc).
- Practical right to install your own OS.





Other ways to help:

- Funding work (NIInet, etc) and helping projects that do that in sustainable ways (Replicant, work to upstream support for devices).
- Connecting with other struggles (anti-planned obsolescence, environmental movement, people that destroy factories if that exists, etc) to go in the right direction and getting stronger together instead of fighting each other.



Have clear demands and attainable goal: First steps

- 100% free software on the main CPU
- 100% free software distribution(s)
- Usable by people:
 - Easy to use
 - Hardware easy to find
 - Hardware that can last and that is not too expensive
- Limits the damage:
 - Add some limits to the invasion of intimacy.
 - Hardware lasts longer.





How to achieve that?

- → Lot of work by many people over many years.
- → Not shipping nonfree firmwares or any nonfree software.
- → Collaborating instead of fighting each other.





What we have now



Free distributions

Distribution	OS	Smartphones support	Shortcomings
Guix	GNU/Linux	Missing packages	
Parabola	GNU/Linux	Missing packages	
PureOS	GNU/Linux	Supports the Librem5 well	Applications to adapt, expensive hardware
Replicant 6	Android	Support 10 devices	Installation, WiFi, 3G only, not sustainable
Replicant 11	Android	Work in progress	Installation, WiFi, 3G only
Trisquel 10	GNU/Linux	Missing packages	



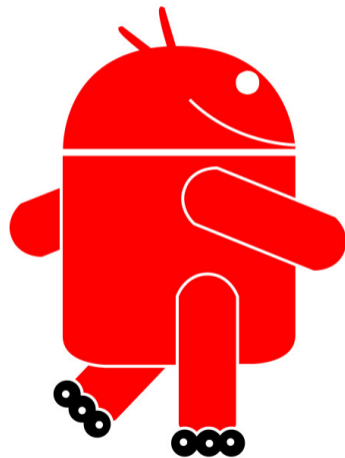
Also in progress:

- Cultural reappropriation: Work on phone shells (Posh, Plasma mobile, etc).
- GSM networks: Free software implementation, but problematic legal situation unless you are indigenous.
- WiFi and more free networks: we really lag behind.



Replicant:

- Fully free Android distribution approved by the FSF
- But the hardware it runs on is not...
- More details on hardware related freedom issues later



Replicant



Quick Facts

- Website: replicant.us
- Exists since September 2009
- Two main versions:
 - Replicant 6:
 - Android 6, last security update: October 2017 [4]
 - based on LineageOS
 - Supports ~ 10 devices (smartphones and tablets)
 - Replicant 11:
 - Android 11, work in progress[5]
 - based on official Android source code
- ~ About 1 full time equivalent contributors (sometimes more) and a community of users and contributors.

Introduction

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Replicant past struggles successes and failures

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Parallel work

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References

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Best (and lot of) effort:

- Display working and graphics fast enough
- Sound working
- Be able to make calls
- etc
- GPS, Camera, and other non crucial hardware may not work, or work in later releases

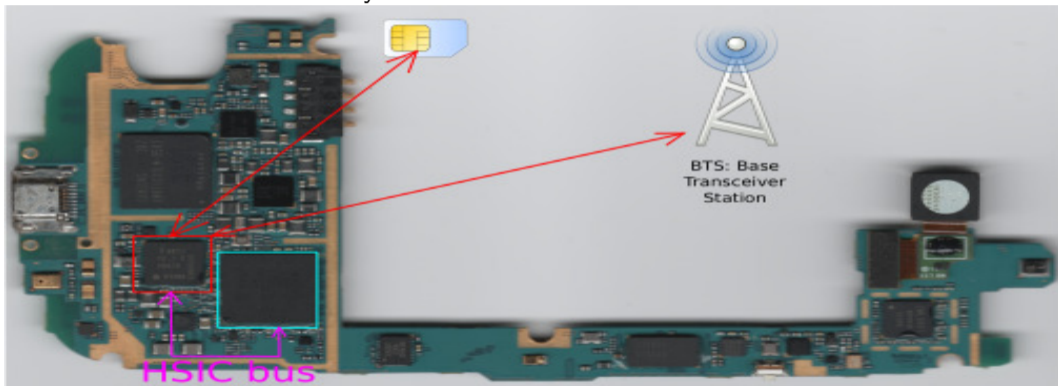




Also:

- Freedom privacy security page
- Extensive documentation on the wiki, not always easy to find
- Infrastructure:
 - OSUOSL: Mailing list, Wordpress, website, Redmine, FTP
 - 1 VM @ FSF: git, domain name, contact address, IRC bridge
 - La Quadrature du net: Mastodon account on mamot.fr

A very short introduction on hardware:



- System on a chip
- Smartphones and the modem



Why is the modem an issue?

- Nonfree firmware
 - → Only 1 free firmware for very old modems (2005) [2][?]
 - Too much work for Replicant
- Modem isolation
 - → Select smartphones with good isolation:
 - HSIC and firmware data controlled by Replicant
 - MIPI
 - USB and free bootloader
 - UART
 - Avoid modem built in the SOCs and shared memory or disable the modem completely.
 - → We still help other projects supporting devices with shared memory and encourage forking Replicant for that.
- Tracking → No real solution
 - Community networks (Indigenous communities in Oxaca)
 - Disable the modem → no calls, SMS or data connection



Devices without modems?

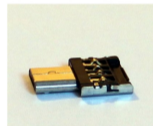
- Some tablets don't have any modem
- Possible to "disable" the modem on some devices.





WiFi: No free firmwares for chip used in mobile devices

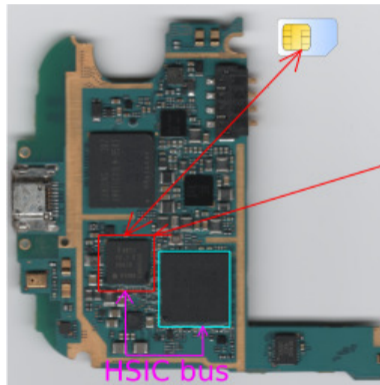
- ath9k compatible adapters consume too much power, require PCIe → not used in devices.
- We badly need help for free firmwares:
 - Broadcom chips through Nexmon ?
 - Realtek by reverse engineering GPL binary firmwares?
- USB device used (ath9k htc compatible) in





Additional issues:

- Nonfree bootloader
 - The SOC enforces signatures
 - TrustZone OS on some devices
 - Incompatible with Linux
 - Hard to support in Replicant 11 and GNU/Linux





Android architecture

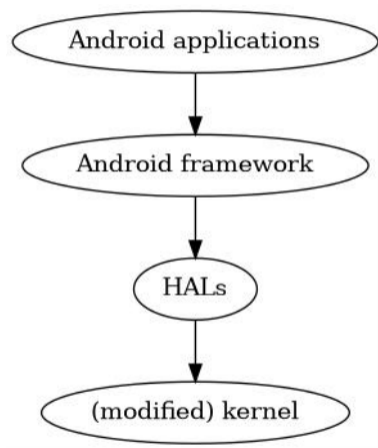
- Goals: time to market
 - Write the code that work as fast as possible
 - Support as many hardware features as possible including new hardware
 - → Varying code quality
 - → Example: One driver rewritten 3 times





How it's done?

- Breaking Kernel API and ABI
 - It can take time (years) to bring in a new framework in Linux
 - Example of API breakage: HTC dream audio driver
 - Solution: Apps ↔ Android framework ↔ HAL ↔ Kernel
 - Getting better in Android: Treble and Generic Kernel images





Not Android specific

- N900
 - Took (years) to have the mediactl API in Linux
 - → hacks in the vendor kernel



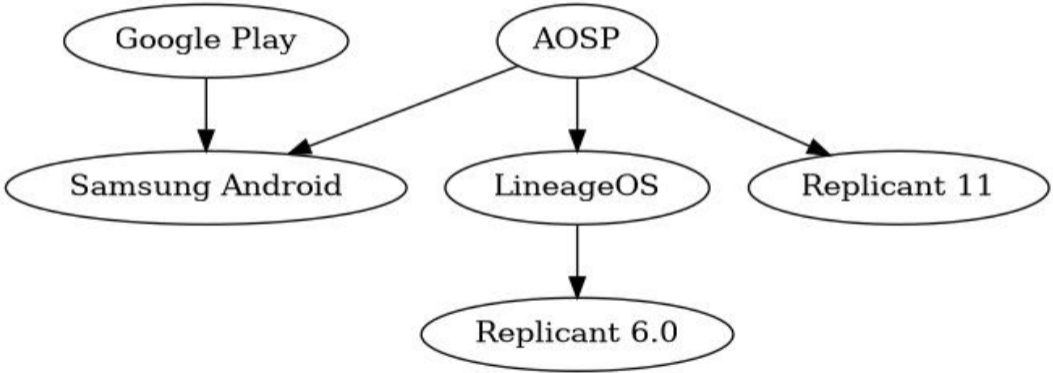


Not Android specific

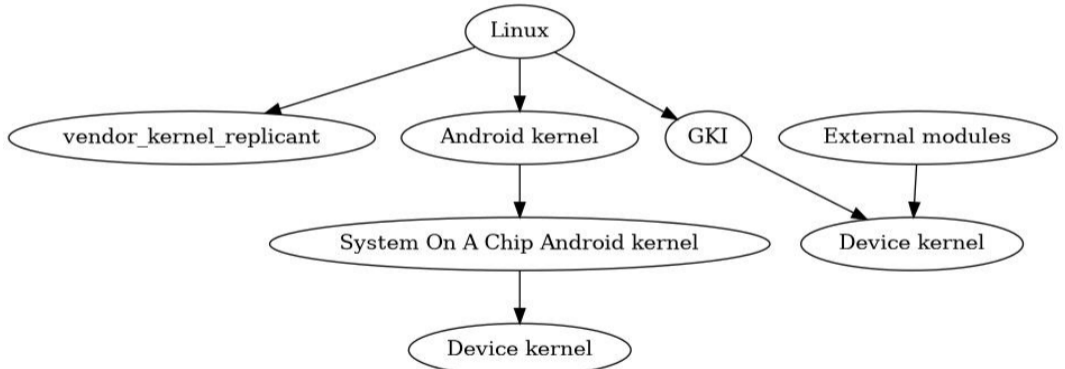
- N900
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Android



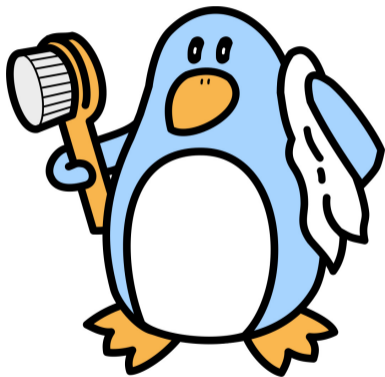
Device kernels





Ugly vendor code is good as we depend it for freedom

- Having the source code under free software licenses, even if the code quality is bad is crucial for freedom:
 - Hardware bringup is often made that way anyway
 - Code can always be cleaned up or rewritten later
 - Worst case: use the source code as documentation or reverse engineer it (add prints)





Why Android?

- GUI and applications adapted to big fingers
- → run on devices that:
 - Lack keyboard
 - Have capacitive touchscreen and no stylus
 - Have very small displays with very high number of pixel





Issues with Android?

- Part of the GNU/Linux architecture is light years away: package management and build system, graphics, audio, etc
- Huge unknown code from Google
- Meant to run proprietary software, not to empower users





Why Replicant?



There is a long tradition of porting GNU/Linux on smartphones and mobile devices





Rough history and context

- 1983: Announcement of the GNU project
- 1985: Creation of the FSF
- 1987: First GCC release
- 1991: First python release
- 1991: First GSM network in Finland (by Radiolinja)
- 1994: First Smartphone (IBM Simon Personal Communicator), not free software
- 1995: Linux 1.2
- 1999: Linux 2.2



- 2000: → Handhelds.org: Project to port GNU/Linux to PDAs and smartphones
- 2001: Linux 2.4
- 2001: Ututo certified by the FSF
- 2002: → GNU/Linux port to the HTC Wallaby Smartphone
- 2003: Linux 2.6
- 2005: → Open-EZX: GNU/Linux community port on EZX Motorola smartphones
- 2007: → OpenMoko GTA02: Hardware compatible with FSDG distros before FSDG
- 2008: HTC Dream: First Android smartphone
- 2009: → Replicant
- 2009: Nokia N900: GNU/Linux smartphone
- 2009: Palm pre: GNU/Linux smartphone



Other attempts

- FirefoxOS → nonfree Android drivers
- Meego, Tizen
- Ubuntu → nonfree Android drivers for (most? all?) devices?



→ GNU/Linux on smartphones is not new



Why Replicant?

```
$ git -c http.sslVerify=false clone http://gitorious.org/replicant/manifest.git/
```

```
$ cd manifest
```

```
$ git checkout origin/replicant
```

```
$ git show f1b1b7a28f114f6900c2d42e83af8c12bc81a421
```

```
commit f1b1b7a28f114f6900c2d42e83af8c12bc81a421
```

```
Author: Denis 'GNUtoo' Carikli <GNUtoo@no-log.org>
```

```
Date: Tue Sep 29 22:15:06 2009 +0200
```

```
Manifest: added initial manifest
```

```
Note that we don't build the kernel and the wifi driver yet
```



GNU/Linux had some issues at the time:

- Required special hardware to work well
 - Resistive touchscreen with stylus
 - Keyboards
 - Not too high pixel density
- Ports took too much time, users and developers gone when almost done.
 - Example: HTC Dream
 - GNU/Linux: 1 year not working well
 - Replicant: less than 1 week and working fine
- Very few smartphones specific applications for GNU/Linux



Also:

- Openmoko dead and has only 128M of RAM
- N900 has 256M of RAM
- Palm pre not working
- Distributions using nonfree drivers



Replicant past struggles, successes and failures



Phase 1: Replicant creation and Qualcomm devices





Replicant

Goal	Success?
Create a 100% free software Android distribution	Yes
Support the HTC Dream	Yes
Usable	Yes
Low maintenance	Yes (AOSP, LinageOS)
Fast to add new devices	Yes
GPS works	Yes
Hardware keyboard	Yes
Free software applications	Started to appear



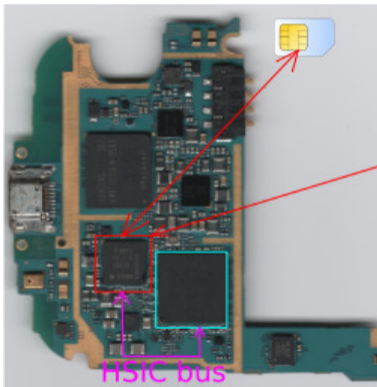
GNU/Linux

Goal	Success?
100% free software distributions	nonfree firmwares
Support the HTC Dream	broken sound, unstable
Usable	No
Low maintenance	?
Fast to add similar devices	?
GPS works	Yes
Hardware keyboard	Yes
Free software applications	Very few were usable



Sounds too good to be true?

- The modem controlled everything: booting, RAM initialization, microphone, GPS, some hardware acceleration.
- Nonfree bootloaders





Phase 2: Qualcomm devices

→ Samsung devices

- Many Samsung smartphones have a separate modem that looks isolated
- Unknown modem protocol





Sounds too good to be true?
(not again)

- Shared memory found:
 - S5PV210_PA_SDRAM is 0x30000000
 - 0x05000000 is 80MiB
 - mdmctl_res is passed to the modem driver

→ This is in the RAM.

- Affected devices:
 - Galaxy S
 - Nexus S

```
static struct resource mdmctl_res[] = {
[...], [2] = {
.name = "onedram",
.start = (S5PV210_PA_SDRAM + 0x05000000),
.end = (S5PV210_PA_SDRAM + 0x05000000),
.flags = IORESOURCE_MEM,
}, };
```



- But it's fixable (kind of)
→ Port to other devices.
- Same modem protocol





Smartphones:

- Galaxy Nexus (GT-I9250)
- Galaxy Note (GT-N7000)
- Galaxy Note II (GT-N7100)
- Galaxy SII (GT-I9100)
- Galaxy SIII (GT-I9300)

Tablets:

- Galaxy Tab 2 (GT-P3100, GT-P3110, GT-P5100, GT-P5110, TODO)
- Galaxy Note 8.0 (GT-N5100, GT-N5110)



Our resistance struggle goals

Goal	Success?
Isolated Modem	Yes
Usable	Yes
Low maintenance	Yes (Lin- eageOS)
Fast to add similar devices	Easy enough (libsamsung- ipc not trivial)
GPS works	No
Hardware keyboard	No



More seriously

Goal	Success?
Isolated Modem	Yes ←
Bootloader	Nonfree
Nonfree code running?	TrustZone (Mobicore)
Firwares	Nonfree for WiFi



Next steps

Goal	Success?
Isolated Modem	Yes
Bootloader	←
Nonfree code running?	←
Firwares	Nonfree for WiFi



Phase 3: Porting Replicant to GNU/Linux smartphones



GTA04 Advantages:

- Longer term support (good support in upstream)
- Free software vendor bootloader (xloader + u-boot fork)
- Documented hardware: GPS, modem, etc, but undocumented 3D acceleration





Our resistance struggle goals

Goal	Success?
Isolated Modem	Somehow (USB)
Usable	No ←
Low maintenance	?
Fast to add similar devices	?
GPS works	Yes
Hardware keyboard	No



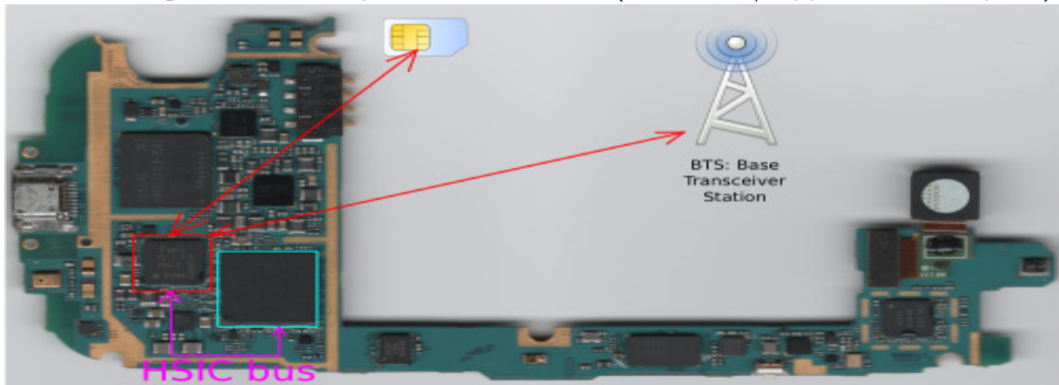
GTA04

- Some limited Replicant 4.2 support
- Got suspend issues with Replicant 6 (kernel)
- → Port failed: could not make suspend/resume work





Power management in smartphones and Android (wakelocks / opportunistic suspend)





Second attempt: LG Optimus black

- Ran Android
- Free bootloader available
- → Integration in Replicant as-is complex
- → Work to upstream it, not finished
- See Paul Kocialkowski's blog for more details [1]



→ Switching focus back to Samsung devices



You have 3 new issues

- LineageOS stopping support for the devices supported by Replicant
- None of the smartphones supported in LineageOS are interesting:
 - Non-isolated modems
 - And/or non-removable batteries
- 3G networks being shut down



You have 2 new interesting devices

- Pinephone
 - Cheap → people can get it
 - Free bootloader, documented hardware
 - Issue: unknown power management
 - Issue: current users don't have it
- Librem5
 - Probably good battery life since has big battery
 - Issue: current users don't have it and probably can't buy one

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→ Support the Galaxy SIII (GT-I9300) with an upstream kernel



How to do it?

- Existing work:
 - Some good Linux support but not complete
 - Modem driver available but not validated
- Funding:
 - 0.5 * 2 people on Graphics (David Ludovino (dllud) and Ricardo Cabrita(Grim))
 - 1 person on the rest and some help from Joonas Kylmälä (Putti)
 - Need additional funding too



Status

- Modem didn't work → Lot of attempts, finally made it work accidentally weeks ago. Need to fix the code.
- Even if part of the work has already been merged, still needs cleanups and integration.
- Replicant 9 (AOSP, LineageOS) → Replicant 10 (LineageOS) → Replicant 11 (AOSP)
- Many tasks took way longer than planned



Replicant 6.0

- Worked on Release with many fixes:
 - Many nonfree software found and removed (Java code, firmwares)
 - Fixed leak of user data (phone numbers)
 - Removed f-droid (tried to fix FSDG compliance upstream but took too long).
 - Fixed important SIM not recognized bug (Thanks Belgin).
 - Many improvements by new contributors (scripts to disable the modem, improved OpenGL compatibility, better USB WiFi integration, etc).
 - Reworked installation instructions (funded by NLnet for Replicant 11).
- TODO:
 - Migration instructions
 - Announce the release (blog post already done)



Quality Assurance

- Automatic tests:
 - Libsamsung-ipc: conversion to coding style, (few) automatic tests added, cleaned up lot of code.
 - WIP python library for automatic tests



Infrastructure: work

- Wiki Migration: Redmine → git → Mediawiki
- Enabling contributions: Almost all the VM under git (apache2 configuration, website, IRC bridge, contact address)



Collaborations with other projects

- Contacts:
 - PostmarketOS: shared our patches, helped with booting upstream Linux on the Galaxy SII (GT-I9100).
 - LineageOS unofficial ports: collaborated a bit when were using upstream Linux.
- Upstreaming:
 - mat2: fix for reproducible zips
 - heimdall: bugreported dangerous issue (no size check when installing recoveries)
 - Trisquel 9 fixes for building Replicant 11 and for the Replicant VM: proguard and fai-server.
 - Linux: small upstreaming work for Replicant 11: buttons, flash for Galaxy SIII and Note II.
 - GRUB: work to upstream some cryptogrub patches to boot Guix on FSF infrastructure (now picked up by Glenn Washburn).
 - WIP wireshark dissector for libsamsung-ipc



Extra readings

- OpenMoko History: <https://www.vanille.de/blog/openmoko-10-years-after-mickeys-story/>
- Paul's blog for on freeing the Optimus black [1]



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- Replicant devices and logo:
 - Replicant Logo https://git.replicant.us/replicant/vendor_replicant_artwork/plain/replicant_logo_alpha.svg?h=main&id=fc213d2ca94cef9047d1e4a71c21c4c4c87f349d CC-BY-SA 3.0 Unported
 - Replicant devices <https://git.replicant.us/infrastructure/www.replicant.us/tree/images/supported-devices?id=2a331698cead2677fa953c3e1ab5d78528e39ef9> CC-BY-SA 3.0 Unported

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-  <https://code.paulk.fr/article21/a-hacker-s-journey-freeing-a-phone-from-the-ground-up-second-part>
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-  <https://osmocom.org/projects/baseband/wiki>
-  [The motorola c115 is from 2005 https://en.wikipedia.org/wiki/List_of_Motorola_products#C_series_\(1998-2006\)](https://en.wikipedia.org/wiki/List_of_Motorola_products#C_series_(1998-2006))
-  https://en.wikipedia.org/wiki/Android_Marshmallow#cite_note-2


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