Replicant: Struggle for independence

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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

Replicant past struggles successes and failures

Parallel work

References
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 on 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 Oaxaca 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.
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 (Nlnet, 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.
Introduction

Replicant past struggles successes and failures

Parallel work

References

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.
<table>
<thead>
<tr>
<th>Introduction</th>
<th>Replicant past struggles successes and failures</th>
<th>Parallel work</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>What we have now</td>
<td></td>
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</table>
### Free distributions

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

- Cultural reapropriation: 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
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.
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 the meantime
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
  - Took (years) to have the mediactl API in Linux
  - → hacks in the vendor kernel
Android

- Google Play
  - Samsung Android
    - Replicant 6.0
  - LineageOS
    - Replicant 11
- AOSP
  - LineageOS
    - Replicant 6.0
Device kernels

- Linux
  - vendor_kernel_replicant
  - Android kernel
  - System On A Chip Android kernel
    - Device kernel
  - GKI
    - External modules
      - Device kernel

References
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 Motorolla 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 attemps

- FirefoxOS \( \rightarrow \) nonfree Android drivers
- Meego, Tizen
- Ubuntu \( \rightarrow \) 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

<table>
<thead>
<tr>
<th>Goal</th>
<th>Success?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Create a 100% free software Android distribution</td>
<td>Yes</td>
</tr>
<tr>
<td>Support the HTC Dream</td>
<td>Yes</td>
</tr>
<tr>
<td>Usable</td>
<td>Yes</td>
</tr>
<tr>
<td>Low maintenance</td>
<td>Yes (AOSP, LineageOS)</td>
</tr>
<tr>
<td>Fast to add new devices</td>
<td>Yes</td>
</tr>
<tr>
<td>GPS works</td>
<td>Yes</td>
</tr>
<tr>
<td>Hardware keyboard</td>
<td>Yes</td>
</tr>
<tr>
<td>Free software applications</td>
<td>Started to appear</td>
</tr>
</tbody>
</table>
### GNU/Linux

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

```c
static struct resource mdmctl_res[] = {
  [...] [2] = {
    .name = "onedram",
    .start = (S5PV210_PA_SDRAM + 0x05000000),
    .end = (S5PV210_PA_SDRAM + 0x05000000 + SZ_16M - 1),
    .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

<table>
<thead>
<tr>
<th>Goal</th>
<th>Success?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolated Modem</td>
<td>Yes</td>
</tr>
<tr>
<td>Usable</td>
<td>Yes</td>
</tr>
<tr>
<td>Low maintenance</td>
<td>Yes (LineageOS)</td>
</tr>
<tr>
<td>Fast to add similar devices</td>
<td>Easy enough (libsamsung-ipc not trivial)</td>
</tr>
<tr>
<td>GPS works</td>
<td>No</td>
</tr>
<tr>
<td>Hardware keyboard</td>
<td>No</td>
</tr>
</tbody>
</table>
More seriously

<table>
<thead>
<tr>
<th>Goal</th>
<th>Success?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolated Modem</td>
<td>Yes ←</td>
</tr>
<tr>
<td>Bootloader</td>
<td>Nonfree</td>
</tr>
<tr>
<td>Nonfree code running?</td>
<td>TrustZone (Mobicore)</td>
</tr>
<tr>
<td>Firwares</td>
<td>Nonfree for WiFi</td>
</tr>
</tbody>
</table>
Next steps

<table>
<thead>
<tr>
<th>Goal</th>
<th>Success?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolated Modem</td>
<td>Yes</td>
</tr>
<tr>
<td>Bootloader</td>
<td>←</td>
</tr>
<tr>
<td>Nonfree code running?</td>
<td>←</td>
</tr>
<tr>
<td>Firwares</td>
<td>Nonfree for WiFi</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Goal</th>
<th>Success?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolated Modem</td>
<td>Somehow (USB)</td>
</tr>
<tr>
<td>Usable</td>
<td>No ←</td>
</tr>
<tr>
<td>Low maintenance</td>
<td>?</td>
</tr>
<tr>
<td>Fast to add similar devices</td>
<td>?</td>
</tr>
<tr>
<td>GPS works</td>
<td>Yes</td>
</tr>
<tr>
<td>Hardware keyboard</td>
<td>No</td>
</tr>
</tbody>
</table>
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
→ 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
Parallel work
Replicant 6.0

- Worked on Relase 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 a 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]
Licenses:

- The Qtmoko and SHR pictures are From are under the GNU Free Documentation License.
  - QtMoko pictures: http://wiki.openmoko.org/wiki/QtMoko

- Raised fist: https://commons.wikimedia.org/wiki/File:Raised_fist.jpg Creative Commons Attribution 3.0 Unported

- We Can Do It: https://commons.wikimedia.org/wiki/File:We_Can_Do_It!_NARA_535413_-_Restoration_2.jpg Public domain
• HTC Dream: https://commons.wikimedia.org/wiki/File:HTC_Dream_opened.jpg Creative Commons Attribution 3.0 Unported

• https://creativecommons.org/licenses/by-sa/4.0/ for the rest.

• WiFi logo: https://commons.wikimedia.org/wiki/File:Wifi.png Public domain, probably trademarked.

• Freedo Redrawn version: https://www.gnu.org/graphics/freedo.html GNU Free Documentation License 1.3 or later

- N900 kernel [https://commons.wikimedia.org/wiki/File:N900_xterm.JPG](https://commons.wikimedia.org/wiki/File:N900_xterm.JPG) CC-BY-SA 3.0 Unported, 2.5 Generic, 2.0 Generic and 1.0 Generic
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  International


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• 4 freedoms https://www.gnu.org/graphics/amihud-4-freedoms.html CC-BY-SA 4.0 International License or GPLv3 or later

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• anti-drm protest https://www.flickr.com/photos/bcatch/164393994/in/album-72157594161735152/ CC-BY-SA 2.0

• GNU buck https://static.fsf.org/licensing/gnu-bucks.tar.gz Unknown license

• anti-smartphone https://commons.wikimedia.org/wiki/File:Bia%C5%82a_Podlaska~21ujcqd.jpg CC-BY-SA 4.0 International
• 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=2a331698ceed2677fa953c3e1ab5d78528e39ef9 CC-BY-SA 3.0 Unported
https://code.paulk.fr/article20/
a-hacker-s-journey-freeing-a-phone-from-the-ground-up-first-part
https://code.paulk.fr/article21/
a-hacker-s-journey-freeing-a-phone-from-the-ground-up-second-part
https://code.paulk.fr/article22/
a-hacker-s-journey-freeing-a-phone-from-the-ground-up-third-part
https://code.paulk.fr/article23/
a-hacker-s-journey-freeing-a-phone-from-the-ground-up-fourth-part

https://osmocom.org/projects/baseband/wiki


https: //redmine.replicant.us/projects/replicant/wiki/PortingToAndroid11

http://www.deccanherald.com/content/332274/there-more-mobile-phones-people.html