

# Extending the lifetime of smartphones with Replicant, a fully free Android distribution

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# Introduction

## Replicant:

- ▶ Fully free Android distribution approved by the FSF.
- ▶ But the hardware it runs on is not...

## Quick Facts

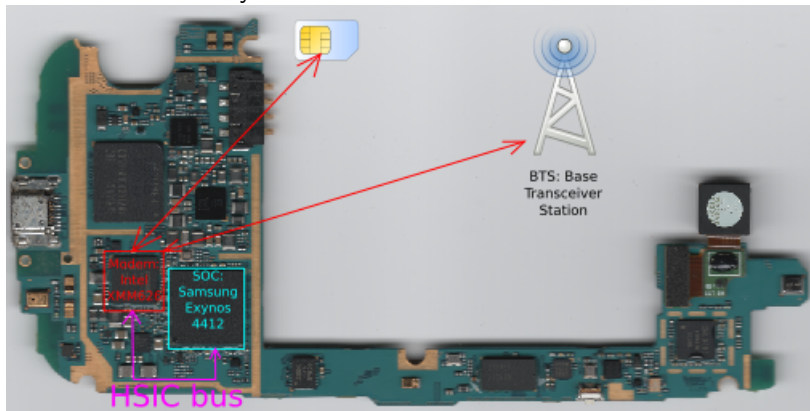
- ▶ Website: [replicant.us](http://replicant.us)
- ▶ Exists since September 2009.
- ▶ Currently based on LineageOS.
- ▶ Android versions:
  - ▶ Replicant 6: Android 6, last security update: October 2017[1].
  - ▶ Replicant 9: Android 9, work in progress[2].
- ▶ Supports ~ 10 devices (smartphones and tablets).
- ▶ ~ 2 full time equivalent contributors and a big community.

Best effort:

minimum feature set required to support a device:

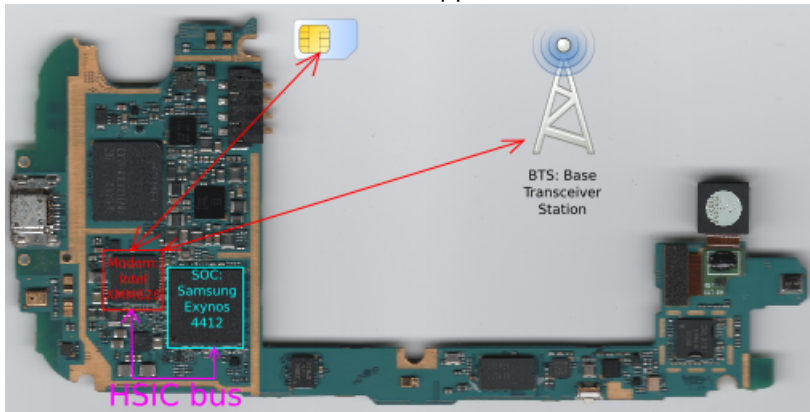
- ▶ Display working and graphics fast enough.
- ▶ Sound working.
- ▶ Be able to make calls.
- ▶ etc.
- ▶ GPS, camera, and other non crucial hardware may not work, or work in later releases.

## A very short introduction on hardware:



- ▶ System on a chip.
- ▶ Smartphones and the modem.

## Freedom issues in supported devices



- ▶ The cellular network.
- ▶ The modem firmware.
- ▶ Other nonfree firmwares.
- ▶ Bootloaders and TrustZone.
- ▶ Upstream anti-feature and huge code base.

## Why Android?

- ▶ Advantages:
  - ▶ 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 pixels.
- ▶ Issues:
  - ▶ Part of the GNU/Linux software 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.



## Android: from time to market driven architecture to sustainability

- ▶ SOCs, WiFi chips, smartphones and tablets:
  - ▶ Write the code that work as fast as possible.
  - ▶ Support as many hardware features as possible.
  - ▶ → Varying code quality.
  - ▶ → Example: One driver rewritten 3 times.
- ▶ 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.

## Ugly code is good (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.
  - ▶ Things can be improved later: always be cleaned up later or if the code quality is too bad, rewritten from scratch.
  - ▶ Having the source code under a free software license is very important.
  - ▶ Worst case: use the source code as documentation or reverse engineer it (add prints).
- ▶ → We depend on that source code.

## Part II

Replicant 6 → More recent Android.

## Requirements += Replacable battery:

- ▶ No need to rush to support the device
- ▶ The device lasts longer
- ▶ → In line with upstreaming longer term work.

## Devices supported by Lineage 16 with a removable battery:

- ▶ Qualcomm MSM8\*:
  - ▶ Fairphone: FP2
  - ▶ LG: G3 (many versions)
  - ▶ OPPO: Find 7a/s
  - ▶ Samsung: Galaxy Note 3 LTE (Many versions)
  - ▶ Samsung: Galaxy S III Neo (2 versions)
  - ▶ Samsung: Galaxy S5 Active
  - ▶ Samsung: Galaxy S5 LTE (Many versions)
  - ▶ Samsung: Galaxy S5 LTE Duos (Many versions)
  - ▶ Wileyfox: Swift
- ▶ Qualcomm APQ8\*
  - ▶ Samsung: Galaxy S4 (Many versions)
  - ▶ Samsung: Galaxy S4 Value Edition (GT-I9515/L)
  - ▶ Samsung: Galaxy S4 Active
  - ▶ Samsung: Galaxy S5 LTE-A
  - ▶ Samsung: Galaxy S5 Plus
- ▶ Samsung Exynos 7580:
  - ▶ Samsung: Galaxy S5 Neo

## Limiting freedom, privacy and security attacks:

- ▶ Isolated modem:
  - ▶ Modem not in the SOC.
  - ▶ No shared memory (RAM) between the modem and the SOC.
    - ▶ HSIC: USB-like, the host control re-enumeration.
    - ▶ MIPI: Should be OK, not extensively reviewed.

Devices supported by Lineage 16 with a removable battery:

- ▶ ~~Qualcomm MSM8\*:~~ Modem in the SOC
  - ▶ ~~Fairphone: FP2~~
  - ▶ ~~LG: G3 (many versions)~~
  - ▶ ~~OPPO: Find 7a/s~~
  - ▶ ~~Samsung: Galaxy Note 3 LTE (Many versions)~~
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  - ▶ ~~Wileyfox: Swift~~
- ▶ Qualcomm APQ8\*
  - ▶ Samsung: Galaxy S4 (Many versions)
  - ▶ Samsung: Galaxy S4 Value Edition (GT-I9515/L)
  - ▶ Samsung: Galaxy S4 Active
  - ▶ Samsung: Galaxy S5 LTE-A
  - ▶ Samsung: Galaxy S5 Plus
- ▶ Samsung Exynos 7580:
  - ▶ ~~Samsung: Galaxy S5 Neo Modem ↔ SOC: shared memory~~



## Hmmm

- ▶ → No Exynos with removable battery and isolated modem.
- ▶ → All the devices supported by Replicant 6.0 have been dropped.
- ▶ → We'd like to support the devices longer...
- ▶ The APQ\* also look interesting, we would need to do more research on it:
  - ▶ Isolated modem?
  - ▶ Upstream support for the SOC?
  - ▶ Nonfree bootloader (~ BIOS+GRUB) (signed?)
  - ▶ Probably way more work needed (different modem, more upstreaming work).
- ▶ We also took the decision when LineageOS didn't support these.

## Part III

Already supported by Replicant 6.0:

- ▶ Galaxy SIII (I9300): Good upstream status, modem support lacking, and other small fixes to do.
- ▶ Galaxy Note II (I9300): Good upstream status, modem and display support lacking.
- ▶ Galaxy SIII 4G (I9305) and Galaxy Note II 4G (N7105): Different modem.

## Making devices more sustainable:

- ▶ → Upstream Linux → We can support them longer.
- ▶ → Most Replicant users and developers already have one.
- ▶ → Known hardware that works and can still be bought second hand.
- ▶ Remaining issues:
  - ▶ RAM size and new Android versions.
  - ▶ Nonfree bootloader.

## Main blocker: Nonfree bootloader

- ▶ Nonfree → Incentive to drop the device.
- ▶ Partially free u-boot port → can't redistribute the nonfree part.
- ▶ Research to understand if we can make it fully free (XBOOT).
- ▶ Stock bootloader incompatible with Linux...

Upstream Linux bootloader requirements  
Documentation/arm/Booting (since 2003):

*The MMU must be off.*

*Instruction cache may be on or off.*

*Data cache must be off.*

Some funding later...

## Replicant 9.0:

- ▶ Galaxy SIII booting, modem initialized.
- ▶ Still work to do(testing, audio, networking, etc.).
- ▶ Slowed down by conferences and other Replicant work (XBOOT, Replicant 6, etc).



## Future directions:

- ▶ Finish the research on XBOOT.
  - ▶ <https://github.com/xboot/xboot>
- ▶ Look into devices like the PinePhone and the Librem5.
- ▶ Share more work with GNU/Linux upstream (OFono, other hardware support libraries).

## Licenses:

- ▶ The SIM card and BTS pictures comes from [https://en.wikipedia.org/wiki/File:Gsm\\_network.png](https://en.wikipedia.org/wiki/File:Gsm_network.png) and are under the GFDL 1.2 or the Creative commons Attributions-Share Alike 3.0 Unported.
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[https://en.wikipedia.org/wiki/Android\\_Marshmallow#cite\\_note-2](https://en.wikipedia.org/wiki/Android_Marshmallow#cite_note-2)



<https://redmine.replicant.us/projects/replicant/wiki/PortingToAndroid9>