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

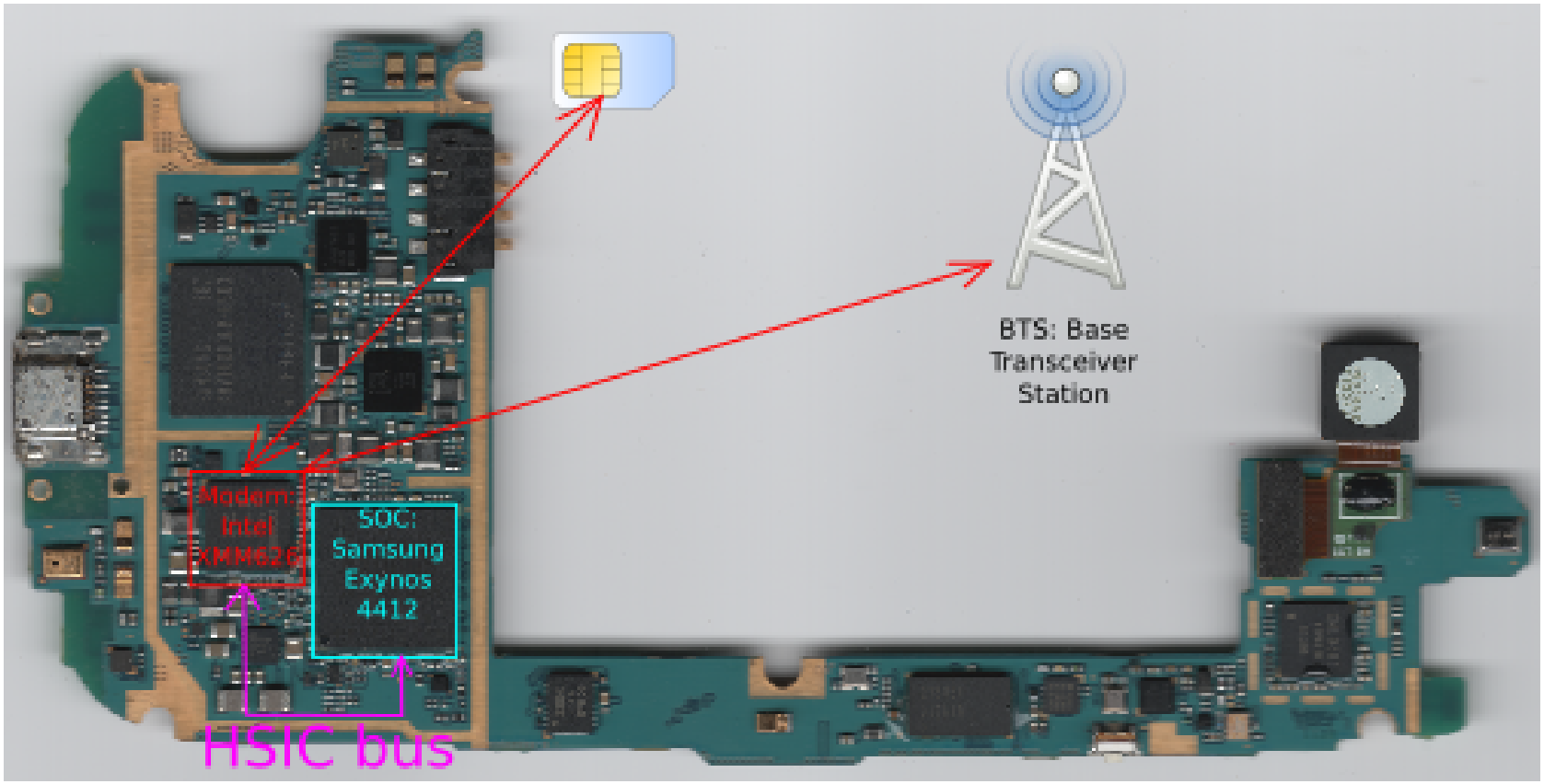
- Website: replicant.us
- Exists since September 2009.
- Currently based on LineageOS.
- Android versions:
  - Replicant 6: Android 6, last security update: October 2017[1].
  - Replicant 9: Android 9, work in progress[2].
- Supports $\sim$ 10 devices (smartphones and tablets).
- $\sim$ 2 full time equivalent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

Best effort:

minimum feature set required to support a device:

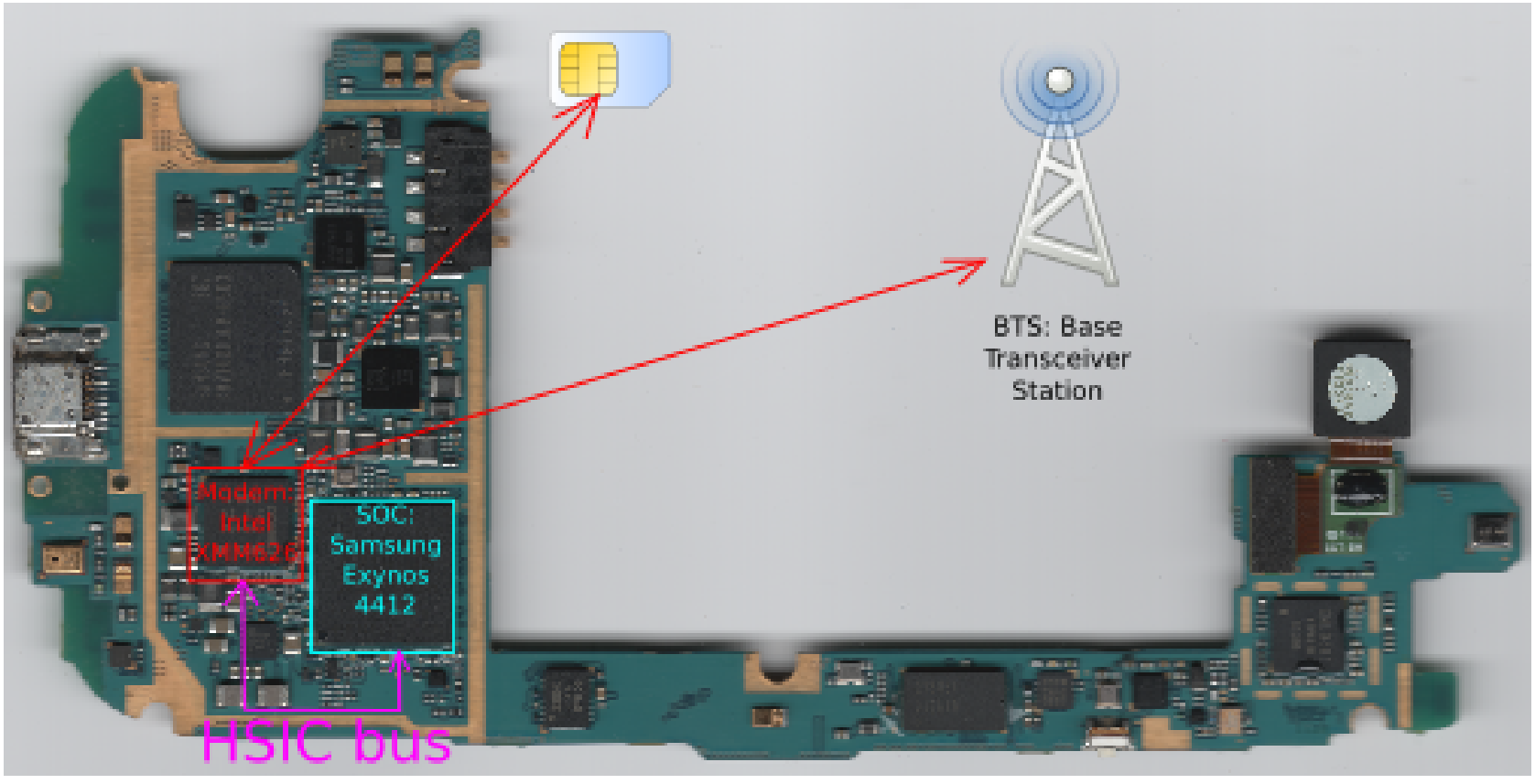
- Display working and graphics fast enough.
- Sound working.
- Be able to make calls.
- etc.
- GPS, camera, and other non crucial hardware may not work, or work in later releases.

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.
  - $\rightarrow$ 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.
  - $\rightarrow$ Varying code quality.
  - $\rightarrow$ 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 $\leftrightarrow$ Android framework $\leftrightarrow$ HAL $\leftrightarrow$ 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).
- $\rightarrow$ We depend on that source code.

Part II

Replicant 6 $\rightarrow$ More recent Android.

Requirements $+=$ Replacable battery:

- No need to rush to support the device
- The device lasts longer
- $\rightarrow$ 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)~~
  - ~~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~~ Modem $\leftrightarrow$ SOC: shared memory

Hmmm

- $\rightarrow$ No Exynos with removable battery and isolated modem.
- $\rightarrow$ All the devices supported by Replicant 6.0 have been dropped.
- $\rightarrow$ 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 ($\sim$ 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:

- $\rightarrow$ Upstream Linux $\rightarrow$ We can support them longer.
- $\rightarrow$ Most Replicant users and developers already have one.
- $\rightarrow$ 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 $\rightarrow$ Incentive to drop the device.
- Partially free u-boot port $\rightarrow$ 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).

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https://en.wikipedia.org/wiki/Android_Marshmallow#cite_note-2

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