

# Free software on cell phones: My user experience with Replicant

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GNU Project

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Updated version, last changed on 2022-10-09. The master copy is at <https://ageinghacker.net/talks/>



# About Android

In the GNU/Linux system I can remove and replace parts to obtain a system I like.

That is:

- GNU (GNU is there but I do not notice it much)
- plus Linux (Linux is there but I do not notice it much)
- (plus other things as well)

Android is GNU/Linux, without the GNU part.

A very sad affair.



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# The Android software

- Android is mostly **free software**. . .
  - . . . but many components running on phones are usually **proprietary**
    - some components are **always proprietary**:
      - almost everything in app "stores"
      - modem driver
      - Wifi driver?
      - Bluetooth driver?
  - The high-level part of the system and apps are written in **Java**
- Android is a huge, complicated, slow build system, and it's not clear how it could be made the industry standard for mobile phones.



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- Android is a highly complicated software system, which is why the majority of its code is not open source.





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# Proprietary software is a particularly serious problem here

Android runs on this kind of hardware.



Any modern cellphone has:

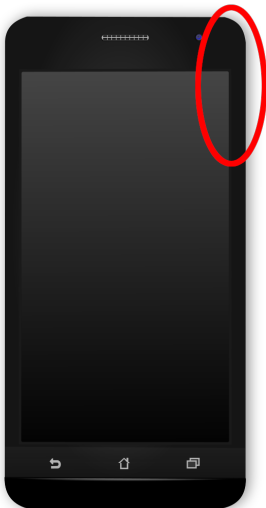
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- microphone
- cameras
- No hardware kill switches

People have this in their pocket, running proprietary (unknown) software!



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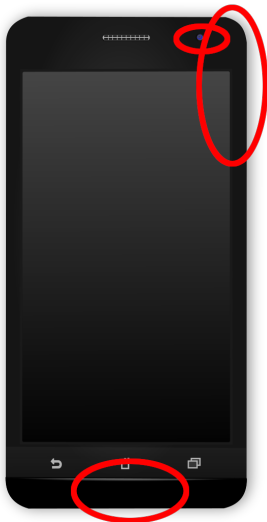
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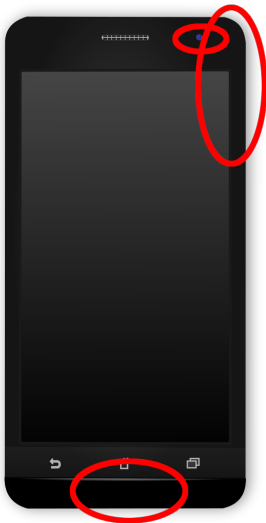
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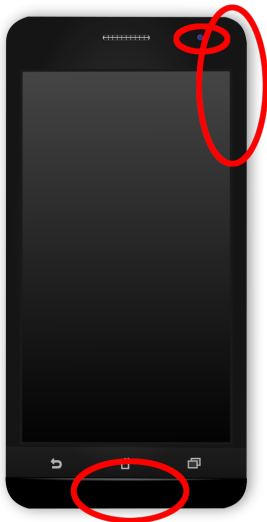
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## Noun [ edit ]

### bug (plural **bugs**)

1. (*entomology*) An [insect](#) of the order [Hemiptera](#) (the “true bugs”).
2. Any of various species of marine or freshwater [crustaceans](#); e.g. a [Moreton Bay bug](#), [mudbug](#). [[quotations ▼](#)]
3. (*informal*) Any [insect](#), [arachnid](#), or other terrestrial [arthropod](#) that is a [pest](#).

*These flies are a bother. I'll get some **bug** spray and kill them.*

4. (US) Any [insect](#), [arachnid](#), [myriapod](#) or [entognath](#).
5. (UK, *obsolete*, specifically) A [bedbug](#). [[quotations ▼](#)]
6. (chiefly computing and engineering jargon) A [problem](#) that needs [fixing](#). [[quotations ▼](#)] [[synonyms ▲](#)]

Synonyms: [defect](#), [glitch](#)

*The software **bug** led the computer to calculate 2 plus 2 as 3.*

7. A contagious [illness](#), or a [pathogen](#) causing it.
8. (*informal*) An [enthusiasm](#) for something; an [obsession](#). [[quotations ▼](#)]

*I caught the skiing **bug** while staying in the Alps.*

9. (*informal*) A keen [enthusiast](#) or [hobbyist](#). [[quotations ▼](#)]
10. A concealed electronic eavesdropping or intercept device.

*We installed a **bug** in her telephone.*

11. A small and usually [invisible file](#) (traditionally a single-pixel image) on a [World Wide Web](#) page, primarily used to [track](#) users.

*He suspected the image was a Web **bug** used for determining who was visiting the site.*

12. (*broadcasting*) A small usually [transparent](#) or [translucent image](#) placed in a corner of a [television](#) program to identify



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# Can we liberate Android?

I am not a fan of the Android user interface.

- ...but a computer always in my pocket sounds good.

- Can we liberate Android?

Reverse-engineering the Android user interface is not the problem. The problem is that the **modem** is usually a device that was designed with some proprietary protocols.

**Almost:** every **modem** is proprietary, and difficult to reverse-engineer.

- However in many cases modems are **isolated**: they do not make the rest of the system insecure.



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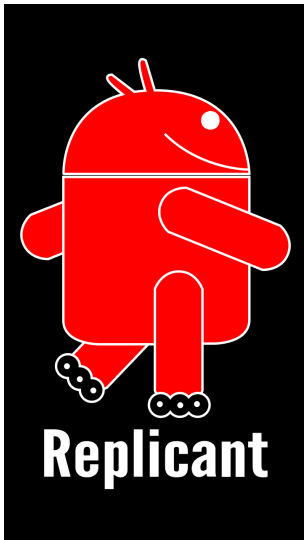
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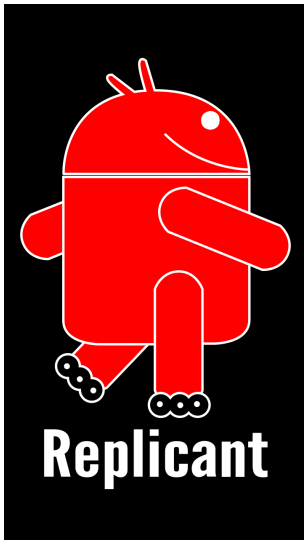
# The Replicant Project 1/2



- **Replicant** is a fork of LineageOS (Android variant rebuilt from source), without proprietary parts (except the **modem**).
- Developed since 2010
- Currently **Android 6**. Porting to the most recent versions in progress.
- Only supports a limited number of not-so-recent devices (3G):



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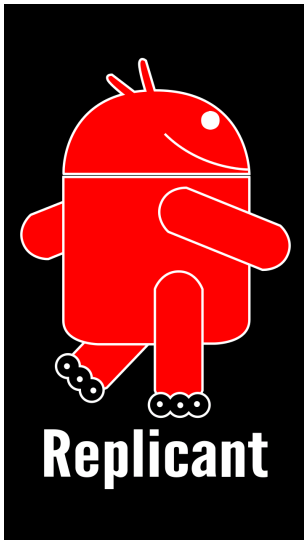


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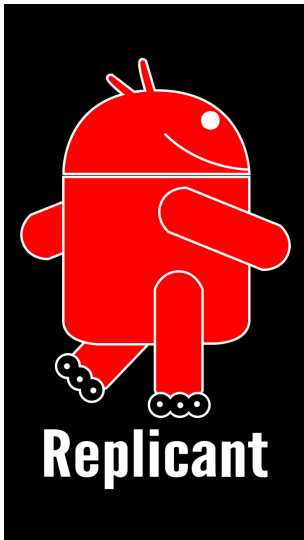
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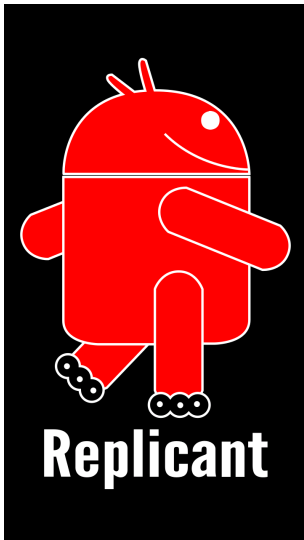
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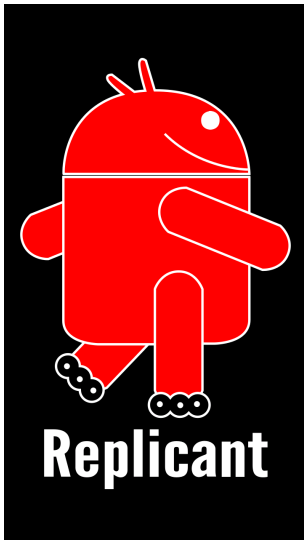
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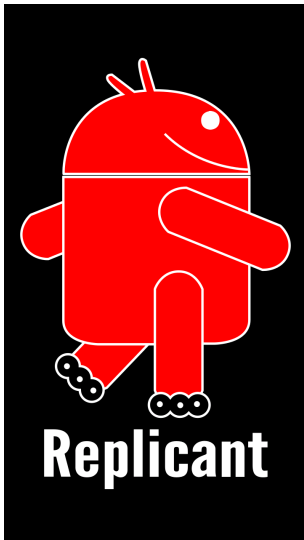
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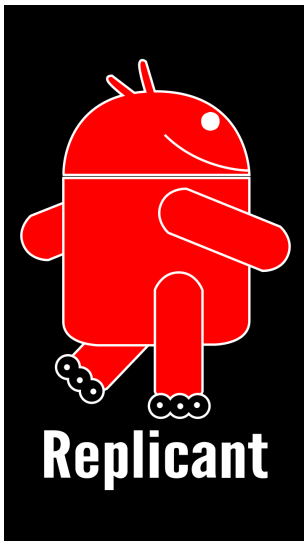


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# My Replicant phone

- Samsung Galaxy Note II (“GT-N7100”, ~2012)
  - Thanks Ege: she bought one second-hand then gifted it to me
  - My first smartphone ever: I started using it in 2021.
  - I replaced the battery (strongly recommended)
- I followed the instructions on <https://replicant.us>
  - Long but relatively easy, very well documented
  - Download images to your GNU/Linux system
  - Use a few utilities to transfer via USB cables to the phone
  - Reboot
  - Prepare to lock up in case you crash everything
- An app “store” with only free-software apps: [f-droid](#)
- You can spend a long time installing apps and (to a limited degree) customising



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  - Used a USB cable to transfer the USB cables to the phone
  - Followed the instructions to install the ROM and the GSI
  - Rebooted the phone and it worked
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- I followed the instructions on <https://replicant.us>
  - Long but relatively easy; very well documented
  - Download images to your GNU/Linux system
  - Use a few utilities to transfer via USB cable: [heimdall](#), [fastboot](#)
  - Prepare to back up in case you crash everything
- An app “store” with only free-software apps: [f-droid](#)
- You can spend a long time installing apps and (to a limited degree) customising





# My Replicant phone

- Samsung Galaxy Note II (“GT-N7100”, ~2012)
  - Thanks Ege: she bought one second-hand then gifted it to me
  - My first smartphone ever: I started using it in 2021.
  - I replaced the battery (strongly recommended)
- I followed the instructions on <https://replicant.us>
  - Long but relatively easy; very well documented
  - Download images to your GNU/Linux system
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# My Replicant phone

- No Wifi, front camera, Bluetooth, GPS (proprietary drivers)
  - But the back camera works with a free-software driver
- Proprietary but isolated GSM modem
- No display acceleration: slowish refresh
  - VLC the only working video player
- The camera app sometimes crashes because of the nonworking front camera
- The entire phone can crash, more easily with some apps (not working)
- A very annoying bug sometimes crashes the GSM modem
  - I have an imperfect workaround
- I can cross-compile from GNU/Linux!
  - I can't build my own OS, this one was just fun and I was curious
  - I can't run Java out of the box. No Java for me without a good reason
- I have a working VPN
- I can transfer files between phone and computer
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- I can cross-compile from GNU/Linux!
  - I can build my own OS, but this is not as just fun and Java as the early Android versions. Not out of the box. No Java runtime without a good reason.
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  - I can build and install this software without a good reason
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# My Replicant phone

It **works!**

(If it crashes now I can fix it quickly.)



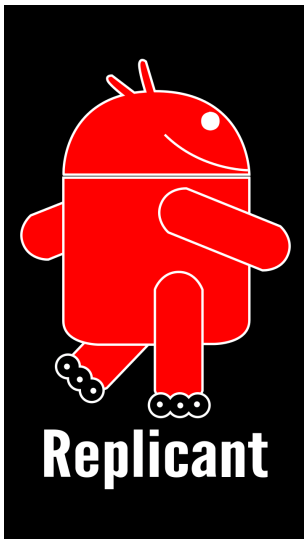
# My Replicant phone

It [works!](#)

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# Boot

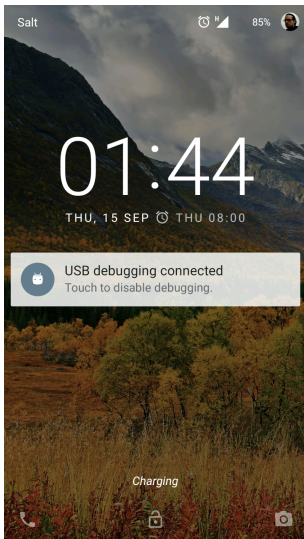


My Replicant system at boot, with the screen locked, in its home screen.





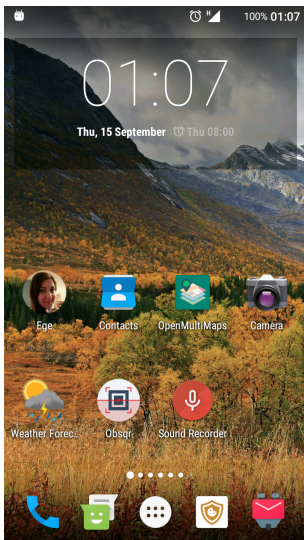
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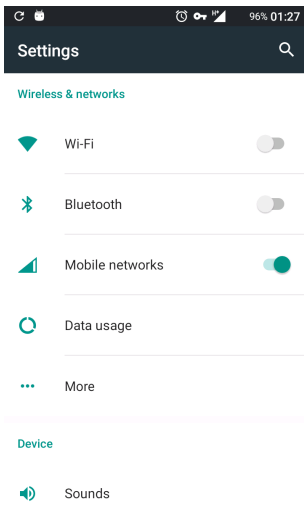
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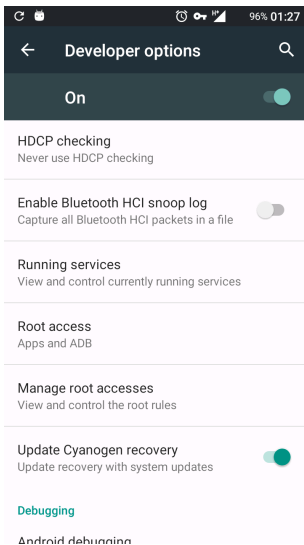
# Settings



The [Android Debugging Bus](#) is useful for controlling your phone from your computer.



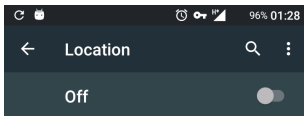
# Settings



The **Android Debugging Bus** is useful for controlling your phone from your computer.



# Settings



Mode  
Location off

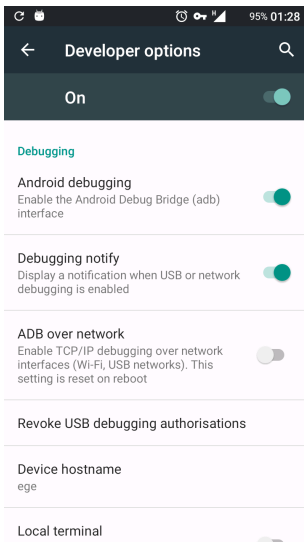
## Recent location requests

No apps have requested location recently

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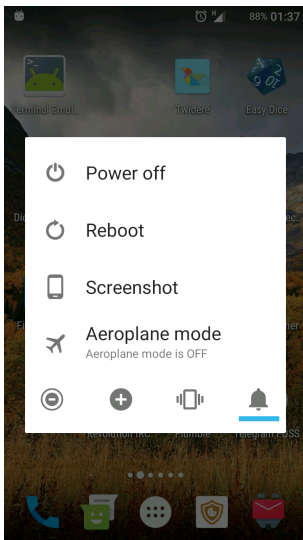
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The **Android Debugging Bus** is useful for controlling your phone from your computer.



# Reboot and recovery mode

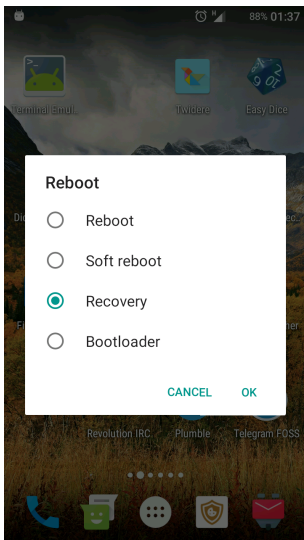


I enabled the “advanced” reboot menu. Recommended.

The Recovery image is useful for backing up and restoring without touching mounted filesystems; and for system upgrades.



# Reboot and recovery mode



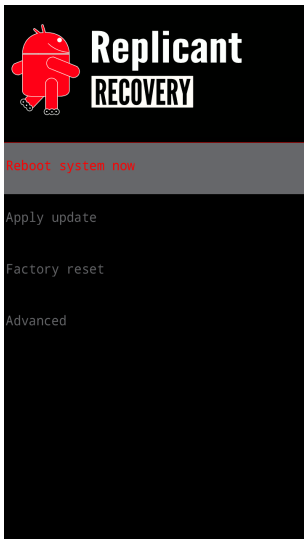
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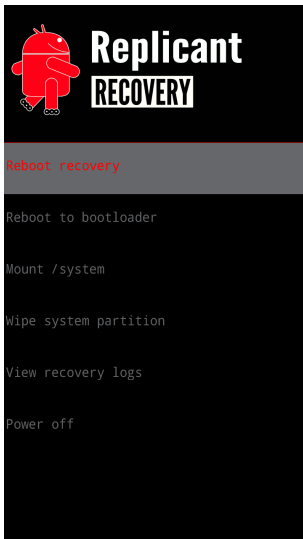


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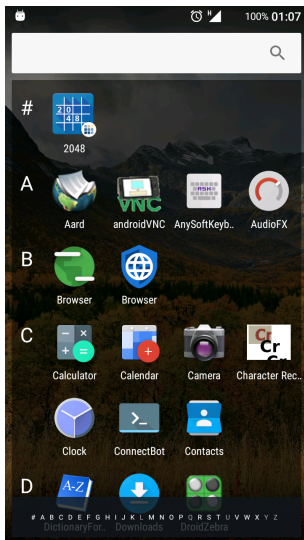


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# My “drawer”

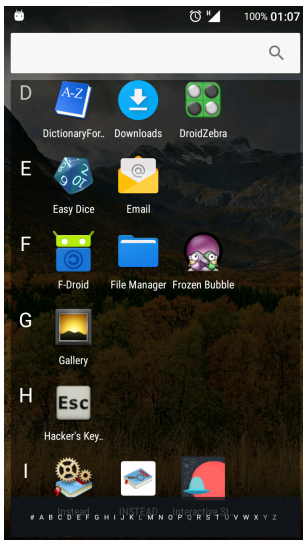


These are the apps I have installed now.

Some I actually use; a few are silly, some I have just tried once.



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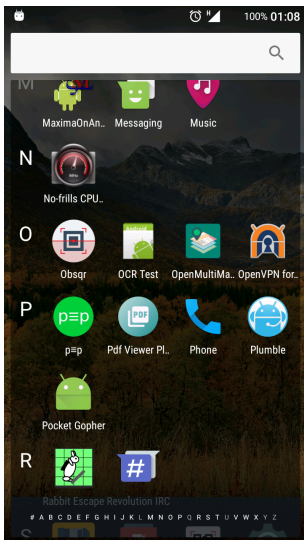


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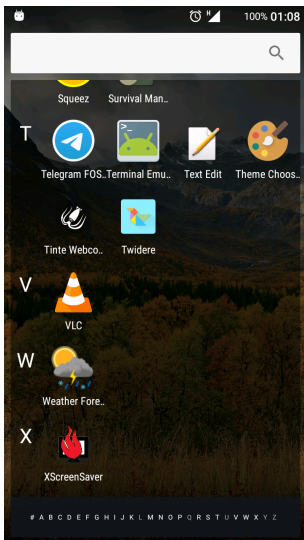


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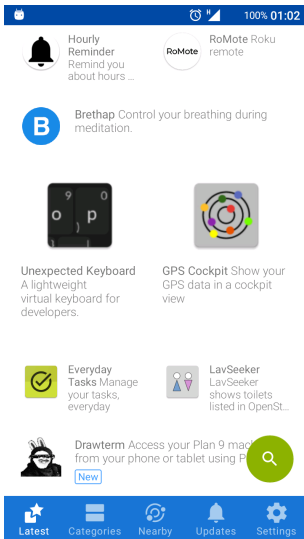


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# The f-droid “app store” for free-software apps

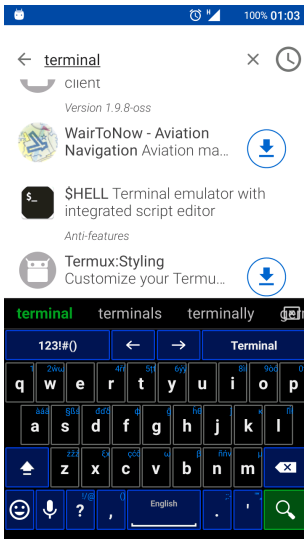


f-droid is an app-store for free-software apps.

Of course you can also install apps manually — or do whatever you want: it is **your** phone!



# The f-droid “app store” for free-software apps



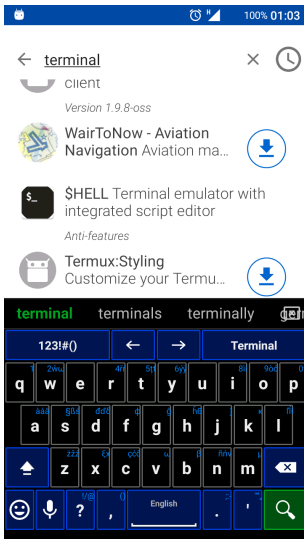
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# The f-droid “app store” for free-software apps



Jami

Updated 6 days ago

46.0 MiB / 47.4 MiB

97% 

## Secure and distributed communication platform

Jami (formerly Ring and SFLphone) is a free distributed multimedia communication software. It is developed by Savoir-faire Linux with the help of a global community of users and contributors. Savoir-faire Linux is a Canadian company specialized in Linux and free software.

Jami allows to make audio or video calls, and to send messages, safely and freely, in confidence. Jami is a Free and open source software that requires no central server.

What can you do with Jami:

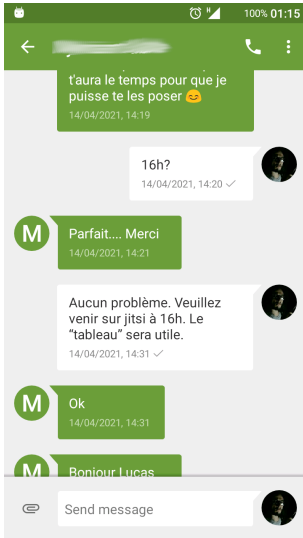
- \* send text messages
- \* make audio calls
- \* make video calls
- \* send files
- \* use your existing SIP account

f-droid is an app-store for free-software apps.

Of course you can also install apps manually — or do **whatever you want**: it is **your phone**!



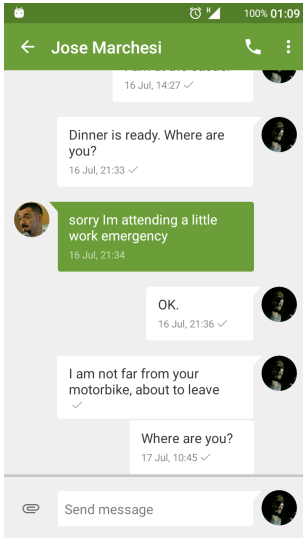
# SMS messages



This is useful in practice and works perfectly well.



# SMS messages



This is useful in practice and works perfectly well.



# (The entirely-free-software version of) Telegram



(This gives you a little more privacy than with SMS.)

Calls and groups also work perfectly well.

[Hello to my awesome Turkish parents-in-law.]



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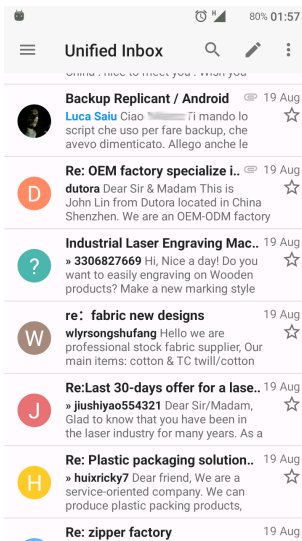
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# Mail: I recommend K-9 Mail



K-9 Mail works well and is somewhat customisable.

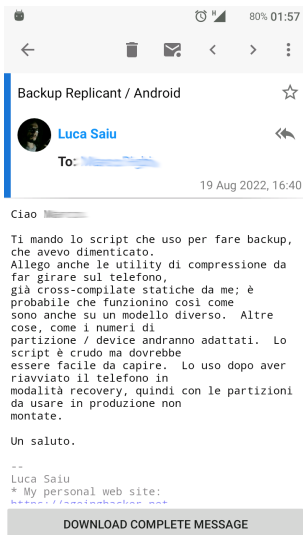
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... But users of mail apps on cell phones will feel perfectly at home with this.





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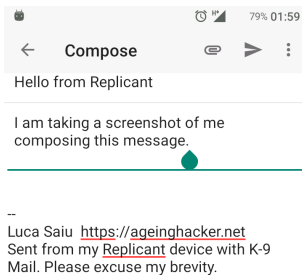
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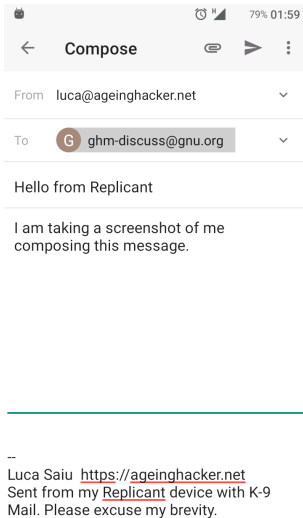
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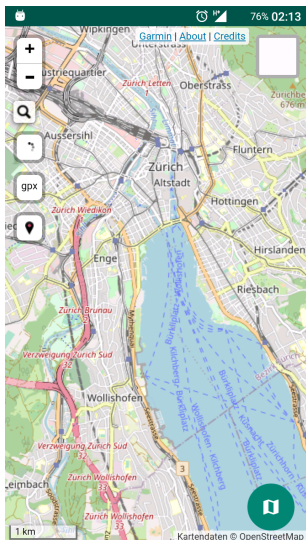
# Web browsing



SmartCookieWeb is the best web browser I found.



# Maps: several unusable apps use OpenStreetMap...



Not so good.

Many of these apps seem **incomplete** (no bookmarks for places!) and unstable.

It is not just my missing GPS driver.



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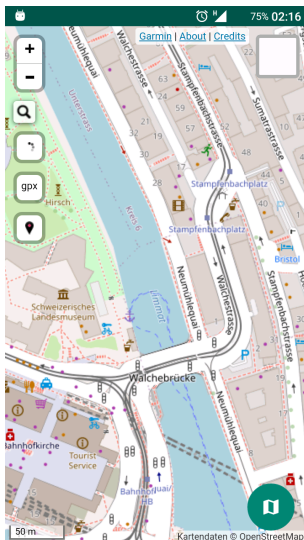
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# ... one very nice OpenStreetMap app: Organic Maps



Organic Maps is unfortunately **slow** on my phone. But it really works, and is usable.

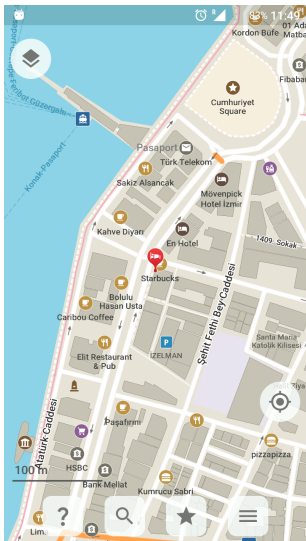
This app downloads maps in advance and uses them **offline**: excellent for privacy.

This is where we are now in Izmir.

Even if I had **no network** I could use here the Turkey maps I had **downloaded back in Switzerland!**



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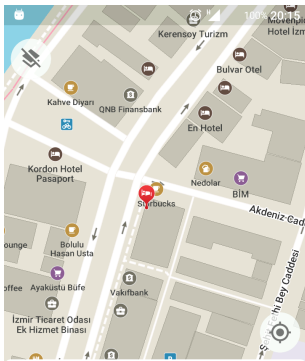
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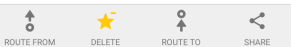


## GHM venue: Park Inn by Radisson

Park Inn by Radisson

My Places • Hotel

Cumhuriyet Bulvarı, 124



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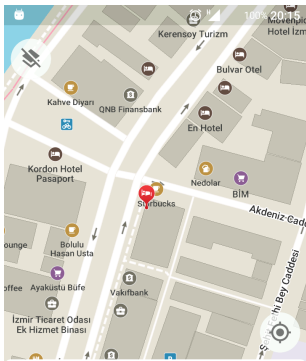
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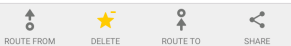


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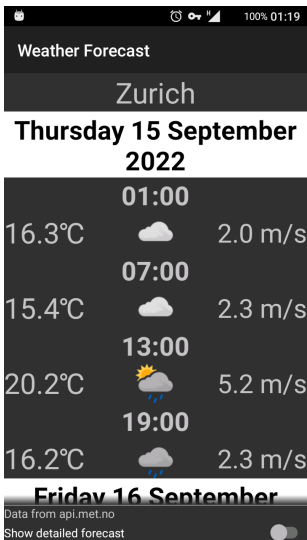
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# Weather Forecast

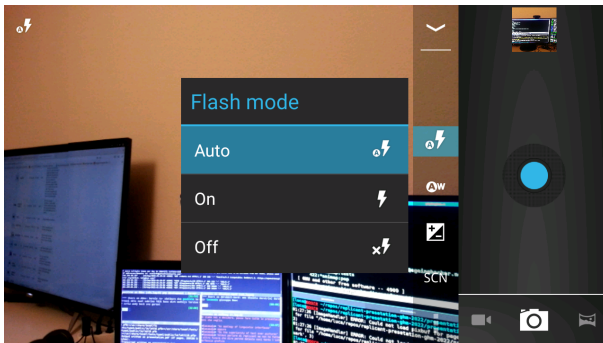


There are weather forecast apps: I do not know which one to recommend.

(Even without a GPS driver I think that this leaks privacy. . . )



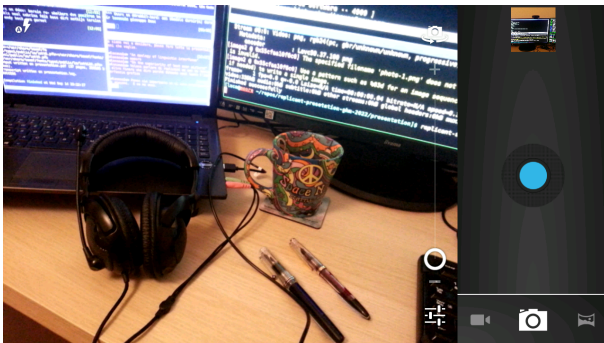
# Taking photos



I have had **system crashes** occasionally when using this in the past.



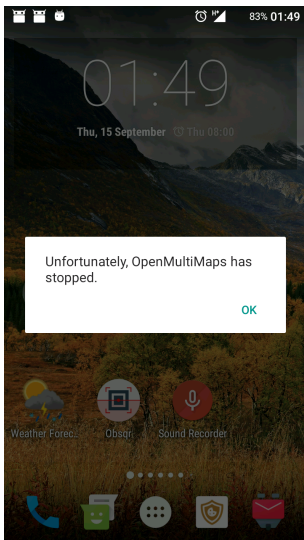
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# Crashes



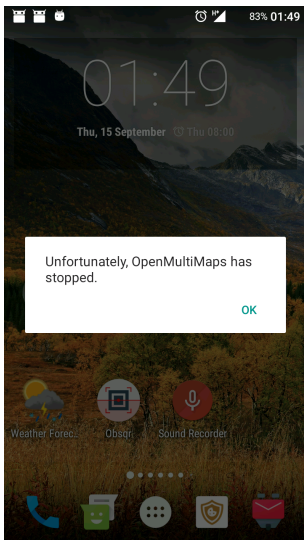
Sometimes app crash.

- This might have depended on a working GPS
- **App** crashes are not a big deal





# Crashes

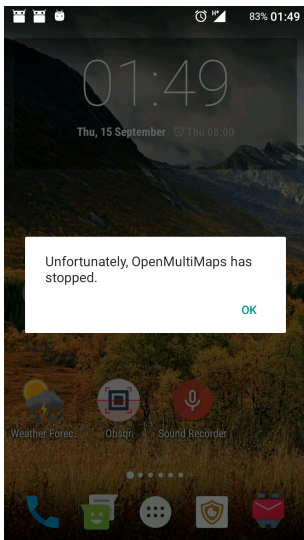


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# Crashes

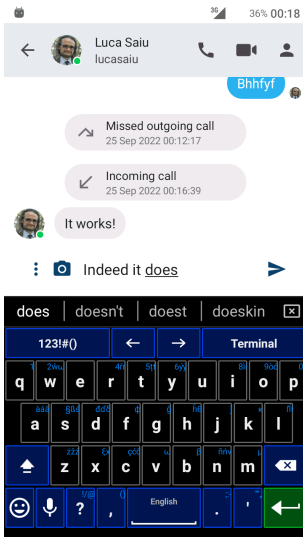


Sometimes app crash.

- This might have depended on a working GPS
- **App** crashes are not a big deal



# Jami

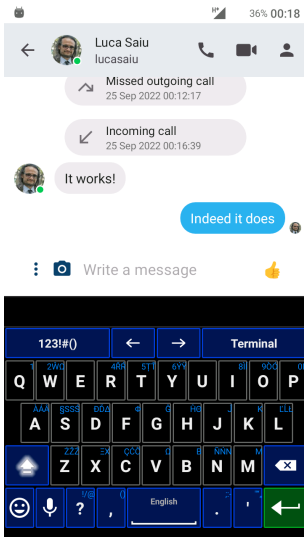


GNU Jami works well, and is a complex application.  
(Recommended).

- Here I am in a Jami video call between phone and computer



# Jami

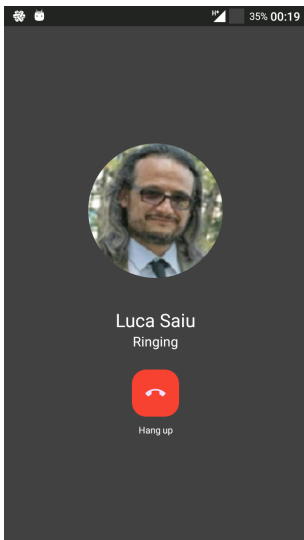


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# Jami

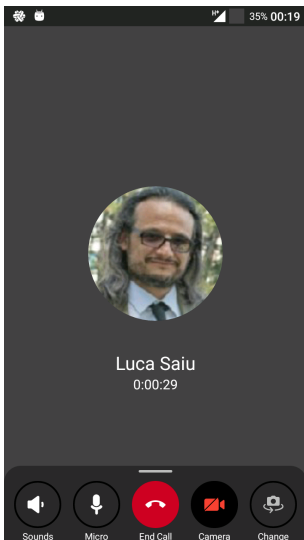


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# Jami

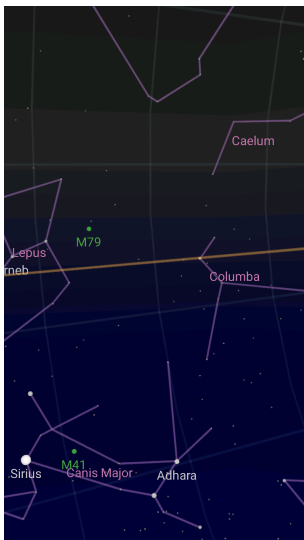


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# Skymap



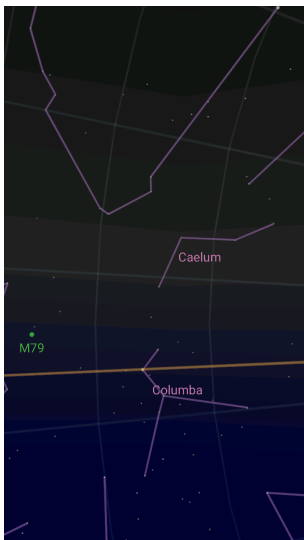
This [Skymap](#) app works well: it depends on the phone's [compass](#) and [accelerometer](#), which are well supported.

- Here I am slowly turning my phone to face up





# Skymap

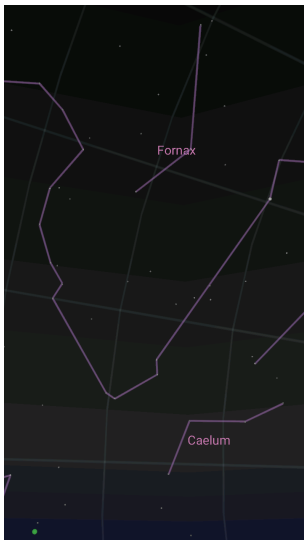


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# Skymap

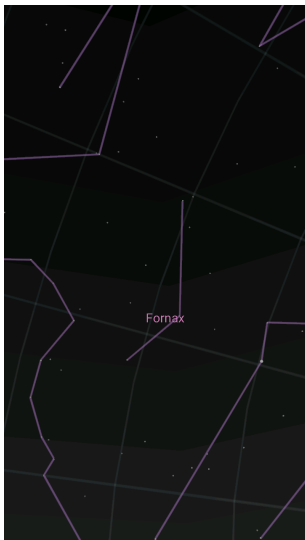


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# Skymap



This [Skymap](#) app works well: it depends on the phone's [compass](#) and [accelerometer](#), which are well supported.

- Here I am slowly turning my phone to face up



# JitterLisp, cross-compiled by me on my computer!

```

=====
JitterLisp (from GNU Jitter version 0.9.286-dirty)
Copyright (C) 2017-2021 Luca Saiu

JitterLisp comes with ABSOLUTELY NO WARRANTY; type (no-warranty)
for details. This program is free software, and you are well
come to redistribute it under the GNU General Public License, version
3 or later; type (copying) to display the license text.
=====
* VM dispatch:          minimal-threading
* Defective instructions: 1 (1 call-related), 51 replacement
* Compiled primitive safety: run-time type and overflow checking
* Heap memory handling:  litter (heap memory leaked!)
* Line editing:          GNU Readline
* Output styling:        GNU Libtextstyle

jitterlisp>
  
```

This [AnySoftKeyboard](#) virtual keyboard is as good as it can be, but a touchscreen is still a terrible interface for the command line.

Finally some assembly in this boring talk!



# JitterLisp, cross-compiled by me on my computer!

```

Window 1
come
to redistribute it under the GNU General Public License, ver
sion
3 or later; type (copying) to display the license text.
=====
* VM dispatch:          minimal-threading
* Defective instructions: 1 (1 call-related), 51 replace
ments
* Compiled primitive safety: run-time type and overflow chec
king
* Heap memory handling:  Litter (heap memory leaked!)
* Line editing:          GNU Readline
* Output styling:        GNU Libtextstyle

jitterlisp> (disassemble cdr)
# 0x4028dd00: IBEGINBASICBLOCK 0x423fed28 (4 B):
0x423fed28 e2844004 add r4, r4, #4
# 0x4028dd04: IREPLACEMENT-procedure-prolog/retR 0x423fed34
(8 B):
0x423fed2c e59d31fc ldr r3, [r13, #508] ; 0x
1fc
0x423fed30 e1a0f003 mov r15, r3
# 0x4028dd08: primitive-cdr/FR 0x4028dd10 (32 B):
0x423fed34 e2453002 sub r3, r5, #2
0x423fed38 e3130007 tst r3, #7
0x423fed3c 0a000002 beq 0x423fed4c
0x423fed40 e5944000 ldr r4, [r4]
0x423fed44 e5943000 ldr r3, [r4]
0x423fed48 e1a0f003 mov r15, r3
0x423fed4c e5955002 ldr r5, [r5, #2]
0x423fed50 e2844004 add r4, r4, #4
# 0x4028dd0c: nsp (4 B):
0x423fed54 e2466004 sub r6, r6, #4
# 0x4028dd10: IREPLACEMENT-return/retR 0x423fed60 (8 B):
0x423fed58 e59d3204 ldr r3, [r13, #516] ; 0x
204
0x423fed5c e1a0f003 mov r15, r3
# 0x4028dd10: IBEGINBASICBLOCK 0x423fed60 (4 B):
0x423fed60 e2844004 add r4, r4, #4
# 0x4028dd14: fall/retR 0x423fed6c (8 B):
0x423fed64 e59d303c ldr r3, [r13, #60] ; 0x
3c
0x423fed68 e1a0f003 mov r15, r3
# 0x4028dd18: unreachable (0 B):
jitterlisp>

```

This **AnySoftKeyboard** virtual keyboard is as good as it can be, but a touchscreen is still a terrible interface for the command line.

Finally some assembly in this boring talk!



# JitterLisp, cross-compiled by me on my computer!

The screenshot shows a mobile device screen with a dark background. At the top, there's a status bar with icons for signal, battery (81%), and time (01:54). Below that is a window title bar labeled 'Window 1'. The main area displays assembly code in a monospaced font. The code includes instructions like 'mov', 'sub', 'tst', 'beq', 'ldr', 'add', 'nlp', 'sub', 'lreplacem', 'ldr', 'mov', 'add', 'fail', 'ldr', 'mov', and 'unreachable'. At the bottom of the screen, there is a virtual keyboard with a numeric keypad at the top, followed by rows of letters, and a bottom row with 'Ctrl', arrow keys, an 'SSH' button, and a backspace key.

```

ifc
0x4023fed30 e1a0f003    mov     r15, r3
# 0x4028dd08: primitive-cdr/rR 0x4028dd10 (32 B):
0x4023fed34 e2453002    sub     r3, r5, #2
0x4023fed38 e3130007    tst     r3, #7
0x4023fed3c 0a000002    beq     0x4023fed4c
0x4023fed40 e5944000    ldr     r4, [r4]
0x4023fed44 e5943000    ldr     r3, [r4]
0x4023fed48 e1a0f003    mov     r15, r3
0x4023fed4c e5955002    ldr     r5, [r5, #2]
0x4023fed50 e2844004    add     r4, r4, #4
# 0x4028dd0c: nlp (4 B):
0x4023fed54 e2466004    sub     r6, r6, #4
# 0x4028dd0c: lreplacem-return/retR 0x4023fed60 (8 B):
0x4023fed58 e59d3204    ldr     r3, [r13, #516] ; 0x
284
0x4023fed5c e1a0f003    mov     r15, r3
# 0x4028dd10: lreplacem-return/retR 0x4023fed60 (4 B):
0x4023fed60 e2844004    add     r4, r4, #4
# 0x4028dd14: fail/retR 0x4023fed6c (8 B):
0x4023fed64 e59d303c    ldr     r3, [r13, #60] ; 0x
3c
0x4023fed68 e1a0f003    mov     r15, r3
# 0x4028dd18: unreachable (0 B):
jitterlisp:
  
```

This [AnySoftKeyboard](#) virtual keyboard is as good as it can be, but a touchscreen is still a terrible interface for the command line.

Finally some assembly in this boring talk!



# OpenVPN



```
Connected: ageinghacker.net:1194 (82.221.139.216) via...
01:18 PROTOCOL OPTIONS:
cipher: AES-256-GCM
digest: NONE
key-derivation: OpenVPN PRF
compress: LZO
peer ID: 0
01:18 We should call this session ageinghacker.net
01:18 Opening tun interface:
01:18 Local IPv4: 10.109.81.6/30 IPv6: (not set) MTU:
1500
01:18 DNS Server: , Domain: null
01:18 Routes: 10.109.0.0/16, 10.109.81.0/24
01:18 Routes excluded:
01:18 VpnService routes installed: 10.109.0.0/16
01:18 Disallowed VPN apps:
01:18 No DNS servers being used. Name resolution may
not work. Consider setting custom DNS Servers. Please
also note that Android will keep using your proxy settings
specified for your mobile/Wi-Fi connection when no DNS
servers are set.
01:18 Connected via tun
01:18 LZO init swap=0 asym=1
01:18 mssfix=1399 (upper bound=1492, overhead=52,
payload_overhead=41, target=1440)
01:18 COMPRESSION_ENABLED: Asymmetric
compression enabled. Server may send compressed
data. This may be a potential security issue.
01:18 Debug state info: CONNECTED HSPA+ to MOBILE
internet, pause: userPause, shouldbeconnected: true,
network: SHOULDBECONNECTED
```

I use an [OpenVPN](#) client to connect my phone to the VPN server on my personal server [ageinghacker.net](#).

Through the VPN I can have my phone and local computers in the same LAN.



# More apps should be free!

It is very frustrating that, for example, **public transport apps are proprietary**.

We should insist that organisations **release the plain data**: we as a community can write good apps ourselves.

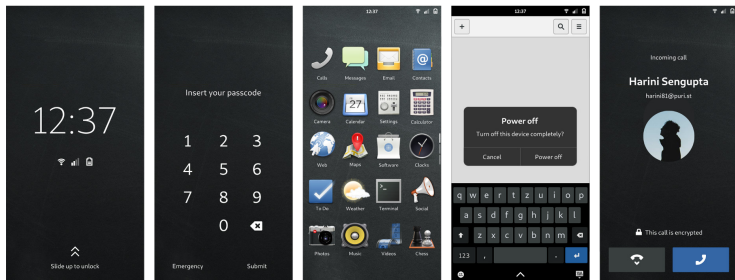
A friendly attendee wanted to help people coming to İzmir for the GHM, but we found **no way** of using one specific form of public transportation without a proprietary app. (This is **not** specific to İzmir or Turkey)





# Alternatives to Replicant

## Purism Librem 5

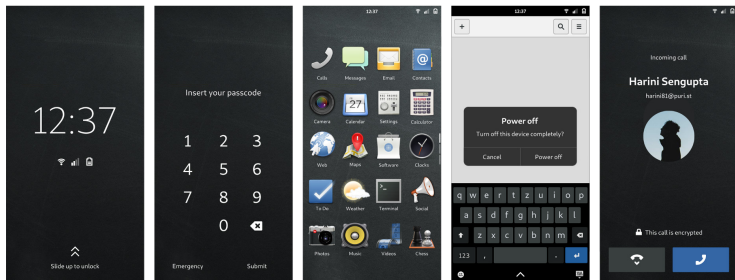


- Almost 100% free software (proprietary modem, isolated);
- *not based on Android*, but on Gnome;
- hardware kill switches;
- Recent: first sold in 2020;
- Limited availability?
- expensive (~2000\$).



# Alternatives to Replicant

## Purism Librem 5

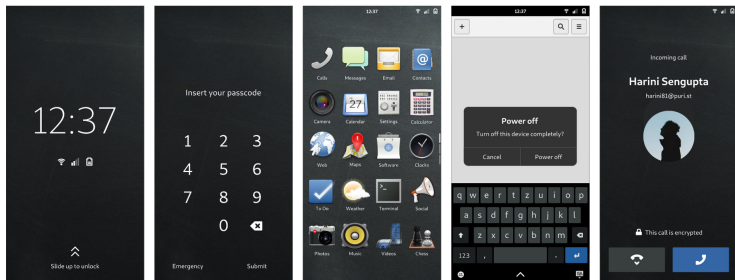


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# Alternatives to Replicant

## Purism Librem 5

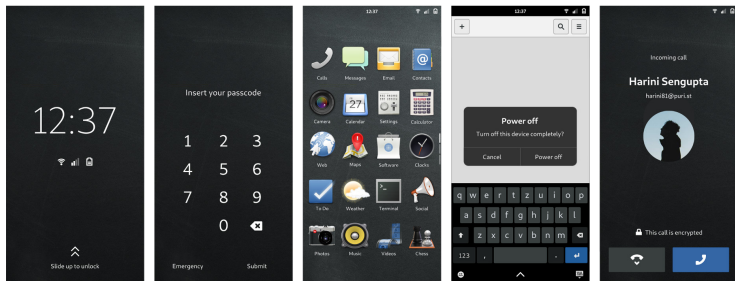


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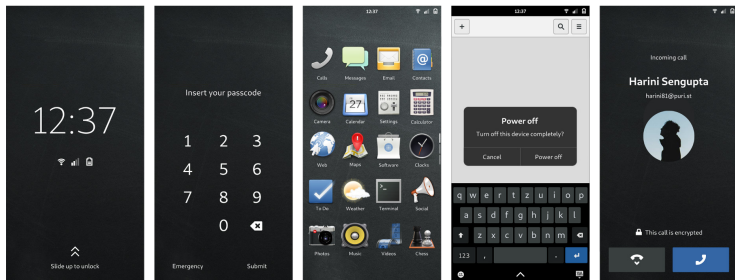


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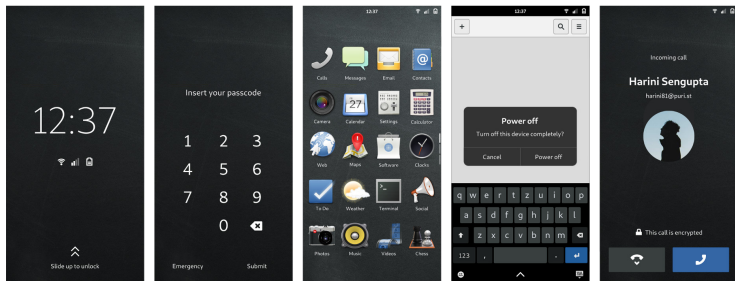


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# Other alternatives to Replicant

[Slide added after the public presentation:

... Apparently more alternatives exist: people in the audience (local and remote) during my talk in İzmir suggested several.

That is good, but **check that these alternative do not require proprietary drivers**, for the exercise not to be futile.]



# The end

- <https://replicant.us>
- I will publish my backup scripts: follow [ghm-discuss](#) and look at the event web page once in a while:  
<https://www.gnu.org/ghm/2022/>.

# Thanks





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# Bibliography I

