Modmobmap

The modest mobile networks mapping tool

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Introduction

- Modmobmap (sounds like “Bimbimpbap”): Modest Mobile networks Mapping tool
- Used to map 2G/3G and 4G networks (maybe more) in real live
- Uses a set of tricks (including the cheapest) to map cells

Where can I use this tool?

Cell towers discovery

- have a list and description of surrounding towers
- spot rogue base stations (mature list required!)

Restricted/smart/magic jamming

Where can I use this tool?

Cell towers discovery

Restricted/smart/magic jamming

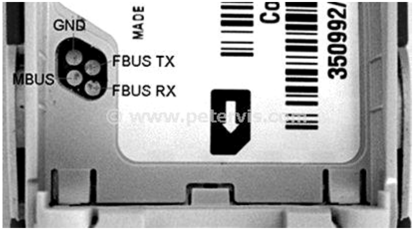
- replace the heavy & noisy & cumbersome jammer (or portable ones with weak signals)
- avoid commercial jamming device reworking (bands disabling)

Remember: monitoring with holy relics

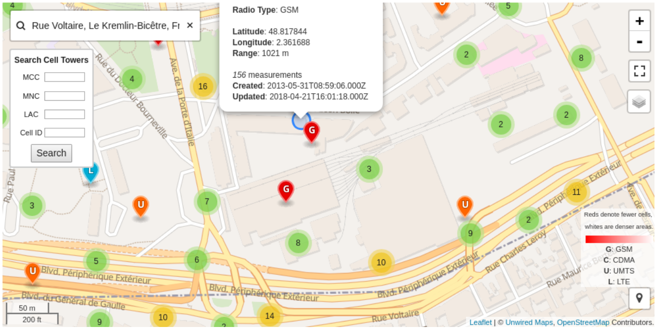
Old Nokia phone have a net monitor mode that could be enabled via FBus or MBUS access.

Tools

- Gnokii, Gammu and others: activate monitor mode, interact with the phone, and capture trace logs.
- DCT3-GSMTAP: evolution of Gammu, capture of GSM Um and SIM-ME via GSMTAP pseudo-header format.



Existing tool


Rue Voltaire, Le Kremlin-Bicêtre, Fr ×

Search Cell Towers

MCC

MNC

LAC

Cell ID

Search

Radio Type: GSM

Latitude: 48.817844
Longitude: 2.361688
Range: 1021 m

156 measurements
Created: 2013-05-31T08:59:06.000Z
Updated: 2018-04-21T16:01:18.000Z

Reds denote fewer cells, whites are denser areas.

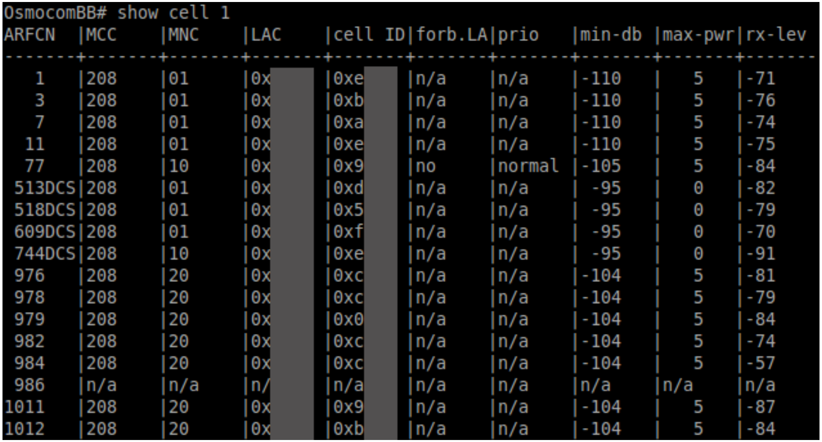
G: GSM
C: CDMA
U: UMTS
L: LTE

Blvd. Périphérique Extérieur
Blvd. du Général de Gaulle
Rue Voltaire
Rue Charles Leroy
Rue du Docteur Bourneville
Ave. de la Porte d'Italie
50 m
200 ft
Leaflet | © Unwired Maps, OpenStreetMap Contributors.

OpenCellID example

But very few information... could be used as a database for spotting rogue base stations. But useless for jamming attacks

Thing we wanna do for 3G, 4G and more



```
OsmocomBB# show cell 1
ARFCN  |MCC    |MNC    |LAC    |cell ID|forb.LA|prio   |min-db |max-pwr|rx-lev
-------+-------+-------+-------+-------+-------+-------+-------+-------+-------
   1   |208    |01     |0x[redacted]|0xe[redacted]|n/a    |n/a    |-110   |   5   |-71
   3   |208    |01     |0x[redacted]|0xb[redacted]|n/a    |n/a    |-110   |   5   |-76
   7   |208    |01     |0x[redacted]|0xa[redacted]|n/a    |n/a    |-110   |   5   |-74
  11   |208    |01     |0x[redacted]|0xe[redacted]|n/a    |n/a    |-110   |   5   |-75
  77   |208    |10     |0x[redacted]|0x9[redacted]|no     |normal |-105   |   5   |-84
 513DCS|208    |01     |0x[redacted]|0xd[redacted]|n/a    |n/a    | -95   |   0   |-82
 518DCS|208    |01     |0x[redacted]|0x5[redacted]|n/a    |n/a    | -95   |   0   |-79
 609DCS|208    |01     |0x[redacted]|0xf[redacted]|n/a    |n/a    | -95   |   0   |-70
 744DCS|208    |10     |0x[redacted]|0xe[redacted]|n/a    |n/a    | -95   |   0   |-91
 976   |208    |20     |0x[redacted]|0xc[redacted]|n/a    |n/a    |-104   |   5   |-81
 978   |208    |20     |0x[redacted]|0xc[redacted]|n/a    |n/a    |-104   |   5   |-79
 979   |208    |20     |0x[redacted]|0x0[redacted]|n/a    |n/a    |-104   |   5   |-84
 982   |208    |20     |0x[redacted]|0xc[redacted]|n/a    |n/a    |-104   |   5   |-74
 984   |208    |20     |0x[redacted]|0xc[redacted]|n/a    |n/a    |-104   |   5   |-57
 986   |n/a    |n/a    |n/[redacted]|n/a[redacted]|n/a    |n/a    |n/a    |n/a    |n/a
1011   |208    |20     |0x[redacted]|0x9[redacted]|n/a    |n/a    |-104   |   5   |-87
1012   |208    |20     |0x[redacted]|0xb[redacted]|n/a    |n/a    |-104   |   5   |-84
```

OsmocomBB cell monitor

Public tools

Recorded mobile towers

- OpenCellid: Open Database of Cell Towers
- Gsmmap.org
- and so on.

Live scanning tools

Public tools

Recorded mobile towers

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Problem!

But these solutions don't map in live and do not give precise information about cell towers.

Live scanning tools

Public tools

Recorded mobile towers

Live scanning tools

- for 2G cells:
  - Gammu/Wammu, DCT3-GSMTAP, and others
  - OsmocomBB via *cell_log* application
- for 3G, 4G and more:
  - only tricks: use of exposed DIAG interface $\rightarrow$decoding $\rightarrow$GSMTAP pseudo-header format
  - SnoopSnitch: not reflexible, but could be reworked for our purposes ;)

Methods to capture cells information

Possible methods are:

- Software-Defined Radio
- Exposed diagnostic interfaces
- Use of Android RIL

Software-Defined Radio

Existing tools:

- Airprobe or GR-GSM
- OpenLTE: *LTE_fdd_dl_scan*
- srsLTE with srsUE

Software-Defined Radio

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No 3G

No 3G tools to capture cell information.

Exposed diagnostic interface

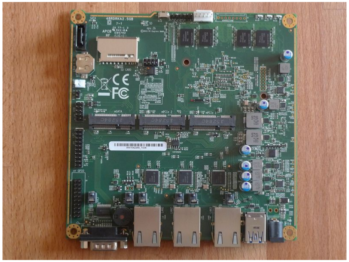
- Diagnostic interface enabled:
  - On old phones and 3G sticks like the *Icon 255*[1] that expose it by default
  - enabling DIAG ourselves: e.g for some LG devices via */sys/devices/platform/lg_diag_cmd/diag_enable*
  - Chips used for development
  - Interfaces kept enabled in production by error (e.g via custome bootmodes →CVE-2016-8467)
- Existing tools:
  - *xgoldmon* for X-Gold Infineon Basebands
  - *diag-parser* for exposed Qualcomm DIAG interfaces

[1] https://events.ccc.de/congress/2011/Fahrplan/attachments/2022_11ccc-qcombbdbg.pdf

Making a development environment

- Good alternative
- Could work with almost all bands we want
- a little expensive: almost 300€
- requirements:

EC20 LTE modem


PCengines APU2

(Funny story about EC20)

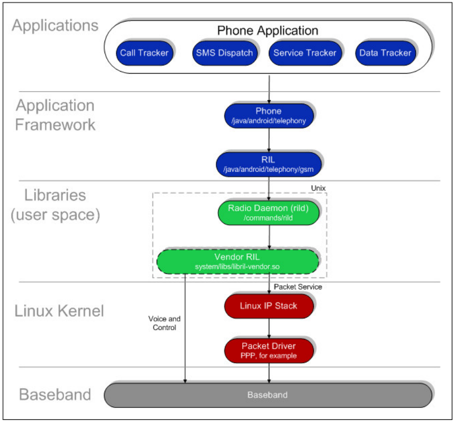
- Seen at 33c3 by Harald Welte[2] $\rightarrow$the modem runs an OE base Linux distribution
- It's also possible to have a shell via the AT command *AT+QLINUXCMD*:

```
# echo -e 'AT+QLINUXCMD="/sbin/getty -L ttyGS0 115200 console"\r\n' > /dev/ttyUSB2
# microcom /dev/ttyUSB1

OpenEmbedded Linux 9615-cdp ttyGS0

msm 20160923 9615-cdp ttyGS0

9615-cdp login: root
Password: oelinux123
root@9615-cdp:~#
```

[2]http git.gnumonks.org/laforge-slides/plain/2016/cellular_modems_33c3/33c3modems.html

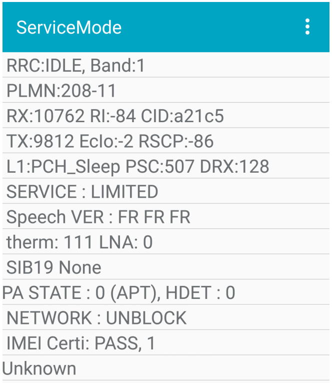
RIL on Android

- Daemon forwards commands/messages: application ⇆Vendor RIL
- vendor library is prorietary and vendor specific
- vendor library knows how to talk to modem:
  - classic AT
  - QMI for Qualcomm
  - (old?) Samsung IPC Protocol
  - and so on.



ServiceMode on Android

- Usually activated by typing a secret code
- Gives interesting details of current cell:
  - implicit network type
  - used band
  - reception (RX/DL) or/and transmission (TX/UP) (E/U)ARFCN (Absolute Radio Frequency Channel Number)
  - PLMN (Public Land Mobile Network) number
  - and so on.



```
RRC:IDLE, Band:1
PLMN:208-11
RX:10762 RI:-84 CID:a21c5
TX:9812 Eclo:-2 RSCP:-86
L1:PCH_Sleep PSC:507 DRX:128
SERVICE : LIMITED
Speech VER : FR FR FR
therm: 111 LNA: 0
SIB19 None
PA STATE : 0 (APT), HDET : 0
NETWORK : UNBLOCK
IMEI Certi: PASS, 1
Unknown
```

ServiceMode in Samsung

Samsung ServiceMode in brief

1. **#0011#* secret code handled by *ServiceModeApp_RIL ServiceModeApp* activity
2. ServiceModeApp →IPC connection →*SecFactoryPhoneTest SecPhoneService*
3. *ServiceModeApp* starts the service mode →*invokeOemRilRequestRaw()* through *SecPhoneService* (send RIL command *RIL_REQUEST_OEM_HOOK_RAW*)
4. *ServiceModeApp* process in higher level ServiceMode messages coming from RIL.

Best place to listen ServiceMode

Two good places exist: RIL library independent of Vendor RIL library implementation, or use *invokeOemRilRequestRaw()*

Getting SM messages: the lazy way

Ask to our best friend →logcat

```
shell@klte:/ $ logcat
[...]
I/ServiceModeApp_RIL( 1542): in QUERT_SERVM_DONE
I/ServiceModeApp_RIL( 1542): size of result : 1700
I/ServiceModeApp_RIL( 1542): Line 0 :  RRC:IDLE, Band:1_
I/ServiceModeApp_RIL( 1542): Line 1 :  PLMN:208-20_
I/ServiceModeApp_RIL( 1542): Line 2 :  RX:10639 RI:-70 CID:1fc09bd_
I/ServiceModeApp_RIL( 1542): Line 3 :  TX:9689 Eclo:-4 RSCP:-74_
I/ServiceModeApp_RIL( 1542): Line 4 :  L1:PCH_Sleep PSC:83 DRX:64_
I/ServiceModeApp_RIL( 1542): Line 5 :  SERVICE : LIMITED_
I/ServiceModeApp_RIL( 1542): Line 6 :  Speech VER : FR FR FR_
I/ServiceModeApp_RIL( 1542): Line 7 :  therm: 111 LNA: 0 _
I/ServiceModeApp_RIL( 1542): Line 8 :  SIB19 Received_
I/ServiceModeApp_RIL( 1542): Line 9 : PA STATE : 0 (APT), HDET : 0_
I/ServiceModeApp_RIL( 1542): Line 10 :  NETWORK : UNBLOCK_
I/ServiceModeApp_RIL( 1542): Line 11 :  IMEI Certi: PASS, 1_
```

Those messages could be then processed to get our current cell information.

What do I need?

At least a phone supporting ServiceMode!

Few contraints to resolve

"KTHX! But...:

1. how to support other operators different from your own SIM card? Do you need a different SIM card for each operator?
2. how to enumerate cells a MS (Mobile Station) is supposed to see?

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Answer

The DFR technique!

DFR technique

D.F.R: "D" for Dirty, "F" for Fuzzy, "R" for Registration

The camping concept in brief

Let's remember 3GPP TS 43.022, ETSI TS 125 304...

- When selecting a PLMN $\rightarrow$MS looks for cells satisfying few conditions (cell of the selected PLMN, not barred, pathloss between MS and BTS below a thresold, and so on.)
- Cells are checked in a descending order of the signal strength
- If a suitable is found $\rightarrow$MS camps on it and tries to register

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Verified through DIAG and ServiceMode

If registration fails $\rightarrow$MS camps to another cell until it can register $\rightarrow$verified via DIAG and ServiceMode

Automate the DFR technique with AT commands

Android phones often expose a modem interface (e.g. */dev/smd0)*

```
127|shell@klte:/ $ getprop rild.libargs
-d /dev/smd0
```

It is possible to:

- set network type: *AT^SYSCONFIG*
- list PLNM and select a PLMN: *AT+COPS*

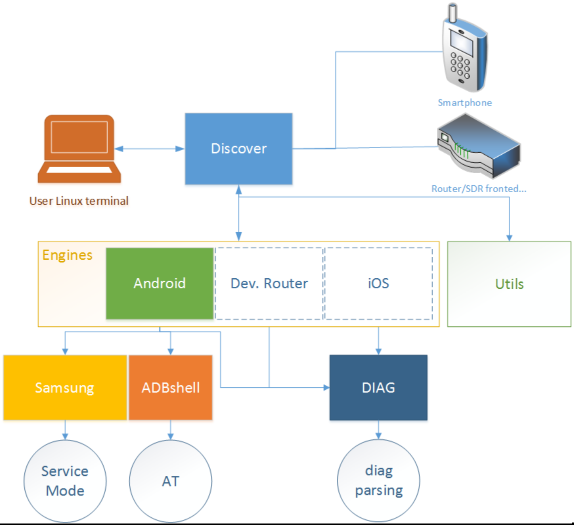
→requires root privileges

We mix all techniques together

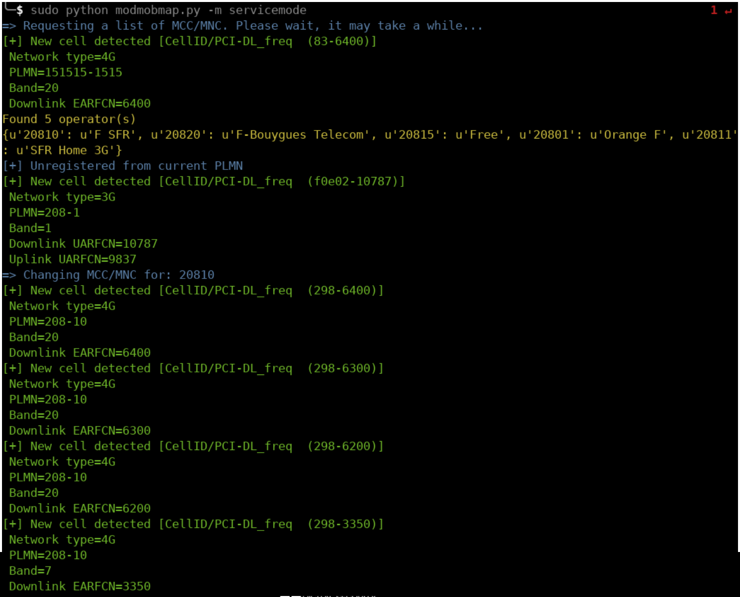
Don’t forget...

*the magic cure powder

Here is the frankenstein: modmobmap



Demo with a Galaxy S5 phone



```
└─$ sudo python modmobmap.py -m servicemode                                                    1 ↵
=> Requesting a list of MCC/MNC. Please wait, it may take a while...
[+] New cell detected [CellID/PCI-DL_freq  (83-6400)]
 Network type=4G
 PLMN=151515-1515
 Band=20
 Downlink EARFCN=6400
Found 5 operator(s)
{u'20810': u'F SFR', u'20820': u'F-Bouygues Telecom', u'20815': u'Free', u'20801': u'Orange F', u'20811'
: u'SFR Home 3G'}
[+] Unregistered from current PLMN
[+] New cell detected [CellID/PCI-DL_freq  (f0e02-10787)]
 Network type=3G
 PLMN=208-1
 Band=1
 Downlink UARFCN=10787
 Uplink UARFCN=9837
=> Changing MCC/MNC for: 20810
[+] New cell detected [CellID/PCI-DL_freq  (298-6400)]
 Network type=4G
 PLMN=208-10
 Band=20
 Downlink EARFCN=6400
[+] New cell detected [CellID/PCI-DL_freq  (298-6300)]
 Network type=4G
 PLMN=208-10
 Band=20
 Downlink EARFCN=6300
[+] New cell detected [CellID/PCI-DL_freq  (298-6200)]
 Network type=4G
 PLMN=208-10
 Band=20
 Downlink EARFCN=6200
[+] New cell detected [CellID/PCI-DL_freq  (298-3350)]
 Network type=4G
 PLMN=208-10
 Band=7
 Downlink EARFCN=3350
```

Conclusion

modmobmap:

- is a cheap way to scan mobile cells
- supports 2 useful interfaces:
  - ServiceMode;
  - GSMTAP captures:
    - host DIAG (could be easily extended for guest DIAG);
    - srsLTE and OpenLTE captures.
- the source code will be published in Github soon!
- any ideas and contribz are welcomed!

AVEZ-VOUS
DES QUESTIONS ?

MERCI DE VOTRE ATTENTION,

SYNACKTIV
DIGITAL SECURITY