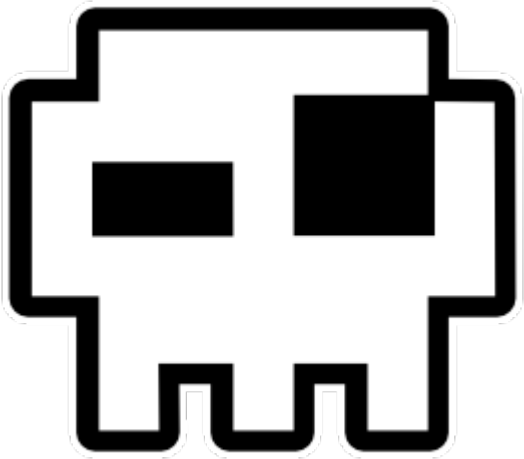
SYNACKTIV
DIGITAL SECURITY

House intercoms attacks

When frontdoors become backdoors

Presented the 02/07/2016
For NDH 2016
By Sébastien Dudek



About me

- **Company: Synacktiv**
- **Interests: radio-communications (Wi-Fi, RFID, GSM, PLC...), networking, web, Linux security… and intercoms!**
- **Do Red Team tests!**

Red team tests at Synacktiv

- **And can get spotted sometimes...**

Our story with intercoms

- **Synacktiv's team got bigger**

  → moved to another place

- **The new place got new toys**

  → access control systems,

  alarms, and a **digital intercom...**

This kind of intercom...

- **Features:**
  - Pass code
  - Vigik
  - Call a resident on his phone

When calling a resident, this intercoms use the mobile network
→ that explains the (+33)6 prefix displayed on the resident's phone

Human curiosity...

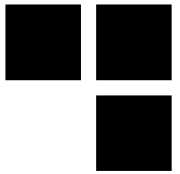
- **Would it be possible to play with the intercom?**
- **We tried to directly call the intercom**

  but the intercom doesn't answer to the call
- **Dump and modify the flash**

  good option, but difficult to do without being spotted in the street…
- **A mobile attack → Better!**

  but we need to understand the functioning of these intercoms first!

Summary



- **Introduction**
  - Context
  - Wiring topology
  - Leaders in the French market
  - Cheaper alternatives
  - Other variants
- **State Of The Art**
- **Short basics on GSM, GPRS, 3G, and 4G…**
- **Analysis of Intercoms**
- **Conclusion & further work**

Context

- **Intercom / door phone / house intercom**
- **A voice communication device → within a building**
- **Numeric → Connected to the mobile network (SIM/USIM cards)**
- **Allows to call a resident to identify the visitor and open a door**

Different types of intercoms exist

Conventional intercoms

- **Used for medium-sized buildings**
- **Has 4+n wires:**
  - Power (2 wires)
  - door system (2 wires)
  - n → number of residents

Simplified intercoms

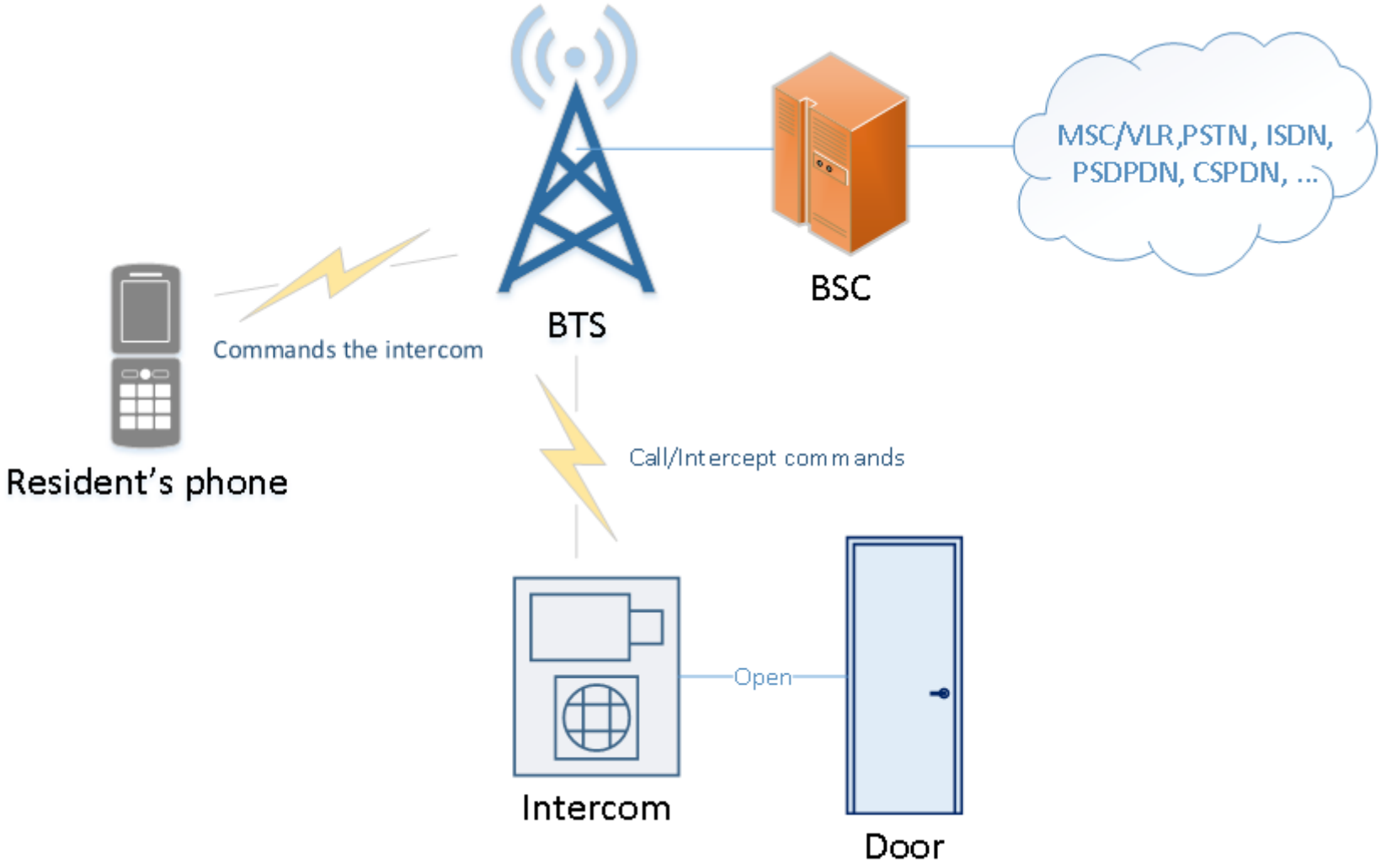
- **One pair replaces the 4 conventional wires**
- **The other wires are for each resident**
  - Like conventional intercoms...

Numeric intercoms

- **No wire for each resident**
- **Wires replaced by:**
  - GSM, 3G, rarely in 4G
  - or a TCP/IP stack
  - or Wi-Fi…

⇒ Avoid complicated and cumbersome cables
⇒ Easy installation

Numeric intercoms: simplified architecture



Leaders in the French market

- **4 brands are strongly present in France:**
  - Intratone
  - Norasly
  - Urmet Captiv
  - Comelit

How to recognize a mobile intercom

- **Not easy… maybe spotting a nice LCD screen, new stainless steel case…**
- **Or...**

Looks like a mobile module?

The 3G module of Intratone

- **Documentation is public: http://www.intratone.fr/media/**
- **The interesting part of the documentation:**

« Lorsque le réseau 3G est inexistant sur les lieux de l'installation, le bloc 3G cherchera le réseau GSM automatiquement et pourra résumer ses fonctionnalités dans ce mode :
- Appel Audio (sans Visio).
- Mise à jour en temps réel sur le réseau GSM et non plus 3G. »

Cheaper alternatives

- **GSM Activate by a UK company**
- **Other devices without name**
- **Linkcom → commonly used by private residents**

  and already seen in two building in the 15th district of Paris

  → Our choice for analysis

Other variants of wireless intercoms

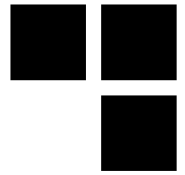
- **Other variants exist:**
  - Wi-Fi
  - DECT (Digital Enhanced Cordless Telecommunications)
  - other unsecure radio protocols
  - and so on.

⇒ We will only focus on intercoms that use the mobile network

Summary

- Introduction
- **State Of The Art**
  - Intercoms
  - Mobile security in the hacking community
  - Existing tools
- Short basics on GSM, GPRS, 3G, and 4G…
- Analysis of Intercoms
- Conclusion & further work

State Of the Art: intercoms



- **Publications about intercoms are nearly nonexistent**
- **But research on mobile security can be applied to attack these devices...**

State Of the Art: Mobile security

- **Many publications exist:**
  - **Attacks on GSM A5/1 algorithm with rainbow tables**

    (at 26c3, Chris Paget and Karsten Nohl)
  - **OsmocomBB**

    (at 2010 at 27c3, Harald Welte and Steve Markgraf)
  - **Hacking the Vodaphone femtocell**

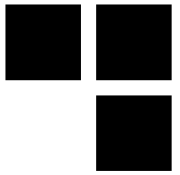
    (at BlackHat 2011, Ravishankar Borgaonkar, Nico Golde, and Kevin Redon)
  - **An analysis of basebands security**

    (at SSTIC 2014, Benoit Michau)
  - **Attacks on privacy and availability of 4G**

    (In October 2015, Altaf Shaik, Ravishankar Borgaonkar, N. Asokan, Valtteri Niemi and Jean-Pierre Seifert)
  - **How to not break LTE crypto**

    (at SSTIC 2016, Christophe Devine and Benoit Michau)
  - And many others...

State Of the Art: tools

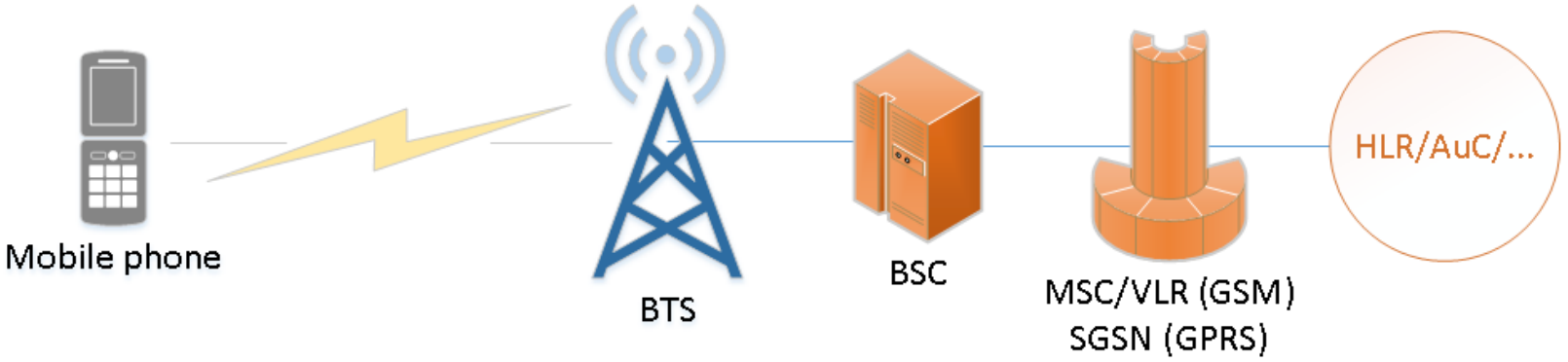


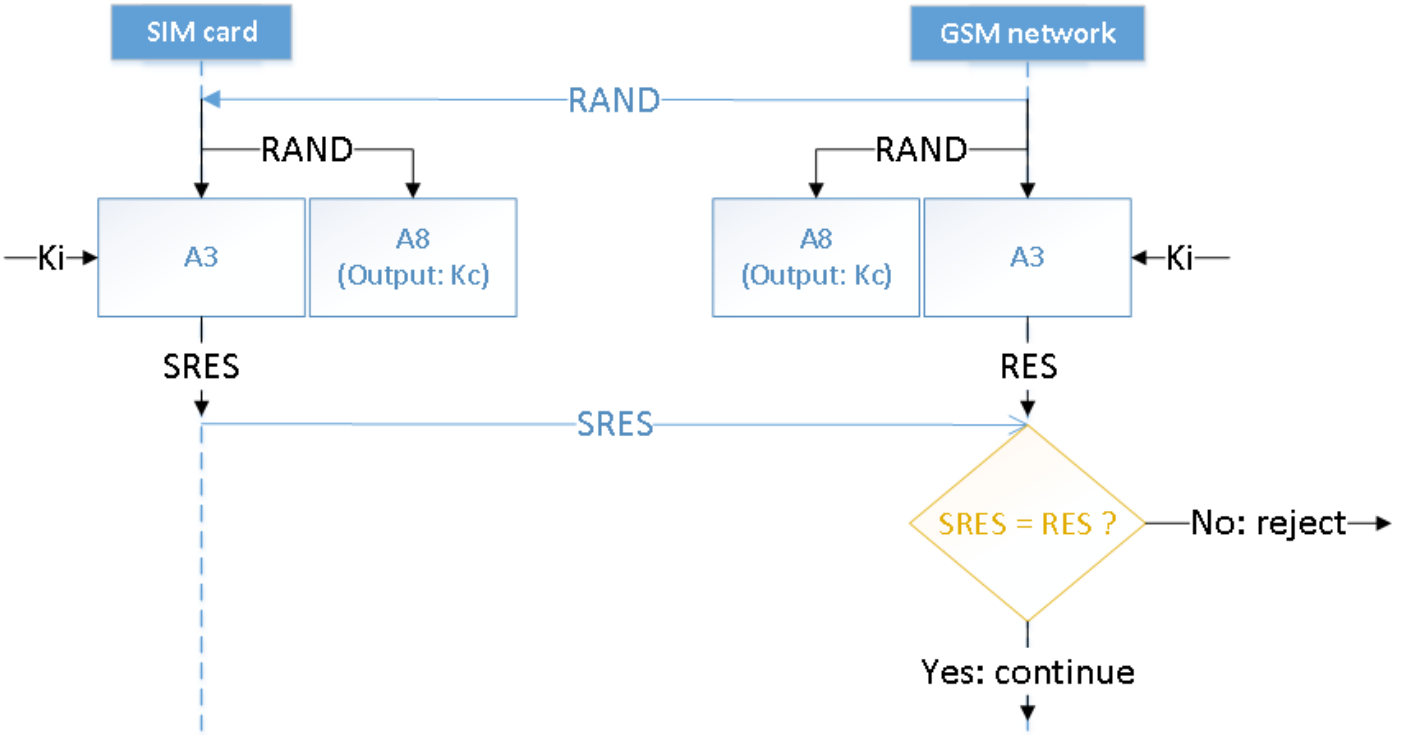
- **Hardware**
  - USRP from 700 € (without daughter-boards and antennas)
  - SysmoBTS from 2,000 €
  - BladeRF from 370 € (without antennas)
- **Software**
  - Setup a mobile network
    - OpenBTS: GSM and GPRS network compatible with USRP and BladeRF
    - OpenUMTS: UMTS network compatible with some USRP
    - OpenLTE: LTE network compatible with BladeRF and USRP
    - OpenAir: LTE network compatible with some USRP
    - YateBTS: GSM and GPRS network compatible with USRP and BladeRF
  - Analyze traffic
    - libmich: Analyze and craft mobile packets captured with GSMTAP
    - Wireshark: Analyze GSMTAP captured packets
    - OsmocomBB: sniff and capture GSM packets

Summary

- Introduction
- State Of The Art
- **Short basics on GSM, GPRS, 3G, and 4G…**
  - GSM and GPRS authentication and confidentiality
  - Mobile handover
  - Differences between GSM and GPRS and possible attacks
  - 3G and 4G advantages
  - Signal attraction...
- Analysis of Intercoms
- Conclusion & further work

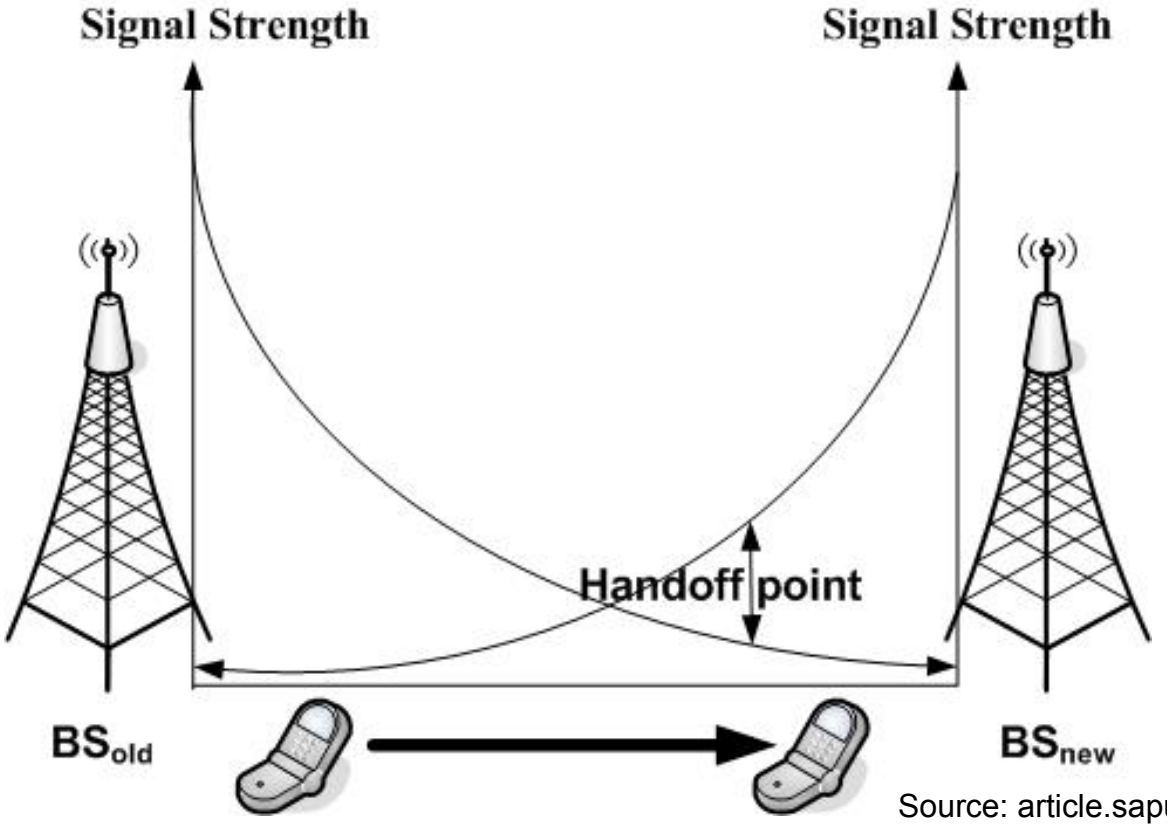
GSM and GPRS: authentication





- BTS: Base Transceiver Station
- BSC: Base Station Controller
- MSC: Mobile Switch Center
- VLR: Visitor Location Register
- HLR: Home Location Register
- AuC: Authentication Center

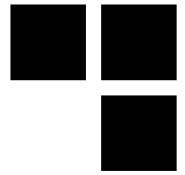
GSM and GPRS: Handover



Source: article.sapub.org

A stronger signal will likely attract User Equipments
→ Useful for attackers

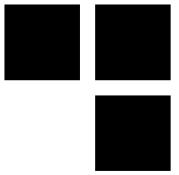
GSM and GPRS: possible attacks



- **No mutual authentication → Fake rogue BTS**
- **Reuse of Authentication triplet RAND, RES, K_c many times**
- **Signaling channel not encrypted → open for attacks**
- **Attacks on the A5/1 algorithm**
- **and so on.**

⇒ Interception is possible on GSM and GPRS

3G/4G: advantages

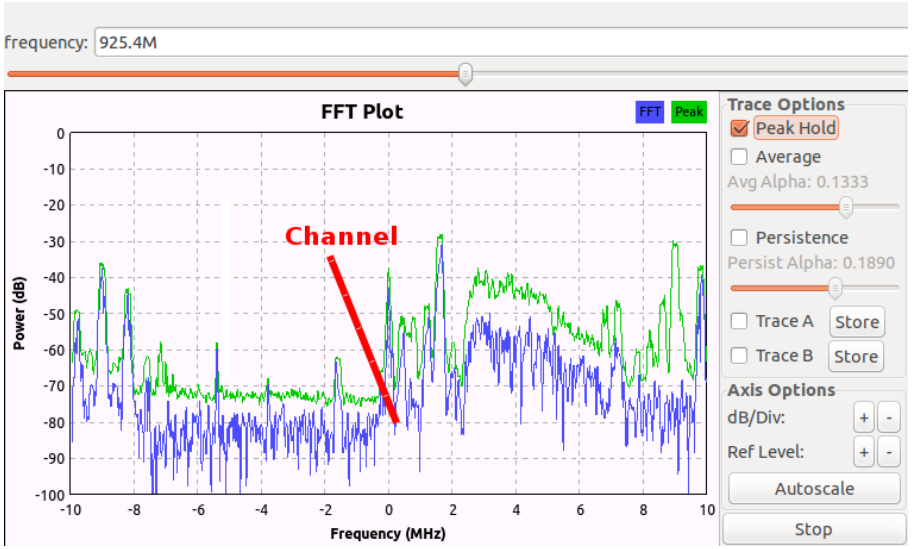


	GSM	3G	4G
Client authentication	YES	YES	YES
Network authentication	NO	Only if USIM is used (not SIM)	YES
Signaling integrity	NO	YES	YES
Encryption	A5/1	KASUMI | SNOW-3G	SNOW-3G | AES | ZUC...

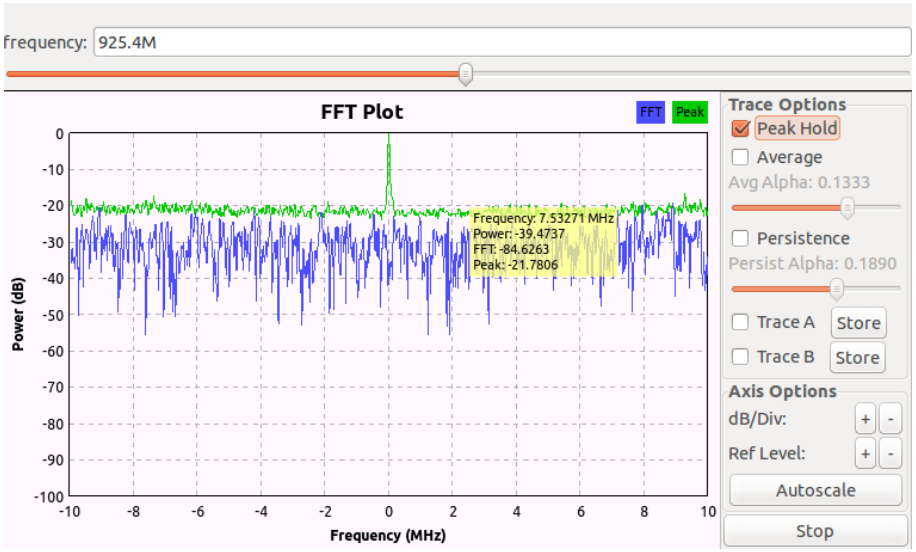
Mobile interception: signal attraction

- **A User Equipment connects to the closest Base Station**
- **3G/4G downgrades to 2G via**
  - jamming attacks → a simple Gaussian noise in targeted channels
  - protocol attacks → difficult
  - baseband strange behaviors

Jamming is generally basic...



Before



After

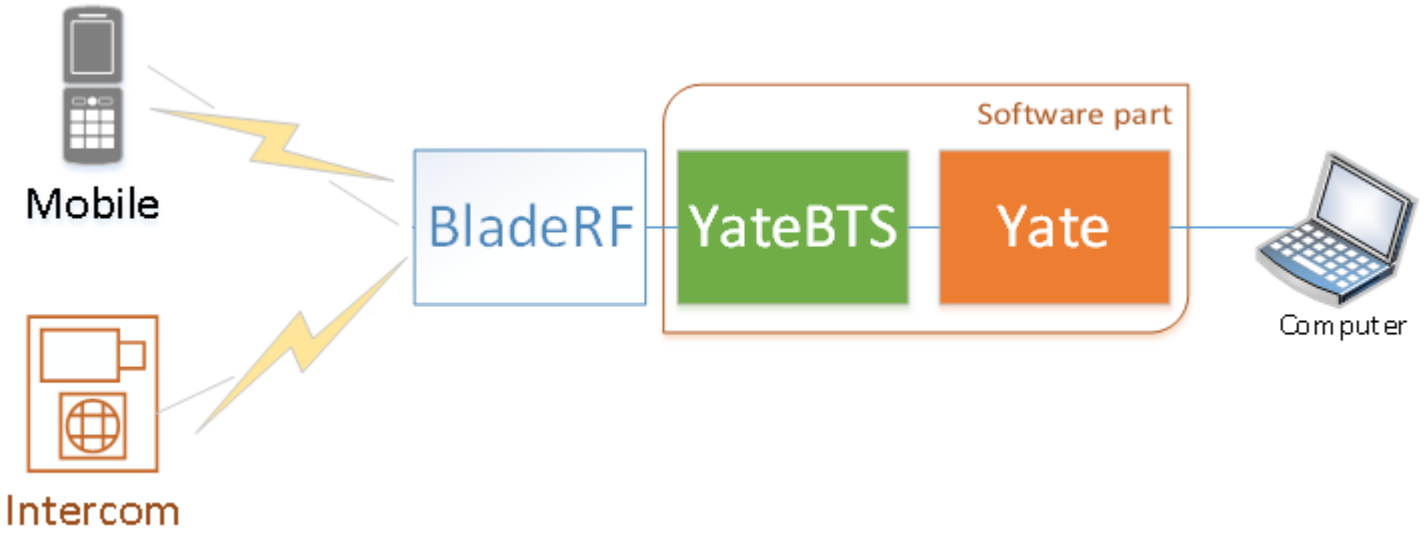
Downgrade 3G → 2G demo

- **Targeted channel jamming**
- **Using a simple HackRF for ~300€**

Summary

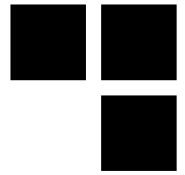
- Introduction
- State Of The Art
- Short basics on GSM, GPRS, 3G, and 4G…
- **Analysis of Intercoms**
  - Tests environment
  - Passive attacks
  - Active attacks → control it and make money out of it!
- Conclusion & further work

GSM Lab setup: for interception



- 1 BladeRF = 370 € minimum
- 2 Antennas = 15 € minimum each
- YateBTS software = FREE
- **Total cost = 400 €**

Intercom setup: hardware part



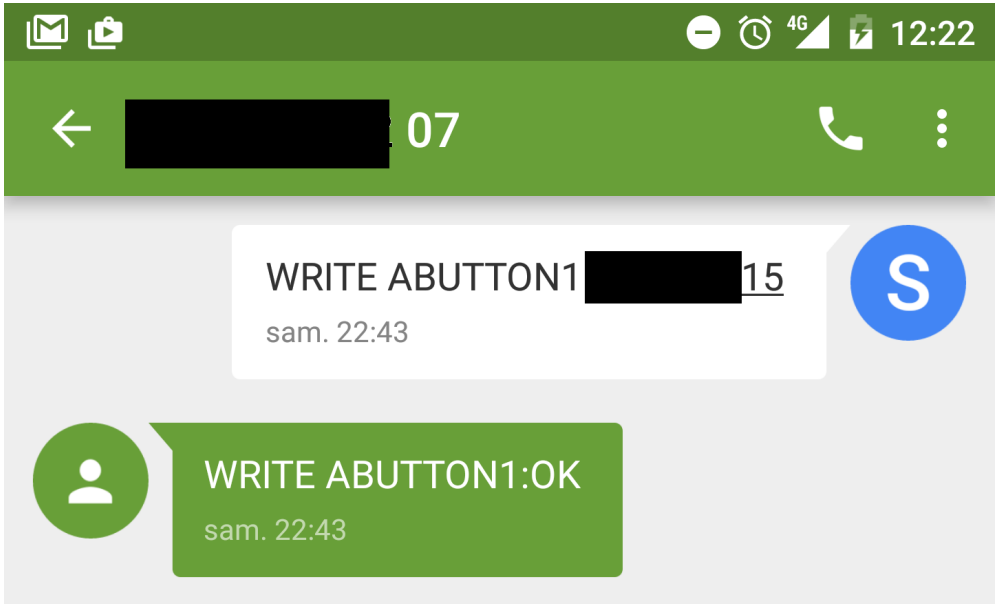
- **For the beginning → Link iDP GSM for ~300€**
- **Can be powered in AC as in DC**

Intercom setup: configuration

- **This intercom can be configured in 3 ways:**
  - With a programming interface and the Link iDP manager software
  - With a SIM card reader/programmer
  - Via SMS messages
- **The SIM card is used as a memory → contains all the settings**
- **A first administrator number “ADMIN1” has to be setup in the SIM card contacts**

First impressions

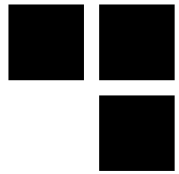
- **Our goals:**
  - impersonate a number, or find a way to bypass it
  - then open a door, or send commands to the intercoms
  - …
- **A good indicator → after sending commands, an acknowledgment is performed by SMS**



Hypotheses as a potential attacker

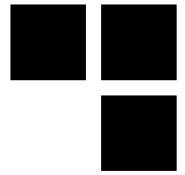
- **We don’t know the mobile operator**
- **We don’t know intercom’s number**
- **The commands could be found with public or leaked documentations, or by performing a firmware analysis**

Attacker steps



1. **Recognize intercom's operator to trap it**
2. **Leak, or guess, numbers to impersonate**
3. **Configure the rogue base station → associate the attacker IMSI (International Mobile Subscriber Identity) to a resident number**
4. **Open the door!**
5. **And manage it with an "admin" number?**

Passive attack: Monitoring



- **CCCH (Common Control Channels) gives a lot of information**
  - Management messages, sometimes SMS in clear, TMSIs (Temporary Mobile Subscriber Identity),...
- **CCCH → paging request → can be exploited to locate someone → our target?**
- **Tools: OsmocomBB, Airprobe, and so on.**

Capture a specific channel (1)

- **List of ARFCN (Absolute Radio Frequency Channel Number)**

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

Capture a specific channel (2)

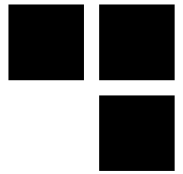
- **Leaked TMSI with *ccch_scan* OsmocomBB tool:**

```
<0001> app_ccch_scan.c:312 Paging1: Normal paging chan tch/f to tmsi M(353       1)
<0001> app_ccch_scan.c:312 Paging1: Normal paging chan tch/f to tmsi M(116       0)
<0001> app_ccch_scan.c:312 Paging1: Normal paging chan tch/f to tmsi M(324       5)
<0001> app_ccch_scan.c:312 Paging1: Normal paging chan tch/f to tmsi M(331       4)
<0001> app_ccch_scan.c:312 Paging1: Normal paging chan tch/f to tmsi M(138       6)
<0001> app_ccch_scan.c:312 Paging1: Normal paging chan tch/f to tmsi M(893       )
<0001> app_ccch_scan.c:312 Paging1: Normal paging chan tch/f to tmsi M(131       )
<0001> app_ccch_scan.c:312 Paging1: Normal paging chan tch/f to tmsi M(596       )
<0001> app_ccch_scan.c:312 Paging1: Normal paging chan tch/f to tmsi M(324       5)
<0001> app_ccch_scan.c:312 Paging1: Normal paging chan tch/f to tmsi M(287       )
```

⇒ Use SMS Class-0 messages to track a user

Problem ⇒ paging requests to the intercoms are mostly rare + we will need more phone to monitor all cells =/
→ what about active attacks?

Active attacks

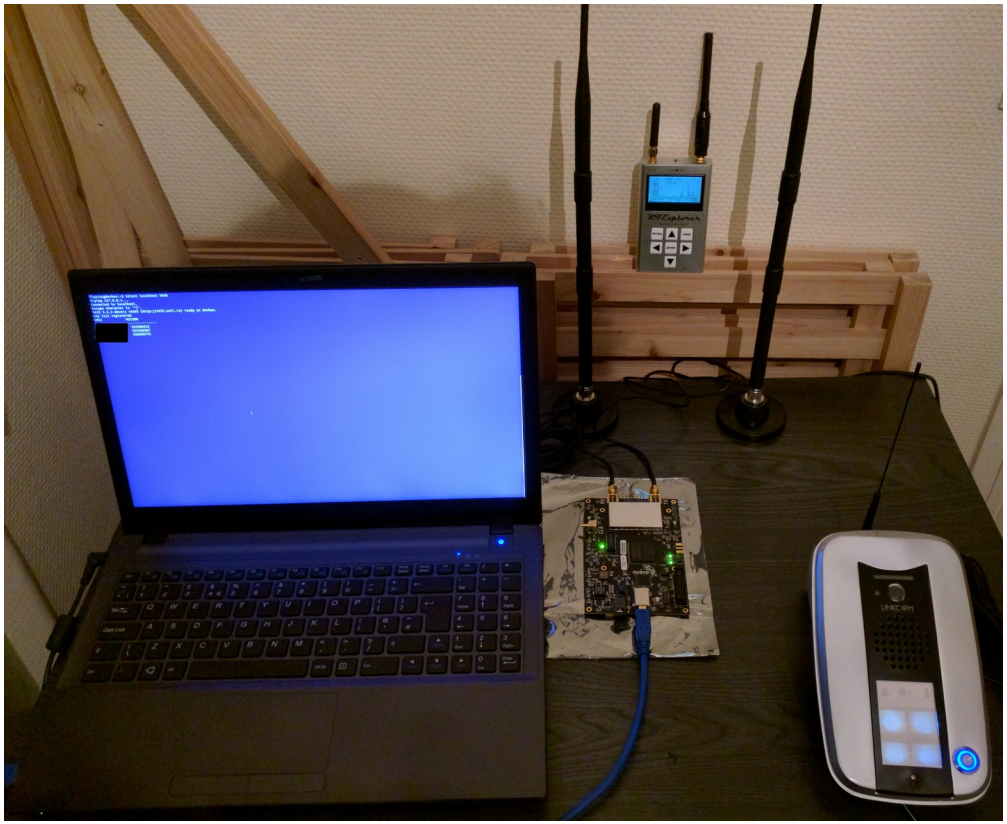


- **A User Equipment decides to register to another base station if**
  - it can register to any Mobile country code (MCC)/Mobile Network Codes (MNC) BTS close to it

    => For example with Orange in France : MCC = “208” and MNC = “01”
  - it can register to any network close to it
  - only the current used network isn’t reachable anymore, even if a rogue base station is closer
  - the signal is strong and the mutual authentication succeeded (not the case in GSM/GPRS)
- **Everything depends on the mobile stack implementations...**

Trap the intercom

- **Bruteforcing the 4 MCC/MNC**
  - 15min~ waiting for each MCC/MNC
- **Strong GSM signal**
- **Button push → calling intercepted → success!**



Note: The used MCC/MNC but mostly the used channel can be discovered with jamming tests over the different channels.

What's next? Let's leak numbers!

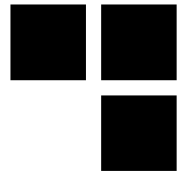
- **Activate GSM tapping on YateBTS → Wireshark**
- **Then push on buttons → CC SETUP**

```
84933 406.0349243…  127.0.0.1   127.0.0.1   LAPDm   81 I, N(R)=1, N(S)=0(DTAP) (CC) Setup
84935 406.0384471…  127.0.0.1   127.0.0.1   LAPDm   81 S, func=RR, N(R)=1
84947 406.0571079…  127.0.0.1   127.0.0.1   LAPDm   81 I, N(R)=1, N(S)=1(DTAP) (CC) Call Proceeding
84955 406.0582432…  127.0.0.1   127.0.0.1   LAPDm   81 U, func=UI
84966 406.0760920…  127.0.0.1   127.0.0.1   LAPDm   81 U, func=UI

    GSM Frame Number: 0
    Channel Type: FACCH/F (9)
    Antenna Number: 0
    Sub-Slot: 0
  Link Access Procedure, Channel Dm (LAPDm)
    Address Field: 0x01
    Control field: I, N(R)=1, N(S)=0 (0x20)
    Length Field: 0x49
  GSM A-I/F DTAP - Setup
    Protocol Discriminator: Call Control; call related SS messages (3)
      .... 0011 = Protocol discriminator: Call Control; call related SS messages (0x03)
      0... .... = TI flag: allocated by sender
      .000 .... = TIO: 0
    01.. .... = Sequence number: 1
    ..00 0101 = DTAP Call Control Message Type: Setup (0x05)
    Called Party BCD Number - (       515)
      Length: 6
      1... .... = Extension: No Extension
      .000 .... = Type of number: unknown (0x00)
      .... 0001 = Numbering plan identification: ISDN/Telephony Numbering (ITU-T Rec. E.164 / ITU-T Rec. E.163) (0x01)
      Called Party BCD Number:       515

0000  00 00 00 00 00 00 00 00  00 00 00 00 08 00 45 00   ........ ......E.
0010  00 43 f7 4d 40 00 40 11  45 5a 7f 00 00 01 7f 00   .C.M@.@. EZ......
0020  00 01 97 fc 12 79 00 2f  fe 42 02 04 01 04 40 00   .....y./ .B....@.
0030  00 00 00 00 00 00 09 00  00 00 01 20 49 03 45 04   ........ ... I.E.
0040  06 60 04 02 00 05 81 5e                 5 f5 2b   .`.....       ..+
0050  2b                                                +
```

What's next? Let's open the door!



- **Before updating a number → find an admin number:**
  - leaked with calling buttons, or alarms
  - if not → use your social engineering tricks
- **Once found → affect this number to your IMSI in *tmsidata.conf***

```
[tmsi]
last=007b0005
[ues]
20820XXXXXXXXXX=007b0003,35547XXXXXXXXXX,XXXXXX
515,1460XXXXXX,ybts/TMSI007b0003
# associating attacker IMSI with a resident number
[...]
```

What’s next? Let's backdoor it!

- **Find commands:**
  - public or leaked documentations
  - Passive channel monitoring → good luck!
  - or buy the same model in commercial web sites such “leboncoin”, eBay, and so on.
- **In our case with Linkcom iDP:**

Command	Description
READ <NAME>	Read the number of a button, or an admin (ADMIN[1-9]).
WRITE <NAME> <number>	Add or update a number associated to a name.
CAL AT<command suffix>	Send an AT command to the baseband through SMS!

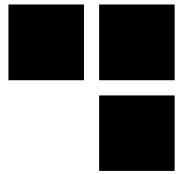
AT commands?

- **We can interact with Intercom's baseband:**
  - retrieve SMS messages → *AT+CMGL="ALL"*
  - spying building door conversations with auto-answer feature (if not disabled) → *ATS0=1*
  - and so on.

Call premium rate numbers

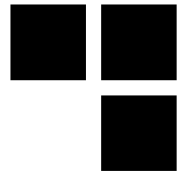
- **We can modify a contact → why not choose a premium number?**
  - Allopass
  - Optelo
  - Hipay
  - and so on.

Demo



- **Trapping an intercom**
- **Sending commands**

Conclusion & further work



- **Intercoms using the mobile network are vulnerable to the same flaws as mobile phones**
- **Other devices in the IoT ecosystem use the mobile network (e.g: Orange MyPlug)**
- **Further work:**
  - include a semi-automatic 3G jammer
  - study 3G and 4G protocol downgrades
  - attack other intercoms

ANY QUESTIONS?

Thanks for your attention !

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