Understanding IMSI Privacy

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Overview

- Unresolved Privacy Issues
  (IMSI catchers and Silent SMS)
- Darshak- Privacy framework
- Use-cases and demos
- Future work

Unresolved Privacy Issues

Mobile Security Status

- Efforts from OS providers, Manufacturers, network operators
- Efforts from researchers, startup companies
- Devices are good but cellular network secure???
- Still all fail when **Targeted Attacks**
- What is Targeted Attacks and who does it?
  - IMSI catchers
  - Illegal entities?
  - Methods of doing?

Targeted Attacks

IMSI catcher or compromising phone

- IMSI catchers
  - Often used
  - Exploits cellular weaknesses
  - Location and interception

3G-GSM TACTICAL INTERCEPTION & TARGET LOCATION

- Pegasus
  - Compromising with OTA update
  - SIM toolkit? Like ANT

The system introduces a powerful and unique monitoring tool, called Pegasus, Which allows remote and stealth

monitoring and full data extraction from remote targets devices via untraceable commands.

Sources: product manuals

Unsolved Security Questions

- Your last call was encrypted/authenticated?
- Is someone tracking you?? No app for that
- Can someone listen to your calls/SMS?
  - Besides legal entities
  - Last call/SMS was encrypted?
- Are you a victim of IMSI catcher attack?
- Is your mobile handset and operator using **up-to-date** encryption standards?

More ecosystem problems

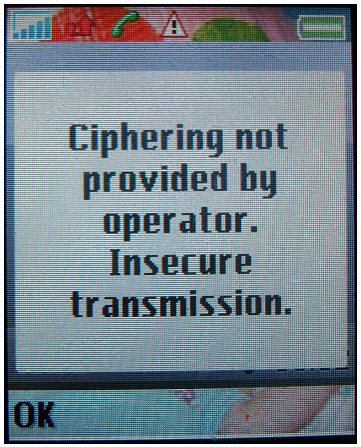
- 3GPP standard for mobile handset features

ETS 300 505 (GSM 02.07 version 4.8.2): January 1998

Table 1: Basic MS features

	Name	Mandatory (M) Optional (O)
1.22	Ciphering Indicator	M*

- No API for Android, iOS, Windows, BB
  - See issue* 5353: Ciphering Indicator (Android)



Source:wikipedia

- Flatrate calling/data/sms rates –
  - you getting free calls?

* https://code.google.com/p/android/issues/detail?id=5353

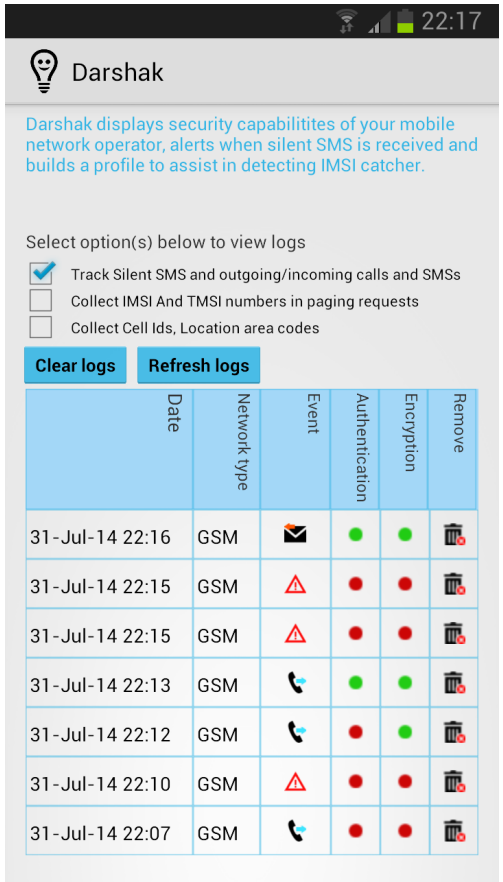
Darshak Framework

Motivation

- Research platform to collect GSM & 3G security relevant data
- Easy to use cellular network security indicator

Darshak* Framework

- Display (in) security capabilities of your cellular network operator
- Android based framework
  - Detection
  - Notification
  - Intelligence
  - Collection
- Security features
  - GSM and 3G networks
  - Captures ‘silent sms’ and notifies user
  - Alerts when operator not doing encryption?
  - Displays suspicious activities

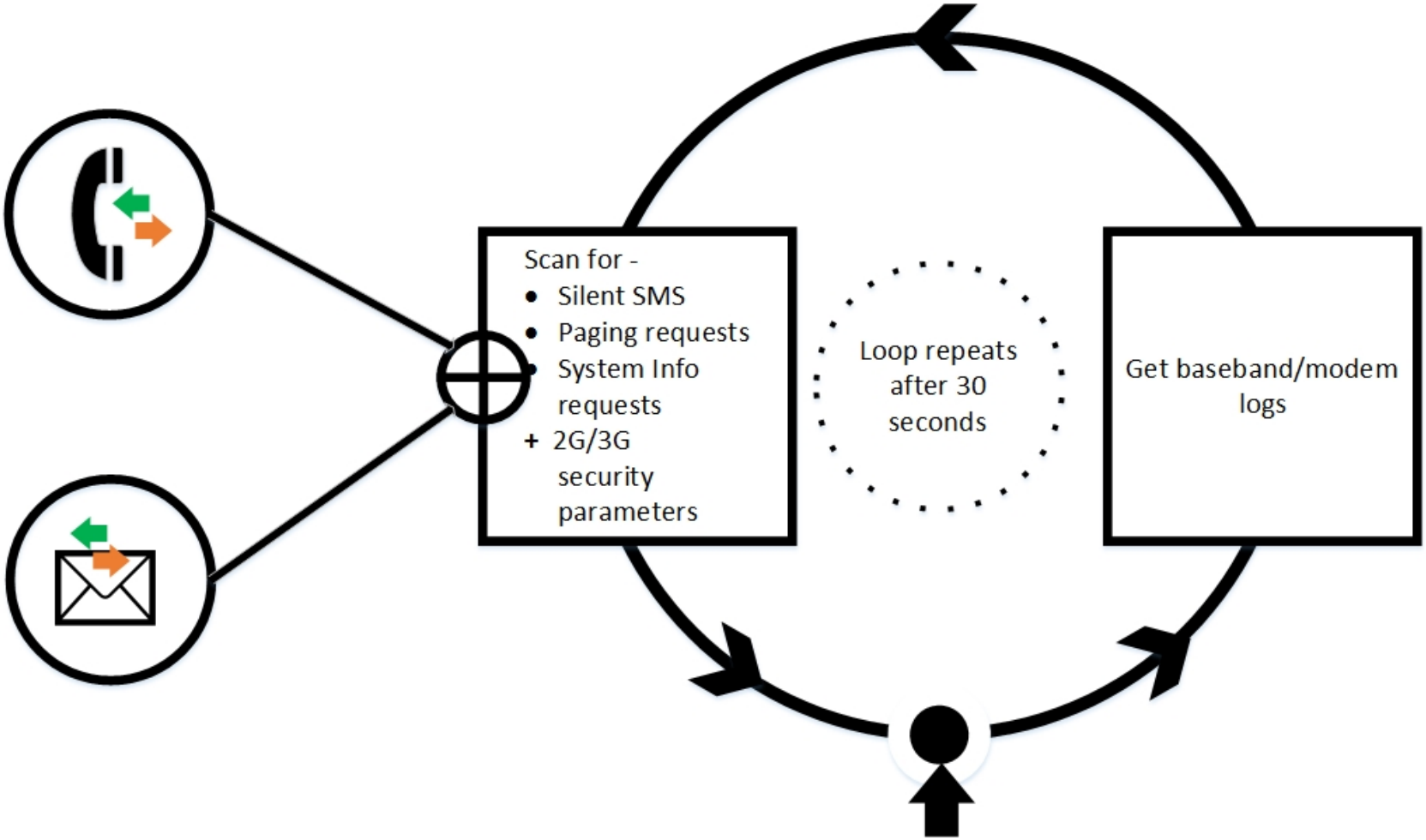


* In ancient Indian language, Darshak means indicator

Technical Details

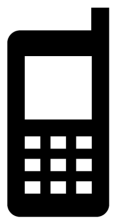
- Running on Intel baseband devices Samsung S3, S2
- Primarily based on Xgoldmon idea
- Thanks to GSMMAP
- Device needs to be rooted
- Notifies sender's number - Silent SMS
- Classify security capabilities of 2G/3G networks A5/0, A5/1,A5/3, (useful while roaming)
- Current TMSI after every event
- Displays authentication tokens (RAND, AUTN)

Methodology



GSM background

GSM Security Issues



MS

No Mutual Authentication

Fake base station / MiTM

Weak algorithms

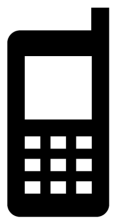
A5/2 broken, A5/1 weak

BTS decides encryption

Downgrading attacks

GSM : BTS

GSM Security Issues



MS

Plaintext over-the-air

IMSI & TMSI

No authentication

IMEI is not authenticated

Local regulations

No upgrade, weak algorithms

GSM : BTS

GSM badly broken

- Proven experimentally by various researchers
- Has it fixed and upgraded by your operator as per GSMA guidelines?
- Authentication
  - Mobile originated – mostly performed
  - Mobile terminated – not often
- Encryption - A5/1 vs A5/3 vs A5/0
- Threat model is not your government (lawful interception) but other illegal entities

Use-cases and Demos

GSM and 3G security indicators

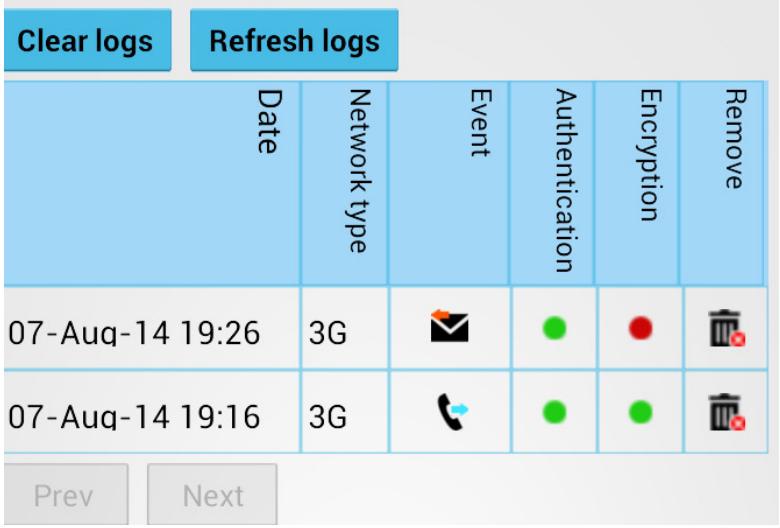
- Invokes at every incoming and outgoing **radio** event

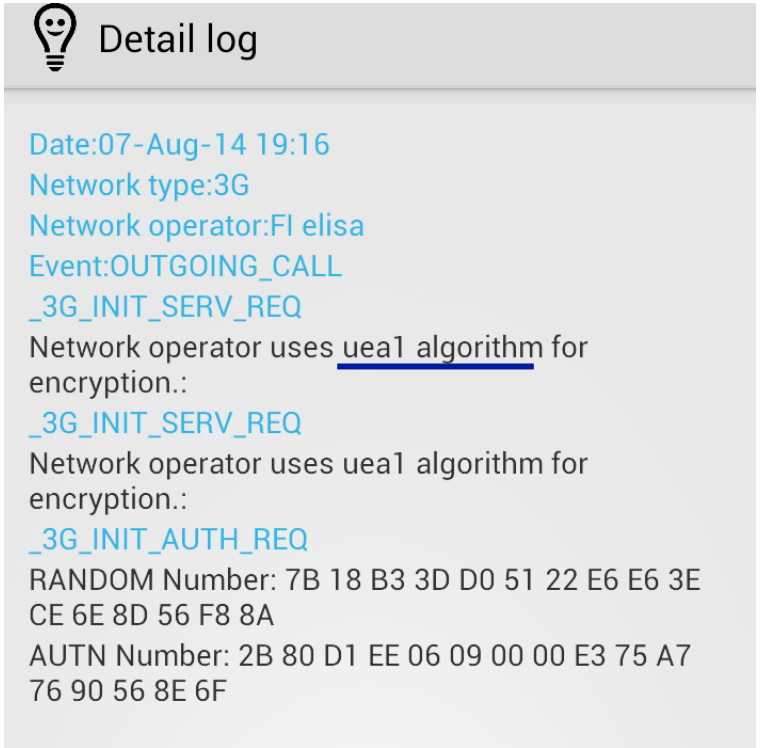
Darshak

Date	Network type	Event	Authentication	Encryption	Remove
28-Jul-14 17:03	GSM				
28-Jul-14 15:57	GSM				
28-Jul-14 11:53	GSM				
28-Jul-14 10:38	GSM				
28-Jul-14 01:01	GSM				
27-Jul-14 23:41	GSM				
27-Jul-14 22:36	GSM				
27-Jul-14 22:00	GSM				
27-Jul-14 21:59	GSM				
27-Jul-14 21:56	GSM				
27-Jul-14 20:13	GSM				
27-Jul-14 20:08	GSM				
27-Jul-14 20:03	GSM				

interception attack

3G security indicators





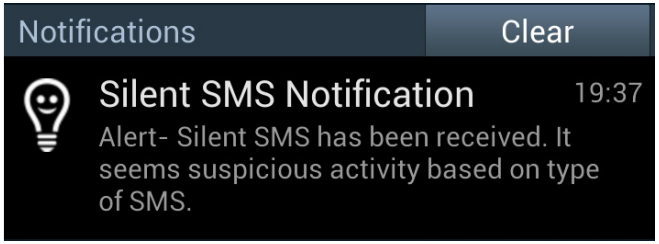
Detecting silent SMS

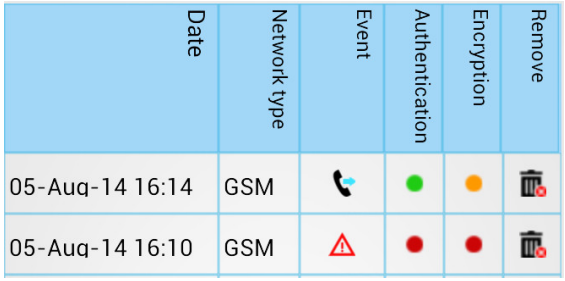
- Type 0 messages
- Standard says mobiles must acknowledge receipt but may discard contents
- Mobiles do not display any notification to end users
- Useful for police or other illegal agencies
- HushSMS tool from @c0rnholio

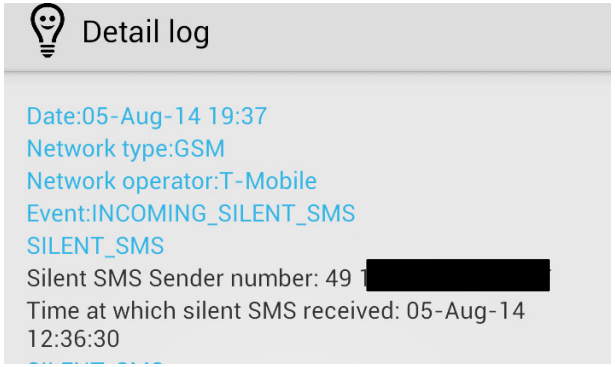
Detecting silent SMS - Demo

- HushSMS allows
  - Ping 3 (0-byte WAP Push)
  - Ping 4 (Emtpy MMSN)
- Detects, alerts with a notification
- Option to turn on airplane mode

  (not useful until you control the baseband)







IMSI Catcher Detection

- Finding parameters to detect
- Need lots of data from different operators
- LAC or Cell id not enough

scanning first

jamming

downgrading

The basic features of NS-17-2 3G catcher are:

- Operation in 850, 900, 1700, 1900, 2100 3G bands;
- Automatically scanning and detecting parameters of all 3G networks;
- Detecting 3G phones and collecting their IMSI/IMEI identities in real time;
- Displaying phone model and name of network Provider;
- Measuring distance to all 3G phones with accuracy of less than 30 m;
- Jamming 3G selected networks in the working area;
- Forcing handsets to migrate to GSM mode. It makes possible interception of such phones by GSM semi/active and passive interception systems.

All software operations described in this document must be performed by organizations and companies only in accordance with national and international Laws.

Finding parameters

- System Information Type 3 messages
  - Layer 3 messages about GSM system configuration

```
123 7.284276000    127.0.0.1  127.0.0.1    GSMTAP        71 (CCCH) (RR) System Information Type 3
124 7.309716000    127.0.0.1  127.0.0.1    GSMTAP        71 (CCCH) (SS)
        Mobile Network Code (MNC): Bharti Airtel Ltd., Maharashtra (90)
        Location Area Code (LAC): 0x1011 (4113)
  ▽ Control Channel Description
      1... .... = MSCR: MSC is Release '99 onwards (1)
      .1.. .... = ATT: MSs in the cell shall apply IMSI attach and detach procedure (1)
      ..00 1... = BS_AG_BLKS_RES: 1
      .... .000 = CCCH-CONF: 1 basic physical channel used for CCCH, not combined with SDCCHs (0)
      .00. .... = CBQ3: Iu mode not supported (0)
      .... .100 = BS-PA-MFRMS: 4
      T3212: 40
  ▽ Cell Options (BCCH)
      .1.. .... = PWRC: True
      ..01 .... = DTX (BCCH): The MSs shall use uplink discontinuous transmission (1)
      .... 0100 = Radio Link Timeout: 20 (4)
  ▽ Cell Selection Parameters
      011. .... = Cell Reselection Hysteresis: 3
      ...0 0000 = MS TXPWR MAX CCH: 0
```

Finding parameters

- Control Channel Description
  - MSCR: shows current GSM network version
  - 0 – MSCR release version 98 or older
  - 1- MSC release version 99 or newer

	Telekom	O2	Vodafone	Play Network	BSNL	Idea	OpenBTS
MSCR	'99 onwards	'99 onwa rds	'99 onwards	'98 or older	'99 onward s	'99 onward s	'98 or older

Finding parameters

- Radio Link Timeout
  - Counter value to judge downlink failure
  - Counter decrease when there is error
  - When 0 radio link failure

	Telekom	O2	Vodafone	Play Network	BSNL	Idea	OpenBTS
MSCR	64	24	64	64	20	40	64

Finding parameters

- PWRC - power control indicator
- Data from various operators and openBTS

	Telekom	O2	Vodafone	Play Network	BSNL	Idea	OpenBTS
MSCR	Flase	True	False	Flase	True	False	False

Building a profile

- Tool collects such parameters
- Very seldom change (no change in a week)
- Build a profile per location : office-work-city
- Work in progress

SYS_INFO_3
Cell Identity: 01 41
Mobile Country Code: 42 F4
Mobile Network Code: 50
Location Area Code: 23 2D
MSCR: MSCR: MSC is Release '99 onwards
PWRC: True
Cell selection parameters: RXLEV-ACCESS-MIN: 05

Future work

- Source code will be released (without IMSI catcher)
- Support to other **possible** devices
- Data upload functionality (anonymous data)
- Building more profiles for IMSI catcher detection
- Collecting and sharing data

Thank you!