Digital forensics

Andrej Brodnik

Cell (mobile) phones

chapter 20

- various technologies of data transfer
- sometimes mostly phones, today mostly computers
- rich source of personal data
  - call history (incoming, outgoing and missed)
  - SMS and MMS history (received and sent)
  - history of location data
  - images, journals, calendars, ...
  - access to the web networks – shortly, all the data which is also found on usual computers

Data on the cell phone

- Example (POCKET-DIAL M FOR MURDER):

  The perpetrator had a phone in his pocket during the crime, which has pocket-dialed cellphone of his wife, who was the victim of the crime. On the wife's phone, the call went to voicemail and it was recorded.

- Computational power of mobile devices is increasing because they contain much more I/O devices
  - thermometers
  - accelerometers
  - credit card scanners
  - ...
  - use of these units went beyond the manufacturer's intentions; e.g. at certain temperature some action is triggered
- phones became one type of *embedded systems*

Mobile device forensics

- devices have more capable operation systems
  - Android
  - iPhone
  - Blackberry
  - Windows Mobile
- and older operation systems (SYMBIAN, ...)

Mobile device forensics

- devices are by the definition network devices
  - GPRS, CDMA, UMTS, ...
  - IEEE 802.11
  - IEEE 802.15 (Bluetooth)
  - Infrared communication
  - ...
- access to the device may destroy or modify the evidence material

Mobile device forensics

- data is usually saved in storage media
  - it cannot be deleted, but it can be copied
  - due to the limited number of writes, writing algorithms spread data across storage media
  - that is why we can get a lot of data that seems to be deleted

Mobile device forensics

- data acquiring from device
  - usually using cable connected to the data port
    - protocol knowledge needed
  - sometimes a direct capture from the storage media is required
    - direct reading from chip

Mobile device forensics

- devices are made from two parts
  - device itself
  - SIM cards
- device has unique identificatio number
  IMEI (*International Mobile Equipment Identity*)

Mobile device forensics

- SIM cards are computers
  - CPU, ROM, RAM
- contain ICC-ID (*Integrated Circuit Card Identifier*):
  - MCC (*mobile country code)*,
  - MNC (*mobile network code*),
  - serial number of card

SIM cards

- *Challenge: Which data SIM card also contains?*
- *Challenge:* What is LAI and what is IMSI?
- *Challenge:* What your SIM card has? What are the values of this data? What is the identification of your mobile device?

Data about and on the device

- on device – depends on the type of the device:
  - baseline phone
  - smart phone
- where the data is also stored:
  - user’s computer
  - operator
  - SIM card
- on device are at least stored:
  - titles
  - incoming, outgoing and missed calls
  - received and sent SMS

SMS as digital evidence

- full information: when is sent/received, from who and content
- no record of when messages were first read

example of data acquired using BitPim (http://www.bitpim.org/)

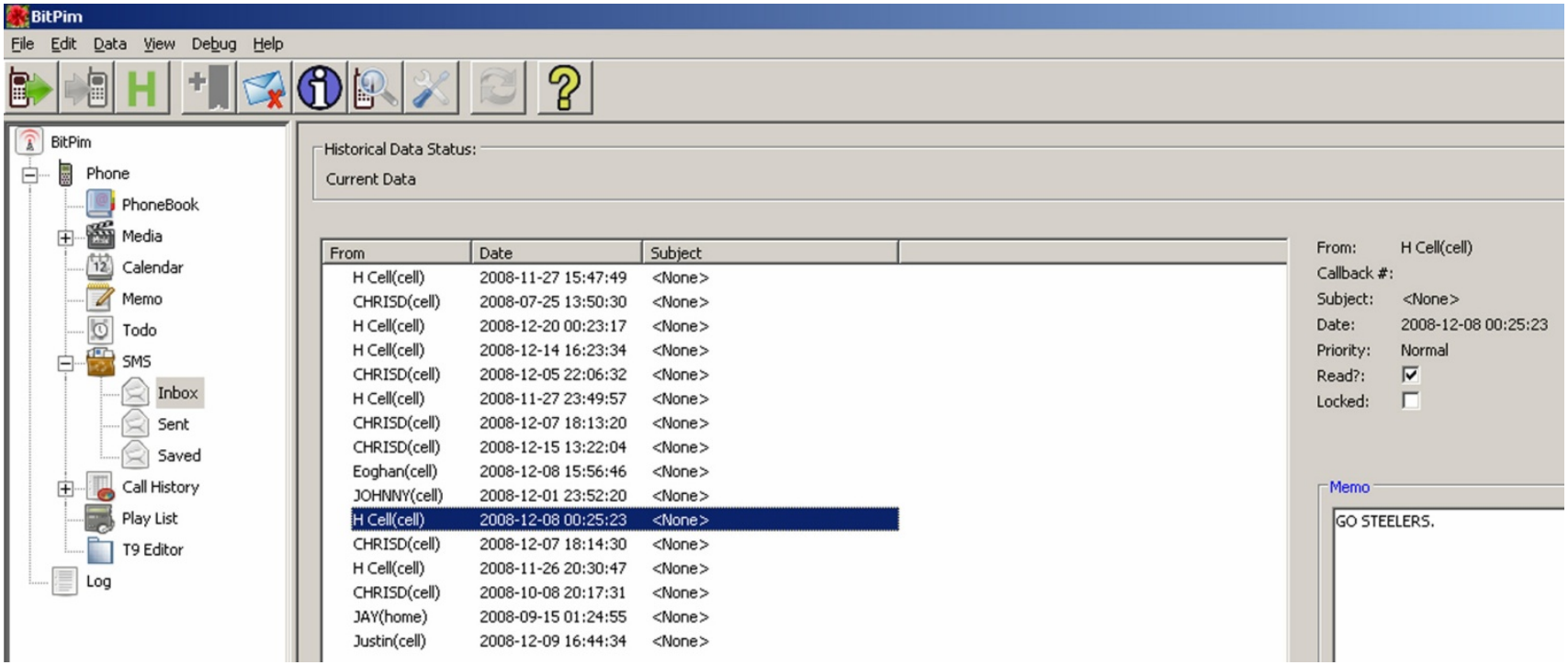
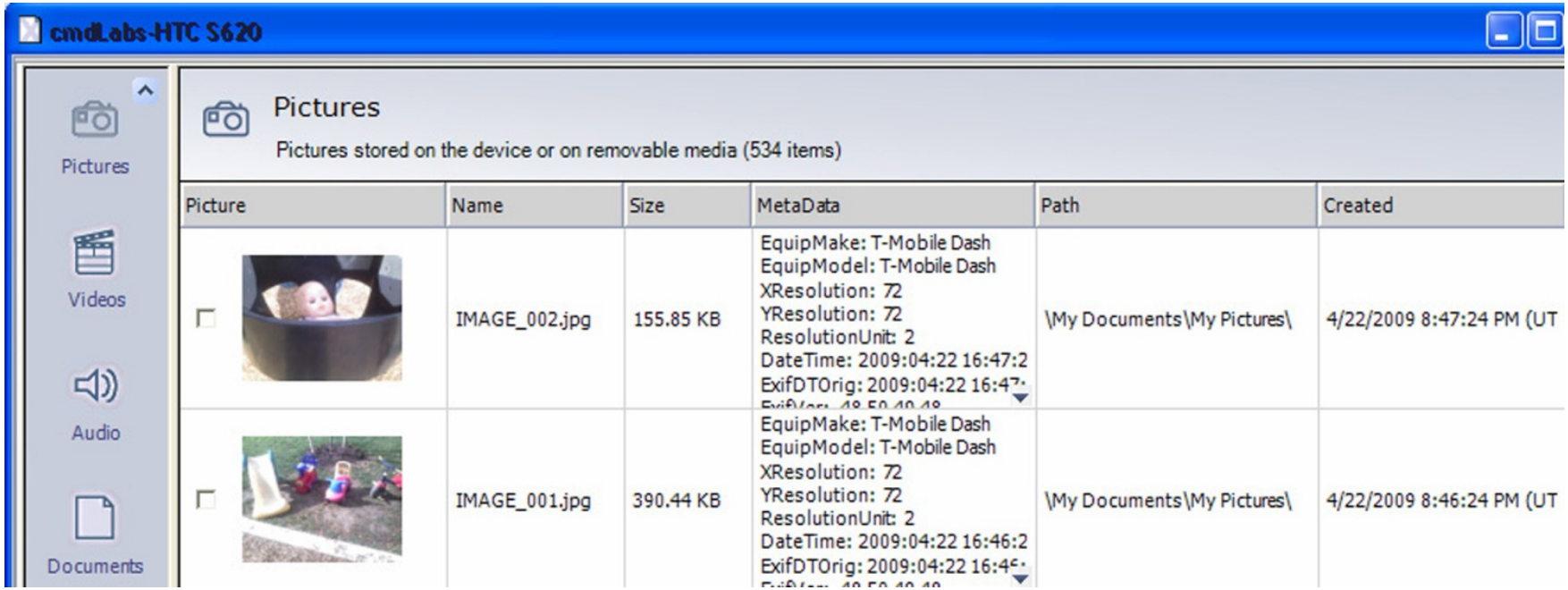


Image data

- smart phones have cameras
- Image data is in EXIF record (usually)

Example of data acquired from Windows Mobile device using XRY (http://www.msab.com/)



Access to the Internet services

- mobile devices enable access to the web
  - often user saves passwords there
  - there is history of entries
  - logs of the last entries
  - ...
- mobile devices enable e-mail reading
  - passwords to access mailboxes
  - last received / sent mails
  - ...
- other applications and their data

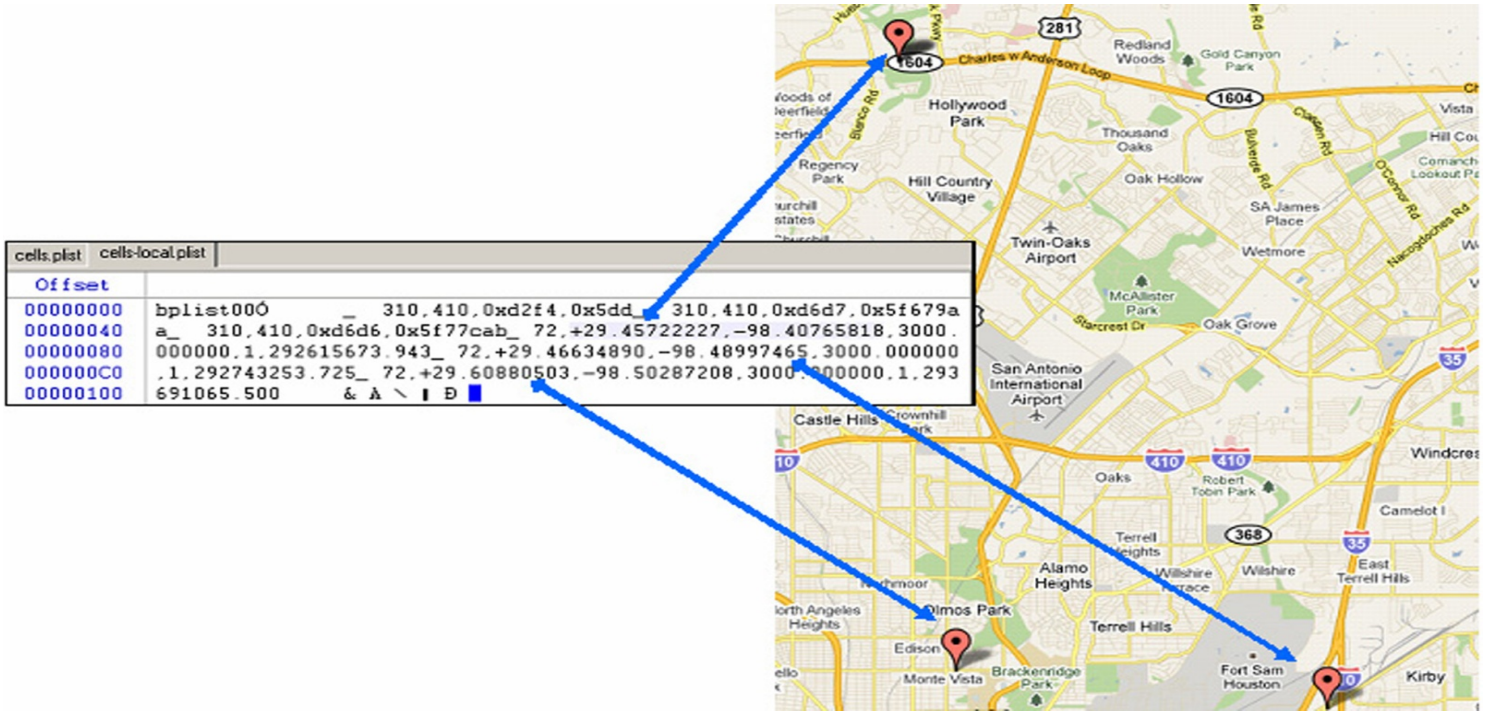
Access to the Internet services

- example of data on an iPhone

```
F:\tools>sqlite3.exe “iPhone2\Keychains\keychain-2.db”
SQLite version 3.6.16
Enter “.help” for instructions
Enter SQL statements terminated with a “;”
sqlite> select labl,acct,svce from genp;
|eric.rooster@yahoo.com|Yahoo-token
|erooster@live.com|
|erikroost@hotmail.com|
|therooster@hotmail.com|
|therooster@hotmail.com|com.apple.itunesstored.keychain
erooster|MMODBracketsAccount|
LumosityBrainTrainer|erooster|LumosityBrainTrainer
```

Location Information

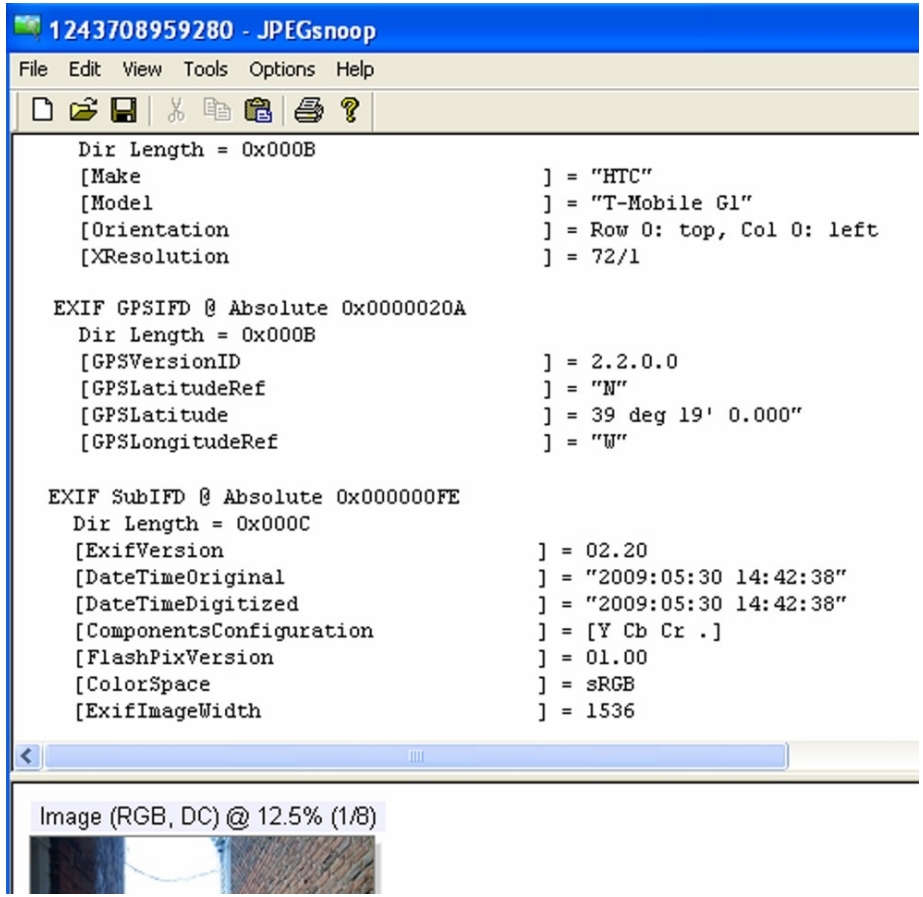
- history of moving between cellular towers can be saved
- GPS devices can save exact coordinates



Location Information

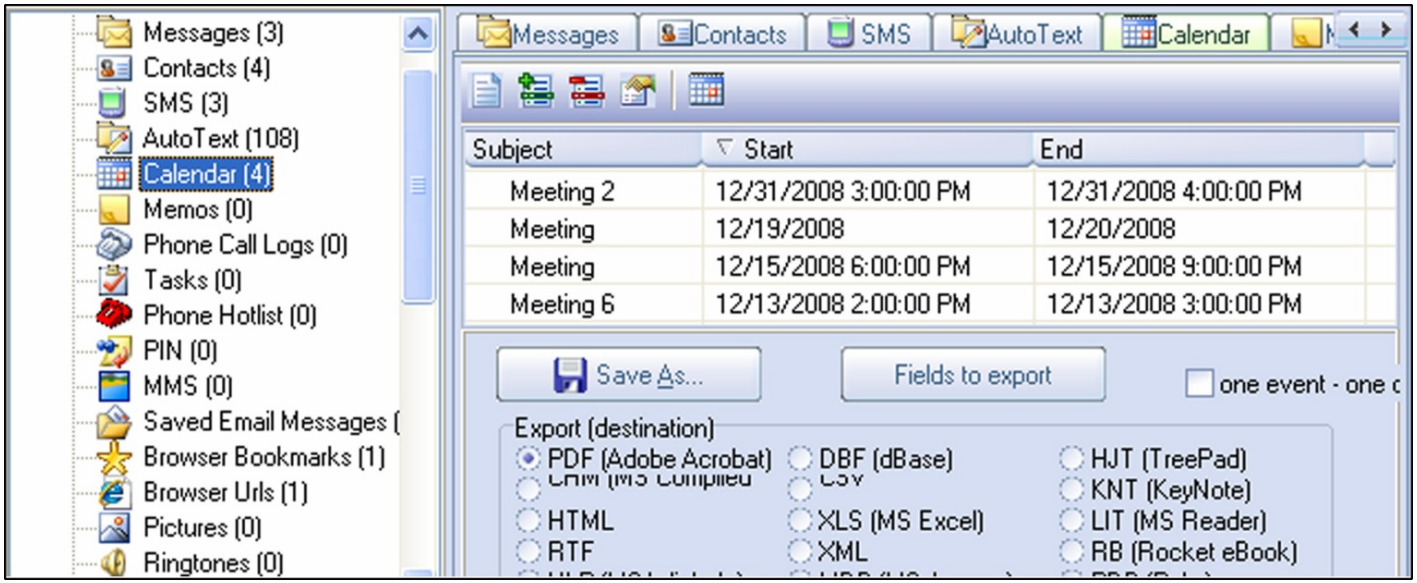
- images can save information such as when and where they were taken
  - e.g. EXIF format

- *Challenge: search for location information in your phone.*



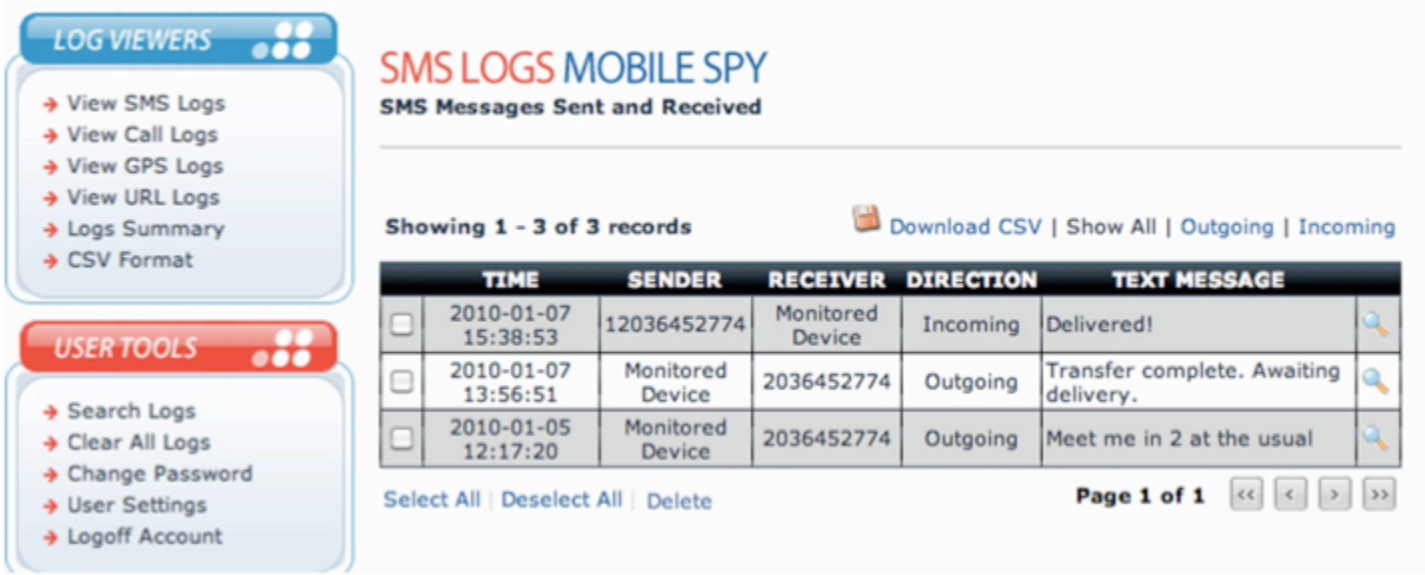
Other data

- calendar, notes, ...
- *Challenge: search for calendar data in your phone.*



Attacks on mobile devices

- the attacker loads his code on the device
  - through the network
  - the user uploads an application that seems useful and friendly (http://www.theregister .co.uk/2010/01/11/android_phishing_app/)
- the application reads passwords, ...
  - allows the attacker to access to bank accounts ...
  - see MobileSpy (http://www.mobile-spy.com/)



Attacks on mobile devices

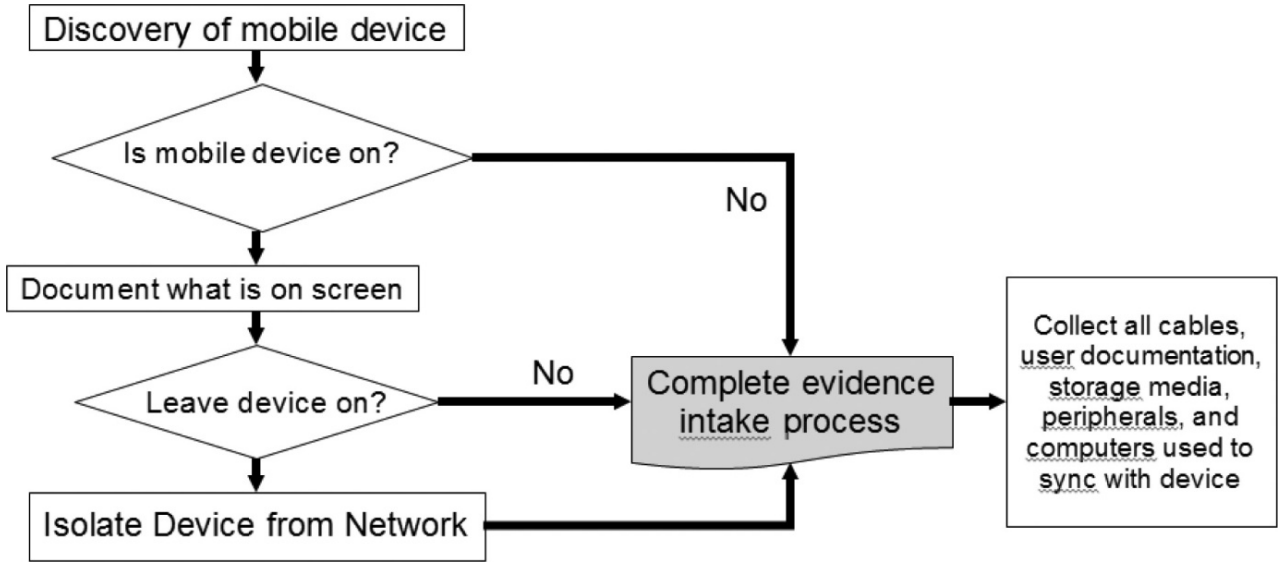
- *Challenge:* How does the MobileSpy work?
- *Challenge:* Find the software that can harm your Android system?
- *Challenge:* Make your own program that reads data on Android (iPhone) system. Can this also be useful software?

Thinking Outside of the Device

- additional data:
  - user's computer
  - operator: call center and base stations
- devices, user knows something about (transitivity)

Handling Mobile Devices

- the device can wirelessly connect with world
- disable
  - remove power
  - other ways



Handling Mobile Devices

- remove storage module
  - storage modules are always smaller
- usually FAT file system
  - iPhone: APFS, Android: Linux design
- otherwise usual procedures (signature, journals, ...)

Accessing the data

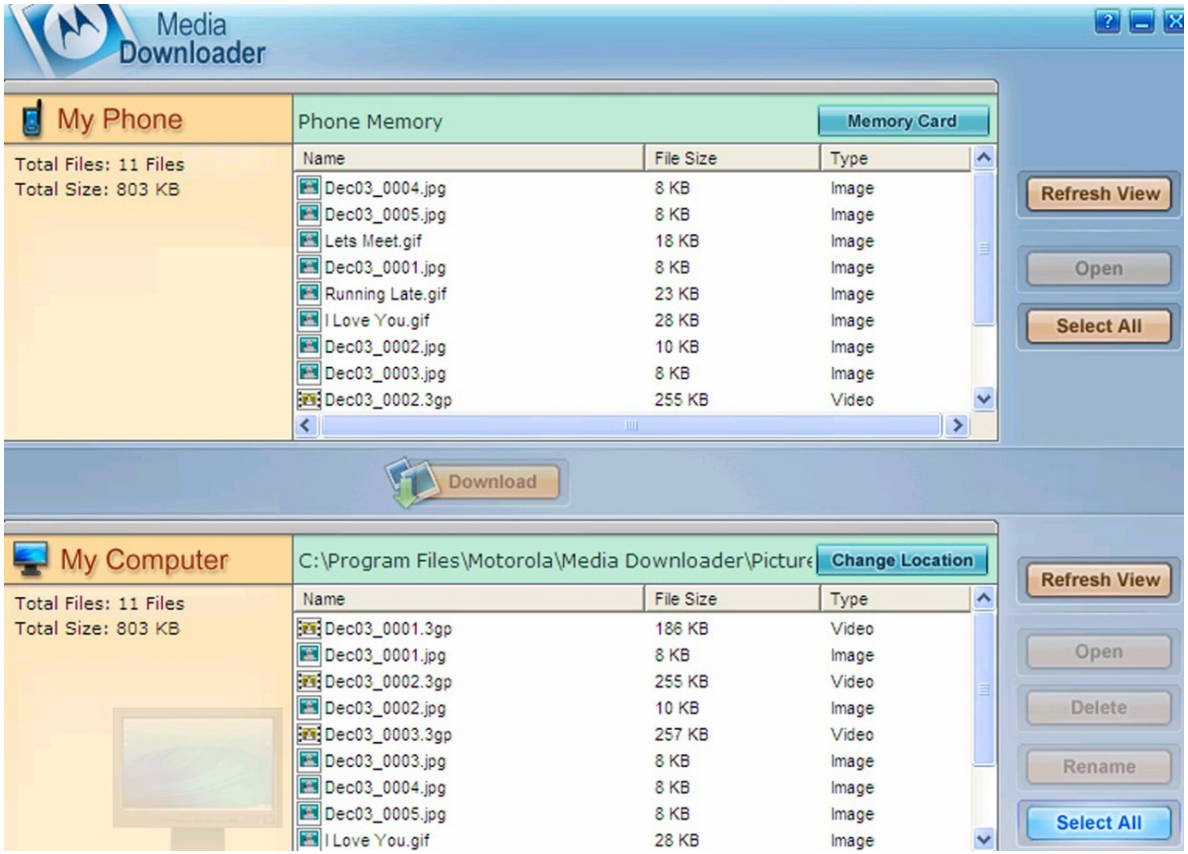
- different methods of accessing with different types
  - not every device has USB guide
- examples:
  - via user interface
  - via communication port
  - property interface (Nokia F-BUS, *Flash BUS*)
  - via JTAG (*Joint Test Action Group*) interface
  - via direct memory chip access

Accessing the data

- some devices provide agent access
  - when device is on, it runs the agent which takes over control of the device (iPhone)
- sometimes we can stop software launching and put our code as further upload
- manufacturers offer data archiving software which also provides access to deleted and other data

Examples ...

- example of stored data with an archive using XACT (Motorola device)



Examples ...

- device, which is partly broken, it may still work well enough

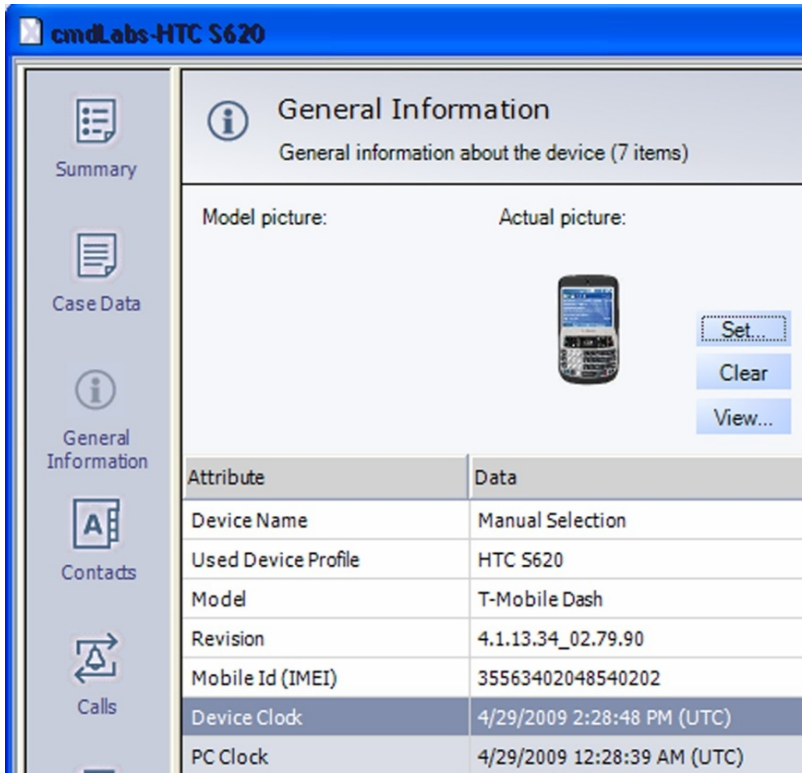
Mobile Device Forensics Tools

- any tool allows access to the device memory (for example disk)
- in the case of a disk, access is relatively safe because it cannot change content by itself
- in case of mobile device that is not necessarily true

Mobile Device Forensics Tools

XRY (http://www.msab.com/)

Cellebrite UFED (*Universal Forensic Extraction Device*) - http://www.cellebrite.com/



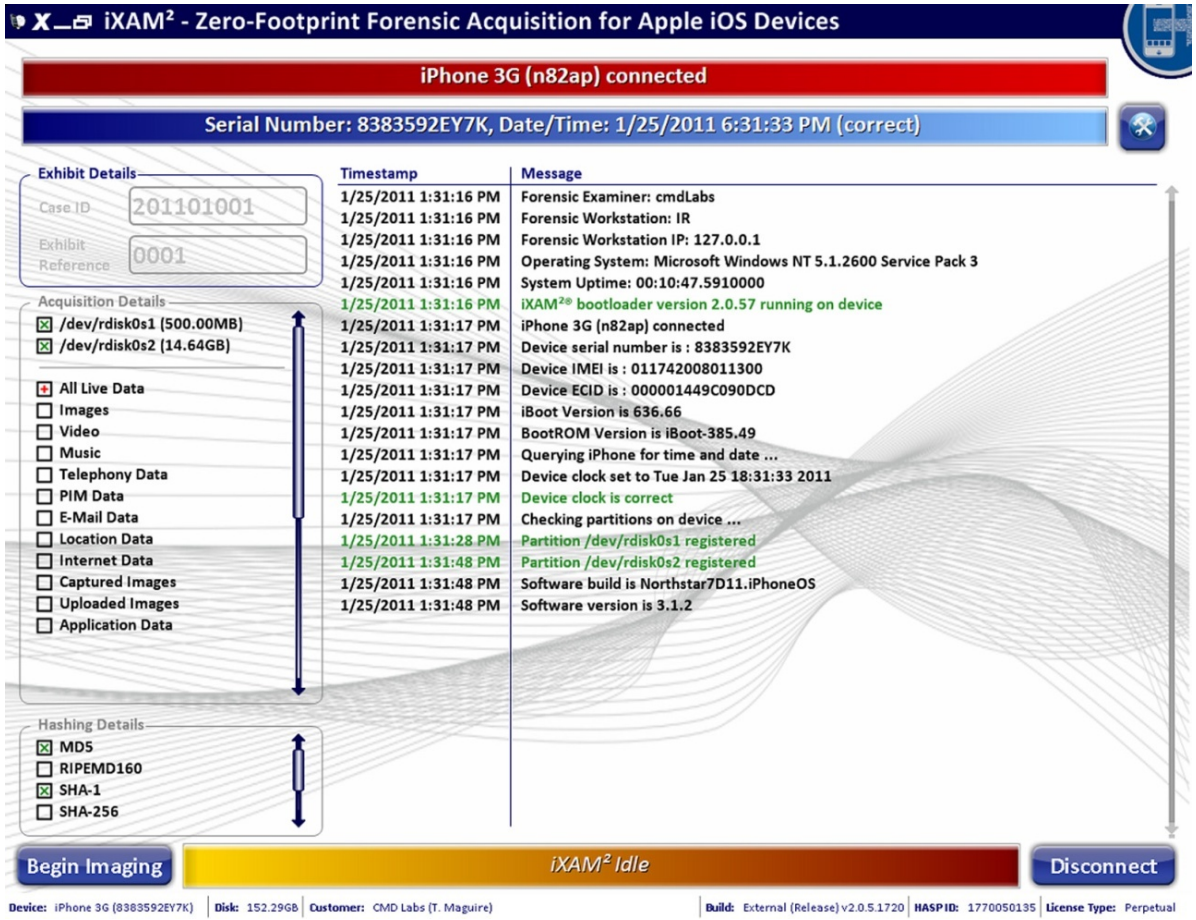
Mobile Device Forensics Tools

Logicube CellDEK
(http://www.logicube.com/)

- MOBILedit! Forensic (http://mobiledit.com/)
- progamming equipment for analysis

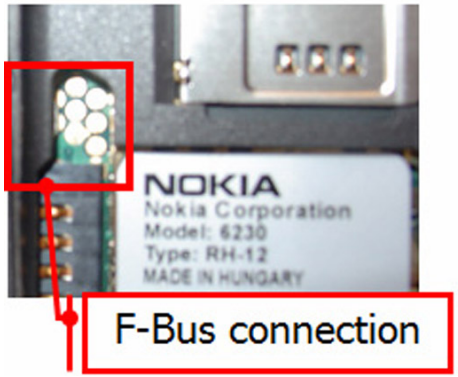
Mobile Device Forensics Tools

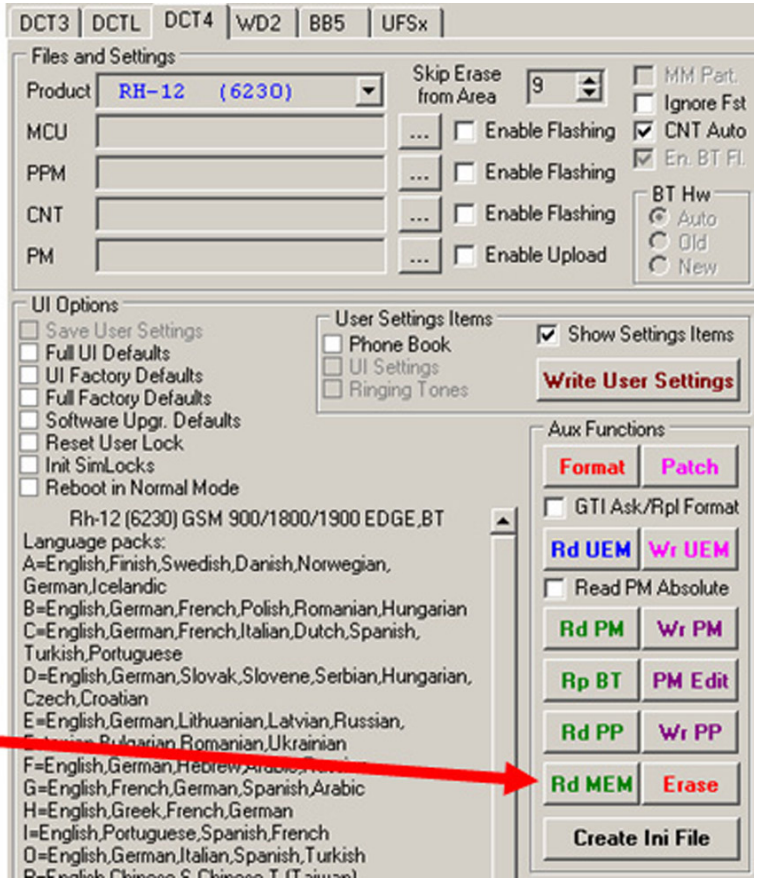
- iXAM (http://www.ixam-forensics.com/)



Mobile Device Forensics Tools

Twister Flasher



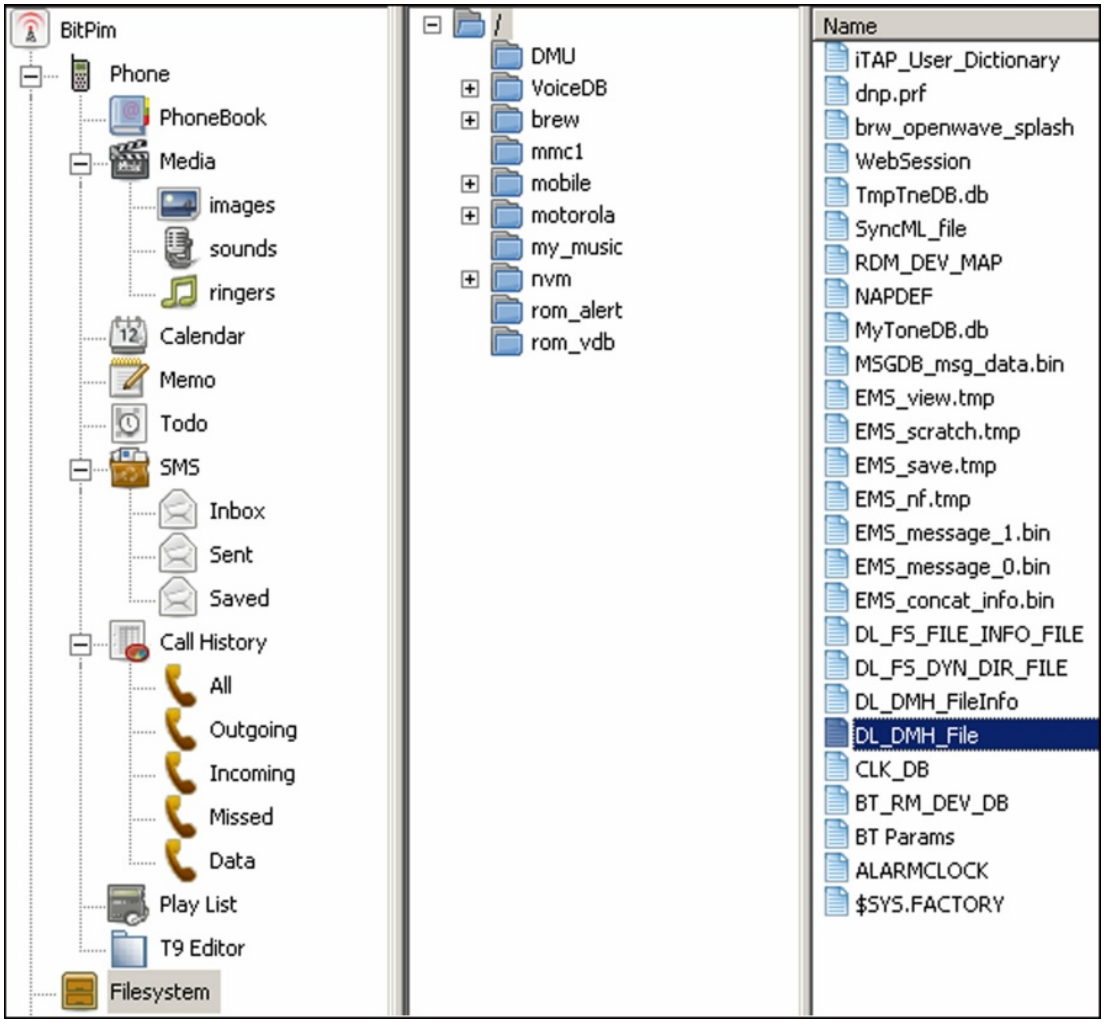


File System Examination

- depends on device
  - unique
  - built in systems Qualcomm (BREW, Binary Runtime Environment for Wireless)
  - FAT, ext2, ext3, HSFX, APFS, …
- various tools are available:

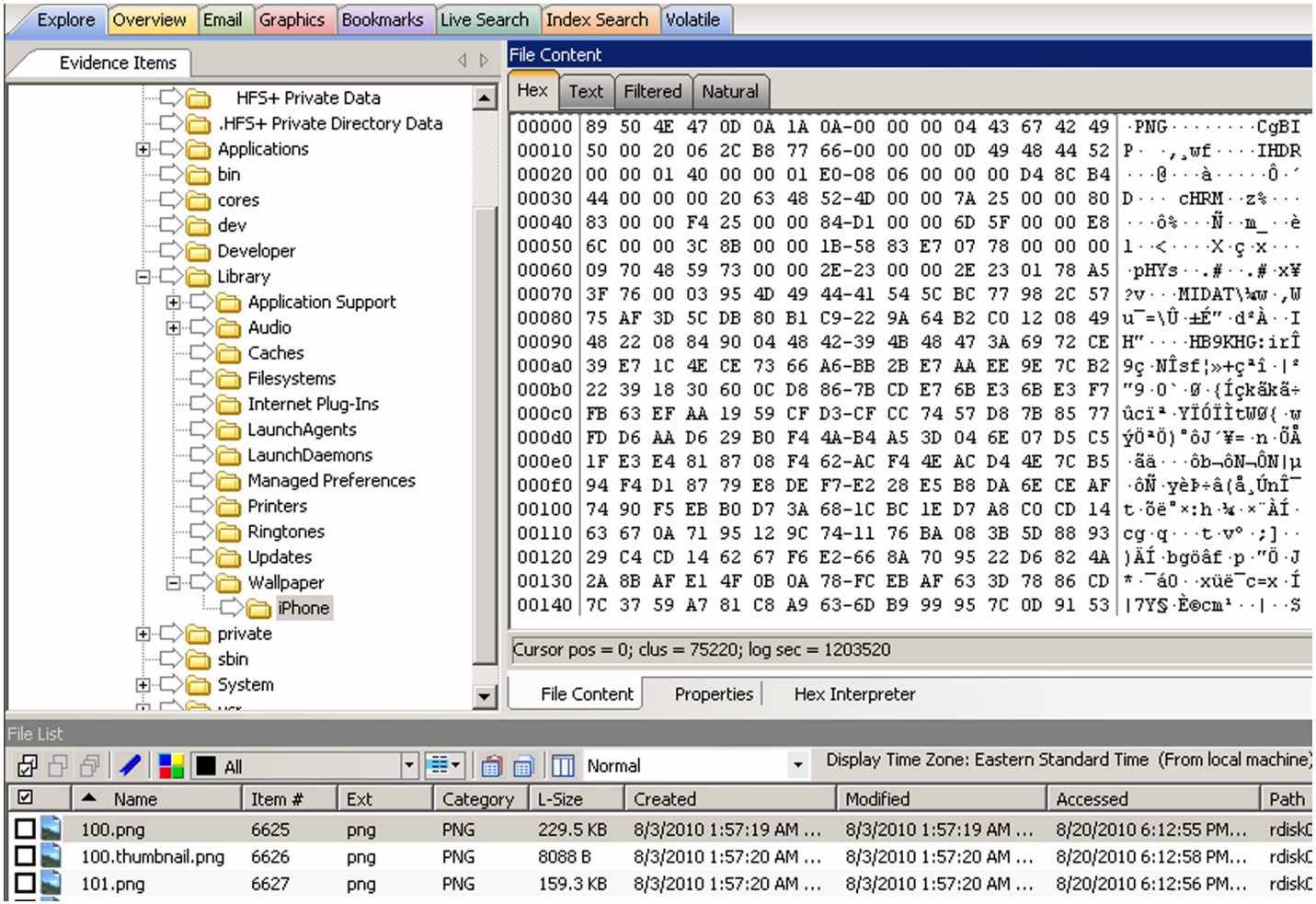
Some basic tools …

BitPim
(http://www.bitpim.org/) –
Motorola CDMA



Some basic tools …

Forensic Toolkit, FTK (http://accessdata.com/products/computer-forensics/ftk)
– iPhone



Data recovery

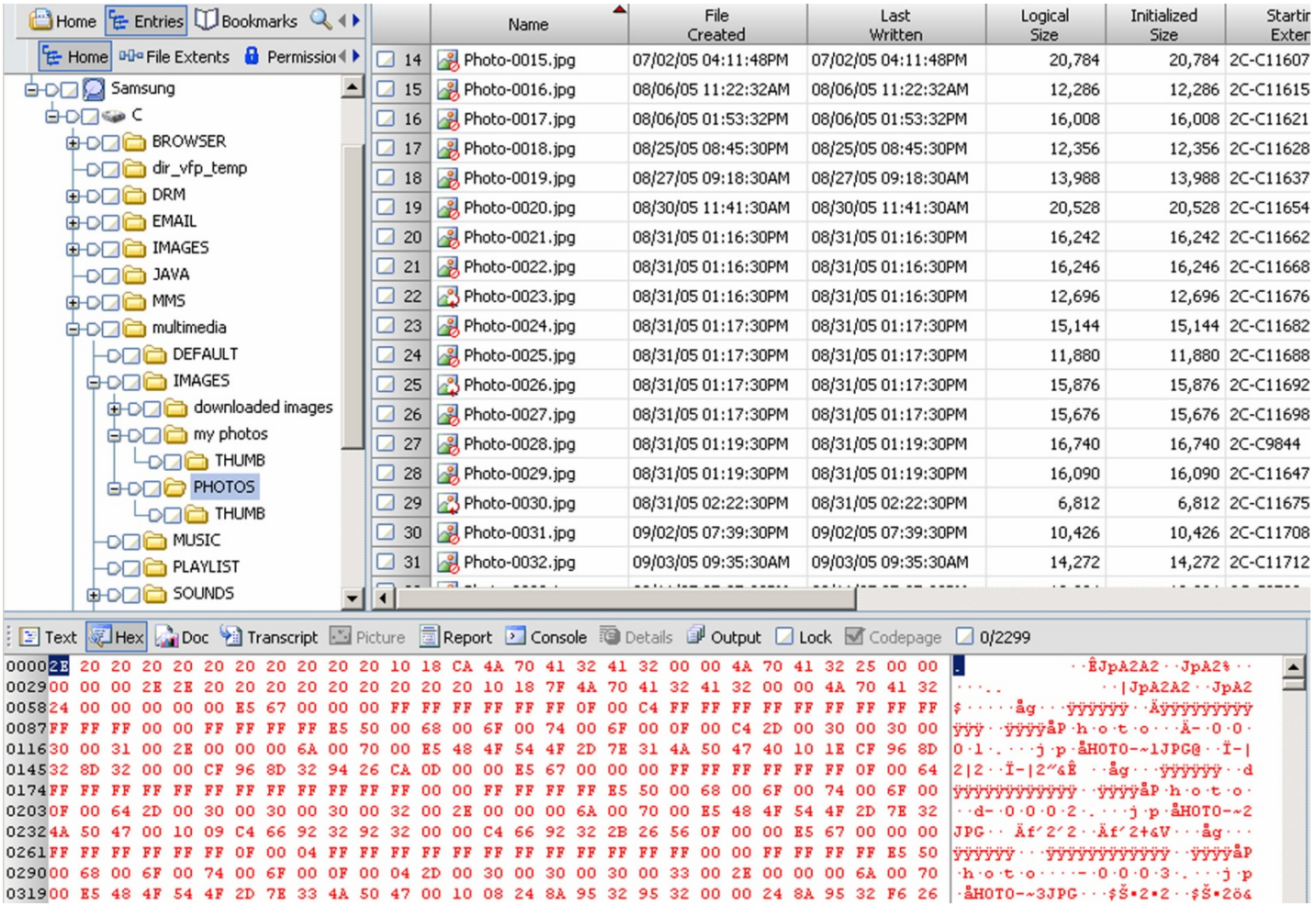
- even if we don’t have all the data we can recover partly deleted data from logical data

MMS937483931.PDU

Offset	
00000000	1▮Mapplication/smil ▮smil Presentation Â"<mms.smil> <smil><head
00000040	><layout><root-layout width="399" height="240"/><region id="imag
00000080	e" width="320" height="240" left="0" top="0" fit="meet"/><region
000000C0	id="text" width="399" height="0" left="0" top="240" fit="hidden
00000100	"/></layout></head><body><par dur="5000ms"><video src="092009120
00000140	1a.3g2" region="image" begin="0ms" end="0ms"/></par></body></smi
00000180	l>C▮▮" video/3gpp2 ▮0920091201a.3g2 ▮0920091201a.3g2 Â"<09200912
000001C0	01a.3g2> ftyp3g2a 3g2a 4▮mdat ¶ ÅÞÅÅ¾Xðää ¨9È ▮5▮O·xÜ
00000200	Ðæ +Ë▮▮S L "±Í¥– [ )l ¯–à>T æG³▮q®▮˜÷;Ö¢ÊJ(s uqK Ïÿ±û® º▮S ö
00000240	uLÛ4) #á 6Ö▮ÁMì²z▮v V]rN®*O6÷^Ï▮È?[æ³[ó}▮r▮¼ ▮>õW $▮µ▮«aãZÌ▮

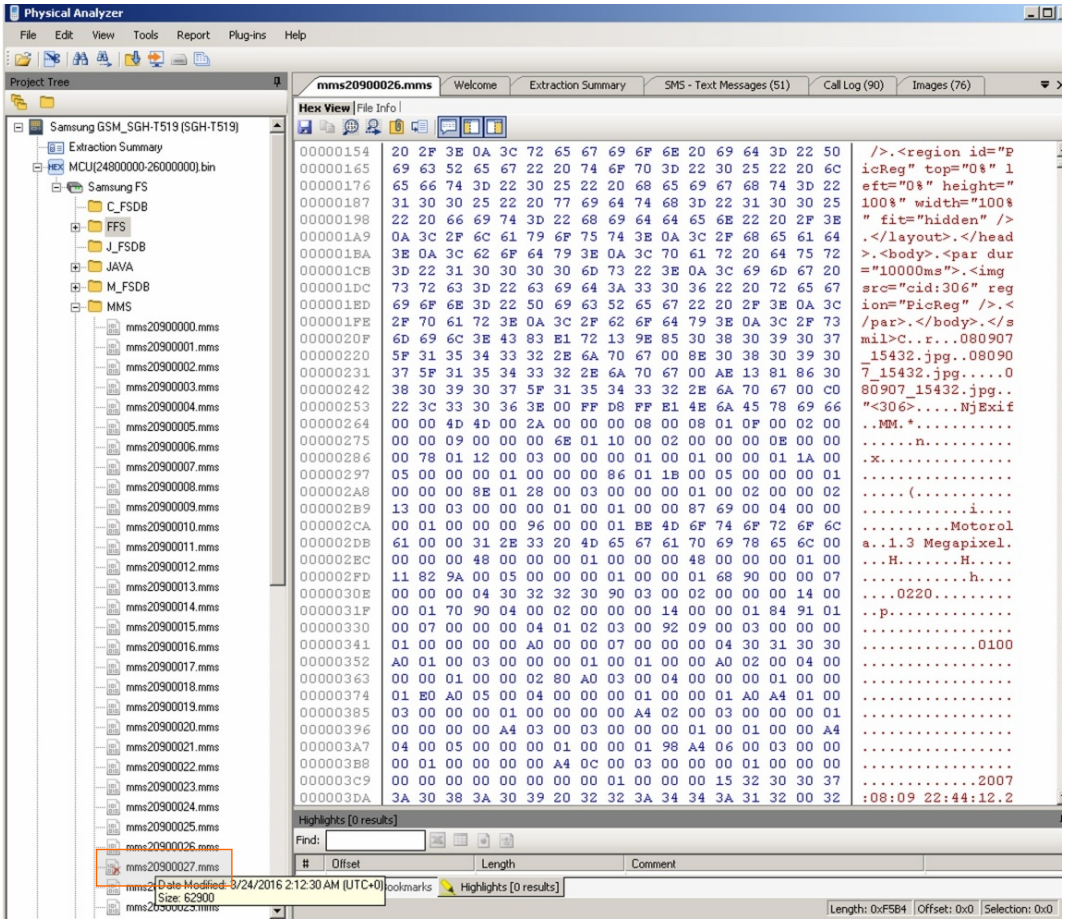
Data recovery

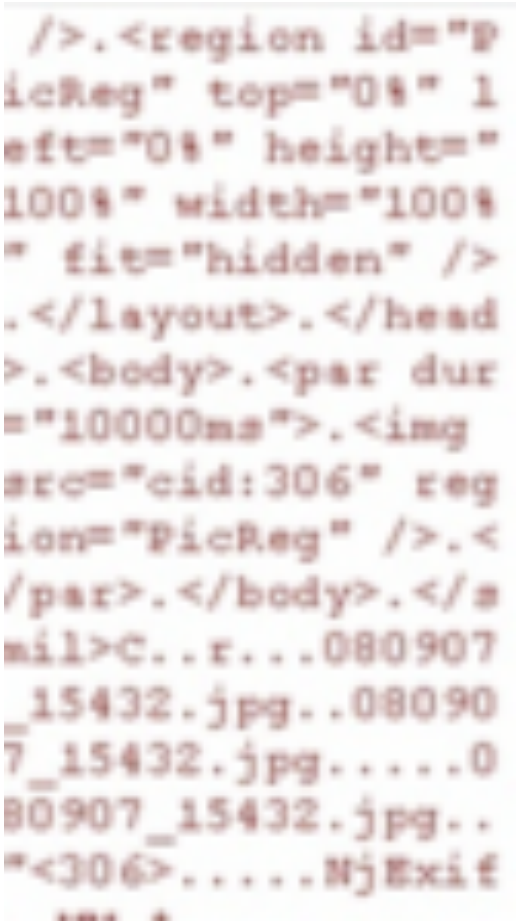
- if it is usual file system (FAT, ext2, ext3, APFS, ...) already known tools
  - EnCase and deleted images



Data recovery

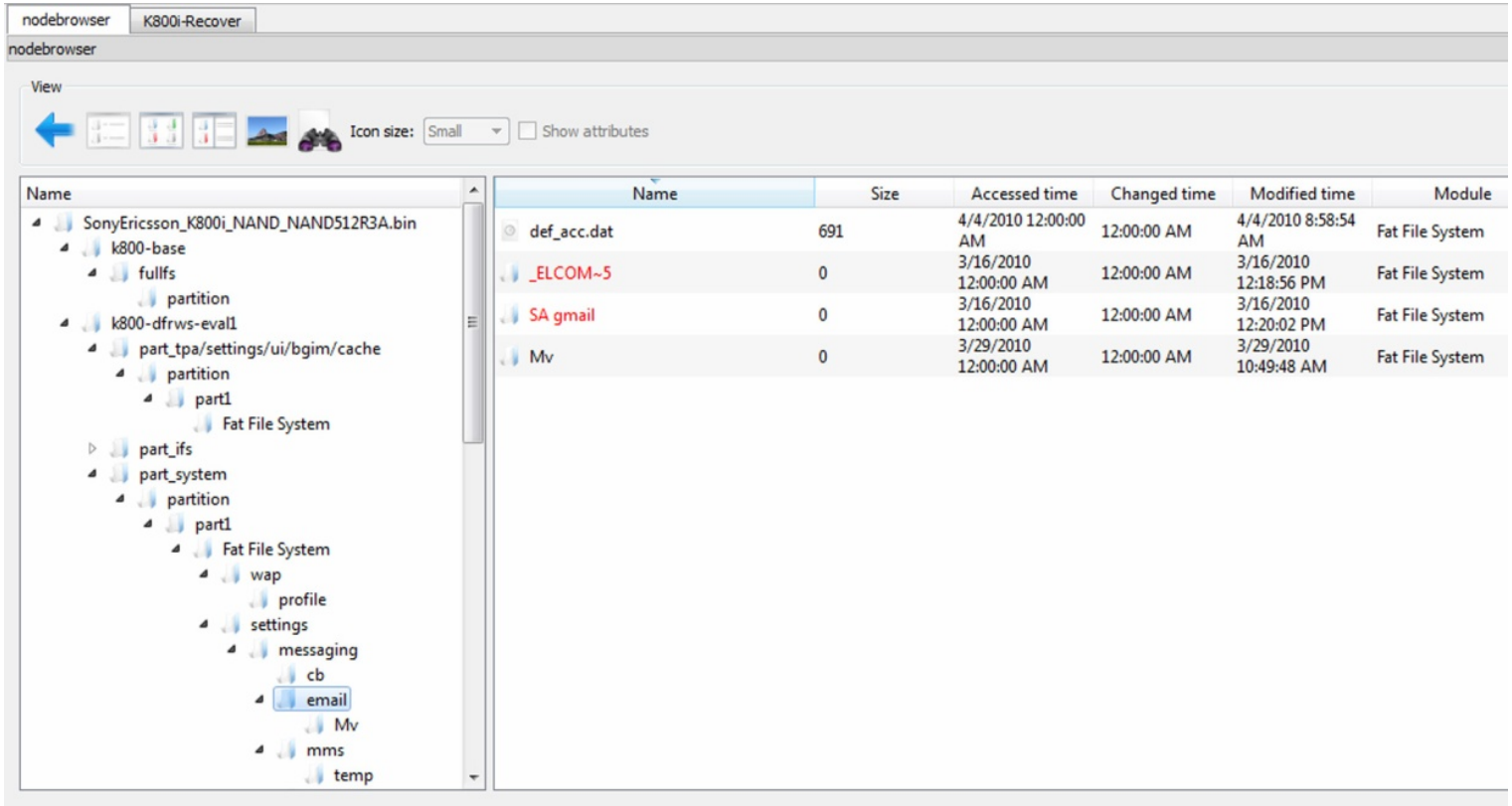
- In this example of composite files (MMS, docx, ...) we can find parts of data





Data recovery

- Example of data captured using DFF (*Digital Forensic Framework, http://www.digital-forensic.org/*)
- *Challenge:* Study the enironment and how it is spread



Data Format SMIL

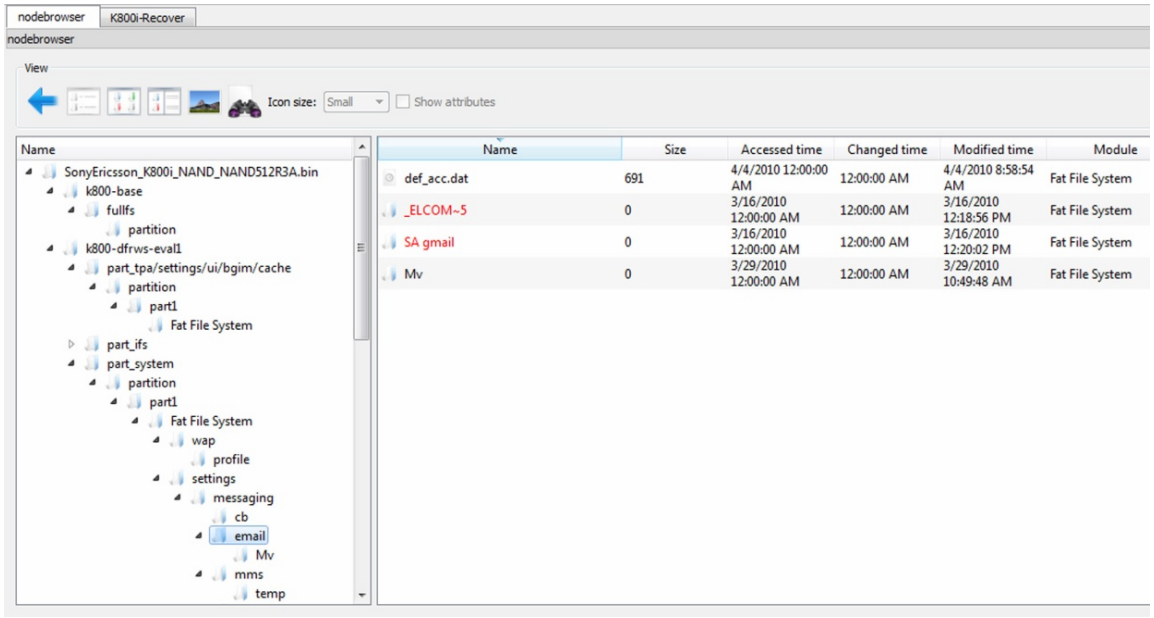
- *Synchronized Multimedia Integration Language*
  - part of W3C standard - http://www.w3.org/AudioVideo/
  - versions 1, 2 in 3 (http://www.w3.org/TR/SMIL3/)
- includes SVG items (enhanced vector graphics, *Scalable Vector Graphics*)
- allows:
  - animation, integration of other images, modularization, ...
- *Challenge:* Find SMIL file and study it.
- *Challenge:* Make your SMIL file and send it to the forum.

Data recovery

- SSD is used as storage
- Data, which are in storage, but not structured
  - Partly deleted data
  - Data in deleted blocks which are scattered per unit
- *Challenge:* look up forensic challenge and solution DRFWS2010 (*Digital Forensic Research Conference*) – http://www.dfrws.org/2010/challenge/
  - Examples of files with the unit are available
- *Challenge:* look up forensic challenge and solution DRFWS2011 – http://www.dfrws.org/2011/challenge/
- *Challenge:* look up forensic challenge DRFWS2012 – http://www.dfrws.org/2012/challenge/

Examination – other data

- A lot of smart phones saves their data in data base
  - SQlite – Android, iPhone, Palm, ...
  - cemail.vol – Windows Mobile



Examination – data formats

- mostly standard formats:
  - 7-bit standard; GSM 03.38: 160 characters
  - 16-bit UCS-2 (*Universal Character Set*, UTF-16): 70 characters

Basic Character Set[2]

	0x00	0x10	0x20	0x30	0x40	0x50	0x60	0x70
0x00	@	Δ	SP	0	¡	P	¿	p
0x01	£	_	!	1	A	Q	a	q
0x02	$	Φ	"	2	B	R	b	r
0x03	¥	Γ	#	3	C	S	c	s
0x04	è	Λ	¤	4	D	T	d	t
0x05	é	Ω	%	5	E	U	e	u
0x06	ù	Π	&	6	F	V	f	v
0x07	ì	Ψ	'	7	G	W	g	w
0x08	ò	Σ	(	8	H	X	h	x
0x09	Ç	Θ	)	9	I	Y	i	y
0x0A	LF	Ξ	*	:	J	Z	j	z
0x0B	Ø	ESC	+	;	K	Ä	k	ä
0x0C	ø	Æ	,	<	L	Ö	l	ö
0x0D	CR	æ	-	=	M	Ñ	m	ñ
0x0E	Å	ß	.	>	N	Ü	n	ü
0x0F	å	É	/	?	O	§	o	à

Basic Character Set Extension[2]

	0x00	0x10	0x20	0x30	0x40	0x50	0x60	0x70
0x00					|			
0x01								
0x02								
0x03								
0x04		^						
0x05							€	
0x06								
0x07								
0x08			{					
0x09			}					
0x0A	FF							
0x0B		SS2						
0x0C				[				
0x0D	CR2			~				
0x0E				]				
0x0F			\					

Examination – data formats

- big and little endian – depending on the processor
  - Motorola – big-endian format
- debeli in tanki košček (*nibble*)
  - number 12036452774 is saved as 2130462577F4 (F is filler)

Examination – SIM card

- SIM (*Subscriber Indenty Module*)
- device is property of user, SIM card is owned by the operator
  - which allows the user to store certain data on it
- detailed definition in:
  - ETSI (*European Telecommunications Standards Institute*): *GSM, Global Mobile Communications*, GSM 11.11, 1995.
  - www.ttfn.net/techno/smartcards/gsm11-11.pdf

SIM card

- very simple interior structure
- it consists of files and each file has its own identification 2-byte code

- first byte represents type of file:
  - 3F –Master File MF
  - 7F –Dedicated File, DF
  - 2F – partial file MF
  - 6F – partial file DF

Description	Location
SMS	7F10:6F3C
MSISDN	7F10:6F40
Last Dialed Numbers (LDN)	7F10:6F44
Abbreviated Dial Numbers (ADN)	7F10:6F3A
IMSI	7F20:6F07
LOCI	7F20:6F7E
LOCIGPRS	7F20:6F53

SIM card

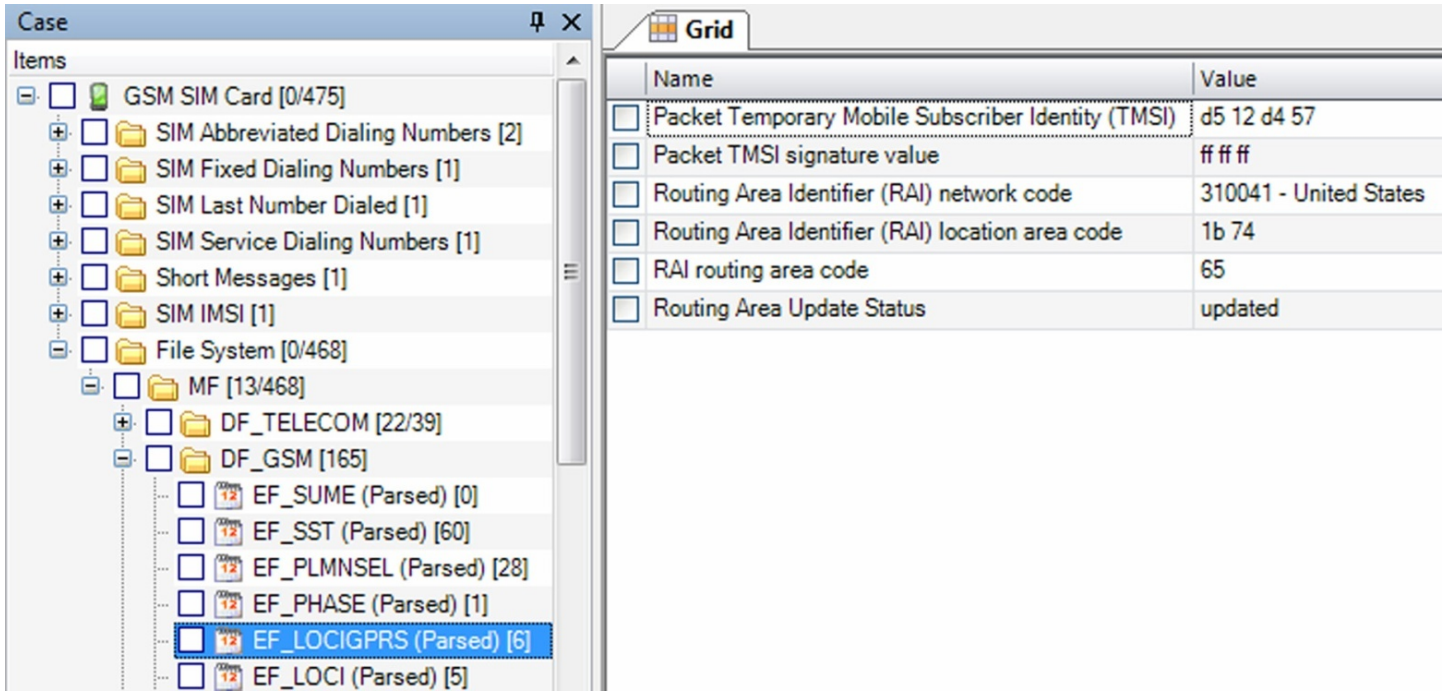
- Some files are defined in the standard
  - 3F00:7F10 (DFTELECOM, *dedicated file*): records on the use of services (i.e. sent SMS, dialed numbers, ...)
  - 3F00:2FE2 (EFICCID, *elementary file*): saves ICC-ID (*Integrated Circuit Card ID*)
  - 3F00:7F20:6F07 EFIMSI: saves IMSI (*International Mobile Subscriber Identity*)
  - 7F20:6F7E (EFLOCI): how the card was moving between operators
  - 7F20:6F53 (EFLOCIGPRS): GPRS routing area

SIM card

- tools for examining SIM card:
  - TULP2G: *Netherlands Forensic Institute*
  - http://tulp2g.sourceforge.net/
  - tool is not updated but it is fine for reading of the SIM card

SIM card

- example of information from SIM card (*Paraben Device Seizure*)



SIM card

- *Challenge:* How can I access the data on your SIM card?
- *Challenge:* Is the entire GPRS history saved?
- *Challenge:* naštejtejte EF, v katere lahko piše uporabnik. List the EF in which user can write.

SIM card and security

- card is protected with PIN (*Personal Identification Number*) code
- if you make too many mistakes (cannot be checked), the card locked itself
- for unlocking we need PUK (*PIN Unlock Key*) code
  - often operator has it