Mobilitics
Inria-CNIL project:
privacy and smartphones

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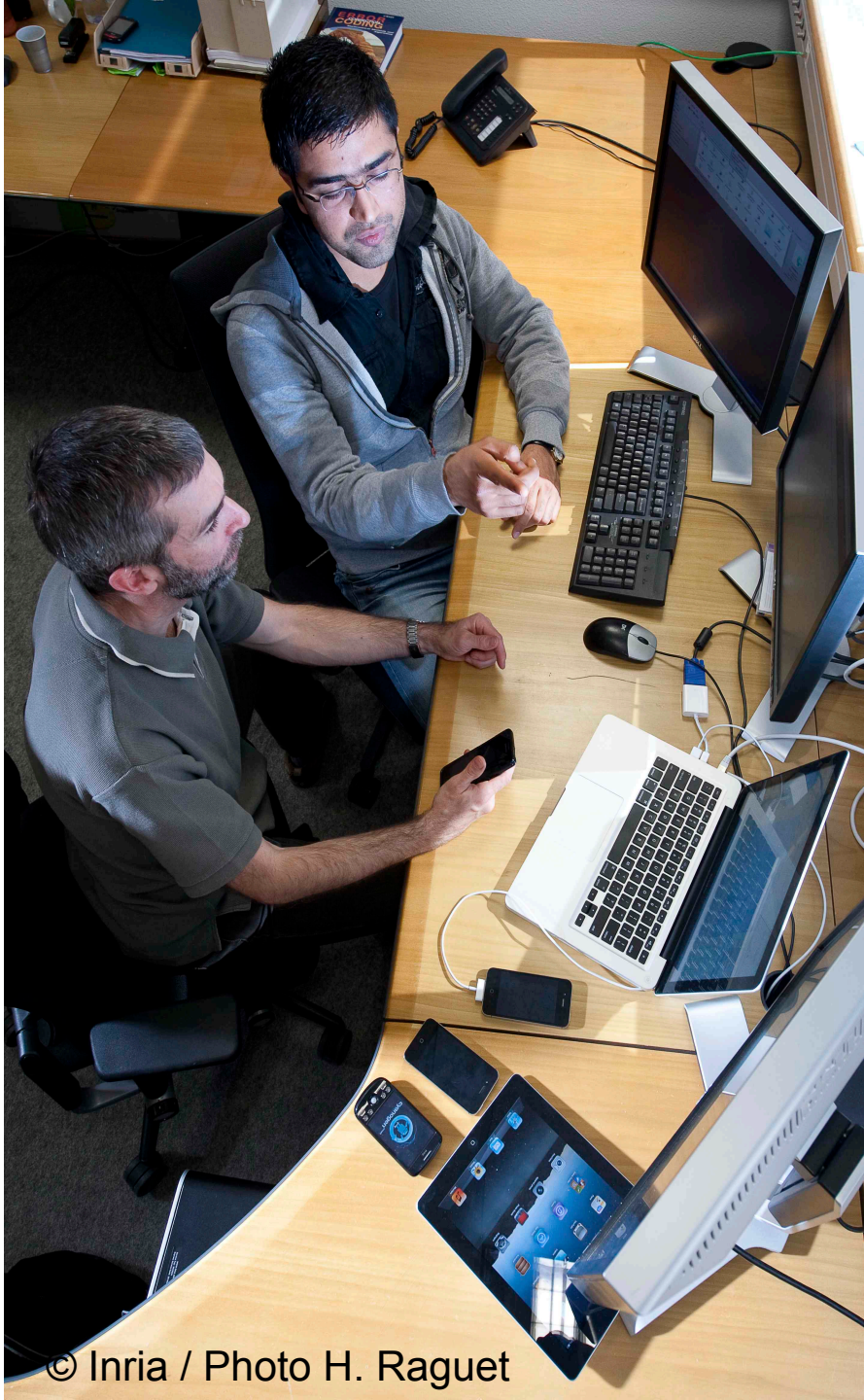
informatiques mathématiques

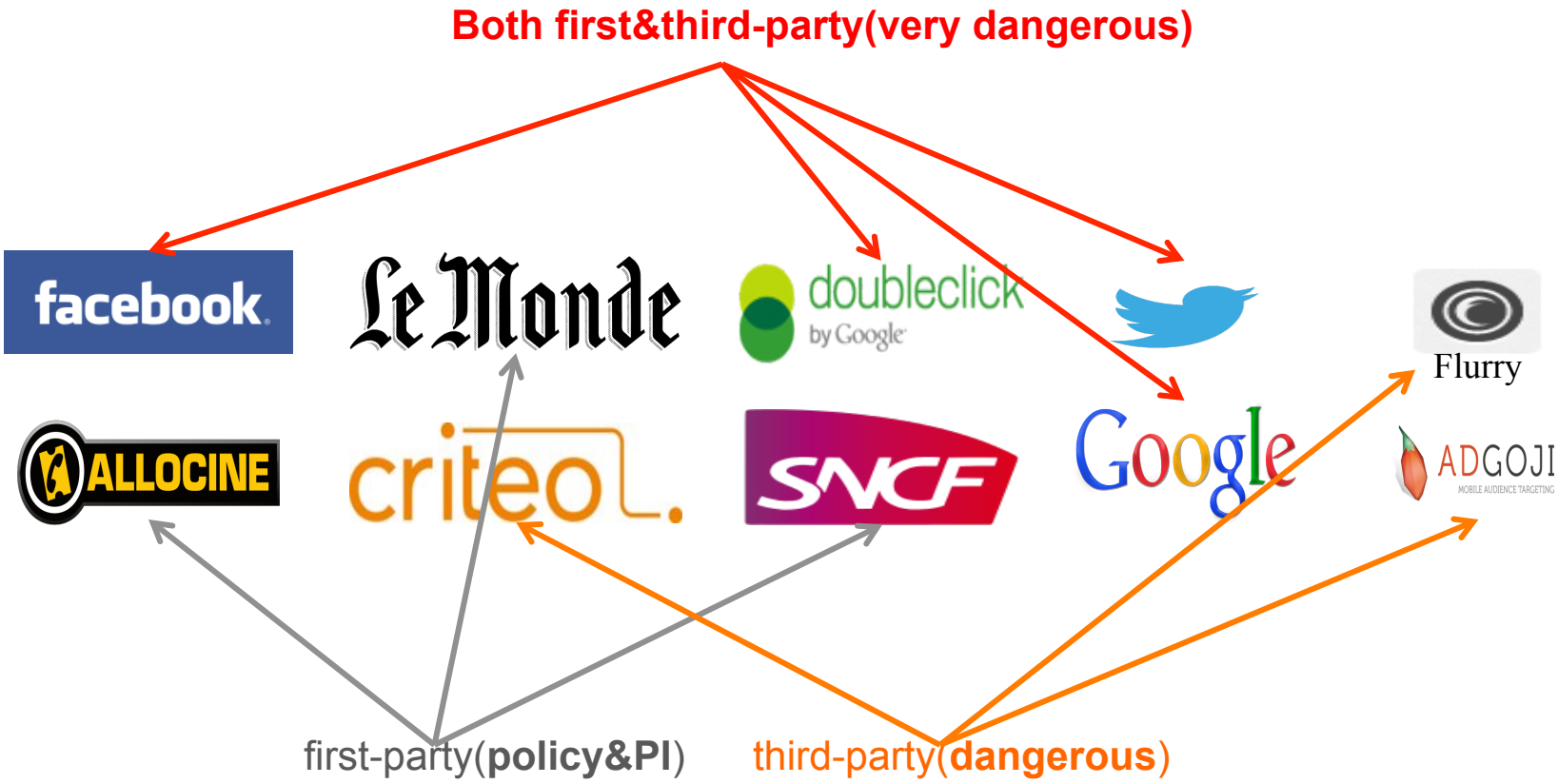
Outline

- ***Motivations***
- “Private Data Leak Detection” methodology and results
- Conclusions



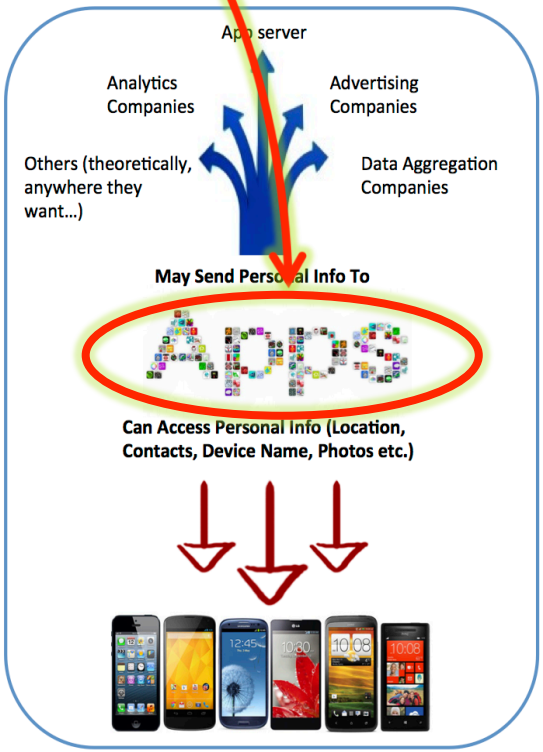
Motivations (1) : The revolutionary arrival of AppStore model of App distribution

- A large number of actors present on the device
  - No more the presence of merely smartphone provider
  - Both first (App server itself) & third-party (trackers, A&A etc.)



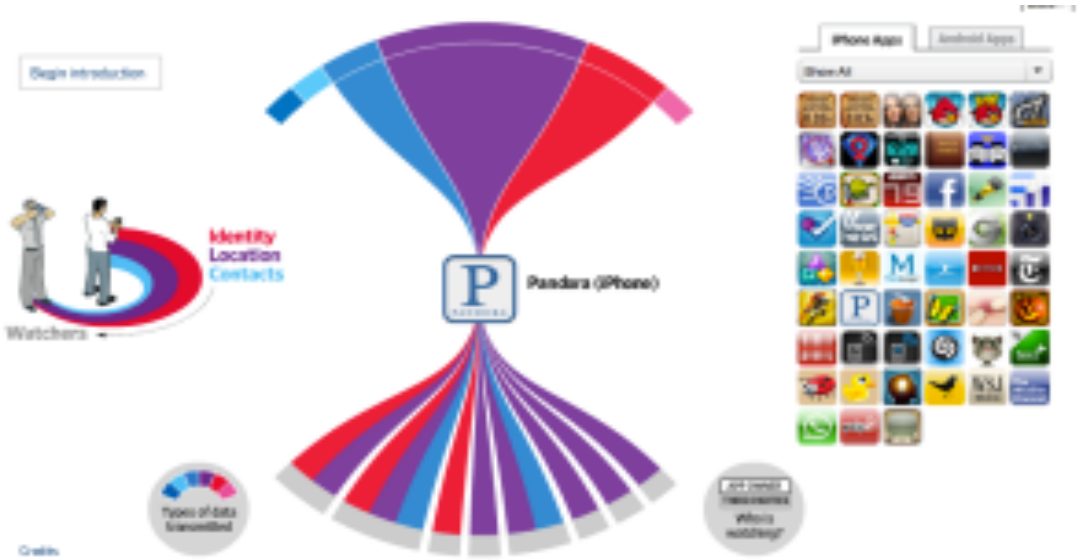
Motivations (2) : The arrival of App stores

- More opportunities for personal information leakage to various parties
  - **Not only limited to web browsers** as is the case in desktops/laptops
  - Apps for dedicated services (FB, LeMonde, SNCF etc.)



Motivations (2)

- Difficult to trust all these parties
  - various scandals in the past
    - **For example, Twitter and Path uploading users all contacts to their servers [1] [2]**
  - WSJ: What they know – Mobile [3]



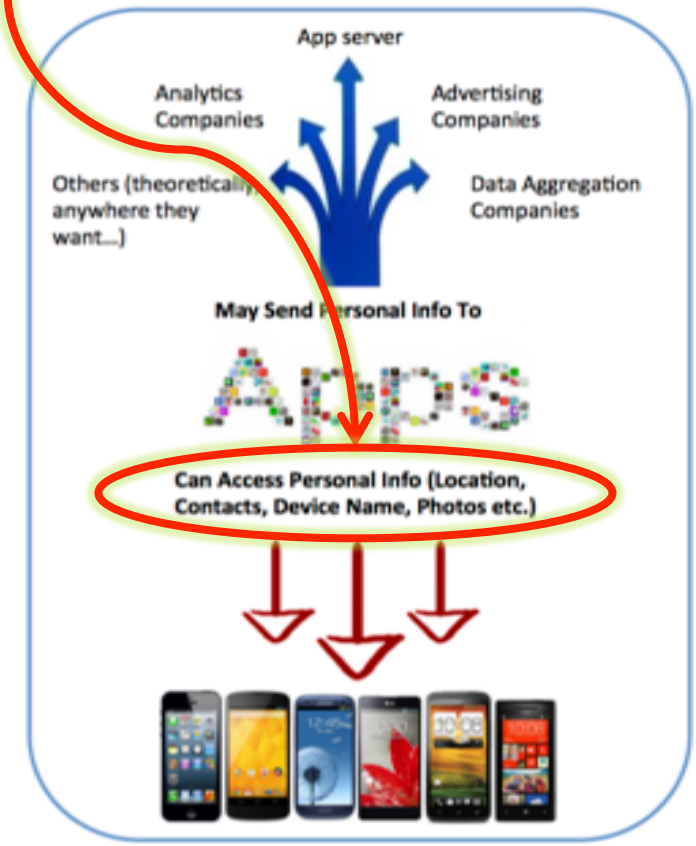
[1] http://mclov.in/2012/02/08/path-uploads-your-entire-address-book-to-their-servers.html

[2] http://www.theregister.co.uk/2012/02/15/twitter_stores_address_books/

[3] http://blogs.wsj.com/wtk-mobile/

Motivations (3)

- Smartphones are well suited to marketers/trackers
  - contain a lot of info on user **interests** and **behaviors**
    - much more than on desktop/laptop
    - because **various sensors** (GPS, Camera etc) and **comm technologies** (WiFi, GSM etc.) generate PI
    - because smartphones are at the **center of our cyber activities**, and **very personal** (it's not shared usually)
    - because smartphones have almost **all-time Internet connectivity**
    - Because they're **barely turned off**



→ leads to accurate and detailed user profiling

Motivations(4)

- A direct consequence is a large presence of online advertisers/trackers

Flurry

and many others…

→→→This requires scrutinizing smartphones for privacy risks

- ***"tracking the trackers"***

Mobilitics project and its goals

- started in January 2012

- focuses on Android and iOS
  - the leading mobile OS

- **Goal**: investigate smartphone Apps and OS for potential privacy risks

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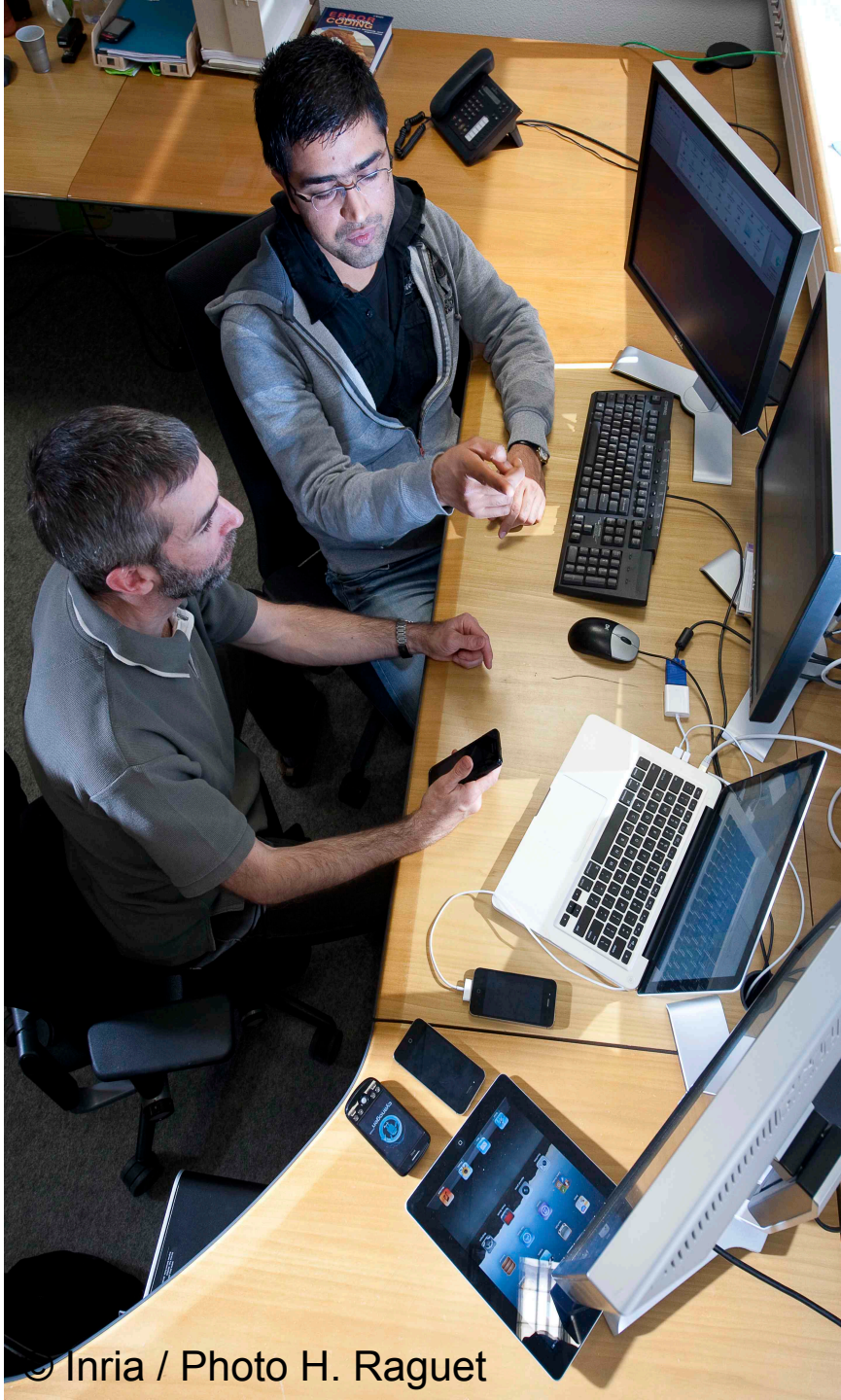


General approach (iOS & Android)

1. Run Apps on instrumented versions of Android and iOS

2. Collect data in a local sqlite database

3. Analyze the data offline for potential private data leakage

iOS (1) : Some background

- Closed source and only code signed from Apple can be executed
  - enforced by secure boot chain
- Instrumenting iOS requires "**Jailbreaking**"
  - essentially a way to bypass Apple's secure boot chain
- Also, no App source available → only binary rewriting is possible

iOS (2) : Some Background

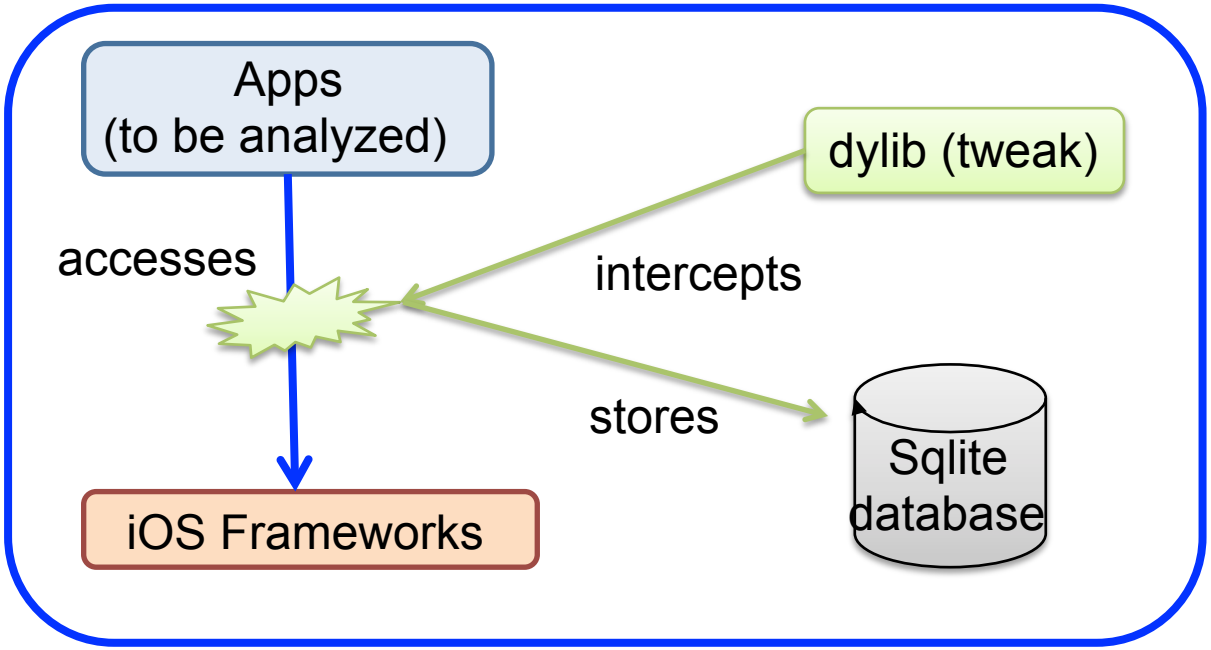
- iOS Apps are written in
  - Objective-C, C, C++

- Private data can only be accessed by Apple defined frameworks written in Objective-C/C/C++

- Enforcement of user privacy by iOS
  1. Apple vetting process when Apps are submitted to AppStore
  2. Users are asked before iOS gives access to PI to an App

iOS (3) : General Idea

- Idea: change the implementation of the APIs responsible for private data access in order to:
  - detect the App accessing the private data
  - collect the data so that it can be searched later if it's transmitted to the network



iOS (4) : But how to do it?

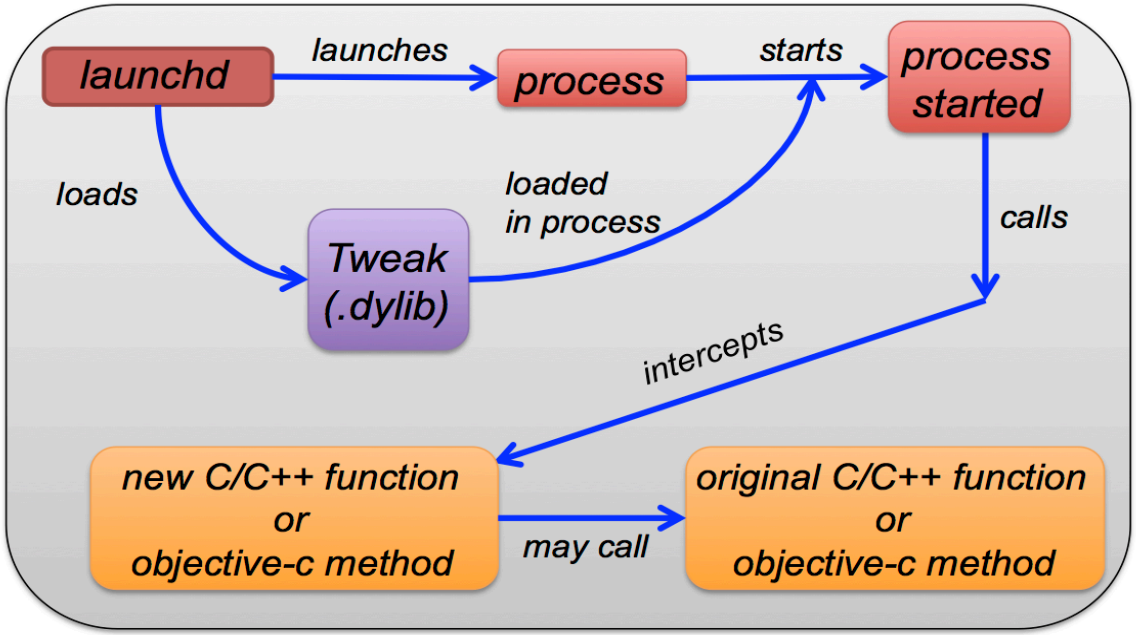
- As source code is not available, binary patching?
  - It's a nightmare, I think!

- Dynamically, at runtime?
  - Fortunately, yes!
    - **Use Objective-C runtime method "method_setImplementation"**
    - **Replace the C/C++ functions at assembly level.**

***NB: we use a third-party framework (MobileSubstrate) which makes it lot simpler… http://iphonedevwiki.net/index.php/MobileSubstrate**

iOS (5) : But how to do it?

- Whole code (modified implementation of the methods) is compiled in a dylib
  - and loaded at launch time in a process of interest



iOS (6) : But how to do it?

- We capture relevant info (method args, return values) and store it in a local sqlite DB

- In order to confirm privacy leaks
  - We also need to dump whole network data
    - **follows the same technique (method/function interception)**
    - **done at BSD Socket level to ensure no App can bypass it**

iOS (7) : Post Analysis of data collected

1. Identify **private data accessed** by Apps

2. Search for private data in the **network traffic** to see if it's sent, and where

3. Search for private data in the input to **cryptographic / hash functions**, and if there's some, search the output in the **network traffic**

4. Find out if Apps use **cross-App tracking** techniques by using the "UIPasteBoard" class

iOS (8) : Limitations

- Are private data manipulations (hash, encryption etc.) done with custom functions…
  - …rather than using standard iOS API?
  - if yes, we cannot detect it as we don't know what to search in the network traffic ☹
  - For example, a simple XOR with a static key is sufficient

→ a **fundamental limitation** of our approach

- hard to evaluate if this is current practice or not
- But this means…results obtained using our technique would be **lower-bound**

iOS (9) : Tests and results

- We chose 78 representative free iOS Apps
  - Goal is to be representative of the main App categories
  - Same set of Apps would be tested on Android (chosen Apps are available on both platoforms): to have a behavioral comparision

Table 1: No. of Apps accessing, modifying and sending Private Information out of a total of 78 Apps tested

Private Information (PI)	Total No. of Apps accessing PI	Total No. of Apps sending unmodified PI	Total No. of Apps modifying PI	Total No. of Apps sending modified PI
UDID	17	0	0	0
Accounts	2	0	0	0
AdIdentifier	36	26	18	0
Location	12	4	0	0
IdentifierForVendor	25	3	11	0
DeviceName	11	2	0	0
AddressBook	2	2	0	0
ProcessNames	NA	4	0	0
Carrier Network	NA	6	2	0
WiFiMACAddress	NA	6	47	17
BluetoothMACAddress	NA	0	17	0
SerialNumber	NA	0	17	0

iOS (10) : Trackers disguise device tracking

- 59% Apps bypass the official iOS6 “AdvertisingID”
  - should not be the case
  - the AdID is supposed to let the end-user control tracking by resetting it as desired…
  - … it’s just an illusion ☹
- 37% Apps will still bypass the AdID with future iOS7 that bans the access to MAC address
  - this % will increase as more companies will shift to other types of permanent identifiers for tracking

Android (1) : Overview of methodology

- We benefit from the open-source nature of Android for instrumentation
  - Change the Android source code itself
- Same technics as with iOS:
  - Add all events captured in a local sqlite database
  - Dump the network data at BSD Socket level
  - Dump the encryption/hash data
  - Perform post-analysis
- Still in progress…

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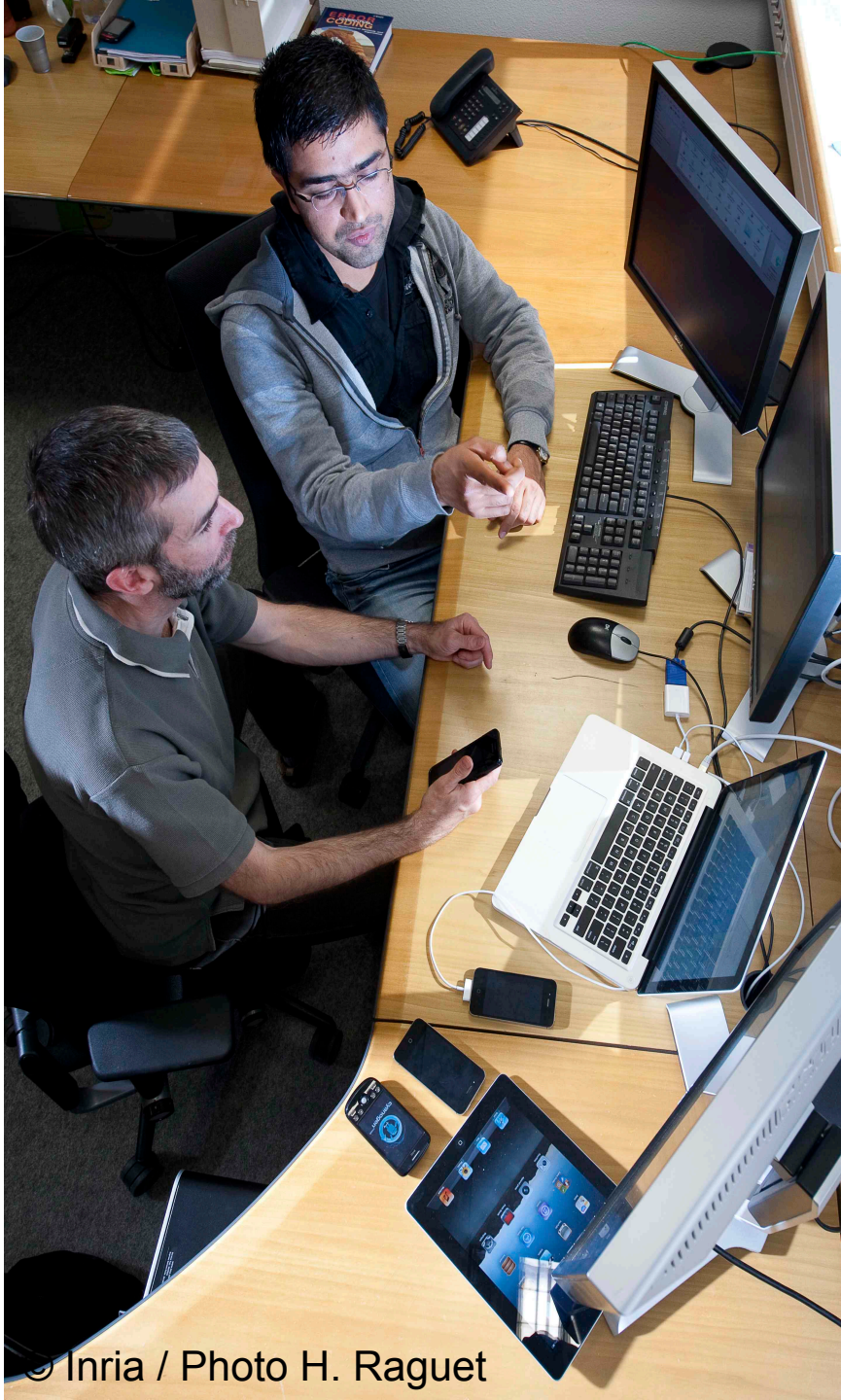


Conclusions and remarks

- Trackers disguise device tracking
  - 59% Apps are employing techniques they are not supposed to, in order to track users
  - makes iOS6 “AdvertisingID” almost useless
  - little progress in future iOS7
  - **Apple can’t ignore this trend**
- Private data is sent to various parties
  - As shown in the Table before
- Live experiment to be conducted at CNIL with various users

Improvements to make (version 2)

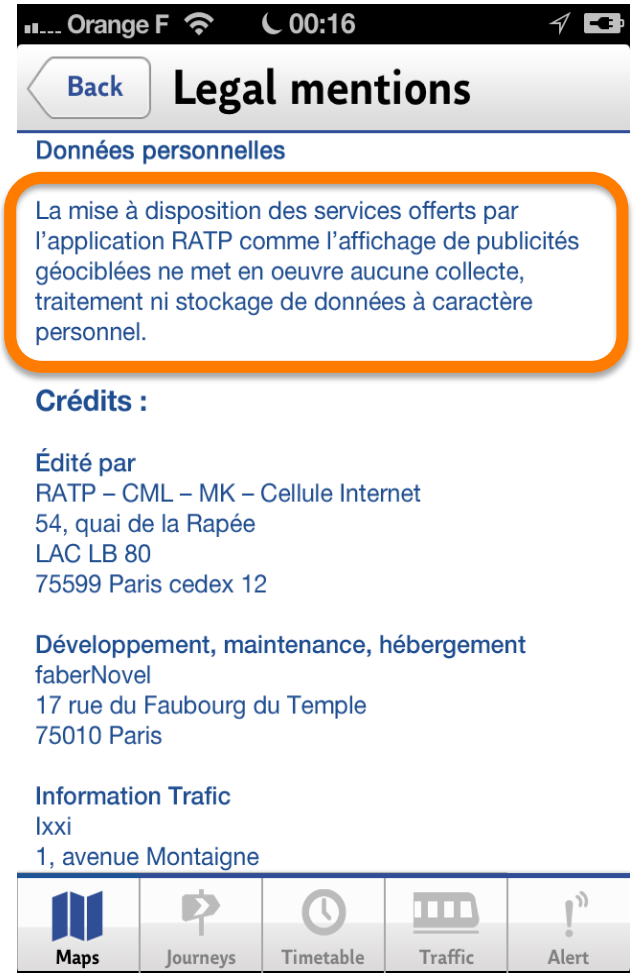
- We still need to **distinguish between first and third-party** (would require manual interception to some extent?)

- Increase the number of Apps being tested (with **paid Apps too** this time to verify if some difference exist wrt. privacy)

- Some known glitches to be fixed (access to serial number, bluetooth MAC Address etc.)

Last but not least: Don't believe naively what you read…

- The RATP App, v5.4.1
  - "We don't collect any personal information"
- Really?
  - "list of active Apps, MAC address, device name, position (20m accuracy), permanent ID"
  - sent to Adgoji (SSL) or Sofialis (cleartext)
- See our blog: : part-1 et part-2



Questions/Remarks?

Thanks