Privacy concerns with everyday technologies
Case study of Android phones and wireless cameras

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- L'impact sur la vie privée est souvent négligé
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  - Nombre d'appareils en pleine croissance
  - Nombre de virus en croissance également
  - Contient d'en plus en plus de données personnelles
  - Qu'en est-il de la localisation d'un appareil ?
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Part I

State of the art

Phone

- Téléphone portable technologie qu'on a pratiquement toujours sur soit et allumé
- Il existe plusieurs façon de localiser un utilisateur de téléphone
- Depuis le téléphone
  - Triangulation via les antennes de GSM
  - GPS présent dans quasi tous les smartphones, maintenant même dans les appareils photos
  - Wifi (cf Google, voir partie android)
  - Malware installé sur l'appareil, cas Flexispy ou Carrier IQ
- L'opérateur ou un extérieur
  - Données RAW dans les trâmes captées par les opérateurs permettent de connaitre la puissance du signal reçu, antennes...
  - SMS furtif envoyé par les autorités
  - Norme 112/911 qui oblige à pourvoir localiser n'importe qui à n'importe quel moment avec une précision relative -¿ problème du mode d'appel d'urgence sans déverouiller la carte SIM
- Scandale avec les iPhones traceurs
  - Présentation des découvertes
  - Pas rentrer dans la technique, laissée pour partie 2 section 1.2.1

RFID

- Présent dans plus en plus de produits
- Parfois toujours actif quand plus utile (sortie de magasin)
- Distance de lecture variable (*cf recherches faites pour lecture à plus longue distance*)
- Si réseau comme carte d'accès UCL était corrompu, pourrait localiser qui va où et quand (*pas fiable à 100%, rentre à plusieurs en même temps, portes pas toujours fermées*)

Wifi

- Cas Wifi UCL
  - Couvre toute la ville de LLN
  - Avec smartphone se connecte d'en plus en plus (3G encore cher)
  - Peut savoir où les étudiants se trouvent
  - Exemple étudiant prétent ne pas venir à un TP car malade, prof peut vérifier si était connecté à un wifi quelque part en ville
- Cas FON
  - Partout en Belgique depuis l'accord avec Belgacom
  - Peut connaitre les déplacements dans les villes

Part II

Android

Introduction

- Pourquoi s'intéresser à Android ?
  - Aujourd'hui OS majoritaire sur smartphone
  - Vente smartphones >ventes pc en 2012
  - Entends d'en plus en plus des problèmes de virus
  - Confie énormément d'info à un smartphone
  - Fait moins attention à ce qu'on fait sur un smartphone qu'un pc
  - Ce qui est valable sur Android est principalement valable pour iOS & co
- La localisation est un aspect souvent négligé
  - Gens pensent *quel est le problème si mon jeu sait où je me trouve quand j'y joue ?*
  - Si arrive à tracer en temps réel les déplacements de l'utilisateur, plus inquiétant.
  - Les gens ne se rendent pas compte ce dont est capable une application.
  - A créé une application pour montrer cela, DroidWatcher
- choisi de se concentrer sur l'aspect applications, pas étudié l'aspect forensic
- court lexique (root, ROM...)

Chapter 1

Localization using Android

Introduction

The localization of the user is a key function of Android. Many applications use this function, as a feature of the application or as a service for the developer. It allows, for example, to directly show the part of the map where the user is on Google Maps, to display advertisements for nearby shops, to automatically select the relevant area for the weather forecast, to give statistical information regarding the using of an application in a particular country.

The details of the localization methods used by the Android system are often unknown or unclear. There exists several techniques to locate a device: using the GPS chip usually present in smartphones or using connection information (cell phone tower or wireless access points). This chapter explains how these techniques work and why they are subject to privacy concerns.

Several facts about the management of the localization have been used in the official declarations or documentations. To verify these assumptions, several experiments have been carried out using an Android 2.3 smartphone. These experiments allow us to have a better understanding of the localization system that mostly works as a black box.

1.1 GPS

1.1.1 GPS signal

The GPS, for Global Positioning System, is a technology based on satellites trilateration [4]. GPS satellites are navigating around the Earth in a way to maximize the number of visible satellites anywhere at any time. There is currently 31 working satellites in orbit. The location-aware device is equipped with a GPS receiver chip. This receiver retrieves broadcasted messages from the reachable satellites. The messages contains :

- the time the message was transmitted
- precise orbital information (the ephemeris)
- the general system health and rough orbits of all GPS satellites (the almanac)

Trilateration is used based on the received messages as shown in Figure 1.1. If, theoretically, three satellites are enough, at least four are required to avoid clock desynchronization errors (at the speed of light, even a small clock error can lead to huge distance gap).

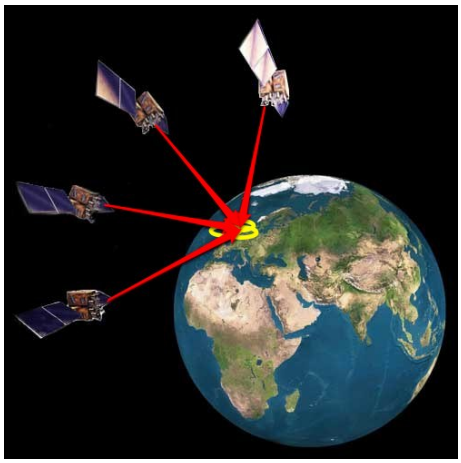

Figure 1.1: Signals from multiple satellites are required to calculate a position
Copyright PocketGPSWorld.com

The accuracy of this method depends on the surrounding of the user. In clear sight, the GPS is accurate to a few meters but it will degrade if the receiver is surrounded by high buildings or inside a dense forest.

The time to first fix (TTFF) depends on the state of the GPS. In a cold start scenario[1], the GPS needs to retrieve the full almanac. This is done in at least 12.5 minutes[5]. To improve the TTFF, embedded GPS often uses assisted-GPS technology (aGPS) by acquiring almanac and ephemeris data over a fast network connection when available.

1.1.2 Degradation

The GPS system was invented by the U.S. Departement of Defense as a military project. As the technology became available to civilians, it was intentionally degraded. To do so, the sattelites used a technology called Selective Availability intended to introduce errors on a GPS signal to decrease its accuracy. The

[1] Device is in factory state or the GPS data are not relevant (several months old or inaccurate)

autorized users (military) could compute the errors and correct them using special recievers and daily cryptographical keys. The Selective Availability was implemented for national security reasons.

In 2000, Bill Clinton ordered to discontinue the usage of the Selective Availability feature on the GPS satellites, allowing each reciever to percieve the most accurate signal possible. In 2007, the new generation of GPS system called *GPS III* was annonced as not capable of producing Selective Availability[3].

1.2 Wireless access point

Each wireless access point has a unique identifier[2]. When the wireless option of the phone is turned on, the device can retrieve the surrounding access points. Assuming the geographical coordinates of all the access points are known, it is possible to estimate the location of the user by trilateration.

The advantage of this method is that for an accuracy of about 100 meters, the localization is faster than using GPS, it works indoors, consumes less battery power than a GPS receiver chip and only one access point is enough to locate a device.

1.2.1 Cache database

To locate a device using the network resources (as opposed to the GPS resources), the system needs an access to a database mapping the geographical coordinates of the requested access points. SkyHook, Apple and Google are three companies well known for using such databases.

SkyHook was one of the first to create a database to locate wireless access points and develop a SDK to query the location of a user . The information is collected by war-driving[3] in North America, Western Europe and some Asian countries[7].

Companies have quickly understood the value of this information and the economical interest of having its own database as a betterment for location aware applications. While Apple was, at first, using SkyHook, it has now developed its own database system. Google is also independent and has created its own database.

As they collect data to improve the accuracy of their location services, these companies recently have been subject to criticism. Users wondered about the usage of this database and how it could to pose a threat to the privacy of users. The privacy aspect of the localization section is analysed in Section 1.4.

[2]BSSID for Basic Service Set IDentification, a unique 48 bits address

[3]Car equipped with a GPS, wireless and cell tower receiver collecting data in the streets

1.2.2 Methods of data collection

In the case of Google, the location server is constructed based on two factors:

- Google Cars
- Crowd-sourcing

The Google Cars are mainly used to take pictures to illustrate the service Google Street View. In addition to that, the cars are also war-driving. Having a GPS module on the car and driving almost all over the world, it was a good opportunity to constitute a very accurate database.

As most Android devices are equipped with a GPS receiver, collecting via crowd-sourcing is also possible. When an Android device uses the Google database to request a location, data are also transmitted to Google servers. This way, the database of wireless access points and cell towers is always up to date[4].

1.2.3 Location cache files

Previous cell tower and access point locations are stored in an unencrypted system files. This allows to locate the user quickly and the device is still able to use the network ressource, even when not connected to the Internet. Each entrie in the cache file is linked with a timestamp representing the date of the retrieval as seen in Figure 1.2.

The recent criticism about privacy concerns is mainly based on the existence of these cache files. If the iOS devices used to have unlimited cache size (fixed in iOS 4.3.3), on an Android device, only the 50 last cells and 200 access points have been observed as stored in the cache files. However, in the course of this research, the observations made based on the analysis of the data collected from several devices have shown that this size is enough to contain locations older than one month. A forensic analysis would allow to retrieve the device location at a given time if a location request was made. Such requests can be run in background by any application having the correct permissions. The DroidWatcher application relays on this fact to monitor the location of the user in background.

To show the ease of retrieving such information, a python script has been developed[1] to parse the content of these two files and produce a GPS trace file in GPX format representing the approximate movement of the device. However, a root access to the phone is required to access these files[5]. This could prevent malicious applications retrieving these data. This cache folder is only created when the *Use wireless networks* option is enabled in the Android settings. However, this option is often required by common applications such as Google Maps which may lead to a large percentage of devices having this option enabled.

[4] Francisco Kattan, feb 2010, `http://franciscokattan.com/2010/02/06/dynamic-cell-id-clever-way-to-block-google-but-will-it-backfire/`

[5] Most of the time, granting a root access requires a system manipulation and voids the warranty.

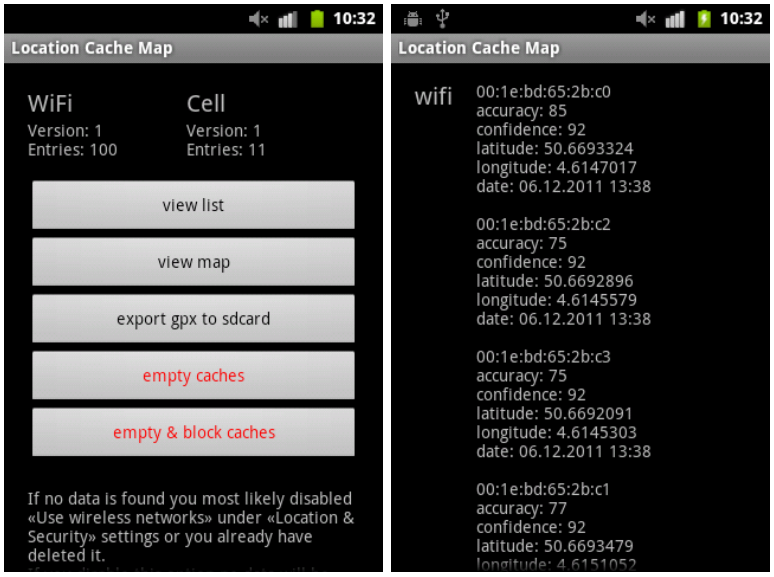

Figure 1.2: Captures from the application Location Cache by Remy Demy

1.3 Cell tower

Similar to the method used with wireless access points, a cell tower can be identified in a unique way. A GSM cell tower is characterized by two factors: a Location Area Code regrouping tens or hundreds of cell towers and a Cell ID identifying a cell tower inside a location area. It is the combination of these two factors that allows a device to identify a unique cell tower. A cellphone can then be located using trilateration based on the surrounding cell towers.

The data collection method and cache management system are very similar to the ones analysed in Section 1.2 and will not be discussed here. The advantage of using cell tower location over the wireless is the fact it allows to locate a device with an approximate accuracy of 1km almost everywhere.

1.4 Privacy concerns

1.4.1 Google Cars

In May 2010, Google admitted to German authorities having collected more than what it was supposed to. In addition to access point's unique identifier, it had "been mistakenly collecting samples of payload data from open networks". These data chunks could include parts of web surf, email, text...[6]. In reaction,

[6]TechEYE, May 2012, `http://news.techeye.net/security/google-admits-it-sniffed-out-peoples-data`

the data collected was asked to be deleted and the CNIL (independent French administrative authority) fined Google with €100.000[7].

1.4.2 _nomap

Some users considered the collected data by the Google Cars and Android devices as private. In November 2011, in reaction to criticism, Google created a way to opt out recording of its access point. The proposition of Google is to end the ESSID of the wireless access point with `_nomap`. The next time it is scanned by a Google Cars or an Android device, the access point is removed from the database. Google hopes than over time, the `_nomap` string will be adopted by other location providers[2].

This proposition was received with much scepticism and did not satisfy the pro-privacy groups. The main complain was the need of an action from the user to explicitly opt out its access point while people wants a way to explicitly opt in instead. Many people that are concerned by privacy issues do not have enough technical knowledge to modify the wireless network name. Furthermore, if this string is not universally adopted by other companies such as Apple or SkyHook, conflicting systems can be imagined, preventing a concerned user to fully opt out its access points from commercial databases.

1.4.3 Research of Samy Kamkar

To reply to privacy concerns, Google ensured "The location information sent to Google servers when users opt in to location services on Android is anonymized and stored in the aggregate and is not tied or traceable to a specific user"[8]. The security researcher Samy Kamkar has also looked at the location requested.

He succeeded to decrypt the request made to Google servers and realized that it contains a unique identifier[6]. The identifier is unique to the cell phone and present in every request. If this string does not directly reveal the identity of the phone owner, it is however possible to tied the string to a specific user and then trace him. He affirms there is no proof the location is anonymized due to the presence of this identifier.

1.5 Personal researches

Several facts about the storage of information and privacy have been announced. To verify these facts, a set of personal researches have been made. The applications used to realize the analyses are present in the appendix.

[7]BBC UK, mar 2011, http://www.bbc.co.uk/news/technology-12809076

To realise the experiments a rooted smartphone using Android 2.3 was used. As most of the location information, including the cache databases files are located in restricted part of the system, the rooting was necessary to explore the whole content of the phone.

1.5.1 Database suppression

Goal

When the option *Use wireless networks* in the system settings is disabled, Google ensured the cache files are deleted. The cache files have been located long ago but the asked question was to know if it was the only place that stored this location information.

Durning this experiment, the content of the device is inspected before and after opting out the option *Use wireless networks* and the two versions are compared to detect the modified or deleted files.

Methodology

1. Make a dump of the internal memory
2. Disable the *Use wireless networks* option
3. Make a dump of the internal memory
4. Compare the two dumps

The dump is done using the script `androdump.py` present in Appendix X which uses the Android Debug Bridge (adb) program connecting the device to a computer. The comparaison is done using the script `compare_dump.py` present in Appendix X which use a hash function on each file present in the dump to detect a modification.

Result

The goal of the comparison was to ensure that only the folder containing the databases is altered and the information is not stored somewhere else. The analysis reveal that, with the exception of some irrelevant system files (battery state...) modified, the database files. The cache data of Google Maps application has been also deleted. This confirms the assumption concerning the deletation of location data.

1.5.2 Impact of location requests

Goal

When a location is requested on an Android device, the system sends an encrypted request to the Google's location servers. The Google's servers reply to the request

with the location of surrounding GSM cell towers and access points.

The goal of the experiment was to detect the impact of a location request. It is known that the surrounding wireless access points and cell towers information is stored in the cache file but other location related information could be stored somewhere else. This experiment inspects the content of the system before and after a localization request is made.

Methodology

1. Make a dump of the internal memory
2. Request the current location
3. Make a dump of the internal memory
4. Compare the two dumps

The location request is made using the `LocateMe` Android application present in Appendix X which does a single location request using the network provider (including GSM cell towers and wifi access points).

Result

The analysis reveals that, with the exception of irrelevant system files, only the database cache files have been modified.

1.5.3 Correlation between size and cache of requests

Goal

As the request is encrypted, its content is unknown. What is known and confirmed in the previous experminents is the fact that the cache files are updated and some wifi and cell towers information are added to these files when a request is made. To guess the content of a location request, it has been tried to determine patterns in the requests form to correlate a request with the content of the cache files.

Methodology

1. Start in *blank state*[8]
2. Start monitoring the traffic
3. Activate the wireless
4. Request the current location
5. Stop monitoring the traffic once a location received

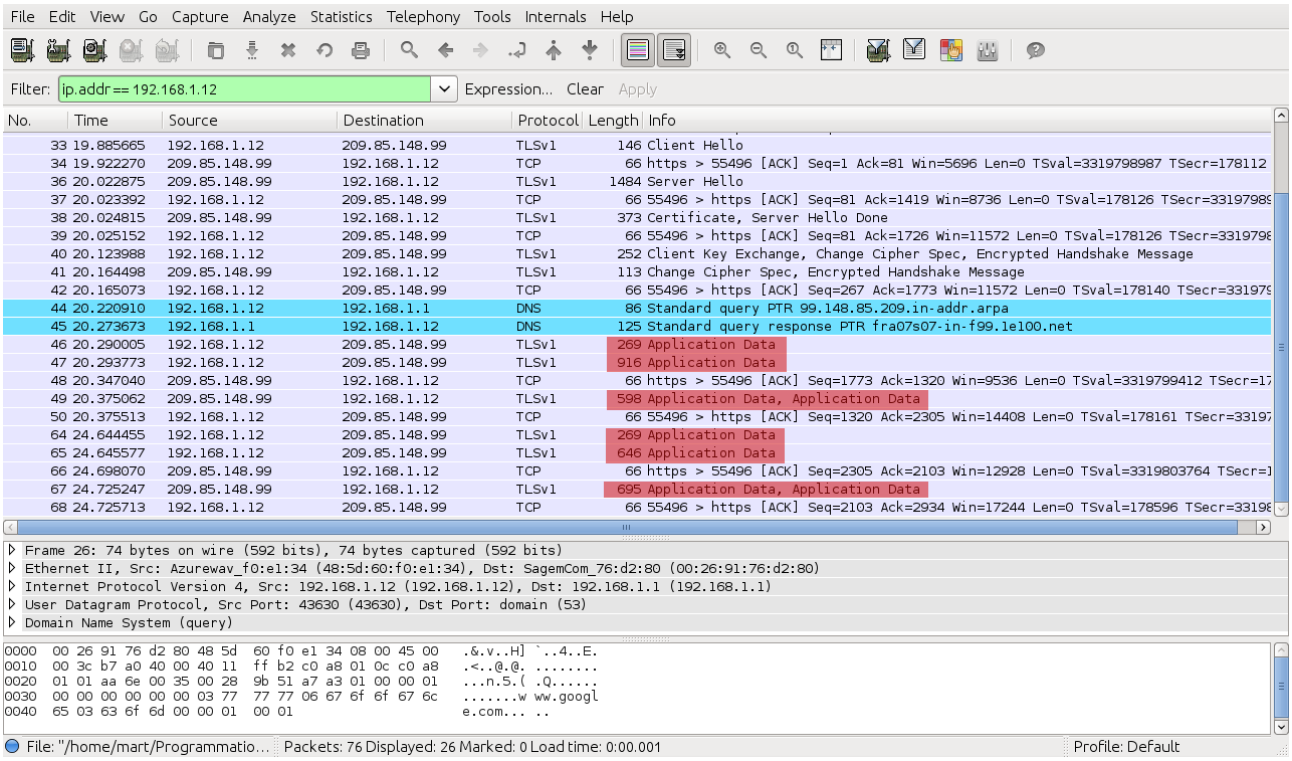

Figure 1.3: Example of tcpdump capture while a location request

The network monitoring has been made with the tool *tcpdump* installed on the Android device.

Result

From the collected trace, the size of the transmitted data was compared with the number of cells and access points added to the cache files. After observation and repeating the experiment, the following pattern was derived :

- Two requests are made, one for the cells, one for the wifi.
- The first packets contains every time 269 bytes.
- The uploaded data size is larger than the downloaded.
- The size of the downloaded data is directly linked to the number of entries in the cache files.

[8] *Blank state* : wireless turned off, empty location cache, location permission turned off, no process requiring the location such as Google Maps running.

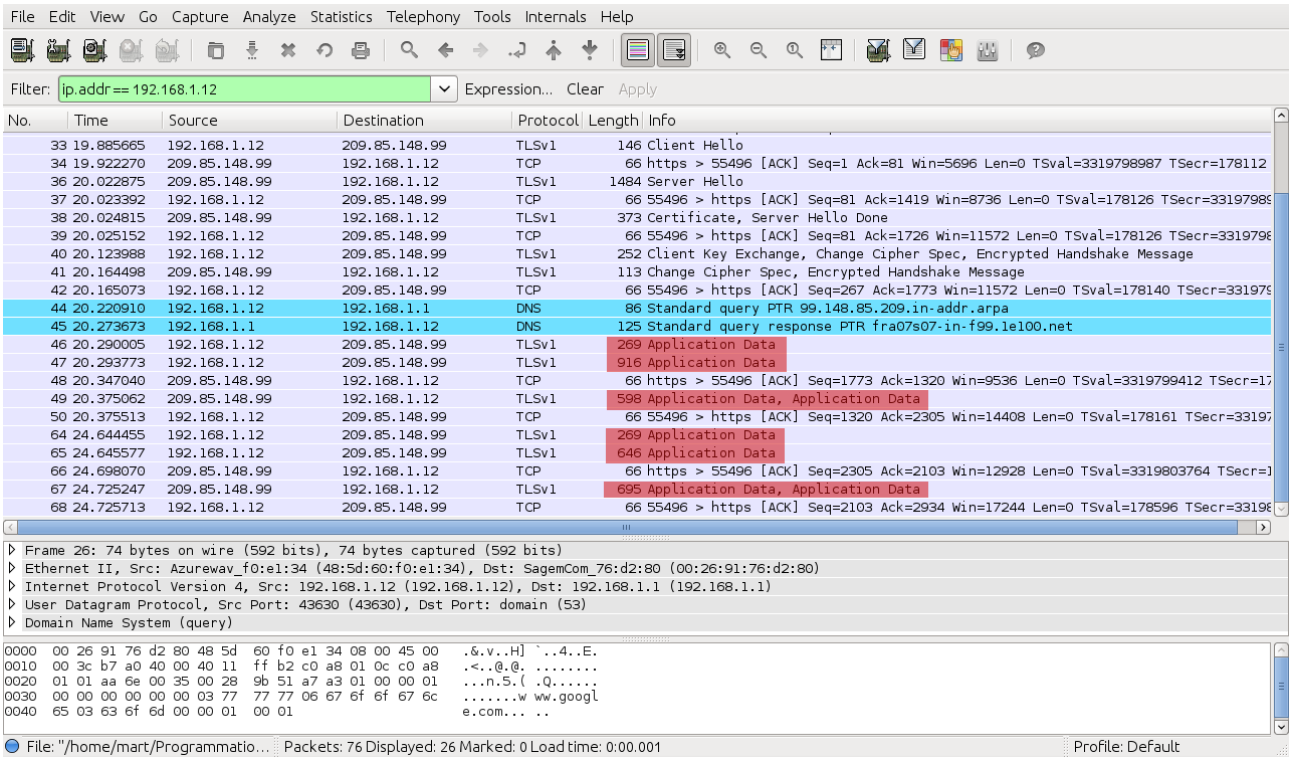

Figure 1.4: Example of tcpdump capture while a location request

Figure 1.4 shows an example of collected trace confirming the derived pattern. The packets number 46 and 64 contain 269 bytes and are the initiating packets of a request for cell towers and wireless access points. The packets number 47 and 65 are the surrounding cell towers and access points uploaded to Google servers. The packets number 49 and 67 are the reply from Google's servers containing the coordinates of the known cell towers and access points. These observations do not allow to validate the suppositions concerning the content of the packet but the patterns are coherent to the model explained before.

1.5.4 Unique identifier

Goal

In Section 1.4.3, Samy Kamkar observed a unique identifier was used in the requests made to Google servers. The presence of this identifier could compromise the privacy of the user as it would allow Google to trace a location requests to a certain user. The purpose of this experiment was to verify this fact.

Methodology

Personal researches showed that this string is contained inside a file `gls.platform.key` next to the cache database. When the option *Use wireless networks* in the Android settings is disabled, the content of the cache location folder (containing the wifi and cell cache files as well as this identifier) is emptied. When the option is enabled, new cache files and unique identifier are create. The content of the identifier file `gls.platform.key` is different to the previous value every time the option is toggled.

Conclusions

The tracability possibility are limited due to this constrain. If it is relatively easy to change this value, we can however imagine that very few users are aware of the existence of this value and will apply this manipulation regulary.

Chapter 2

Security of Android

Introduction

As the number of smartphones is in constant raise, concerns about the security of the system appears. Paradoxically, the users tend to store more and more personal informations on their smartphones and are not aware of the security issues of such devices. Malwares have been discovered on the official applications store and antivirus softwares for Android are now sold. Android runs on top of a Linux kernel which is yet reputed to be virus free.

The aim of this chapter is to explain in detail the current security mechanisms used to protect the users against malicious applications. Using the presented information, a user should be able to reduce his infection risk by adopting simple security principles. The focus of this chapter is the application capabilities and propagation. Different security threads are examined and the risks associated are evaluated. The different procedures from the publication to the installation of an application on a device are particularly examined.

The forensic aspect to retrieve information from a device without the owner consent have not been analysed here.

These clarifications are essentials to understand the limits and possibilities for the developed *DroidWatcher* (see Chapter 3) application to be effective.

2.1 Permissions

For an application to run on the Android operating system and access to critical resources, it should have explicitly been allowed to do so. For a set of defined tasks, a permission should be enabled. These tasks are, for example, accessing the current location of the user, update the address book, use Internet, write to the SD card... At the installation of an application, the permissions necessary are mentioned.

The permission system is designed to control the usage of internal methods and resources of Android. Without a permission, an application can not access to certain resources or methods in the Android system.

2.1.1 Technical details

In Appendix 3.6, the list of available permissions are mentioned. These permissions are defined in the configuration file `AndroidManifest.xml` present in every application. Without the correct permission, an application throws an exception when the method accessing the forbidden resource is launched.

Listing 2.1: Example of permission violation log

```
E/AndroidRuntime( 1274): FATAL EXCEPTION: main
E/AndroidRuntime( 1274): java.lang.RuntimeException:
    Unable to start activity ComponentInfo{com.example.
    gpstest/com.example.gpstest.MainActivity}: java.lang.
    SecurityException: Provider gps requires
    ACCESS_FINE_LOCATION permission
...
E/AndroidRuntime( 1274): Caused by: java.lang.
    SecurityException: Provider gps requires
    ACCESS_FINE_LOCATION permission
...
```

In Listing 2.1, is shown the Android debugger trace of an application requesting the location of the device using the GPS location provider without having requested the `ACCESS_FINE_LOCATION` permission. If the error is not caught properly, the execution of the application is interrupted and the users receives a notification of the crash of the application.

The permission processed is conceived to control the access to an information and not a phone characteristic. For example, the `ACCESS_COARSE_LOCATION` permission is not limited to the usage of the high level `LocationManager` methods but is also required for an application to retrieve the surrounding cell towers informations (as these towers have a unique identifier, this lower level information could also be used to locate the user[1]).

2.1.2 Weaknesses

The way the permission system is implemented does not fully prevent malicious behaviours. The permission description is unclear and can include different purposes. For example, the permission `READ_PHONE_STATE` is required for many actions. It allows an application to be notified when a phone call is processed or when the device is locked, it also gives information about the phone unique identifier and SIM id. This permission is often used to suspend services or simply

[1]This method is used in the DroidWatcher application to estimate the location even when no network connectivity is available

track a device using the unique identifier. The problem is that, in case of a phone call, it also provides the access to methods allowing to retrieve the caller phone number. This is an information leakage that could have been avoided.

Also, it is unclear when and why an application requires a permission at the installation process. Many free applications display advertisements to fund their development. This kind of applications requires the permission to access the internet to download the advertisement content. A malicious gaming application could justify the need for the two permissions `INTERNET` and `WRITE_EXTERNAL_STORAGE` (access the microSD card of the device) for advertising and score storing. Using these permissions, it could upload the full content of the SD card (which may contains personal information from the other applications) to a server. Only a deep analysis such as network monitoring can detect malicious behaviours of an application.

Finally, if a user disagree with the need of a suspicious permission, it has no other choice than not install the application. There is no possibility to partially accept the permissions. Due to this restriction, if they want to use the application, we can assume than most users will accept, whatever the asked permissions are.

2.2 Installation of application

Unlike iOS where the App Store is the only permitted source of applications[2], the Android operating system proposes several ways to install an application.

2.2.1 Play Store

By default[3], the Android Play Store (formerly named Android Market before its merging with Google Music) is the only source of applications. Once a Google account is associated to the user's phone, it can use the application Google Play Store which lists the available applications and install them quickly. Figure 2.1 shows an example of the interface of the application.

The Android Play Store as several features that can be handy for the average user:

- Warning when an update is available
- Control by Google against malicious applications
- User comments and review
- Paid system with Google Checkout

[2]Alternative markets and applications distributions exist on iOS but they require jailbreaking which is not allowed by Apple

[3]The Play Store is available only on official Android devices approved by Google. The Android operating system is open source which allows the port on many devices but the Android Play Store application is closed sources and compatible with only the official Android devices.

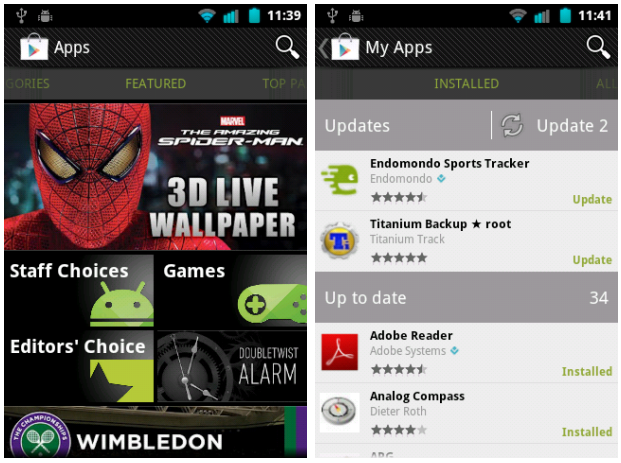

Figure 2.1: Google Play Store interface

On the website `https://play.google.com/store`, the content of the Android Play Store is available from a browser. An important feature of this website is the possibility, once logged with the associated Google account, to select applications to install. The next time the Android device is connected to the internet, it will automatically download and install the selected applications without any user interaction required. A simple notice is displayed on the phone once the application is installed.

2.2.2 Other sources

By default, the possibility to install applications from other sources than the Play Store is disabled. Changing this setting is proposed when a user is trying to install a software from another source for the first time.

.apk file

The *.apk* extension is the convention for installable applications on the Android operating system in the same way as *.deb* or *.rpm* are on Debian and Fedora operating systems.

A user trying to open such files on his device launches the installation process in the same way as if he was using the Android Play Store. The required permissions are displayed and ask for the approval of the user. Figure 2.2 shows the permission screen when a user tries to install the application DroidWatcher. This is the same screen while using either the Google Play Store or installing an *.apk* file.

An apk file is produced after the compilation of a program and is often proposed on small projects or for beta versions. Once an application is installed on the system,

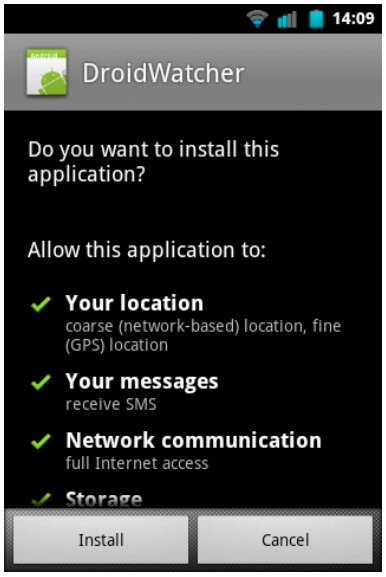

Figure 2.2: Permissions required to install DroidWatcher

the apk file is stored on the system.

Alternative marketplace

In the same way as the Android Play Store, it exists several alternative market places. Alternative market places are a way to download apk files from a centralized interface. It is seen as an alternative to the Google Play Store with the advantages of a centralised distribution medium (paid system, users reviews, moderation...). Manufacturers or service providers sometimes sell smartphones with their own marketplace instead of the Google Play Store.

Debug mode

If the debug mode of an android device is turned on (done in the configuration settings of the device), interaction between a computer and the device is possible. Using the official Android Debug Bridge toolkit[4], an application can be installed in a few seconds from a computer without any notifications or user interactions on the device connected to a computer (connection done typically using a usb cable).

[4]Documentation `https://developer.android.com/tools/help/adb.html`

2.3 Attack schemes

As the multiple installation procedures make the propagation of application easier, it also allows abuses and permit the propagation of malwares. Figure 2.3 presents the different possibilities for a malicious applications to propagate and be installed on a device. The attack types are described in Section 2.4.1.

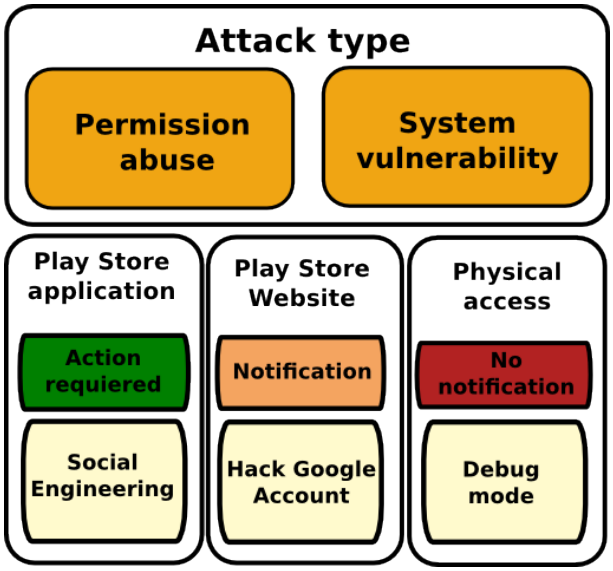

Figure 2.3: Malicious applications propagation possibilities

2.3.1 Play Store publication policy

In comparaison to the Apple iOS system, Google has adopted an open policy of application publication. This strategy choice makes the Android system an easier target in term of malware propagation on the official applications distribution plateform.

To distribute an application on the Android Play Store, the registered developer can upload his application on Google Play servers and make it available in a few hours[5]. There is no control before the publication of an application. The upload of a malicious application would be detected only after its publication which can lead to infected users. In comparaison, when submitting an iOS application, Apple will review the application which can takes several days.

To become a registered developer, the owner of a Google account has only to pay a 25$ fee and no other information than a name and a phone number. In

[5]Official Distribution Control guidelines `https://developer.android.com/distribute/googleplay/about/distribution.html`

comparaison, to become a registered Apple developer, a minimum of 99$/year fee[6] to subscribe to the developer program is required and more personal information such as credit card information for identity verification.

This difference in the verification process and ease to create a developer profile between Google and Apple may lead to the precense of more malicious applications on the Android platerform than on iOS. The presence of an application on the Android Play Store is then, by no means, a guarantee of safety and a user should check carefully before installing any application.

As for the Play Store, alternative market places are as secured as the control of their owners over the applications acceptance process. The *Amazon AppStore*[7] developed by Amazon.com Inc. has an approval process to publish applications similar to Apple regarding iOS applications[8].

2.3.2 Play Store website

In the case of an attacker gaining access to the Google account of an Android user, it could remotely install any application. This would allow the attacker to do almost any kind of actions the device is capable of. It would be possible to monitor the activity of the user or remotely command the phone. A simple notification is displayed at the application installation that can be unoticed or not understood as an infection sign by inexperienced users.

2.3.3 Social engineering

As the developer policy of Google is open by nature, the description of an application published on the Play Store may not describe the real behaviour of an application. Free games or widgets are often attractives and are an ideal target for a malicious application writer that can use social engineering. Pretending another purpose than the actual behaviour of an application leads to its installation willingly from the user.

This attack scheme is relevant for applications on the Play Store or installed using any of the other sources. However, there is frequently a confusion from the users supposing the Play Store is more secure than it actually is. This may lead to reduce the suspicion of the users and makes the attack more effective.

Also, websites have appear on the web proposing applications that are non-free on the Play Store. These applications can be instead a malware or have been manipulated to inject malicious code in the original application. Therefore, applications downloaded on such websites should be considered as are the warrez websites on the Windows operating system: highly risky in term of malware propagation.

[6] According to Apple Developer Programs `https://developer.apple.com/programs/`

[7] Available in the US only at `http://www.amazon.com/appstore`

[8] Approval Process and Content Guidelines `https://developer.amazon.com/help/faq.html#Approval`

2.3.4 Physical access

If a malicious user has a physical acces to a device, it can install an application from a computer using the *adb* utility in debug mode. The micro-USB connectivity is an European standard recommandation for smartphone connectivity. It is then easy to connect any smartphone to a computer with this connectivity. If the debug mode is enabled[9], there is no need to activate the phone which makes the presence of screen lock uneffective.

When a malicious application is installed using this method, no notification is displayed, the only detection possibility is the presence of the application in the installed applications list.

It is adviced to disable the debug mode when not required and

2.4 Malwares

2.4.1 General malware type

There is two main types of Android malwares: abuse of permission or use of security flaws.

The first kind of malware takes advantage of the lack of suspicions from the users and simply ask for permissions permitting a malicious behaviour. This is usually the case for applications sending text messages to overtaxed number or stealing contact information from the address book. This kind of malware tends to be timeless and works as long as the users do not inspect attentively the permission screen whatever the operating system version he is running. As some "honest" applications have a large range of features (that the user may never use), it is common to see such applications asking for many permissions (for example, the official Facebook application requires 19 different permissions[10]). The reasons of the asked permissions is usually not mentioned by the application makers[11].

The usage of security flaws is possible due to the slow update process. The manufacturers tends to provide only a limited number of version updates if any[12]. A device older than a year is usually not maintained anymore. The only solution for users owning such devices is to install alternative ROMs such as CyanogenMod that provides a longer support for a large range of devices. When a security flaw is discovered and a patch published, only a very small percentage of users beneficiate from the patch through an update in the months following the flaw discovered.

[9] The debug mode is required for any interaction between a computer and a smartphone

[10] Discovered by decompiling the downloaded application from the Android Play Store

[11] Counterexample: Firefox browser created a page to explain the reason each permission is used `http://mzl.la/FirefoxPermissions`

[12] Computerworld has computed the percentage of Android phones upgraded to Froyo (released in May 2010) by each manufacturer within 2010 `http://blogs.computerworld.com/17649/android_upgrades`

Malware writers can them wrote programs taking advantage of that flaw.

2.4.2 The DroidDream malware

In spring 2011, a malware named *DroidDream* has widely spread across the Android devices. The particularity of this malware was that he used the official Android Play Store (called Android Market at that time). Refering to Figure 2.3, it is classified as using social engineering to exploit a system vulnerability.

The attackers created several developers accounts and malicious applications (above 50 different applications were detected) on the Play Store. The applications used social engineering by taking the name of popular applications and using modified versions of the application to trick the users into downloading them. The malware used exploits effective until the version 2.2 (99% of the devices at that time[13]) to break the sandboxing mechanism, root the device and install other applications preventing the removal. The malware has been called DroidDream as it was set up to run between 11pm and 8am to act as a botnet. Due to its ability to install other applications, the Kaspersky Lab's analysts suppose it could have been monetized in the future to be used as a botnet for example.

In reaction to the discovery of this malware, Google activated the *kill switch* which deleted the malware from the user devices remotely. It was the first known example of widely spread command-and-control malware on mobile devices. Researchers estimated the number of infected users between 50,000 and 200,000 devices[14]. Variants of this malware called DroidDream Lite have been detected a few months later.

2.4.3 Protection

Observing the large increase of malware applications on the Android platform[15], users and developers wonder about the need of antivirus software. As the antivirus for desktop computers works, these antivirus usually work using a malware database basis. Such software would be efficient on antivirus using flaws and derived in several applications such as the DroidDream malware did. However, on the second kind of malicious applications, the efficiency of the antivirus is mitigated as it is very easy and quick to develop applications abusing from the granted privileges.

The PDroid application[16] takes another approach than the antivirus softwares. Instead of detecting the known malicious applications, it allows the users to redefine

[13] Data collected from `https://developer.android.com/about/dashboards/index.html`

[14] According to the number of time the applications have been downloaded in total

[15] Between 2011 and 2012, the number of Android malware families has increased from 10 to 37 according to F-Secure `http://www.zdnet.com/blog/security/android-malware-families-nearly-quadruple-from-2011-to-2012/12171`

[16] Available on the xda-developers forum at `http://forum.xda-developers.com/showthread.php?t=1357056`

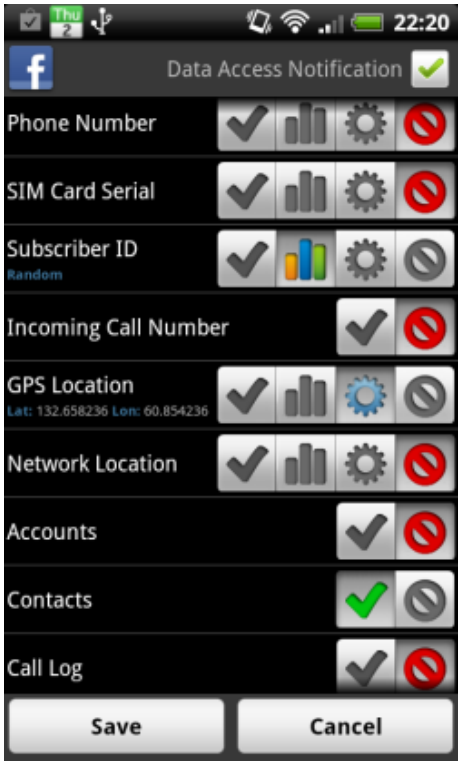

Figure 2.4: PDroid on the Facebook application

the granted permissions and revoking them at wish. Another possibility instead of disallowing the access to certain information is to define a fixed or random value (eg: in the case of geographical coordinates). For each application, a notification can be launched at the time the resource granted by a permission is used. This feature can be useful to detect abuse of permissions. However, as the PDroid application works as a intermediate layer between the operating system and the other applications, the application need the root privileges and the user has to apply a patch on the ROM files. These requirement are most of the time not possible on manufactured phones with closed sources ROM and are reserved to users with good computer knowledge. Although it is not applicable to most Android users, PDroid is a possibility of big improvement on the permission model and we can hope a similar model to be adopted in future versions of Android. Figure 2.4 is an example of usage of the PDroid application capabilities on the Facebook application.

Chapter 3

DroidWatcher

3.1 Presentation

DroidWatcher is an application that requests several permissions including the one to access the user location. Using this permission the application can record the user permission at all time and monitor its movements. The application can be also controlled via text messaging invisibly and sends the recorded location over the internet to a remote server. The application purpose is not to create a malware tracing devices but making the users realising what a device is capable of and how important it is to estimate the risk of malicious behaviour before installing an application. Also having having this application installed could be useful in case of loss or theft of the device.

3.1.1 Monitoring

Every specified time interval (15min by default), DroidWatcher records the location of the device. Depending on what is available, it can use the GPS, wireless or GSM cell location capabilities, keeping the most accurate one. The locations received are stored in a file on the SD card. Once the device is connected to internet, it will sync to a remote server to upload the last recorded coordinates.

All these operations are done automatically and does not require any user interaction. The application keeps recording locations when the user do not use its smartphone. The application starts at phone boot or when unlocked (exception with Android 4.0 or above, see Section 3.3.2).

3.2 Location features

3.2.1 GPS activation

The GPS of a device can be remotely activated (see SMS commands Section 3.4.2). This feature is possible due to a bug discovered in the power control widget[1]. Even if the security flaw has been revealed in April 2010 and a patch released in April 2011, the flaw has been observed as still exploitable on most Android devices running Android 2.3.

3.2.2 Cell triangulation

The native triangulation mechanism using GSM cell towers is inefficient if the device is not connected to the Internet at the time of the location request. To resolve this constraint, the DroidWatcher application monitors the surrounding cell towers identification information and will use this information to compute the location in the future, the next time the device is connected to internet.

An unofficial API to the Google GSM cell tower database has been discovered and is used to retrieve the location of each cell tower. This database has been selected as it is one of the most complete compared to the other free alternatives.

This triangulation mechanism is however known as imprecise as explained in Section 3.3.3 about technical difficulties.

3.3 Technical difficulties

To develop this application, several constrains were met that limited the effect of the application.

3.3.1 Automatic idle

Once going in idle state (once the device is not used by the user for a certain amount of time), the operating system will limit the possibility of the system to save battery. Some applications will be paused in there running process. The effectiveness of the localisation process done by DroidWatcher is affected by this idle purpose.

This is the case, for example, of the GPS that needs to constantly update of the position. The GPS will sometime stop monitoring the position of the user if it can not get a fix[2] on the location of the user. This effect is independent of the application but the direct consequence of the system behaviour for battery saving. This issue is often a complain related to the tracking application (eg: sport monitoring application). A solution is avoid the phone to going to idle state by

[1] Issue 7890 `https://code.google.com/p/android/issues/detail?id=7890`

[2] See Section 1.1 for the information needed to get a GPS fix

keeping it in awake state. However, this solution is not used in DroidWatcher as it would have greatly compromised the battery usage of the phone and consequently the effectiveness of the application in monitoring the location the longest and most discrete way as possible.

3.3.2 Android 4.0

As the author of this thesis owns only a device with the Android version 2.3. At the time of development, end 2011, the fourth version[3] of Android was just released and very few devices were capable of running it. Consequently the testing has been done mainly on devices running the second version of the operating system[4].

An unexpected change introduced in the 4.0 version of Android is the way a device manage the start of an application in background. DroidWatcher has been conceived to be started when a device is booting or waked from idle. This feature participated in the aim to be fully discrete and that the application was not noticeable without analysis. With Android 4.0, an application can no longer start during the boot or after having been woken up if the interface has not been launched a first time.

To fix this problem, an interface screen has been developed. This screen allows the user to see location information and basic configuration.

This change is certainly an improvement in the security of a device as the need for a graphical interface will strongly reduce the possibility of malicious *invisible* application to run. However malicious applications often use a fake interface (weather forecast, game...) to hide the malicious behaviour of the software and this protection will therefore not affect these applications.

3.3.3 Cell tower triangulation

To compute the location of the user, a triangulation algorithm has been developed. This algorithm is however known as imprecise for several reason. To compute the location, the algorithm uses the signal strength of captured GSM cell towers nearby. The signal strength is a very fluctuating variable. At a same distance to a cell tower, the signal varies if the device is inside or outside a building or if monitored by two different devices with different GSM receiver. The main imprecision comes from the fact that all cell tower do not emit signal at the same signal strength (rural areas are usually covered with less cell towers emitting using higher signal strengths.

As efficient computation of the signal strength would have required long monitoring and observation on a large number of devices and areas. The computation and weighting of the variables has been done based on personal observations. This

[3]The third version of the operating system was limited to tablet devices and not phones limiting greatly the propagation of this version of the system.

[4]The third version of Android was available only for tablets and not smartphones

is known as imprecise but achieves the purpose to be able to record a reasonable approximation of the location at any time when GSM connectivity is available.

3.4 User manual

3.4.1 Interface

For configuration ease and to solve the restriction appearing on Android 4.0 as explained in Section 3.3.2, a configuration interface has been created. This interface allows to see the last location computed and the date of the last synchronisation to the remote server. The option are also given to specify a specific data collection URL and choose if the phone will or not reply to SMS commands.

3.4.2 SMS commands

The application can be controlled through SMS commands sent to the phones running the application. The messages are intercepted before arriving to the message application. If the message contains a pre-defined code, the phone will execute an action in consequence.

- The messages are not case sensitive.
- The match should be exact (no extra character).
- The application does not record the content of messages, the messages not containing the code will not be affected.

`BIGBRO` : starting code for a command.

- `LOCME` : reply with the last recorded location
- `GPSON` : turn the GPS on
- `WIFION` : turn the wireless on
- `SETSERVER[new_server_url]` : set the url of the server, default `http://watcher.dotzero.me/collect`

Examples of correct messages:

- BIGBROGPSON
- bigbroSetServerhttp://watcher.dotzer.me/collect
- Ping

Examples of incorrect messages

- BIGBRO GPSON
- Ping!

To easily test if the application is running, the message `PING` can be send, the targeted cell phone replies with message containing `PONG`.

Turning on the GPS is done by exploiting a bug in some Android roms. It was reported as working on v2 Android ROM and CyonengMod 7.

3.5 FAQ

3.5.1 What data is collected by the application ?

- Estimated location and time of the recording
- Google username
- IMSI (International Mobile Subscriber Identity)
- Phone number (if written in the SIM card, usually not)

The Google username is collected to easily differentiate the users while the IMSI and phone number are to ensure the uniqueness. Note that the IMSI and phone number do not require any permission and that any application can collect it.

3.5.2 What is collected by the application ?

- Estimated location and time of the recording
- Google username
- IMSI (International Mobile Subscriber Identity)
- Phone number[5]

The Google username is collected to easily differentiate the users while the IMSI and phone number are to ensure the uniqueness. Note that the IMSI and phone number do not require any permission and that any application can collect it.

3.5.3 When run the application ?

The application start at the phone boots and when the user unlock its phone. Except if using Android 4.0 or above, killing the process will only stop it until the next time the phone is unlocked. Uninstalling the application `DroidWatcher` will fully remove it.

[5] Only if written in the SIM card, depends on the phone provider.

3.5.4 What is stored on the phone ?

The last collected cell towers and last locations are collected in the file `.log.obj` at the root of the SD card. You can remove this file safely.

3.5.5 Who is able to see the recorded location ?

To ensure privacy, only the owner of the server is able to see the collected location.

3.6 Installation of the web application

To watch the collected information, the DroidWatcher collecting website can be installed on your own web server. The server use the python framework Django 1.3[6]. The following steps explain the deployment of the application on a Debian Lenny server running Apache and mod-wsgi. The full configuration and security of the apache server is considered as out of the scoop of these explanations.

1. Download the latest version of Django
   ```
   $ wget http://www.djangoproject.com/download/1.3.1/tarball/ -O
   django.tar.gz
   ```
2. Extract and install
   ```
   $ tar -xzvf django.tar.gz
   $ cd Django-1.3.1
   $ sudo python setup.py install
   ```
3. Extract and deploy the DroidWatcher Django application from the DroidWatcher package
   ```
   $ tar -xzvf watcher.tar.gz
   $ sudo mv watcher /var/www/watcher
   ```
4. Change the ownership to the apache user
   ```
   $ sudo chown -R www-data:www-data /var/www/watcher
   ```
5. Update the apache configuration file (probably `/etc/apache2/sites-enabled/000-default`) and add

   ```
   <VirtualHost *:80>
                ServerName SERVERURL
                Alias /static/ /var/www/watcher/static/
                <Directory /var/www/watcher/static>
                Order deny,allow
                Allow from all
                </Directory>
                WSGIScriptAlias / /var/www/watcher/apache/django.wsgi
   </VirtualHost>
   ```

[6] Available at `https://www.djangoproject.com/`

6. Update eventually the django setting in `watcher/settings.py` files if you want to configure your email or have changed the location of the application folder.

7. Generate the database. In the application folder, execute
   `$ python manage.py syncdb`
   and choose an admin password.

8. Restart the apache module
   `$ sudo service apache2 restart`

9. Access the received location by going to `http://SERVERURL/admin` to log in and them access to the recorded location at `http://SERVERURL/`

Appendix

List of permissions

String	ACCESS_CHECKIN_PROPERTIES	Allows read/write access to the "properties" table in the checkin database, to change values that get uploaded.
String	ACCESS_COARSE_LOCATION	Allows an application to access coarse (e.g., Cell-ID, WiFi) location
String	ACCESS_FINE_LOCATION	Allows an application to access fine (e.g., GPS) location
String	ACCESS_LOCATION_EXTRA_COMMANDS	Allows an application to access extra location provider commands
String	ACCESS_MOCK_LOCATION	Allows an application to create mock location providers for testing
String	ACCESS_NETWORK_STATE	Allows applications to access information about networks
String	ACCESS_SURFACE_FLINGER	Allows an application to use SurfaceFlinger's low level features
String	ACCESS_WIFI_STATE	Allows applications to access information about Wi-Fi networks
String	ACCOUNT_MANAGER	Allows applications to call into AccountAuthenticators.
String	AUTHENTICATE_ACCOUNTS	Allows an application to act as an AccountAuthenticator for the AccountManager
String	BATTERY_STATS	Allows an application to collect battery statistics
String	BIND_APPWIDGET	Allows an application to tell the AppWidget service which application can access AppWidget's data.
String	BIND_DEVICE_ADMIN	Must be required by device administration receiver, to ensure that only the system can interact with it.
String	BIND_INPUT_METHOD	Must be required by an InputMethodService, to ensure that only the system can bind to it.
String	BIND_REMOTEVIEWS	Must be required by a RemoteViewsService, to ensure that only the system can bind to it.
String	BIND_WALLPAPER	Must be required by a WallpaperService, to ensure that only the system can bind to it.
String	BLUETOOTH	Allows applications to connect to paired bluetooth devices
String	BLUETOOTH_ADMIN	Allows applications to discover and pair bluetooth devices
String	BRICK	Required to be able to disable the device (very dangerous!).
String	BROADCAST_PACKAGE_REMOVED	Allows an application to broadcast a notification that an application package has been removed.
String	BROADCAST_SMS	Allows an application to broadcast an SMS receipt notification
String	BROADCAST_STICKY	Allows an application to broadcast sticky intents.

String	BROADCAST_WAP_PUSH	Allows an application to broadcast a WAP PUSH receipt notification
String	CALL_PHONE	Allows an application to initiate a phone call without going through the Dialer user interface for the user to confirm the call being placed.
String	CALL_PRIVILEGED	Allows an application to call any phone number, including emergency numbers, without going through the Dialer user interface for the user to confirm the call being placed.
String	CAMERA	Required to be able to access the camera device.
String	CHANGE_COMPONENT_ENABLED_STATE	Allows an application to change whether an application component (other than its own) is enabled or not.
String	CHANGE_CONFIGURATION	Allows an application to modify the current configuration, such as locale.
String	CHANGE_NETWORK_STATE	Allows applications to change network connectivity state
String	CHANGE_WIFI_MULTICAST_STATE	Allows applications to enter Wi-Fi Multicast mode
String	CHANGE_WIFI_STATE	Allows applications to change Wi-Fi connectivity state
String	CLEAR_APP_CACHE	Allows an application to clear the caches of all installed applications on the device.
String	CLEAR_APP_USER_DATA	Allows an application to clear user data
String	CONTROL_LOCATION_UPDATES	Allows enabling/disabling location update notifications from the radio.
String	DELETE_CACHE_FILES	Allows an application to delete cache files.
String	DELETE_PACKAGES	Allows an application to delete packages.
String	DEVICE_POWER	Allows low-level access to power management
String	DIAGNOSTIC	Allows applications to RW to diagnostic resources.
String	DISABLE_KEYGUARD	Allows applications to disable the keyguard
String	DUMP	Allows an application to retrieve state dump information from system services.
String	EXPAND_STATUS_BAR	Allows an application to expand or collapse the status bar.
String	FACTORY_TEST	Run as a manufacturer test application, running as the root user.
String	FLASHLIGHT	Allows access to the flashlight
String	FORCE_BACK	Allows an application to force a BACK operation on whatever is the top activity.
String	GET_ACCOUNTS	Allows access to the list of accounts in the Accounts Service
String	GET_PACKAGE_SIZE	Allows an application to find out the space used by any package.

String	GET_TASKS	Allows an application to get information about the currently or recently running tasks: a thumbnail representation of the tasks, what activities are running in it, etc.
String	GLOBAL_SEARCH	This permission can be used on content providers to allow the global search system to access their data.
String	HARDWARE_TEST	Allows access to hardware peripherals.
String	INJECT_EVENTS	Allows an application to inject user events (keys, touch, trackball) into the event stream and deliver them to ANY window.
String	INSTALL_LOCATION_PROVIDER	Allows an application to install a location provider into the Location Manager
String	INSTALL_PACKAGES	Allows an application to install packages.
String	INTERNAL_SYSTEM_WINDOW	Allows an application to open windows that are for use by parts of the system user interface.
String	INTERNET	Allows applications to open network sockets.
String	KILL_BACKGROUND_PROCESSES	Allows an application to call killBackgroundProcesses(String).
String	MANAGE_ACCOUNTS	Allows an application to manage the list of accounts in the AccountManager
String	MANAGE_APP_TOKENS	Allows an application to manage (create, destroy, Z-order) application tokens in the window manager.
String	MASTER_CLEAR	
String	MODIFY_AUDIO_SETTINGS	Allows an application to modify global audio settings
String	MODIFY_PHONE_STATE	Allows modification of the telephony state - power on, mmi, etc.
String	MOUNT_FORMAT_FILESYSTEMS	Allows formatting file systems for removable storage.
String	MOUNT_UNMOUNT_FILESYSTEMS	Allows mounting and unmounting file systems for removable storage.
String	NFC	Allows applications to perform I/O operations over NFC
String	PERSISTENT_ACTIVITY	This constant is deprecated. This functionality will be removed in the future; please do not use. Allow an application to make its activities persistent.
String	PROCESS_OUTGOING_CALLS	Allows an application to monitor, modify, or abort outgoing calls.
String	READ_CALENDAR	Allows an application to read the user's calendar data.
String	READ_CONTACTS	Allows an application to read the user's contacts data.
String	READ_FRAME_BUFFER	Allows an application to take screen shots and more generally get access to the frame buffer data
String	READ_HISTORY_BOOKMARKS	Allows an application to read (but not write) the user's browsing history and bookmarks.

String	READ_INPUT_STATE	Allows an application to retrieve the current state of keys and switches.
String	READ_LOGS	Allows an application to read the low-level system log files.
String	READ_PHONE_STATE	Allows read only access to phone state.
String	READ_SMS	Allows an application to read SMS messages.
String	READ_SYNC_SETTINGS	Allows applications to read the sync settings
String	READ_SYNC_STATS	Allows applications to read the sync stats
String	REBOOT	Required to be able to reboot the device.
String	RECEIVE_BOOT_COMPLETED	Allows an application to receive the ACTION_BOOT_COMPLETED that is broadcast after the system finishes booting.
String	RECEIVE_MMS	Allows an application to monitor incoming MMS messages, to record or perform processing on them.
String	RECEIVE_SMS	Allows an application to monitor incoming SMS messages, to record or perform processing on them.
String	RECEIVE_WAP_PUSH	Allows an application to monitor incoming WAP push messages.
String	RECORD_AUDIO	Allows an application to record audio
String	REORDER_TASKS	Allows an application to change the Z-order of tasks
String	RESTART_PACKAGES	This constant is deprecated. The restartPackage(String) API is no longer supported.
String	SEND_SMS	Allows an application to send SMS messages.
String	SET_ACTIVITY_WATCHER	Allows an application to watch and control how activities are started globally in the system.
String	SET_ALARM	Allows an application to broadcast an Intent to set an alarm for the user.
String	SET_ALWAYS_FINISH	Allows an application to control whether activities are immediately finished when put in the background.
String	SET_ANIMATION_SCALE	Modify the global animation scaling factor.
String	SET_DEBUG_APP	Configure an application for debugging.
String	SET_ORIENTATION	Allows low-level access to setting the orientation (actually rotation) of the screen.
String	SET_POINTER_SPEED	Allows low-level access to setting the pointer speed.
String	SET_PREFERRED_APPLICATIONS	This constant is deprecated. No longer useful, see addPackageToPreferred(String) for details.
String	SET_PROCESS_LIMIT	Allows an application to set the maximum number of (not needed) application processes that can be running.
String	SET_TIME	Allows applications to set the system time
String	SET_TIME_ZONE	Allows applications to set the system time zone
String	SET_WALLPAPER	Allows applications to set the wallpaper
String	SET_WALLPAPER_HINTS	Allows applications to set the wallpaper hints

String	SIGNAL_PERSISTENT_PROCESSES	Allow an application to request that a signal be sent to all persistent processes
String	STATUS_BAR	Allows an application to open, close, or disable the status bar and its icons.
String	SUBSCRIBED_FEEDS_READ	Allows an application to allow access the subscribed feeds ContentProvider.
String	SUBSCRIBED_FEEDS_WRITE	
String	SYSTEM_ALERT_WINDOW	Allows an application to open windows using the type TYPE_SYSTEM_ALERT, shown on top of all other applications.
String	UPDATE_DEVICE_STATS	Allows an application to update device statistics.
String	USE_CREDENTIALS	Allows an application to request authtokens from the AccountManager
String	USE_SIP	Allows an application to use SIP service
String	VIBRATE	Allows access to the vibrator
String	WAKE_LOCK	Allows using PowerManager WakeLocks to keep processor from sleeping or screen from dimming
String	WRITE_APN_SETTINGS	Allows applications to write the apn settings
String	WRITE_CALENDAR	Allows an application to write (but not read) the user's calendar data.
String	WRITE_CONTACTS	Allows an application to write (but not read) the user's contacts data.
String	WRITE_EXTERNAL_STORAGE	Allows an application to write to external storage
String	WRITE_GSERVICES	Allows an application to modify the Google service map.
String	WRITE_HISTORY_BOOKMARKS	Allows an application to write (but not read) the user's browsing history and bookmarks.
String	WRITE_SECURE_SETTINGS	Allows an application to read or write the secure system settings.
String	WRITE_SETTINGS	Allows an application to read or write the system settings.
String	WRITE_SMS	Allows an application to write SMS messages.
String	WRITE_SYNC_SETTINGS	Allows applications to write the sync settings

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