Short Paper: WifiLeaks: Underestimated Privacy Implications of the ACCESS_WIFI_STATE Android Permission

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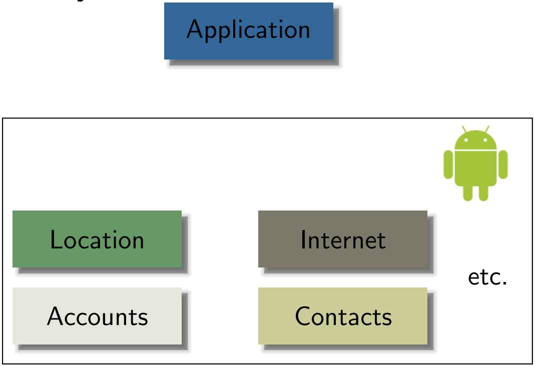
July 25th, 2014

Android Permission System



Application

Location

Internet

Accounts

Contacts

etc.

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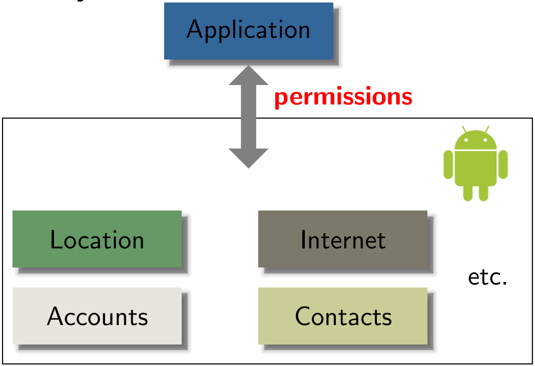

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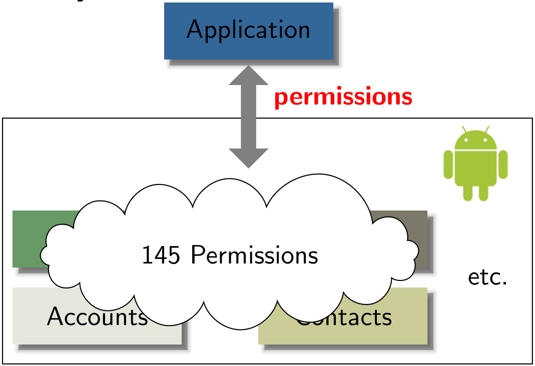

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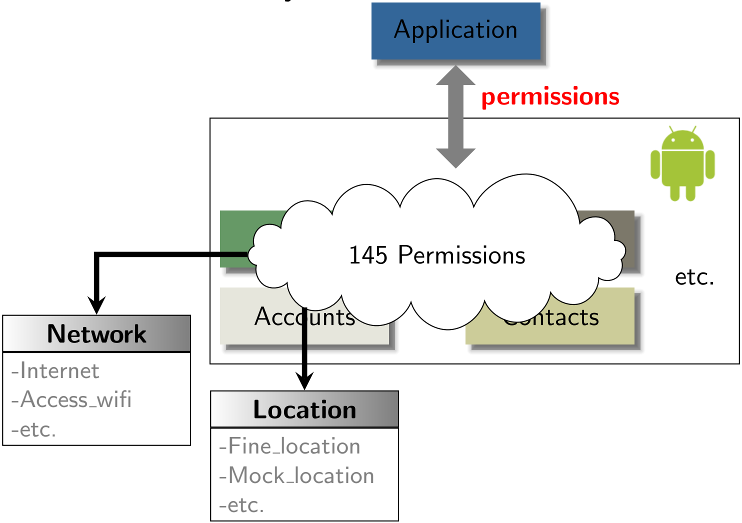

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-Access_wifi
-etc.

Location

-Fine_location
-Mock_location
-etc.

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(Nature-based classification)

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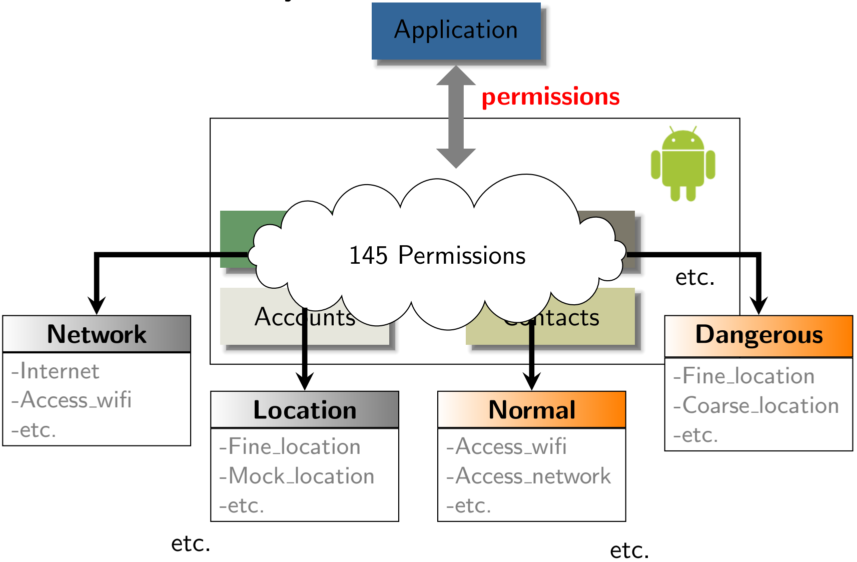

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Network

-Internet
-Access_wifi
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Location

-Fine_location
-Mock_location
-etc.

Normal

-Access_wifi
-Access_network
-etc.

Dangerous

-Fine_location
-Coarse_location
-etc.

etc.

etc.

(Nature-based classification) **(Protection level-based classification)**

Effectiveness of Android Permission System

- Poor understanding [Felt et. al. SOUPS'12]
- Private Information retrieval without any permission [Zhou et. al. CCS'13]
    - Privatae Information: Geolocation, Identity etc.

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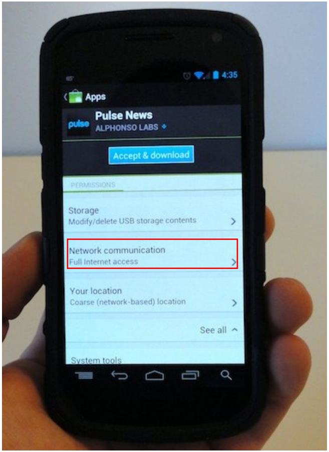

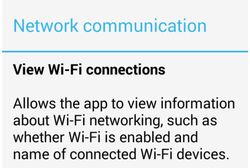

Network communication

View Wi-Fi connections

Allows the app to view information about Wi-Fi networking, such as whether Wi-Fi is enabled and name of connected Wi-Fi devices.

Permission description displayed to users

- Required to access raw Wi-Fi data
- Group [2]: ‘Network’
- Protection level [1]: ‘Normal’

Looks innocuous at first glance!

[1] http://developer.android.com/reference/android/Manifest.permission_group.html
[2] http://developer.android.com/guide/topics/manifest/permission-element.html

The case of ACCESS_WIFI_STATE permission (2)

In fact, it looks innocuous but it is not!

It is known that:

- **Raw Wi-Fi data**: A source of sensitive information
  1. **Surrounding Wi-Fi APs** → Approximate user location
  2. **Wi-Fi MAC address** → A unique device identifier
  3. **Configured Wi-Fi APs** → Travel history and Social links [1]
  4. **Connected Wi-Fi APs and time** → Points of interests

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Motivation/Goals

As this permission seems exploitable, two questions raised:

1. Do users understand the implications of this permission?
   - i.e., what is the user perception of this permission?

2. Is this permission already being exploited by Apps?
   - i.e., what is the current situation on Google PlayStore?

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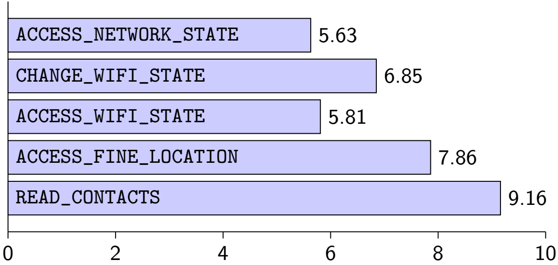
Survey Description

- A total of 156 users answered
- Diffused through social media and mailing-lists
- Composed of 12 questions divided into 3 parts:
  1. Demographic info
  2. User attitude towards privacy and his experience on Android
  3. User perception of the ACCESS_WIFI_STATE permission

A digest of Survey Results



1. Less risky than other permissions (like **Geoloc**)!
2. Privacy implications (geolocation, travel history) are not well understood
    - Less than half know about geolocalization!
    - Less than half know about device unique identifier!
    - Only 35% know about previously visited locations!

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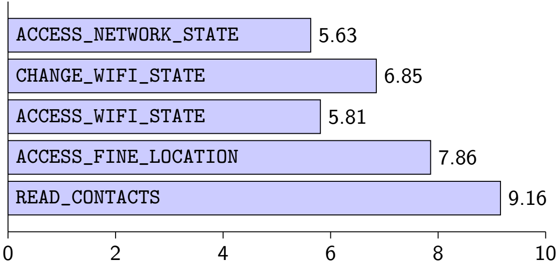

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Application Analysis: Overview

First Step: Permission analysis through crawling [1]:

- # of Apps: 2700 Apps (100 * 27 categories)
- Results: 41% Apps request ACCESS_WIFI_STATE

Second Step: 998 APKs requesting this permission are downloaded for:

1. Static analysis
2. Dynamic analysis (only 88 Apps are chosen based on static analysis results)

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Static Analysis: Technique

- Custom tool (on top of Androguard [1])
- Analysis: Methods of WifiManager class [2]
- 3 privacy-sensitive methods:
  1. getScanResults(): List of surrounding Wi-Fi APs
  2. getConnectionInfo(): Connected AP Info + Wi-Fi MAC
  3. getConfiguredNetworks(): SSIDs of previously connected APs

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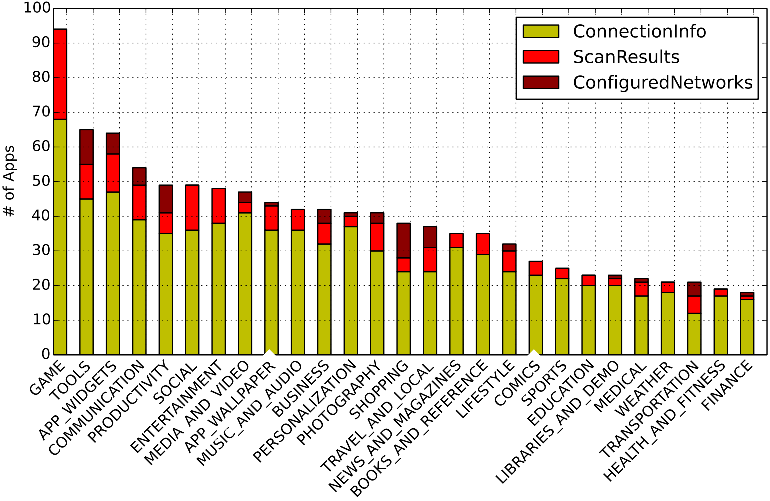

App category wise distribution

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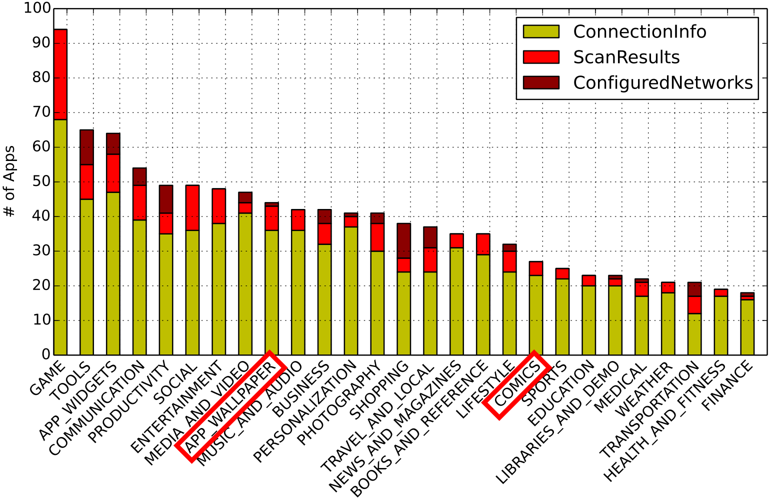

App category wise distribution

Static Analysis: Results

ConnectionInfo		ScanResults		ConfiguredNetworks	
Third-party	**# Apps**	**Third-party**	**# Apps**	**Third-party**	**# Apps**
inmobi.com	74	inmobi.com	9	google.com	10
chartboost.com	55	domob.cn	9	mobiletag.com	4
tapjoy.com	49	mologiq.com	6	lechucksoftware.com	2
vungle.com	47	tencent.com	5	android.com	2
jirbo.com	43	skyhookwireless.com	4	Unibail.com	1

Top 5 third-parties accessing various methods

Notions adopted:

- First-party: App developer,
  Third-party: Included libraries
- class_package_name != main_package_name ⟹ third_party

Dynamic Analysis: Technique

- Modification of Android OS to log interesting events...
- The modification includes methods from:
  1. WiFiManager and WifiInfo class
  2. Network stack (clear-text or ssl)
  3. Data modification APIs (hashes and encryption)
- Logged events are further analyzed automatically

Dynamic Analysis: Results

Info	Third-parties	First-parties
MAC Address	appsflyer.com (SSL), revmob.com (SSL), adsmogo.mobi (plain-text), adsmogo.org (plain-text), vungle.com (plain-text), supersonicads.com (plain-text), trademob.net (SSL), sponsorpay.com (SSL), beintoo.com (SSL), adsmogo.com (plain-text), 115.182.31.2/3/4 (plain-text)[7], tapjoyads.com (SSL)	Not found
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What if I turn off my location to all Apps? ⟹ Out of luck!

Potential Solution

❶ Protection of Wi-Fi scan results with location permissions

- It is currently the case with neighboring cell towers

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1. Protection of Wi-Fi scan results with location permissions
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2. Change of protection level: From 'Normal' to 'Dangerous'
3. Modification of Permission description
   - Proposal for Improvement: *"Allows the app to view information about Wi-Fi networking. MAC address can be used for user tracking and the list of configured Wi-Fi APs may reveal travel history."*

Conclusion

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Solution exists!

Thanks for your attention!

Questions?