

A Field Study of Run-Time Location Access Disclosures on Android Smartphones

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Why Run-Time Location Access Disclosures on Smartphones?

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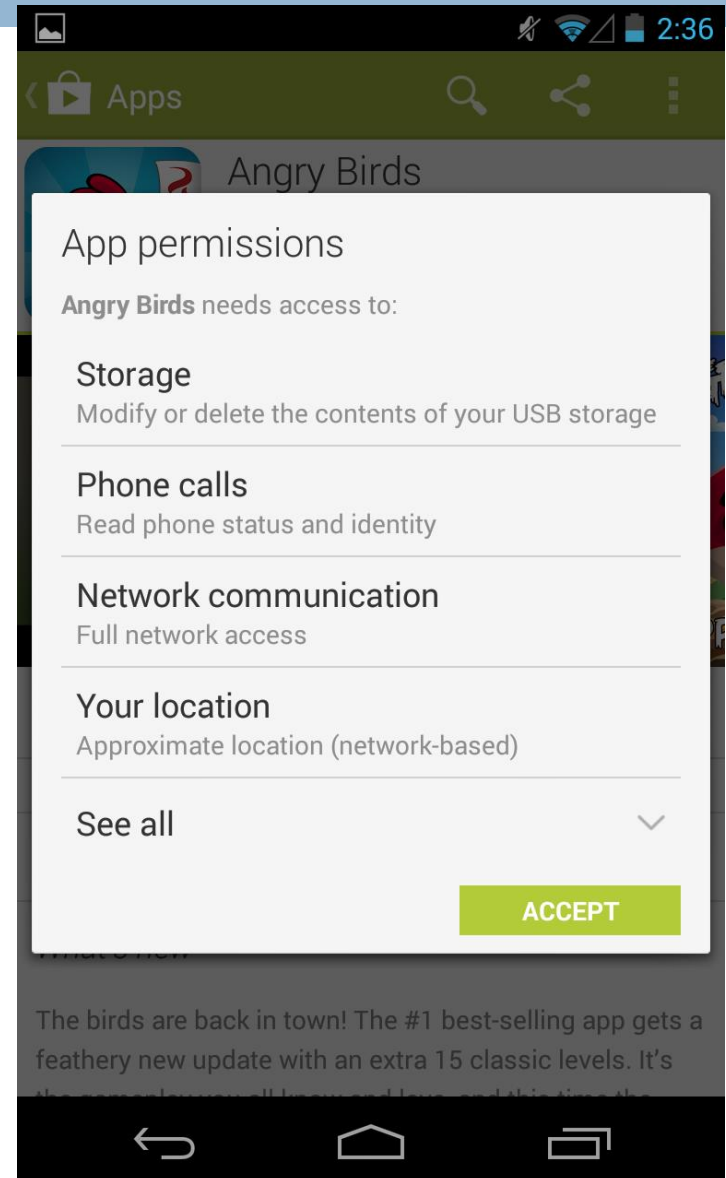
- Large amount of users use Android phones (**76 million Android users** in US)
- **74% smartphone users** use location-based services
- Users are interested to know about their location usage by apps
 - Previous technical report showed that more than 70% of participants (n=791) desired to know about location data collection by apps on mobile devices (Balebako 2013)
- **Feedback** is one of the two **principles in privacy design** (Bellotti 1993) and **immediate notifications** was **effective** to inform users about location request for contextual instant messaging (Hsieh 2007)

Existing Location Access Disclosures

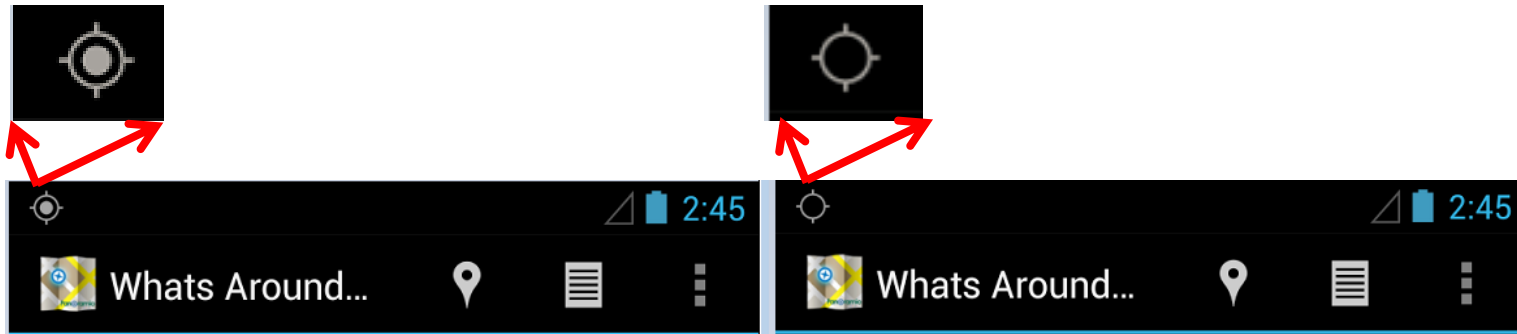
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- Android permissions at installation time

- Permissions are **not effective**
 - Users ignore the permission list
 - Users do not understand the permissions

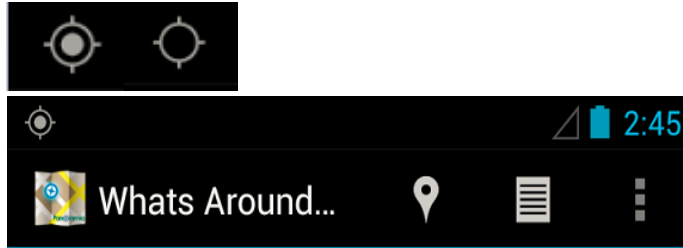


- Android GPS icon flashing at run-time
 - When the app is trying to update location using GPS, the GPS icon flashes on the upper left corner



- Effectiveness? **Unknown**

- What is the **effectiveness** of Android GPS icon flashing at run-time?

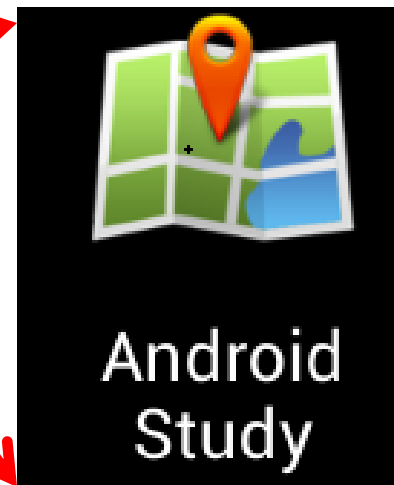
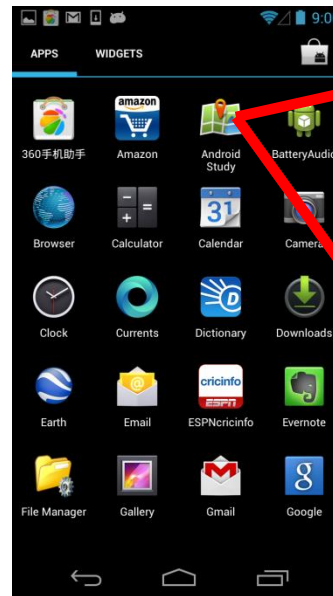


- What **better** run-time location access **disclosure** methods should be?
- What are **users' reactions** if they were notified of their apps accessing location **in daily life**? We note that these apps are used of their own choice on their own phones.

Solutions: User Level Study App

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- User level study app can be installed on participants' phones without any changes
 - Detect apps' location access at run-time
 - No changes to participants' phones



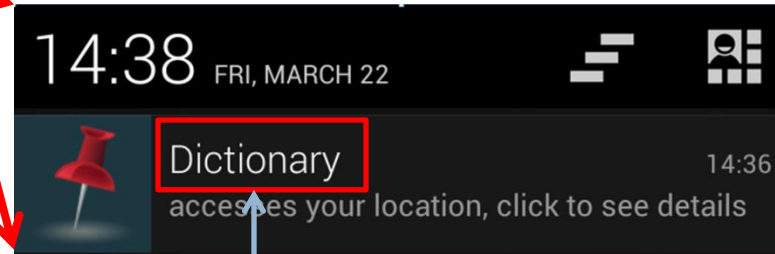
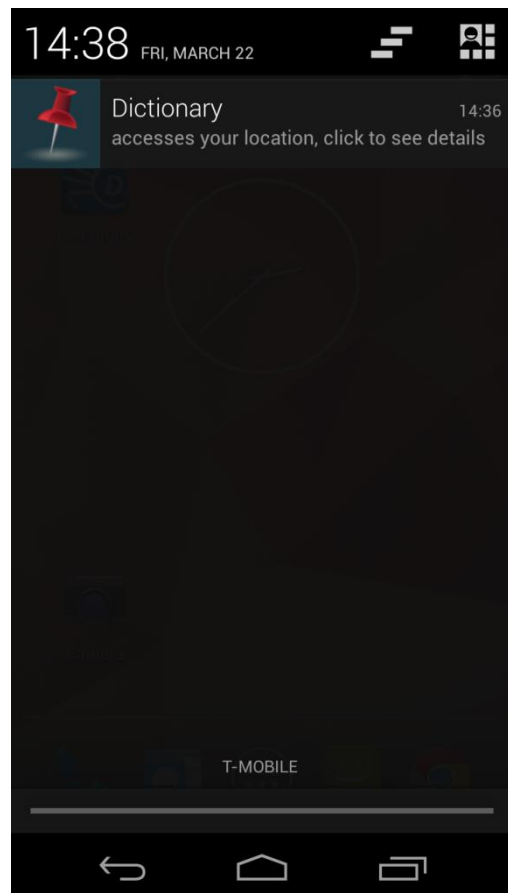
Study App's Disclosure Features

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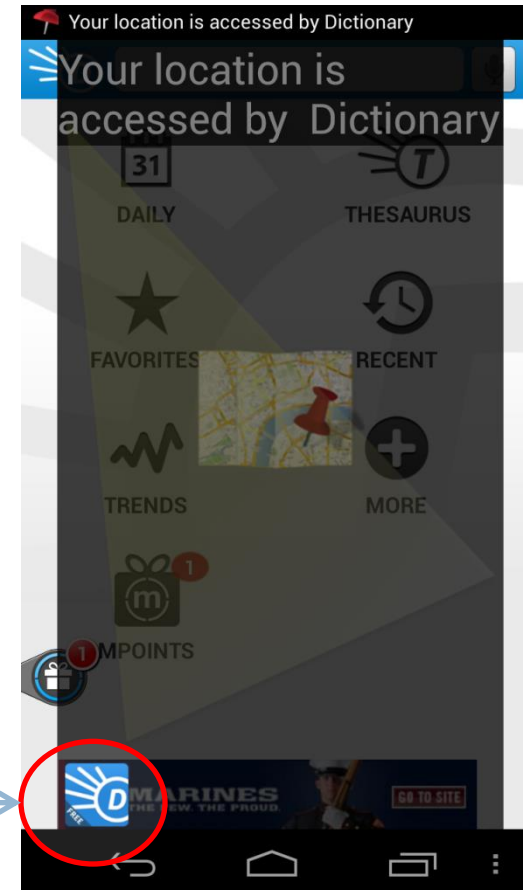
Run-time location access disclosure features

Notifications in the notice bar

Toast notification on screen



App's Name



App's Icon

Four-Week Field Study

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□ Recruitment

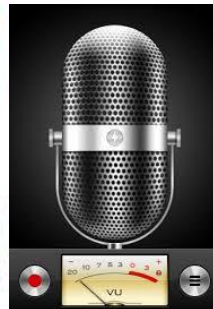
□ Flyers, Mailing list, craigslist, enrollment on campus

□ Study Procedures

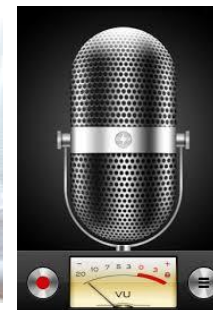
□ Entry Interview

□ Install study app

□ 4 weeks intervention in daily life



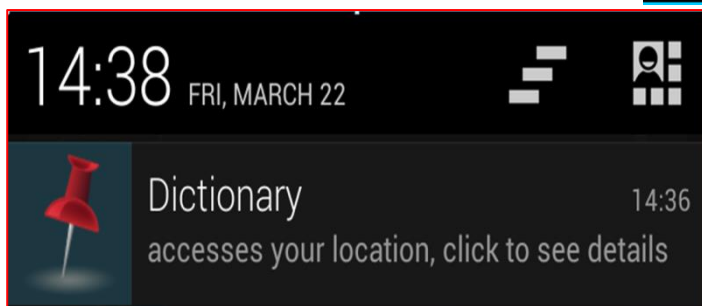
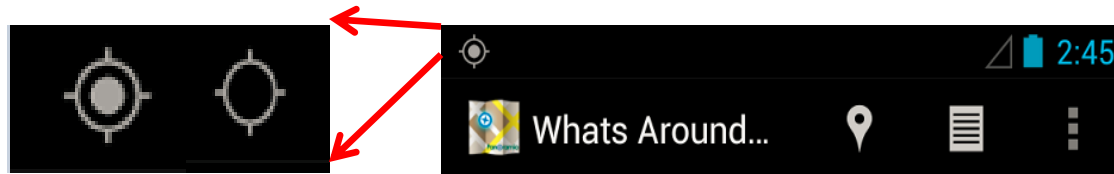
□ Exit Interview



Four-Week Field Study

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- Assign randomly to two groups before entry interview
- Totally 22 participants in two groups to analyze
 - Disclosure group (n=13)
 - No Disclosure group (n=9)



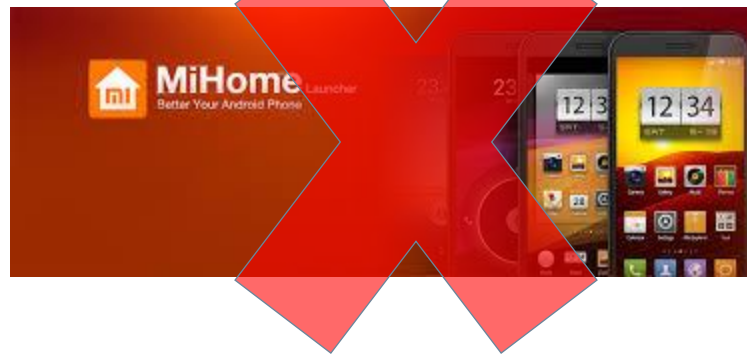
Results: Apps Unexpected to Access Location

- Almost all participants had several apps unexpected to access location in both groups
- 12 out of 13 participants in the Disclosure group unexpected some apps to access location
 - Mean of number of apps: 6.4, sd=5.4
- 8 out of 9 participants in the No Disclosure group unexpected some apps to access location
 - Mean of number of apps: 5.7, sd=3.3

Results: Reactions in the Disclosure Group

- Uninstall apps after receiving disclosures
 - P11 **uninstalled** a Launcher App unexpected to access location

“a launcher app did **not need** location for its function”



- **Uninstall** app was an **extreme action**, the apps were not available on the phones any more after being uninstalled.

Results: Reactions in the Disclosure Group

- Uninstall apps after receiving disclosure notifications
 - P4 **uninstalled** 3 game apps

“**not like** these apps accessing location, not need these apps any more”



Results: Reactions in the Disclosure Group

- Stop using some apps after receiving disclosure notifications
 - P4 and P5 **stopped** playing some games unexpected to access location

“If a **game** access my **location** I will **not play** the game anymore.”



Results: Reactions in the Disclosure Group

- Reduce frequency of using some apps
 - P6 tried to use other apps to **replace** the apps unexpected to access location by using other apps

“would pay attention to these apps and use them more **carefully**”

“not have **reasons** to access location”



Results: Reactions in the Disclosure Group

- Disable location access setup for the app
 - P2 **disabled** location access of a game app unexpected to access location



**“still worked well
after location
being disabled”**



- Most participants might prefer this action, but participants assumed most apps did not give the option to disable location

Disclosure group Learned How Apps Used Their Location Data

- Apps' location usage learned from run-time disclosure
 - Participants learned how often each app accessed location. They might make different decisions depending the frequency.

“I would like to know the times each app accessed location... if I know some apps access my location too often, I would probably stop using them.”



“Your app used to notify me ... which of the app was accessing location at what time. Sometimes I was surprised, oh this app used my location sort of that way.”



Disclosure Group Appreciated the Transparency

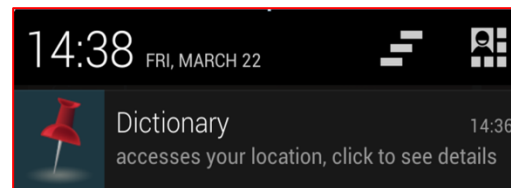
- Transparency brought by the run-time disclosure was appreciated by participants in the Disclosure group
 - Most participants would like to be aware of what was happening on their phones



“Actually it made me **more aware of** what was going on. I **appreciated** that.”



- Most participants would like to continue receiving the notifications in the notice bar



Questions?

Thank You !