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

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Why Location Access Disclosures?

- Large amount of users use Android phones (76 Millions 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)
Existing Location Access Disclosures

- Android Permissions at installation time

- Permissions are not effective
  - Users might ignore the permission list
  - Users might not understand the permissions
Android GPS icon flashing at run-time

- When the app was trying to update location using GPS, the GPS icon would be flashing on the upper left corner

- Effectiveness? Unknown
Problems To Explore in Field Study

- 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

- User level study app can be installed on participants’ phones without any changes
  - Detect apps’ location access at run-time
  - Not need changes to participants’ phones
Study App’s Disclosure Features

- Run-time location access disclosure features
  - Notifications in the notice bar
  - Toast notification on screen
Four-Week Field Study

- 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)
Expected Reactions In Two Groups

Using Location Based Apps

Aware of Apps’ Location Access

YES

• Uninstall the app
• Stop using the app
• Do Nothing

NO

Apps’ Location access is not in user’s control after being installed

Choose your own location sharing options
Results: Apps Unexpected to Access Location

- Disclosure group and No Disclosure group
- Almost all participants had several apps unexpected to access location

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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 unexpected to access location
  - P4 stopped using some game apps unexpected to access location

“Played a lot of games before, now stopped playing some games after knowing their accessing location”
Results: Reactions in the Disclosure Group

- Stop using some apps after receiving disclosure notifications
  - 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”
  - Game AppX Setup
    - Location
    - OFF

- 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 on 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!
Results: Comparison between Two Groups

- Reactions were different in the two groups
  - Various reactions to manage apps’ location access in the Disclosure group
  - No reactions in the No Disclosure group

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<th>No Disclosure Group</th>
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<td>(1) No actions due to GPS icon; (2) only one user might be more careful when downloading apps after reading The New York Times article</td>
<td>(1) Uninstall apps; (2) replace apps; (3) stop using some apps; (4) search through setup to disable the apps’ location</td>
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Heuristic

Location Permission
ACCESS_FINE_LOCATION
ACCESS_COARSE_LOCATION

getLastKnownLocation

YES
Location changes?

NO

No notifications

YES
Location permission?

NO

No notifications

Notify foreground app accessing location with time limit
Challenges for Field Study on Location Access Disclosures

- How to grante the *ecological validity* of the field study?
  - Rooting phones?
  - Second phone?
Challenges for Field Study on Location Access Disclosures

- How to detect apps’ location access on users’ phones?
  - Android platform prevent one app from accessing other apps’ data and methods

- Changing Android Framework to monitor apps’ location access require rooting users’ phones
Heuristic

- Apps actively update location: requestLocationUpdates
- Usually only foreground apps actively update location
Study App’s Disclosure Features

- History location access disclosure features
  - List of apps accessed location
  - Maps of location accessed by apps
Four-Week Field Study

- Totally 22 participants in two groups assign randomly
  - Disclosure group (n=13)
  - No Disclosure group (n=9)
Disclosure group received 3351 disclosure notifications