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

Huiqing Fu
Yulong Yang, Nileema Shingte,
Janne Linqdvist, Marco Gruteser

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

Why Location Access Disclosures?

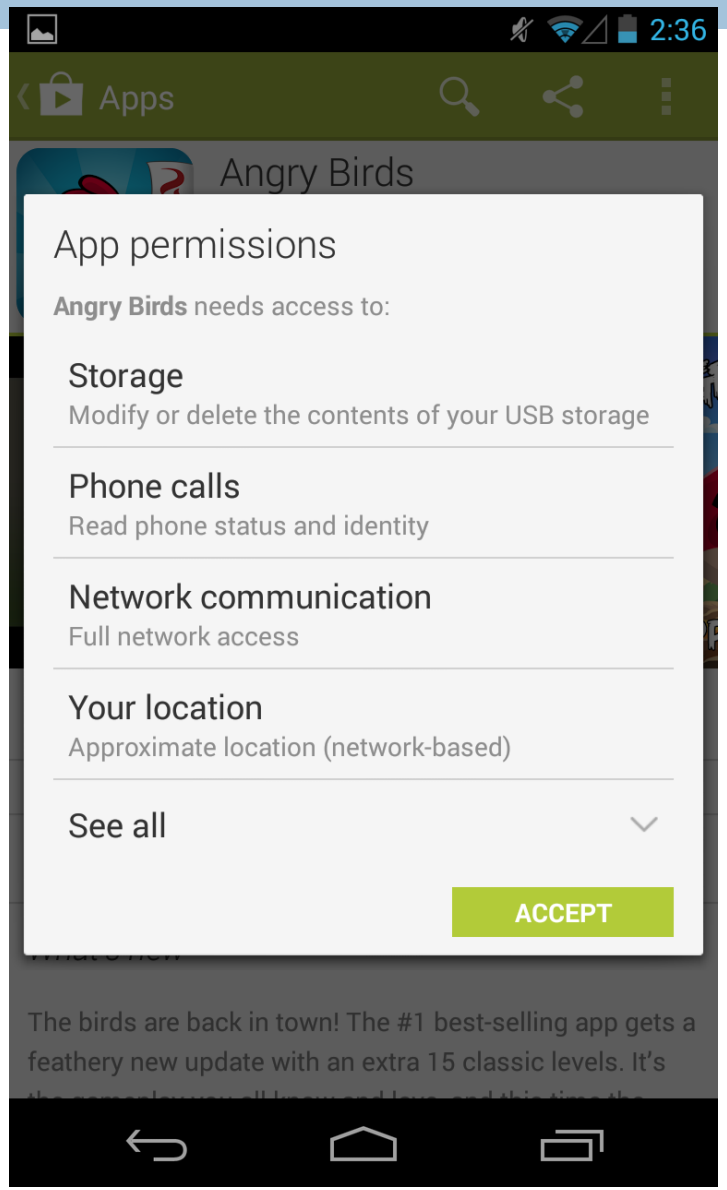
THE STATE UNIVERSITY OF NEW JERSEY RUTGERS

- 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

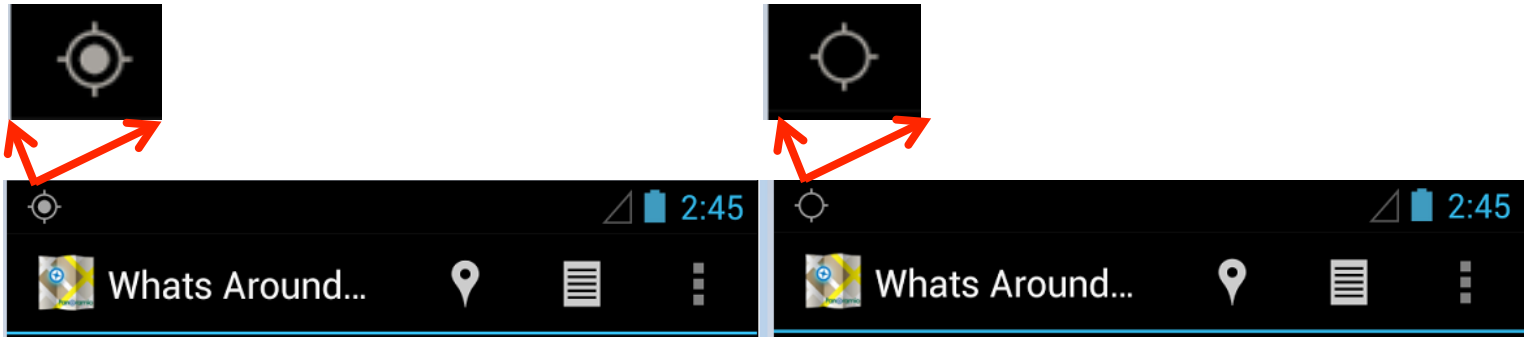
- Android Permissions at installation time

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



Existing Location Access Disclosures

- 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

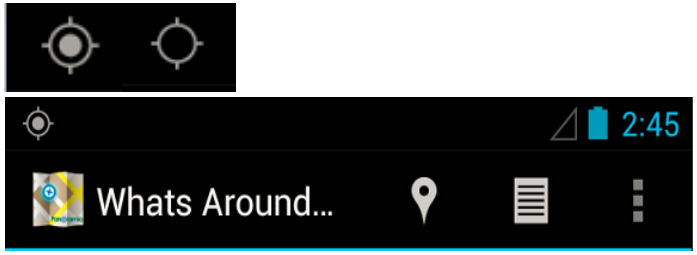


- Effectiveness? Unknown

Problems To Explore in Field Study

THE STATE UNIVERSITY OF NEW JERSEY RUTGERS

- 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

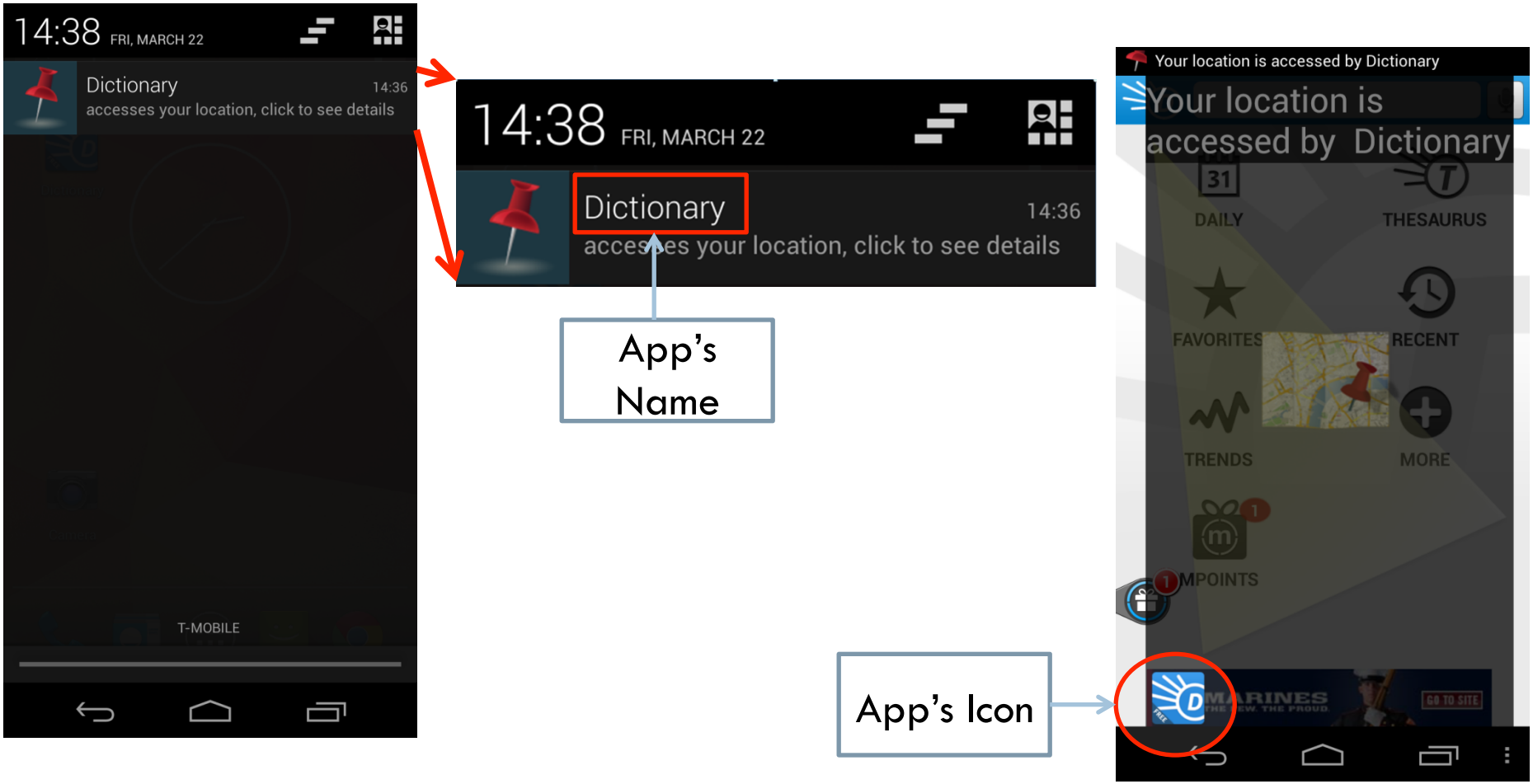
THE STATE UNIVERSITY OF NEW JERSEY RUTGERS

- 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

THE STATE UNIVERSITY OF NEW JERSEY RUTGERS

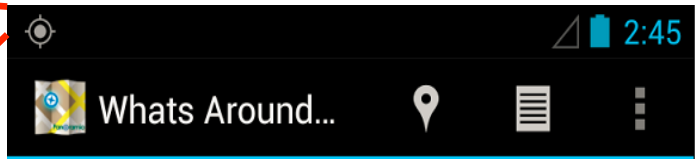
- Run-time location access disclosure features
  - Notifications in the notice bar
  - Toast notification on screen

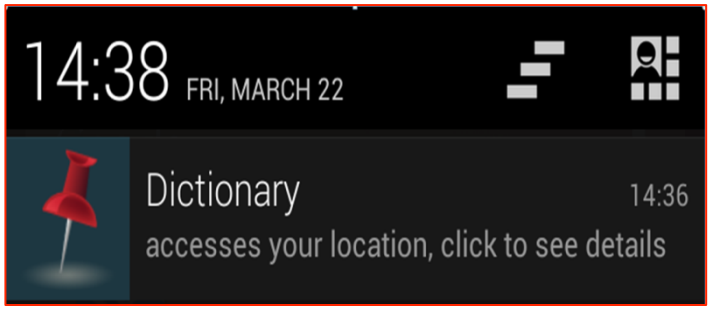


Four-Week Field Study

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

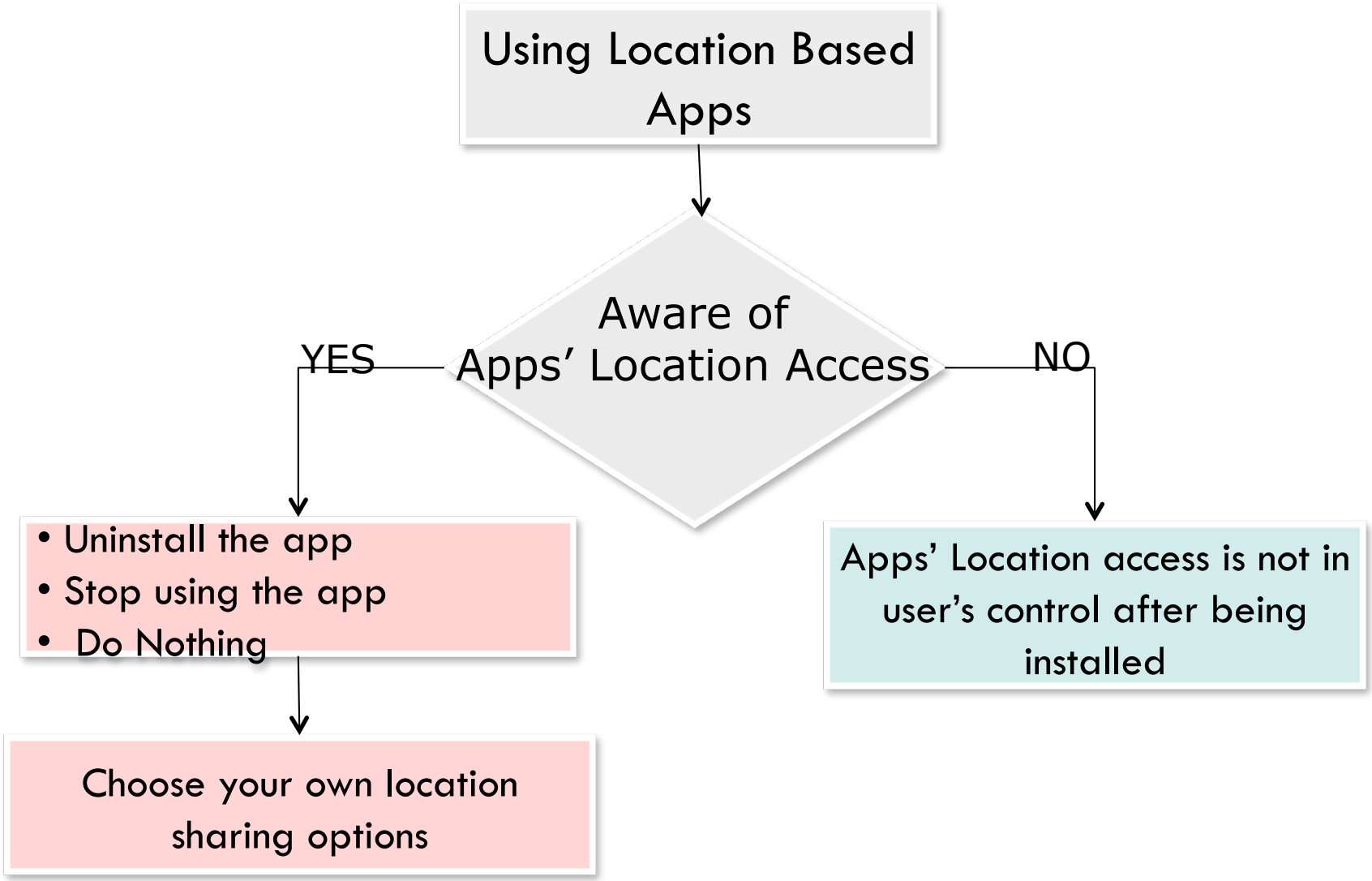
- Assign randomly to two groups before entry interview
- Totally 22 participants in two groups to analyze
  - Disclosure group (n=13)
  - No Disclosure group (n=9)





Expected Reactions In Two Groups

THE STATE UNIVERSITY OF NEW JERSEY RUTGERS



Results: Apps Unexpected to Access Location

THE STATE UNIVERSITY OF NEW JERSEY RUTGERS

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

ID	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13
Total	28	19	2	21	20	8	39	29	5	19	41	37	21
Not Exp	**7**	**4**	**0**	**17**	**8**	**5**	**3**	**1**	**4**	**3**	**3**	**14**	**14**

ID	C1	C2	C3	C4	C5	C6	C7	C8	C9
Total	40	13	23	22	32	10	0	16	11
Not Exp	**9**	**5**	**5**	**9**	**8**	**3**	**0**	**9**	**3**

Results: Reactions in the Disclosure Group

THE STATE UNIVERSITY OF NEW JERSEY RUTGERS

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

- 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

THE STATE UNIVERSITY OF NEW JERSEY RUTGERS

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

Results: Reactions in the Disclosure Group

THE STATE UNIVERSITY OF NEW JERSEY RUTGERS

- 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

THE STATE UNIVERSITY OF NEW JERSEY RUTGERS

- 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

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

  - 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

THE STATE UNIVERSITY OF NEW JERSEY RUTGERS

- 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."

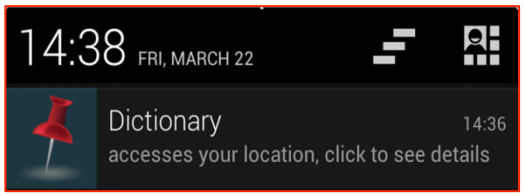
Disclosure Group Appreciated the Transparency

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

- 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?

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

Thank You !

Results: Comparison between Two Groups

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

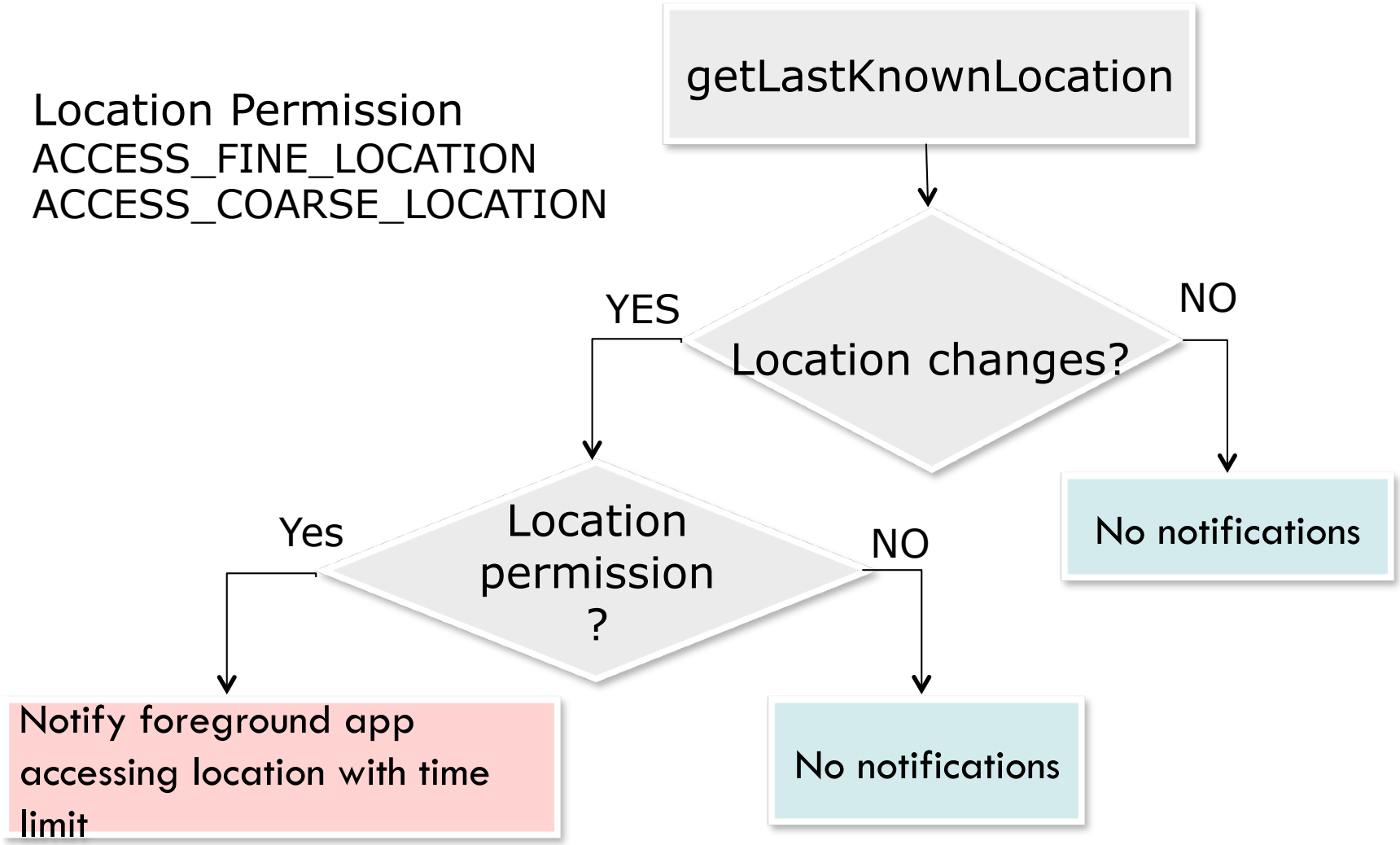
- Reactions were different in the two groups
  - Various reactions to manage apps' location access in the Disclosure group
  - No reactions in the No Disclosure group

No Disclosure Group	Disclosure Group
(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	(1) Uninstall apps; (2) replace apps; (3) stop using some apps; (4) search through setup to disable the apps' location

Heuristic

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

Location Permission
ACCESS_FINE_LOCATION
ACCESS_COARSE_LOCATION



Challenges for Field Study on Location Access Disclosures

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

- How to grantee the ecological validity of the field study?
  - Rooting phones?
  - Second phone?

Challenges for Field Study on Location Access Disclosures

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

- 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

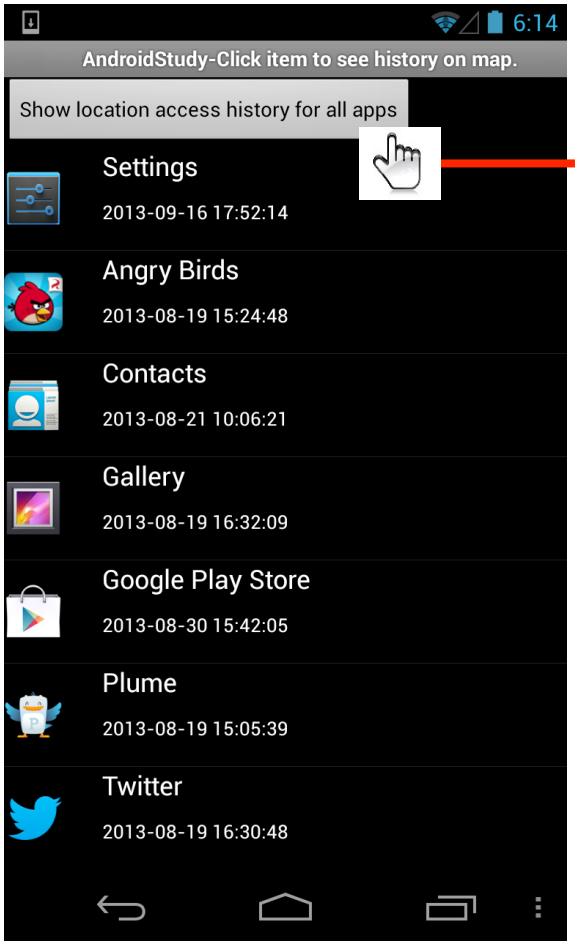
Heuristic

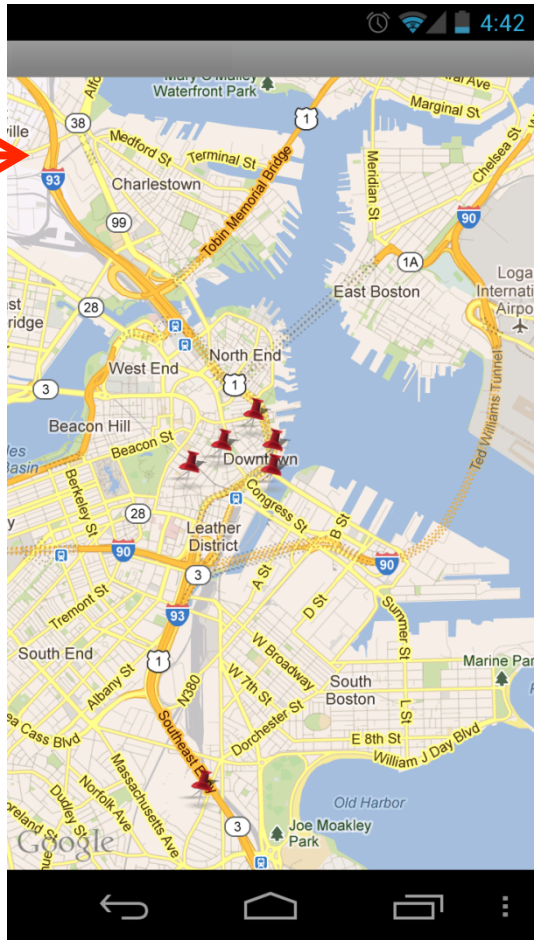
- Apps actively update location: requestLocationUpdates
- Usually only foreground apps actively update location

Study App's Disclosure Features

THE STATE UNIVERSITY OF NEW JERSEY RUTGERS

- History location access disclosure features
  - List of apps accessed location
  - Maps of location accessed by apps

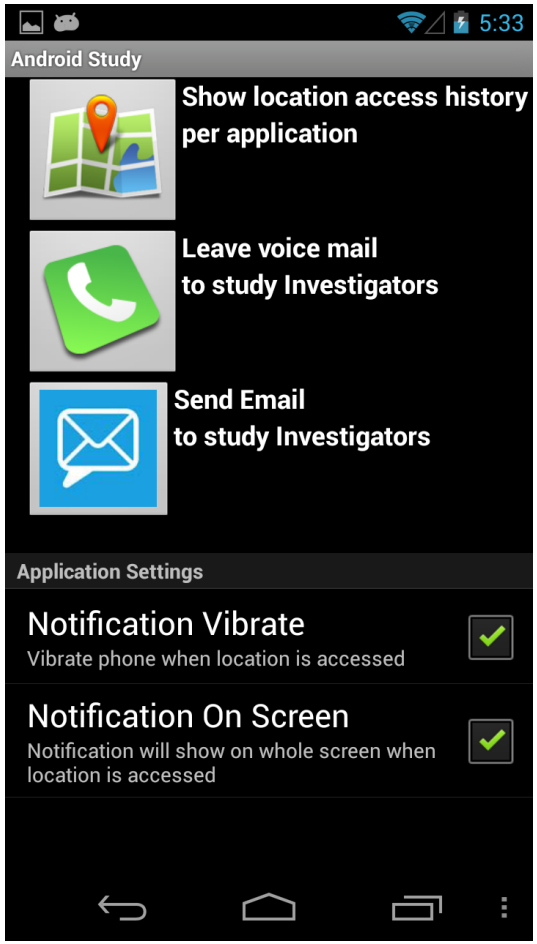


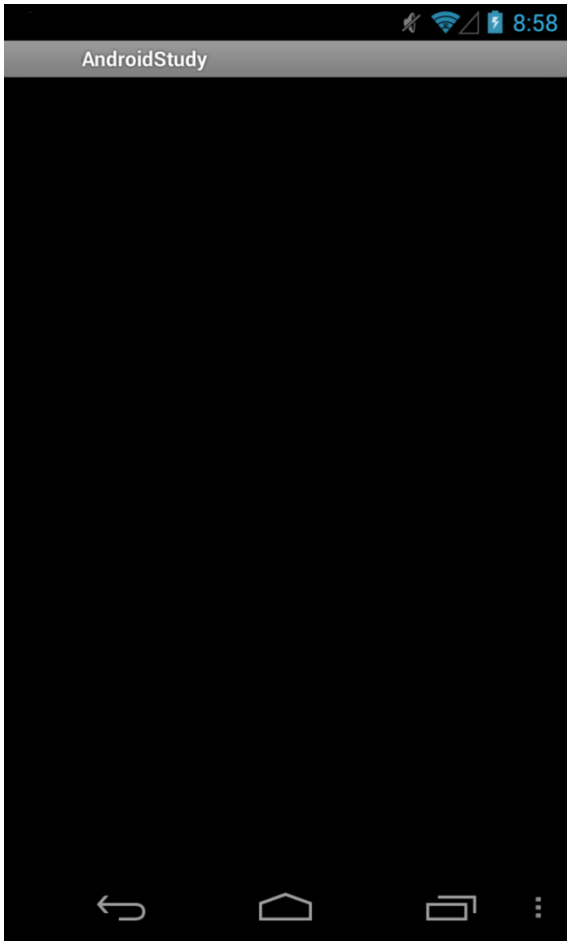


Four-Week Field Study

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

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





Resutls:Interventions Received in Study

THE STATE UNIVERSITY OF NEW JERSEY
RUTGERS

- Disclosure group received 3351 disclosure notifications