User Comfort With Android Background Resource Accesses in Different Contexts

Daniel Votipka, Seth M. Rabin, Kristopher Micinski, Thomas Gilray, Michelle L. Mazurek, and Jeffrey S. Foster
Resource Access in Android

- Apps access sensitive resources for functionality
Resource Access in Android

- Apps access sensitive resources for functionality
- Request permission on first use
Resource Access in Android

- Apps access sensitive resources for functionality
- Request permission on first use
Resource Access in Android

- Apps access sensitive resources for functionality
- Request permission on first use
- Apps acquire blanket use of resource
Find Nearby Singles

Allow Datr access to your Location?
Find Nearby Singles

Allow Datr
access to your
Location?

datr.com
Decision-Making Support

• Privacy Agents
  [Wijesekera et al., 2018]
  [Lin et al. 2014]

• Recommendations by privacy auditors
  [Micinski et al. 2017]
Decision-Making Support

- Privacy Agents
  [Wijesekera et al., 2018]
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- Recommendations by privacy auditors
  [Micinski et al. 2017]

All must determine which elements of context to consider
Decision-Making Support

• Privacy Agents
  [Wijesekera et al., 2018]
  [Lin et al. 2014]
• Recommendations by privacy auditors
  [Micinski et al. 2017]

Which elements of context have the most significant effect on user comfort?

All must determine which elements of context to consider
Method

- Online survey
- Participants shown sensitive resource access a mock scenario
- Asked to indicate comfort with the scenario
App Description
App Description

Attention Check

Resource Use Description
# Conditions Studied

<table>
<thead>
<tr>
<th>App</th>
<th>Resource</th>
<th>When</th>
<th>Why</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dating</td>
<td>SMS</td>
<td>Foreground Interaction</td>
<td>Personalize</td>
</tr>
<tr>
<td>Rideshare</td>
<td>Contacts</td>
<td>Prefetch</td>
<td>First Party Server</td>
</tr>
<tr>
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<td>Location</td>
<td>Background Interaction</td>
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<td>On Change</td>
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Conditions Studied

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Selected based on related literature review and manual analysis of 20 popular apps.
When: Foreground Interaction
When: Foreground Interaction

Location Accessed

Find Singles Nearby

AT HOME

AT COFFEE SHOP

AT PARK
When: Foreground Interaction

- Explicitly triggered by interaction
- Obvious use of resource
- On screen
When: Prefetch

Find Singles Nearby

AT HOME

Location Accessed

AT PARK
When: Prefetch

- Obvious use of resource
- On screen
When: Background Interaction
When: Background Interaction
When: Background Interaction

- No obvious use of resource
- On screen
When: Resource Change

AT HOME

AT HOME

Location Accessed

AT COFFEE SHOP

AT COFFEE SHOP

Location Accessed

AT PARK

ads.com
When: Resource Change

- No obvious use of resource
- Off screen
Why: Personalize
Why: Personalize

- On device
- Benefit to user

Location Accessed
Why: First Party Server
Why: First Party Server

- Off device to the app developer
- Benefit to user

Location Accessed

datr.com
Why: Analytics

Location Accessed

AT HOME

AT HOME

AT COFFEE SHOP

AT COFFEE SHOP

AT PARK

analytics.com
Why: Analytics

- Off device to a third party
- Benefit to user
Why: Advertising

Location Accessed

AT HOME: ads.com

AT HOME

AT COFFEE SHOP

AT COFFEE SHOP

AT PARK

ads.com
Why: Advertising

- Off device to a third party
- No benefit to user
## Conditions Studied

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For comparison to current information provided to users

**None Given**
• How comfortable are you with this access?
• Would you recommend this app to a friend?
• How comfortable are you with this access?
• Would you recommend this app to a friend?
• Give a short description of why you think the app collected this data.
• How comfortable are you with this access?
• Would you recommend this app to a friend?
• Give a short description of why you think the app collected this data.
Study Logistics

• Mechanical Turk survey of 2,198 users

• Tested 52 different scenarios
  ‣ Each user saw one scenario
  ‣ Round-robin assignment

• Paid $1.20, median time of ~5 minutes
Results: When

- Trends match in direct and indirect comfort responses
- No significant interaction effects observed between the When and Why components of comfort
Results: When

Foreground Int.
Prefetch
Background Int.
Resource Change

<table>
<thead>
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<th>Percentage of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
</tr>
</tbody>
</table>

- Very comfortable
- Comfortable
- Neither comfortable nor uncomfortable
- Uncomfortable
- Very uncomfortable
Results: When

Foreground Int.

Prefetch

Background Int.

Resource Change

Caused by obvious interaction

Not caused by obvious interaction

Percentage of participants

- Very comfortable
- Comfortable
- Neither comfortable nor uncomfortable
- Uncomfortable
- Very uncomfortable
Results: When

- Foreground Int.
  - Caused by obvious interaction
  - On screen, not caused by obvious interaction
  - Off screen

- Prefetch

- Background Int.

- Resource Change
  - Very comfortable
  - Comfortable
  - Neither comfortable nor uncomfortable
  - Uncomfortable
  - Very uncomfortable

Percentage of participants
Results: When

1. Is app on screen?
2. Access caused by obvious interaction?
Results: Why

<table>
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<tr>
<th>Service</th>
<th>Very comfortable</th>
<th>Comfortable</th>
<th>Neither comfortable nor uncomfortable</th>
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<tr>
<td>Advertising</td>
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<td></td>
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</table>
Results: Why

- **Personalize**: 3rd Party
- **First Party Server**: 1st Party
- **Analytics**: 3rd Party
- **Advertising**: 3rd Party

Percentage of participants:
- **Very comfortable**
- **Comfortable**
- **Neither comfortable nor uncomfortable**
- **Uncomfortable**
- **Very uncomfortable**
Results: Why

Percentage of participants:

- 3rd Party
  - Very comfortable
  - Comfortable
  - Neither comfortable nor uncomfortable
  - Uncomfortable
  - Very uncomfortable

- 1st Party
  - Very comfortable
  - Comfortable
  - Neither comfortable nor uncomfortable
  - Uncomfortable
  - Very uncomfortable

Sharing data with the company’s own servers did not increase discomfort.
Results: Why

Percentage of participants

<table>
<thead>
<tr>
<th>3rd Party</th>
<th>1st Party</th>
</tr>
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<tr>
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<td>Comfortable</td>
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</table>

Personalize

First Party Server

Analytics

Advertising

Sharing data with the company’s own servers did not increase discomfort

No significant difference between Analytics and Advertising
Results: No Why Given

- Personalize: 60%
- Advertising: 20%
- Analytics: 5%
- Don’t Know: 5%
Results: No Why Given

“It wants to match you with people that are currently closest to you”

- Personalize
- Advertising
- Analytics
- Don’t Know

Percentage of participants

0 20 40 60
Results: No Why Given

- **Personalize**: 60%
- **Advertising**: 20%
- **Analytics**: 5%
- **Don’t Know**: 5%

"To collect info, probably to sell"
Percentage of participants:
- Very comfortable
- Comfortable
- Neither comfortable nor uncomfortable
- Uncomfortable
- Very uncomfortable

Results: No Why Given

- Personalize
- First Party Server
- Analytics
- Advertising
- None Given
Results: No Why Given

- Personalize:
  - Very comfortable: 3%
  - Comfortable: 25%
  - Neither comfortable nor uncomfortable: 50%
  - Uncomfortable: 22%
  - Very uncomfortable: 10%

- First Party Server:
  - Very comfortable: 3%
  - Comfortable: 25%
  - Neither comfortable nor uncomfortable: 50%
  - Uncomfortable: 22%
  - Very uncomfortable: 10%

- None Given:
  - Very comfortable: 3%
  - Comfortable: 25%
  - Neither comfortable nor uncomfortable: 50%
  - Uncomfortable: 22%
  - Very uncomfortable: 10%

- Analytics:
  - Very comfortable: 3%
  - Comfortable: 25%
  - Neither comfortable nor uncomfortable: 50%
  - Uncomfortable: 22%
  - Very uncomfortable: 10%

- Advertising:
  - Very comfortable: 3%
  - Comfortable: 25%
  - Neither comfortable nor uncomfortable: 50%
  - Uncomfortable: 22%
  - Very uncomfortable: 10%
Results: No Why Given

- Personalize
- First Party Server
- None Given
- Analytics
- Advertising

Less comfortable than when assumed reason (Personalize) stated explicitly, but more comfortable than worst case (Advertising)
Recommendations
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• Developers should provide context-sensitive access descriptions
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• Privacy support agents should learn privacy preferences related to the identified tiers of context
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• Developers should provide context-sensitive access descriptions

• Privacy support agents should learn privacy preferences related to the identified tiers of context

• App auditors should focus on tiers of context
Summary

• When:
  • Caused by obvious interaction vs. not caused by obvious interaction
  • On screen vs. off screen

• Why:
  • 1st Party vs. 3rd Party
  • Expect personalization as background use

Questions: dvotipka@cs.umd.edu