Can Systems Explain Permissions Better? Understanding Users’ Misperceptions under Smartphone Runtime Permission Model

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Permissions control sensitive data

• We can perform various activities with apps on the smart phones.

• For certain functionalities, apps may need certain permissions to access sensitive data or operations.
Runtime permission model

• Users need to **comprehend** the permission requests to make decisions.

• System mainly provide brief information in the dialogs.
Research Questions

1. (Permission model change) How commonly do users still have apps with install-time permission model?

2. (Runtime comprehension) Can the current system-provided information help users comprehend the permissions and their capabilities?

3. (Extra system information) What extra information (if the systems can provide) would impact users’ decisions?
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Android permission model change

Install-time model 2015

Runtime model

What OS do if app does not change?

App-level change

Low-version app: target to an Android version that only supports install time model
Android permission model change

Install-time model 2015  Runtime model

1. How commonly do users use low-version apps?
2. Can users differentiate the low-version apps?
Methodology 1: permission data analysis

• Analysis of Android permission model change
  • Dataset:
    • The lists of installed apps from 4,636 Permission Checker [1] users
    • App metadata and user’s real permission settings (allow or deny) for the apps
  • Threat:
    • The demographics of Permission Checker users are unknown

Low-version apps are pervasive

• Among the 4,636 real Android users in our study, a large percentage (61.8%) have at least one such app installed.
  • Many apps are popular and still updating!

<table>
<thead>
<tr>
<th>App Name</th>
<th># install</th>
<th>Update date*</th>
</tr>
</thead>
<tbody>
<tr>
<td>TextNow</td>
<td>10M +</td>
<td>09/19/18</td>
</tr>
<tr>
<td>ES File Explorer</td>
<td>100M +</td>
<td>09/17/18</td>
</tr>
<tr>
<td>Settings DB Editor</td>
<td>100K +</td>
<td>09/01/18</td>
</tr>
<tr>
<td>WiFiMan</td>
<td>100K +</td>
<td>08/30/18</td>
</tr>
<tr>
<td>Advanced Tools</td>
<td>100K +</td>
<td>07/27/18</td>
</tr>
</tbody>
</table>

* (Date retrieved from Google Play on 09/20/2018)
Users cannot differentiate low-version apps

• More than one-third (38.3%) of users believe low-version apps will ask for permissions at runtime.

• Even though users can revoke low-version apps’ permissions, only one user revoked its permission.

* Permission dialog for low-version apps on Android P.
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Permission groups

• A permission group has a set of related functionalities.
• Users can only make decisions by groups.

Can users comprehend all the permissions and capabilities inside the permission group?

- Get your phone number
- Get your phone unique ID (e.g. IMEI)
- Make phone call
- Answer phone call
- Know whether the phone is making phone calls
Methodology 2 – Survey

• Survey 1: Permission group comprehension (n=359 iOS & Android)
  • Choose all operations included in the permission group

- Get your phone number
- Get your phone unique ID (e.g. IMEI)
- Make phone call
- Answer phone call
- Read your location
- Know whether the phone is making phone calls
- Read call history
- None of these
- I don’t know
Hard to infer the accurate scope from the system-provided information

- **Only 1 in 20 (6.1%)** can infer the accurate scope of permission groups from info. in the system dialogs.

  - Not all answers are correct
  - Answer all 4 questions correctly
Reasons for misunderstand the permission group

• Reason 1: Hard to infer from the system description

![Permission Request]

- Get your phone unique ID (e.g. IMEI) 23.5%
Reasons for misunderstand the permission group

• Reason 1: Hard to infer from the system description
• Reason 2: Function-related permissions

![Permission dialog]  
- **Take pictures and record video**:  
  - Android: 88.6%  
  - iOS: 90.3%  
- **Read pictures and video**:  
  - Android: 41.4%  
  - iOS: 33.3%
Developer-provided explanations

• iOS requires developers to provide permission rationales for their permission request.
  • App store will audit the rationales.
  • But rationales mostly focus on benefits or make wrong claims [1,2].

[1] The effect of developer-specified explanations for permission requests on smartphone user behavior, CHI 2017
[2] A large-scale empirical study on android runtime-permission rationale messages, IEEE VL/HCC 2018
Misunderstanding for permission rationale

- **More than half (54.7%)** of users do not know that the explanations are provided by the developers.

![Pie chart showing the distribution of users' responses to permission rationale.]

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Don’t Allow</td>
<td>OK</td>
</tr>
</tbody>
</table>

1. Uniform appearance across apps
2. Don’t trust apps would help them understand the permissions.
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Methodology

Semi-structured Interview

- Concerns in granting permissions

Survey on Decision Factors

- Factors’ impact on users’ decisions
  - 6 factors
  - 3 scenarios
  - Positive/negative framings

Qualitative study

Quantitative study
Decision factors in granting permissions

• We find several factors related to users’ decisions.
• Internal factors (how the data will be used)
  • Background access
  • Data transmission
• External factors (people’s opinion on the app)
  • Brand reputation
  • Rating
  • Reviews

More results in the paper (Section 6)
Recommendations

• Security vs backward compatibility
  • System should provide clear notices for security enhancements
  • Joint-effort from app stores.

• Address common permission misunderstandings
  • Design permission groups that fit into user expectations
  • Developer-provided rationale should be regulated/highlighted!

• Extra information to address user concerns
  • Internal factors may be obtained with OS level support
  • External factors require crowdsourcing efforts
Conclusion

• Users have common misunderstandings in the permission model.
  • Low-version apps are still prevalent three years after the introduction of runtime permission model.
  • Many users mistakenly believe that the low-version apps still need to request permissions at runtime.

• Runtime permission group comprehension
  • User commonly misperceived the scope of permission groups from the limited information provided by systems.
  • Many users mistakenly believe that iOS provides the rationale messages.

• Systems can provide more information that impact users’ decisions.
  • Comparison of factors: background access, data transmission, brand reputation, rating, review and grant rate
  • Negative messages can have a stronger impact on users’ permission decisions.
Thank you!

More results can be found in our paper!

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https://github.com/ucsdopera/PermissionStudyUsenix21
Backup slides
Permission model change

Install-time model

**Decision Time**
- Install time
- Runtime

**Decision Result**
- All-or-nothing
- By-group

**Decision Context**
- Group w/ detailed info.
- Short description

Runtime model (Android 2015-)

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Participants

- UCSD participants, flyers, Amazon Mturk workers
- Interview (n=20)
- Survey 1 (n=359)
- Survey 2 (n=1200)