Context-Aware Privacy Management on Smartphones

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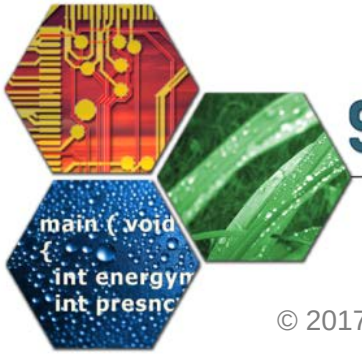

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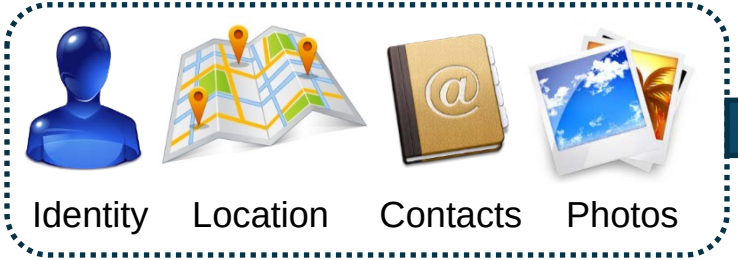
Smartphones: Ensuring User Privacy



Changed landscape: Smartphones and “Apps”

- >1.4M Apps, 100 Billion downloads, >100K developers

Concerns: untrusted, inexperienced developers

- Financial models unclear – Free Apps, Ad support

Result: Mobile Apps access *your* private data

- May be for valid reasons, or for no clear utility?

{App, Permission}: Are they effective?

Decision overload:

- 80 Apps * ~5 Permissions => **400 Decisions**

Purpose of data access is still unclear

- **“Why”** is the data accessed, **“where”** does it flow?

Android privacy controls are still at an App level

- Developers routinely use 3rd Party Libraries
- Cannot currently allow access based on functionality
- **These libraries have access to the same user data**

{App, Permission, Purpose} Controls?

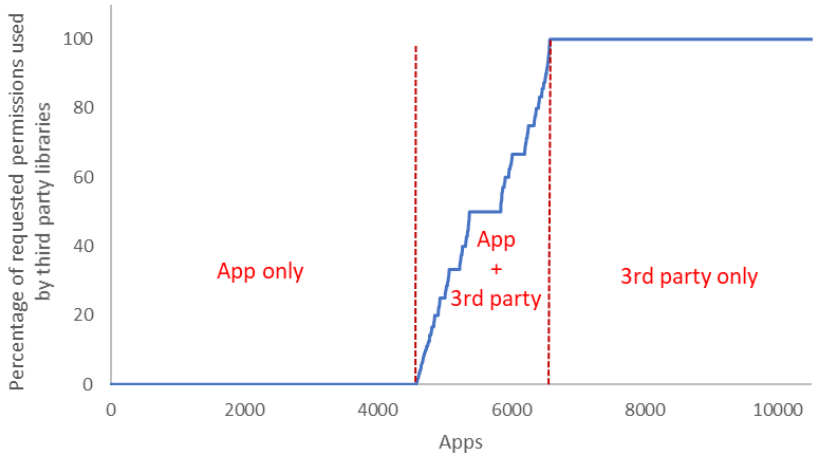
Decision (further) overload?

- **App** x **Permissions** x **Purpose** (multiple libraries?)
- User attention is scarce

- Sounds like we might make things even worse….

- Question: What are these 3rd party libraries?
  - Is there something that we can leverage?

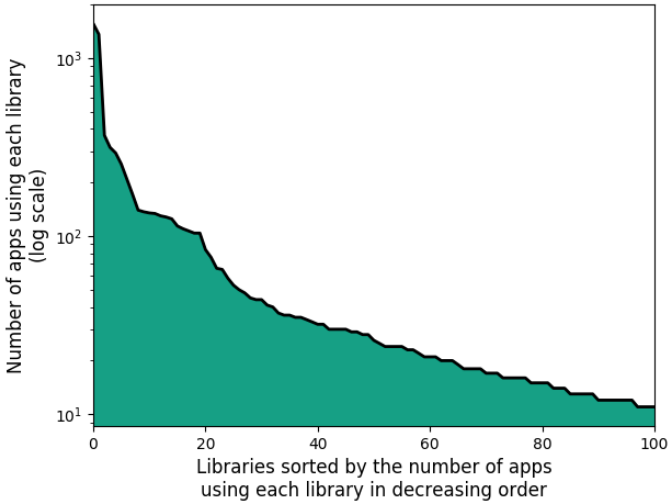
Private Data Accesses by 3rd party Libraries



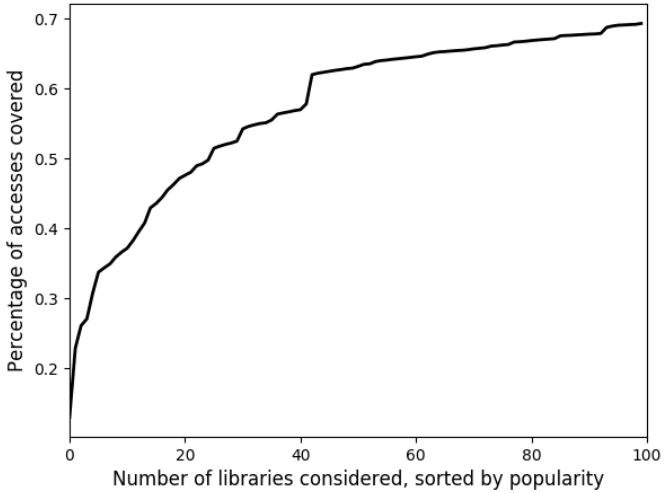
- Collected ”stack-trace” data
- Shows context around privacy sensitive data accesses
- Categorized accesses by the App itself or some 3rd party lib

Insight #1: 3rd Party Libraries are responsible for a large fraction of the accesses in popular Apps.

Understanding 3rd Party Library Data Accesses



Insight #2: Use of libraries in apps is heavy tailed



Insight #3: A small set of libraries account for many privacy sensitive data accesses

App+Library Based Controls

{App, permission} + {Library, permission}

- Separate out data flows between app and library

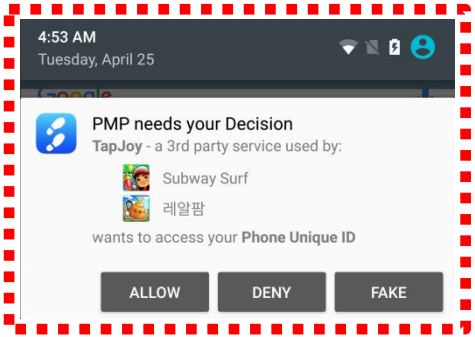
What about the purpose?

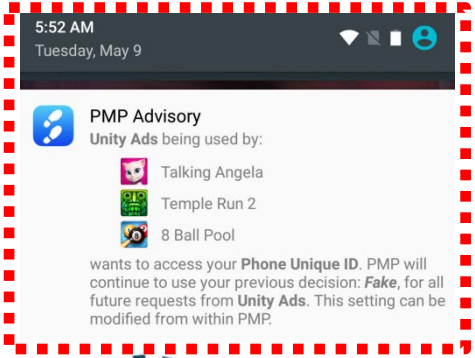
- Third-party libraries have specific use cases

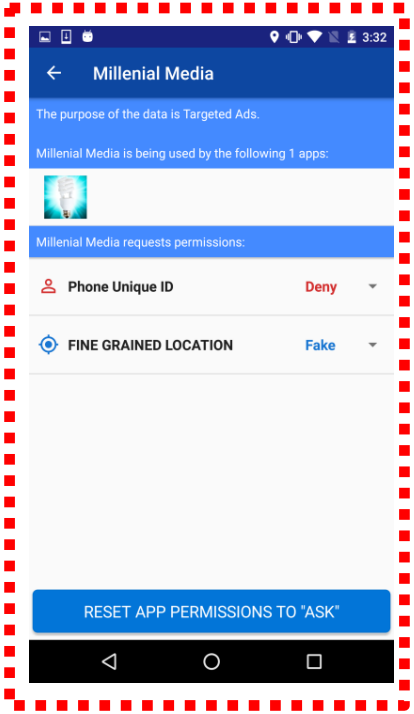
Use crowd-sourcing to scale data collection

- Users upload App stack traces, need at least one
- Multiple users can upload different stack traces

PmP v2: App Screenshots

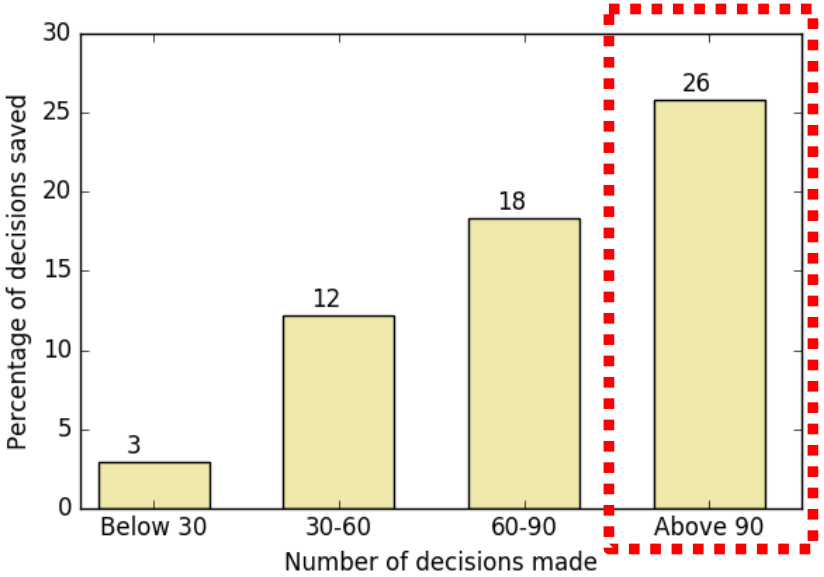






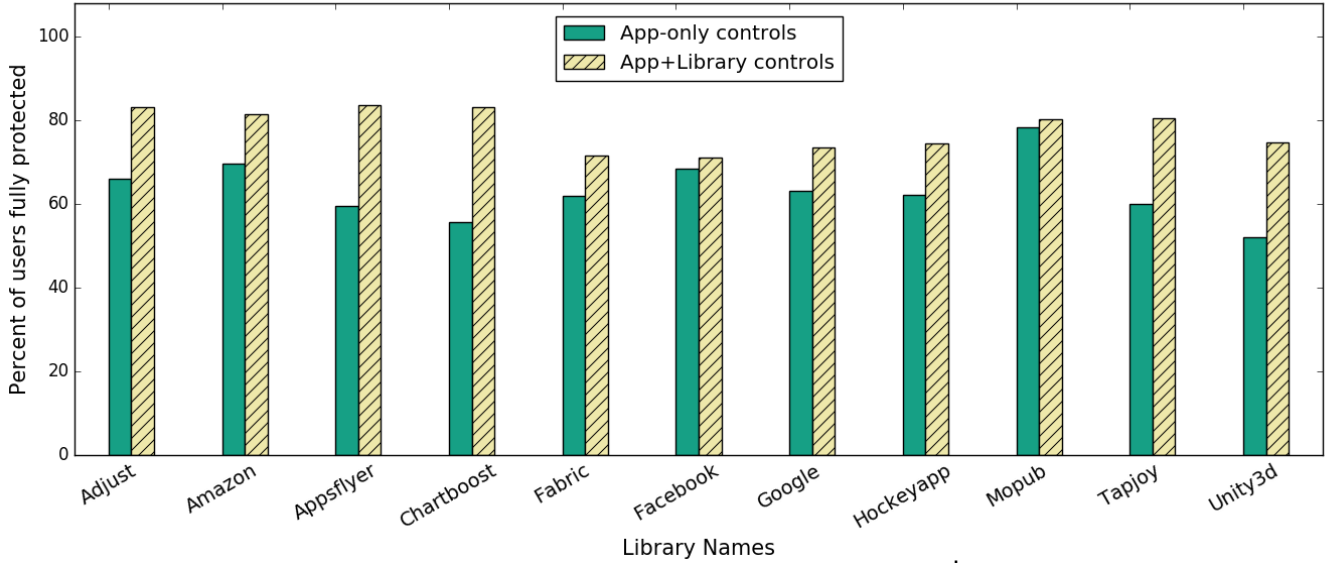
Results: Reduced Number of Decisions

1300+ real world users who discovered our A



- 90 Decisions
- About 18 Apps
  - 5 permissions

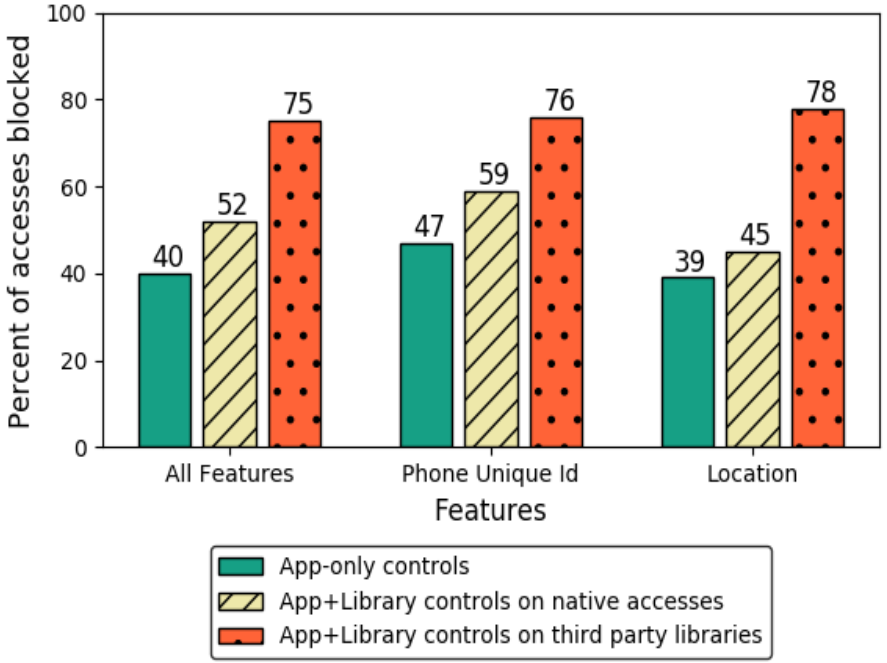
Results: Effectiveness Against Data Leaks



- Data flowing to 3rd party libraries is reduced
  - On average 25% more users protected
- Users are better protected in all cases

Results: Changes in User's Decisions

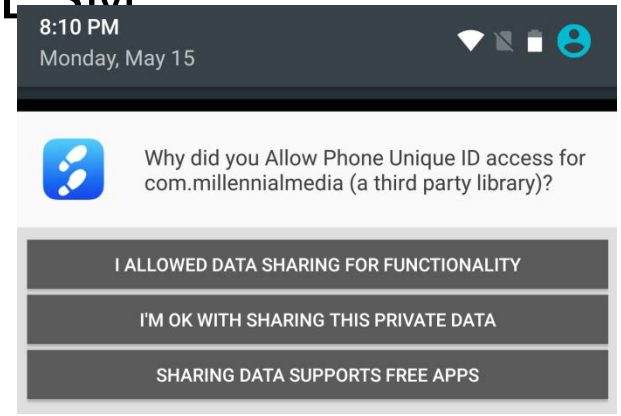
- Overall users block more decisions
  - Both for "Native" as well as "Library" accesses

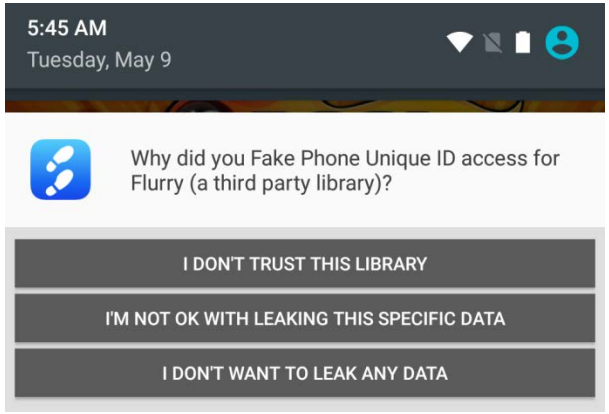


Results: Why do users make these decisions?

Why do users allow **ANY** data to libraries?

Gather In-App feedback for libraries, use ESM

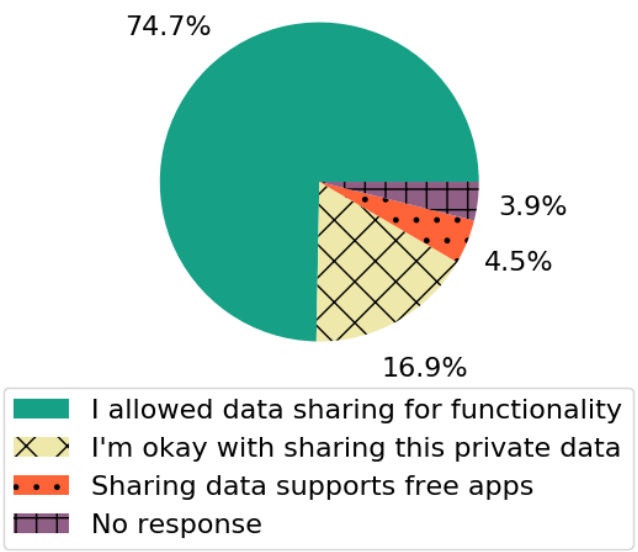




Results from User Feedback

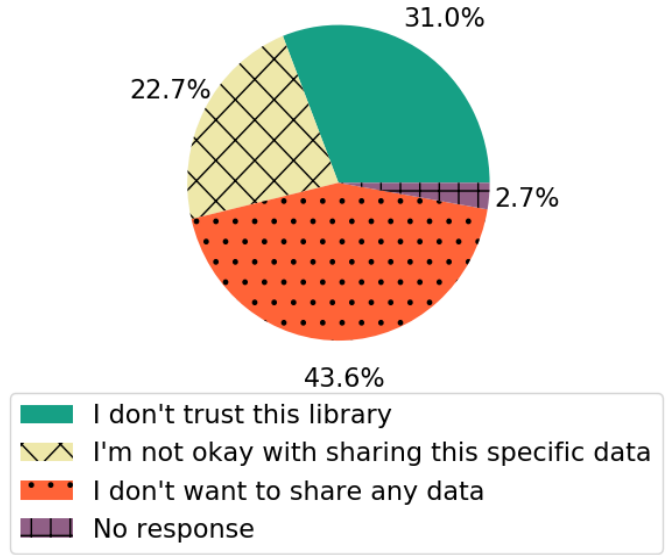
Results for Allowing Library Access

25% of all accesses by Libraries were allowed



Results for Denying Library Access

75% of all accesses by Libraries were blocked



Conclusion

ProtectMyPrivacy for Android

- Context driven privacy controls => App, Libraries
- Annotate purposes for private data accesses
- Built an PmP App + crowdsourcing based backend

Evaluate on 1300+ users, 11K Popular Apps

- 25% fewer decisions in App+Library model
- Users are more effectively protected against libraries
- Users more likely to share data for native App access

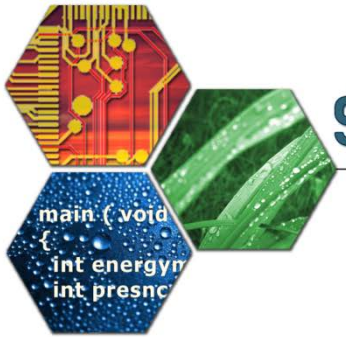
Thank you!

:: Systems, Security, Privacy

:: Domain: IoT / Mobile / Buildings

Others contributing to this research:

Edison Gao, Vikram Shanker, David Simon, Joseph Chan
Sandeep Agarwal, Kunal Bhuwalka, Dohyun Kim, …. !



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