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Should I Protect You? Understanding Developers' Behavior to Privacy-Preserving APIs

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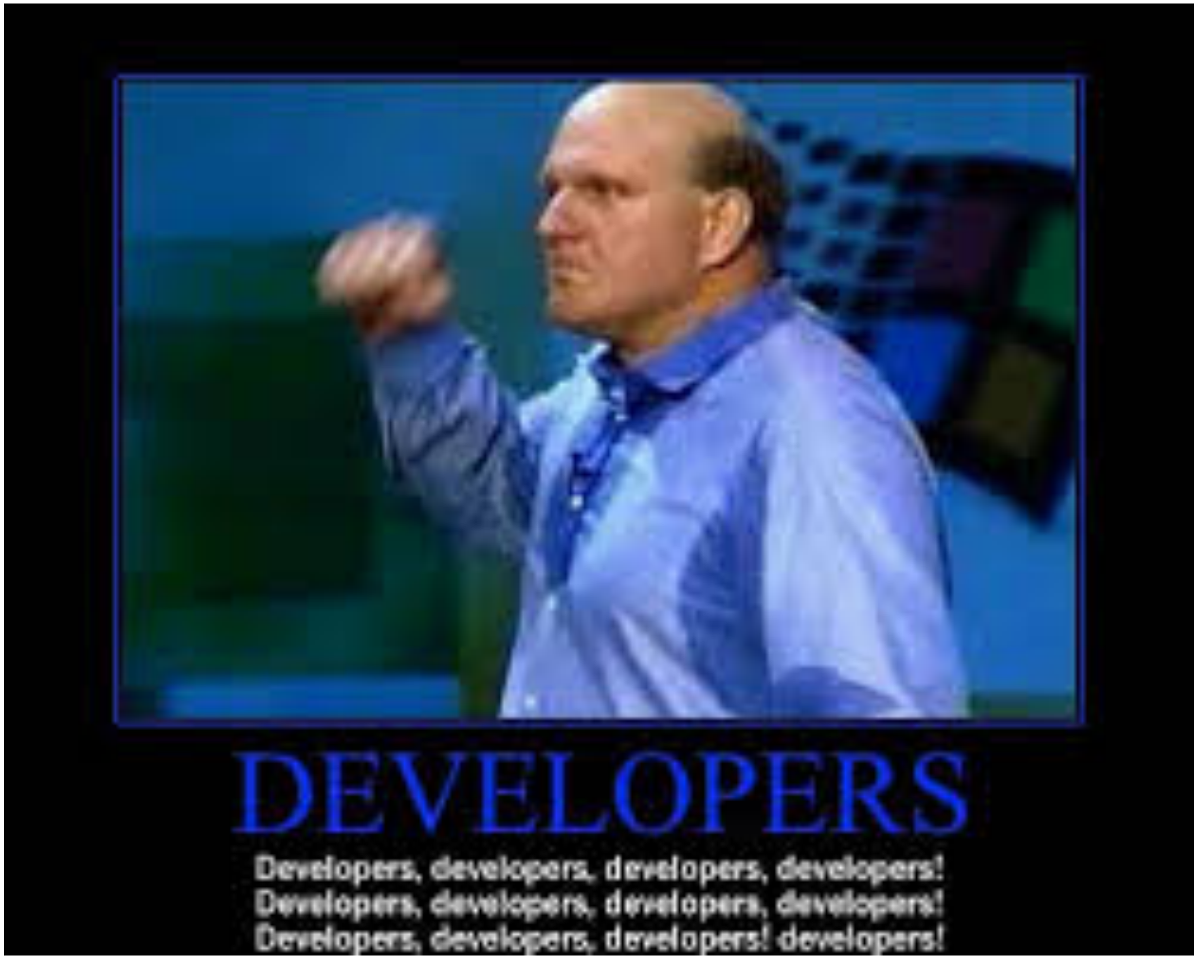
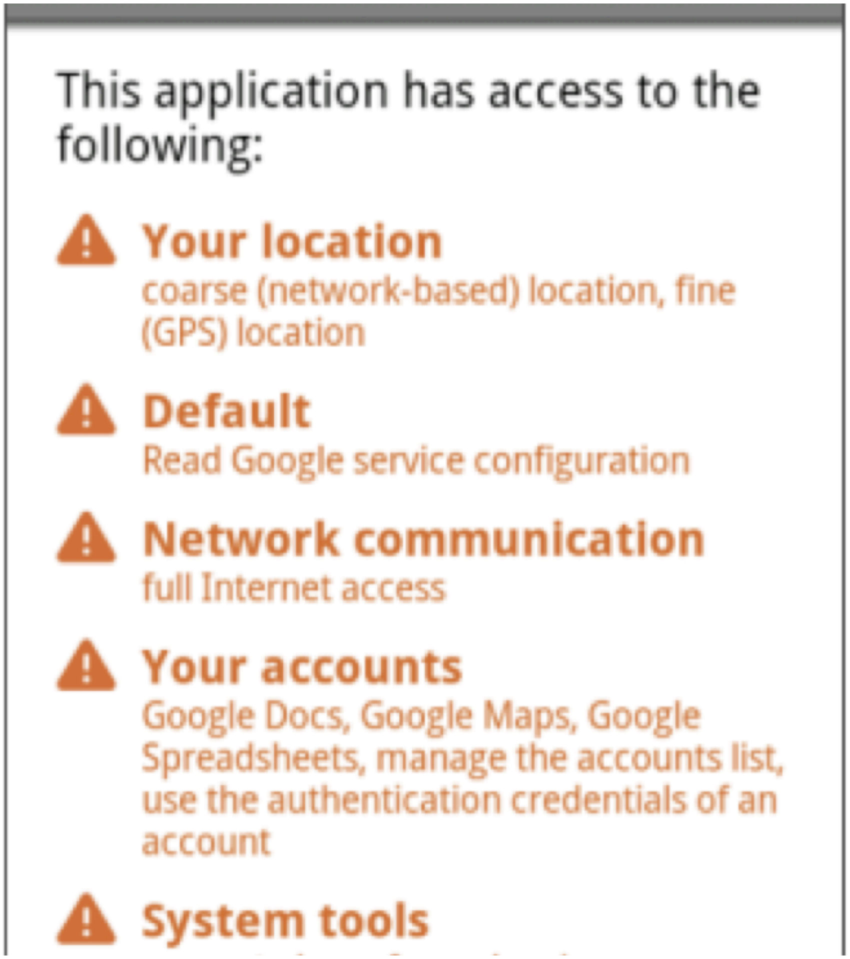
Developers? Developers! Developers!


DEVELOPERS
Developers, developers, developers, developers!
Developers, developers, developers, developers!
Developers, developers, developers! developers!

Privacy-Preserving API design?

- *Observation*: today developers have options
  - take all,
  - or nothing
- *Evidence*: some developers are trying to follow least privilege
- *1. Question*: Can we design a privacy-preserving clean-slate API?



This application has access to the following:

⚠ **Your location**
coarse (network-based) location, fine (GPS) location

⚠ **Default**
Read Google service configuration

⚠ **Network communication**
full Internet access

⚠ **Your accounts**
Google Docs, Google Maps, Google Spreadsheets, manage the accounts list, use the authentication credentials of an account

⚠ **System tools**

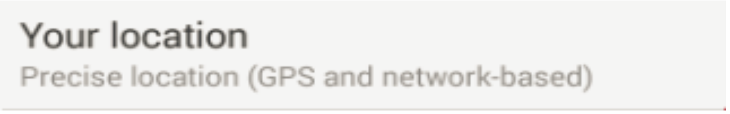
Can We Nudge Developers?

- *1. Question*: Can we design a privacy-preserving API?
  - Yes
  - Other have done it, too!

- *What we should be asking*: Can we nudge developers to make better user privacy decisions with API designs?

Localization Options (Permissions)

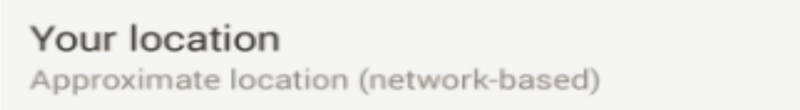
- ACCESS_FINE_LOCATION (GPS)



Your location

Precise location (GPS and network-based)

- ACCESS_COARSE_LOCATION (WiFi or cell network)



Your location

Approximate location (network-based)

- "To meet the privacy expectations of users when your app requests permission for coarse location (and not fine location), the system will not provide a user location estimate that's more accurate than a city block." – Android 4.2.

Android Location API

```
//Acquire a reference to the system Location Manager
LocationManager locationManager = (LocationManager)
this.getSystemService (Context.LOCATION SERVICE);
//Define a listener that responds to postal code updates
LocationListener locationListener = new LocationListener() {
public void onLocationChanged(Location location) {
String msg = "Updated Location: " +
          Double.toString(location.getLatitude()) + "," +
          Double.toString(location.getLongitude());
```

- And then reverse geocoding

Example Modified API

```
// Acquire a reference to the system Location Manager
LocationManager locationManager = (LocationManager)
this.getSystemService (Context.LOCATION SERVICE);
// Define a listener that responds to postal code updates
LocationListener locationListener = new LocationListener() {
public void onPostalCodeChanged(Location location) {
        String zipCode = location.getPostalCode() ;
        getMyWeather (zipCode) ;
```

Method

- Participants screened and randomly divided to five groups
- Non-Android Group (Some Java experience)
  - Control Group (using just the baseline API)
  - Treatment group A (TA)
  - Treatment group B (TB)
- Android Group (Some Experience with Java/Android)
  - Treatment group C (TC)
  - Treatment group D (TD)

- No mention about privacy to avoid biasing participants.
  - Questions about privacy after completing the tasks

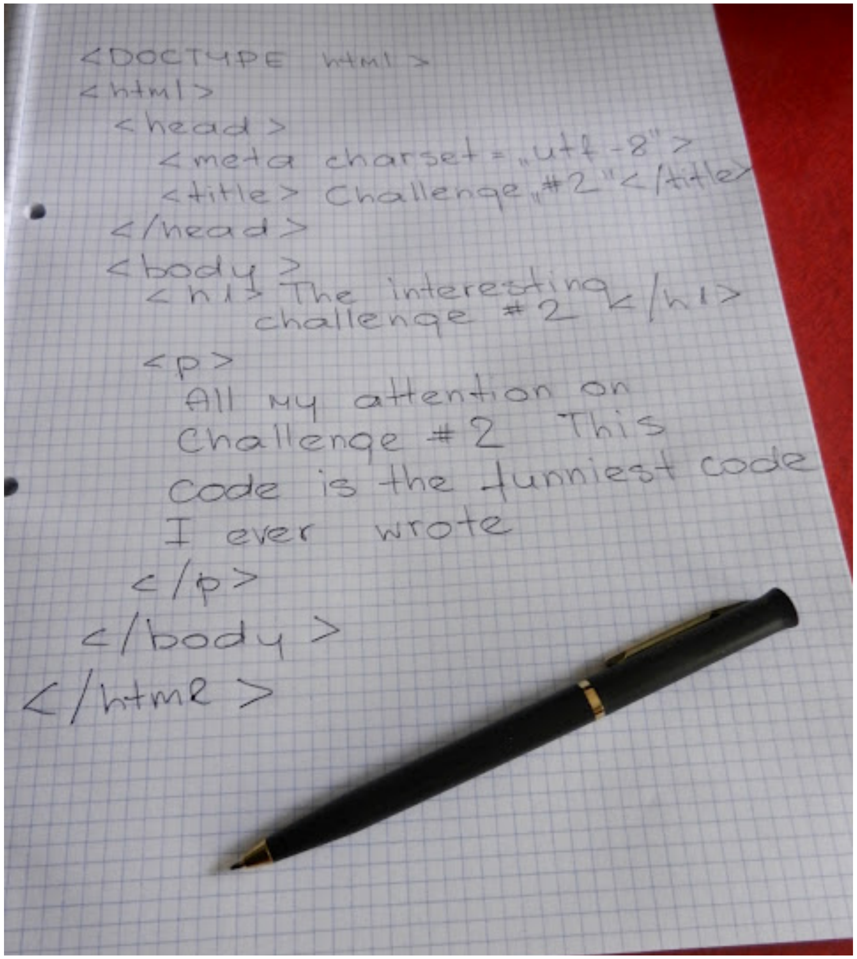
Method

- Android Location baseline API documentation
- Treatment Android Location API
  - Everything in the baseline API
  - And our modified APIs
  - Order of the presentation varied between treatment groups (TA, TC) vs (TB, TD)

- Programming Tasks:
  - Weather app
  - Running app
  - Address app

Method: Lo-fi programming

Prototyping for Tiny Fingers



```
<DOCTYPE html>
<html>
  <head>
    <meta charset=„utf-8">
    <title> Challenge „#2"</title>
  </head>
  <body>
    <h1> The interesting
          challenge #2 </h1>
    <p>
      All my attention on
      Challenge #2  This
      code is the funniest code
      I ever wrote
    </p>
  </body>
</html>
```

Results

Group	Participants	Used Our API	Reverse Geo	Copied example	????????? ????????
CG	6	N/A	3	2	1
TA	5	4	0	1	0
TB	6	3	1	1	1
TC	5	5	0	0	0
TD	3	2	1	0	0

Why?

- *“I tried to make it the postal code or city because that is usually what people want. They don’t usually want latitude and longitude”* - TA2, on using the getPostalCode(), requestPostal- CodeUpdates() and onPostalCodeChanged() for the weather task.

- *“Geocoder was the most confusing part”* - TB5.

Why not?

- *“You get them [geocoordinates] from location manager. Then you have to use this part - geocoding. I tried to do that for this one but I didn’t really know how to”* - TB2.

- “I may have chosen this [Geocoder class] because it was first. I was reading through and I saw this and I was like, oh that will work” - TD4.

When Asked About Privacy

- *“I know about them [location privacy issues]. It flashed my mind for a second, like do you want to track every single detail? But then I just continued doing what I was doing ”* - TA3 (used our API).

- *“That’s why I tried to avoid GPS when possible because lots of people are sensitive to giving fine location data away. And I tried to use the network when possible because even if they’re sure they know you’re connected to this tower, still towers cover such a vast area and depending on where you are there is such a huge number of people attached to that network they cant identify who you are without more information on that”* - TC1 (used our API).

When Asked About Privacy

- *"Your phone is capable of sending your coordinates at all times to a server. I chose to use postal code as opposed to street address or coordinates because I didn't want to send out too much information"* - TC4, discussing his code on weather application.

- *"I didn't think about it [location privacy] because I just assume that once they [users] install the application they've already given permission for it."* - TC3

Limitations

- Participants Rutgers CS/ECE undergrads/grads
- Small group sizes, no statistical analysis
- Monetary incentives: 3rd party ad-network libraries
- StackOverflow?

Conclusions

- When approaching API documentation from a “blank slate” participants tend to follow the sample code closely.

- First step to indicate that if developers have privacy-preserving examples in official documentation, developers could be using them instead of less privacy-preserving alternatives.

Shameless Plug

- Afternoon session: Huiqing Fu et al. “A Field Study of Run-Time Access Disclosures on Android Smartphones”
- Over 200 articles around the world.
  - MIT TR, Le Monde, Yahoo! News, ComputerWorld, Heise, Slashdot, The Register, NOS 3, IEEE Spectrum…
  - New Age Online (?), US liberal and conservative media

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Thank you

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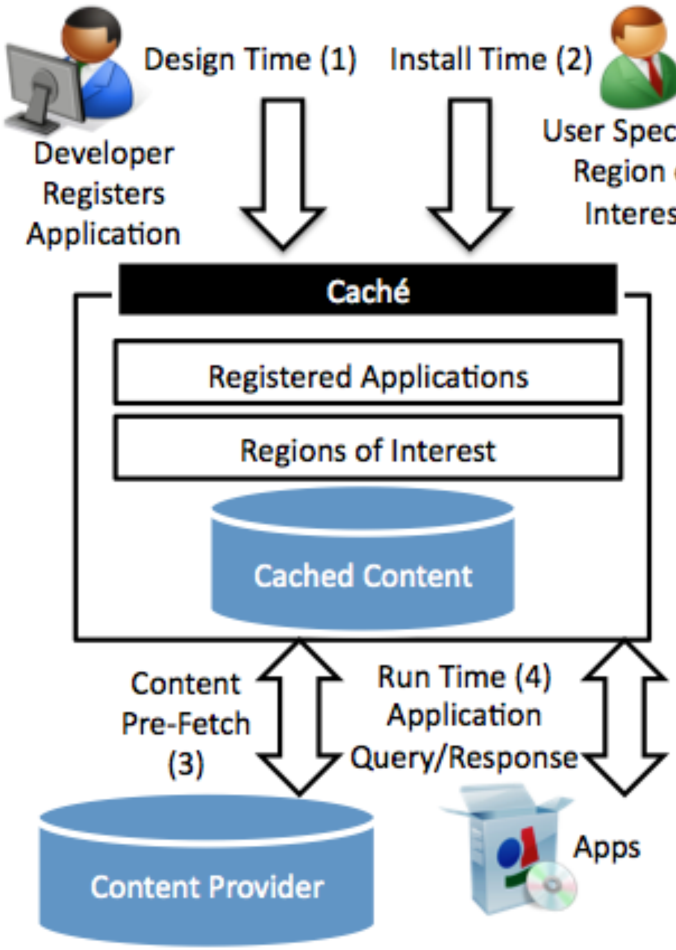
BACKUP SLIDES

Caché Architecture (Amini et al., MobiSys'11)


Design Time (1)
Install Time (2)
Developer Registers Application
User Specifies Region of Interest
Caché
Registered Applications
Regions of Interest
Cached Content
Content Pre-Fetch (3)
Run Time (4) Application Query/Response
Content Provider
Apps