CSE 484 / CSE M 584: Computer Security and Privacy

Mobile Platform Security
[continued]

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Admin

- Office hours: Wed 1:30 (not today)

- Lab 3 is out **(due June 3, 8pm)**
  - Android security
  - 3 parts (+1 extra credit)
  - You should not need to write a lot of code
  - Don't procrastinate on getting an Android development environment set up!

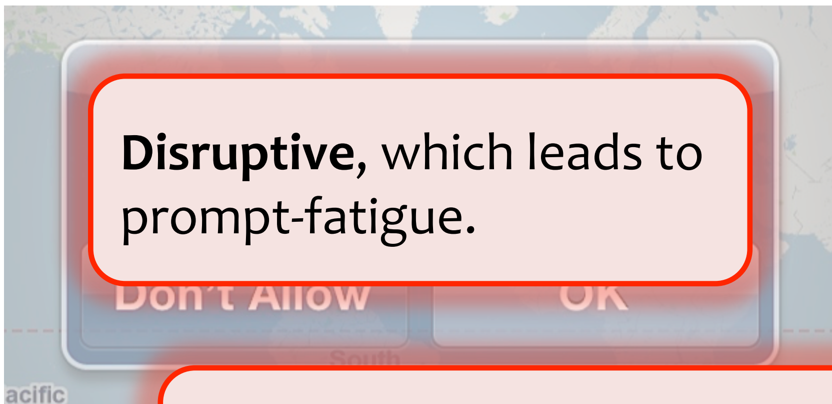
Challenges with Isolated Apps

So mobile platforms isolate applications for security, but…

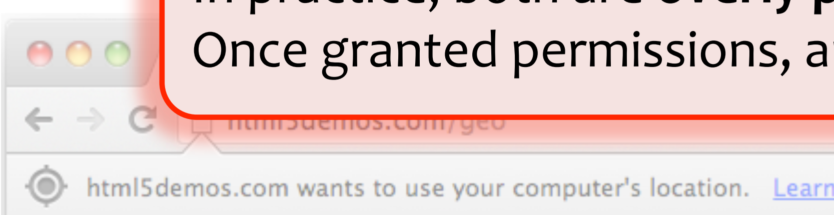
1. Permissions: **How can applications access sensitive resources?**
2. Communication: How can applications communicate with each other?

State of the Art

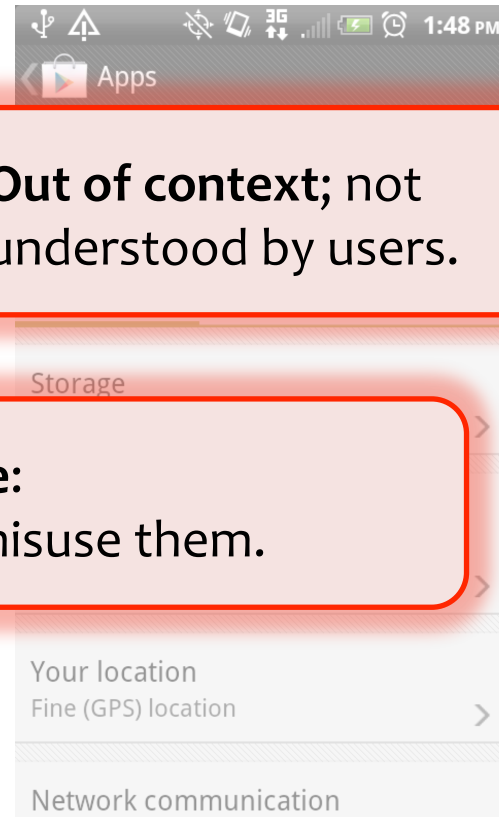
Prompts (time-of-use)



Disruptive, which leads to prompt-fatigue.



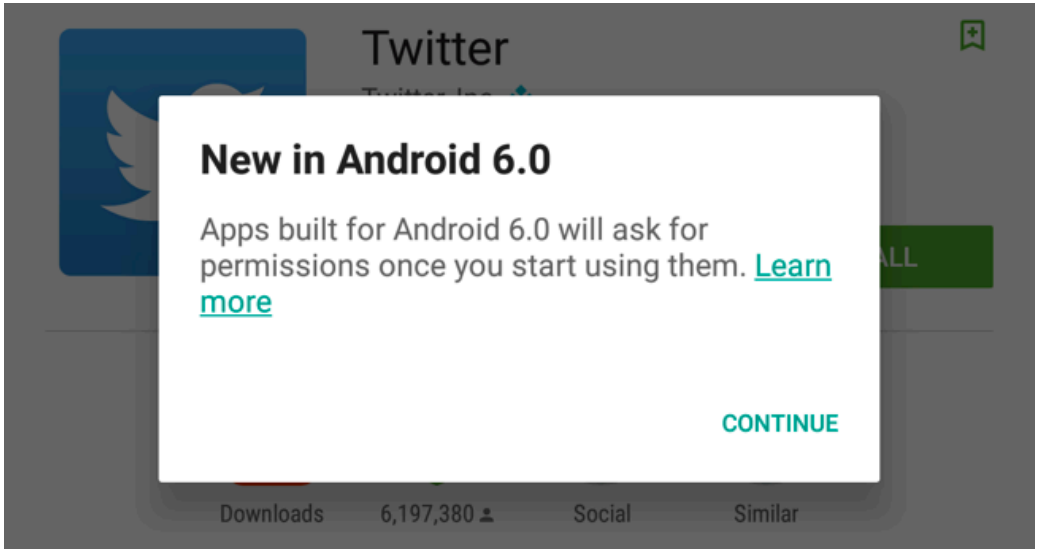
Manifests (install-time)



Out of context; not understood by users.

In practice, both are **overly permissive:**
Once granted permissions, apps can misuse them.

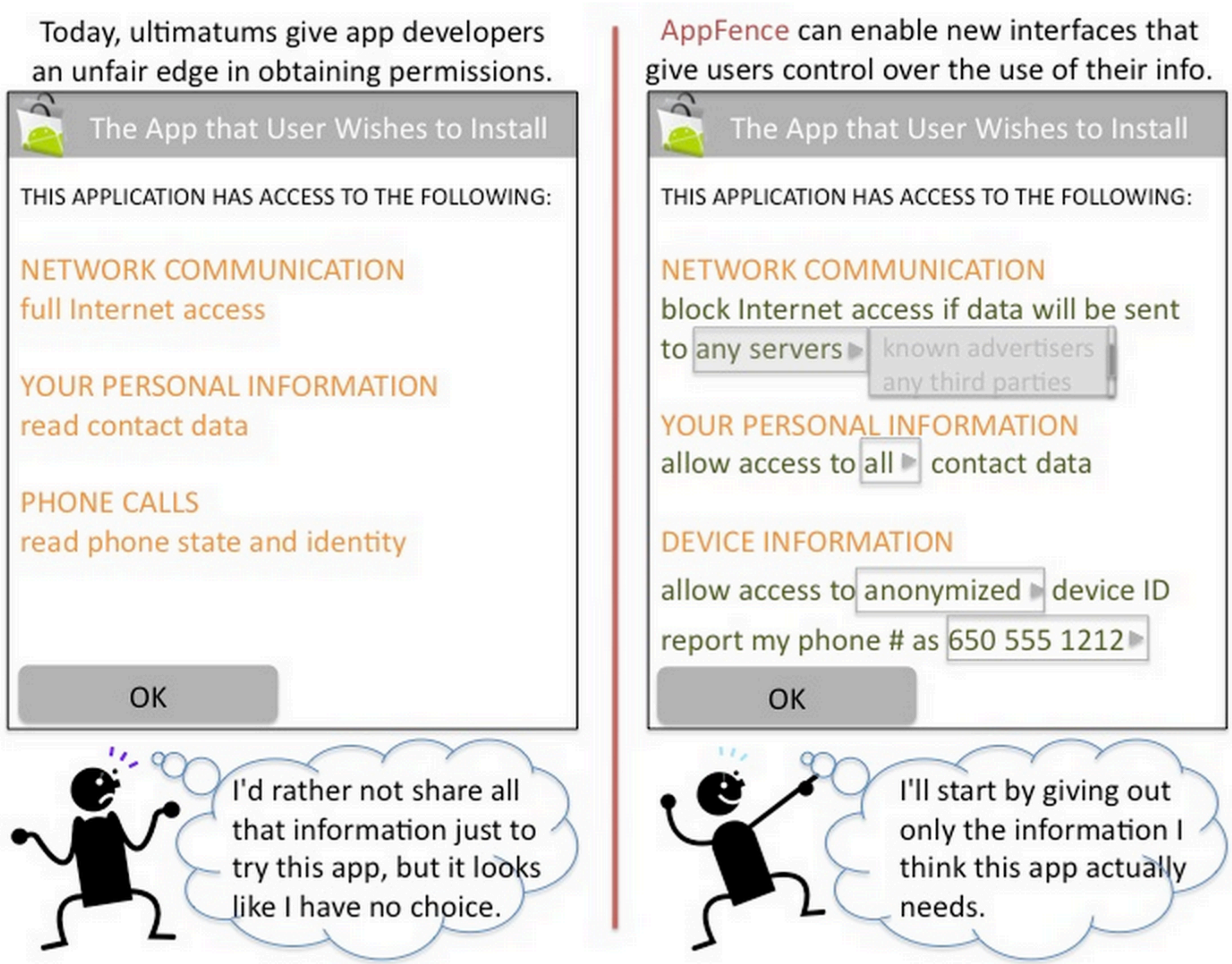
Android 6.0: Prompts!



- First-use prompts for sensitive permission (like iOS).
- Big change! Now app developers need to check for permissions or catch exceptions.

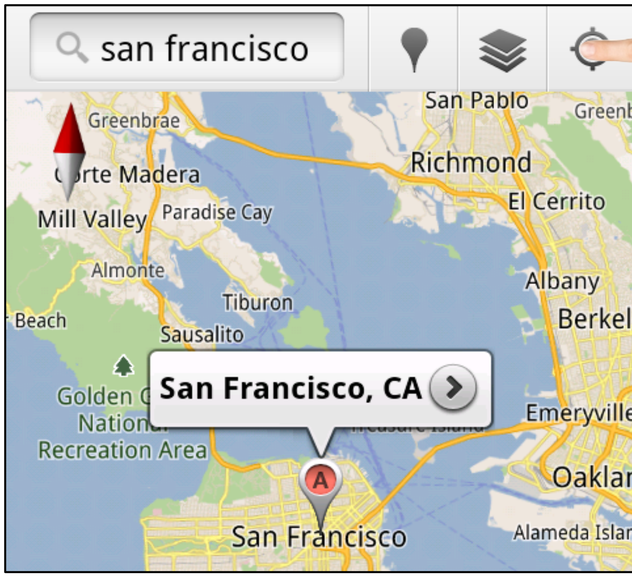
[Hornyack et al.]

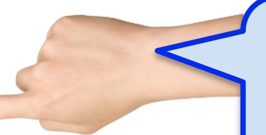
Improving Permissions: AppFence



[our work]

Improving Permissions: User-Driven Access Control

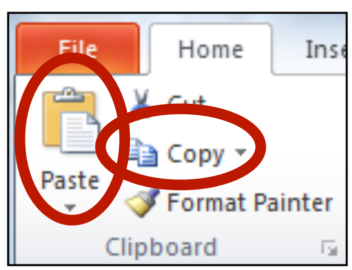


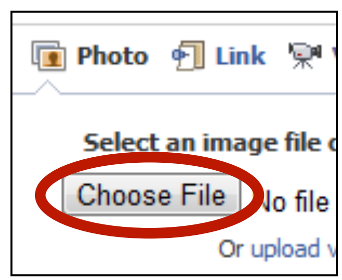


Let this application access my location **now**.

Insight:

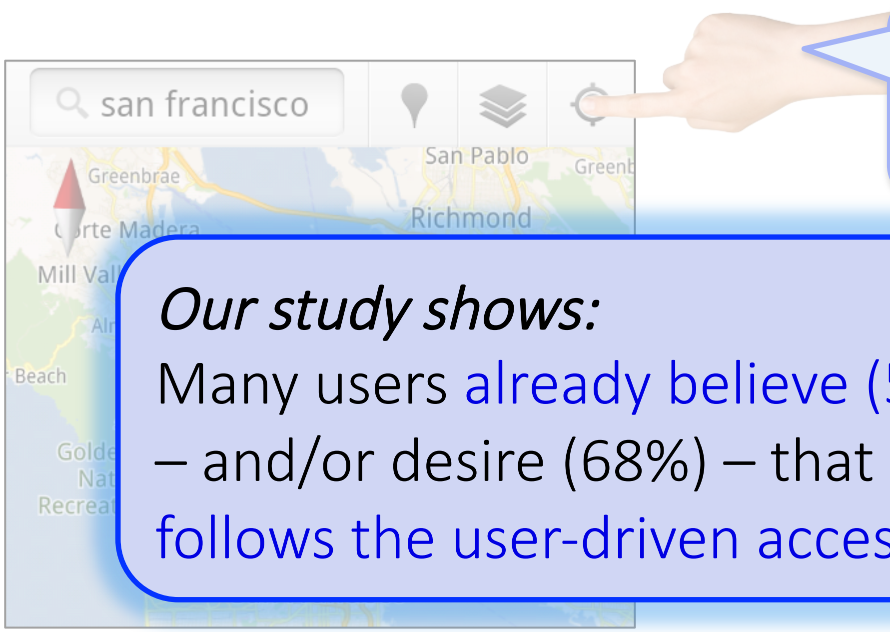
A user's natural UI actions within an application implicitly carry permission-granting semantics.





[our work]

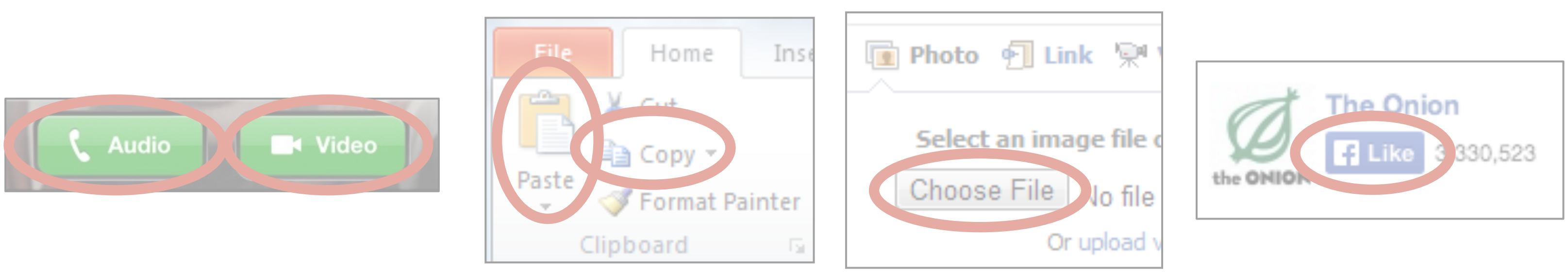
Improving Permissions: User-Driven Access Control



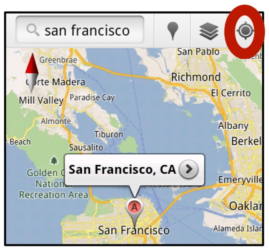
Let this application access my location **now**.

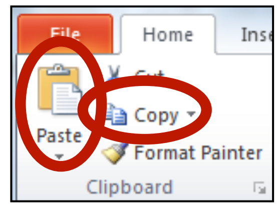
s within
carry
antics.

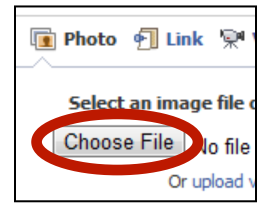
Our study shows:
Many users already believe (52% of 186) – and/or desire (68%) – that resource access follows the user-driven access control model.



New OS Primitive:
Access Control Gadgets (ACGs)







Approach: Make resource-related UI elements first-class operating system objects (access control gadgets).

- To receive resource access, applications must embed a system-provided ACG.
- ACGs allow the OS to capture the user's permission granting intent in application-agnostic way.

Challenges with Isolated Apps

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Reminder: Android Applications

- Activities provide user interfaces.
- Services run in the background.
- BroadcastReceivers receive messages sent to multiple applications (e.g., BOOT_COMPLETED).
- ContentProviders are databases addressable by their application-defined URIs.

- AndroidManifest.xml
  - Specifies application components
  - Specifies required permissions

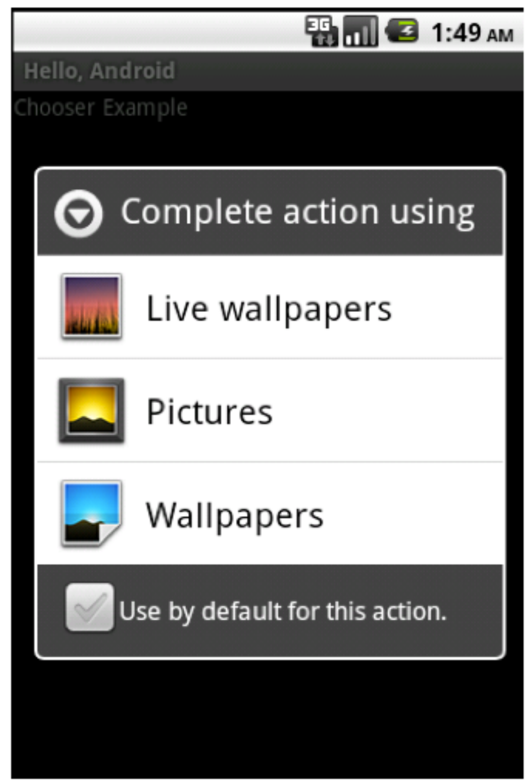
(2) Inter-Process Communication

- Primary mechanism in Android: Intents
  - Sent between application components
    - e.g., with `startActivity(intent)`
  - Explicit: specify component name
    - e.g., com.example.testApp.MainActivity
  - Implicit: specify action (e.g., ACTION_VIEW) and/or data (URI and MIME type)
    - Apps specify Intent Filters for their components.

[Chin et al.]

Unauthorized Intent Receipt

- Attack #1: Eavesdropping / Broadcast Thefts
  - Implicit intents make intra-app messages public.
- Attack #2: Activity Hijacking
  - May not always work:
- Attack #3: Service Hijacking
  - Android picks one at random upon conflict!



[Chin et al.]

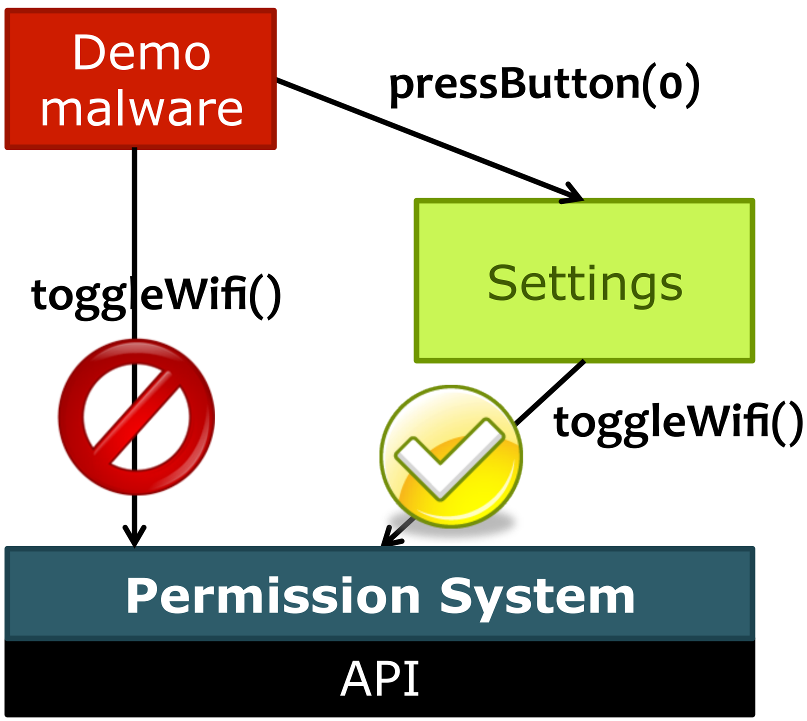
Intent Spoofing

- Attack #1: General intent spoofing
  - Receiving implicit intents makes component public.
  - Allows data injection.
- Attack #2: System intent spoofing
  - Can't directly spoof, but victim apps often don't check specific "action" in intent.

[Felt et al.]

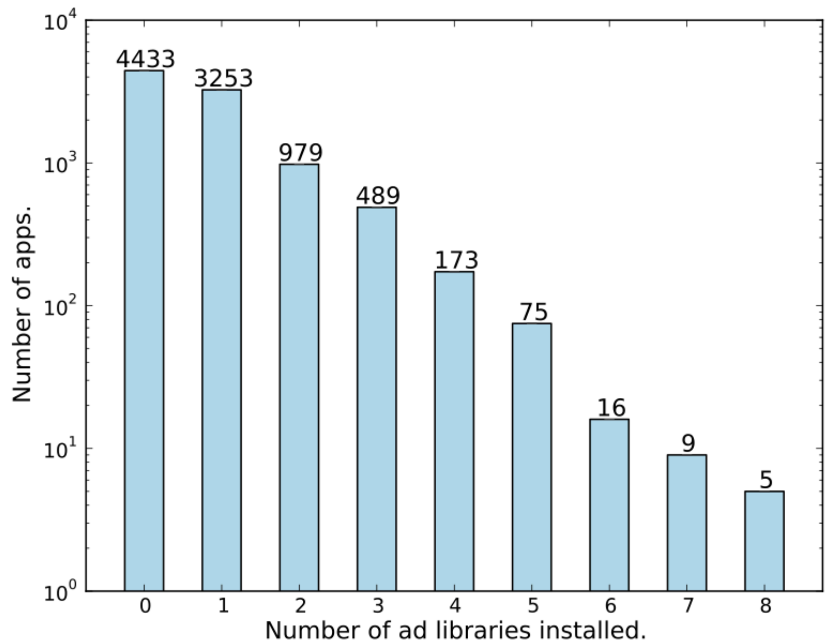
Permission Re-Delegation

- An application without a permission gains additional privileges through another application.
- Demo video
- Settings application is deputy: has permissions, and accidentally exposes APIs that use those permissions.

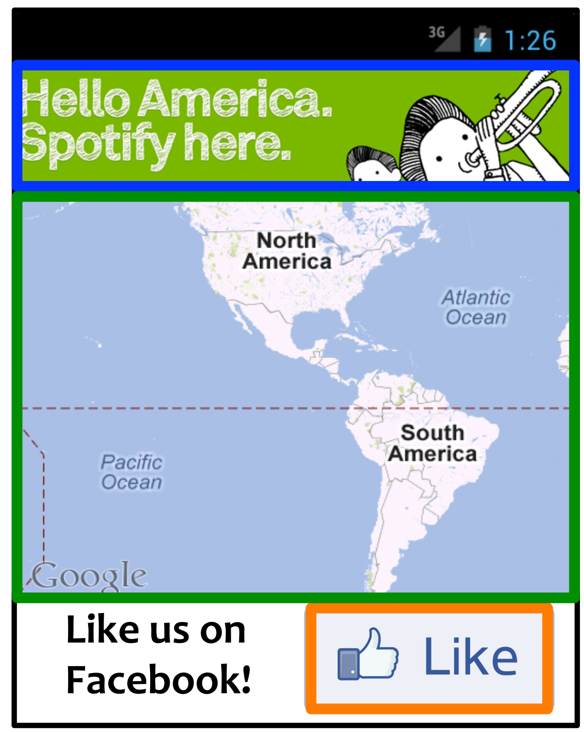


Aside: Incomplete Isolation

Embedded UIs and libraries always run with the host application's permissions! (No same-origin policy here…)



[Shekhar et al.]



Ad from ad library

Map from Google library

Social button from Facebook library

More on Android…

Android Application Signing

- Apps are signed
  - Often with self-signed certificates
  - Signed application certificate defines which user ID is associated with which applications
  - Different apps run under different UIDs
- Shared UID feature
  - Shared Application Sandbox possible, where two or more apps signed with same developer key can declare a shared UID in their manifest

Shared UIDs

- App 1: Requests GPS / camera access
- App 2: Requests Network capabilities

- Generally:
  - First app can't exfiltrate information
  - Second app can't exfiltrate anything interesting
- With Shared UIDs (signed with same private key)
  - Permissions are a superset of permissions for each app
  - App 1 can now exfiltrate; App 2 can now access GPS / camera

File Permissions

- Files written by one application cannot be read by other applications
  - Previously, this wasn't true for files stored on the SD card (world readable!) – Android cracked down on this

- It is possible to do full file system encryption
  - Key = Password/PIN combined with salt, hashed

Memory Management

- Address Space Layout Randomization to randomize addresses on stack
- Hardware-based No eXecute (NX) to prevent code execution on stack/heap
- Stack guard derivative
- Some defenses against double free bugs (based on OpenBSD's dmalloc() function)
- etc.

[See http://source.android.com/tech/security/index.html]

Android Fragmentation

- Many different variants of Android (unlike iOS)
  - Motorola, HTC, Samsung, …
- Less secure ecosystem
  - Inconsistent or incorrect implementations
  - Slow to propagate kernel updates and new versions

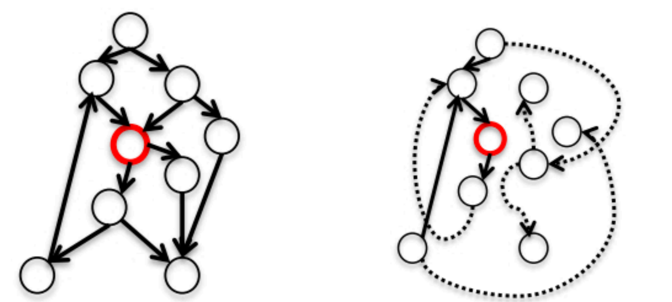
Version	Codename	API	Distribution
2.2	Froyo	8	0.1%
2.3.3 - 2.3.7	Gingerbread	10	2.2%
4.0.3 - 4.0.4	Ice Cream Sandwich	15	2.0%
4.1.x	Jelly Bean	16	7.2%
4.2.x		17	10.0%
4.3		18	2.9%
4.4	KitKat	19	32.5%
5.0	Lollipop	21	16.2%
5.1		22	19.4%
6.0	Marshmallow	23	7.5%

Data collected during a 7-day period ending on May 2, 2016.
Any versions with less than 0.1% distribution are not shown.

[https://developer.android.com/about/dashboards/index.html]

What about iOS?

- Apps are sandboxed
- Encrypted user data
  - See recent news…
- App Store review process is (maybe) stricter
  - But not infallible: e.g., see Wang et al. "Jekyll on iOS: When Benign Apps Become Evil" (USENIX Security 2013)
- No "sideloading" apps
  - Unless you jailbreak



CFG exhibited in vetting process. Red node represents the vulnerabilities.

Dynamic CFG in victim's device after exploiting vulnerabilities.

Figure 1: High Level Intuition