CSE 484 / CSE M 584: Computer Security and Privacy

Mobile Platform Security

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Roadmap

- Mobile malware
- Mobile platforms vs. traditional platforms
- Deep dive into Android
  - Continued next Wednesday
  - More details on iOS in section

- Guest lectures Wednesday and Friday
- Holiday on Monday!

Questions: Mobile Malware

Q1: How might malware authors get malware onto phones?

Q2: What are some goals that mobile device malware authors might have?

Q3: What technical things might malware authors do?

Smartphone (In)Security

Users accidentally install malicious applications.


Over 60% of Android malware steals your money via premium SMS, hides in fake forms of popular apps

By Emil Protalinski, Friday, 5 Oct '12 , 05:50pm

Smartphone (In)Security

Even legitimate applications exhibit questionable behavior.

Top Mobile Apps Overwhelmingly Leak Private Data: Study

By Robert Lemos | Posted 2013-07-31 Email Print

paid apps
pplication-

isk more often
more likely to
applications,
according to a survey of the top 400 mobile applications

Hornyack et al.: 43 of 110 Android applications sent location or phone ID to third-party advertising/analytics servers.

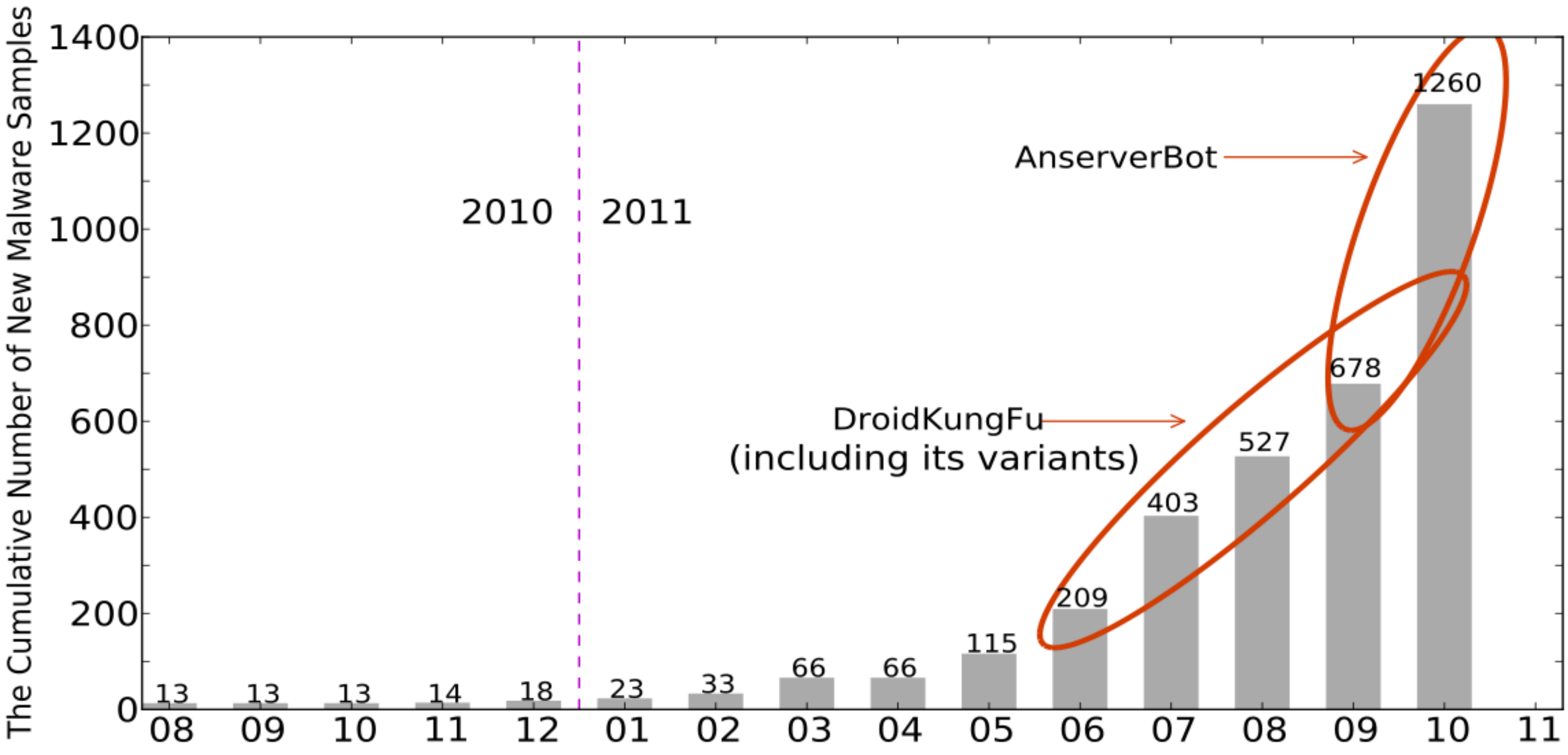
Android flashlight app tracks users via GPS, FTC says hold on

By Michael Kassner in IT Security, December 11, 2013, 9:49 PM PST

[Zhou et al.]

Malware in the Wild

Android malware is growing.



Mobile Malware Attack Vectors

- Unique to phones:
  - Premium SMS messages
  - Identify location
  - Record phone calls
  - Log SMS
- Similar to desktop/PCs:
  - Connects to botmasters
  - Steal data
  - Phishing
  - Malvertising

Mobile Malware Examples

- **DroidDream** (Android)
  - Over 58 apps uploaded to Google app market
  - Conducts data theft; send credentials to attackers
- **Zitmo** (Symbian,BlackBerry,Windows,Android)
  - Poses as mobile banking application
  - Captures info from SMS – steal banking 2nd factors
  - Works with Zeus botnet
- **Ikee** (iOS)
  - Worm capabilities (targeted default ssh pwd)
  - Worked only on jailbroken phones with ssh installed

Mobile Malware Examples

"ikee is never going to give you up"

[Zhou et al.]

(Android) Malware in the Wild

What does it do?

	Root Exploit	Remote Control		Financial Charges			Information Stealing		
		Net	SMS	Phone Call	SMS	Block SMS	SMS	Phone #	User Account
# Families	20	27	1	4	28	17	13	15	3
# Samples	1204	1171	1	256	571	315	138	563	43

Rooting and Jailbreaking

- Allows user to run applications with root privileges
  - e.g., modify/delete system files, app management, CPU management, network management, etc.
- Done by exploiting vulnerability in firmware to install `su` binary.
- Double-edged sword…
- Note: iOS is more restrictive than Android
  - Doesn't allow "side-loading" apps, etc.

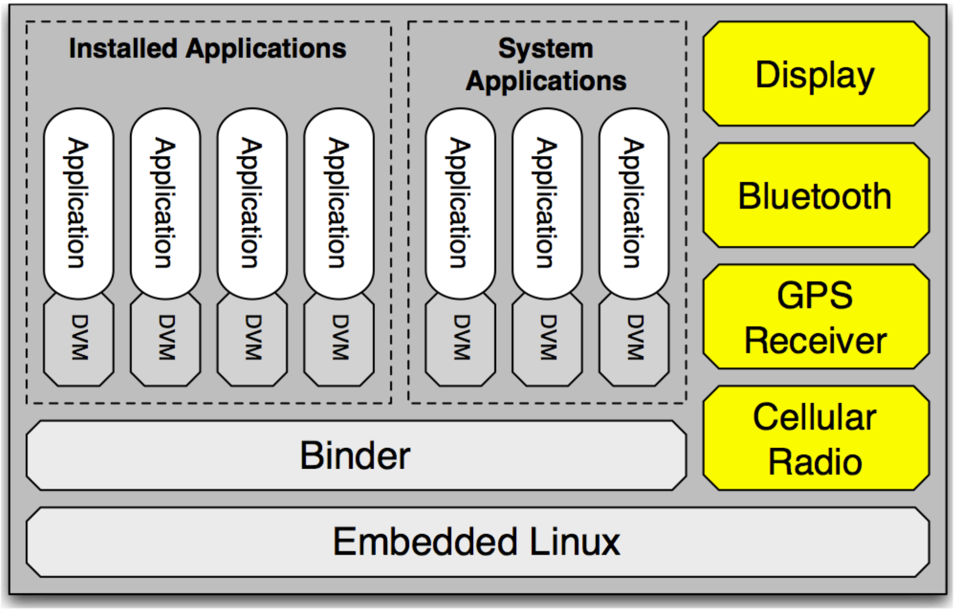
What’s Different about Mobile Platforms?

- Applications are isolated
  - Each runs in a separate execution context
  - No default access to file system, devices, etc.
  - **Different than traditional OSes** where multiple applications run with the same user permissions!

- **App Store:** approval process for applications
  - Market: Vendor controlled/Open
  - App signing: Vendor-issued/self-signed
  - User approval of permissions

More Details: Android

[Enck et al.]



- Based on Linux
- Application sandboxes
  - Applications run as separate UIDs, in separate processes.
  - Memory corruption errors only lead to arbitrary code execution in the context of the **particular** application, not complete system compromise!
  - (Can still escape sandbox – but must compromise Linux kernel to do so.) ← allows rooting

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

Android Malware Techniques

- Add background Service
- Modify existing application source code
- Component library replacement

- To avoid basic signature detection:
  - Dynamically download new Dalvik bytecode
  - Use DexClassLoader API to run the downloaded code

- Use exploit to obtain root access
- Many other techniques

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?

(1) Permission Granting Problem

Smartphones (and other modern OSes) try to prevent such attacks by limiting applications' access to:

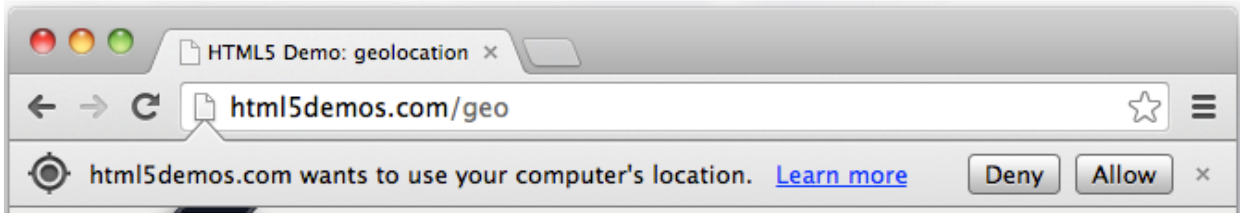
- System Resources (clipboard, file system).
- Devices (camera, GPS, phone, …).

How should operating system grant permissions to applications?

Standard approach: Ask the user.

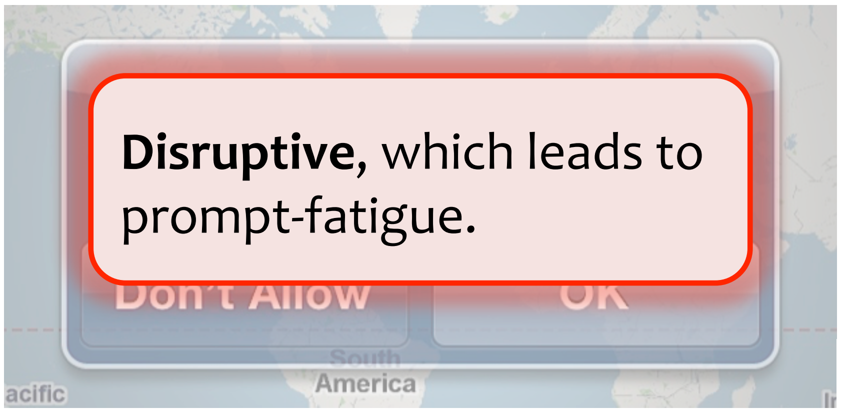
State of the Art

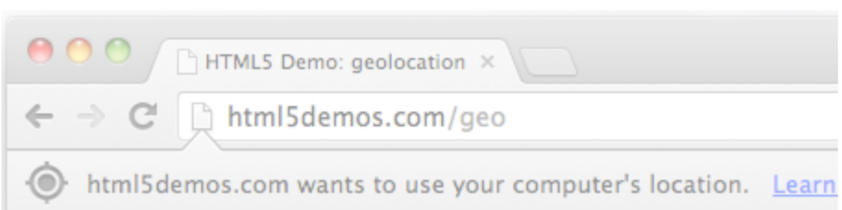
Prompts (time-of-use)



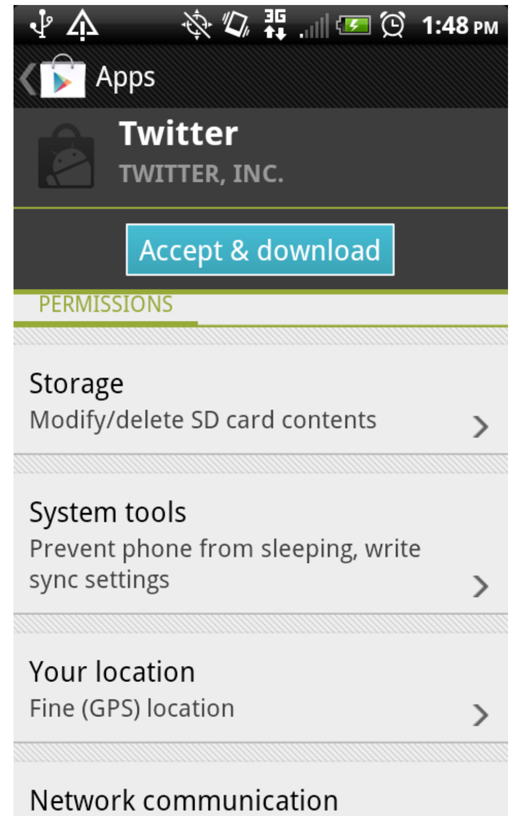
State of the Art

Prompts (time-of-use)



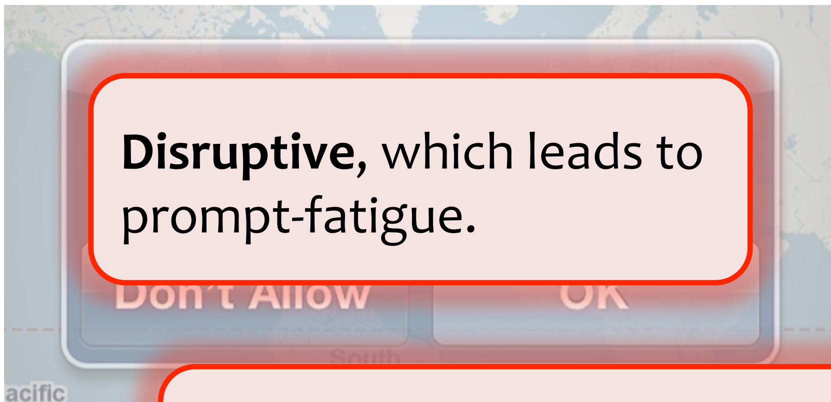


Manifests (install-time)

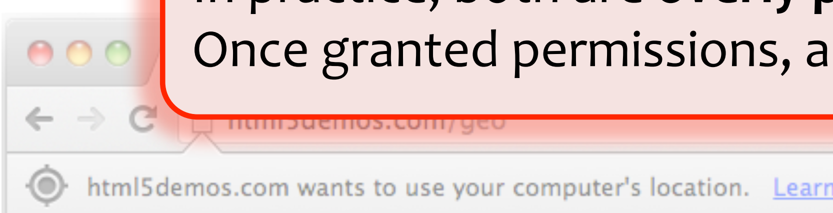


State of the Art

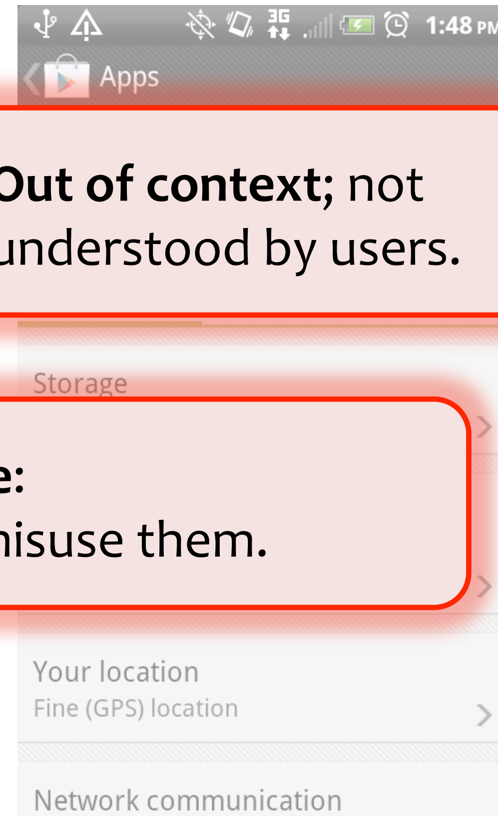
Prompts (time-of-use)



Disruptive, which leads to prompt-fatigue.



Manifests (install-time)

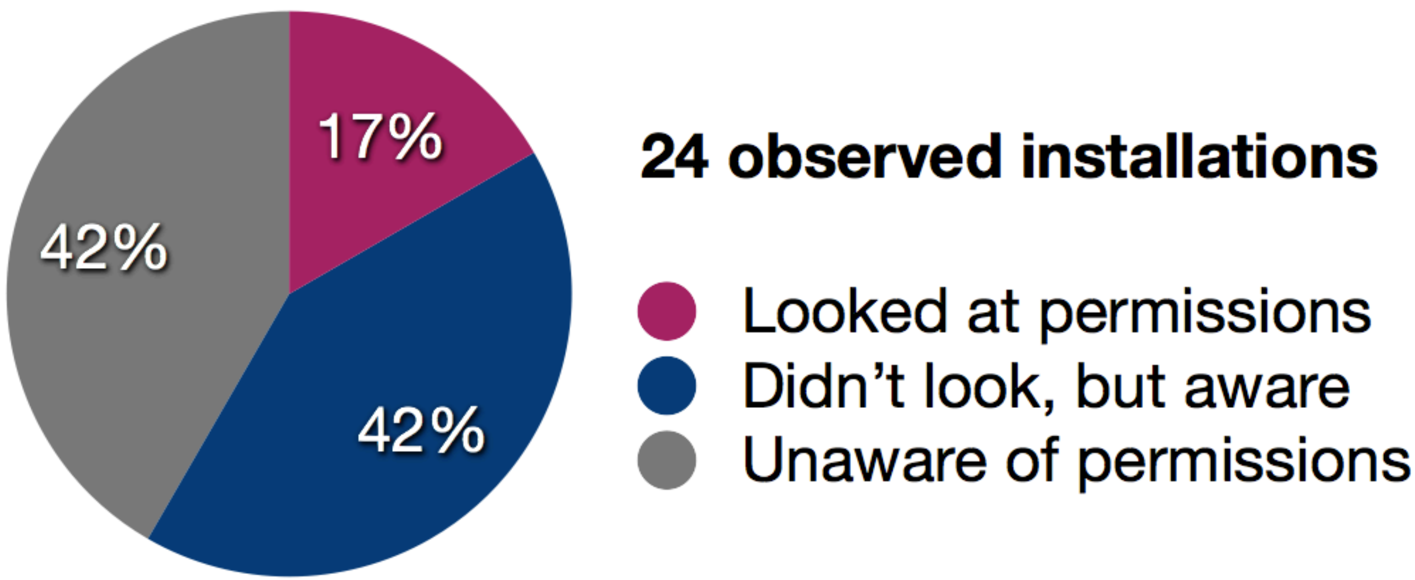


Out of context; not understood by users.

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

Are Manifests Usable?

Do users pay attention to permissions?



… but 88% of users looked at reviews.

[Felt et al.]

Are Manifests Usable?

Do users understand the warnings?

	Permission	n	Correct Answers	
1 Choice	READ_CALENDAR	101	46	45.5%
	CHANGE_NETWORK_STATE	66	26	39.4%
	READ_SMS1	77	24	31.2%
	CALL_PHONE	83	16	19.3%
2 Choices	WAKE_LOCK	81	27	33.3%
	WRITE_EXTERNAL_STORAGE	92	14	15.2%
	READ_CONTACTS	86	11	12.8%
	INTERNET	109	12	11.0%
	READ_PHONE_STATE	85	4	4.7%
	READ_SMS2	54	12	22.2%
4	CAMERA	72	7	9.7%

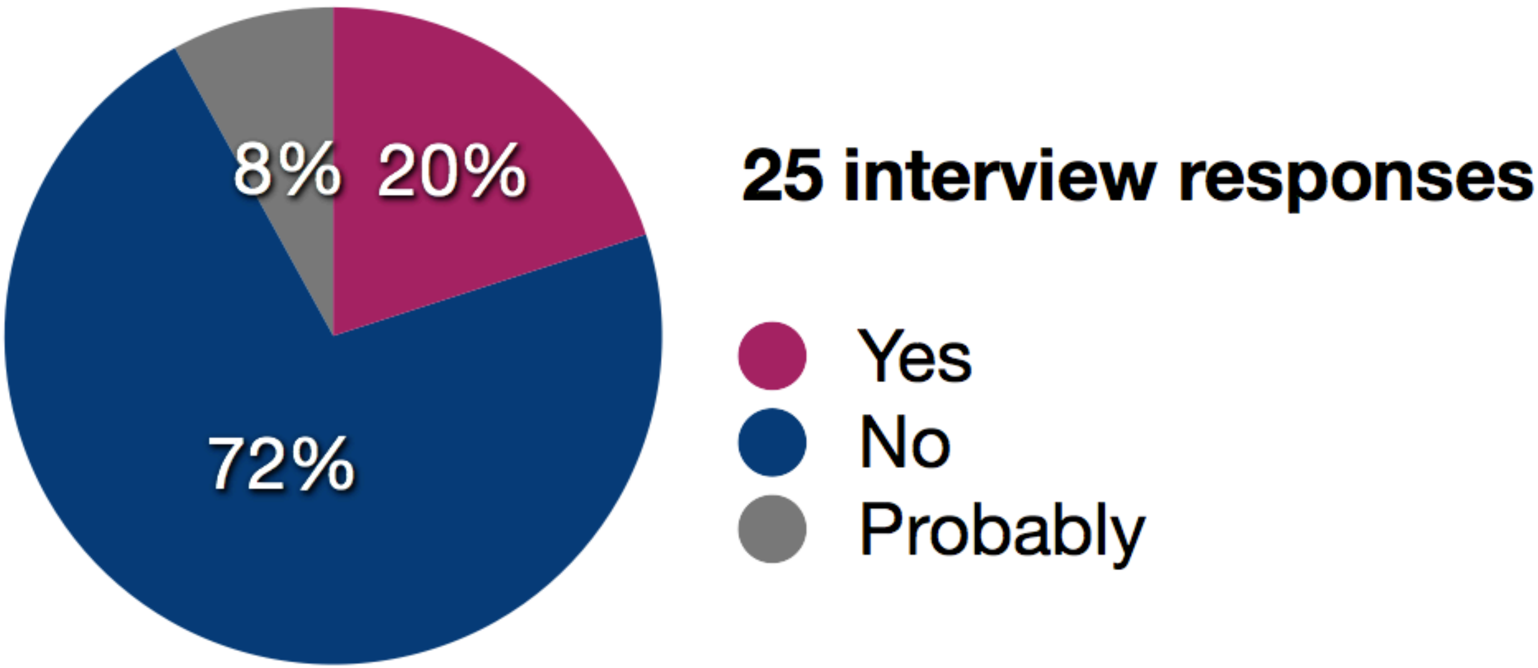
Table 4: The number of people who correctly answered a question. Questions are grouped by the number of correct choices. n is the number of respondents. (Internet Survey, $n = 302$)

[Felt et al.]

Are Manifests Usable?

Do users act on permission information?

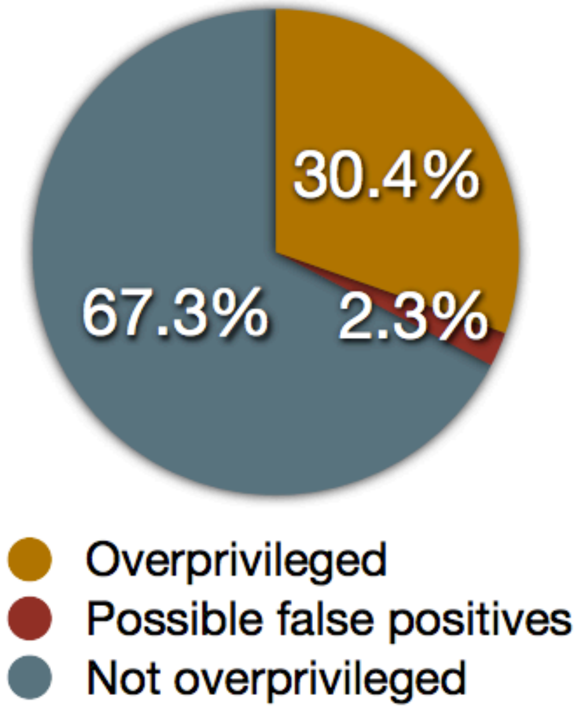
"Have you ever not installed an app because of permissions?"

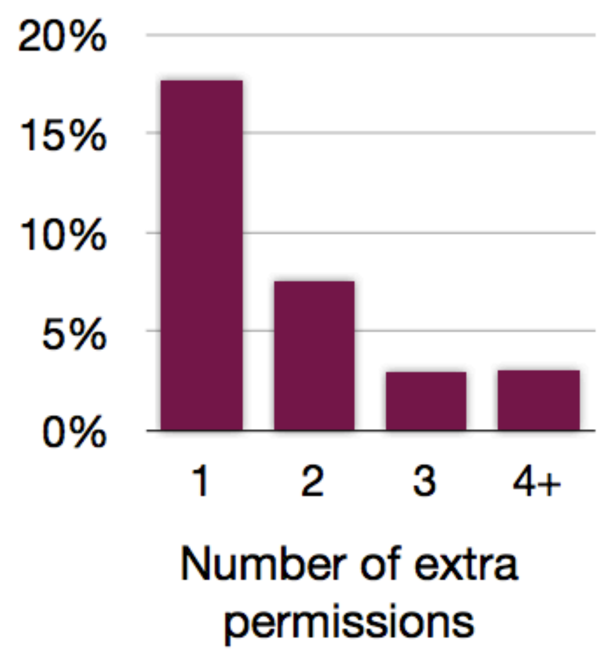


Over-Permissioning

- Android permissions are badly documented.
- Researchers have mapped APIs → permissions.

www.android-permissions.org (Felt et al.), http://pscout.csl.toronto.edu (Au et al.)

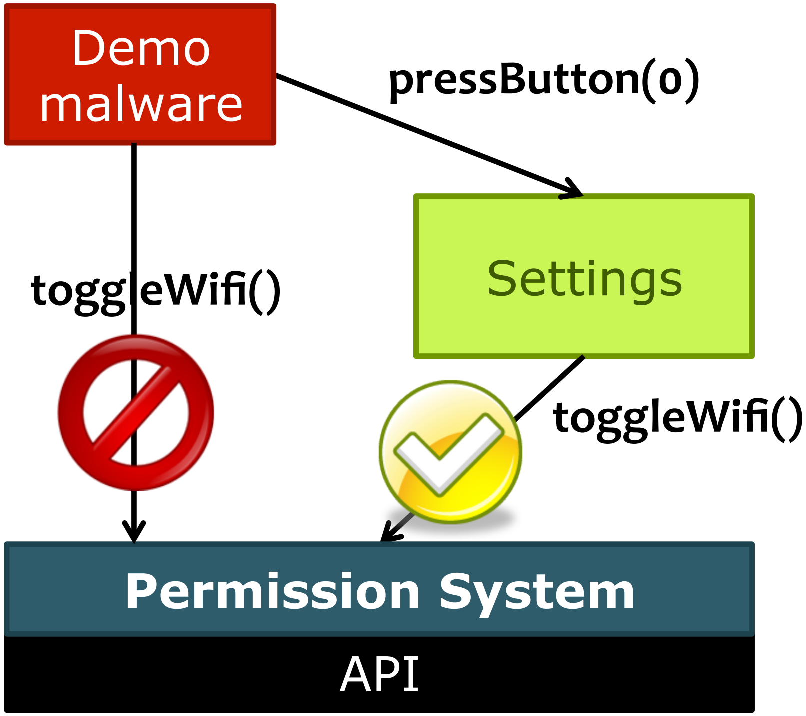




[Felt et al.]

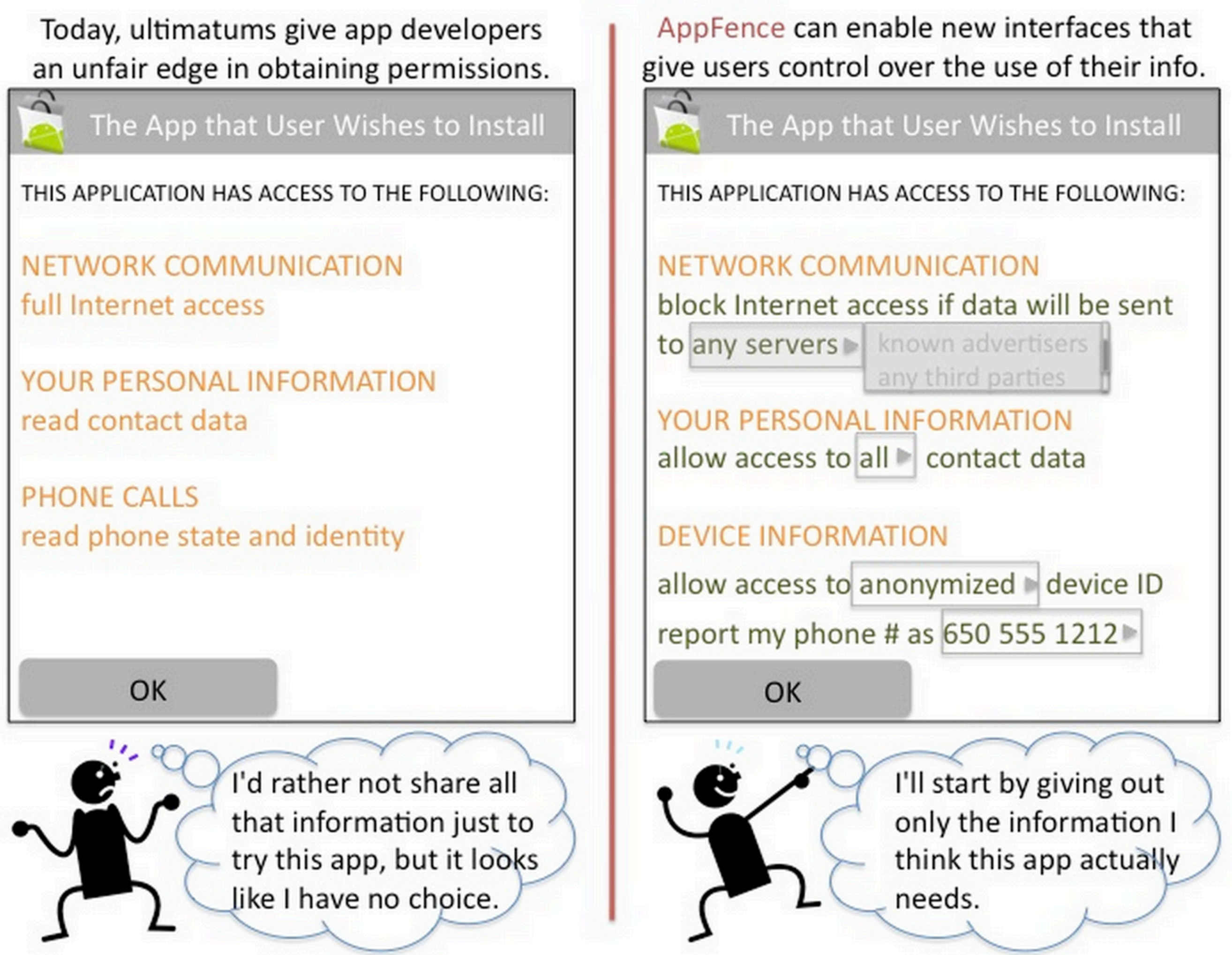
Permission Re-Delegation

- 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.



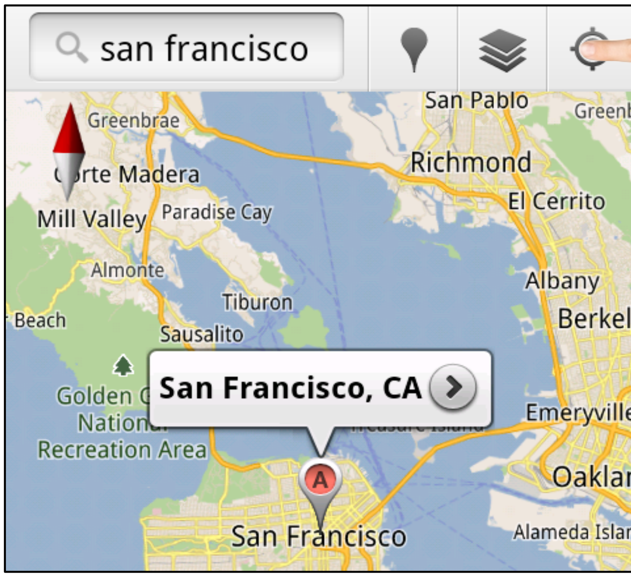
[Hornyack et al.]

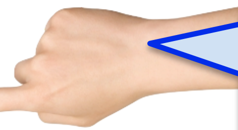
Improving Permissions: AppFence



[our work]

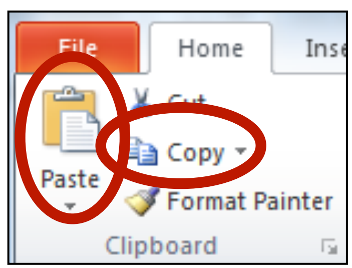
Improving Permissions: User-Driven Access Control

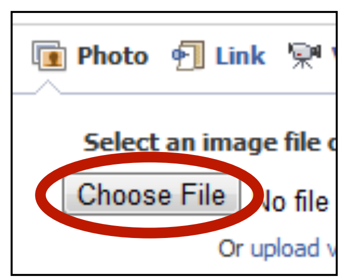




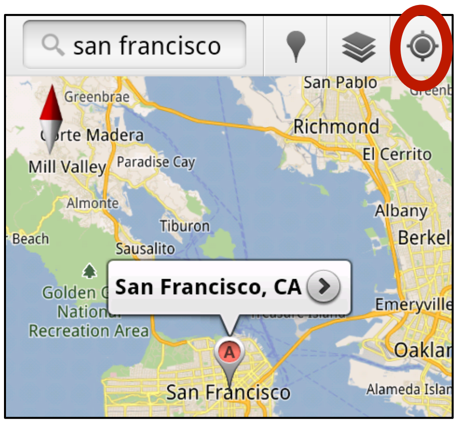
Let this application access my location **now**.

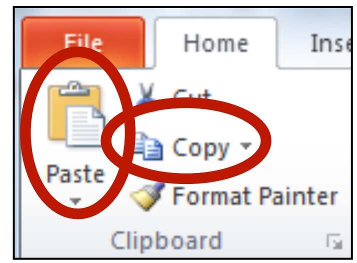
Insight:
A user's natural UI actions within an application implicitly carry permission-granting semantics.

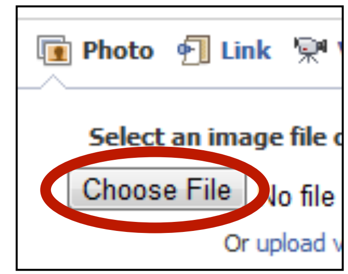




Access Control Gadgets (ACGs)







- Special UI elements that carry permission-granting semantics: When user clicks, grant access.
- ACGs are owned by system and embedded by apps: need to secure them!
  - No clickjacking, no programmatic clicking, etc.