CSE 484 / CSE M 584: Computer Security and Privacy

Anonymity
Mobile

Autumn 2018

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Admin

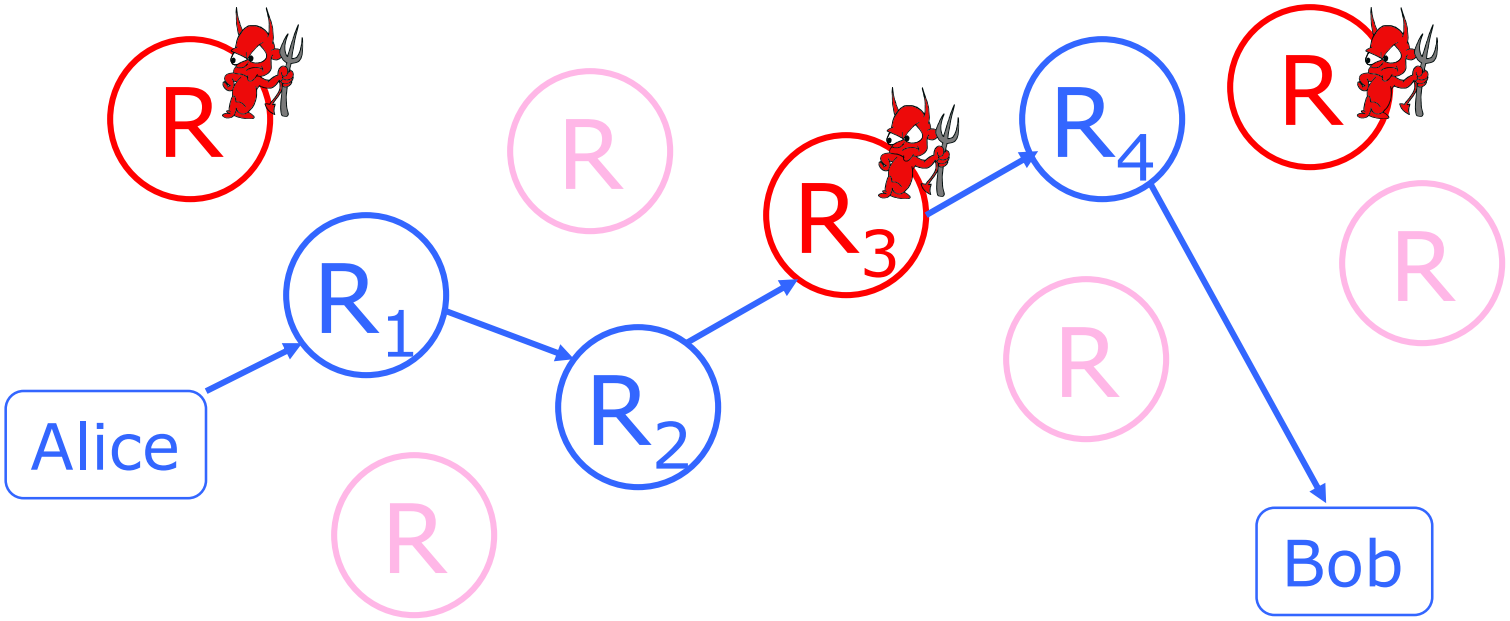
- HW 3 due Nov 30
- Lab 3 out this week, due Dec 7 (Quiz Section on Nov 29)

Admin

- Final Project Proposals: Looked great!
- Final Project Checkpoint: Nov 30 – preliminary outline and references
- Final Project Presentation: Dec 10 – 12-15-minute video – **must** be on time
- Explore something of interest to you, that could hopefully benefit you or your career in some way – technical topics, current events, etc

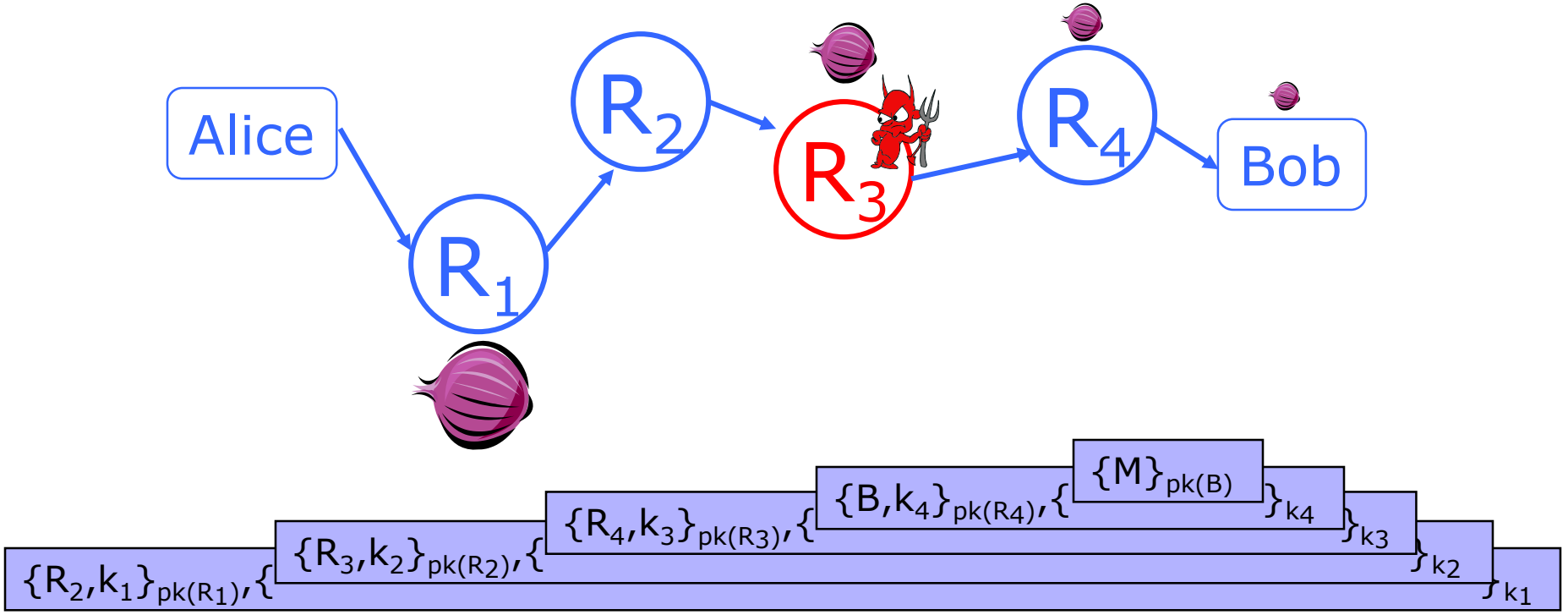
[Reed, Syverson, Goldschlag 1997]

Review: Onion Routing



- Sender chooses a random sequence of routers
  - Some routers are honest, some controlled by attacker
  - Sender controls the length of the path

Review: Route Establishment



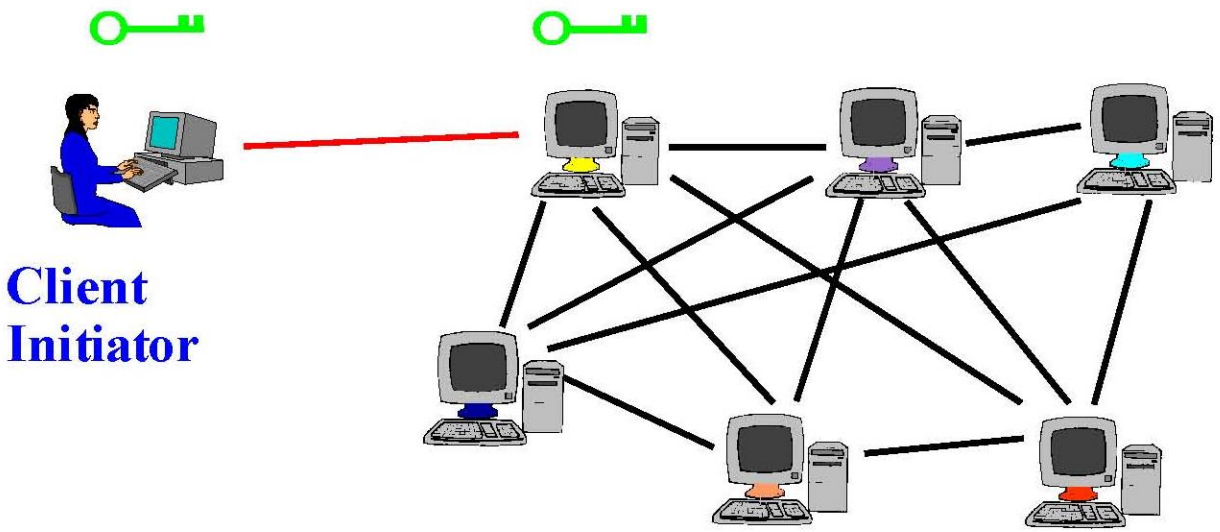
- Routing info for each link encrypted with router's public key
- Each router learns only the identity of the next router

Tor

- Second-generation onion routing network
  - http://tor.eff.org
  - Developed by Roger Dingledine, Nick Mathewson and Paul Syverson
  - Specifically designed for low-latency anonymous Internet communications
- Running since October 2003
- "Easy-to-use" client proxy
  - Freely available, can use it for anonymous browsing

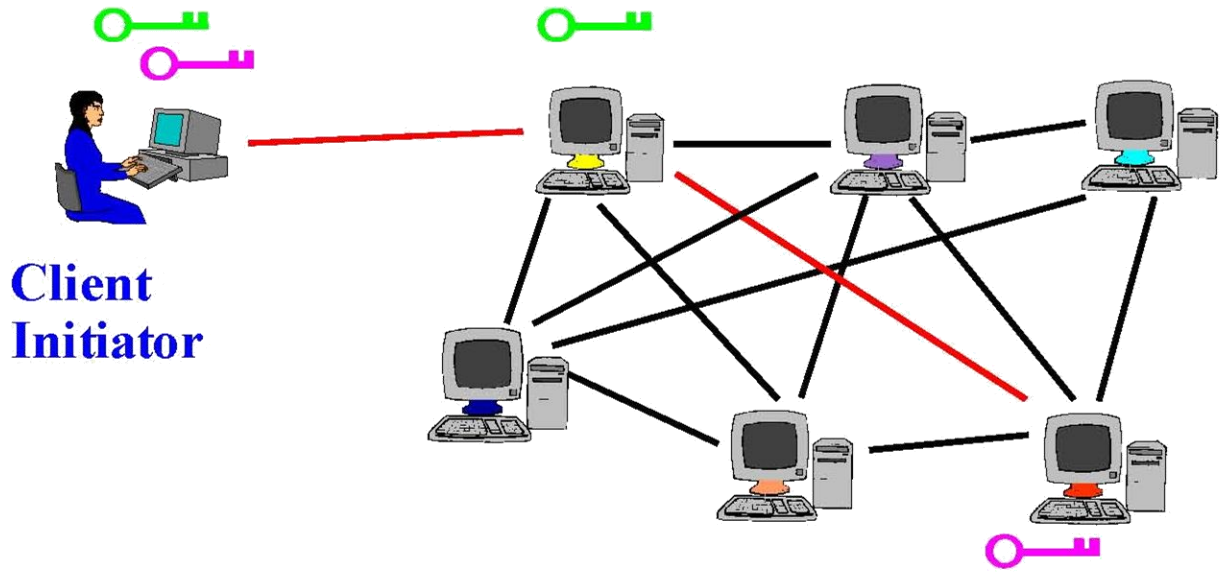
Tor Circuit Setup (1)

- Client proxy establishes a symmetric session key and circuit with Onion Router #1



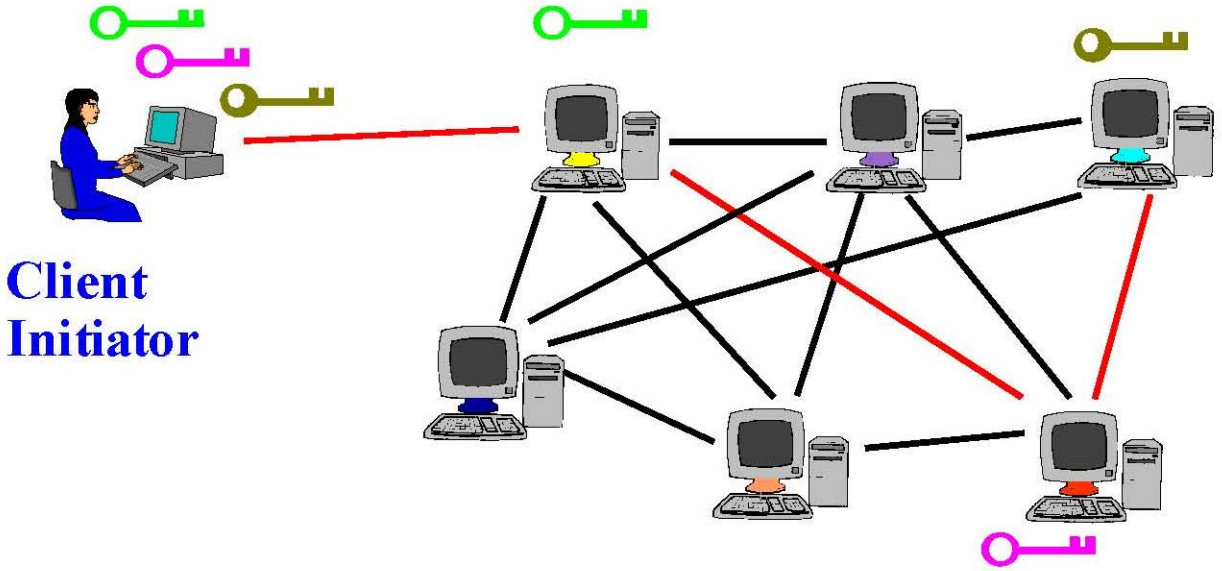
Tor Circuit Setup (2)

- Client proxy extends the circuit by establishing a symmetric session key with Onion Router #2
  - Tunnel through Onion Router #1



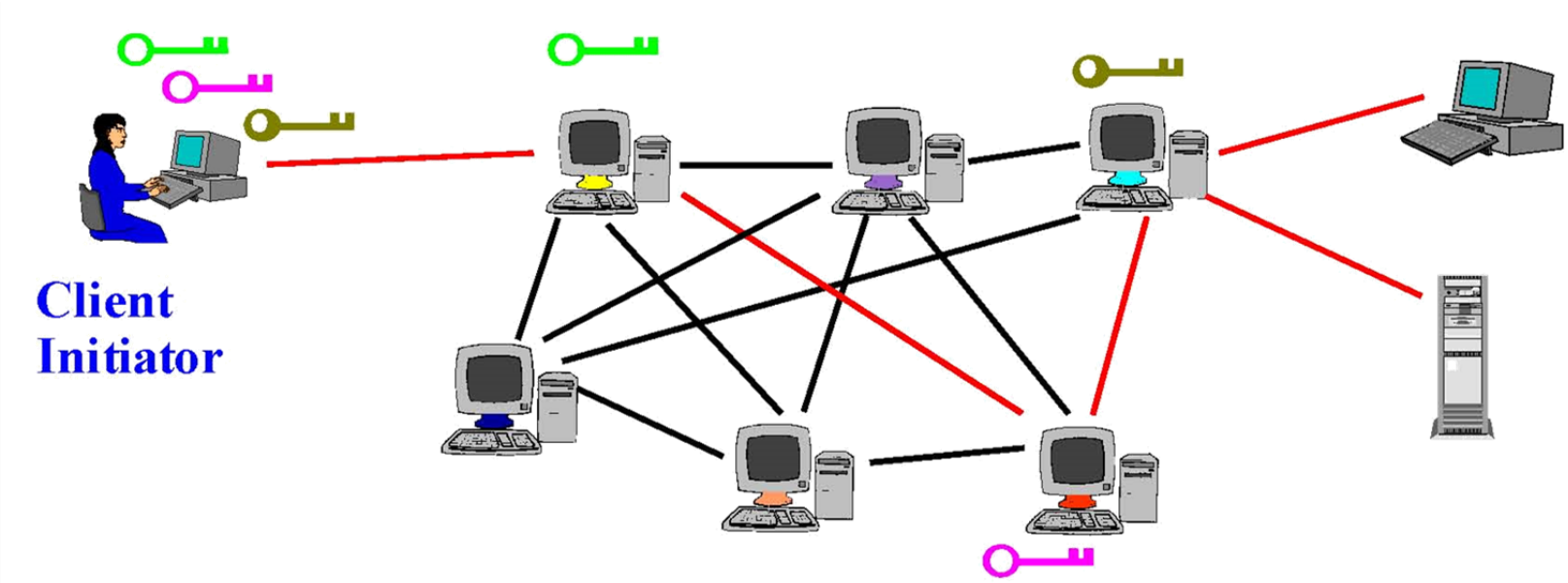
Tor Circuit Setup (3)

- Client proxy extends the circuit by establishing a symmetric session key with Onion Router #3
  - Tunnel through Onion Routers #1 and #2



Using a Tor Circuit

- Client applications connect and communicate over the established Tor circuit.



Tor Management

- Many applications can share one circuit
  - Multiple TCP streams over one anonymous connection
- Tor router doesn't need root privileges
  - Encourages people to set up their own routers
  - More participants = better anonymity for everyone
- Directory servers
  - Maintain lists of active onion routers, their locations, current public keys, etc.
  - Control how new routers join the network
    - "Sybil attack": attacker creates a large number of routers
  - Directory servers' keys ship with Tor code

Is Tor Perfect?

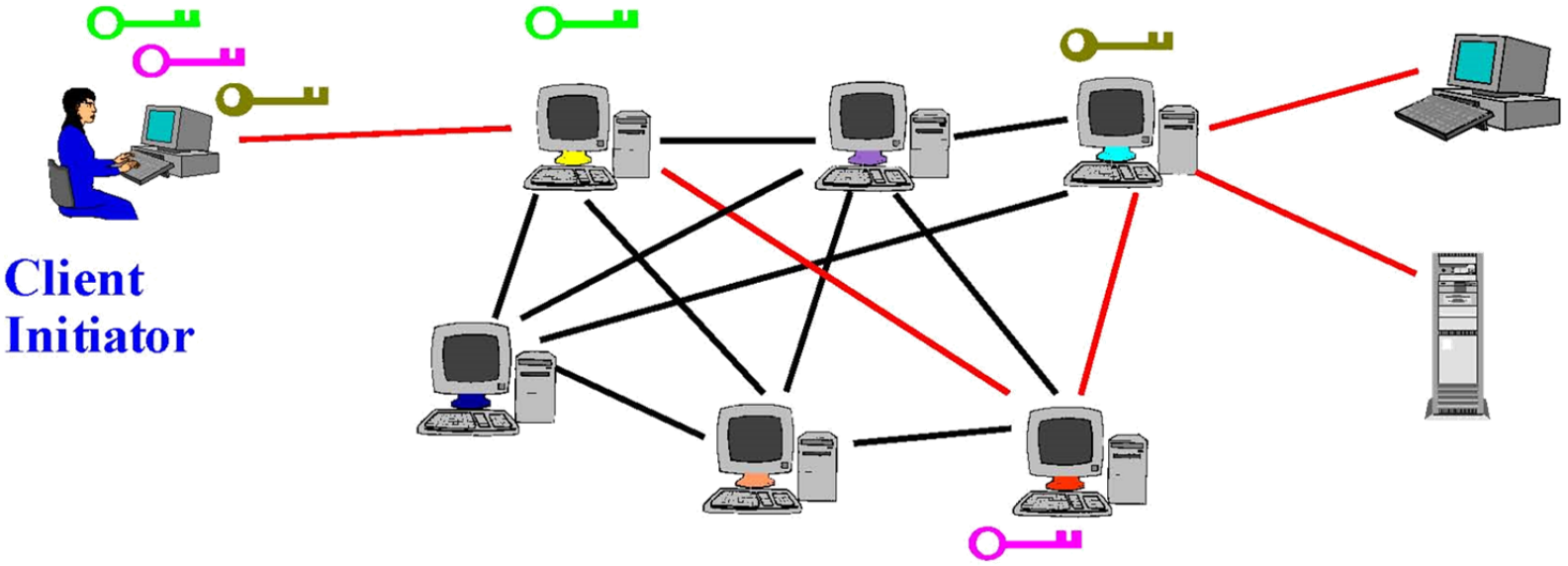
- Q: What can "go wrong" with the use of Tor?

Issues and Notes of Caution

- Passive traffic analysis
  - Infer from network traffic who is talking to whom
  - To hide your traffic, must carry other people's traffic!
- Active traffic analysis
  - Inject packets or put a timing signature on packet flow
- Compromise of network nodes
  - Attacker may compromise some routers
    - And powerful adversaries may have "too many" routers (e.g., a super computer at a national lab)
  - It is not obvious which nodes have been compromised
    - Attacker may be passively logging traffic
  - Better not to trust any individual router
    - Assume that some fraction of routers is good, don't know which

Issues and Notes of Caution

- Tor isn't completely effective by itself
  - Tracking cookies, fingerprinting, etc.
  - Exit nodes can see everything!



Issues and Notes of Caution

- The simple act of using Tor could make one a target for additional surveillance
- Hosting an exit node could result in illegal activity coming from your machine

Mobile Security

Roadmap

- History, How we got here

- Mobile malware
- Mobile platforms vs. traditional platforms
- Dive into Android

Questions: Mobile Malware

Q: How might malware authors get malware onto phones?

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

Smartphone (In)Security

Users accidentally install malicious applications.

Smartphone (In)Security

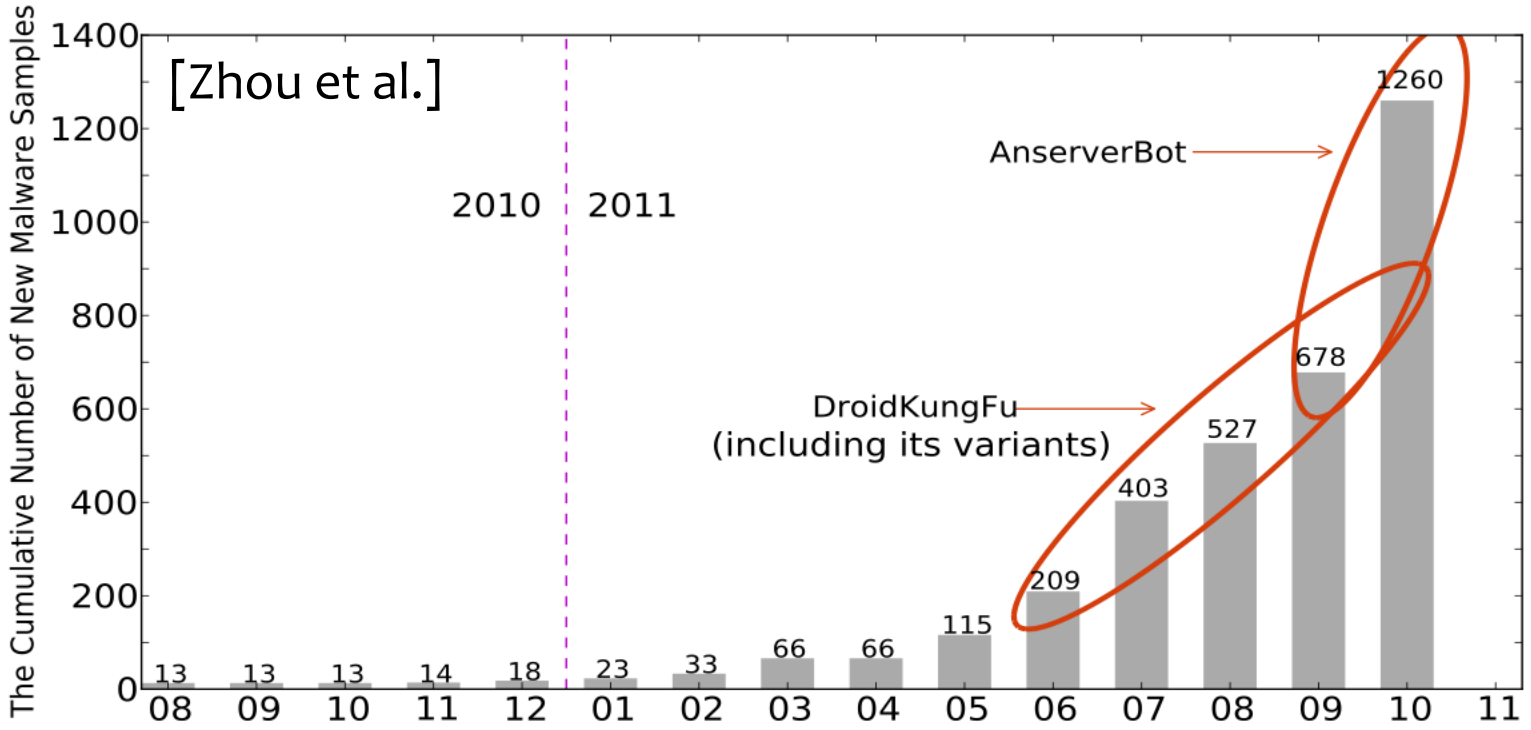
Even legitimate applications exhibit questionable behavior.

Mobile Malware Goals

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

Malware in the Wild

Android malware grew quickly!
Today: millions of samples.



Mobile Malware Examples Over Time

- **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 password)
  - Worked only on jailbroken phones with ssh installed

Background: Before Mobile Platforms

Assumptions in traditional OS (e.g., Unix) design:

1. There may be multiple users who don't trust each other.
2. Once an application is installed, it's (more or less) trusted.

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1. There may be multiple users who don't trust each other.
2. **Once an application is installed, it's (more or less) trusted.**

Apps can do anything the UID they're running under can do.

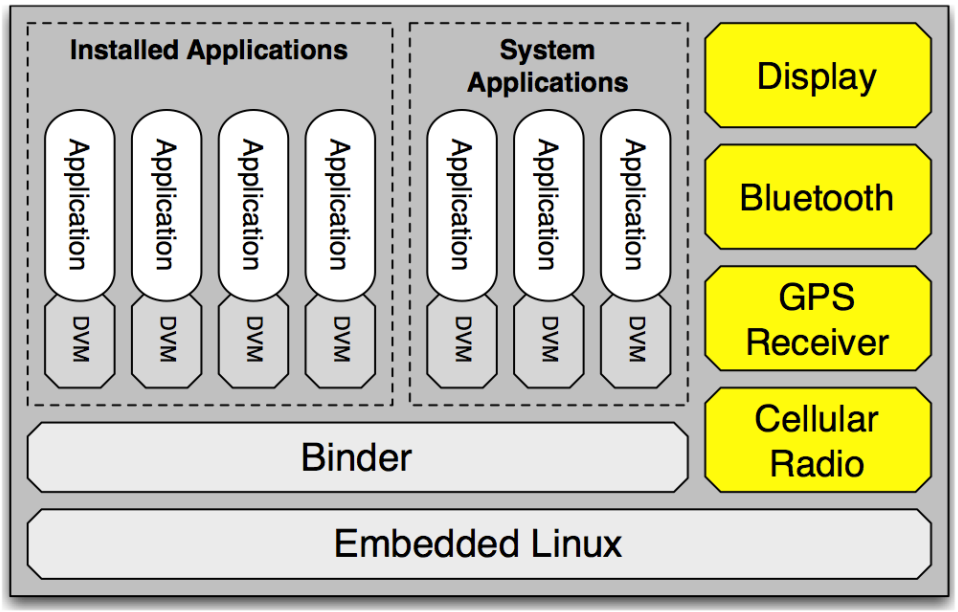
What's Different about Mobile Platforms?

- **Isolation:** 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

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?

Permission Granting Problem

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

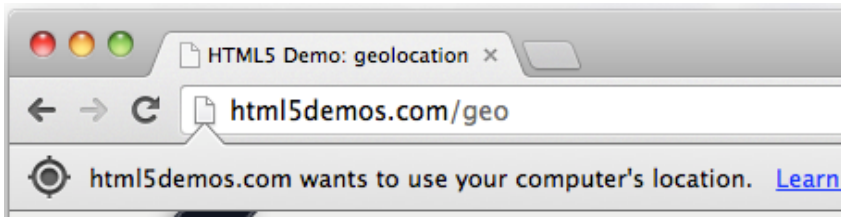
- System Resources (clipboard, file system).
- Devices (camera, GPS, phone, …).

How should operating system grant permissions to applications?

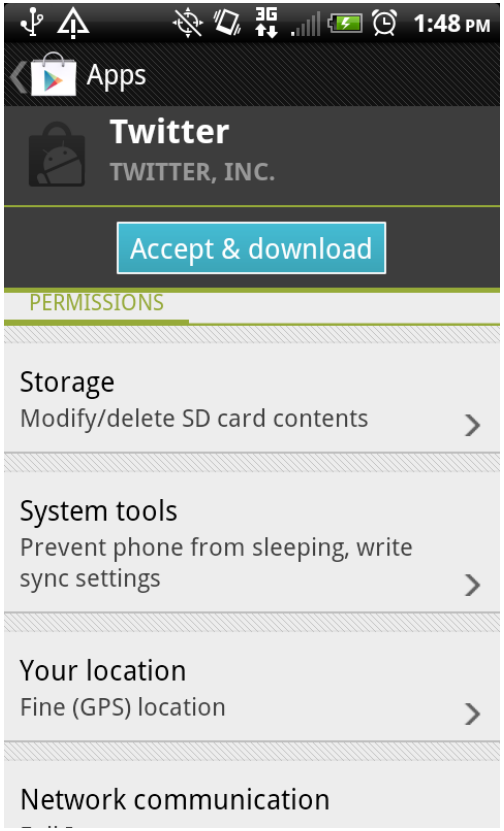
Standard approach: Ask the user.

Two Ways to Ask the User

Prompts (time-of-use)



Manifests (install-time)

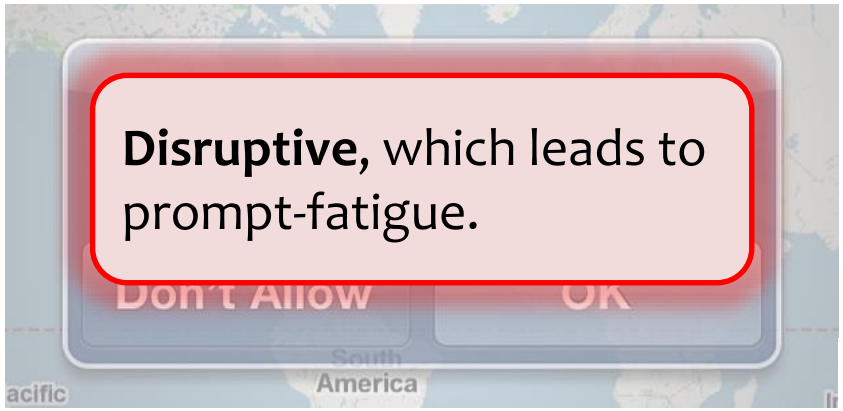


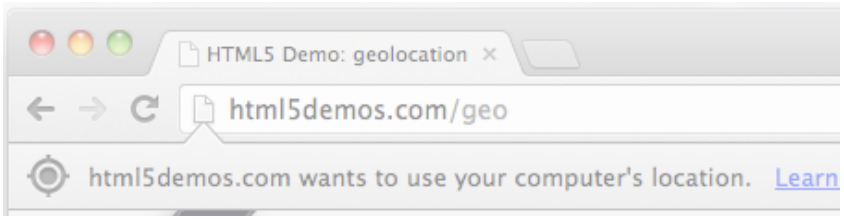
Questions

- Q: What are the pros and cons of the manifest-based permission model?
- Q: What are the pros and cons of the “ask each use” permission mode?

Two Ways to Ask the User

Prompts (time-of-use)





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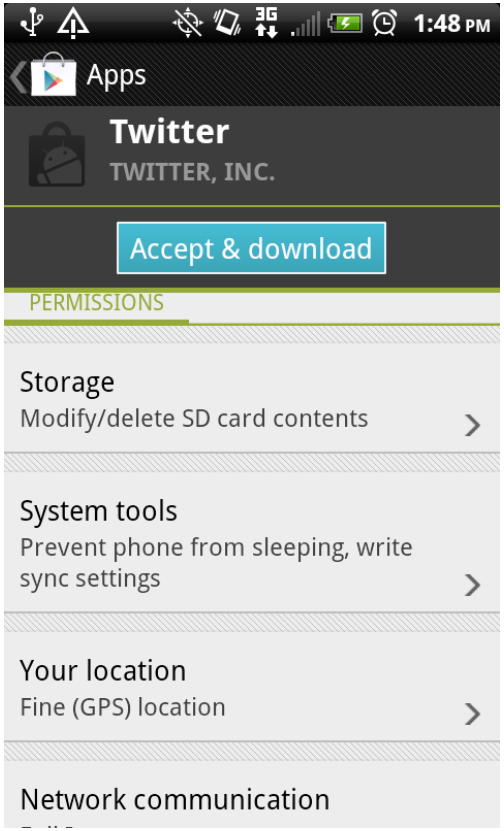

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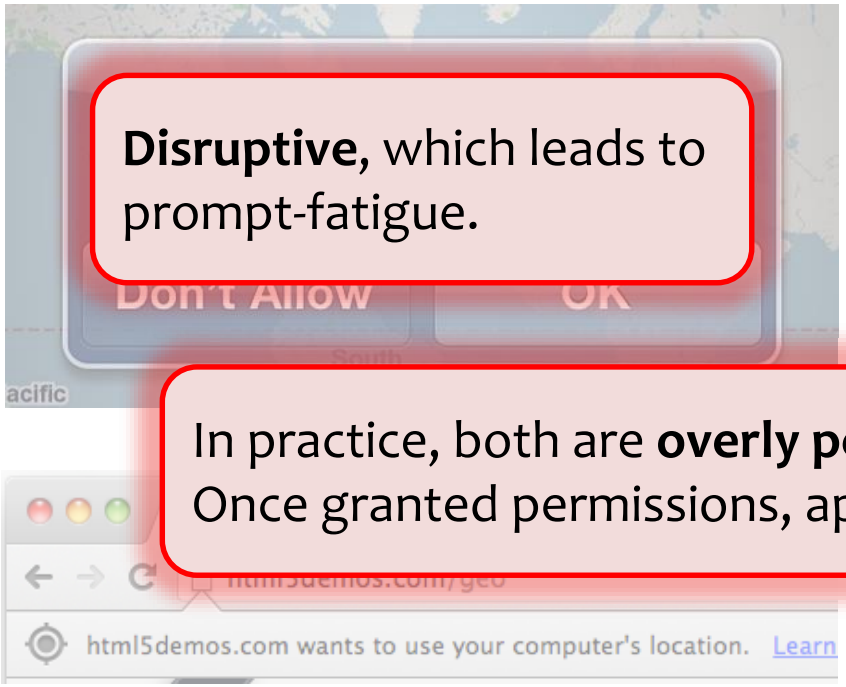
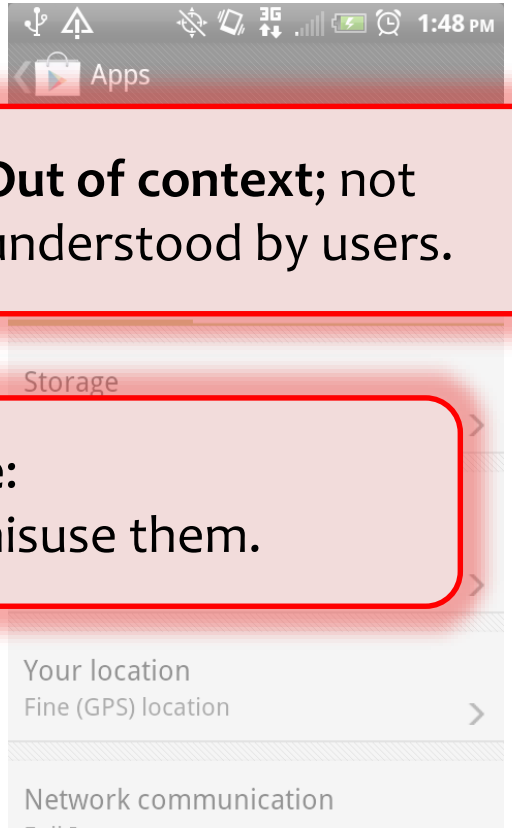


Disruptive, which leads to prompt-fatigue.

Manifests (install-time)



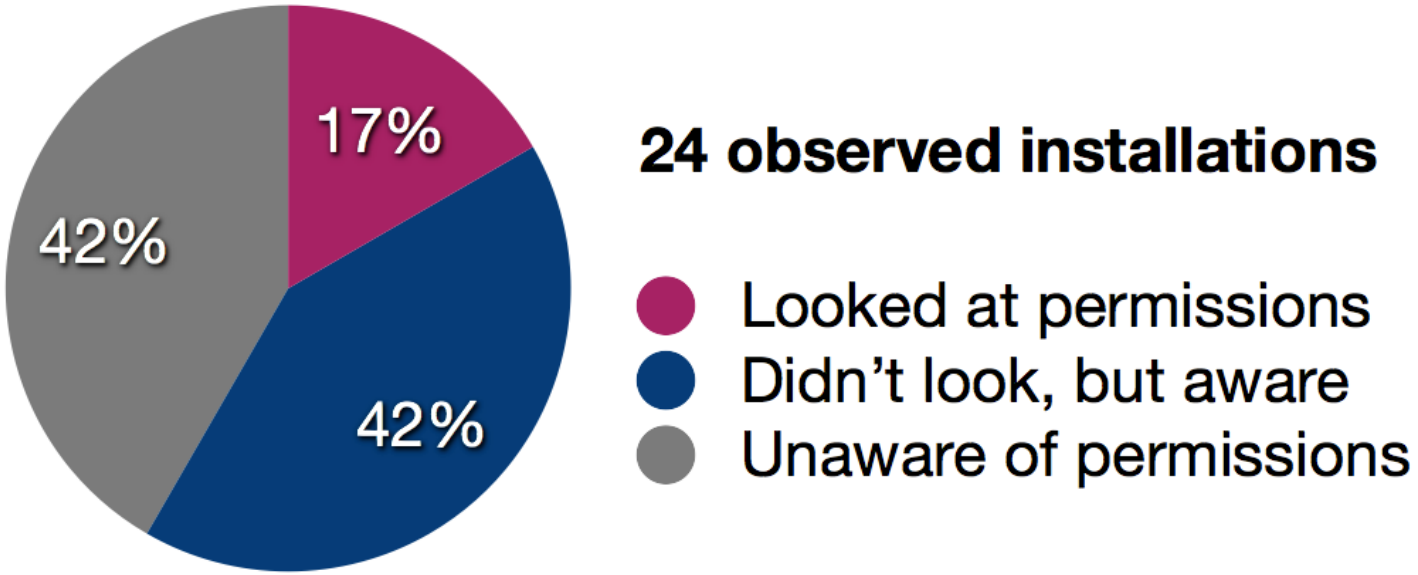
Out of context; not understood by users.

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

[Felt et al.]

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_SMS$_1$	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_SMS$_2$	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?"