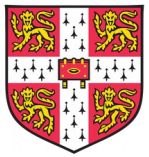
UNIVERSITY OF CAMBRIDGE

Security Analysis of Anti-Theft Solutions by Android Mobile Anti-Virus Apps

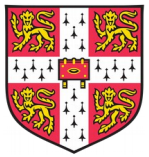
Laurent Simon
lmrs2@cam.ac.uk
https://www.cl.cam.ac.uk/~lmrs2/

Talk outline



- Background
- Mobile Anti Virus (MAV) sample
- Lock
- Wipe

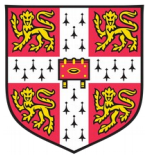
Background



- Phone theft is a growing problem
  - 2013:
    - 3.1M devices stolen in the USA
    - 120,000 in London

- 50% of users don't lock their phone

Anti-Theft Solutions

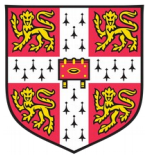


- Wide offering – enterprise and consumer-grade

  => This talk: *consumer grade* only

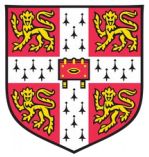
- Top 10 Mobile Anti Virus apps (MAV), downloaded from Google Play hundreds of millions of times (top 2 between 100M and 500M)
- Anti-theft enable *remote wipe* and *remote lock* with an app on phone + remote trigger via
  - web page
  - SMS

Partition storing user data



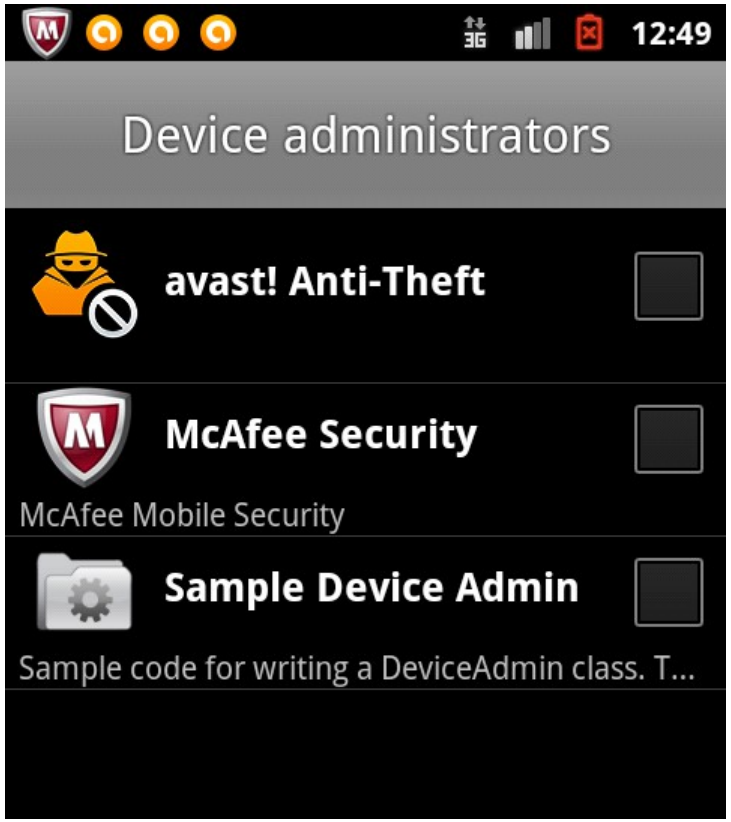
- *Data partition* mounted on /data
  - Sensitive info, ext4 (eMMC), yaffs2 ("raw flash")
- *Internal (primary) "SD card"*: mounted on /sdcard
  - Music, pictures, FAT, emulated (FUSE)
- *External SD card*: removable
  - Same as internal one, FAT
  - Secondary SD card, or primary if no internal one

Admin API

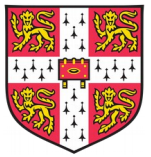


- Provides admin features, i.e. sensitive functions
- Access to various "policies": e.g. *force-lock*, *wipe-data*, *reset-password*
- Like traditional Android permissions, *each policy declared in Android manifest file*
- Like traditional Android permissions, policies not accepted at installation but manually enabled/disabled in the phone Settings

Admin API (Cont'ed)

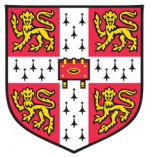


Admin API (Cont'ed)



- If user does not grant admin access, app can still run ... without admin privileges
- To uninstall/remove admin app, admin privileges must be disabled first
- Restrictions imposed: cannot read other apps' data or read/write chip at block level

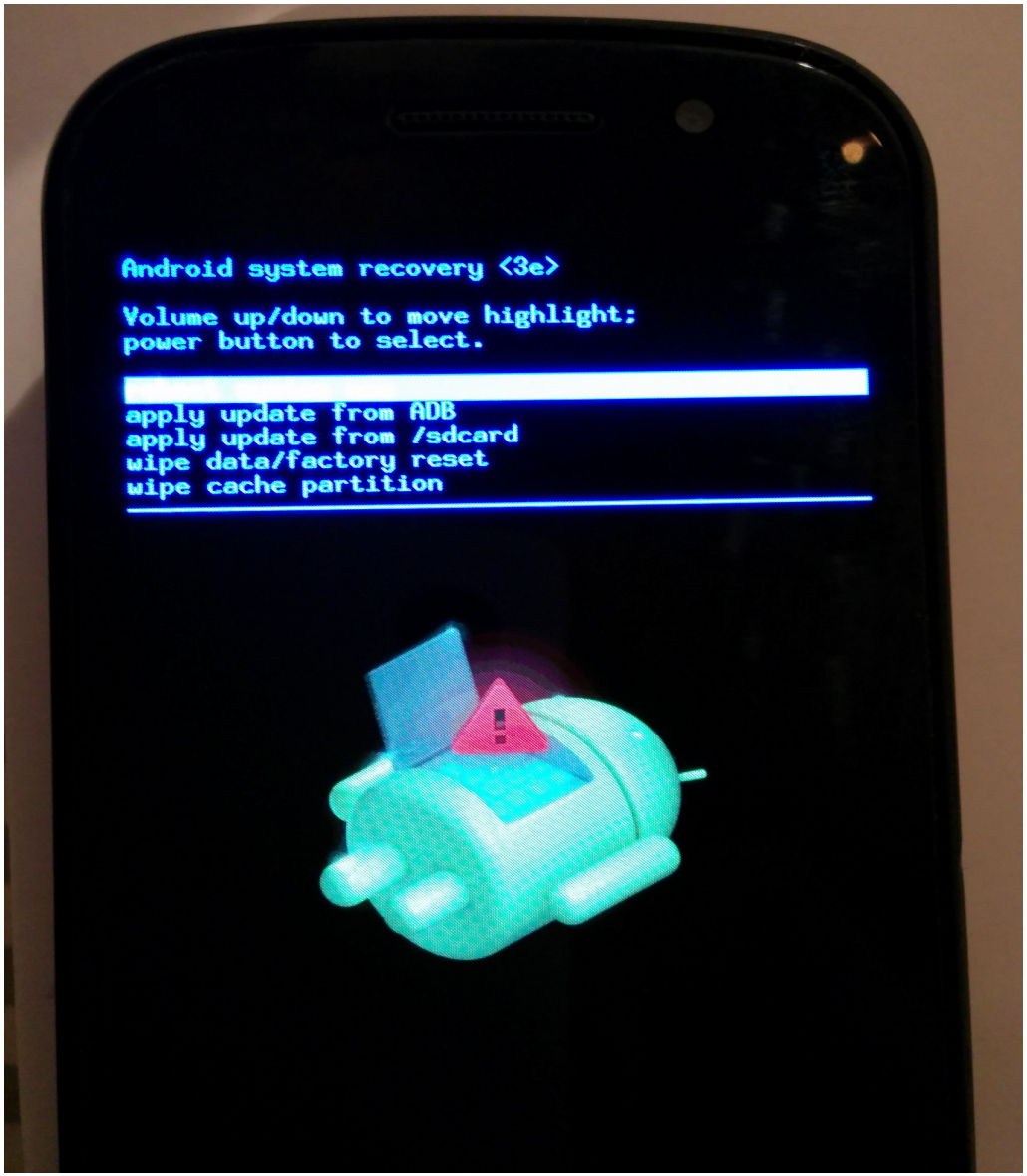
Admin API (Cont'ed)



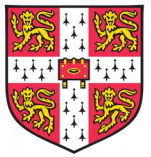
- Focus of this talk: force-lock and wipe-data policies
- *wipeData(int flag)*:
  - Triggers the built-in Factory Reset
  - Flag indicates:
    - Wipe only data partition
    - Wipe data partition AND primary SD card
- *LockNow()*: lock the screen with default Android PIN
- No admin granted: ad-hoc solutions

Modes

- Normal mode: Android
- Safe mode
- Recovery/Bootloader mode

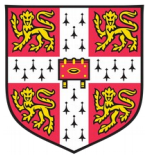


Talk outline



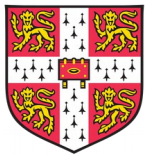
- Background
- Mobile Anti Virus (MAV) sample
- Lock
- Wipe

Apps studied



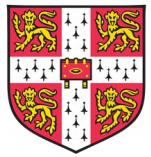
- 10 most downloaded Mobile Anti Virus (MAV) apps on Google Play
  - *AVG, Lookout, Avast, Dr.web, Norton, McAFee, Kaspersky, TrustGo, TrendMicro, Avira*
- Top 2 downloaded 100M-500M
- Following top 4 10M-50M

Talk outline

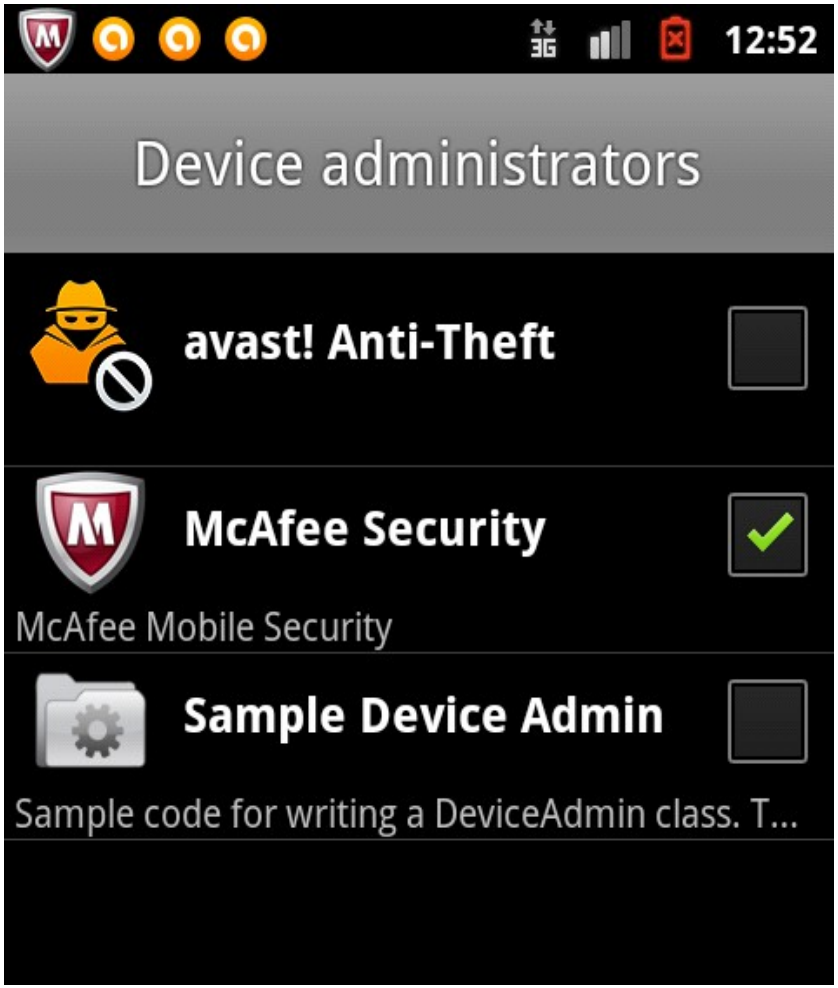


- Background
- Mobile Anti Virus (MAV) sample
- Lock
- Wipe

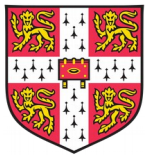
Removal of MAVs & API Misuse



- Scenario: admin + non-locked:
- 7/10 MAVs do not prevent disabling admin privileges
- McAfee and Avast prompt user with PIN when trying to disable admin



Removal of MAVs & API Misuse

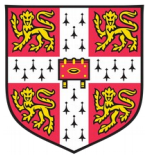


```
public class McAfeeReceiver extends DeviceAdminReceiver {

 public void onDisabled(Context paramContext,
                        Intent paramIntent){
  [...] // removed
  displayLockScreen();
 }
}
```

- Android doc: "called *prior* to the administrator being disabled"
- BUT called *after* on Gingerbread (GB, v2.3.x)
- *OnDisabledRequested()* called prior on GB, ICS, JB

Other API Misuses

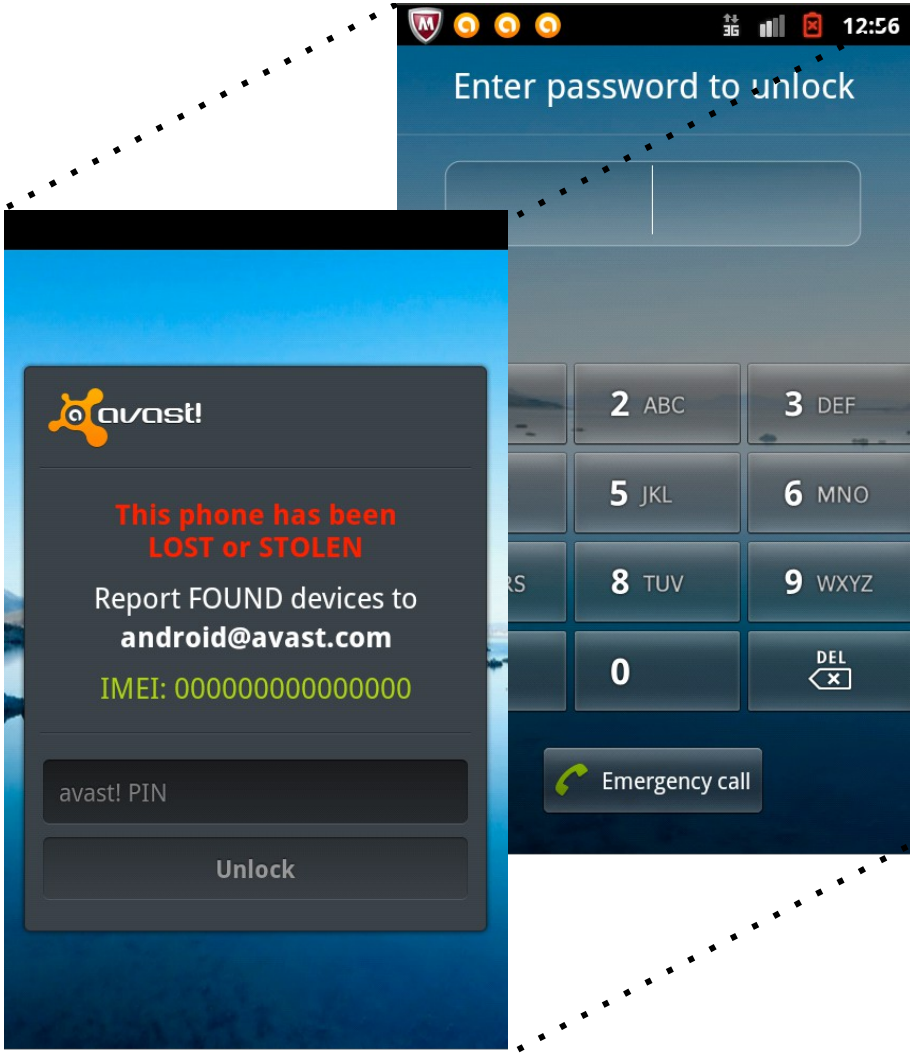


- Scenario: admin + locked: proper lock implementation requires:
  - Force-lock policy declared in manifest file by MAV
  - Manual granting of admin by users
  - Proper use of API by MAV, e.g. lockNow()
- 4/10 MAVs do not use *lockNow()* even when granted admin privileges
  - Bypass thru Safe mode

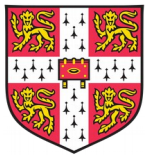
Rate Limiting

- Scenario: admin + locked + use *lockNow()*

- Overlay of custom lock screen on top of default Android PIN screen



Rate Limiting

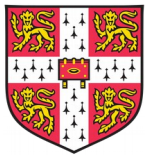


- 5/10 MAVs do not enforce rate limiting in their screen => brute-force PIN feasible

- For a 4-digit PIN and 5sec/PIN attempt, about 7hrs on average for randomly selected PINs

- <5mn for 60 most common PINs ~ 30%
- <40mn for 400 most common PINs ~ 50%

Rate Limiting

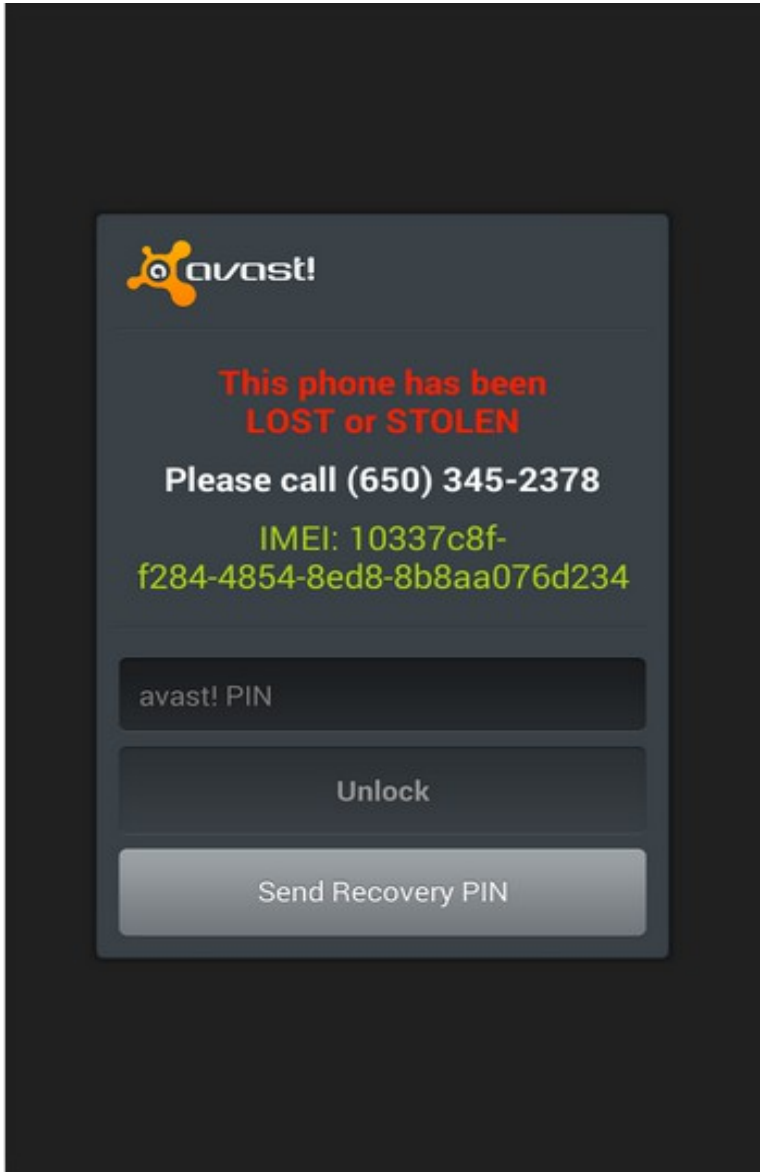


- Scenario: admin + locked + use *lockNow()* + rate limiting
- Some devices have no rate limiting (e.g. Samsung Galaxy S Plus)
- Reboot into Safe mode where user-installed apps do not run automatically
- Counter storing glitches: e.g. for Lookout, removing battery resets the state

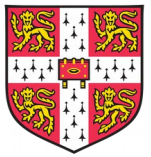
Network-level attacks: GSM

- Avast (100M-500M download) sends temp PIN in clear

- Similar issue for Dr.Web with commands sent via SMS

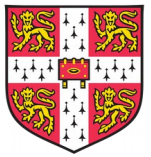


Network-level attacks: TLS



- Impersonate as cloud server to send an unlock command
- One app did not validate the CN of certs

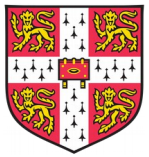
Vendor customisations



- Charging mode gives shell: e.g. LG L7 runing JB (v4.1.2)

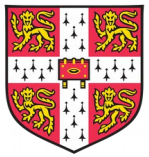
- Unprotected Recovery/Booloader: flash arbitrary binaries to access data regardless of Android lock. Most Samsung/LG phones in our sample.

Talk outline



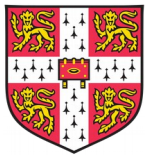
- Background
- Mobile Anti Virus (MAV) sample
- Lock
- Wipe

Wipe implementations



- Data partition: 10/10 use admin API to wipe it
  - If no admin privileges, just use phone APIs (contact, SMS, etc)
- Primary SD: 5/10 MAVs use admin API to wipe it
  - Other MAVs unlink and/or overwrite files and/or format partition
- Secondary SD: 10/10 MAVs use ad-hoc solutions (unlink, overwrite files, format partition). *Android has no API to wipe it*.

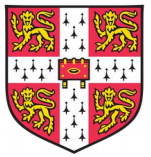
Lookout implementation



- Overwrites files and unlinks them
- Dev assume file update occurs "in-place"
- On Galaxy S Plus, FAT-formatted primary SD:

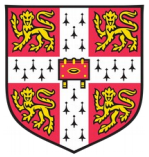
  >90% data recoverable

Avast implementation



- "Thorough wipe" option:
  - Unlinks all files from external storage
  - Creates a 1MB file and overwrites it 1000 times with zeros
- Dev assume file update does NOT occurs "in-place", so 1GB (1000x1MB) unallocated space is overwritten
- Partitions formatted with ext4 update "in-place", 99% of data is recoverable

Conclusion



- Lock implementations can be circumvented because of misuse of APIs, vendor customisations, restrictions imposed by Android
- Wipe implementations are not better than the buit-in (possibly flawed) Factory Reset
- Vendor solutions only have the potential to increase reliability

Thanks!

UNIVERSITY OF CAMBRIDGE

Laurent Simon

lmrs2@cam.ac.uk

https://www.cl.cam.ac.uk/~lmrs2/