To Write or not to Write, that is the Question - Abusing of Leaked Data and Vulnerable User Assets on Android

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March 28th, 2019 - Budapest

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  - (Dr.) Julien Thomas

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  - talk about bug hunting on Android
- Data exposure, again?
  - focus on app based (app data) exposure
  - minimal concern regarding insecure shared data loading

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  - an app with network permission only
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- Question: what can be done in general / worst cases?
  - file listing (other topic)?
  - user identity disclosure?
  - user credential disclosure?
  - (encrypted) remote file disclosure?
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Documentation: case 1 - R**M

- *getExternalFilesDirs* (vs *getFilesDir*)[1]: absolute paths to application-specific directories
  - internal to the app, **not typically visible to the user as media**.
  - shared storage may not always be available
  - no security is enforced with these files. Any application holding *WRITE_EXTERNAL_STORAGE* can write to these files.

[1] https://developer.android.com/reference/android/content/Context.html, https://developer.android.com/reference/android/os/Environment.html

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- getExternalStorageDirectory
  - storage can hold a relatively large amount of data, shared across all apps (does not enforce permissions)
  - each user has their **own isolated shared storage**
    - apps **only have access to the shared storage for the user they're running as**.

[1] `https://developer.android.com/reference/android/content/Context.html`, `https://developer.android.com/reference/android/os/Environment.html`

Documentation: case 2

- Internal storage[2]:
  - **files saved here are accessible by only your app**.
  - when the user uninstalls your app, the system removes all your app's files from internal storage.

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- External storage:
  - it's world-readable, so files saved here may be read outside of your control.
  - when the user uninstalls your app, **the system removes your app's files from here only if you save them in the directory from** *getExternalFilesDir*().
  - external storage is the best place for files that don't require access restrictions and for **files that you want to share with other apps** or allow the user to access with a computer.

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- Standard calls to Android framework
  - *getFilesDir*(), *getDatabasePath*()
  - *PackageInfo.applicationInfo.dataDir*

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drwxrwx--x 48 root sdcard_rw /sdcard/Android/data/my_app
/dev/fuse on /storage/emulated type fuse (rw,nosuid,nodev,noexec,noatime,
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- However
  - sdcard is a misleading name
  - sdcard/android/data is a misleading path
  - documentation triggers wrong perspectives

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- Recurring “external storage features”
  - storage is persistent
  - as per documentation, *getExternalStorageDirectory* makes, per default, file not being removed on uninstall
- “SDcards are not supported”
  - so per default we are fine unless a SD Card is used
- Yet, good luck if you try to go against these arguments in bug bounties

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Core principles

- Private data
  - only the app can directly access /data/data/my_app resources
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- “Shared” data as per storage structure
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Shared storage: implementation

- Generate folders for each apps: “mount” on demand
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  - SDCardFS (Android O) sdcardfs/sdcardfs.h,sdcardfs/inode.c
- Until Q, everything is owned by *sdcard_rw*
  - Android Q: more-fine grained?

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- Question: who knows about Content provider ?
  - Concept
  - Vulnerabilties
  - Analysis tools

Content provider (2)

- A feature to expose data out of the box (exposes files/shared)

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- A powerful framework
  - If not fully understood, better stay away ... from custom implementation

Developer perspectives

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- Private folder is a constraint
  - hard to debug
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- Private folder is a constraint
  - hard to debug
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- External folder is great
  - easy to debug (logs are accessible through USB)
  - lot of storage capability
  - persistence is possible (“hacking”?)
  - data sharing is easy (once again, is it really easier?)

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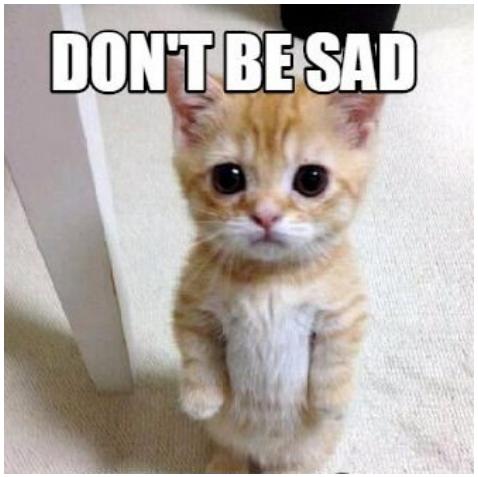

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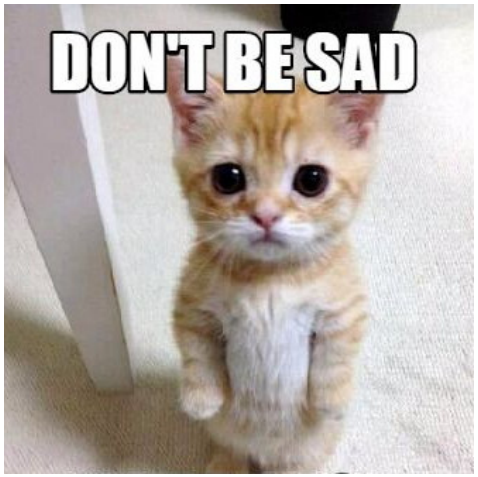

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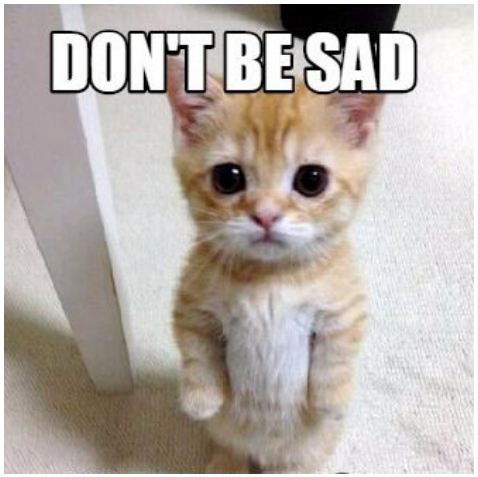

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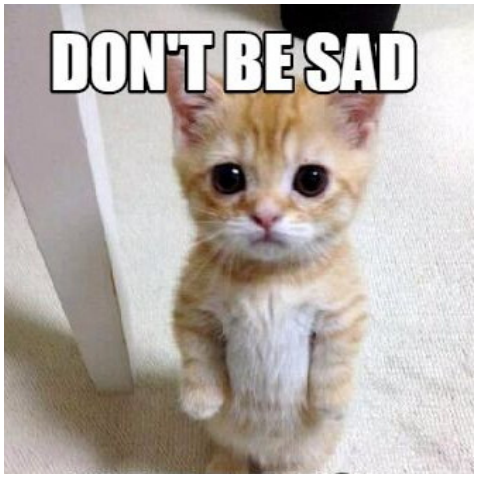

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- ended a little better, still in progress

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user PII	email	PII, phone owner		
	user profile	PII, phone owner		
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	bank info			
app secrets	auth token	account takeover		
	credentials	account takeover		
	protocol IDs	device takeover		
user activity	browsing	user profiling		
	geo location	protected info		
corporate data	sensitive data	corporate secrets		
	credentials			

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	protocol IDs	device takeover	✓	10m
user activity	browsing	user profiling	✓	100m
	geo location	protected info	✓	110m
corporate data	sensitive data	corporate secrets	✓	511m
	credentials		✓	1m

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- Next sections: interactive session
  - detection patterns
  - fixes

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- Detection method
  - grep for email address
  - grep for keywords like “auth” or “token”

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  - grep for keywords like “auth” or “token”

- clean your logs from user identifiers
- keep your logs private and rotate them

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- hash of (user email, user ID) as folder name
- local_id $\mapsto$ user mapping in private database

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assert the behavior of underlying components

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Custom format can be read on another device.
Assert device data policy: *READ_EXTERNAL_STORAGE* does not equal *ACCESS_FINE_LOCATION*

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- if you think exposing is still fine, timestamp control cache
- never allow user input alteration

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- make it obvious or at least secure by default
- let user devices the storage root directory

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- always review data storage and data “format”
- we are talking about confidential data and paid feature ...

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- Assert the way media is generated: “Camera generated” differs from “Taken from Media folders”
- or discloses (and delete) them all

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- heard of race conditions?
- heard of trusted inputs (outputs)?

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- anonymize internal inputs unless you need long term traceability or identification

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- assert data security before exporting them
- do not (try to) hide externalized data, it's worst

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- Hard to standardize the approach
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- Often relies on the combo (install app) + (“find -mtime”) + (find/grep PII)
  - not the most pleasant job
  - better target the right app category

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- (soon) escalation to Google Play team

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- Often, changing the vision of the vendor is “hard”
  - no matter how critical the issue is

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- Things strongly depends on the vendor replies
  - bug fixes
  - future work (your requests at goo.gl/5qzwAL)