Normal Permissions in Android: An Audiovisual Deception

Deepsec 2017

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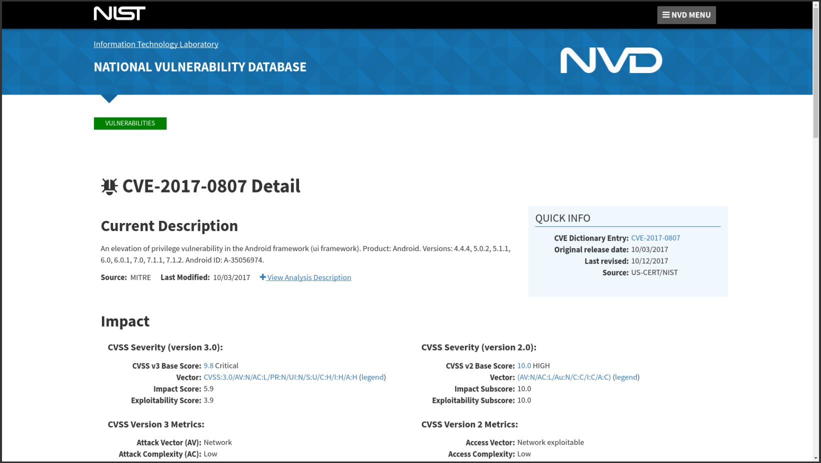
Prelude

Full disclosure

One of the highlights of this talk is the full disclosure of a security issue we reported last February and was patched last month from the Android security team. Sadly, the patch is available only in the Pixel/Nexus security bulletin.

CVE details


NIST
NVD MENU
Information Technology Laboratory
NATIONAL VULNERABILITY DATABASE
NVD
VULNERABILITIES

CVE-2017-0807 Detail

Current Description

An elevation of privilege vulnerability in the Android framework (ui framework). Product: Android. Versions: 4.4.4, 5.0.2, 5.1.1, 6.0, 6.0.1, 7.0, 7.1.1, 7.1.2. Android ID: A-35056974.

Source: MITRE **Last Modified:** 10/03/2017 +View Analysis Description

QUICK INFO

CVE Dictionary Entry:	CVE-2017-0807
Original release date:	10/03/2017
Last revised:	10/12/2017
Source:	US-CERT/NIST

Impact

CVSS Severity (version 3.0):

CVSS v3 Base Score:	9.8 Critical
Vector:	CVSS:3.0/AV:N/AC:L/PR:N/UI:N/S:U/C:H/I:H/A:H (legend)
Impact Score:	5.9
Exploitability Score:	3.9

CVSS Severity (version 2.0):

CVSS v2 Base Score:	10.0 HIGH
Vector:	(AV:N/AC:L/Au:N/C:C/I:C/A:C) (legend)
Impact Subscore:	10.0
Exploitability Subscore:	10.0

CVSS Version 3 Metrics:

Attack Vector (AV):	Network
Attack Complexity (AC):	Low

CVSS Version 2 Metrics:

Access Vector:	Network exploitable
Access Complexity:	Low

Other bugs

We believe that Android has far more security issues which allow an adversary to steal a lot of sensitive information. Some of these are presented in this talk.

Unfortunately, while we have disclosed some of them more than one year, little or no progress has been made.

Our side

As Android users we feel rather uncomfortable knowing that the Security team of Android considers that many of what will be displayed in this talk are “working as intended”, silently patched but not acknowledged, or are “infeasible” etc.

We have reasons to believe that others may have been already exploiting it. Some of these things *must* be fixed.

For more details: [2, 1].

Acknowledgments

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O{P}ERANDO
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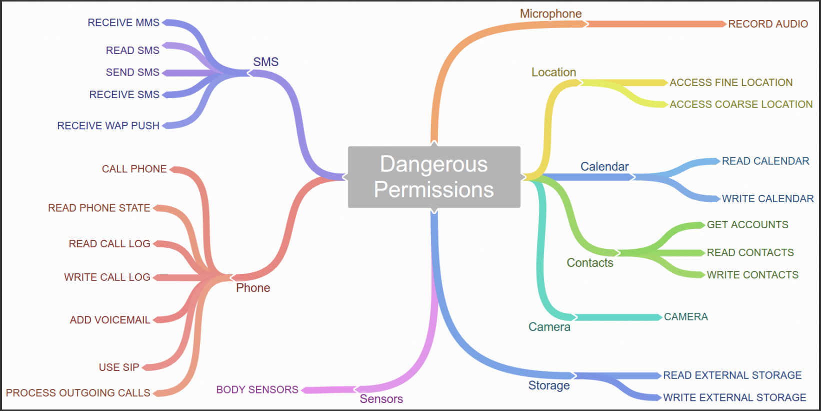
Introduction

Android Permissions

Google made a radical redesign of its security model in the last versions of Android. Part of them was the introduction of *runtime persmissions*.

Users can grant/revoke app *dangerous* permissions.

Dangerous permissions



Normal permissions

These permissions can be regarded as the ones that expose the user or the system to the least possible risk when granted. Therefore, the system automatically grants them at installation, without asking for the user’s explicit approval.

They cannot be revoked, and in many cases they cannot be “seen”.

What the user understands

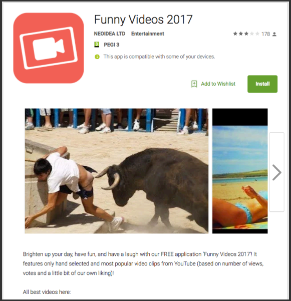
If an app does not use any dangerous permission, then the app is harmless!

It cannot use: camera, mic, phone, storage, location, SMS, calendar or contacts.

How bad can it be?

Presumption

We assume that a user has been tricked into installing an app. In order not to raise any suspicion and to convince the user to install the app, we **do not** use any dangerous permission.



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PEGI 3

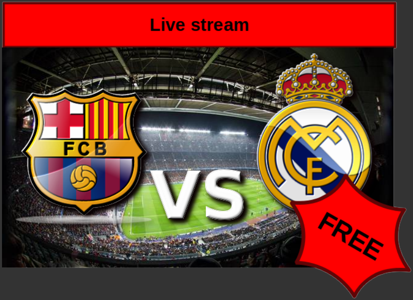
This app is compatible with some of your devices.

Add to Wishlist Install

Brighten up your day, have fun, and have a laugh with our FREE application 'Funny Videos 2017'! It features only hand selected and most popular video clips from YouTube (based on number of views, votes and a little bit of our own liking)!

All best videos here:

VS



The latter app does not ask for any permission, every permission is normal so automatically granted...

Visual illusions

Goal

What you see is **not** what you think.

Android UI

Android is designed to run in a rather constrained environment it terms of both size and computational resources which imply many constraints for the UI.

Basically, what we have is layers with UI components, which are stacked one on top of the other.

Who is on top?

Does it matter?

The layer which is on top is the one that the user sees and interacts, **but** due to size, UI and other OS constraints the user **cannot** determine **which** is the foreground app.

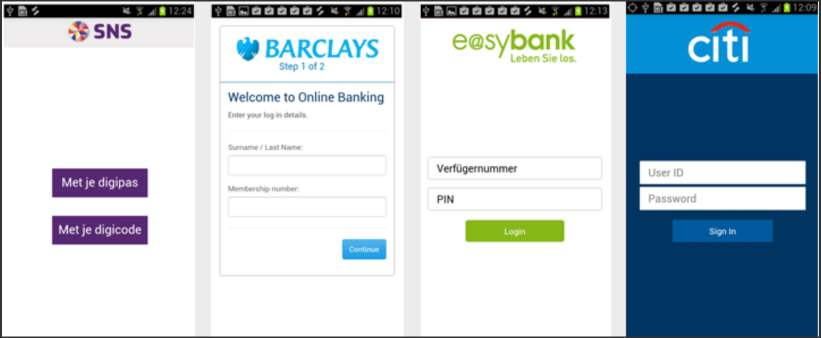
Note that every installed app in Android knows which other apps are installed.

So what?

If an adversary knew that you have installed a banking app, he could overlay it and get your credentials.

Bankbot, Bankun, Koler, Lockdroid, MazarBot, SlemBunk, and Svpeng exploit such capabilities.

Example



To quantify the problem, according to CheckPoint [5] 74% of ransomware, 57% of adware, and 14% of banker malware abuse the `SYSTEM_ALERT_WINDOW` permission.

The notorious `SYSTEM_ALERT_WINDOW`

This permission is clearly **very** dangerous.

According to Google Developer resources [4]: “*Very few apps should use this permission; these windows are intended for system-level interaction with the user*”.

The permission is poorly implemented leading to well-known attacks such as [9, 6].

Foreground app

I know what you use and when. Usage statistics are very important for many companies. Android has a special permission for monitoring apps through `UsageStatsManager`.

Android Developer:

> *This API requires the permission* `android.permission.PACKAGE_USAGE_STATS`*, which is a system-level permission and will not be granted to third-party apps. However, declaring the permission implies intention to use the API and the user of the device can grant permission through the Settings application.*

How to make visual illusions

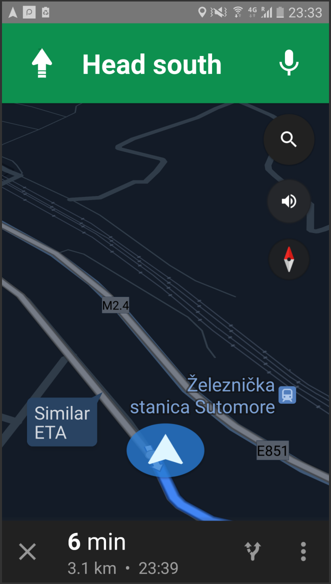
Our tricks:

- Determine foreground app (<Nougat)
- Make the user open an app you control (All Android versions)
- Steal PIN/Pattern. (All Android versions)
- Overlay others apps. (All Android versions before Oreo, Pixel/Nougat branches excluded)

All the above **without** using any dangerous permission.

Sniffing secure lock PIN/Pattern

Motivation


23:33
Head south
M2.4
Železnička stanica Sutomore
Similar ETA
E851
6 min
3.1 km • 23:39

Where is this information stored?

- The pattern is stored as an unsalted SHA-1 hash in `/data/system/gesture.key`
- PIN/passphrase are stored in `/data/system/password.key` as a concatenation of the password’s SHA-1 and MD5 hash values. Contrary to the patterns, the text-based passwords use a salt which is stored in the `/data/system/locksettings.db`.

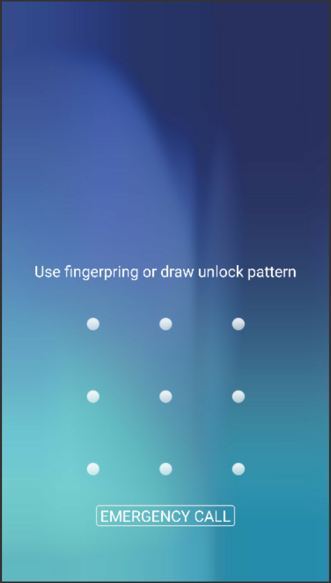
How does the user lock his device?

No read/write access to contents of `/data/`

What is the size of these files?

```
ls -l /data/system/gesture.key
```

Let's replicate the lock screen! Goal



Get user’s wallpaper

All applications are allowed to access device’s wallpaper by requesting the `getDrawable` property without the need for declaring any dangerous permission, as we reported in Security Issue 219663.

Draw the screen

Since we know how the user unlocks his screen, we know what to show.

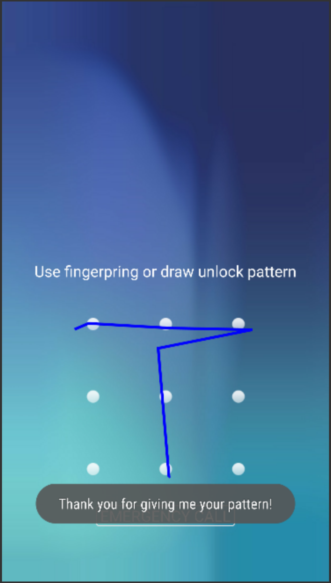
We don’t know when to show it, *yet*...

Presenting the fake lock screen

We create a BroadcastReceiver to listen for screen-off events (`ACTION_SCREEN_OFF`), while our app is running on the foreground. Our attack is triggered by the user, not when he tries to unlock his device by using the power button, but when he locks it!

Our fake lock screen will be brought to the foreground after the screen-off event and will remain there invisible until the user tries to unlock his smartphone.

The fake lock screen



Use fingerpring or draw unlock pattern

Thank you for giving me your pattern!

Get foreground app

Get foreground activity–Not applicable to Nougat

Let’s work the other way around: If I don’t know which is the foreground app, could I find which one is **not** the foreground app?

Get foreground activity–Not applicable to Nougat

Android is Linux powered so it uses `procfs` to store the data of its processes. Information in this filesystem is well protected, in terms of reading and altering the stored information, but we have side leakages as some metadata are publicly available to *all* applications.

Starting an app

Android runs in mobile devices which have constrained resources, whereas many refinements have been introduced by Google to allow Android to perform resource allocation and release. If there is free memory, Android uses Zygote to launch a new VM through Dalvik or ART.

If not let’s *kill* someone!

The oom_adj_score file

If there is not any free memory, Android has to close the least used application. Each application is given a `oom_adj_score`, stored under `/proc/[pid]/`.

Pruning all the system applications we can determine which is the application which is less probable to be killed.

Can you “guess” which one is this?

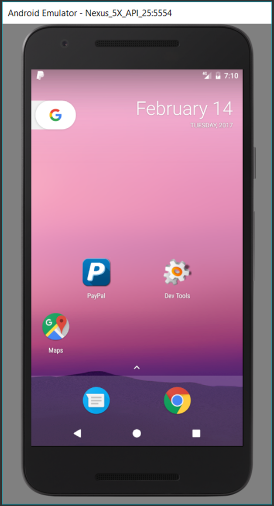
Luring the user

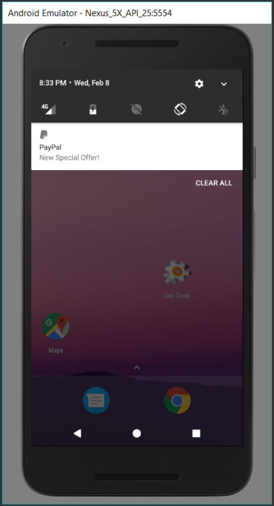
Notifications

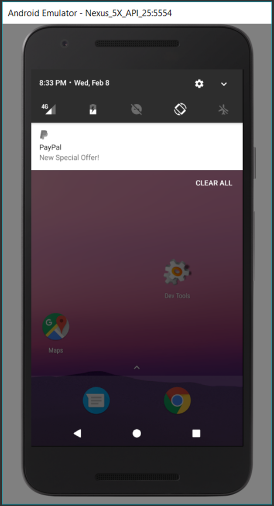
From API level 11, one must denote the text of the notification; through `setContentText` which accepts a string variable, the title of the notification; through `setContentTitle` which also accepts a string variable, and the notification icons for the status bar and the notification view, using `setSmallIcon` and `setLargeIcon` respectively.

As of API level 23, both icons can be set dynamically using custom bitmaps. Prior to API level 23, only the `setLargeIcon` provided this feature, as `setSmallIcon` required an integer which denoted the resource ID in the application's package of the drawable to use.

Fake Notifications







Home-Screen Shortcuts

Apps can create home-screen shortcuts using the normal permission `INSTALL_SHORTCUT` in their manifest. The underlying mechanism to create a shortcut is intents, so the developer has to declare three variables: a string which denotes the caption of the shortcut (`EXTRA_SHORTCUT_NAME`), a string which denotes the "action" of the intent to be launched (`setAction`), and its icon as a bitmap (`EXTRA_SHORTCUT_ICON`).

Overlays

Who can draw on top of other apps?

UI Window Type	Required Permission	Manifest Declaration	Focusable	Duration	Launch from service	Attack
Toast Messages				3.5 sec		[7, 10]
Alert Messages	SYSTEM_ALERT_WINDOW		✓	No limit		[9, 6]
System Alerts	SYSTEM_ALERT_WINDOW		✓	No limit	✓	[9, 3, 6]
Keyguards*		Required	✓	No limit	✓	
Normal activity		Required	✓	No limit	✓	[2]
Notification				No limit	✓	[8, 2]

What if...

Normal activities are in **all** Android apps, versions and flavors.

They are the default user interaction elements in Android.

Could you resize them? Could they overlay other apps?

Customizing activities

Let’s play with the manifest!

Let’s use the `Theme.Translucent.NoTitleBar` to remove any possible title. Now let’s make it flow!

```
<item name="android:windowIsFloating">true</item>
<item
name="android:windowIsTranslucent">true</item>
<item
name="android:windowBackground">@android:color/transpare
<item name="android:windowNoTitle">true</item>
```

More customization

We override the activity's `onCreate()` method. Create `WindowManager.LayoutParams` object with `dimAmount` set to 0, flagged with the attributes `FLAG_LAYOUT_NO_LIMITS` and `FLAG_NOT_TOUCH_MODAL`.

Positioning

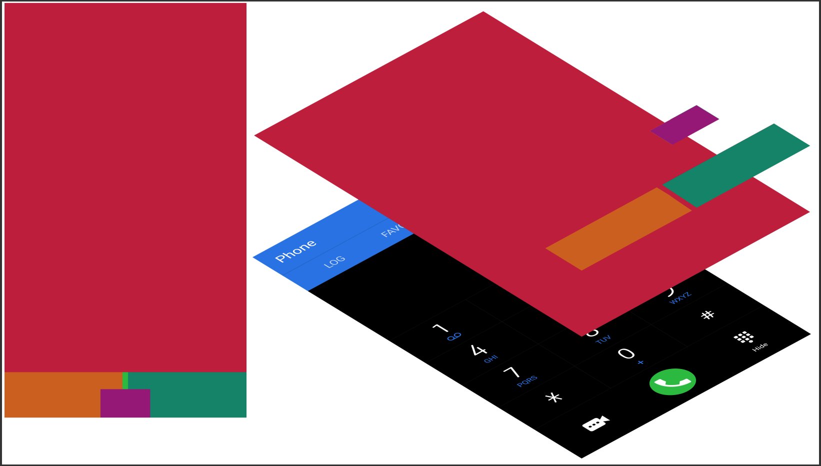
To position the sized floating activity on the screen, one can fine tune several parameters of the corresponding `LayoutParam` *e.g.* “Gravity” parameters, or actual position through (X,Y) on-screen coordinates.

Result

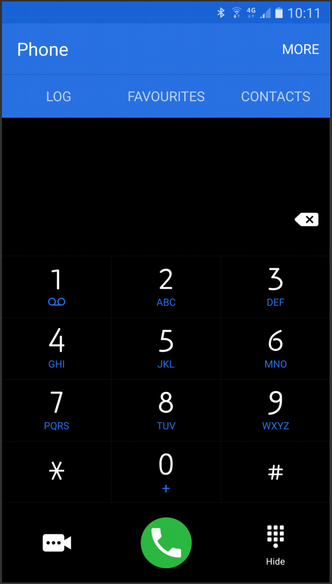
(Semi) Transparent, sizeable activities.

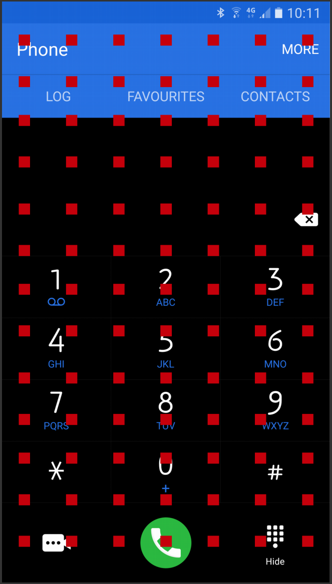
Question: How many of these can I have?

Scenario 1



Scenario 2


10:11
Phone
MORE
LOG
FAVOURITES
CONTACTS
1
2 ABC
3 DEF
4 GHI
5 JKL
6 MNO
7 PQRS
8 TUV
9 WXYZ
*
0 +
#
Hide


10:11
Phone
MORE
LOG
FAVOURITES
CONTACTS
1
2 ABC
3 DEF
4 GHI
5 JKL
6 MNO
7 PQRS
8 TUV
9 WXYZ
*
0 +
#
Hide

Does Android detect overlays?

Nope! Only when it comes to app/runtime permissions...

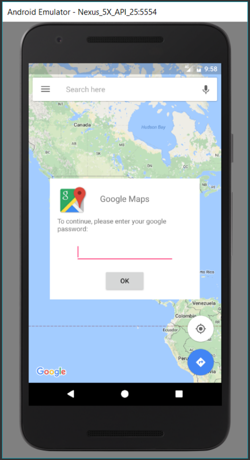
OS Components Overlay Protection

Feature	Protected
Device Administrators	X
Optimise Battery Usage	X
Do not disturb permission	X
Apps that can appear on top	X
Vr Helper Services	X
Change System Settings	X
Notification Access	X
Use Premium SMS Services	X
Allow Unrestricted Data Usage	X
Usage Data Access	X
General App Permissions	✓
Specific App Permissions	✓
Runtime Permissions	✓

OS Components Overlay Protection (Cont.)

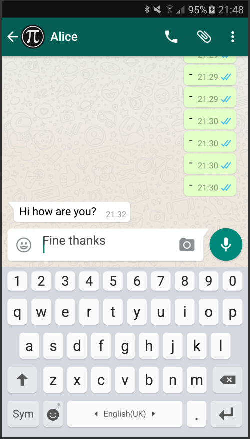
Feature	Protected
ACTION_SETTINGS	X
ACTION_SECURITY_SETTINGS	X
ACTION_WIRELESS_SETTINGS	X
ACTION_WIFI_SETTINGS	X
ACTION_APN_SETTINGS	X
ACTION_BLUETOOTH_SETTINGS	X
ACTION_DATE_SETTINGS	X
ACTION_LOCALE_SETTINGS	X
ACTION_INPUT_METHOD_SETTINGS	X
ACTION_DISPLAY_SETTINGS	X
ACTION_LOCATION_SOURCE_SETTINGS	X
ACTION_INTERNAL_STORAGE_SETTINGS	X

How we use it: Partially overlay apps/system activities


Android Emulator - Nexus_5X_API_25:5554

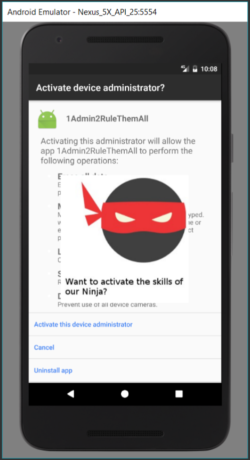
Google Maps

To continue, please enter your google password:



Hi how are you? 21:32

Fine thanks


Android Emulator - Nexus_5X_API_25:5554

Activate device administrator?

1Admin2RuleThemAll

Activating this administrator will allow the app 1Admin2RuleThemAll to perform the following operations:

Want to activate the skills of our Ninja?

Prevent use of all device cameras.

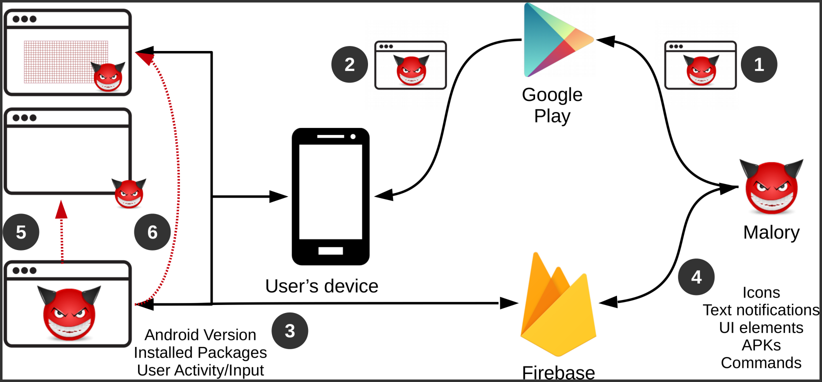
Who can do it?

All Android apps!

When we reported the issue, all Android versions we tested (Oreo preview as well) were vulnerable. We did not test below 4 :/

Result

Automated exploit lifecycle



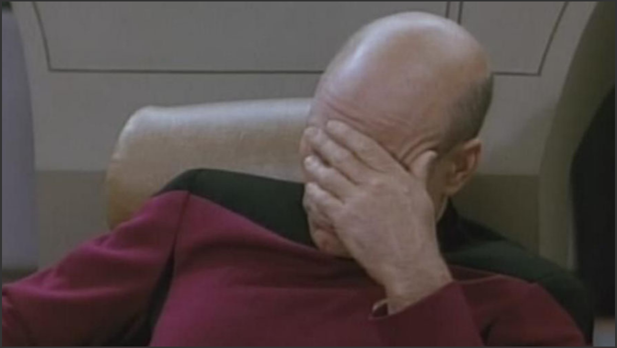
Audio Illusions

Using the mic

To use the mic, one needs to request the corresponding dangerous permission.

Exploiting features

Well, what if I don’t care about your voice, but about *what* you say? Android has a feature to allow developers get voice input from the users and convert it to text. Speech-to-Text. You can use it via intents.



So what?

You create an app, (it can be invisible or in a service like activity) and fire the event for Speech to Text regularly to get what the user says in a text format.

SMEAGOL SHOWS THEM SECRET WAYS THAT
NOBODY ELSE COULD FIND, AND THEY SAY SNEAK.
imgflip.com

Voice assistants

Now that we have a mechanism to get data from the user’s output we can extract additional data from the user.

Guess who else can be fired without permissions? How do you send a command? Text to Speech (and some sleep time)!

Exploit ideas

- "Ok Google, send my location to Alice"
- "Ok Google, what is my next appointment"
- "Ok Google, call 1 2 3 4 5 6 7"
- "Ok Google, read my last SMS"
- Open camera with intent, use Text to Speech to say "Shoot" and snap a photo (you need storage though to get the photo).
- Initiate video calls, post to IM or social media.

The list is endless as everyone rushes to use them with their apps.

Some of the permissions Google Assistant has

(full list has 84 permissions!)

READ_CONTACTS	WRITE_SETTINGS	READ_SMS
WRITE_CONTACTS	MEDIA_CONTENT_CONTROL	RECORD_AUDIO
ACCESS_NETWORK_STATE	ACCESS_FINE_LOCATION	SEND_SMS
CAPTURE_AUDIO_HOTWORD	CALL_PHONE	GET_TASKS
USE_CREDENTIALS	CALL_PRIVILEGED	REAL_GET_TASKS
MANAGE_ACCOUNTS	READ_CALL_LOG	WRITE_CALENDAR
WRITE_EXTERNAL_STORAGE	CAMERA	INTERNET
DOWNLOAD_WITHOUT_NOTIFICATION	WRITE_SMS	USE_FINGERPRINT

Special caution

“Ok Google, read my last SMS”

Chain the result

You can issue commands to other assistants and get their output.

Demo time!

EOF

Thank you for your attention

Questions?

`kpatsak@unipi.gr`

`www.cs.unipi.gr/kpatsak`

`https://androidsp.cs.unipi.gr`

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