The Hitchhacker's Guide to the Mobile Galaxy

nviso

Workshop

BSides Munich 2023

Your Captain

- Penetration tester at NVISO with focus on web and mobile
- Develops and teaches trainings on secure coding practices and pentesting basics
- Guest lecturer at FH Hagenberg (Austria) for *Mobile and Embedded OS* course

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Our Journey

Adventures
on Android

Meddling in
the Middle

Big Bang
of Basics

Incidents
on iOS

Travel Advisories

DON'T PANIC

Travel Advisories

Buckle up!

This course will be hands-on

Don't be Shy!

Ask whenever anything is unclear, or you need help. Your neighbours can help, too!

Keep exploring!

The course will only scratch the surface

Our Journey

Adventures on Android

Meddling in the Middle

Big Bang of Basics

Incidents on iOS

Short Planetology

Android and iOS basics

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Chronology of the mobile universe

1973

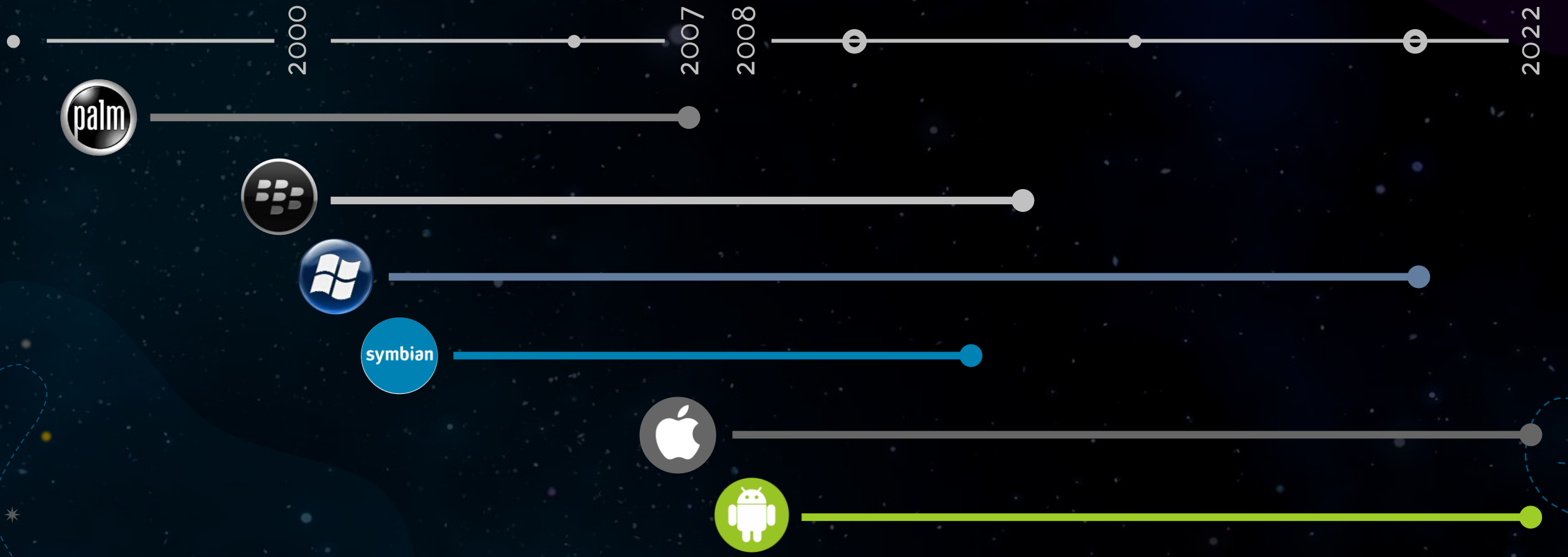
First portable cell phone by Motorola

By: Rico Shen

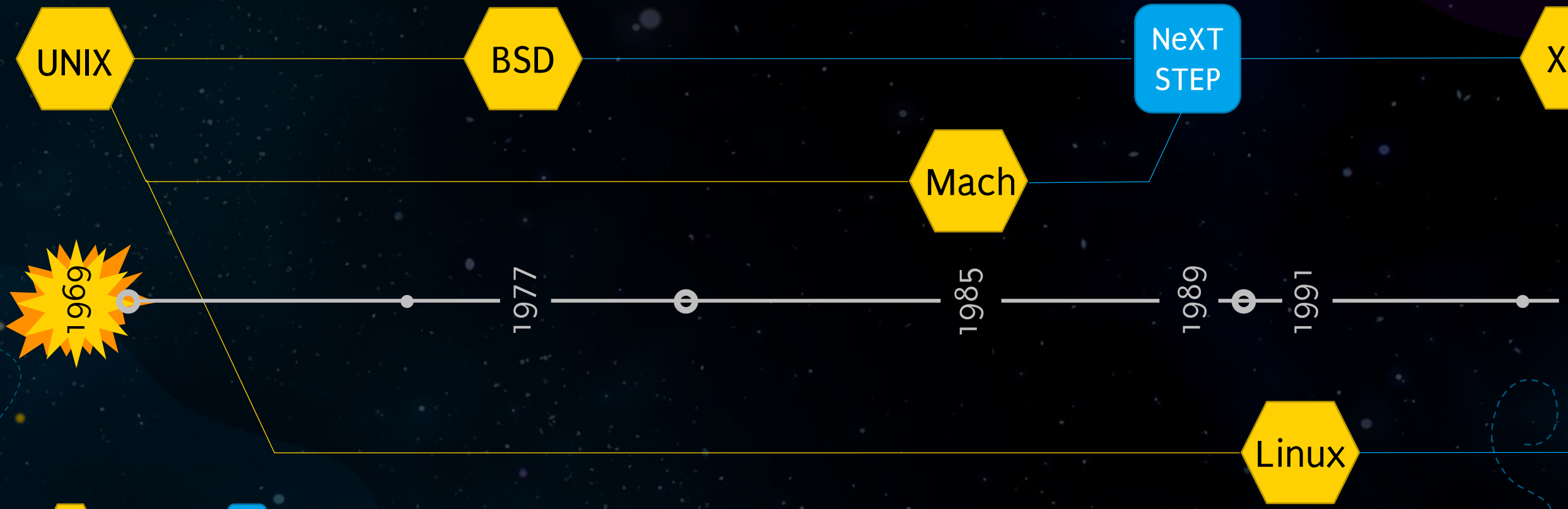
1994

First touchscreen phone by IBM

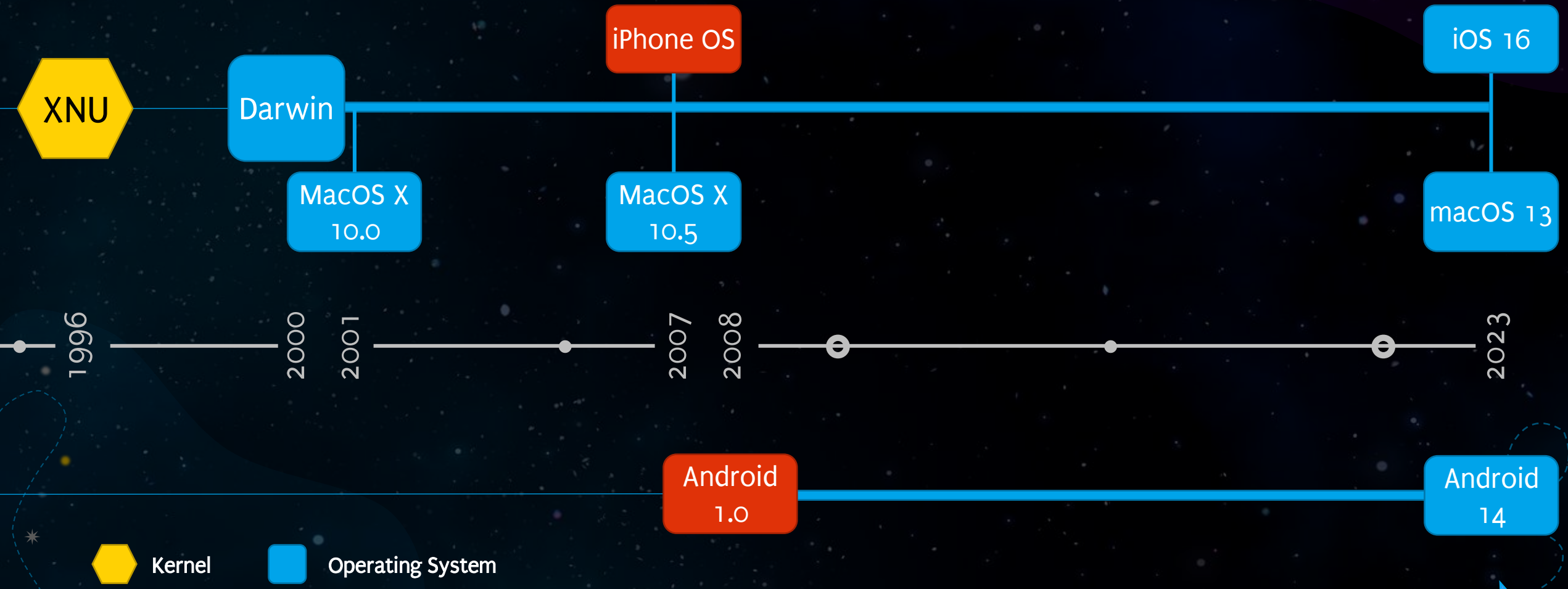
Chronology of the mobile universe



Evolution of Android and iOS



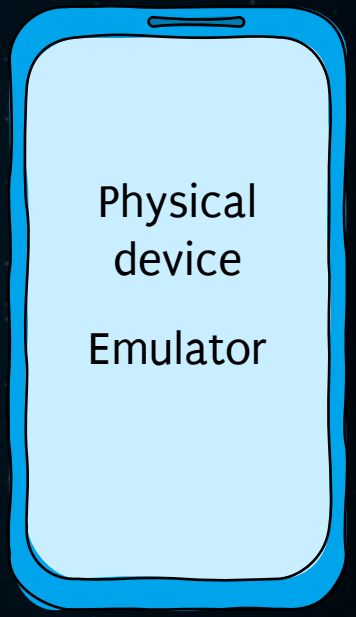
Evolution of Android and iOS

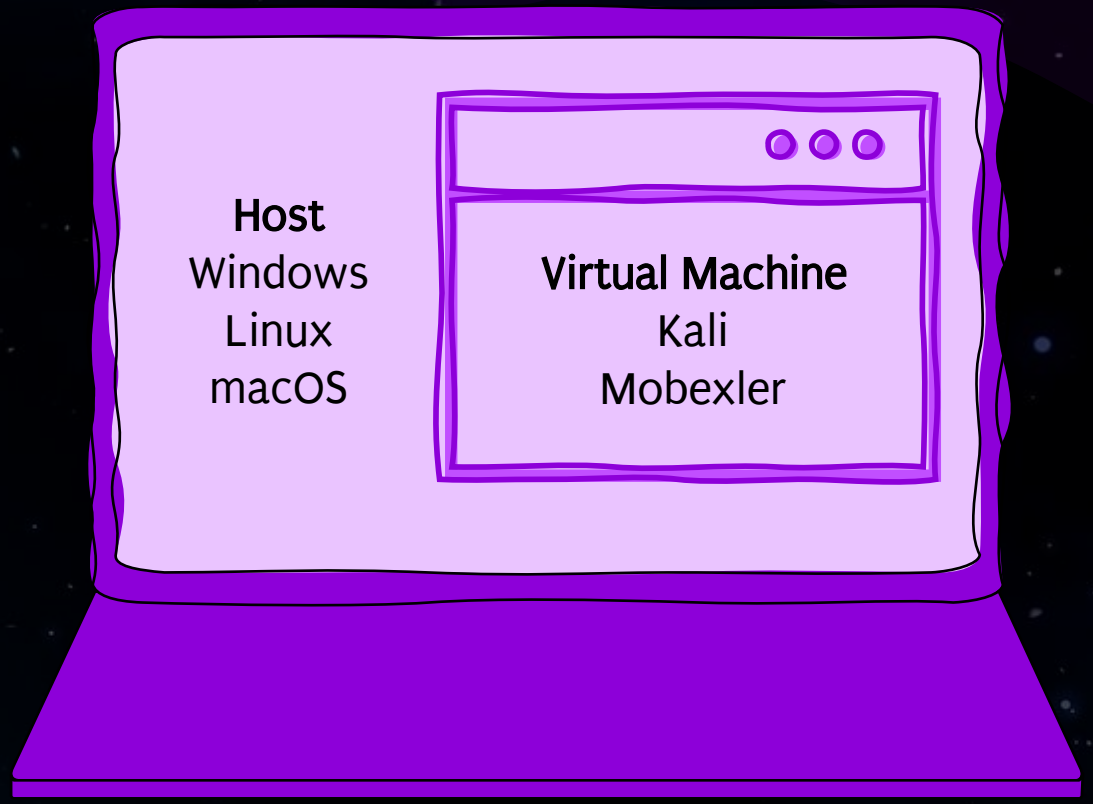


Boarding the Spaceship

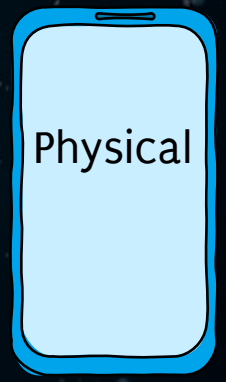
Setting everything up

Assembling the parts





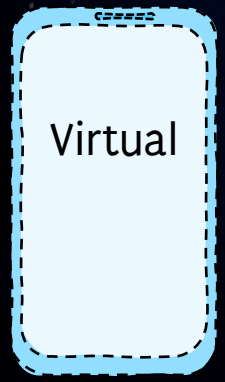
Assembling the parts



ARM processor

Not all devices are easily rootable

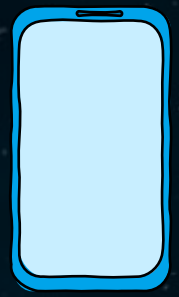
Cost factor



Usually x86 processor;
ARM processor can also be emulated
but will be very slow

Missing features, e.g. biometrics, NFC

Assembling the parts

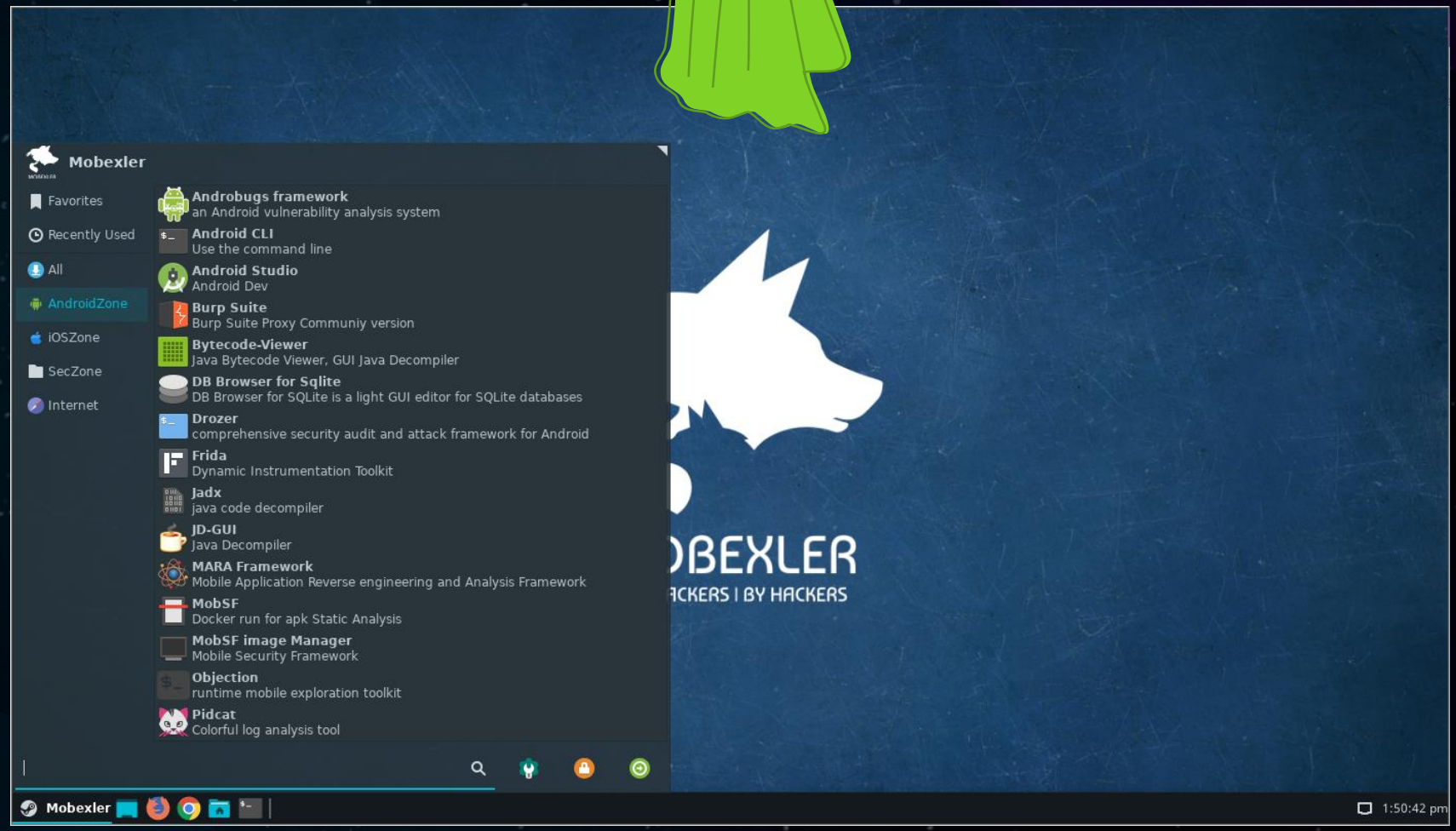


android studio

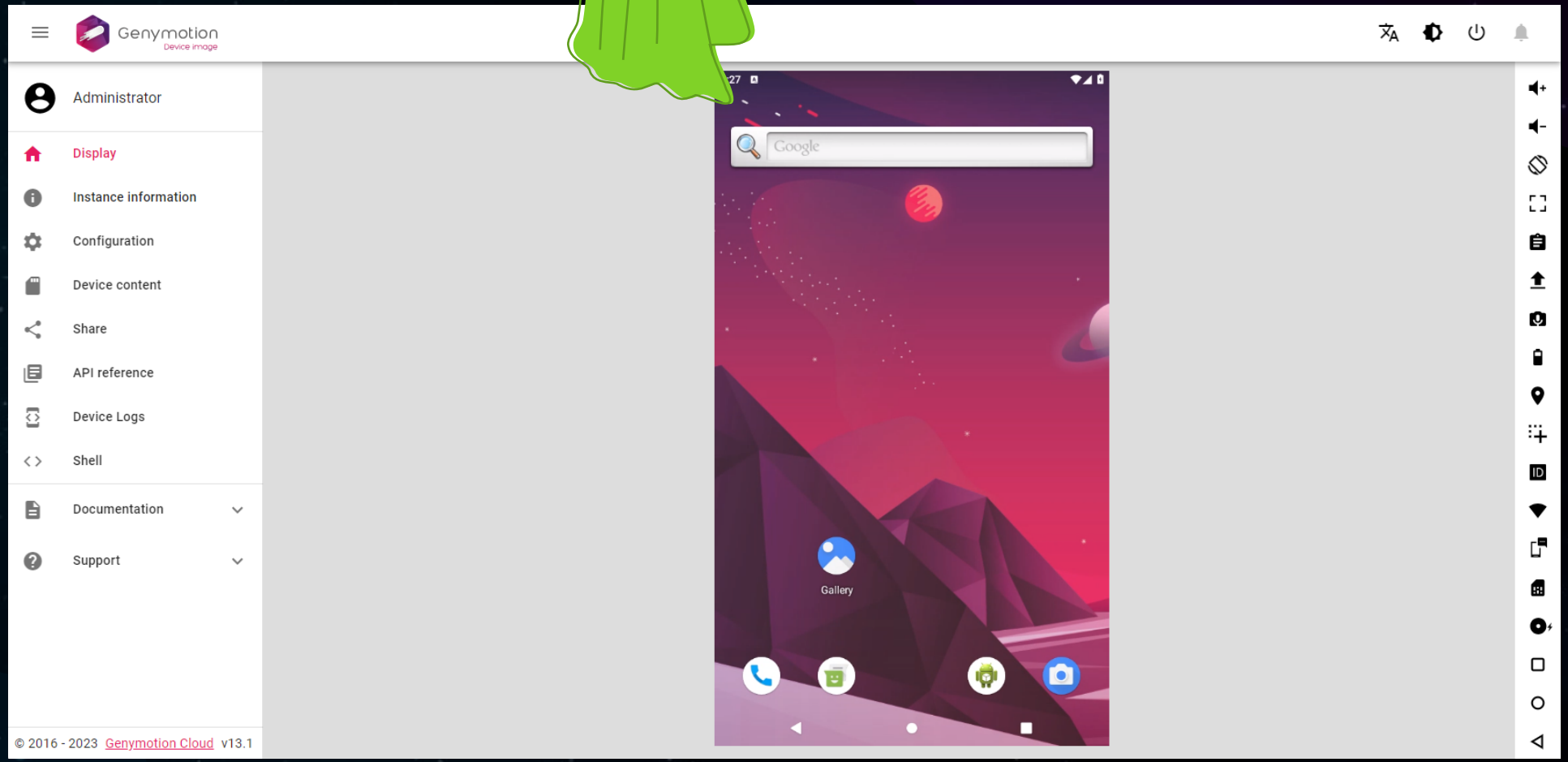
Genymotion

CORELLIUM

Grab Your Towels



Grab Your Towels



Genymotion

Grab Your Towels

All exercises, files and instructions are available at:

http://bsides.hitchhacker.space

Username: bsides
Password: hitchhacker

The bridge is yours

1. Launch Mobexler; PW: mobexler
2. Install missing tools:
   - `sudo apt install apktool adb`
   - `wget https://github.com/patrickfav/uber-apk-signer/releases/download/v1.3.0/uber-apk-signer-1.3.0.jar`
   - ```
     git clone https://github.com/Hamz-a/frida-android-helper
     cd frida-android-helper
     sudo python3 setup.py install
     ```
     ```

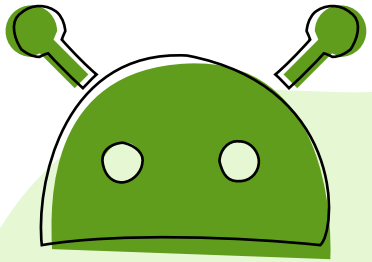
Our Journey

Adventures on Android

Meddling in the Middle

Big Bang of Basics

Incidents on iOS



Getting Ready for Launch

Devices & rooting

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Android Studio

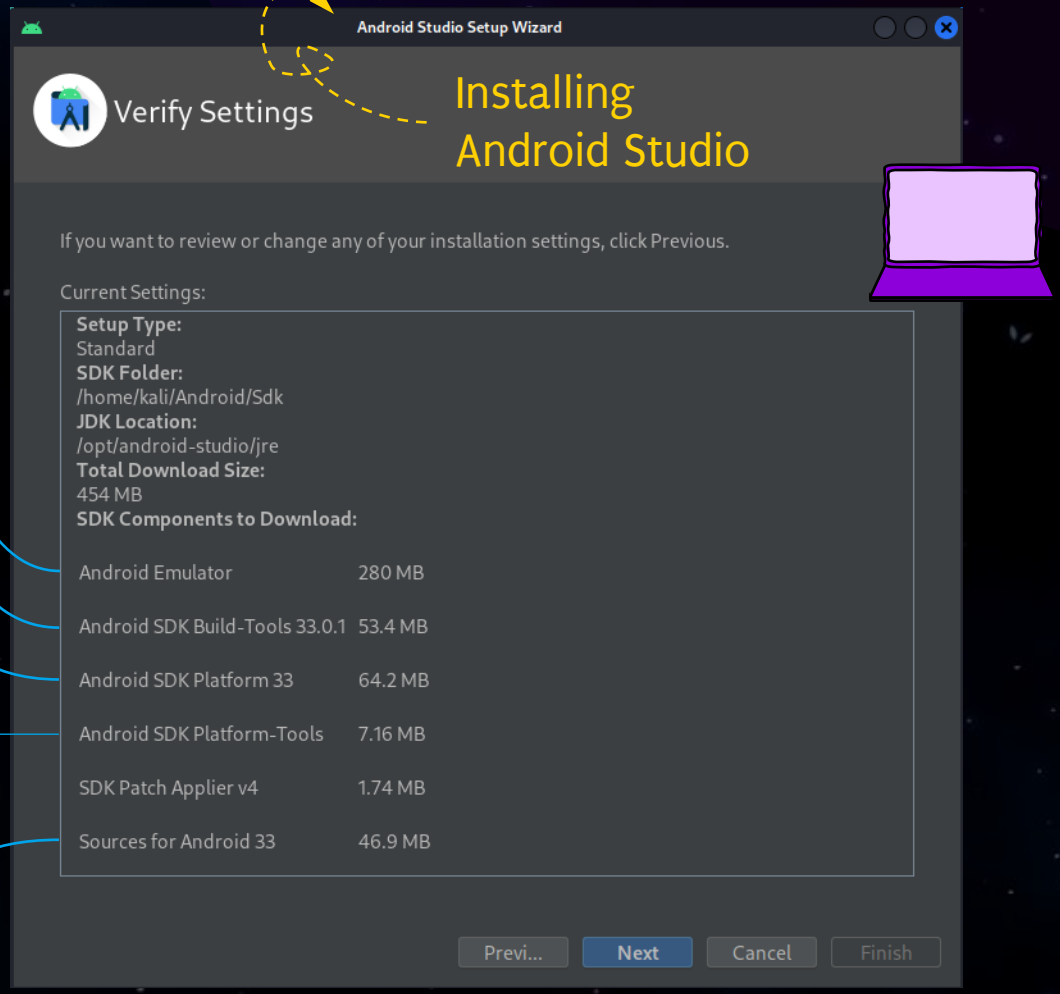
Emulates Android devices (Android Virtual Device, AVD)

Tools for building Android apps `<sdk>/build-tools/`

Tools and libraries for app development

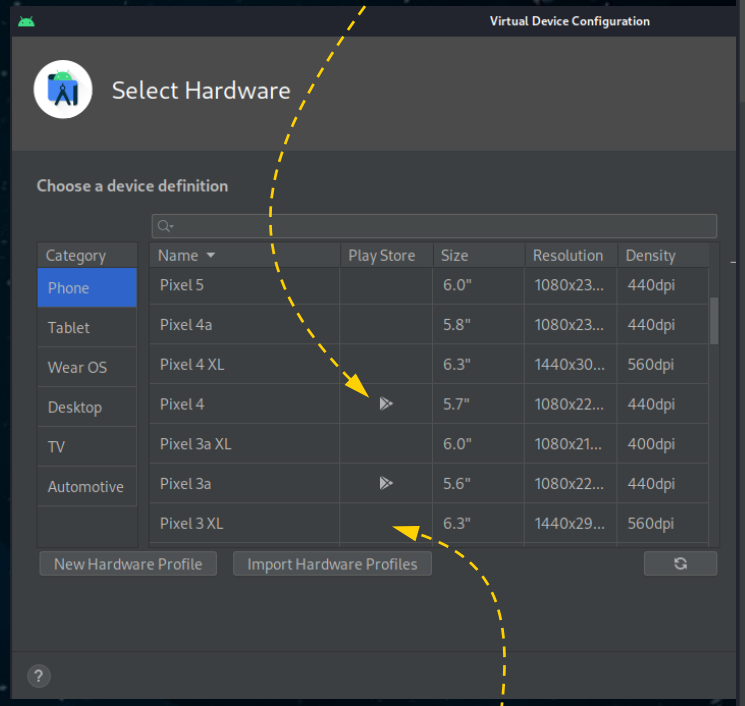
Command line tools interfacing with the Android platform, e.g. `adb` and `fastboot`

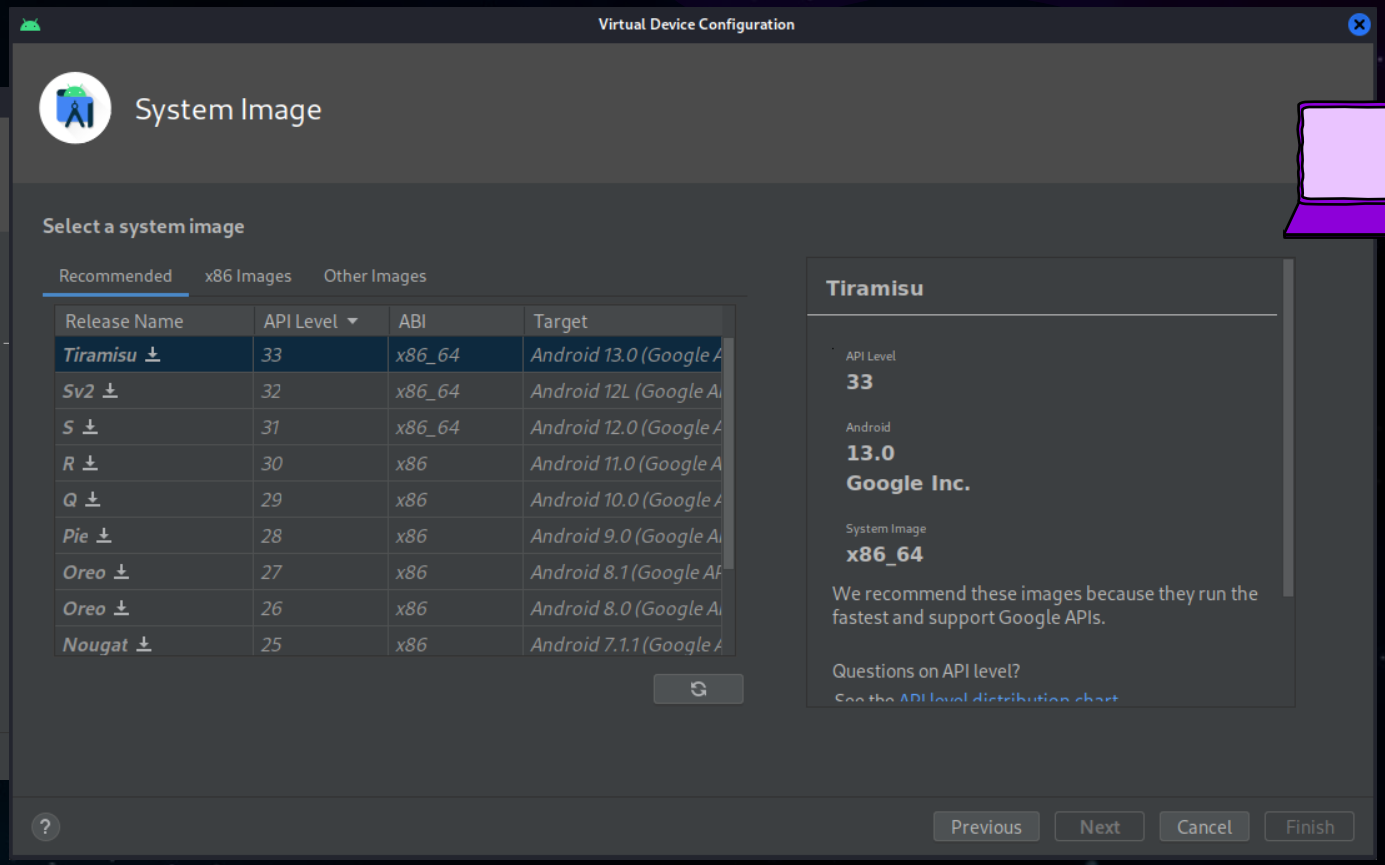
Android source files



Android Studio Emulator

Play Store available on emulated device, but no root access



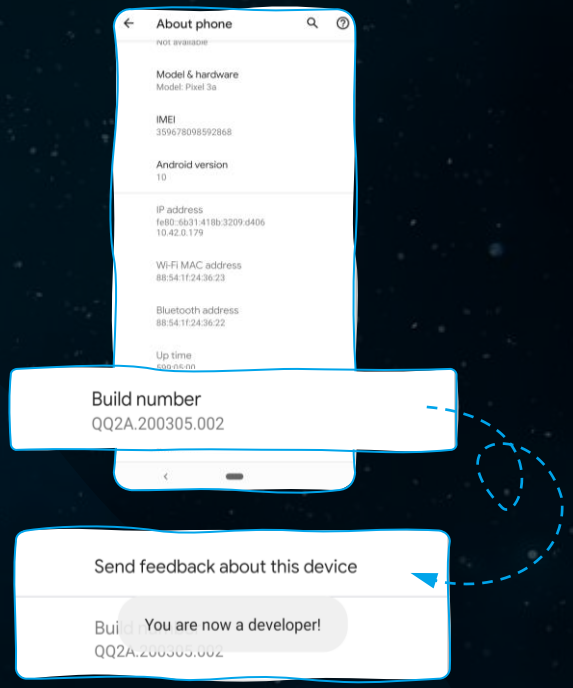


Root access on emulated device

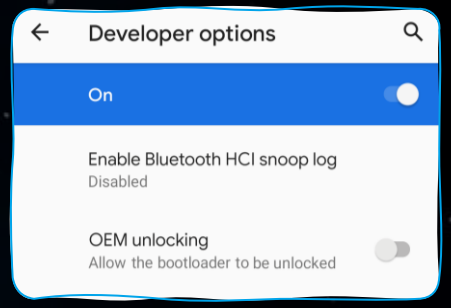
Rooting

Rooting steps differ from device type and Android version but usually require these high-level steps

Enabling developer options to enable USB debugging



Unlocking the bootloader




```
$> adb reboot bootloader

$> fastboot flashing unlock
```

Flashing a patched image

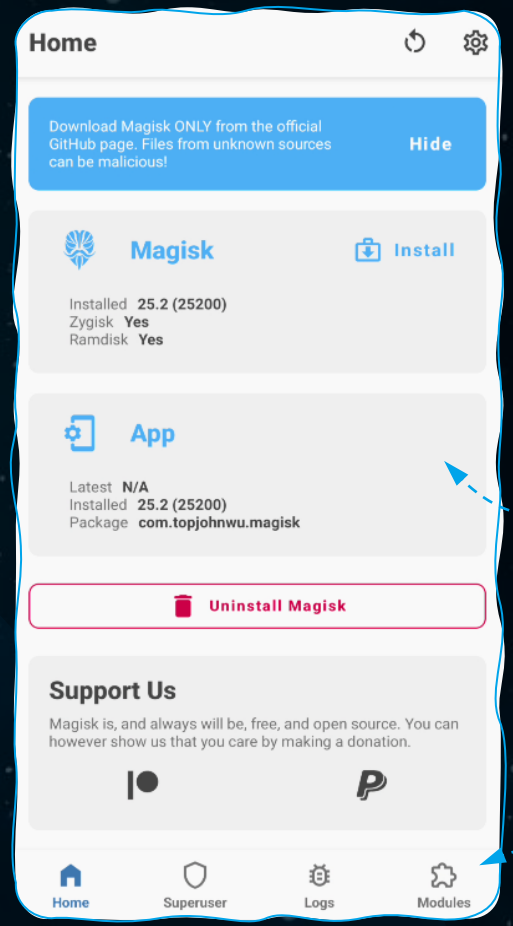
```
$> fastboot flash boot
magisk_patched.img
```

Or sideloading a custom ROM

```
$> fastboot flash recovery
lineage-recovery.img

$> adb sideload lineageos.zip
```

Magisk



Magisk

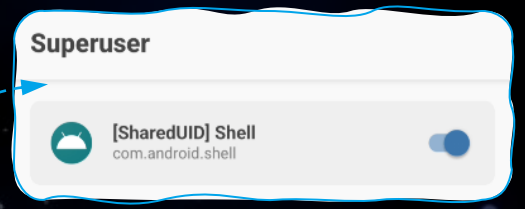
The Magic Mask for Android

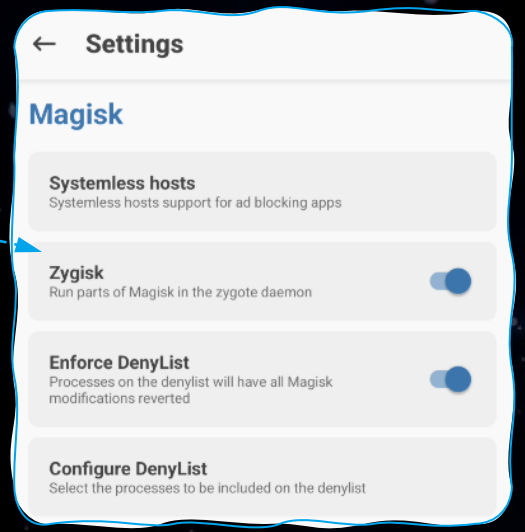
https://github.com/topjohnwu/Magisk

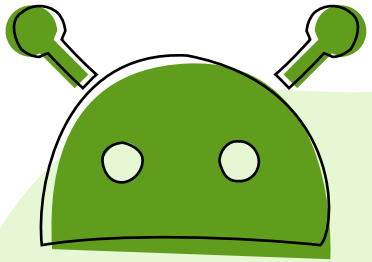
Rooting without modifying the /system partition

Run inside Zygote process and unload it for certain apps (e.g. in case of root detection)

Installing additional modules







First Contact

Reaching out

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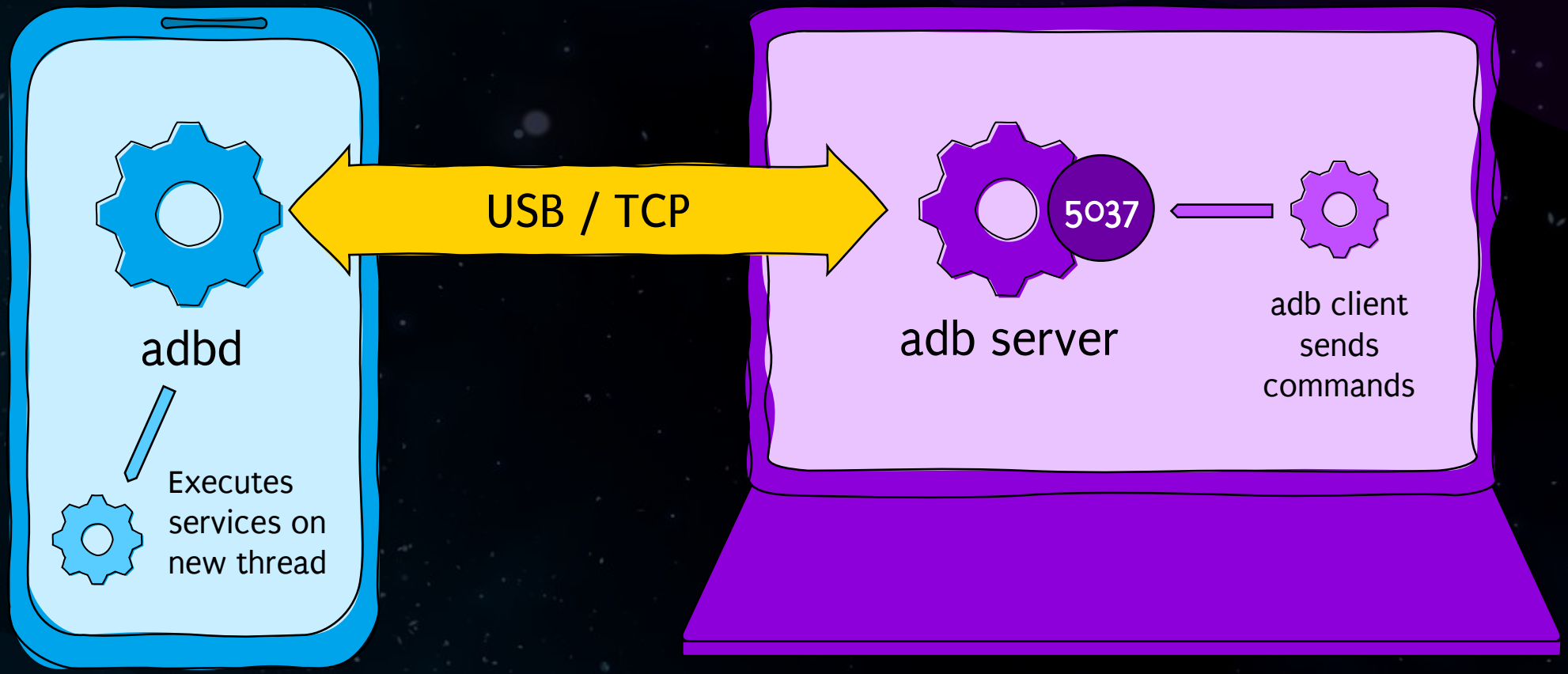
Reaching out



Reaching out

command starts adb client, which first checks if server is running

```
$> adb devices
* daemon not running; starting now at tcp:5037
* daemon started successfully

$> netstat -ant
Active Internet connections (servers and established)
Proto Recv-Q Send-Q Local Address           Foreign Address         State
tcp        0      0 127.0.0.1:5037          0.0.0.0:*               LISTEN
```

```
sargo:/ $ ps -A | grep adb
root          1310     1 10886352  2012 0                   0 S adb_root
shell        15209     1 11012400  7744 0                   0 S adbd
```

Reaching out

List all available devices

Start an interactive shell on a device connected via USB

If there are multiple devices, we need to specify the serial number of the target device

Restart adb as root and start a root shell (only possible on rooted devices)

Connect to a device via TCP (useful for connecting to virtual devices)

```
$> adb devices
List of devices attached
A01X21CF00E      device
RF1DB6K177Y      device

$> adb shell
$> adb -s A01X21CF00E shell
sargo:/ $

$> adb root
$> adb shell
sargo:/ #

$> adb connect [IP]:5555
```

Reaching out

Install an app package (apk)

```
$> adb install hitchhacker.apk
Performing Streamed Install
Success
```

List all installed packages, e.g. to find out package name of installed app

```
$> adb shell pm list packages | grep hitch
package:space.hitchhacker.guide
```

Find out install location of the app binary

```
$> adb shell pm path space.hitchhacker.guide
package:/data/app/~~ogBY1Czkk7OW3C63cFVYdA==/
space.hitchhacker.guide-
uSilirCcYZWeKbnAasXZTg==/base.apk
```

Uninstall an app

```
$> adb uninstall space.hitchhacker.guide
Success
```

Reaching out

Copy file to the phone

```
$> adb push file.txt /sdcard
file.txt: 1 file pushed, 0 skipped. 0.0 MB/s
(18 bytes in 0.099s)
```

Copy file from the phone

```
$> adb pull /sdcard/file.txt ~/Documents
/sdcard/file.txt: 1 file pulled, 0...ped. 0.0
MB/s (18 bytes in 0.008s)
```

View system log

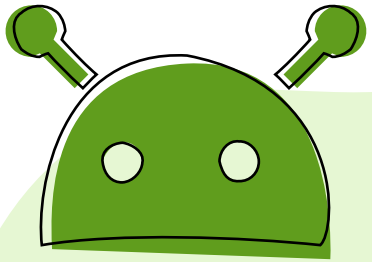
```
$> adb logcat
```

Create backup of an app (deprecated!)

```
$> adb backup -f mybackup.ab -apk
   -shared space.hitchhacker.guide
Now unlock your device and confirm the backup
operation...
```

The bridge is yours

1. Activate adb access
2. Install the Hitchhacker app with “adb install” or via drag&drop
3. Open a shell on the device andfind out the package name of the app
4. Browse to the app binary



Rocket Science

Inside an APK

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Inside an APK

```
$> unzip hitchhacker.apk -d hitchhacker
$> ls -la hitchhacker
```


assets


META-INF


res


AndroidManifest.xml

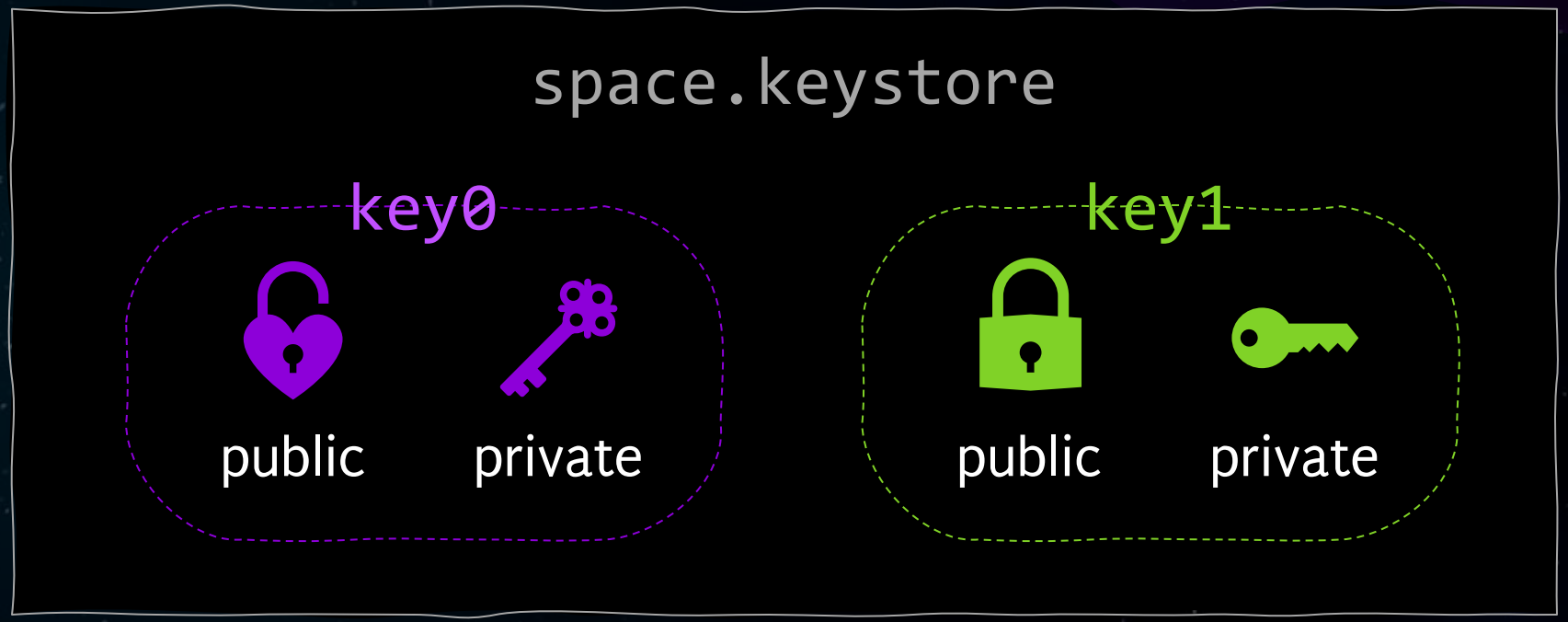

classes.dex


resources.arsc

Inside an APK

assets	*Application assets, e.g. document templates*
META-INF	*Signature and certificate for app distribution*
res	*UI resource files, e.g. XML configuration files*
AndroidManifest.xml	*Binary file; app information*
classes.dex	*Dalvik file: app code*
resources.arsc	*Binary file; describes app resources*

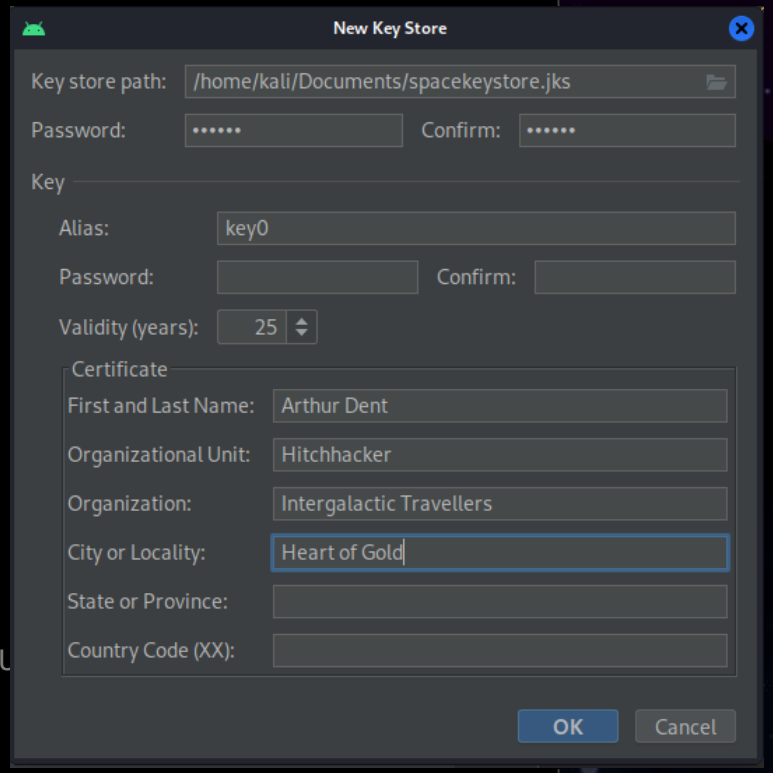
Signing off - Keystore



Signing off - Creating a keystore

```
$> keytool -genkey -v -keystore space.keystore -alias key0 -keyalg RSA -keysize 2048 -validity 10000
Enter keystore password:
Re-enter new password:
What is your first and last name?
  [Unknown]:  Arthur Dent
What is the name of your organizational unit?
  [Unknown]:  Hitchhacker
What is the name of your organization?
  [Unknown]:  Intergalactic Travellers
What is the name of your City or Locality?
  [Unknown]:  Heart of Gold
What is the name of your State or Province?
  [Unknown]:
What is the two-letter country code for this unit?
  [Unknown]:
Is CN=Arthur Dent, OU=Hitchhacker, O=Intergalactic Travellers, L=Heart of Gold, ST=U
  [no]:  yes

Generating 2,048 bit RSA key pair and self-signed certificate (SHA256withRSA) with a validity of 10,000 days
        for: CN=Arthur Dent, OU=Hitchhacker, O=Intergalactic Travellers, L=Heart of Gold, ST=Unknown, C=Unknown
[Storing space.keystore]
```



Signing off - Signing an app

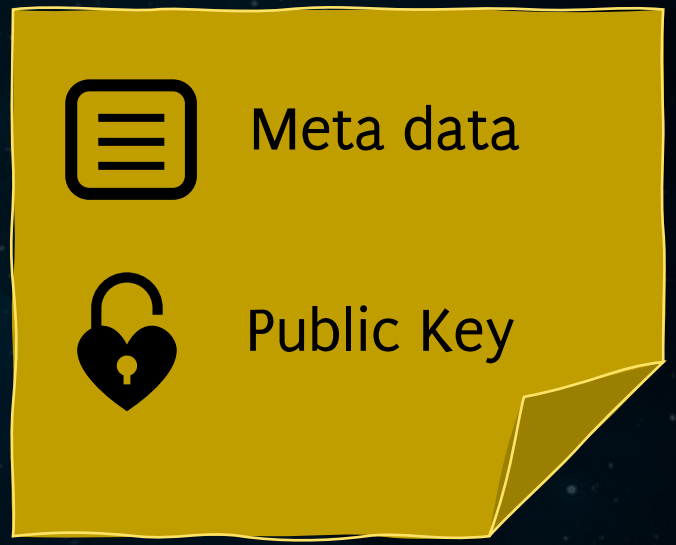
Private Key

App Signature

```
$> apksigner sign --ks spacekeystore.jks --ks-key-alias key0 universe.apk
Keystore password for signer #1:
```

Signing off - Signing an app

Certificate for app signature

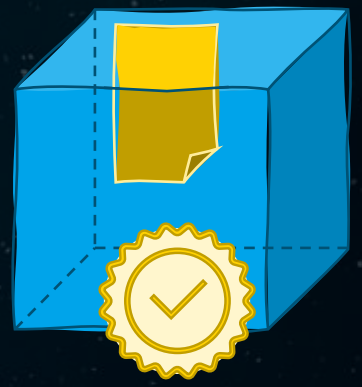



```
$> apksigner verify --print-certs universe.apk
Signer #1 certificate DN: L=Heart of Gold, O=Intergalactic
          Travellers, OU=Hitchhackers, CN=Ford Prefect
Signer #1 certificate SHA-256 digest:
          f2ea49fb4bed82a93207928e15df91dc21fba7d08bfac3010f
          f8d37ad85e7586
Signer #1 certificate SHA-1 digest:
          08ad6226f6e41c3f9220950d7df5f9bf04af7d19
Signer #1 certificate MD5 digest:
          827d01734d6141b91fa17ea32655cbd6
```

Signing off - Verifying the Signature

Certificate inside APK

META-INF/CERT.RSA



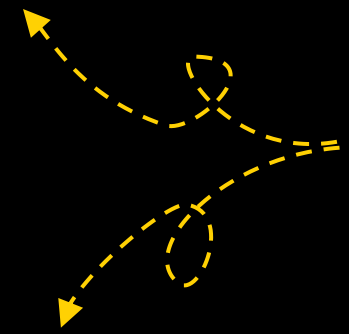
App Signature

Android Package Manager verifies upon installation if app signature (private key) and contained certificate (public key) match

Signing off... for Some else?

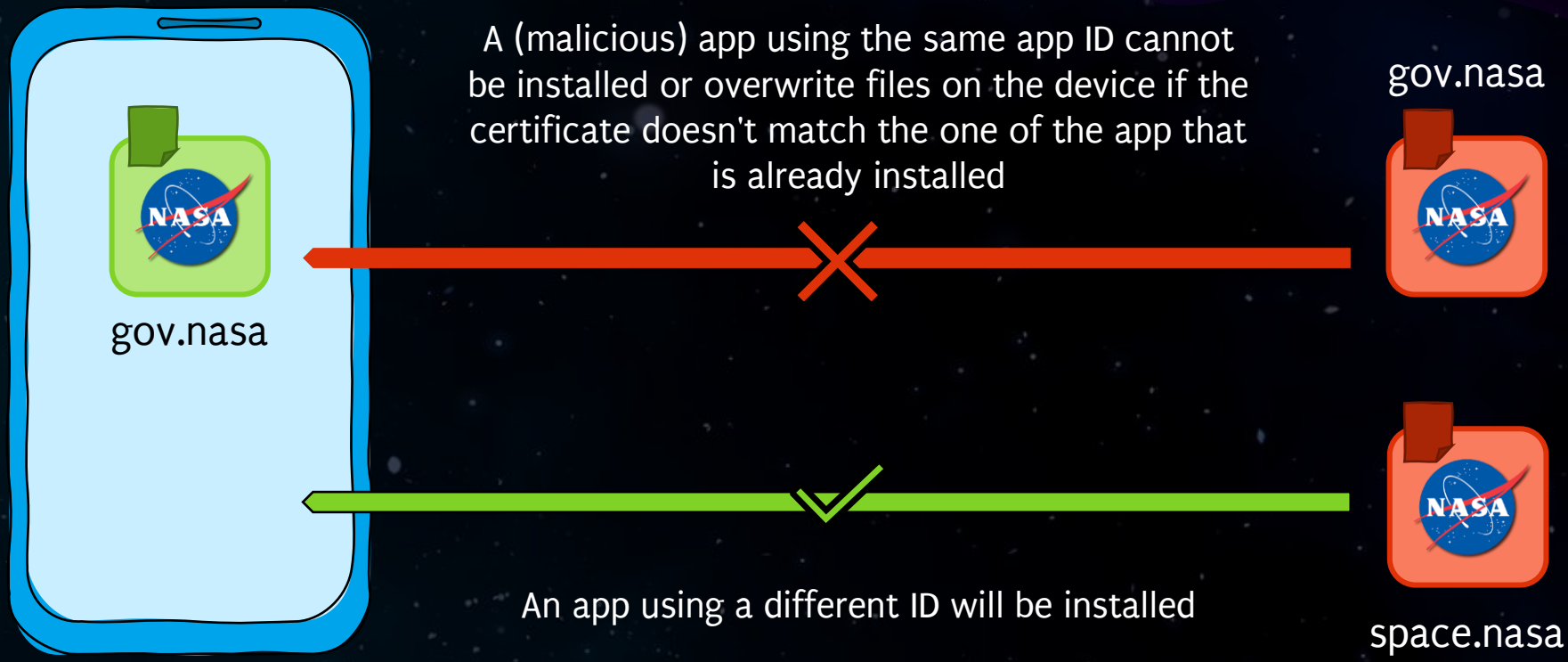
```
$> jarsigner -verify -verbose -certs NASA.apk
...
- Signed by "CN=NASA Ames Research Center, OU=Ames Research Center, O=NASA, L=Mountain
  View, ST=CA, C=US"
    Digest algorithm: SHA-256
    Signature algorithm: SHA256withRSA, 2048-bit key

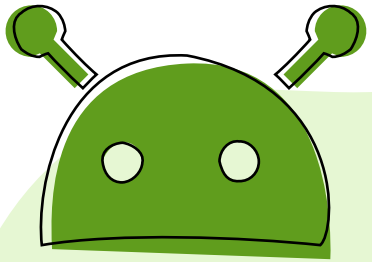

$> jarsigner -verify -verbose -certs NASA.apk
...
- Signed by "CN=Zaphod Beeblebrox, OU=Heart of Gold, O=Galaxy, L=Betelgeuse, ST=Galaxy,
  C=GA"
    Digest algorithm: SHA-256
    Signature algorithm: SHA256withRSA, 2048-bit key
```



Android does not perform CA verification for application certificates - you can sign with whatever you want

Signing off... for Some else?





Scanning the Area

Static analysis

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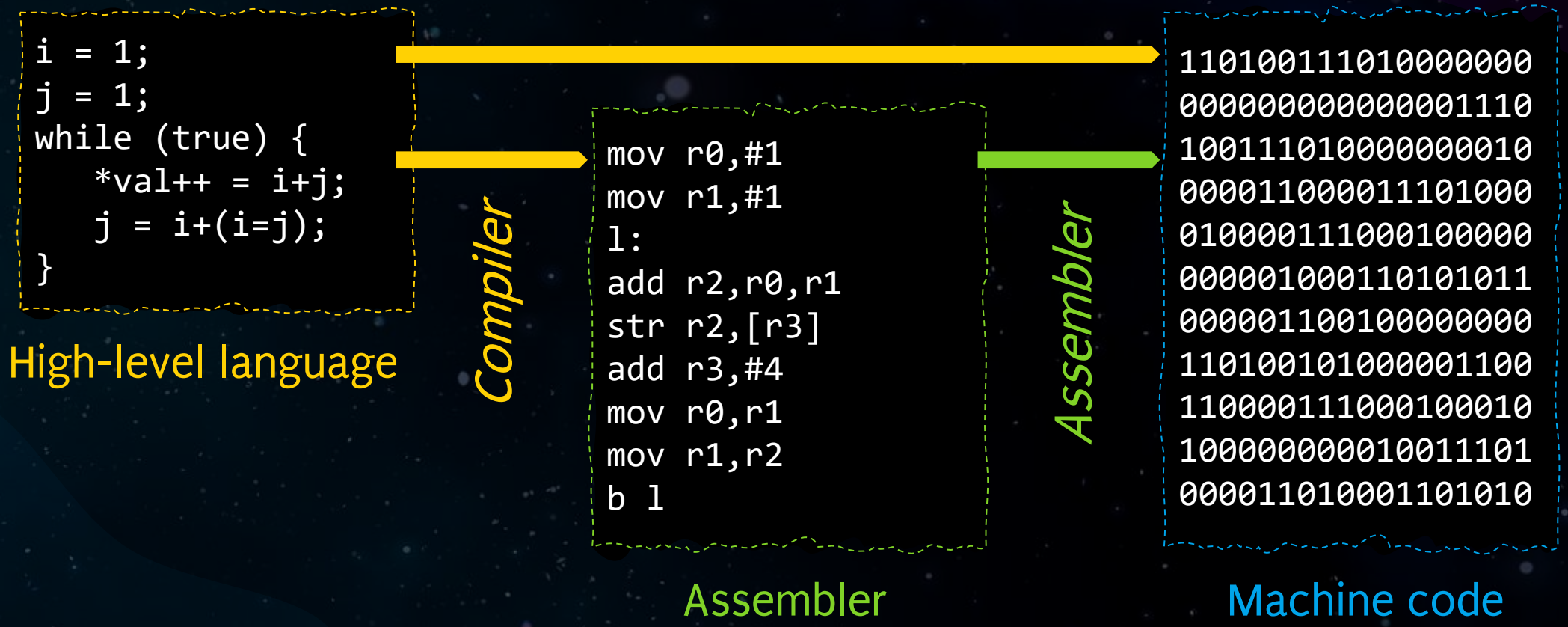
Decompiling apps



Decompiling apps

```
public static void
main(String[] args) {
    int a = 1;
    int b = 2;
    int c = a + b;
}
```

Source code (.java)

Compiler

```
Code:
stack=2, locals=4,
args_size=1
0: iconst_1
1: istore_1
2: iconst_2
3: istore_2
4: iload_1
5: iload_2
6: iadd
7: istore_3
8: return
```

Byte code (.class)

JVM

```
11010011101000000
00000000000001110
10011101000000010
00001100011101000
01000011100010000
00000100011010101
1
00000110010000000
11010010100001100
11000011100010010
10000000010011101
00001101000110101
0
```

Machine code

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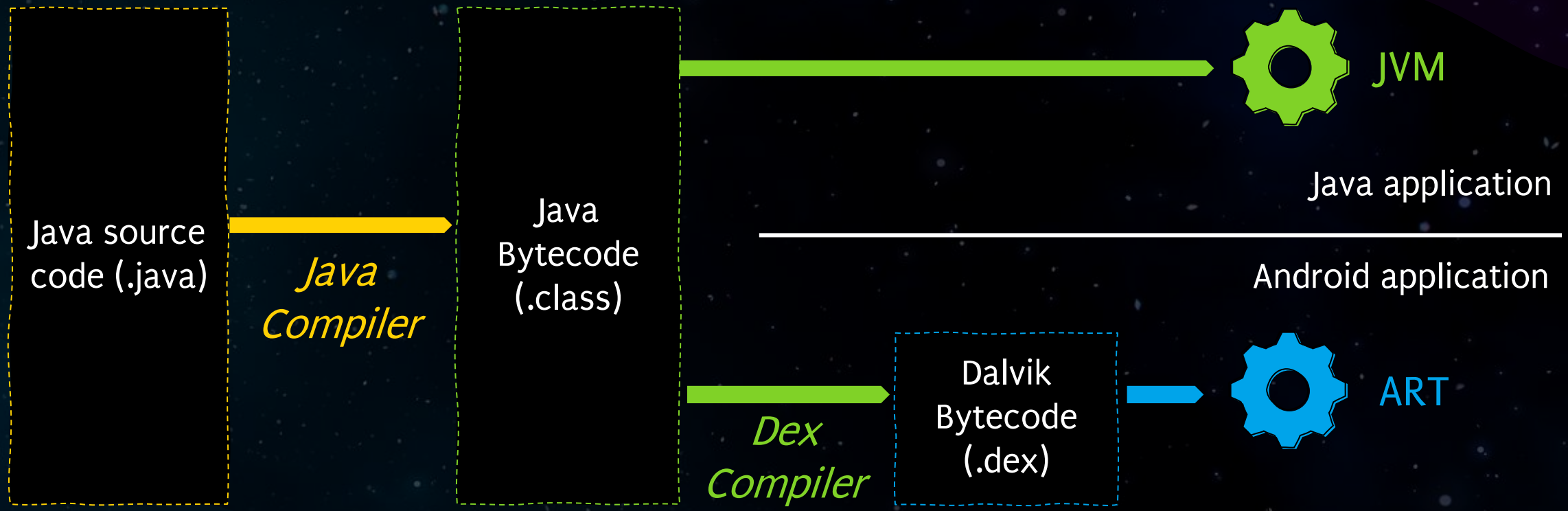
Decompiling apps



Decompiling APK files

```
if (isExternalStorageWritable()) {
    File file = new File (Environment.getExternalStorageDirectory(), "password.txt");
    // Log.d("Storage Directory", String.valueOf(Environment.getExternalStorageDirectory()));
    String password = "L33tS3cr3t";
    FileOutputStream fos;
    try {
        fos = new FileOutputStream(file);
        fos.write(password.getBytes());
        fos.close();
    } catch (FileNotFoundException e) {
         e.printStackTrace();
    } catch (IOException e) {
         e.printStackTrace();
    }
}
```

Original source code

Decompiling APK files

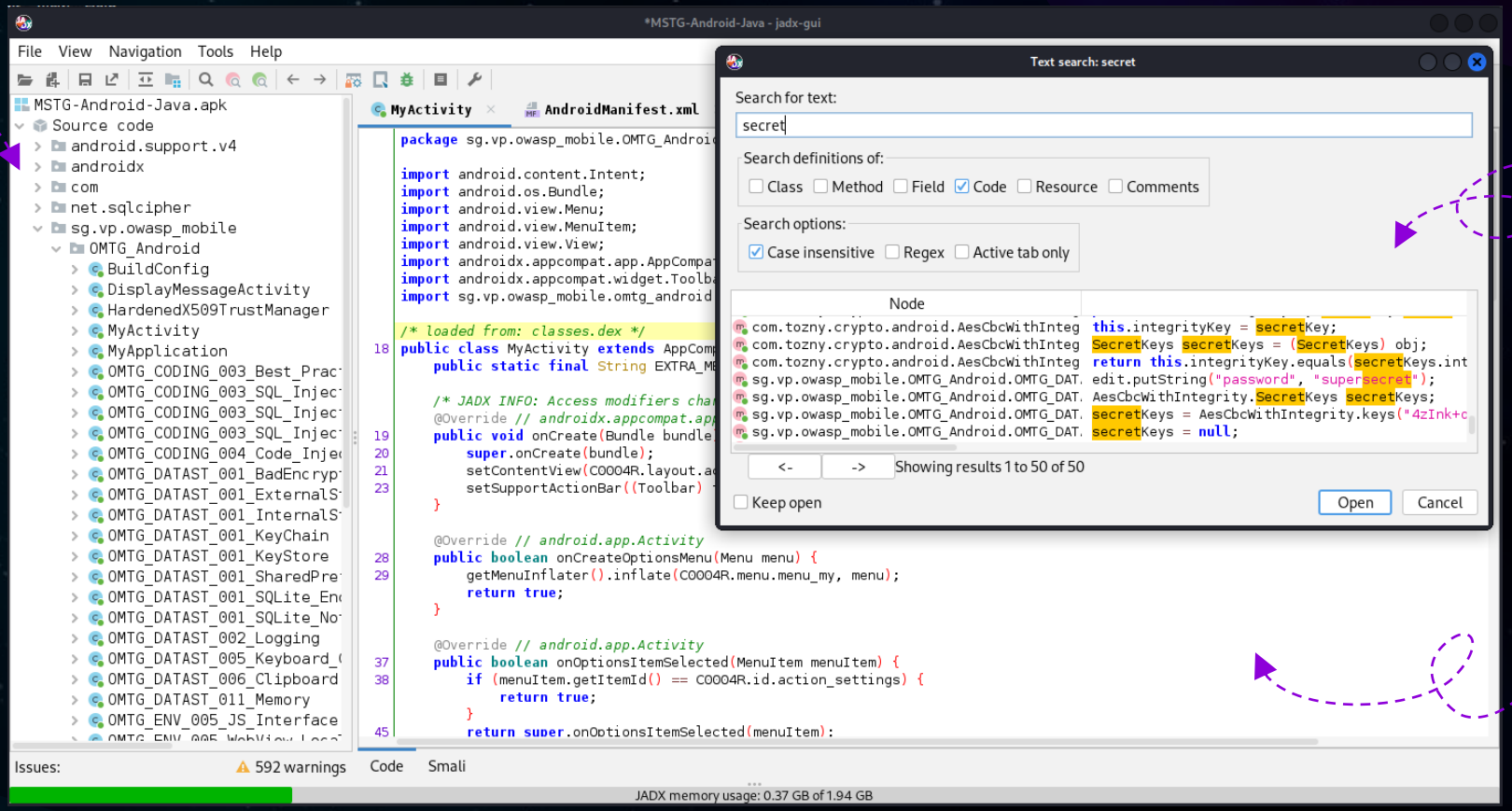
```
if (isExternalStorageWritable()) {
    File file = new File (Environment.getExternalStorageDirectory(), "password.txt");
    // Log.d("Storage Directory", String.valueOf(Environment.getExternalStorageDirectory()));
    String password = "L33tS3cr3t";
    FileOutputStream fos;
    try {
        fos = new FileOutputStream(file);
        fos.write(password.getBytes());
        fos.close();
    } catch (FileNotFoundException e) {
         e.printStackTrace();
    } catch (IOException e) {
         e.printStackTrace();
    }
}
```

```
if (isExternalStorageWritable()) {
  try {
    FileOutputStream fileOutputStream = new FileOutputStream(new
      File(Environment.getExternalStorageDirectory(),
      "password.txt"));
    fileOutputStream.write("L33tS3cr3t".getBytes());
    fileOutputStream.close();
  } catch (FileNotFoundException e) {
    e.printStackTrace();
  } catch (IOException e2) {
    e2.printStackTrace();
  }
}
```

By decompiling we can easily retrieve nearly the original source code

JADX-GUI

Package structure



Searching within classes

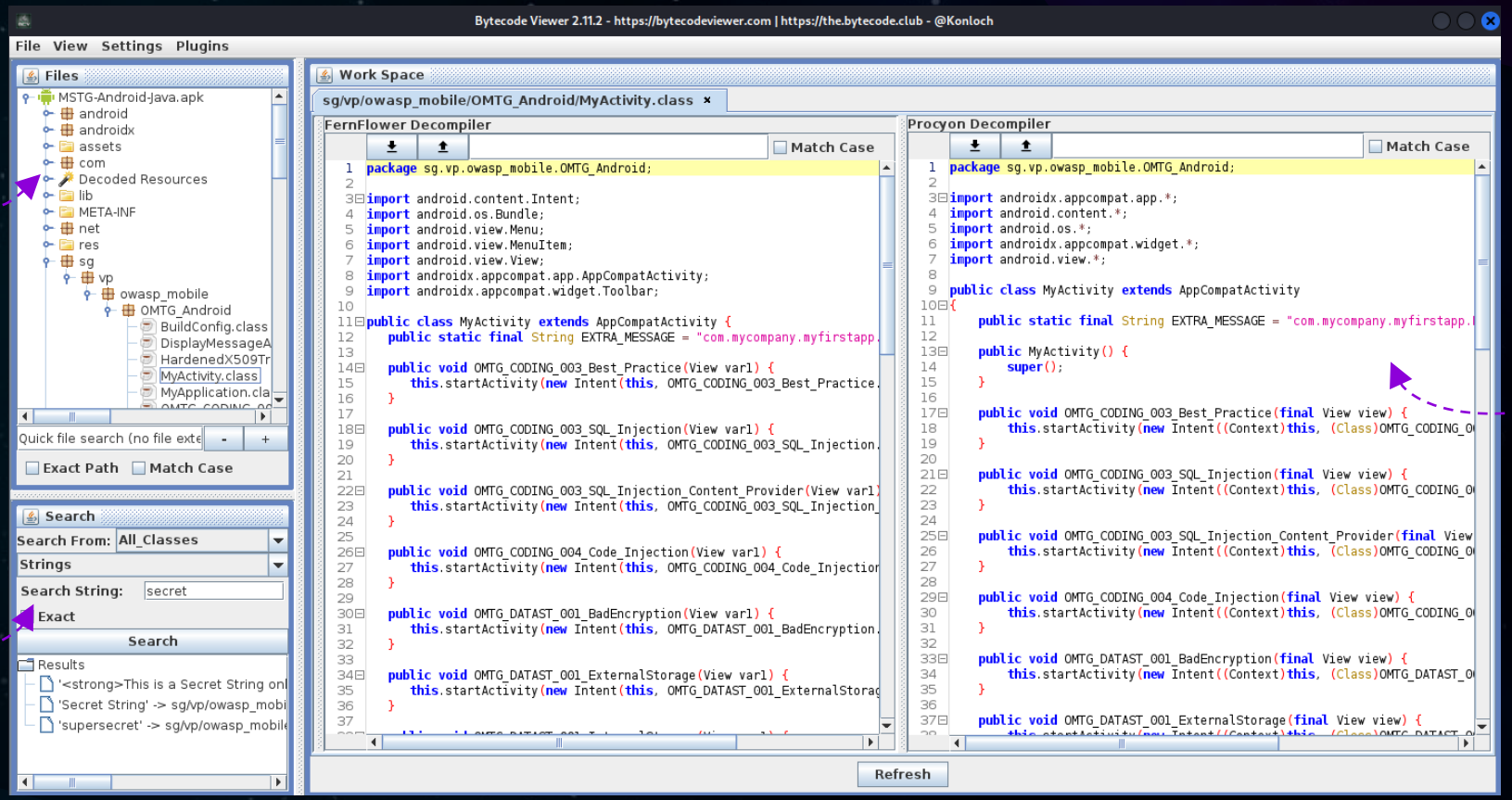
Decompiled Java code

https://github.com/skylot/jadx

Bytecode Viewer

Package structure

Searching within classes



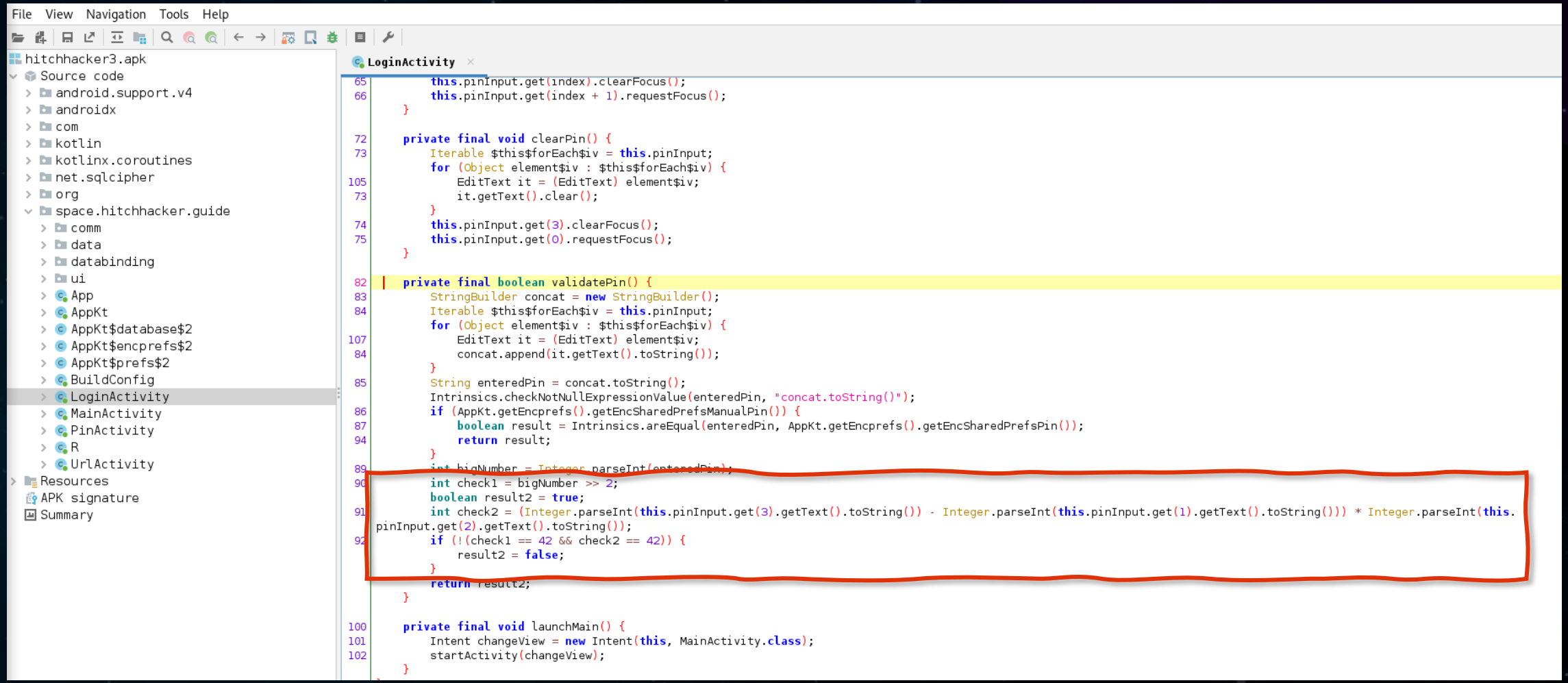
Decompiled Java code using up to three different decompilers

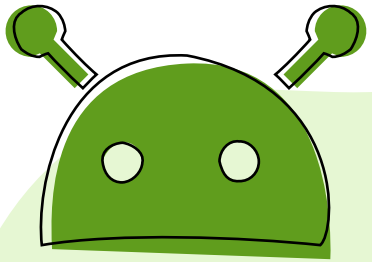
https://github.com/Konloch/bytecode-viewer

The bridge is yours

1. Demo: Using jadx-gui
2. Find the Hitchhacker app's original pin by using static analysis

Solution





The Cargo Bay

How data is stored on Android

nviso

One app, multiple locations

/data/app/~~xyz/space.hitchhacker.guide

- base.apk
- oat
- lib

/data/data/space.hitchhacker.guide

- cache
- code-cache
- databases
- files
- lib
- shared_prefs

/storage/emulated/0/Android/data/space.hitchhacker.guide

- files

Getting an APK

```
$> adb shell pm path space.hitchhacker.guide
package:/data/app/~~gF7fUVcWUu59lRcvexS8tQ==/space.hitchhacker.guide-shjdiXYF3O0VtZfhqrAjQg==/base.apk

$> adb pull /data/app/~~gF7fUVcWUu59lRcvexS8tQ==/space.hitchhacker.guide-shjdiXYF3O0VtZfhqrAjQg==/base.apk
/data/app/~~gF7fUVcWUu59lRcvexS8tQ==/space.hitchhacker.guide-shjdiXYF3O0VtZfhqrAjQg==/base.apk: 1 file pulled, 0 skipped. 30.9 MB/s (5295949 bytes in 0.163s)
```

Split APKs

/data/app/~~xyz/space.hitchhacker

- base.apk
- split_config.arm64.apk
- split_config.nl.apk
- split_config.xxhdpi.apk

```
$> python3 patch-apk.py space.hitchhacker

Getting APK path(s) for package: space.hitchhacker
[+] APK path: /data/app/~~XqZX_gCpfQQ==/space.hitchhacker-XvabuQowwLc8uGKXUaqHPw==/base.apk
[+] APK path: /data/app/~~XqZX_gCpfQQ==/space.hitchhacker-XvuQowc8uGKXUaqHPw==/split_config.arm64_v8a.apk
...
Pulling APK file(s) from device.
[+] Pulling: space.hitchhacker-base.apk
[+] Pulling: space.hitchhacker-split_config.arm64_v8a.apk
...
[+] Pulling: space.hitchhacker-split_config.xxhdpi.apk

App bundle/split APK detected, rebuilding as a single APK.
```

https://github.com/TheDauntless/patch-apk/tree/master

Shared Preferences

```xml
<?xml version='1.0' encoding='utf-8' standalone='yes' ?>
<map>
    <string name="UsernameKey">arthurdent</string>
    <string name="PasswordKey">acupoftea</string>
</map>
```

Key-value pairs stored in XML

Stored in clear text by default

```xml
<?xml version='1.0' encoding='utf-8' standalone='yes' ?>
<map>
    <string name="ARCyFuEcW9/TcaBiAs+tOgZubZYGzw5i9NkTORKY764=">
    AWu/DKgTl/TWIaesThkCZtqssJwcg8a1RICuP/UQem9iFxh08vDrgRGM8rMBrlqKvGoE
    </string>
    <string name="__androidx_security_crypto_encrypted_prefs_key_keyset__">
        12a901e172...001
    </string>
    ...
</map>
```

Stored encrypted using `androidx.security.crypto.EncryptedSharedPreferences`

Databases

```
sargo:/data/data/glaxy.hitchhacker.guide/databases # sqlite3 travelCcompanions
SQLite version 3.32.2 2021-07-12 15:00:17
Enter ".help" for usage hints.
sqlite> .tables
Companions          android_metadata
sqlite> select * from Companions;
fordprefect|goosnargh
```

SQLite databases are not encrypted by default

We can use the external library SQLCipher to encrypt the entire database

Databases

Realm DB

Not encrypted by default

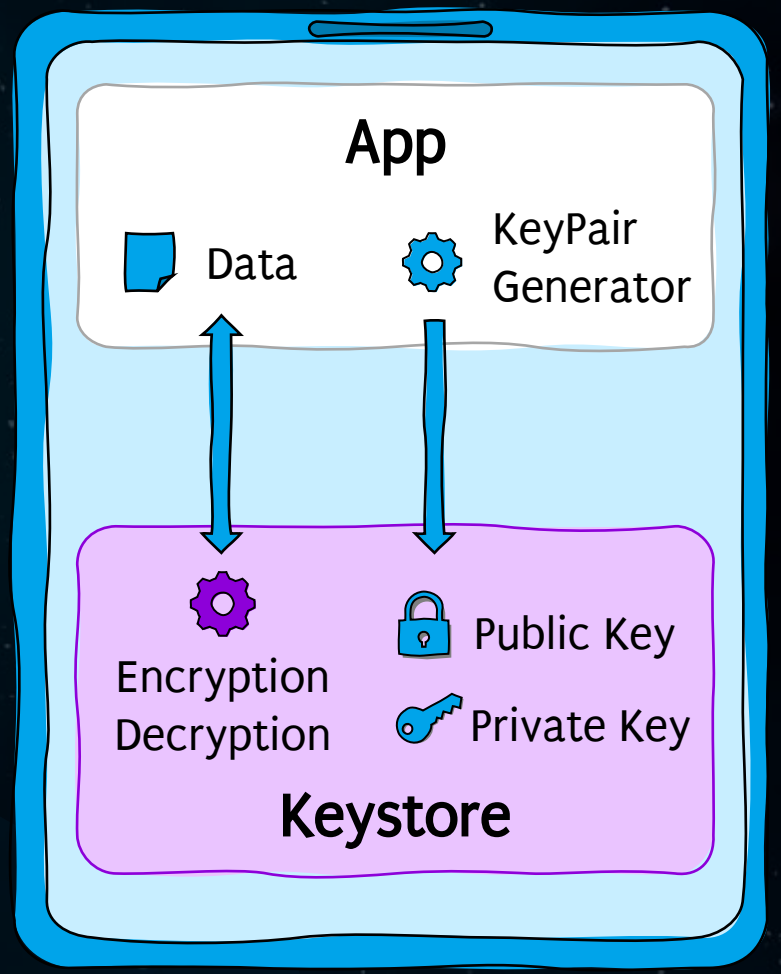
Encryption can be enabled through configuration

Firebase DB

Cloud database, encrypted in transit, but not locally

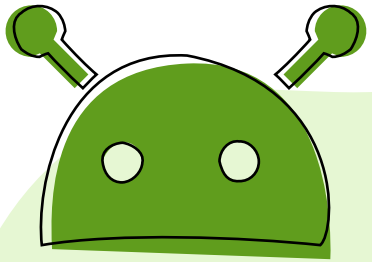
Main security concern: Proper authorization & access controls

Keystore



Secure container for storing keys and performing cryptographic operations

- Software-based at /data/misc/keystore/user_0
- Hardware-based as secure area on main processor or separate microchip



InSide the engine

Identifying the attack surface

nviso

Android Manifest

XML file defining information and components of the application

```
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android" android:versionCode="97" android:versionName="2.05" android:installLocation="auto" android:compileSdkVersion="30"
android:compileSdkVersionCodename="11" package="galaxy.hitchhacker" platformBuildVersionCode="30" platformBuildVersionName="11">
    <uses-sdk android:minSdkVersion="21" android:targetSdkVersion="30"/>
    <uses-permission android:name="android.permission.ACCESS_NETWORK_STATE"/>
    <uses-permission android:name="android.permission.ACCESS_WIFI_STATE"/>
    <uses-permission android:name="android.permission.INTERNET"/>
    <uses-permission android:name="android.permission.READ_EXTERNAL_STORAGE"/>
    <uses-permission android:name="android.permission.WRITE_EXTERNAL_STORAGE"/>
    <uses-feature android:name="android.hardware.location.gps" android:required="false"/>
    <application android:theme="@style/AppTheme_NoActionBar" android:label="Hitchhacker" android:icon="@mipmap/hitchhacker_guide" android:name="galaxy.hitchhacker,guide"
android:allowBackup="false" android:usesCleartextTraffic="true">
        <meta-data android:name="com.google.android.geo.API_KEY" android:value="AIzaSyB159r06yyIvPEBG37daQUaaial6RdryVc"/>
        <activity android:theme="@style/AppTheme_NoActionBar" android:label="Hitchhacker" android:name="galaxy.hitchhacker.MainActivity">
            <intent-filter>
                <action android:name="android.intent.action.MAIN"/>
                <category android:name="android.intent.category.LAUNCHER"/>
            </intent-filter>
        </activity>
        <provider android:name="galaxy.hitchhacker.GuideBrowser" android:exported="false"
                  android:authorities="galaxy.hitchhacker.provider" android:grantUriPermissions="true" />
        <service android:name="galaxy.hitchhacker.SpaceshipMonitor" android:permission="android.permission.BIND_JOB_SERVICE"
                 android:enabled="@bool/enable_system_job_service_default" android:exported="true" android:directBootAware="false"/>
        <receiver android:name="galaxy.hitchhacker.SpaceshipAlert" android:exported="true">
            <intent-filter>
                <action android:name="galaxy.spaceship.signal.RECEIVE"/>
            </intent-filter>
        </receiver>
    </application>
</manifest>
```

Exported components can be interacted with by other apps

Attack Surface

```
<application android:theme="@style/AppTheme_NoActionBar" android:label="Hitchhacker
             android:icon="@mipmap/hitchhacker_guide" android:name="galaxy.hitchhacker,guide"
             android:allowBackup="false" android:usesCleartextTraffic="true">
    <activity android:theme="@style/AppTheme_NoActionBar" android:label=" Hitchhacker"
              android:name="galaxy.hitchhacker.MainActivity">
       <intent-filter>
          <action android:name="android.intent.action.MAIN"/>
          <category android:name="android.intent.category.LAUNCHER"/>
       </intent-filter>
    </activity>
   <provider android:name="galaxy.hitchhacker.GuideBrowser" android:exported="false"
             android:authorities="galaxy.hitchhacker.provider" android:grantUriPermissions="true" />
    <service android:name="galaxy.hitchhacker.SpaceshipMonitor"
             android:permission="android.permission.BIND_JOB_SERVICE"
             android:enabled="@bool/enable_system_job_service_default" android:exported="true"
             android:directBootAware="false"/>
    <receiver android:name="galaxy.hitchhacker.SpaceshipAlert" android:exported="true">
        <intent-filter>
            <action android:name="galaxy.spaceship.signal.RECEIVE"/>
        </intent-filter>
    </receiver>
</application>
```

Implicitly exported component through intent-filters
(as of Android 12, explicit exports are obligatory)

Explicitly exported component

Permissions

Permissions required by the app

```
<uses-permission android:name="android.permission.ACCESS_NETWORK_STATE"/>
<uses-permission android:name="android.permission.ACCESS_WIFI_STATE"/>
<uses-permission android:name="android.permission.INTERNET"/>
<uses-permission android:name="android.permission.READ_EXTERNAL_STORAGE"/>
<uses-permission android:name="android.permission.WRITE_EXTERNAL_STORAGE"/>
```

```
            <intent-filter>
                <action android:name="android.intent.action.MAIN"/>
                <category android:name="android.intent.category.LAUNCHER"/>
            </intent-filter>
        </activity>
        <provider android:name="galaxy.hitchhacker.GuideBrowser" android:exported="false"
                  android:authorities="galaxy.hitchhacker.provider" android:grantUriPermissions="true" />
        <service android:name="galaxy.hitchhacker.SpaceshipMonitor" android:permission="android.permission.BIND_JOB_SERVICE"
                 android:enabled="@bool/enable_system_job_service_default" android:exported="true" android:directBootAware="false"/>
        <receiver android:name="galaxy.hitchhacker.SpaceshipAlert" android:exported="true">
            <intent-filter>
                <action android:name="galaxy.spaceship.signal.RECEIVE"/>
            </intent-filter>
        </receiver>
    </application>
</manifest>
```

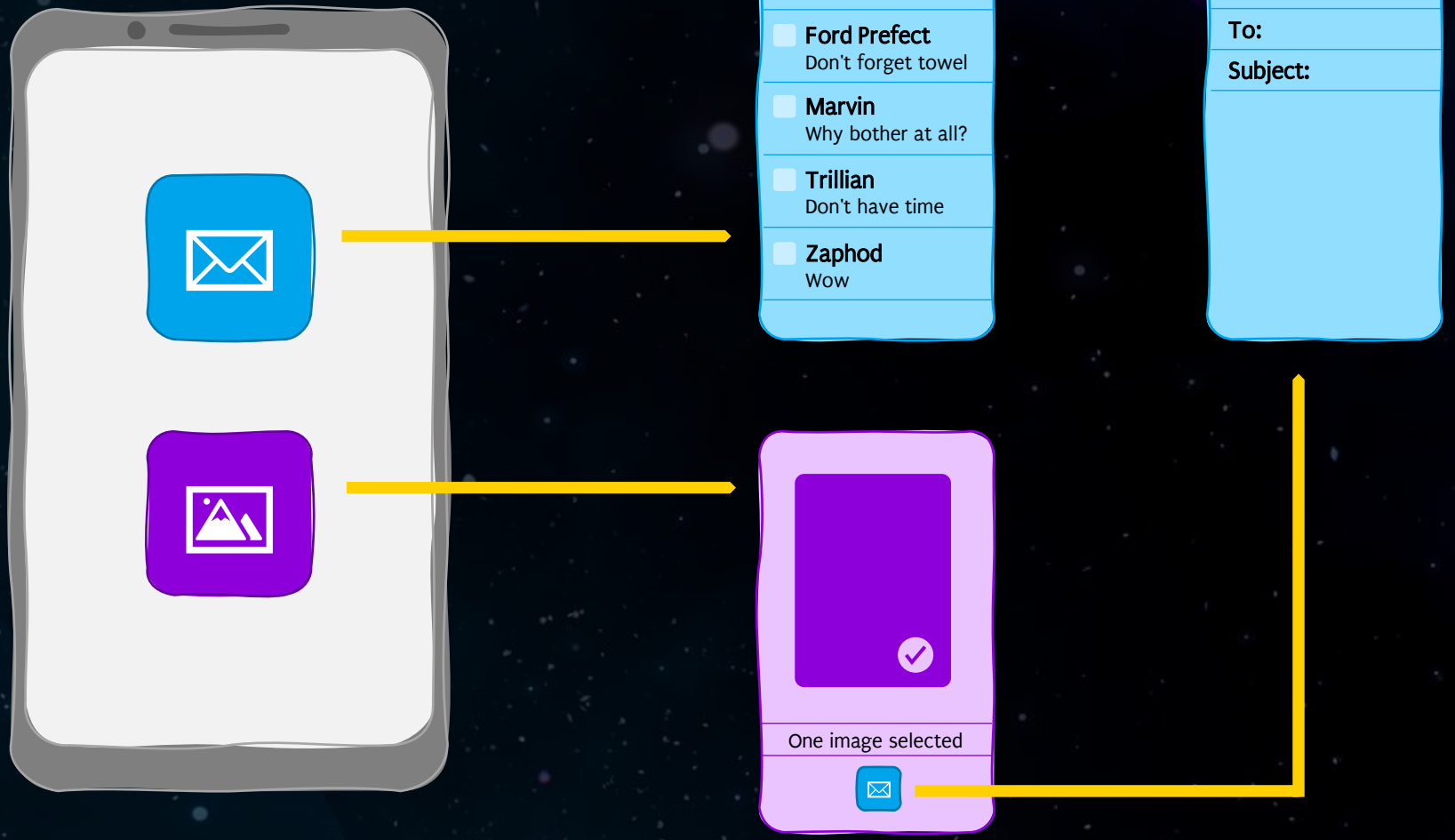
Activities

```
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android" android:versionCode="97" android:versionName="2.05" android:installLocation="auto" android:compileSdkVersion="30"
android:compileSdkVersionCodename="11" package="galaxy.hitchhacker" platformBuildVersionCode="30" platformBuildVersionName="11">
    <uses-sdk android:minSdkVersion="21" android:targetSdkVersion="30"/>
    <uses-permission android:name="android.permission.ACCESS_NETWORK_STATE"/>
    <uses-permission android:name="android.permission.ACCESS_WIFI_STATE"/>
    <uses-permission android:name="android.permission.INTERNET"/>
    <uses-permission android:name="android.permission.READ_EXTERNAL_STORAGE"/>
    <uses-permission android:name="android.permission.WRITE_EXTERNAL_STORAGE"/>

<activity android:theme="@style/AppTheme_NoActionBar" android:label="Hitchhacker" android:name="galaxy.hitchhacker.MainActivity">
    <intent-filter>
        <action android:name="android.intent.action.MAIN"/>
        <category android:name="android.intent.category.LAUNCHER"/>
    </intent-filter>
</activity>

            android:enabled="@bool/enable_system_job_service_default" android:exported="true" android:directBootAware="false"/>
        <receiver android:name="galaxy.hitchhacker.SpaceshipAlert" android:exported="true">
            <intent-filter>
                <action android:name="galaxy.spaceship.signal.RECEIVE"/>
            </intent-filter>
        </receiver>
    </application>
</manifest>
```

Activities = Visible parts in an application

Name hints at the class that implements the activity

Activities



Activities

Action name (optional)

```
android:/ $ am start -a android.intent.action.MAIN
            -n galaxy.hitchhacker/.MainActivity
```

package_name/.activity_name

Content Providers

```
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android" android:versionCode="97" android:versionName="2.05" android:installLocation="auto" android:compileSdkVersion="30"
android:compileSdkVersionCodename="11" package="galaxy.hitchhacker" platformBuildVersionCode="30" platformBuildVersionName="11">
    <uses-sdk android:minSdkVersion="21" android:targetSdkVersion="30"/>
    <uses-permission android:name="android.permission.ACCESS_NETWORK_STATE"/>
    <uses-permission android:name="android.permission.ACCESS_WIFI_STATE"/>
    <uses-permission android:name="android.permission.INTERNET"/>
    <uses-permission android:name="android.permission.READ_EXTERNAL_STORAGE"/>
    <uses-permission android:name="android.permission.WRITE_EXTERNAL_STORAGE"/>
    <uses-feature android:name="android.hardware.location.gps" android:required="false"/>
    <application android:theme="@style/AppTheme_NoActionBar" android:label="Hitchhacker" android:icon="@mipmap/hitchhacker_guide" android:name="galaxy.hitchhacker,guide"
android:allowBackup="false" android:usesCleartextTraffic="true">
        <meta-data android:name="com.google.android.geo.API_KEY" android:value="AIzaSyB159r06yYlVPLBGa7daQUaaial6Rd
        <activity android:theme="@style/AppTheme_NoActionBar" android:label="Hitchhacker" android:name="galaxy.hitchhacker.MainActivity">
            <intent-filter>
                <action android:name="galaxy.spaceship.signal.Receive" />
            </intent-filter>
        </receiver>
    </application>
</manifest>
```

```
<provider android:name="galaxy.hitchhacker.GuideBrowser" android:exported="false"
          android:authorities="galaxy.hitchhacker.provider" android:grantUriPermissions="true" />
```

Content Provider = Share data stored in app database between apps

Not exported, i.e. not available to other apps

Content Providers

Access using a URI

```
sargo:/ $ content query --uri "content://galaxy.
          hitchhacker.provider/galaxies/1"
```

Can be queried like a database:
provider/database/entryId
(name of the database can usually determined through source code analysis)

Services

```
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android" android:versionCode="97" android:versionName="2.05" android:installLocation="auto" android:compileSdkVersion="30"
android:compileSdkVersionCodename="11" package="galaxy.hitchhacker" platformBuildVersionCode="30" platformBuildVersionName="11">
    <uses-sdk android:minSdkVersion="21" android:targetSdkVersion="30"/>
    <uses-permission android:name="android.permission.ACCESS_NETWORK_STATE"/>
    <uses-permission android:name="android.permission.ACCESS_WIFI_STATE"/>
    <uses-permission android:name="android.permission.INTERNET"/>
    <uses-permission android:name="android.permission.READ_EXTERNAL_STORAGE"/>
    <uses-permission android:name="android.permission.WRITE_EXTERNAL_STORAGE"/>
    <uses-feature android:name="android.hardware.location.gps" android:required="false"/>
    <application android:theme="@style/AppTheme_NoActionBar" android:label="Hitchhacker" android:icon="@mipmap/hitchhacker_guide" android:name="galaxy.hitchhacker,guide"
android:allowBackup="false" android:usesCleartextTraffic="true">
        <meta-data android:name="com.google.android.geo.API_KEY" android:value="AIzaSyB159r06yyIvPEBG37daQUaaial6Ru
        <activity android:theme="@style/AppTheme_NoActionBar" android:label="Hitchhacker" android:name="galaxy.hitchhacker.MainActivity">
            <intent-filter>
                <action android:name="android.intent.action.MAIN"/>
                <category android:name="android.intent.category.LAUNCHER"/>
            </intent-filter>
        </activity>
        <provider android:name="galaxy.hitchhacker.GuideBrowser" android:exported="false"
                  android:authorities="galaxy.hitchhacker.provider" android:grantUriPermissions="true" />

    <service android:name="galaxy.hitchhacker.SpaceshipMonitor" android:permission="android.permission.BIND_JOB_SERVICE"
             android:enabled="@bool/enable_system_job_service_default" android:exported="true" android:directBootAware="false"/>

</manifest>
```

Service = Perform tasks in the background

Services

package_name/.service_name

```
sargo:/ $ am startservice
          -n galaxy.hitchhacker/.SpaceshipMonitor
          --es ship "Vogon Constructor Fleet"
```

Name of a StringExtra expected by the service

Content of the StringExtra

Broadcast Receivers

```
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android" android:versionCode="97" android:versionName="2.05" android:installLocation="auto" android:compileSdkVersion="30"
android:compileSdkVersionCodename="11" package="galaxy.hitchhacker" platformBuildVersionCode="30" platformBuildVersionName="11">
    <uses-sdk android:minSdkVersion="21" android:targetSdkVersion="30"/>
    <uses-permission android:name="android.permission.ACCESS_NETWORK_STATE"/>
    <uses-permission android:name="android.permission.ACCESS_WIFI_STATE"/>
    <uses-permission android:name="android.permission.INTERNET"/>
    <uses-permission android:name="android.permission.READ_EXTERNAL_STORAGE"/>
    <uses-permission android:name="android.permission.WRITE_EXTERNAL_STORAGE"/>
    <uses-feature android:name="android.hardware.location.gps" android:required="false"/>
    <application android:theme="@style/AppTheme_NoActionBar" android:label="Hitchhacker" android:icon="@mipmap/hitchhacker_guide" android:name="galaxy.hitchhacker.guide"
android:allowBackup="false" android:usesCleartextTraffic="true">
        <meta-data android:name="com.google.android.geo.API_KEY" android:value="AIzaSyB159r06yyIvPEBG37daQUaaia6R
        <activity android:theme="@style/AppTheme_NoActionBar" android:label="Hitchhacker" android:name="galaxy.hitchhacker.MainActivity">
            <intent-filter>
                <action android:name="android.intent.action.MAIN"/>
                <category android:name="android.intent.category.LAUNCHER"/>
            </intent-filter>
        </activity>
        <provider android:name="galaxy.hitchhacker.GuideBrowser" android:exported="false"
</ma
```

Broadcast Receiver = Listen and handle incoming intents, e.g. notifications

```
<receiver android:name="galaxy.hitchhacker.SpaceshipAlert" android:exported="true">
    <intent-filter>
        <action android:name="galaxy.spaceship.signal.RECEIVE"/>
    </intent-filter>
</receiver>
```

Broadcast Receivers

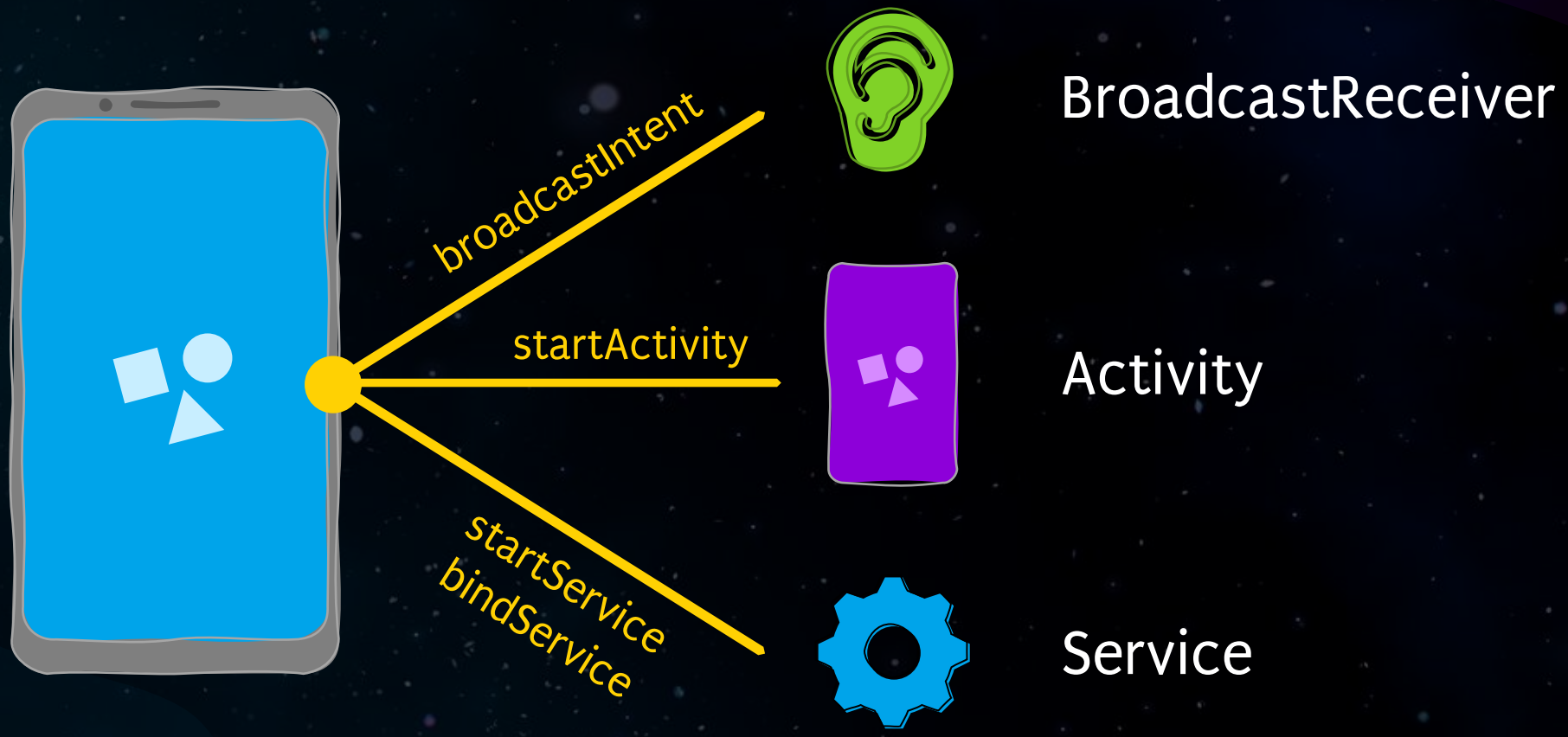
package_name/.receiver_name

```
sargo:/ $ am broadcast
          -n galaxy.hitchhacker/.SpaceshipAlert
          --es ship "Vogon Constructor Fleet"
```

Name of a StringExtra expected by the receiver

Content of the StringExtra

Intents



Intents

Explicit Intent

Supplies class name or target app's package name that is to handle the intent

- Sent to specified app

Implicit Intent

Declares an action to perform without specifying a certain component

- Sent to all apps

```
Intent showDetail = new Intent(this, DetailActivity.class);
startActivity(showDetail);
```

```
Intent showUrl = new Intent(Intent.ACTION_VIEW, Uri.parse(url));
startActivity(showUrl);
```

Explicit Intents - Examples

Calling an activity within the same app

```
Intent showDetail = new Intent(this, DetailActivity.class);
startActivity(showDetail);
```

Calling an activity that is part of another app

```
ComponentName cn = new ComponentName("space.hitchhacker.other",
    "space.hitchhacker.other.DetailActivity");
Intent showDetails = new Intent();
showDetails.setComponent(cn);
showDetails.setAction("space.hitchhacker.SHOW_DETAILS")
startActivity(showDetails);
```

Implicit Intents - Examples

Calling an app that can display URLs (e.g. browser)

```
Intent showUrl = new Intent(Intent.ACTION_VIEW,
                 Uri.parse("https://hitchhacker.space"));
startActivity(showUrl);
```

Calling an app for making a phone call

```
Intent callNumber = new Intent(Intent.ACTION_DIAL,
                    Uri.parse("tel:123456"));
startActivity(callNumber);
```

Sending data with intents

```
Intent emailIntent = new Intent(Intent.ACTION_SEND);
emailIntent.putExtra(Intent.EXTRA_EMAIL, new String[] {"arthur@hitchhacker.space"});
emailIntent.putExtra(Intent.EXTRA_SUBJECT, "Packing List");
emailIntent.putExtra(Intent.EXTRA_TEXT, "Towel");
emailIntent.putExtra("Custom", "Something else");
startActivity(emailIntent)
```

Data contained in an intent can be accessed by the receiving component

```
Intent intent = getIntent();
String subject = intent.getStringExtra(Intent.EXTRA_SUBJECT);
Bundle allExtras = intent.getExtras();
```

Intent Filters

```
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android" android:versionCode="97" android:versionName="2.05" android:installLocation="auto" android:compileSdkVersion="30"
android:compileSdkVersionCodename="11" package="galaxy.hitchhacker" platformBuildVersionCode="30" platformBuildVersionName="11">
    <uses-sdk android:minSdkVersion="21" android:targetSdkVersion="30"/>
    <uses-permission android:name="android.permission.ACCESS_NETWORK_STATE"/>
    <uses-permission android:name="android.permission.ACCESS_WIFI_STATE"/>
    <uses-permission android:name="android.permission.INTERNET"/>
    <uses-permission android:name="android.permission.READ_EXTERNAL_STORAGE"/>
    <uses-permission android:name="android.permission.WRITE_EXTERNAL_STORAGE"/>
    <uses-feature android:name="android.hardware.location.gps" android:required="false"/>
    <application android:theme="@style/AppTheme_NoActionBar" android:label="Hitchhacker" android:icon="@mipmap/hitchhacker_guide" android:name="galaxy.hitchhacker,guide"
android:allowBackup="false" android:usesCleartextTraffic="true">
        <meta-data android:name="com.google.android.geo.API_KEY" android:value="AIzaSyB159r06yyIvPEBG37daQUaaial6RdryVc"/>
        <activity android:theme="@style/AppTheme_NoActionBar" android:label="Hitchhacker" android:name="galaxy.hitchhacker.MainActivity">
            <intent-filter>
                <action android:name="android.intent.action.MAIN"/>
                <category android:name="android.intent.category.LAUNCHER"/>
            </intent-filter>
        </activity>

        <receiver android:name="galaxy.hitchhacker.SpaceshipAlert" android:exported="true">
            <intent-filter>
                <action android:name="galaxy.spaceship.signal.RECEIVE"/>
            </intent-filter>
        </receiver>

    </application>
</manifest>
```

Intent filters specify which types of implicit intents the component handles

Intent Filters - Examples

Default intents

Handles ACTION_SEND intents that contain text data; starts the ReceiveText activity within the app

```
<activity android:name=".ReceiveText">
    <intent-filter>
        <action android:name="android.intent.action.SEND"/>
        <category android:name="android.intent.category.DEFAULT"/>
        <data android:mimeType="text/plain"/>
    </intent-filter>
</activity>
```

Custom intents

Handles the custom SHIPLAUNCH intent; starts the LaunchShip activity within the app

```
<activityandroid:name=".LaunchShip" >
    <intent-filter>
        <action android:name="space.hitchhacker.SHIPLAUNCH" />
        <category android:name="android.intent.category.DEFAULT" />
    </intent-filter>
</activity>
```

Intent Filters - Examples

Launcher

Intent filter that handles when the app is started from the Launcher

```
<intent-filter>
    <action android:name="android.intent.action.MAIN"/>
    <category android:name="android.intent.category.LAUNCHER"/>
    <category android:name="android.intent.category.DEFAULT"/>
</intent-filter>
```

Deep Links

Intent filter that can handle incoming links that begin with space://hitchhacker

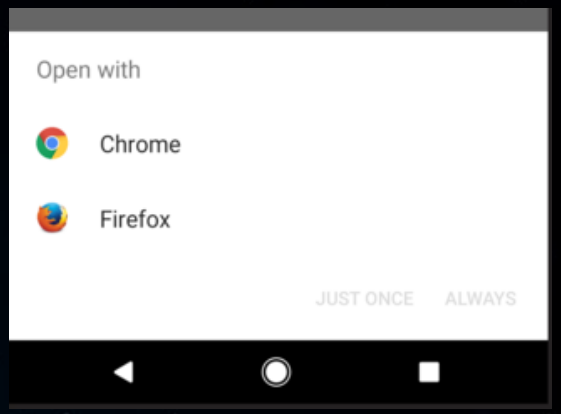
```
<intent-filter>
    <action android:name="android.intent.action.VIEW" />
    <category android:name="android.intent.category.DEFAULT" />
    <category android:name="android.intent.category.BROWSABLE" />
    <data android:scheme="space" android:host="hitchhacker" />
</intent-filter>
```

Intent Filters - Handling

If no app exists that can handle the intent, an exception occurs

```
try {
    startActivity(intent);
} catch (ActivityNotFoundException e) {
    // Do something
}
```

An app can register for any implicit intents; if more than one app exists that can handle the intent, the app picker is shown

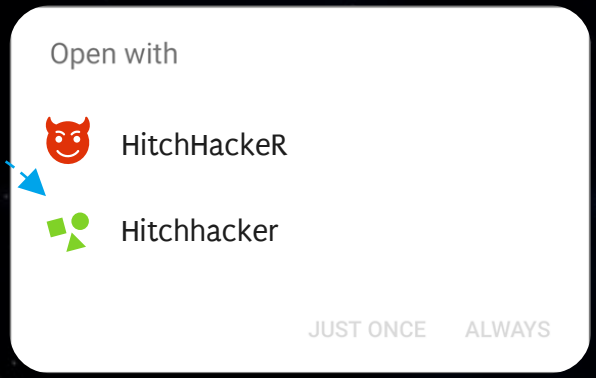


Deep Links

```
<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="space" android:host="hitchhacker" />
</intent-filter>
```

App will open when custom URL scheme `space://hitchhacker` is invoked

Dialog appears if another app has registered the same scheme



App Links

```
<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="https" android:host="hitchhacker.space"/>
</intent-filter>
```

App Link is tied to a website

```
[{
  "relation": ["delegate_permission/common.handle_all_urls"],
  "target": {
    "namespace": "android_app",
    "package_name": "space.hitchhacker",
    "sha256_cert_fingerprints": ["14:6D:E9:83:---SNIP---:A0:83:42:E6:1D:BE:A8:8A:E5"]
  }
}]
```

Handling app is specified in Digital Asset Links file at https://hitchhacker.space/.well-known/assetlinks.json

The bridge is yours

1. Analyze the Hitchhacker's app directories (using adb) and find out which data is stored where
2. Analyze the Android Manifest and find a way to:
   - Bypass the pin activity
   - ★ Read the contents of the diary

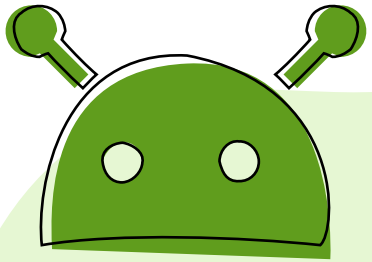
Solution

1. Storage
   - Search terms: `/storage/emulated/0/Android/data/space.hitchhacker.guide/files/my_files/search.txt`
   - Diary entries: `/data/data/space.hitchhacker.guide/databases/diary.db`
   - Username: `/data/data/space.hitchhacker.guide/shared_prefs/shared_prefs.xml`
   - Pin code: `/data/data/space.hitchhacker.guide/shared_prefs/secret_shared_prefs.xml`
2. Bypass pin activity

```
$> adb shell am start -a android.intent.action.MAIN -n space.hitchhacker.guide/.PinActivity
```

3. Read content of the diary

```
$> adb shell content query -uri “content://space.hitchhacker.guide.contentprovider/diary/”
```

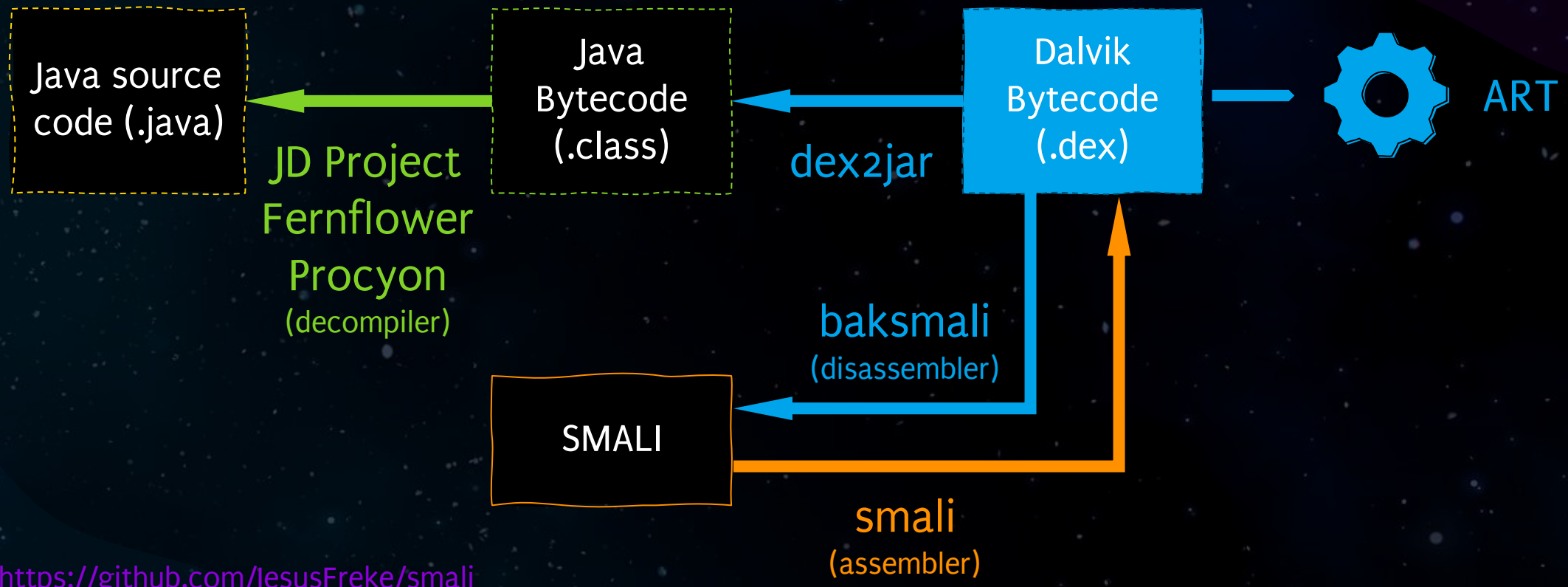


Journey to Deep Space

Reverse engineering

nviso

Take apart and rebuild



https://github.com/JesusFreke/smali
https://github.com/pxb1988/dex2jar
http://java-decompiler.github.io/

Take apart and rebuild

Disassemble

```
$> apktool d hitchhacker.apk
I: Using Apktool 2.5.0-dirty on app-debug.apk
I: Loading resource table...
...
```

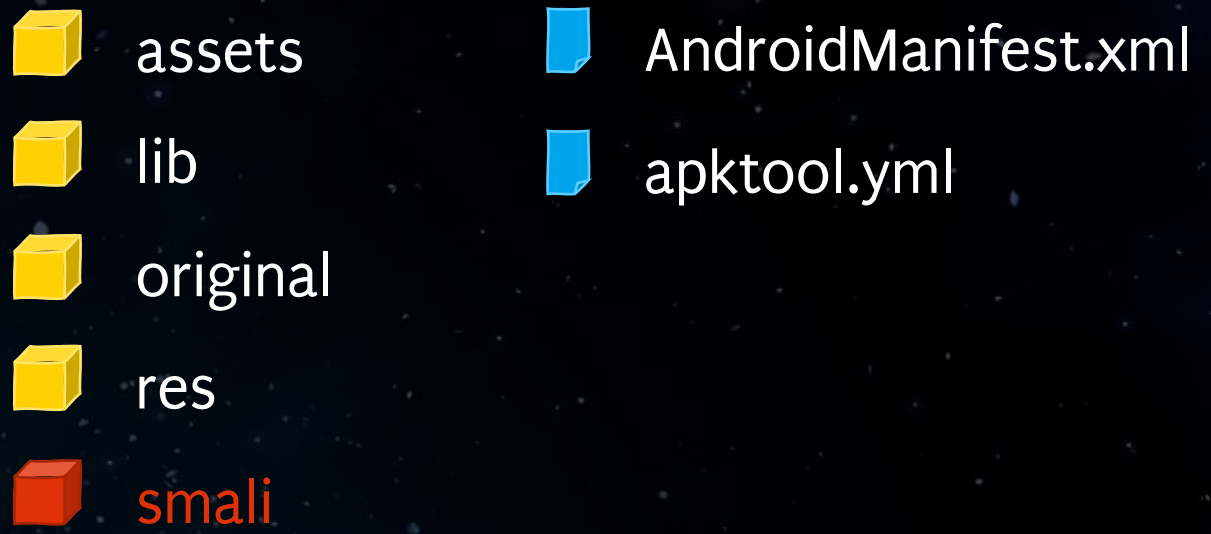
Reassemble

```
$> apktool b hitchhacker
I: Using Apktool 2.5.0-dirty
I: Checking whether sources has changed...
...
```

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

The Android Babel fiSh - Smali

```
$> apktool d hitchhacker.apk
```



The Android Babel fish - Smali

```java
public class MainActivity extends AppCompatActivity
{

    @Override
    protected void onCreate(Bundle
savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_main);
        TextView tv =
(TextView)findViewById(R.id.message);
        tv.setText("Don't Panic");
    }
}
```

```
.class public Lgalaxy/hitchhiker/dontpanic/MainActivity;
   [...]
   .line 14
    const v0, 0x7f0800e2
    invoke-virtual {p0, v0},
        Lgalaxy/hitchhiker/dontpanic/MainActivity;->
        findViewById(I)Landroid/view/View;
    move-result-object v0
    check-cast v0, Landroid/widget/TextView;

    .line 15
    .local v0, "tv":Landroid/widget/TextView;
    const-string v1, "Don\'t Panic"

    invoke-virtual {v0, v1}, Landroid/widget/TextView;->
        setText(Ljava/lang/CharSequence;)V

    .line 16
    return-void
.end method
```

Smali crash course

```
sget-object v0, Ljava/lang/Boolean;->TRUE:Ljava/lang/Boolean;
const-string v1, "Life, The Universe, and Everything"

invoke-virtual {v0}, Ljava/lang/Boolean;->booleanValue()Z
move-result v2

if-eqz v2, :cond_0
invoke-direct {p0, v1}, Lgalaxy/hitchhiker/dontpanic/MainActivity;->getAnswer(
    Ljava/lang/String;)Ljava/lang/Integer;
goto :goto_0

:cond_0
invoke-virtual {p0}, Lgalaxy/hitchhiker/dontpanic/MainActivity;
    ->getNoAnswer()Ljava/lang/String;

:goto_0
return-void
```

Smali crash course

```
sget-object v0, Ljava/lang/Boolean;->TRUE:Ljava/lang/Boolean;
const-string v1, "Life, The Universe, and Everything"

invoke-virtual {v0}, Ljava/lang/Boolean;->booleanValue()Z
move-result v2

if-eqz v2, :cond_0
invoke-direct {p0, v1}, Lgalaxy/hitchhiker/dontpanic/MainActivity;->getAnswer(
    Ljava/lang/String;)Ljava/lang/Integer;
goto :goto_0

:cond_0
invoke-virtual {p0}, Lgalaxy/hitchhiker/dontpanic/MainActivity;
    ->getNoAnswer()Ljava/lang/String;

:goto_0
return-void
```

Simple data type marked by an uppercase letter

V	void
Z	Boolean
B	byte
C	char
I	int
F	float
S	short
J	long

Smali crash course

```
sget-object v0, Ljava/lang/Boolean;->TRUE:Ljava/lang/Boolean;
const-string v1, "Life, The Universe, and Everything"

invoke-virtual {v0}, Ljava/lang/Boolean;->booleanValue()Z
move-result v2

if-eqz v2, :cond_0
invoke-direct {p0, v1}, Lgalaxy/hitchhiker/dontpanic/MainActivity;->getAnswer(
    Ljava/lang/String;)Ljava/lang/Integer;
goto :goto_0

:cond_0
invoke-virtual {p0}, Lgalaxy/hitchhiker/dontpanic/MainActivity;
    ->getNoAnswer()Ljava/lang/String;

:goto_0
return-void
```

Complex data types are denoted as:
L‹fully qualified name›;

Smali crash course

```
sget-object v0, Ljava/lang/Boolean;->TRUE:Ljava/lang/Boolean;
const-string v1, "Life, The Universe, and Everything"

invoke-virtual {v0}, Ljava/lang/Boolean;->booleanValue()Z
move-result v2

if-eqz v2, :cond_0
invoke-direct {p0, v1}, Lgalaxy/hitchhiker/dontpanic/MainActivity;->getAnswer(
    Ljava/lang/String;)Ljava/lang/Integer;
goto :goto_0

:cond_0
invoke-virtual {p0}, Lgalaxy/hitchhiker/dontpanic/MainActivity;
    ->getNoAnswer()Ljava/lang/String;

:goto_0
return-void
```

Data stored in local registers **vX**

Parameter register **pX**

p0 = "this"

Smali crash course

```
sget-object v0, Ljava/lang/Boolean;->TRUE:Ljava/lang/Boolean;
const-string v1, "Life, The Universe, and Everything"

invoke-virtual {v0}, Ljava/lang/Boolean;->booleanValue()Z
move-result v2

if-eqz v2, :cond_0
invoke-direct {p0, v1}, Lgalaxy/hitchhiker/dontpanic/MainActivity;
    ->getAnswer(Ljava/lang/String;)Ljava/lang/Integer;
goto :goto_0

:cond_0
invoke-virtual {p0}, Lgalaxy/hitchhiker/dontpanic/MainActivity;
    ->getNoAnswer()Ljava/lang/String;

:goto_0
return-void
```

Directive for method call

Fully qualified class name

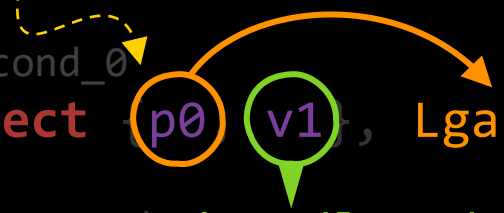
Called method

Type of argument passed to method

Type of return value

Smali crash course

Registers with values passed to the method call



```
sget-object v0, Ljava/lang/Boolean;->TRUE:Ljava/lang/Boolean;
const-string v1, "Life, The Universe, and Everything"
invoke-virtual {v0}, Ljava/lang/Boolean;->booleanValue()Z
move-result v2

if-eqz v2, :cond_0
invoke-direct {p0, v1}, Lgalaxy/hitchhiker/dontpanic/MainActivity;
    ->getAnswer(Ljava/lang/String;)Ljava/lang/Integer;
goto :goto_0

:cond_0
invoke-virtual {p0}, Lgalaxy/hitchhiker/dontpanic/MainActivity;
    ->getNoAnswer()Ljava/lang/String;

:goto_0
return-void
```

Smali crash course

```
sget-object v0, Ljava/lang/Boolean;->TRUE:Ljava/lang/Boolean;
const-string v1, "Life, The Universe, and Everything"

invoke-virtual {v0}, Ljava/lang/Boolean;->booleanValue()Z
move-result v2

if-eqz v2, :cond_0
invoke-direct {p0, v1}, Lgalaxy/hitchhiker/dontpanic/MainActivity;->getAnswer(
    Ljava/lang/String;)Ljava/lang/Integer;
goto :goto_0

:cond_0
invoke-virtual {p0}, Lgalaxy/hitchhiker/dontpanic/MainActivity;
    ->getNoAnswer()Ljava/lang/String;

:goto_0
return-void
```

Return value of method call is stored in register

Smali crash course

```
sget-object v0, Ljava/lang/Boolean;->TRUE:Ljava/lang/Boolean;
const-string v1, "Life, The Universe, and Everything"

invoke-virtual {v0}, Ljava/lang/Boolean;->booleanValue()Z
move-result v2

if-eqz v2, :cond_0
invoke-direct {p0, v1}, Lgalaxy/hitchhiker/dontpanic/MainActivity;
    ->getAnswer(Ljava/lang/String;)Ljava/lang/Integer;
goto :goto_0

:cond_0
invoke-virtual {p0}, Lgalaxy/hitchhiker/dontpanic/MainActivity;
   ->getNoAnswer()Ljava/lang/String;

:goto_0
return-void
```

Private method call

Public method call

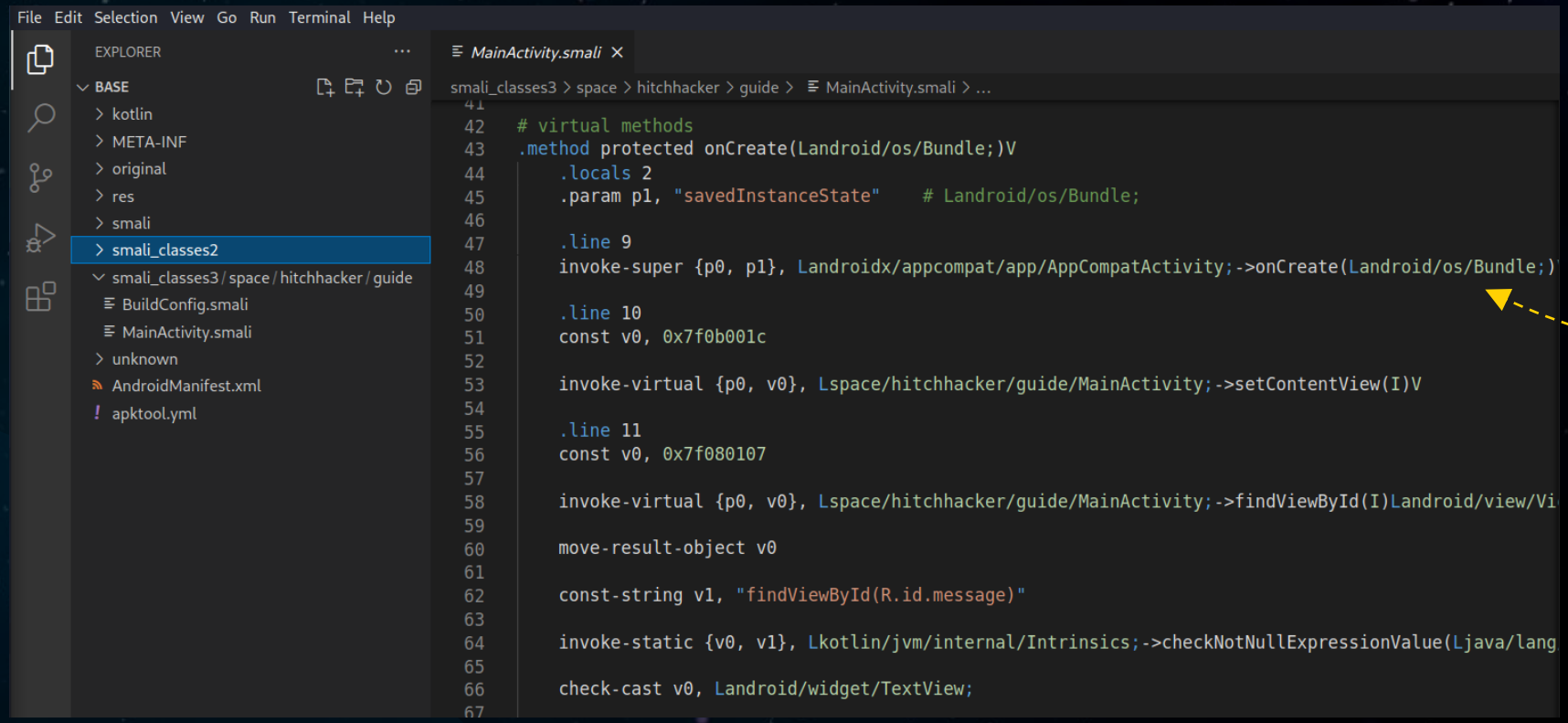
Smali crash course

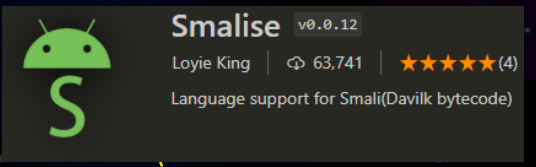
```
sget-object v0, Ljava/lang/Boolean;->TRUE:Ljava/lang/Boolean;
const-string v1, "Life, The Universe, and Everything"

invoke-virtual {v0}, Ljava/lang/Boolean;->booleanValue()Z
move-result v2

if-eqz v2, :cond_0
invoke-direct {p0, v1}, Lgalaxy/hitchhiker/dontpanic/MainActivity;->ge
    Ljava/lang/String;)Ljava/lang/Integer;
goto :goto_0

:cond_0
invoke-virtual {p0}, Lgalaxy/hitchhiker/dontpanic/MainActivity;
   ->getNoAnswer()Ljava/lang/String;

:goto_0
return-void
```

Conditional jump

if-eq v1, v2	v1 == v2
if-ne v1, v2	v1 != v2
if-lt v1, v2	v1 < v2
if-gt v1, v2	v1 > v2
if-le v1, v2	v1 <= v2
if-ge v1, v2	v1 >= v2
if-eqz v2	v2 == 0
if-nez v2	v2 != 0
if-ltz v2	v2 < 0
if-gtz v2	v2 > 0
if-lez v2	v2 <= 0
if-gez v2	v2 >= 0

VSCode & Smalise





Provides syntax highlighting and helps finding code references

Modify and reassemble

Reassemble the APK

```
$> apktool b hitchhacker
I: Checking whether sources has changed...
...
```

Create a key pair for signing

```
$> keytool -genkey -v -keystore foo.keystore -alias keyalias -
keyalg RSA -keysize 2048 -validity 10000
Enter keystore password:
...
```

Sign the APK

```
$> jarsigner -sigalg SHA1withRSA -digestalg SHA1 -keystore
   foo.keystore hitchhacker.apk keyalias
Enter Passphrase for keystore:
...
```

Align the APK

```
$> zipalign -v 4 hitchhacker.apk hitchhacker-aligned.apk
Verifying alignment of hitchhacker-aligned.apk (4)...
```

But we like being lazy

Sign and zipalign the APK using the integrated debug keystore

```
$> java -jar uber-apk-signer.jar --apks hitchhacker.apk
```

Sign the APK with your own keystore

```
$> java -jar uber-apk-signer.jar --apks hitchhacker.apk --ks
   foo.keystore --ksAlias keyalias
```

https://github.com/patrickfav/uber-apk-signer

The bridge is yours

Patch the Hitchhacker app so you can log in without knowing the pin code

Decompile: `apktool d -r hitchhacker.apk`
Recompile: `apktool b --use-aapt2 -o fixed_hitchhacker.apk hitchhacker`
Sign: `java -jar uber-apk-signer.jar --apks fixed_hitchhacker.apk`

- Install and launch the Vogon Construction application. Patch the app to get around the login restrictions

Solution

1. Patch Hitchhacker app

```
$> java -jar /usr/local/bin/apktool.jar b --use-aapt2 -o
   fixed_hitchhacker.apk hitchhacker
$> java -jar uber-apk-signer.jar --apks
   fixed_hitchhacker.apk
$> adb install fixed_hitchhacker-aligned-debugSigned.apk
```

```
    mul-int/2addr v2, v1

    const/16 v1, 0x2a

    if-ne v0, v1, :cond_2

    if-ne v2, v1, :cond_2

    move v0, v4

    goto :goto_1

    :cond_2
    const/4 v0, 0x0

    :goto_1
    return v0
.end method
```

```
    mul-int/2addr v2, v1

    const/16 v1, 0x2a

    if-ne v0, v1, :cond_2

    if-ne v2, v1, :cond_2

    move v0, v4

    goto :goto_1

    :cond_2
    const/4 v0, 0x1

    :goto_1
    return v0
.end method
```

2. Patch Vogon Construction app

```
if(!isVogonOperator()) {…}
```

```
.line 29
invoke-direct {p0}, Leu/nviso/vogonconstruction/MainActivity;->isVogonOperator()Z

move-result p1

if-nez p1, :cond_33

.line 30
new-instance p1, Landroidx/appcompat/app/AlertDialog$Builder;

const v0, 0x7f100002

invoke-direct {p1, p0, v0}, Landroidx/appcompat/app/AlertDialog$Builder;-><init>(Lan

invoke-virtual {p1}, Landroidx/appcompat/app/AlertDialog$Builder;->create()Landroidx
```

```
.end method

.method protected onCreate(Landroid/os/Bundle;)V
    .locals 3

    .line 26
    invoke-super {p0, p1}, Landroidx/appcompat/app/AppCompatActivity;-

    const p1, 0x7f0b001e

    .line 27
    invoke-virtual {p0, p1}, Leu/nviso/vogonconstruction/MainActivity;

    .line 29
    invoke-direct {p0}, Leu/nviso/vogonconstruction/MainActivity;->isV

    move-result p1

    if-eqz p1, :cond_0

    .line 30
    new-instance p1, Landroidx/appcompat/app/AlertDialog$Builder;
```

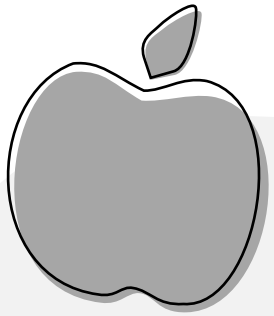
Our Journey

Adventures on Android

Meddling in the Middle

Incidents on iOS

Big Bang of Basics

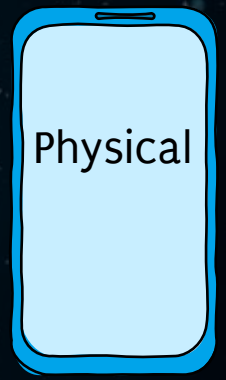


Boarding the Spaceship

Devices & jailbreaking

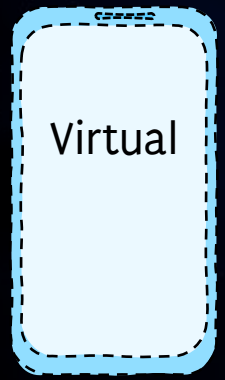
nviso

Getting a testing device



Usually only older iOS versions can be jailbroken

Cost factor



iOS simulator in Xcode cannot run apps from App Store

Limited other options due to Apple's closed environment

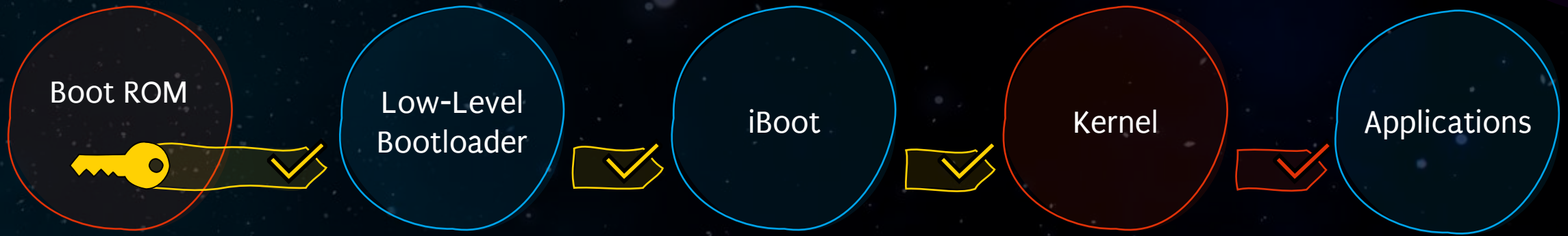
Jailbreaking

Apple Public Key

Code signing and signature validation from boot to app execution

Jailbreaking

A jailbreak nullifies one or more signature validation checks



checkra1n

palera1n

uncover

Fugu15

Jailbreaking

checkra1n

iPhone 5s - iPhone X
iOS 12.3 - 14.8

https://checkra.in/

palera1n

iPhone 5s - iPhone X
iOS 15.0 - 16.x

https://github.com/palera1n/palera1n

uncover

iOS 11.0 - 14.8

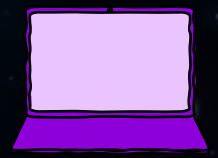
https://uncover.dev/

Fugu15

iOS 15.0 - 15.4.1

https://github.com/pinauten/Fugu15

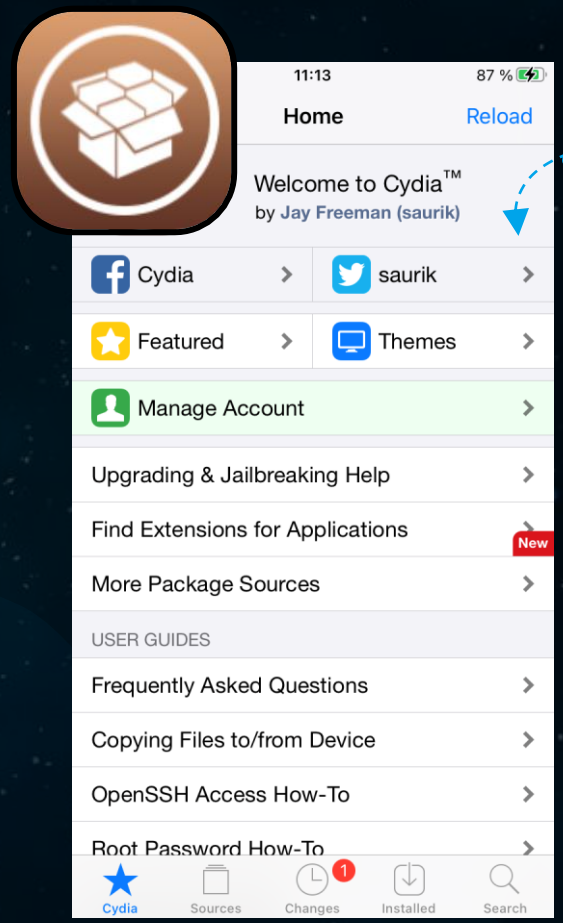
Jailbreaking

	 Host needed for jailbreak	 Jailbreak without host
Reboots jailbroken 	Tethered	Untethered
Reboots non-jailbroken 	Semi-Tethered	Semi-Untethered

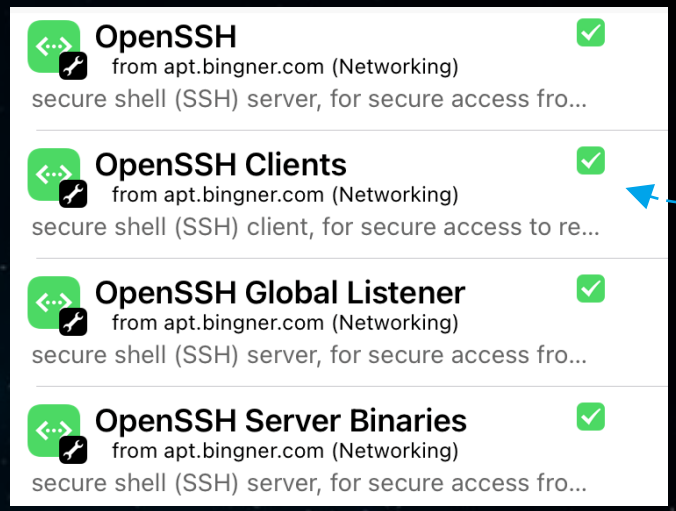
Jailbreaking

	Host needed for jailbreak	Jailbreak without host
Reboots jailbroken	Tethered: palera1n	Untethered
Reboots non-jailbroken	Semi-Tethered: checkra1n, palera1n	Semi-Untethered: Fugu15, uncover

Gear Up

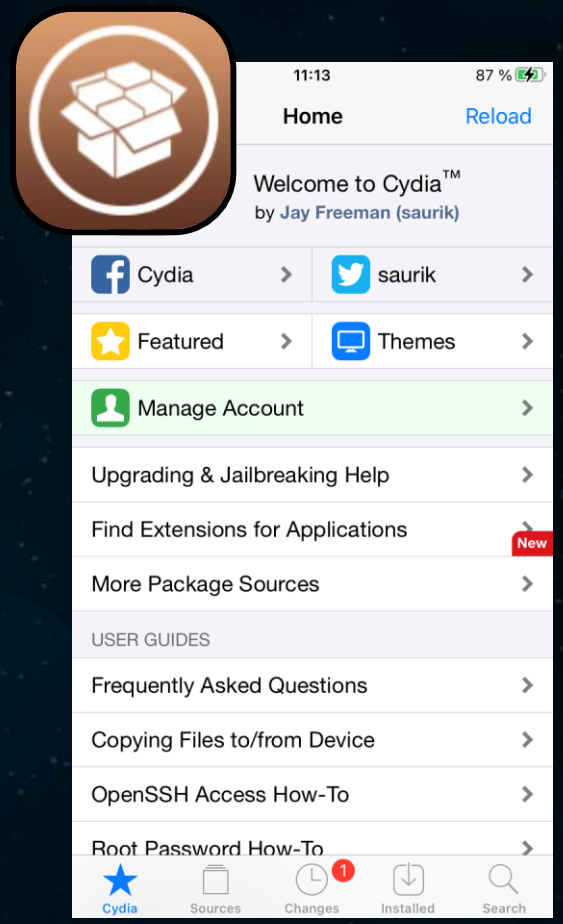


Cydia App Store is included in most jailbreaks and allows us to install useful tools for pentesting



Most jailbreaks install an SSH server on the device. If not, you can install it via Cydia

Gear Up



Frida – build.frida.re
Frida server to observe and reprogram running apps

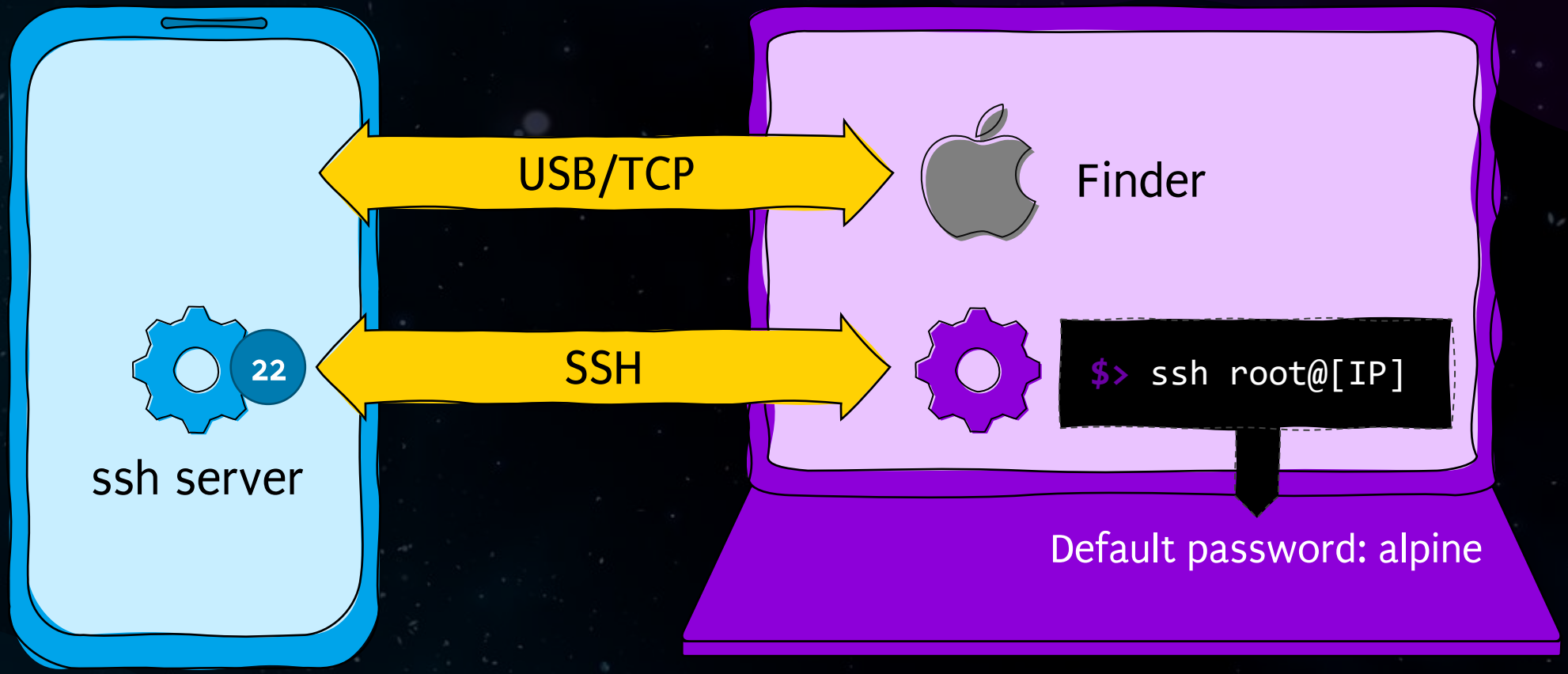
BigBoss tools – apt.thebigboss.org
Useful tools, e.g. zip, unzip, sqlite3, wget, OpenSSH etc.

Filza – cydia.akemi.ai
File manager and IPA installer

AppSync Unified – cydia.akemi.ai
Disable signature requirements for installing apps

iHide – repo.kc57.com
Bypass jailbreak detection

Reaching out



Exploring the planet

the content of the IPA

/private/var/containers/Bundle/Application/[appID]

- Payload

/var/mobile/Containers/Data/Application/[appID]

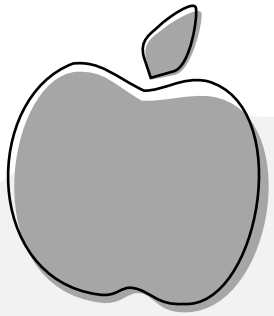
- Documents
- Library
- SystemData
- tmp

Exploring the planet

```
iPhone:~ root# ipainstaller -l
com.apple.TestFlight
com.swiftkey.SwiftKeyApp
space.hitchhacker.Hello
...
iPhone:~ root# ipainstaller -i space.hitchhacker.Hello
Identifier: space.hitchhacker.Hello
Version: 1
Short Version: 1.0
Name: Hello
Display Name: Hello
Bundle: /private/var/containers/Bundle/Application/6A745F9C-D991-43E4-9C4A-0F380CD18D9B
Application: /private/var/containers/Bundle/Application/6A745F9C-D991-43E4-9C4A-
0F380CD18D9B/Hello.app
Data: /private/var/mobile/Containers/Data/Application/BEA183DA-19AF-48D8-A5C8-F1F22C7CF48E
```

IPA Installer Console can be installed via Cydia

Locates local files related to the application



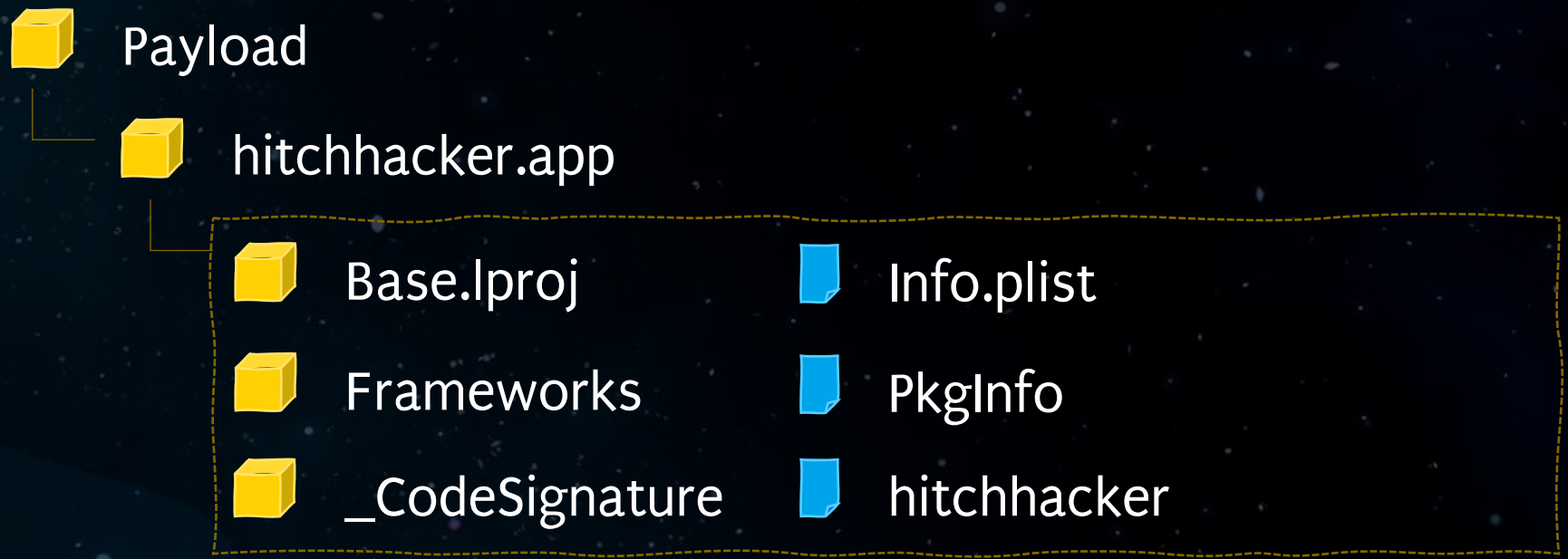
Rocket Science

Inside an IPA

nviso

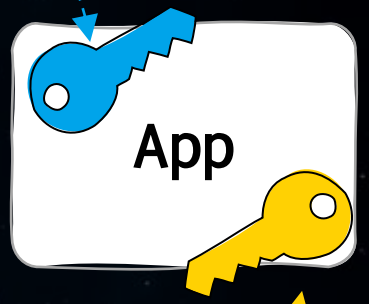
Inside an IPA

```
$> unzip hitchhacker.ipa -d hitchhacker
$> ls -la hitchhacker
```



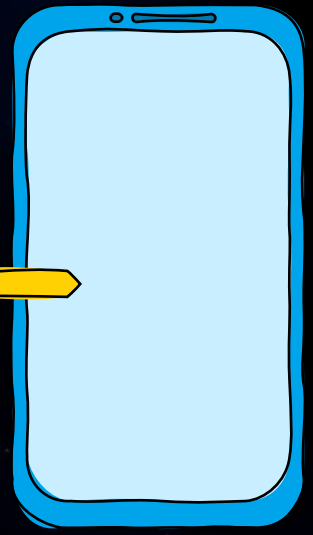
Signing off

Developers build and sign app



Apple approves the app and signs it with their private key

Upon installation, iOS checks the app signatures and refuses app in case of invalid signatures



Signing off

For testing purposes apps can be distributed with a provisioning profile instead of being signed with Apple's private key

App identifier

Dev certificate

Ad-Hoc Certificate

- Free developer account
  - Valid for 7 days
  - For up to 100 devices
- Paid developer account ($99/year)
  - Valid for 1 year
  - For up to 100 devices

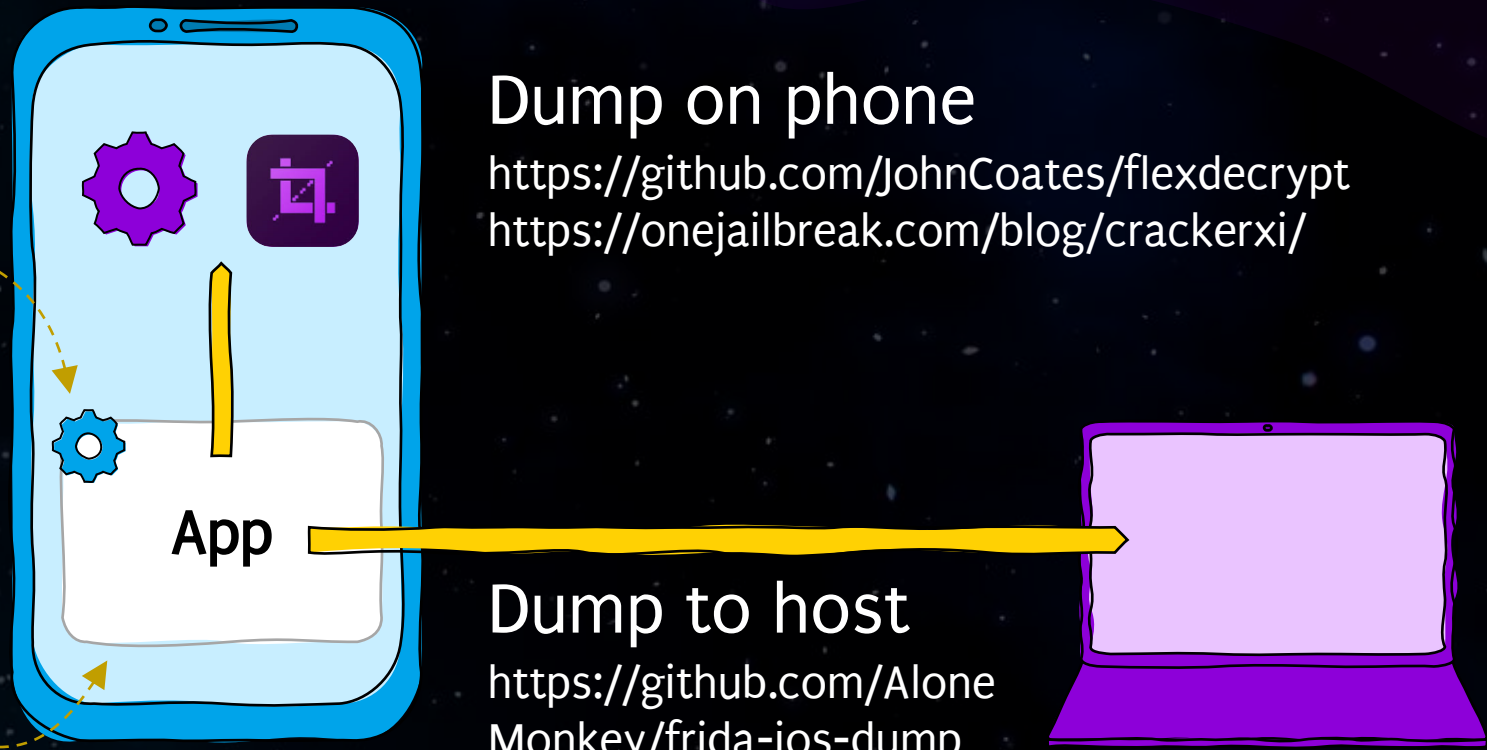
Enterprise Certificate

- $299/year for companies with more than 100 employees
- Valid for 3 years
- Unlimited devices

Obtaining an IPA

Apps are encrypted, so we need to obtain the IPA when the app is decrypted while running

We need a jailbroken device

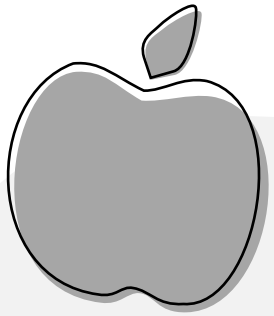


Dump on phone

https://github.com/JohnCoates/flexdecrypt
https://onejailbreak.com/blog/crackerxi/

Dump to host

https://github.com/AloneMonkey/frida-ios-dump



The Cargo Bay

How data is stored on iOS

nviso

File protection

Data object with file content

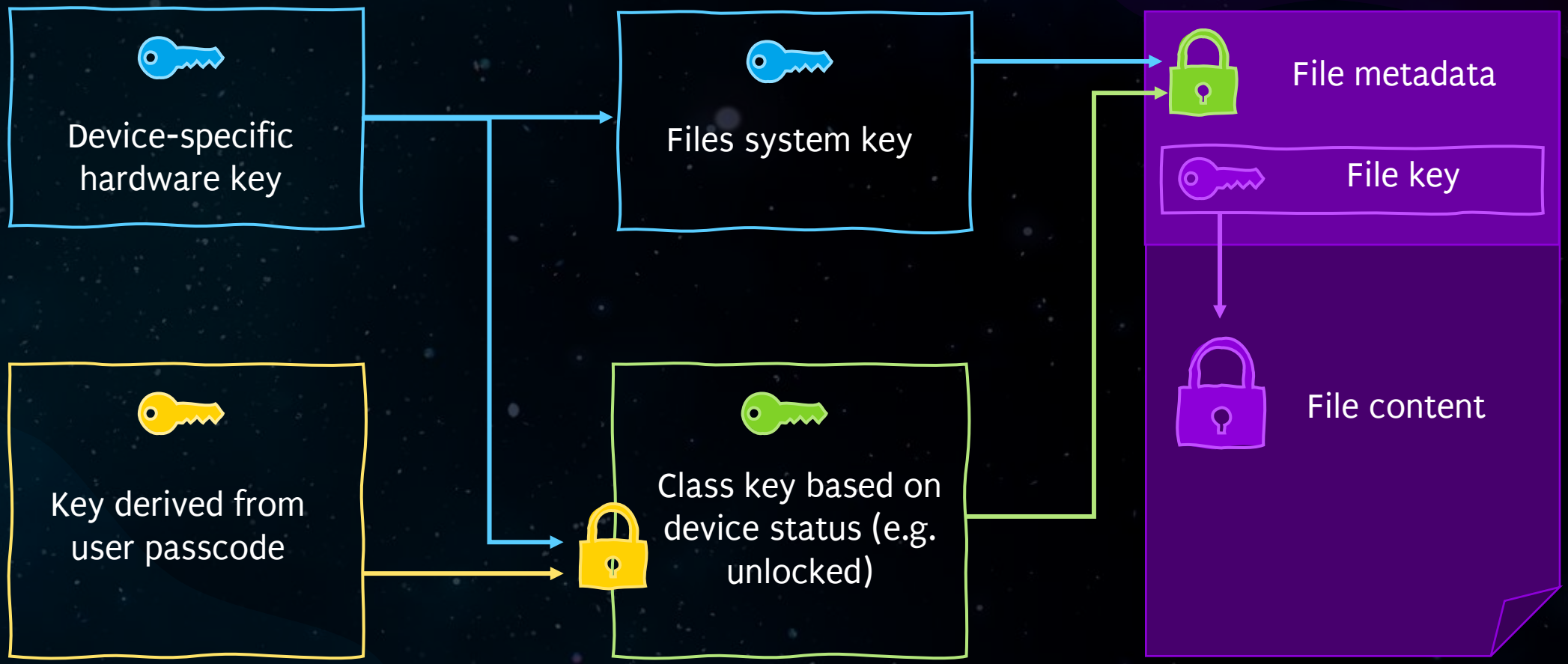
```
do {
    try data.write(
        to: fileURL,
        options: .completeFileProtection
    )
} catch {
    // Handle errors
}
```

Protection level that determines encryption of file

Protection levels

`.noFileProtection`	Unencrypted Reading and writing always possible
`.completeFileProtection`	Encrypted Reading and writing only possible if device is unlocked
`.completeFileProtectionUnlessOpen`	Encrypted Reading and writing only possible if device is unlocked; files remains available for background use
`.completeFileProtectionUntilFirstUserAuthentication` (default)	Encrypted Reading and writing only possible if device has been unlocked once after a reboot

File encryption



NSUserDefaults

To store small pieces of information

```
// Write
UserDefaults.standard.set("42", forKey: "UltimateAnswer")

// Read
UserDefaults.standard.string(forKey: "UltimateAnswer")
```

plist files

```
iPhone:/private/var/.../Library/Safari root# file *.plist
FrequentlyVisitedSitesBannedURLStore.plist: XML 1.0 document, ASCII text
PasswordBreachStore.plist:                  Apple binary property list
```

Binary or
XML data

plist files

```
$> plistutil -i PasswordBreachStore.plist -o Store.out

$> head Store.out
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE plist PUBLIC "-//Apple//DTD PLIST 1.0//EN"
"http://www.apple.com/DTDs/PropertyList-1.0.dtd">
<plist version="1.0">
<dict>
        <key>KeychainPersistentIdentifierCanaryValue</key>
        <string>6F30D983-A91B-4337-9D78-5FE72480B153</string>
        <key>Version</key>
        <integer>1</integer>
        <key>KeychainPersistentIdentifierCanaryPersistentIdentifier</key>
        <data>
```

Convert binary plist to XML

Key-value pairs

Databases

SQLite

Realm

Firebase

same as for Android

Couchbase Lite

NoSQL database

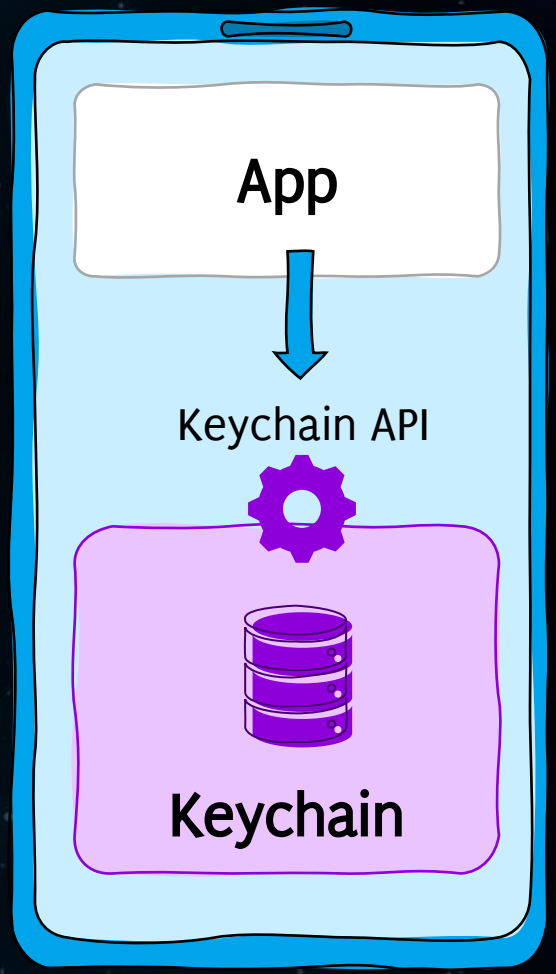
Not encrypted by default

Encryption can be enabled through configuration

Keychain

Encrypted SQLite database

Single Keychain for all apps



Data can be stored with an Accessibility attribute that determines when the data becomes accessible

- Always
- After unlocking the device once after restart
- When device is unlocked
- Only when passcode is set for device

Data access

```
let username = "arthur"
let password = "acupoftea".data(using: .utf8)!
let query: [String: Any] = [
    kSecClass as String: kSecClassGenericPassword,
    kSecAttrAccount as String: username,
    kSecValueData as String: password,
    kSecAttrAccessible as String: kSecAttrAccessibleWhenUnlocked
]
let status = SecItemAdd(query as CFDictionary, nil)
guard status == errSecSuccess else { throw KeychainError.unhandledError(status: status) }
```

Data can be stored with an Accessibility attribute which specifies when access to the data item is possible

Data access

`Always` (deprecated)	Always accessible
`AfterFirstUnlock`	Accessible if device has been unlocked once after a reboot
`WhenUnlocked`	Accessible if the device is currently unlocked
`WhenPasscodeSetThisDeviceOnly`	Accessible if the device is currently unlocked and the user has set up a passcode for the device
`…ThisDeviceOnly`	For a backup, data will be encrypted with a device-specific key; thus it cannot be restored on a different device

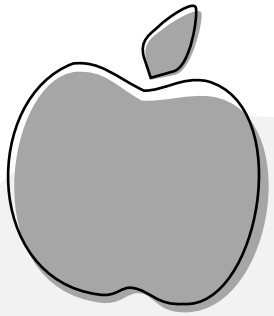
Access control

```
let access = SecAccessControlCreateWithFlags(nil,
                 kSecAttrAccessibleWhenPasscodeSetThisDeviceOnly,
                 .userPresence,
                 nil)

let query: [String: Any] = [kSecClass as String: kSecClassInternetPassword,
                            kSecAttrAccount as String: account,
                            kSecAttrServer as String: server,
                            kSecAttrAccessControl as String: access as Any,
                            kSecUseAuthenticationContext as String: context,
                            kSecValueData as String: password]
```

Access control instance defines accessibility and authentication requirements of a keychain item

Access control

`userPresence`	Require biometric authentication or fall back to passcode if biometry is not available
`biometryAny`	Require biometric authentication with any enrolled biometrics (Touch or Face ID)., i.e. also biometric features that were enrolled after the creation of the keychain item
`biometryCurrentSet`	Require biometric authentication with *currently enrolled* biometrics (Touch or Face ID). If biometric features are added or removed, the item becomes invalid
`devicePasscode`	Require device passcode



Static analysis

Opening the binary

nviso

Creating iOS apps

The original language

Highly dynamic

Still used, but less and less

RE friendly

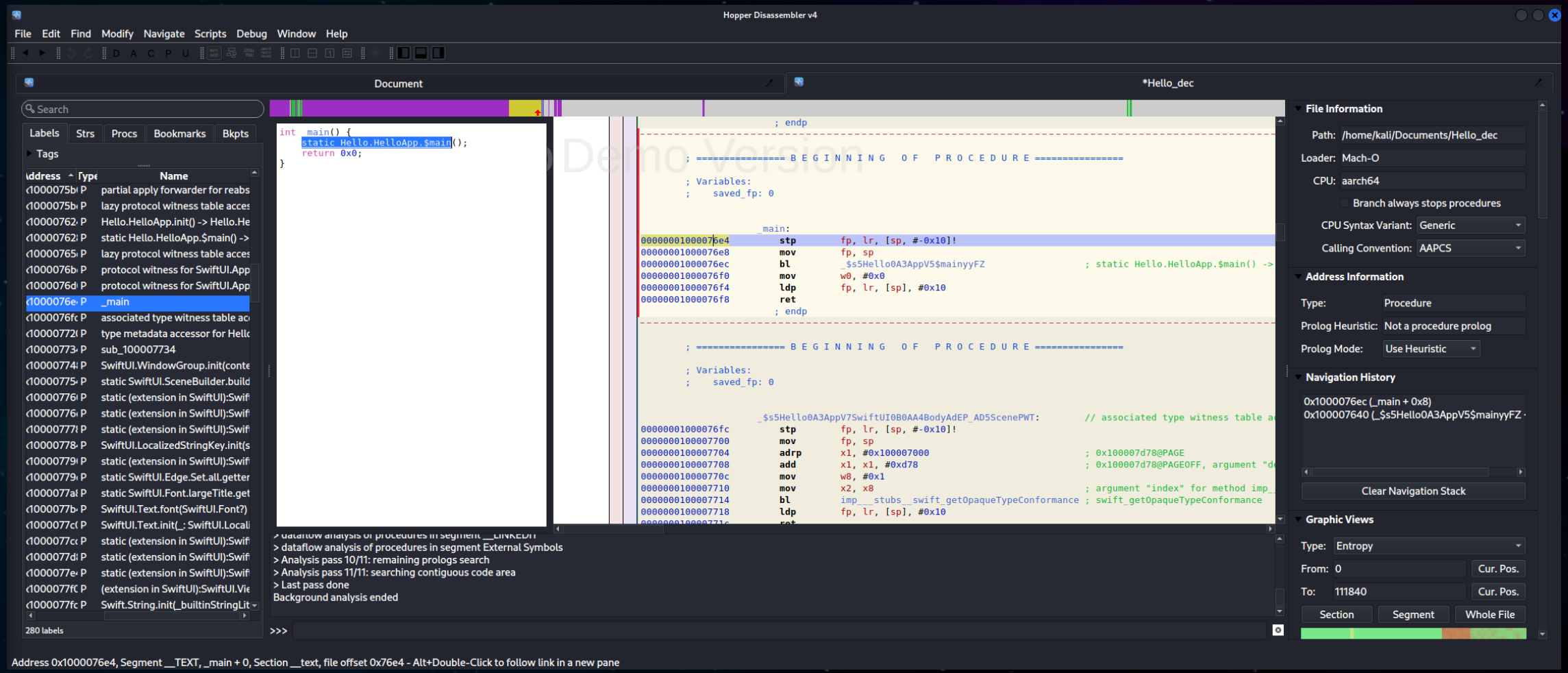
New kid on the block

Compiles to normal C

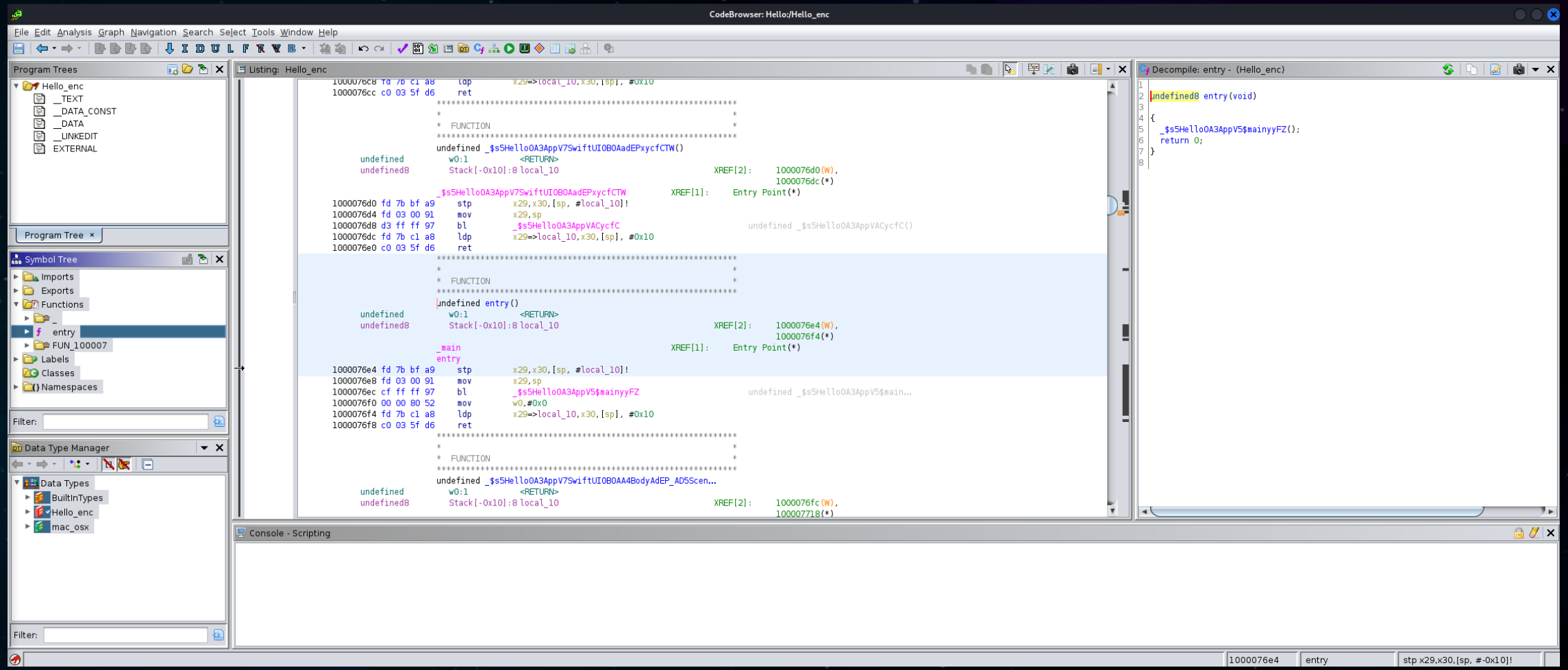
Used more and more

Difficult to RE

Hopper



Ghidra



Decompiled ObjC / C

Decompile: addKey:withValue: - (Playground)

```
1
2  /* Function Stack Size: 0x20 bytes */
3
4  void VulnerableVault::addKey:withValue:(ID param_1,SEL param_2,ID param_3,ID param_4)
5
6  {
7    id value;
8    id pvVar1;
9    id value_00;
10   CFDictionaryRef attributes;
11
12   value = _objc_retain((id)param_3);
13   pvVar1 = (id)_objc_msgSend(param_4,"dataUsingEncoding:",4);
14   pvVar1 = _objc_retainAutoreleasedReturnValue(pvVar1);
15   value_00 = (id)prepareDict:(param_1,(SEL)"prepareDict:",(ID)value);
16   attributes = (CFDictionaryRef)_objc_retainAutoreleasedReturnValue(value_00);
17   _objc_release(value);
18   _objc_msgSend(attributes,"setObject:forKey:",pvVar1,*(undefined8 *)PTR__kSecValueData_1000104a8);
19   _objc_msgSend(attributes,"setObject:forKey:",&cf_VulnerableVaultService,
20                 *(undefined8 *)PTR__kSecAttrService_100010490);
21   _SecItemAdd(attributes,(CFTypeRef *)0x0);
22   _objc_release(attributes);
23   _objc_release(pvVar1);
24   return;
25 }
26
```

Our Journey

Adventures on Android

Meddling in the Middle

Big Bang of Basics

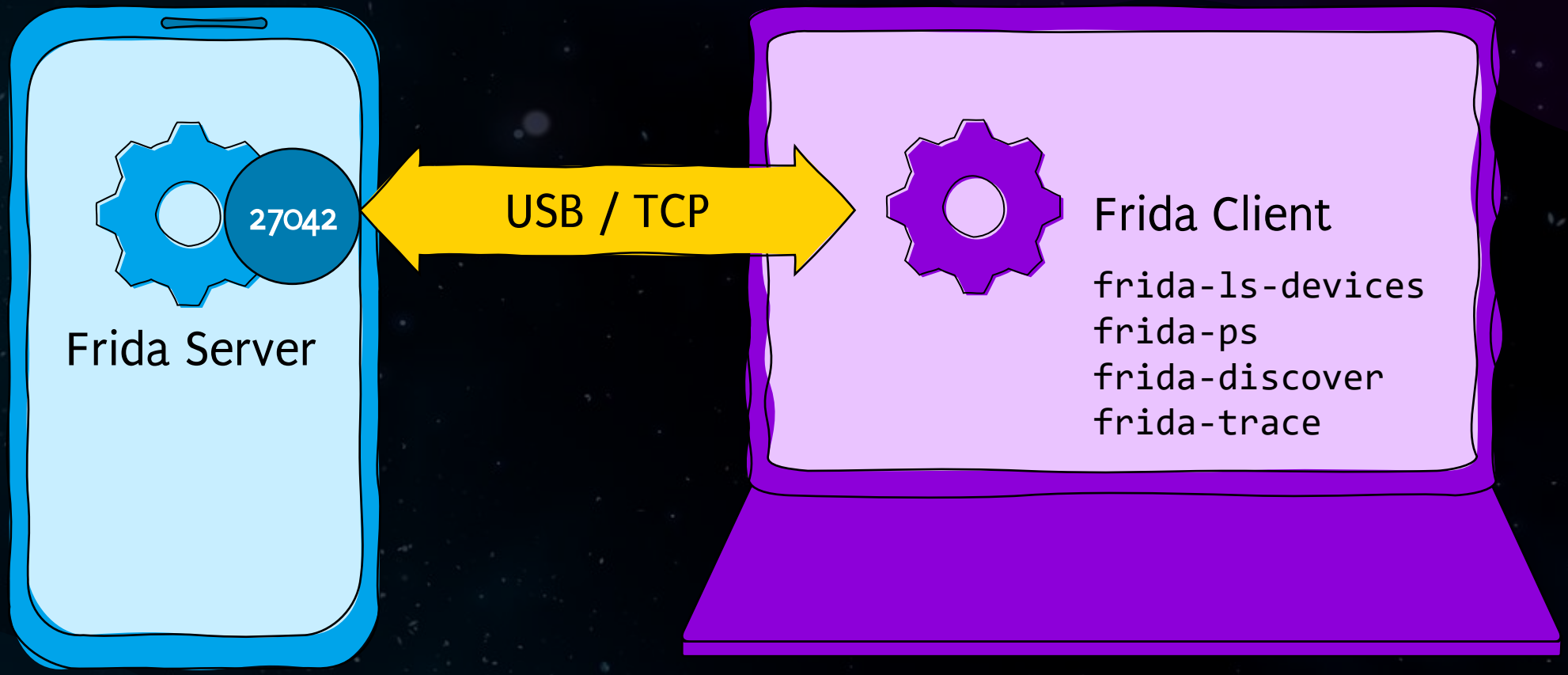
Incidents on iOS

Igniting the Infinite Improbability Drive

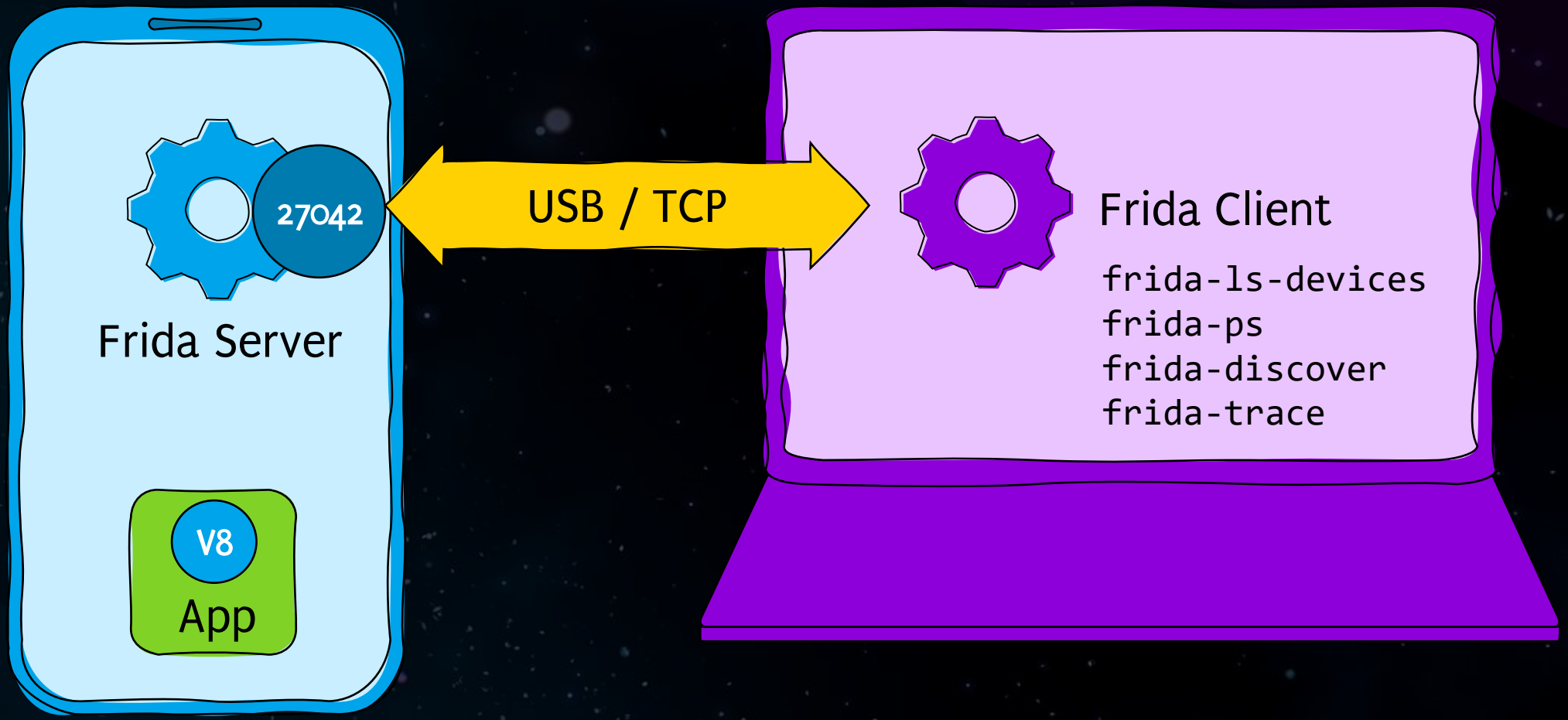
Hooking with Frida

nviso

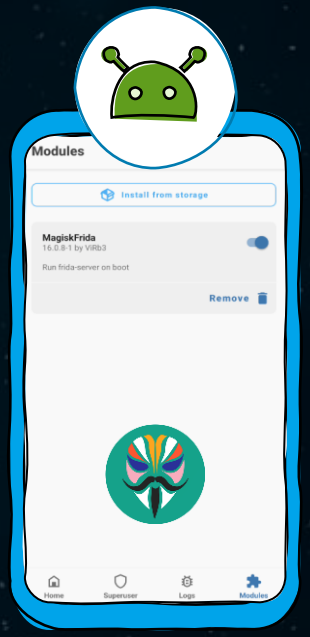
Frida



Frida



Frida



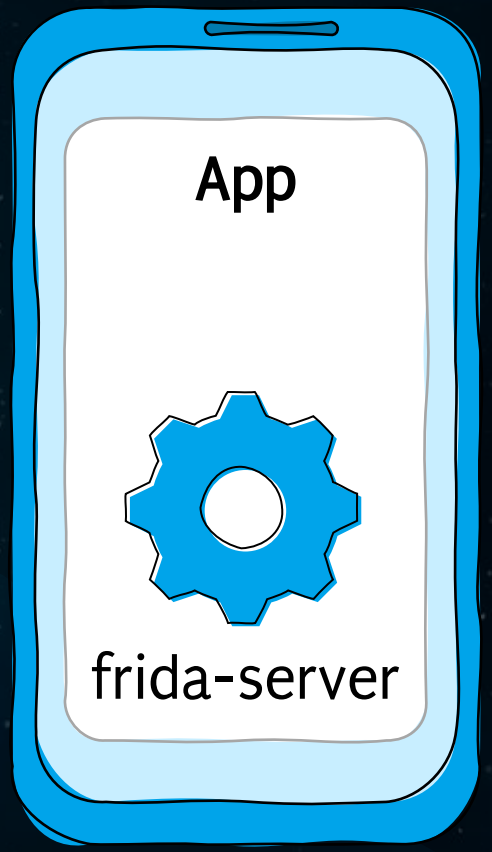
github.com/ViRb3/
magisk-frida

build.frida.re

```
$> pip install frida-tools
```

https://github.com/frida/frida/

What to do without root?



On non-rooted/jailbroken devices, we can compile frida-agent.so (Android) / FridaGadget.dylib (iOS) into the app

```
$> objection patchapk --source ./hitchhacker.apk

$> objection patchipa --source "HitchHacker.ipa"
   --codesign-signature XXXXXXXXXXXXXX
```

Frida

```
$> frida-ps -Ua
PID  Name      Identifier
---  --------  ------------------
946  Calendar  com.apple.mobilecal
985  Poems     space.hitchhacker.guide

$> frida -Uf space.hitchhacker.guide
     ____
    / _  |   Frida 16.0.2 - A world-class dynamic instrumentation toolkit
   | (_| |
    > _  |   Commands:
   /_/ |_|       help      -> Displays the help system
   . . . .       object?   -> Display information about 'object'
   . . . .       exit/quit -> Exit
   . . . .
   . . . .   More info at https://frida.re/docs/home/
   . . . .
   . . . .   Connected to iOS Device (id=d7070753257d3c069acf97f642f2de6917061448)
[iOS Device::space.hitchhacker.guide]->
```

Connect via USB

List running user-land applications

Interactive console

Frida for Android - Inspect

```
$> [Pixel 3a::space.hitchhacker.guide]-> Java.enumerateLoadedClassesSync()
[
    "android.icu.text.UnicodeSet$ComparisonStyle",
    "android.icu.text.CharsetRecog_mbcs$iteratedChar",
    "android.icu.impl.duration.impl.XMLRecordWriter",
...
$> [Pixel 3a::space.hitchhacker.guide]-> Java.enumerateMethods("space.hitchhacker.guide.
                                        LoginActivity!*")
[
    {
        "classes": [
            {
                "methods": [
                    "$r8$lambda$ABD1GrxfYNKMF77fryH3xXrhFCo",
                    "$init",
                    "launchMain",
                    "validatePin",
                    ...
```

List all loaded classes

*List all methods using wildcards: *class*!*method**

Frida for Android - Scripts

Our script

```
$> frida -U -l theanswer.js -f space.hitchhacker.guide
```

App package name
that we want to attack

Frida Scripts - Analyzing static variables

```
package space.hitchhacker;
public class TheAnswer
{
  public static String question;
  public static String getAnswer()
  {
    String answer = calculate(this.guestion);
    return answer;
  }
}
```

We want to know the value of the static variable "question"

Frida Scripts - Analyzing static variables

```
package space.hitchhacker;
public class TheAnswer
{
  public static String question;
  public static String getAnswer()
  {
    String answer = calculate(this.question);
    return answer;
  }
}
```

```
function myFunction() {

    // Here goes the hooking code

}
Java.perform(myFunction);
```

Frida Scripts - Analyzing static variables

```
package space.hitchhacker;
public class TheAnswer
{
  public static String question;
  public static String getAnswer()
  {
    String answer = calculate(this.question);
    return answer;
  }
}
```

```
Java.perform(() => {

    // Here goes the hooking code

});
```

Frida Scripts - Analyzing static variables

```
package space.hitchhacker;
public class TheAnswer
{
  public static String question;
  public static String getAnswer()
  {
    String answer = calculate(this.question);
    return answer;
  }
}
```

Fully qualified name of the class to be analyzed

```
function myFunction() {
    var answerClass = Java.use("space.hitchhacker.TheAnswer");

    // ...TODO...
}
Java.perform(myFunction);
```

Frida Scripts - Analyzing static variables

```
package space.hitchhacker;
public class TheAnswer
{
  public static String question;
  public static String getAnswer()
  {
    String answer = calculate(this.question);
    return
  }
}
```

```
function myFunction() {
    var answerClass = Java.use("space.hitchhacker.TheAnswer");

    console.log("Question: " + answerClass.question.value)
}
Java.perform(myFunction);
```

We're logging the value of the "question" variable

Frida Scripts - Analyzing arguments

```
package space.hitchhacker;
public class TheAnswer
{
  public String question;
  public String getAnswer(String question)
  {
    String answer = calculate(question);
    return answer;
  }
}
```

We want to know which "question" is passed to the "getAnswer" method

Frida Scripts - Analyzing arguments

```java
package space.hitchhacker;
public class TheAnswer
{
  public String question;
  public String getAnswer(String question)
  {
    String answer = calculate(question);
    return answer;
  }
}
```

Method name and arguments whose implementation we want to analyze

```javascript
function myFunction() {
    var answerClass = Java.use("space.hitchhacker.TheAnswer");

    answerClass.getAnswer.implementation = function(question) {
        console.log("Question: " + question);
    }
}
Java.perform(myFunction);
```

We're logging the value of "question"

Frida Scripts - Analyzing arguments

```
package space.hitchhacker;
public class TheAnswer
{
  public String question;
  public String getAnswer(String question)
  {
    String answer = calculate(question);
    return
  }
}
```

```
function myFunction() {
    var answerClass = Java.use("space.hitchhacker.TheAnswer");

    answerClass.getAnswer.implementation = function(question) {
        console.log("Question: " + question);
        this.getAnswer(question);
    }
}
Java.perform(myFunction);
```

We have to call the original method so it is executed

Frida Scripts - Modifying arguments

```
package space.hitchhacker;
public class TheAnswer
{
  public String question;
  public String getAnswer(String question)
  {
    String answer = calculate(question);
    return answer;
  }
}
```

We want to get the answer for a certain question

Frida Scripts - Modifying arguments

```
package space.hitchhacker;
public class TheAnswer
{
  public String question;
  public String getAnswer(String question)
  {
    String answer = calculate(question);
    return answer;
  }
}
```

```
function myFunction() {
    var answerClass = Java.use("space.hitchhacker.TheAnswer");

    answerClass.getAnswer.implementation = function(question) {
        this.getAnswer("My custom question");
    }
}
Java.perform(myFunction);
```

Calling the function with modified arguments

Frida Scripts - Analyzing return values

```
package space.hitchhacker;
public class TheAnswer
{
  public String question;
  public String getAnswer(String question)
  {
    String answer = calculate(question);
    return answer;
  }
}
```

We want to know which "answer" is returned by the method

Frida Scripts - Analyzing return values

```
package space.hitchhacker;
public class TheAnswer
{
  public String question;
  public String getAnswer(String question)
  {
    String answer = calculate(question);
    return
  }
}
```

```
function myFunction() {
    var answerClass = Java.use("space.hitchhacker.TheAnswer");

    answerClass.getAnswer.implementation = function(question) {
        var answer = this.getAnswer(question);
        console.log("Answer: " + answer);
        return answer;
    }
}
Java.perform(myFunction);
```

We're logging the return value of the function and then return it normally

Frida Scripts - Modifying return values

```
package space.hitchhacker;
public class TheAnswer
{
  public String question;
  public String getAnswer(String question)
  {
    String answer = calculate(question);
    return answer;
  }
}
```

We want to set a certain value to be returned as "answer"

Frida Scripts - Modifying return values

```
package space.hitchhacker;
public class TheAnswer
{
  public String question;
  public String getAnswer(String question)
  {
    String answer = calculate(question);
    return answer;
  }
}
```

```
function myFunction() {
    var answerClass = Java.use("space.hitchhacker.TheAnswer");

    answerClass.getAnswer.implementation = function(question) {
        return "42";
    }
}
Java.perform(myFunction);
```

The answer is always 42

Frida Scripts - Method overload

```
package space.hitchhacker;
public class TheAnswer {

  public String getAnswer(String question)  {
    String answer = calculate(question);
    return answer;
  }

    public String getAnswer(int numquestion)  {
    String answer = calculate(numquestion);
    return answer;
  }

    public String getAnswer(String[] questionarray)  {
    String answer = calculate(questionarray);
    return answer;
  }

}
```

Methods have the same name but expect different arguments

Frida Scripts - Method overload

```
package space.hitchhacker;
public class TheAnswer {

  public String getAnswer(String question)  {
    String answer = calculate(question);
    return answer;
  }

    public String getAnswer(int numquestion)  {
    String answer = calculate(numquestion);
    return answer;
  }

    public String getAnswer(String[] questionarray)  {
    String answer = calculate(questionarray);
    return answer;
  }

}
```

```
function myFunction() {
    var answerClass =
        Java.use("space.hitchhacker.TheAnswer");

    answerClass.getAnswer.overload("java.lang.String
        ").implementation = function(question) {
        // ...
    }
}
Java.perform(myFunction);
```

Frida Scripts - Method overload

```
package space.hitchhacker;
public class TheAnswer {

  public String getAnswer(String question)  {
    String answer = calculate(question);
    return answer;
  }

    public String getAnswer(int numquestion)   {
    String answer = calculate(numquestion);
    return answer;
  }

    public String getAnswer(String[] questionarray)  {
    String answer = calculate(questionarray);
    return answer;
  }

}
```

```
function myFunction() {
    var answerClass =
        Java.use("space.hitchhacker.TheAnswer");

    answerClass.getAnswer.overload("int").implementa
        tion = function(question) {
        // ...
    }
}
Java.perform(myFunction);
```

Frida Scripts - Method overload

```
package space.hitchhacker;
public class TheAnswer {

  public String getAnswer(String question)  {
    String answer = calculate(question);
    return answer;
  }

    public String getAnswer(int numquestion)   {
    String answer = calculate(numquestion);
    return answer;
  }

    public String getAnswer(String[] questionarray)  {
    String answer = calculate(questionarray);
    return answer;
  }

}
```

```
function myFunction() {
    var answerClass =
        Java.use("space.hitchhacker.TheAnswer");

    answerClass.getAnswer.overload(
        "[Ljava.lang.String").implementation =
        function(question) {
        // ...
    }
}
Java.perform(myFunction);
```

Frida Scripts - Method overload

Java	Frida	Java	Frida
int	int	int[]	[I
byte	byte	byte[]	[B
short	short	short[]	[S
long	long	long[]	[J
float	float	float[]	[F
double	double	double[]	[D
char	char	char[]	[C
<Object> (z.B. String)	<package>.<Object> (z.B. java.lang.String)	<Object>[] (z.B. String[])	[L<package>.<Object> (z.B. [Ljava.lang.String)

Frida Scripts - Static inner classes

```
package space.hitchhacker.guide;
public class TheAnswer {

    static class TheStaticAnswer {


        public static String getAnswer() {
            return 'Static 42';
        }

    }

}
```

We can access them via <OuterClass>$<StaticCLass> and then call methods directly

```
function myFunction() {
    var staticAnswerClass =
          Java.use("space.hitchhacker.TheAnswer$TheStaticAnswer");

    console.log(staticAnswerClass.getAnswer())
}

Java.perform(myFunction);
```

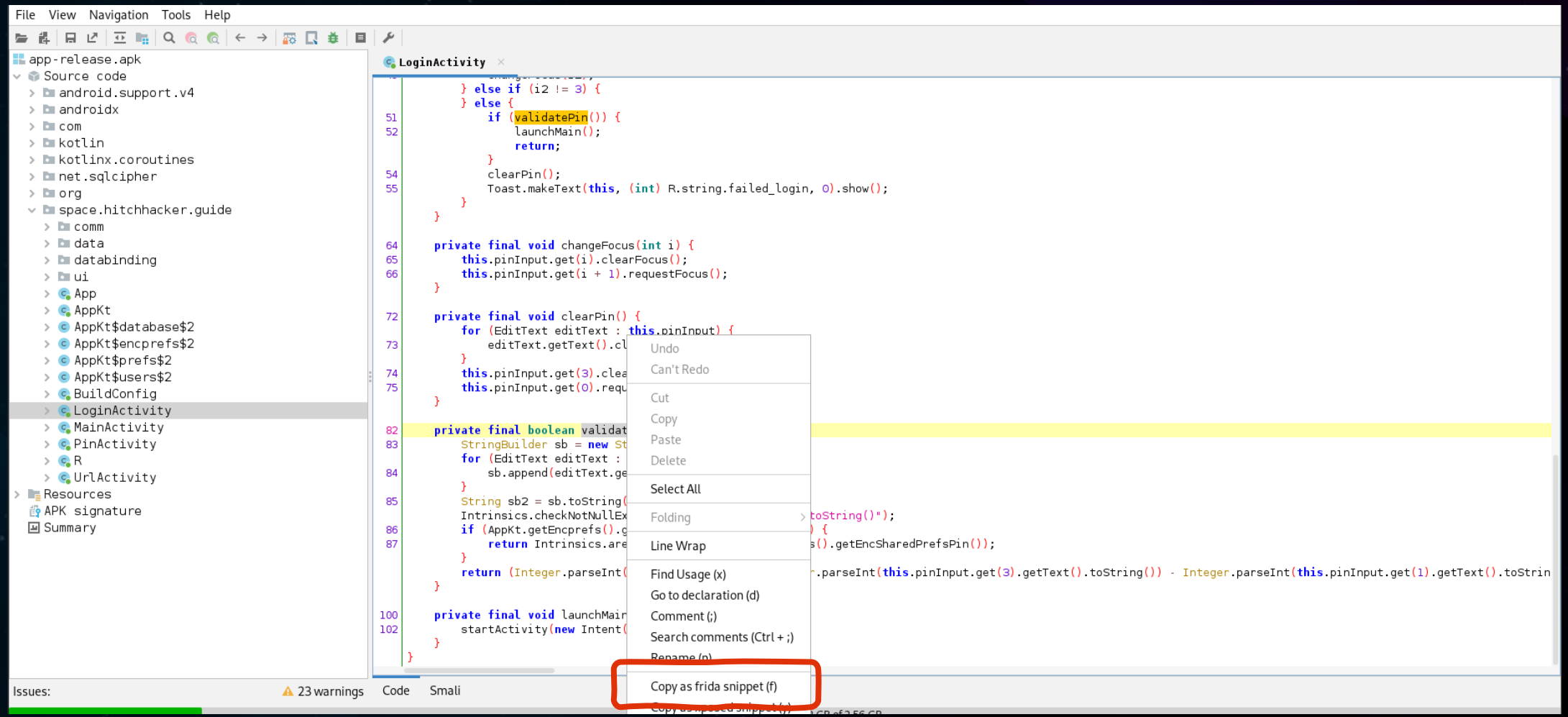
Frida Scripts - Non-static inner classes

```
package space.hitchhacker.guide;
public class TheAnswer {

    class TheExactAnswer {

        public String getAnswer() {
            return '42';
        }

    }


}
```

We can access them via <OuterClass>$<InnerClass> and have to create a new instance with $new before calling a method

```
function myFunction() {
    var answerClass = Java.use("space.hitchhacker.TheAnswer");

    var exactAnswerClass =
         Java.use("space.hitchhacker.TheAnswer$TheExactAnswer");

    var answerInstance = answerClass.$new();
    var exactAnswerInstance = exactAnswerClass.$new(answerInstance)

    console.log(exactAnswerInstance.getAnswer())
}
Java.perform(myFunction);
```

Frida - jadx to the rescue



Frida - jadx to the rescue

```
let LoginActivity = Java.use("space.hitchhacker.guide.LoginActivity");
LoginActivity.validatePin.implementation = function(){
    console.log('validatePin is called');
    let ret = this.validatePin();
    console.log('validatePin ret value is ' + ret);
    return ret;
};
```

Generated JavaScript code

Don't forget to wrap it in Java.perform()

Frida Scripts for iOS

Get references to class and method

```
var SC = ObjC.classes["SharedCredentialController"]
var pC = SC["- passwordCredential"];
Interceptor.attach(pC.implementation,
{
        onEnter: function(args)
        {
                console.log(args[0]);
        },
        onLeave: function(retval)
        {
                console.log(new ObjC.Object(retval).toString());
                retval.replace(1);
        }
});
```

Use Interceptor.attach

Implement onEnter / onLeave functions (both are optional)

Beg, Borrow, Steal, Create

https://learnfrida.info/

RMS Runtime Mobile Security

github.com/mobilesecurity/RMS-Runtime-Mobile-Security

MOBSF

github.com/MobSF/Mobile-Security-Framework-MobSF

OBJECTION RUNTIME MOBILE EXPLORATION GIT.IO/OBJECTION

github.com/sensepost/objection

Grapefruit

github.com/ChiChou/grapefruit

Hook & Collect DEXCALIBUR

github.com/FrenchYeti/dexcalibur

FRIDA

codeshare.frida.re

House

github.com/nccgroup/house

nviso

The bridge is yours

Demo: Setting up Frida

The bridge is yours

Bypass the login pin of the Hitchhacker app

Launch the Vogon Construction App

- Disable the access restrictions
- ★ Obtain the SQLite password
- ★ Obtain the deactivation password
- ★ Obtain all users and their passwords

Solution

Hitchhacker: Pin bypass

```
Java.perform(() => {
    var myClass = Java.use("space.hitchhacker.guide.LoginActivity");

     myClass.validatePin.implementation = function() {
         console.log("Returning true for pin");
         return true;
     }
});
```

Solution

Vogon Construction: Disable access restriction

```
Java.perform(() => {
    var myClass = Java.use("eu.nviso.vogonconstruction.MainActivity");

    myClass.isVogonOperator.implementation = function() {
        console.log("Returning true for vogon operator");
        return true;
    }

});
```

Solution

Vogon Construction: Obtain SQLite password

```
Java.perform(() => {
    let AnonymousClass1 = Java.use("eu.nviso.vogonconstruction.UserProvider$1");
    AnonymousClass1.toString.implementation = function(){
        console.log('toString is called');
        let ret = this.toString();
        console.log('toString ret value is ' + ret);
        return ret;
    };
});
```

Solution

Vogon Construction: Obtain deactivation password

```
Java.perform(() => {
    let ControlPanel = Java.use("eu.nviso.vogonconstruction.ControlPanel");
    ControlPanel.generateNewPassword.implementation = function(){
        console.log('generateNewPassword is called');
        let ret = this.generateNewPassword();
        console.log('generateNewPassword ret value is ' + ret);
        return ret;
    };
});
```

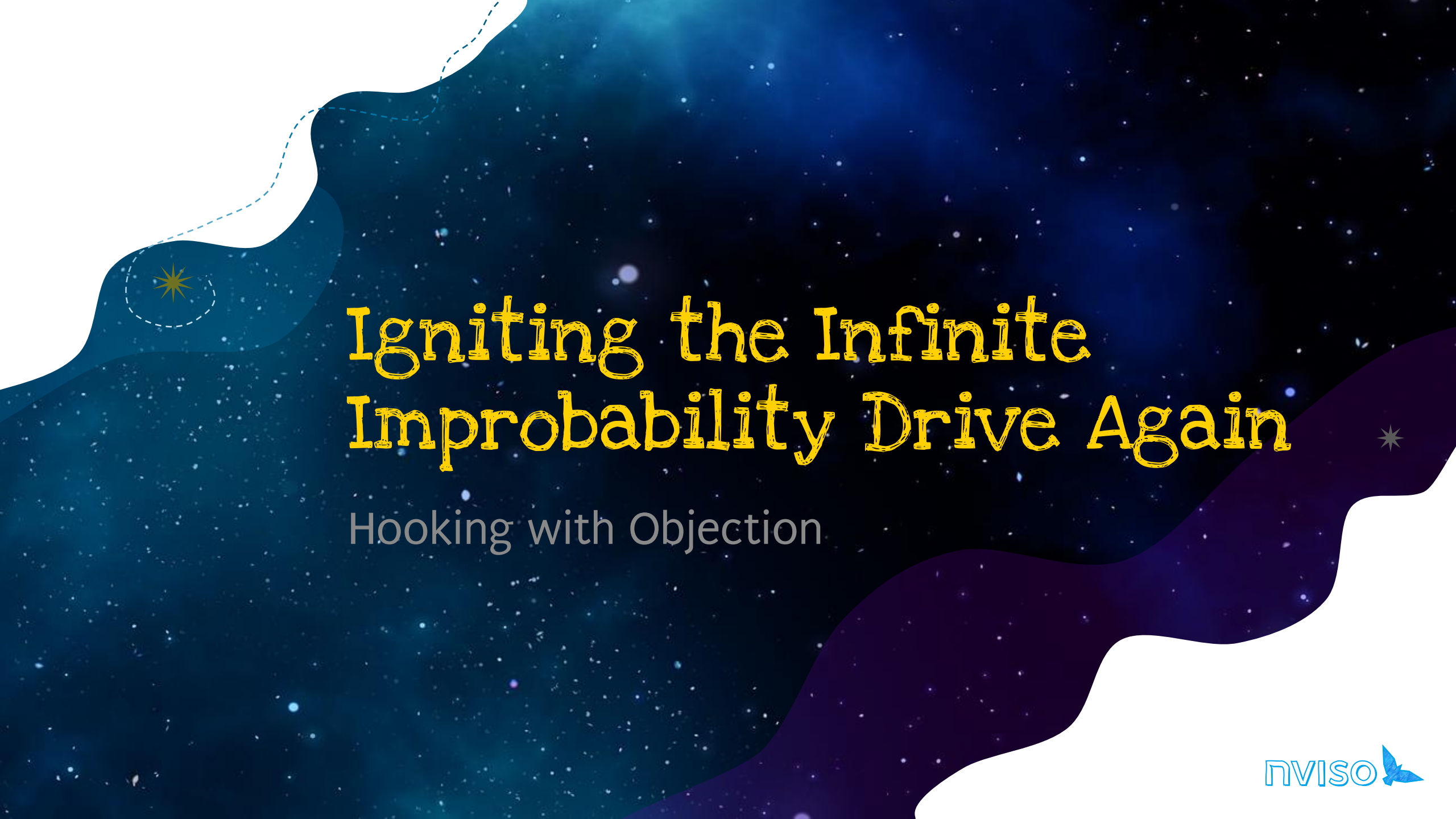
Solution

Vogon Construction: Obtain all users and their passwords

```
Java.perform(() => {
    let UserProvider = Java.use("eu.nviso.vogonconstruction.UserProvider");
    UserProvider.query.implementation = function(uri, strArr, str, strArr2, str2){
        let ret = this.query(uri, strArr, str, strArr2, str2);
        while(ret.moveToNext()) {
            console.log("User: " + ret.getString(ret.getColumnIndexOrThrow("name")));
            console.log("Password: " + ret.getString(ret.getColumnIndexOrThrow("password")));
            console.log("---");
        }
        return ret;
    };
});
```

Igniting the Infinite Improbability Drive Again

Hooking with Objection



Objection

Install with pip

```
$> pip3 install objection
$> objection -g space.hitchhacker.guide explore
Using USB device `SM G950F`
Agent injected and responds ok!

     _     _       _     _
 ___| |_ _|___ ___| |_ _|___ ___
| . | . | |  _|  _|  _| | . |   |
|___|___| |___|___|_| |_|___|_|_|
      |___|(object)inject(ion) v1.11.0

     Runtime Mobile Exploration
        by: @leonjza from @sensepost

[tab] for command suggestions
Space.hitchhacker.guide on (samsung: 12) [usb] #
```

Built on top of Frida
Supports Android and iOS

Interactive console

Objection for Android

Calling default scripts for common scenarios

```
# android sslpinning disable

(agent) Custom TrustManager ready, overriding SSLContext.init()
(agent) Found com.android.org.conscrypt.TrustManagerImpl, overriding
TrustManagerImpl.verifyChain()
(agent) Found com.android.org.conscrypt.TrustManagerImpl, overriding
TrustManagerImpl.checkTrustedRecursive()
(agent) Registering job 523285. Type: android-sslpinning-disable

# android root disable
(agent) Registering job 040751. Type: root-detection-disable
```

May or may not work...

Objection for Android

```
# android hooking list activities
com.google.android.gms.ads.AdActivity
com.google.android.gms.common.api.GoogleApiActivity
org.proxydroid.AppManager
org.proxydroid.BypassListActivity
org.proxydroid.FileChooser
org.proxydroid.ProxyDroid

# android intent launch_activity org.proxydroid.BypassListActivity
Starting activity org.proxydroid.BypassListActivity...
(agent) Activity successfully asked to start.

# android hooking search classes proxy
$Proxy0
$Proxy2
[Landroid.net.IpConfiguration$ProxySettings;
[Landroid.net.ProxyInfo;
...
```

List all activities

Launch any activity (including non-exported ones)

Search for interesting classes

Objection for Android

List all methods

```
# android hooking list class_methods org.proxydroid.ProxyDroid
private android.widget.LinearLayout org.proxydroid.ProxyDroid.getLayout(android.view.ViewParent)
private boolean org.proxydroid.ProxyDroid.isTextEmpty(java.lang.String,java.lang.String)
private boolean org.proxydroid.ProxyDroid.serviceStart()
...
```

Monitor function usage

```
# android hooking watch class_method org.proxydroid.ProxyDroid.serviceStart
(agent) Attempting to watch class org.proxydroid.ProxyDroid and method serviceStart.
(agent) Hooking org.proxydroid.ProxyDroid.serviceStart()
(agent) Registering job 459083. Type: watch-method for: org.proxydroid.ProxyDroid.serviceStart
```

```
# android hooking set return_value org.proxydroid.ProxyDroid.serviceStart true
(agent) Attempting to modify return value for class org.proxydroid.ProxyDroid and method serviceStart.
(agent) Hooking org.proxydroid.ProxyDroid.serviceStart()
(agent) Registering job 785400. Type: set-return for: org.proxydroid.ProxyDroid.serviceStart
```

Modify basic return values

Objection for iOS

```
$> objection -N -h 10.11.1.1 -g com.apple.mobilecal explore
Using networked device @`10.11.1.1:27042`
Agent injected and responds ok!

     _   _                 _   _
 ___| |_|_|___ ___ ___| |_|_|___ ___
| . | . | |  -_|  _|  _| | . |   |
|___|___| |___|___|_| |_|___|_|_|
      |___|(object)inject(ion) v1.11.0

     Runtime Mobile Exploration
        by: @leonjza from @sensepost

[tab] for command suggestions
com.apple.mobilecal on (iPhone: 15.7) [net] #
```

Connect over network using –N and -h

Interactive console

Objection for iOS

Default scripts for common scenarios

```
# com.apple.mobilecal on (iPhone: 15.7) [net] # ios sslpinning disable
(agent) Hooking common framework methods
(agent) Found NSURLSession based classes. Hooking known pinning methods.
(agent) Hooking lower level SSL methods
(agent) Hooking lower level TLS methods
(agent) Hooking BoringSSL methods
(agent) Registering job 440948. Type: ios-sslpinning-disable
# com.apple.mobilecal on (iPhone: 15.7) [net] # ios jailbreak disable
(agent) Registering job 492880. Type: ios-jailbreak-disable
```

May or may not work…

Objection for iOS

```
com.apple.mobilecal on (iPhone: 14.7.1) [usb] # ios keychain dump
Created  Accessible  ACL  Type  Account  Service  Data
-------  ----------  ---  ----  -------  -------  ----
2022-04-29 08:37:09 +0000  AfterFirstUnlock  None  kSecClassKey
(Key data not displayed)
2022-04-29 08:36:06 +0000  AfterFirstUnlock  None  Password  arthur@space
com.apple.gs.beta.auth.com.apple.account.AppleIDAuthentication.token
AA---SNIP---9E=

com.apple.mobilecal on (iPhone: 14.7.1) [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
```

Dump the content of the keychain for the current app

Save the dump to a json file on the host

Objection for iOS

```
# ios hooking search classes Security
NSFileSecurity
__NSPlaceholderFileSecurity
__NSFileSecurity
SecuritydXPCCallback
SecuritydXPCClient
UISUISecurityContext
AFSecurityConnection
...

# ios hooking list class_methods AFSecurityConnection
- _connection
- setInternalAuthSessionToken:completion:
- _processData:usingProcedure:completion:
- processDataMap:usingProcedure:completion:
- initWithInstanceContext:
...
```

Search for interesting classes

List class methods

Objection for iOS

Monitor function usage

```
# ios hooking watch method  "-[AFSecurityConnection setInternalAuthSessionToken:completion:]"
(agent) Found selector at 0x18ea9b758 as -[AFSecurityConnection setInternalAuthSessionToken:completion:]
(agent) Registering job 328546. Type: watch-method for: -[AFSecurityConnection
setInternalAuthSessionToken:completion:]
com.apple.mobilecal on (iPhone: 15.7) [net] #
```

```
# ios hooking set return_value  "-[AFSecurityConnection setInternalAuthSessionToken:completion:]" false
(agent) Found selector at 0x18ea9b758 as -[AFSecurityConnection setInternalAuthSessionToken:completion:]
(agent) Registering job 545668. Type: set-method-return for: -[AFSecurityConnection
setInternalAuthSessionToken:completion:]
com.apple.mobilecal on (iPhone: 15.7) [net] #
```

Modify basic return values

The bridge is yours

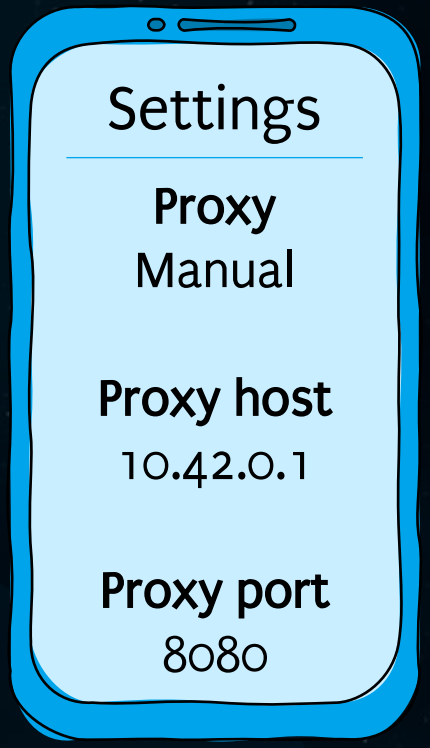
1. Launch the Hitchhacker app with Objection
2. List all activites and launch and launch one of them
3. Identify the methods of the LoginActivity and modify the return value of the appropriate method to log in without knowing the pin

Back to Earth

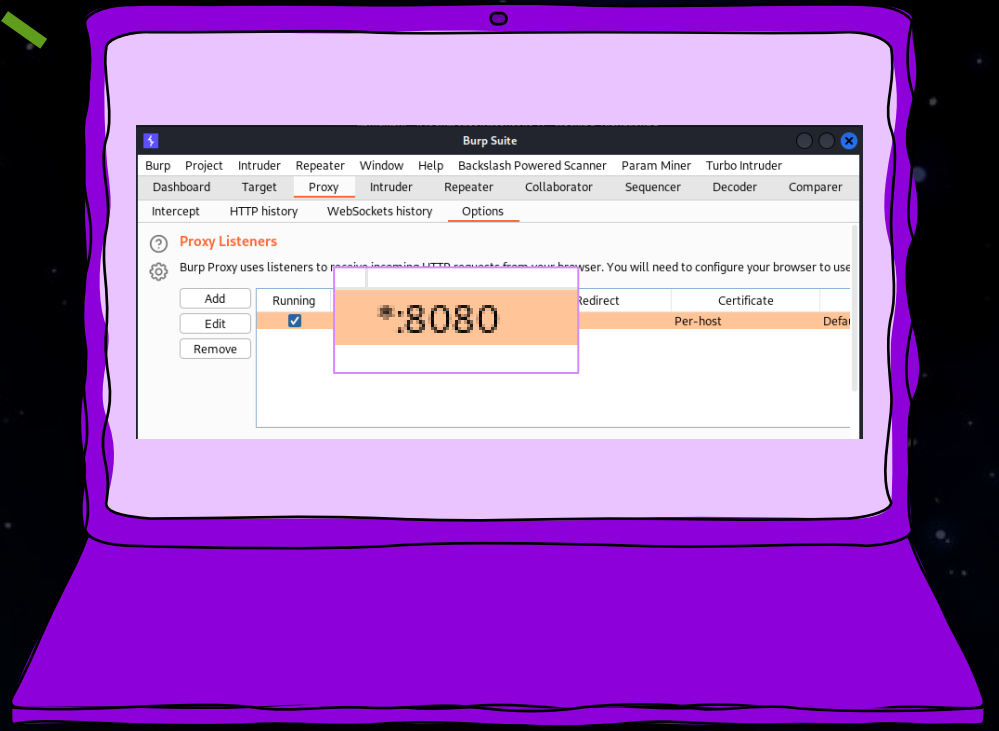
Adventures we didn’t have time for

Establishing a Man in the Middle

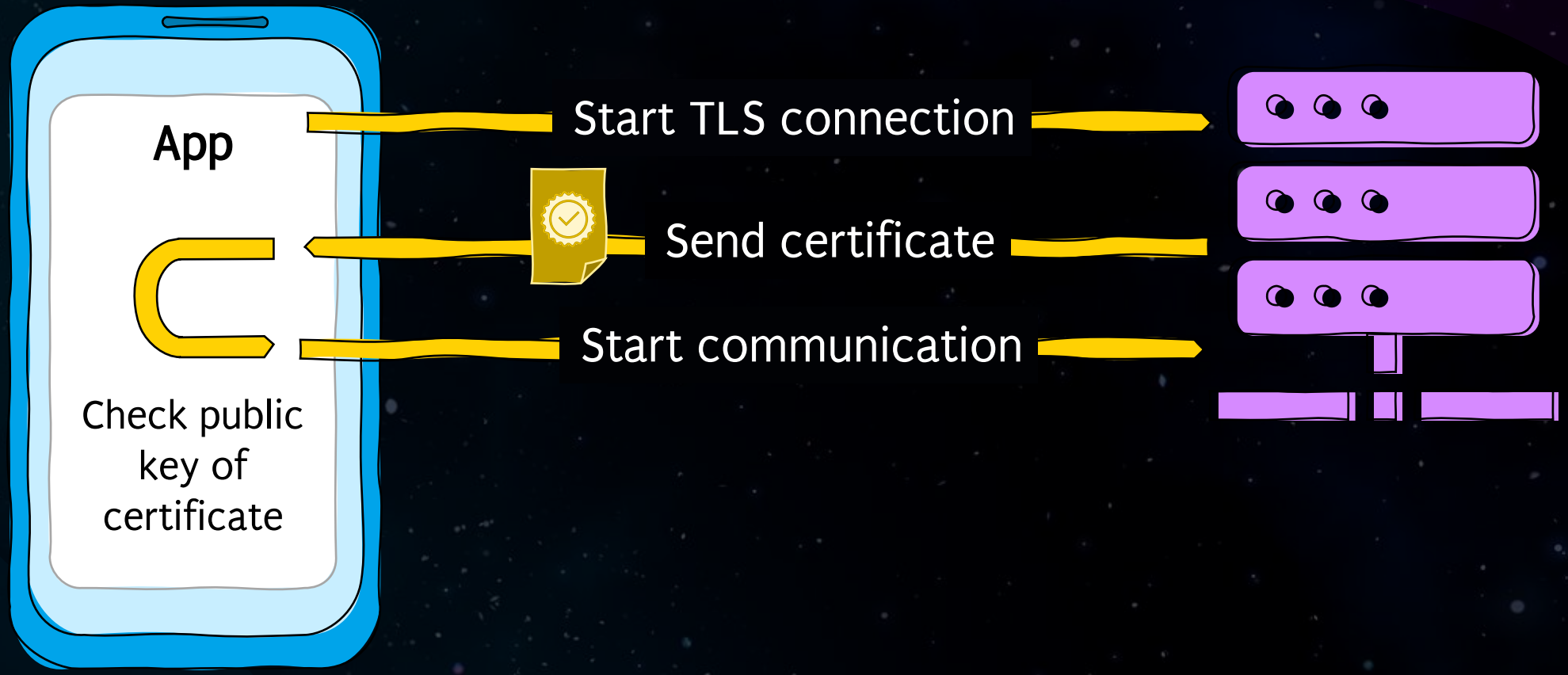
10.42.0.2



10.42.0.1



Bypassing SSL pinning



Frameworks

Xamarin

Unity

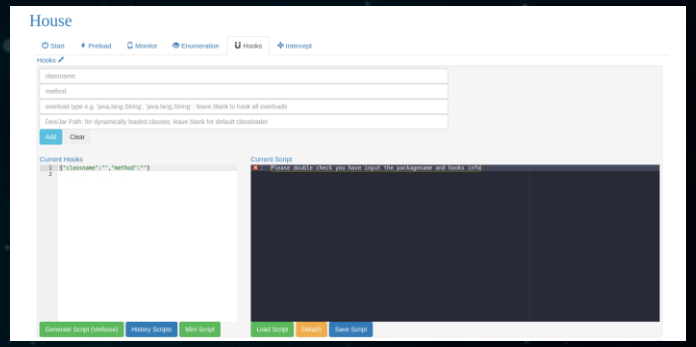
React Native

Ionic

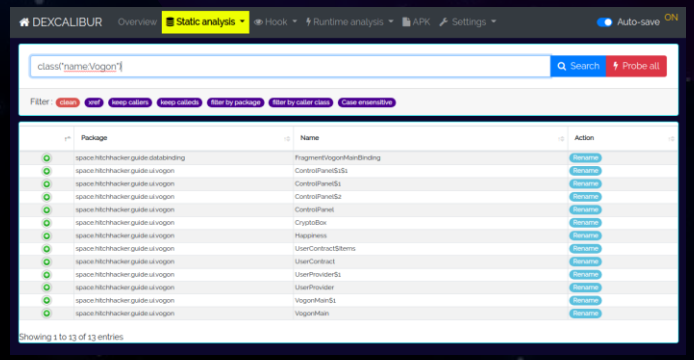
Flutter

Apache Cordova

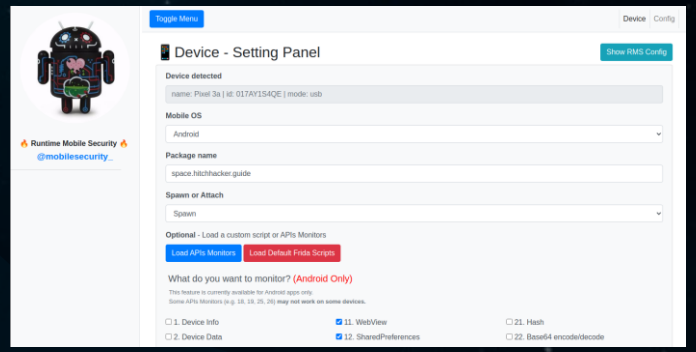
Further tools



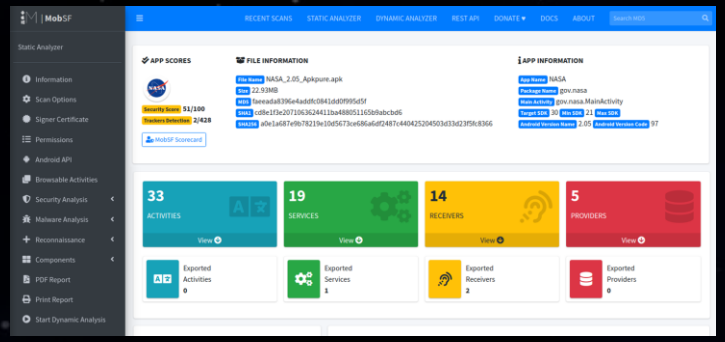
https://github.com/nccgroup/house



https://github.com/FrenchYeti/dexcalibur



https://github.com/mobilesecurity/RMS-Runtime-Mobile-Security



https://github.com/MobSF/Mobile-Security-Framework-MobSF

MASVS

https://mas.owasp.org/


Mobile Application Security
Verification Standard

OWASP MASTG v1.5.0 (commit: 3b92788)
OWASP MASVS v1.4.2 (commit: 2a8b582)

Data Storage and Privacy Requirements

ID	MASVS-ID	Detailed Verification Requirement	L1	L2	R	Common	Android	IOS	Status
2.1	MSTG-STORAGE-1	System credential storage facilities need to be used to store sensitive data, such as PII, user credentials or cryptographic keys.					Test Case	Test Case	Pass
2.2	MSTG-STORAGE-2	No sensitive data should be stored outside of the app container or system credential storage facilities.					Test Case	Test Case	Pass
2.3	MSTG-STORAGE-3	No sensitive data is written to application logs.					Test Case	Test Case	Fail
2.4	MSTG-STORAGE-4	No sensitive data is shared with third parties unless it is a necessary part of the architecture.					Test Case	Test Case	N/A
2.5	MSTG-STORAGE-5	The keyboard cache is disabled on text inputs that process sensitive data.					Test Case	Test Case	Pass
2.6	MSTG-STORAGE-6	No sensitive data is exposed via IPC mechanisms.					Test Case	Test Case	Fail
2.7	MSTG-STORAGE-7	No sensitive data, such as passwords or pins, is exposed through the user interface.					Test Case	Test Case	Fail
2.8	MSTG-STORAGE-8	No sensitive data is included in backups generated by the mobile operating system.					Test Case	Test Case	Fail

So Long, and Thanks for All the Fish

nviso