Defeating SSL Pinning on an Unrooted Android Device

Note: For this project, I am using a non-rooted Samsung Galaxy Note 5 and a laptop running the Ubuntu 18.04.1 operating system.

Why Did I Write This?

While working on this project, I found lots of documentation that walked me through the steps of defeating SSL Pinning, but I didn't find any that mentioned the errors that I was facing, which mostly stemmed from Apktool. I don't know if this will help anyone else with these issues, but I decided to write up my workaround so that hopefully it may help someone else.

Background

I had an Android application with a previously discovered finding that allowed the bypassing of SSL Pinning. If you don't already know, SSL Pinning essentially allows an application to only trust valid certificates. This is a security feature that is meant to prevent attackers from using proxies and executing man-in-the-middle attacks to intercept and edit the requests being sent and received by the application. If SSL Pinning is not implemented, then you can set up a proxy, such as Burp Suite (https://blog.ropnop.com/configuring-burp-suite-with-android-nougat/), which will allow you to act as a man-in-the-middle intercepting all requests being made by the application. However, if the application has SSL Pinning enabled, the requests will be rejected by the application since it does not trust the certificate that is presented by Burp Suite.

For this particular application, SSL Pinning was enabled, but it was implemented in a way that was easily bypassed. When this issue was originally reported, the application did not have any root detection enabled, which meant that it was possible to run the application on a rooted Android device. This allowed for a few options when defeating SSL Pinning (as well as exploiting other security issues). Since then, the development team has implemented root detection, so the application will no longer operate on a rooted device. This greatly improved the overall security of the application, but it made my job of testing SSL Pinning more difficult since I had to find a way to do so without a rooted device.

Initial Solution

There are several blog posts and other documentation on the internet describing multiple ways to defeat SSL Pinning for both Android and iOS. For example:

- https://blog.netspi.com/four-ways-bypass-android-ssl-verification-certificate-pinning/
- https://ninadmathpati.com/all-about-ssl-pinning-bypass/
- https://medium.com/@GowthamR1/android-ssl-pinning-bypass-using-objection-and-frida-scripts-f8199571e7d8
- https://vavkamil.cz/2019/09/15/how-to-bypass-android-certificate-pinning-and-intercept-ssl-traffic/

- https://blog.jamie.holdings/2018/09/05/bypass-certificate-pinning-on-android/

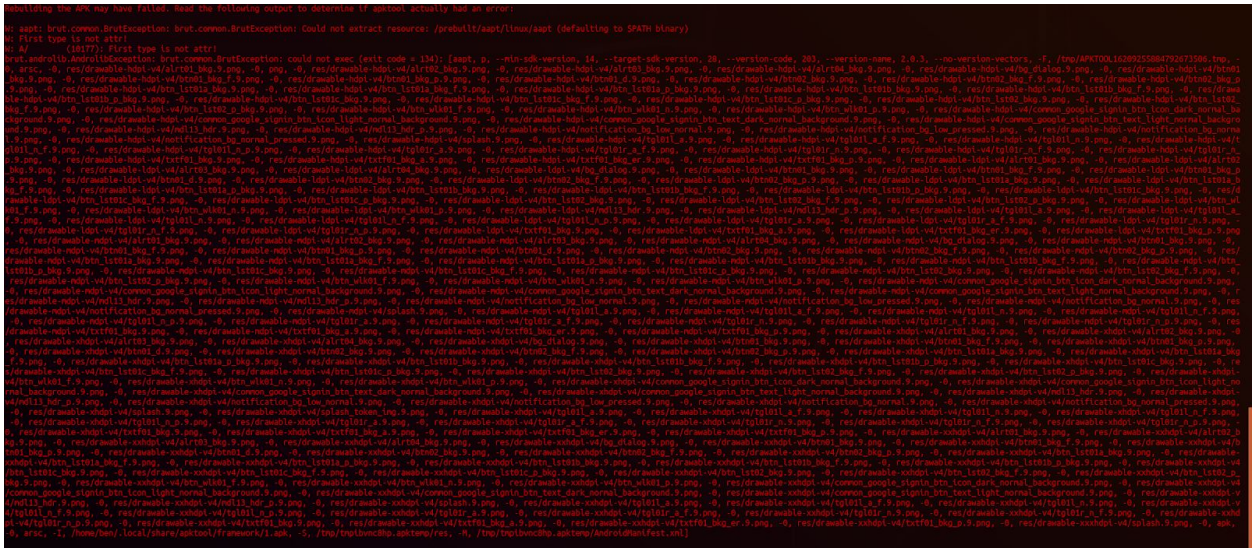
According to most of the documentation on the internet, the most popular and easiest solution is through the use of Frida (https://frida.re/). Unfortunately, Frida must be installed on the mobile device (which requires the device to be rooted), so I had to find another solution. The next best solution I found was a tool called Objection (https://github.com/sensepost/objection). Objection uses the same basic technology as Frida and is often used alongside Frida, but it is less dynamic and has less scripting options available. Most importantly though, Objection does not require root since nothing needs to be installed on the device other than the application that you are testing. There is plenty of documentation on the internet on how to use Objection to defeat SSL Pinning, so I began following those steps. To briefly summarize the process (more detailed documentation can be found at the links posted above):

1. Install Objection, including all dependencies (https://github.com/sensepost/objection/wiki/Patching-Android-Applications#patching---dependencies)
    - Run `pip3 install objection` in a terminal
2. Connect the (non-rooted) Android device that will be used for testing to your computer via USB and allow ADB access to the device
    - If you do not know how to set up and use ADB, instruction can be found here: https://www.xda-developers.com/install-adb-windows-macos-linux/
3. After the device is connected and authorized (this is required so that Objection can determine the proper architecture that should be used), run `objection patchapk -s target.apk` in a terminal (*Note: replace* `target.apk` *with the name of the APK that you are testing*)

This step is where my problems began to arise…

Troubleshooting

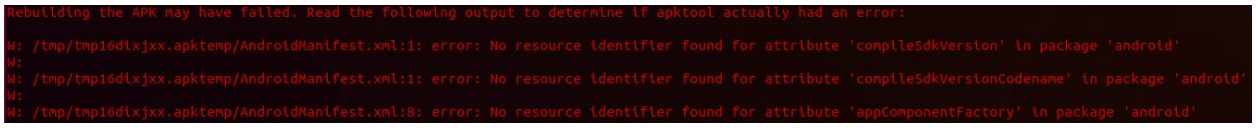
I made it to step 3 of the instructions that I summarized above before I started getting errors. When Objection tried to rebuild the APK, I was presented with a wall of error messages (shown in the screenshot below), and those error messages suggested that Apktool might be the source of the problem.



Apktool is a tool that is used to reverse engineer and rebuild Android applications, and Objection uses Apktool to handle the unpacking and rebuilding of the APK. Of course, I googled these error messages, but I didn't have much luck figuring out what the problem was. However, I eventually looked at the version of Apktool that I had installed, and that was when I noticed that the installed version was listed as `2.3.4-dirty`. According to a comment from the developer that created Apktool, "dirty means the application was built without git support, so it couldn't pull snapshot information." For some reason the version of Apktool that was available from the Ubuntu repository was a dirty build, so I removed that build (`apt-get remove apktool`) and installed the latest build directly from GitHub following the official installation instructions (https://ibotpeaches.github.io/Apktool/install/).

After installing the new version of Apktool, I attempted to complete step 3 again…

This time I did not get the massive wall of errors that I was seeing previously, but I did still get a couple of error messages that mentioned `No resource identifier found`.



After googling this error message, I found a message board post on GitHub that talked about the exact same error that I was seeing (https://github.com/iBotPeaches/Apktool/issues/1842). This post gave a solution that reportedly solved the issue for multiple people. The solution was to run `apktool empty-framework-dir --force`, which empties out the framework files that are included with Apktool. Initially, I thought I would have to edit the Objection source code or something more complex in order to implement this solution during the execution of the Objection command. Fortunately, I realized with some trial and error that I could just run

`apktool empty-framework-dir --force` once before running the Objection command, and that would actually fix my issue. I could then use Objection as many times as I would like, and I would no longer get those `No resource identifier found` errors.

Finally Moving on to Step 4

After spending several hours of research and trial and error, step 3 of the original process was finally complete, and I could move on to step 4. The remaining steps to defeat SSL Pinning using Objection are briefly outlined below, but more detailed instructions can be found at the links that I posted above:

4. Install the newly repackaged APK onto the Android device (the new APK should have the same name as the original APK, except the name should now end with `.objection.apk` instead of just `.apk`)
    - Run `adb install target.objection.apk` (make sure that the Android device is still connected via USB and ADB access is authorized)
5. Open the application on the Android device
    - After installing the APK, open the app on the device just like you would run any normal app
    - The app should begin to open, but it will stop on a blank screen without actually opening
6. While the app is on that blank screen, open a terminal window and run the command `objection explore`
    - The application should finish launching and you should see the message `Agent injected and responds ok!` in the terminal
    - You should also see a prompt in the terminal with the package name of the application
7. At this new prompt, run the command `android sslpinning disable`
    - SSL Pinning should now be disabled for this application and you should be able to use any of your normal proxy tools to execute man-in-the-middle attacks