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iOS instrumentation without jailbreak

This article describes a process of instrumenting an iOS application without a jailbroken device. Because of the absence of jailbreak in the latest versions of iOS and the requirement for testing applications on the latest versions of iOS, it is necessary to find ways of assessing iOS applications non-jailbroken environments. In this post we will show the steps we need to follow to configure our environment, re-sign IPA files in order to access the application's information after being deployed a instrument the binary to trace functions and/or modify its behaviour.

Note: The tools we will use are macOS-based hence an Apple Mac with macOS and XCode 7 is required for the entire process.

Configure the environment

Create a developer profile

The first step is creating a developer profile from Xcode. This will allow us to generate signing identi and provision files. Since Xcode 7, it is possible to create free developer profiles. To do so, first ope the Xcode settings window and go to the Accounts tab as shown below:

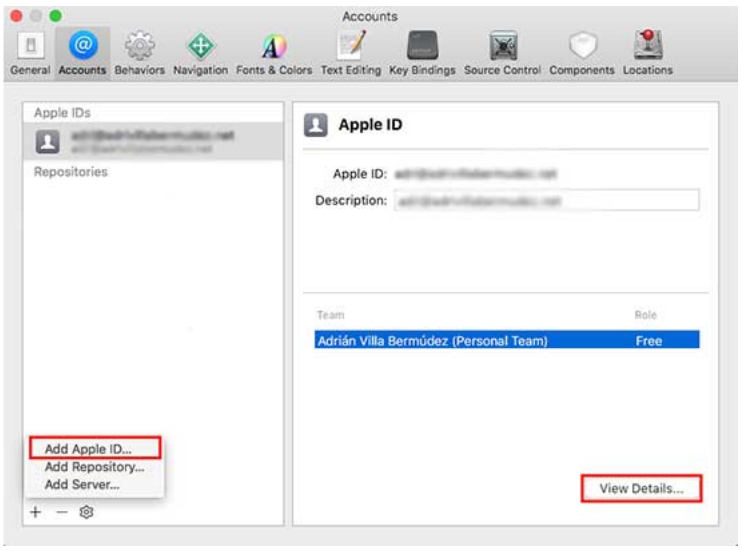


Figure 1 - Screenshot showing the buttons we need to click on the Accounts tab of the setti window

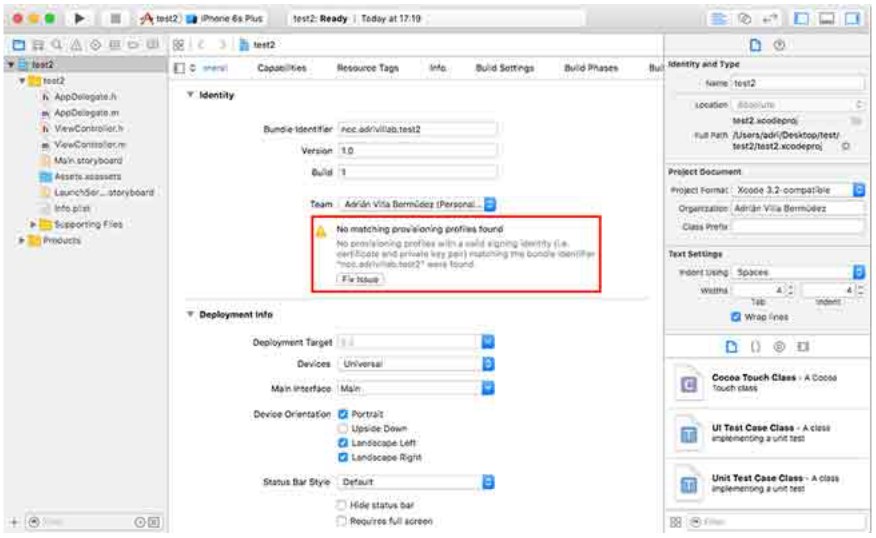
Once we have added an Apple ID, the next step is to create the signing identities from the "*View details...*" option. For the purpose of this guide, the only signing identity required will be **iOS Development**. Click on the "*Create*" button and, after the identity has been created, click on the "*Done*" button to finish the operation.

Create provisioning file and deploy developer profile

Once the developer profile has been created, the next step is to generate a provision profile file and deploy it to the iOS device. A provisioning profile is a file needed in all iOS applications that to satis almost each security check an application made before running, e.g. check if the certificate used fo signing the app is valid, check the AppleID, verify the entitlements (permissions) an application requ etc.

We need to generate a provisioning file with our developer profile because the re-signing process (s later) will substitute the original file with our provision file that contains our AppleID and our signing certificate. Doing this, we will indicate to the device that the application is developed by us, allowin access to the application container, the logs, etc.

To do this, create an empty iOS application project, fix the provision profile issue (as per the image below), and deploy it to the device.


test2 | iPhone 6s Plus | test2: **Ready** | Today at 17:19

Identity

Bundle Identifier: noc.adrivillab.test2
Version: 1.0
Build: 1
Team: Adrián Villa Bermúdez (Personal...

No matching provisioning profiles found
No provisioning profiles with a valid signing identity (i.e. certificate and private key pair) matching the bundle identifier "noc.adrivillab.test2" were found.
Fix Issue

Deployment Info

Deployment Target:
Devices: Universal
Main Interface: Main
Device Orientation: ✓ Portrait, Upside Down, ✓ Landscape Left, ✓ Landscape Right
Status Bar Style: Default
Hide status bar
Requires full screen

Identity and Type
Name: test2
Location: Absolute
test2.xcodeproj
Full Path: /Users/adri/Desktop/test/test2/test2.xcodeproj

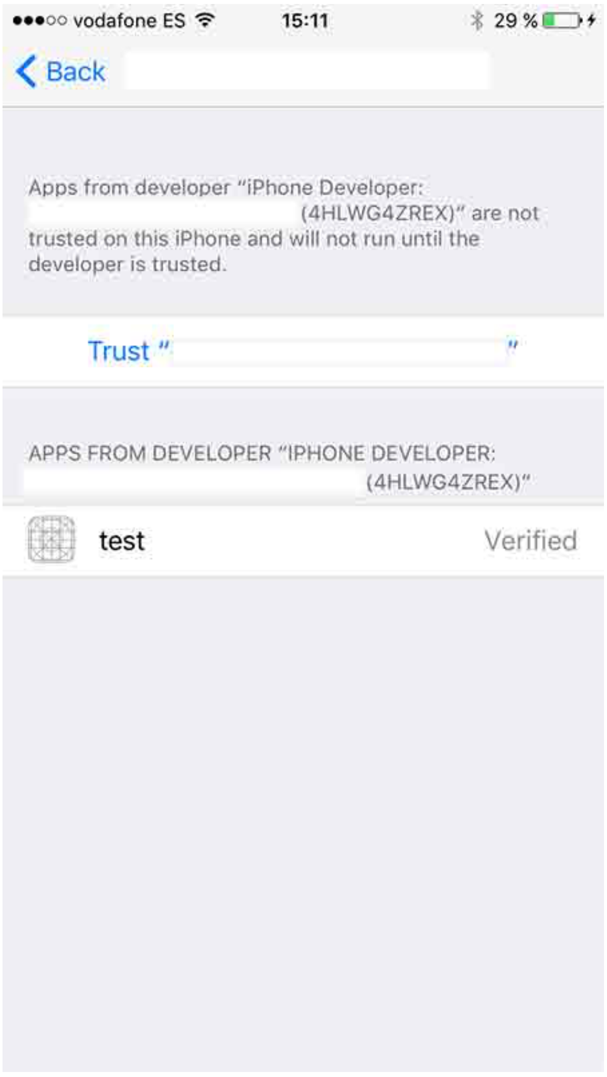
Project Document
Project Format: Xcode 3.2-compatible
Organization: Adrián Villa Bermúdez
Class Prefix:

Text Settings
Indent Using: Spaces
Widths: 4 Tab, 4 Indent
✓ Wrap lines

Cocoa Touch Class - A Cocoa Touch class
UI Test Case Class - A class implementing a unit test
Unit Test Case Class - A class implementing a unit test

Figure 2 - Screenshot showing the provision profile issue

After deploying the profile, navigate to “General settings -> Profile” and accept the developer profile


●●●○○ vodafone ES 15:11 29 %

Back

Apps from developer “iPhone Developer: (4HLWG4ZREX)” are not trusted on this iPhone and will not run until the developer is trusted.

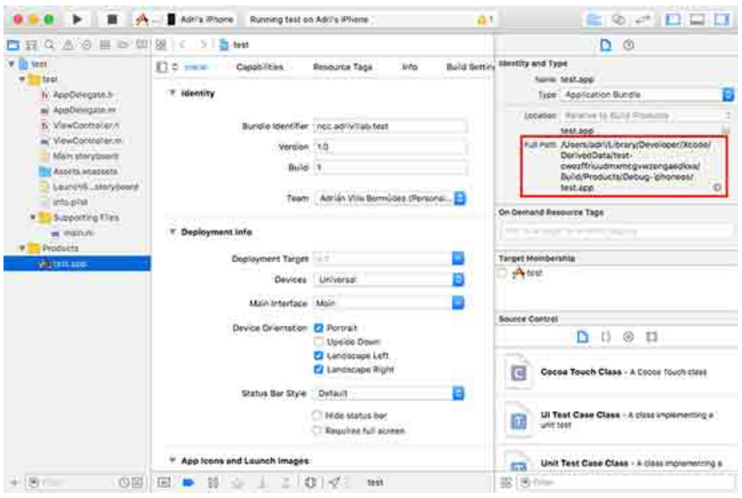
Trust “ ”

APPS FROM DEVELOPER “IPHONE DEVELOPER: (4HLWG4ZREX)”

test Verified

Figure 3 - Screenshot showing the developer profile within the device

To obtain the “embedded.mobileprovision” file from the empty project created, first find the applica container and then extract the file from it. The location of the container can be obtained from the “*Identity and type*” menu of the generated file within Xcode.



Running test on Adri's iPhone

Identity

Bundle Identifier: ncc.adri.vilab.test

Version: 1.0

Build: 1

Team: Adrián Villa Bermúdez (Persona...

Deployment Info

Devices: Universal

Main Interface: Main

Device Orientation: [✓ Portrait] Upside Down [✓ Landscape Left] [✓ Landscape Right]

Status Bar Style: Default

Identity and Type

Name: test.app

Type: Application Bundle

Location: Relative to Build Products

test.app

Full Path: /Users/adri/Library/Developer/Xcode/DerivedData/test-cwozffriuudmxmtgvwzongaedkxa/Build/Products/Debug-iphoneos/test.app

Figure 4 - Screenshot showing the section of Xcode where the file path is showed

Once located, open the container folder and copy the file to a safe location.

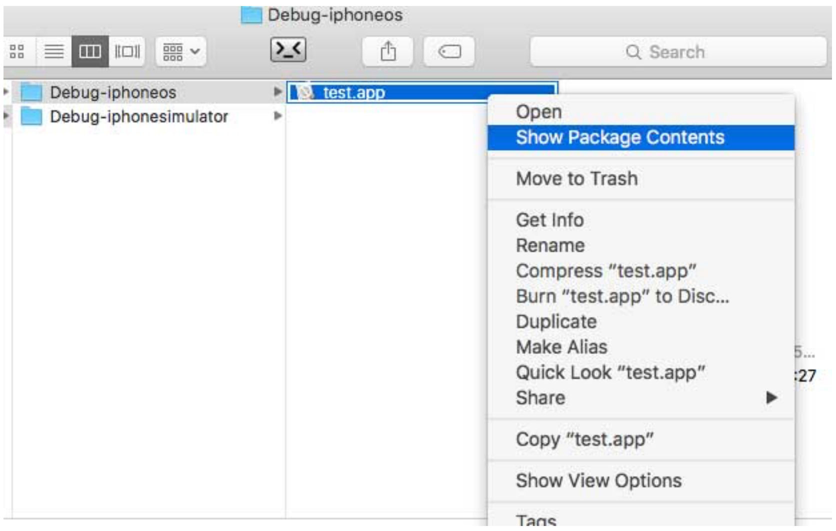


Figure 5 - Screenshot showing how to open a container file

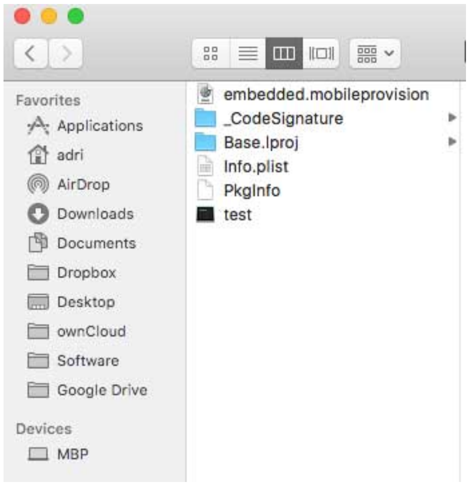


Figure 6 - Screenshot showing the files inside the container, including the provision file

1 Re-sign IPA File

The iOS side loading app deployment process forces signing of every application with a developer certificate. After the application has been deployed a developer can then access the container folde see the log debug messages on a non-jailbroken device. Therefore, in order to properly assess an application in a non-jailbroken device, it is necessary to re-sign the application with a developer certificate under our control before installing the application.

The process to re-sign an application involves several steps:

1. Re-sign the application binary and the libraries

2. Insert a new provision file

3. Fix the entitlements and the plist file

In order to speed up this process, a tool developed by Sergi Alvarez (@pancake), from NowSecure, called **node-applesign** (https://github.com/nowsecure/node-applesign (https://github.com/nowsecure/node-applesign)), can be used.

Before using node-applesign for the first time, it is necessary to install node.js and the project's dependencies. After that, the repository can be either cloned or downloaded, and finally we can execute the "*ipa-resign.js*" file. To re-sign an application with this tool there are several elements required:

- a developer identity hash-id;
- the path of the provision file; and
- the path of the IPA file.

The identity hash-id can be obtained using the *node-applesign* tool, specifying the -L flag, or with tl *security* command tool:

```
$ ./ipa-resign.js -L
```

```
$ security find-identity -v -p codesigning
```

After selecting the correct identity, use the tool to re-sign the IPA. The following command re-signs IPA file, replacing the original file, in order to allow us find easily our application on the phone.

```
$ ./ipa-resign.js -r -i 23CE9621AA7324F4E89481C6630591603A2ACD5E -m

~/pentest/iOS/myprovision.mobileprovision ~/pentest/iOS/test.ipa
```

If the process finishes successfully, the application can then be deployed using the *Device Xcode* tc or preferably, using the *ios-deploy* command line tool.

Note: If the process terminates with the message "Error: This IPA is encrypted", an additional step w be required to decrypt the binary using a Jailbroken device and an app such as Clutch.

2 Binary instrumentation

At this point it should be possible to modify IPA files, before being deployed, in order to insert new resources as libraries. For this purpose Frida (http://www.frida.re/ (http://www.frida.re/)) will be usec instrument the binary and analyse the application.

Frida, as described by its documentation, "*is a dynamic code instrumentation toolkit. It lets you inje snippets of JavaScript into native apps on Windows, Mac, Linux, iOS and Android. Frida also provid you with some simple tools built on top of the Frida API. These can be used as-is, tweaked to your needs, or serve as examples of how to use the API*".

Frida provides a dynamic library called "*FridaGadget.dylib*" that can be used to instrument newly developed applications on a non-jailbroken device. To do so, it is necessary to insert the library as a new project's resource of the application. Additionally, it is also possible to use this library with an existing compiled application, which is our current scenario, just by modifying the binary and inserti new load command.

Before continuing, it is necessary to have at least a small understanding of the binary structure of ai iOS application. iOS applications use a binary format called Mach-O, short for Match Object file forı which is a substitute to the a.out (assembler output) file format. Mach-O is used by most systems based on the Mach kernel, such as macOS (previously known as OSX) and iOS.

The Mach-O (iOS binary format) binary structure is divided into several sections. The header contaiı general information about the binary: byte order (magic number), CPU type, amount of load commands, etc. The load commands section is like a table of contents of the binary: it describes th position of the segments, symbols table, dynamic symbols table etc. Each load command includes meta-information, such as type of command, its name, position in a binary, etc. The data section contains the application code and the data, such as symbol tables, dynamic symbol tables, etc.

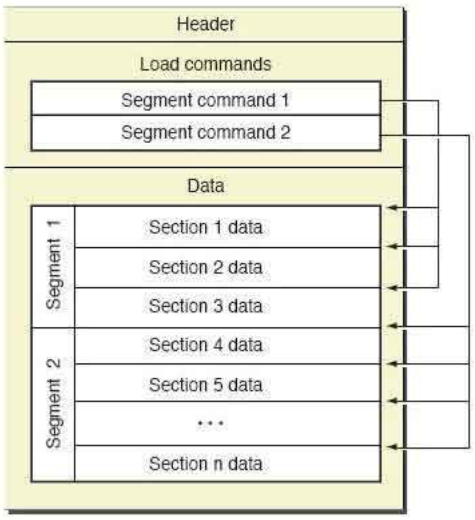


Figure 7 - Screenshot showing the Match-O structure

The process to insert a new library involves multiple steps:

1. Insert the library to the application container

2. Insert the load command on the load commands section of the binary

3. Increment the load command counter on the header section

4. Increase the size binary number on the header section

Again, in order to speed up and facilitate this process, a tool called **insert_dylib** (https://github.com/Tyilo/insert_dylib (https://github.com/Tyilo/insert_dylib)) will be used. First, clone download the repository, open it with Xcode, and compile the tool. Now that the environment and th tools have been prepared and configured, it is possible to start instrumentation of the binary.

The following steps need to be completed in order to start the instrumentation:

1. Decompress the IPA file and copy inside the application container (at the same level as the binar the *FridaGadget.dylib* file:

```
$ cd Payload/Test.app/

$ curl -O https://build.frida.re/frida/ios/lib/FridaGadget.dylib
```

2. Modify the binary to insert the load command with the *insert_dylib* tool. It is necessary to specify strip-codesign option to ensure the re-signing process works fine later on:

```
$ ./insert_dylib --strip-codesig --inplace  @executable_path/FridaGadget.dylib

Payload/Test.app/Test
```

3. Re-sign the IPA file. This will require compressing the “*Payload*” folder into an IPA file, and then u the *ipa-resign* tool, as explained before.

4. Due to a feature of the *ios-deploy* tool, it is necessary to decompress the IPA file again, otherwise we deploy the IPA file instead, the application container will throw a signature error.

5. Now the application can be deployed using *ios-deploy* in debugging mode. The application must executed in debugging mode as we will execute unsigned by Apple.

```
$ ios-deploy  --bundle Payload/Test.app --id

92c8551cb5486d13d35140a597318cb3a3926807 -d
```

6. Once the application is started, the dynamic library starts the Frida server. Wait until the Frida ser starts messaging on the debugging console.

7. Once the Frida server is listening on the device, it is possible to start interacting with the process using the Frida toolbox. The first step is to verify if the gadget was deployed correctly using, for example, *frida-ps*.

```
$ frida-ps -Uai
```

8. At this point the *FridaGadget* is waiting for an input, which allows for instrumentation. Due to a problem with the non-jailbroken devices, it is necessary to spawn a new process and apply the instrumentation on this new process, instead of applying it on the original. For this guide, we will us the scripts available on the project frida-scripts (https://github.com/as0ler/frida-scripts (https://github.com/as0ler/frida-scripts)) that allows the tracking of known functions. If we want, we could develop our own scripts, instrumenting concrete functions.

```
$ python frida-scripts/hooker.py -S re.frida.Gadget
```

9. After this, the execution of the application can be resumed. To do so, use the *frida* command, wh allow us to interact with the Frida server.

```
$ frida -U -f re.frida.Gadget

      [USB::iPhone::[re.frida.Gadget]] -> %resume
```

Once all the steps have been completed, it should be possible to see, on the hooker.py output messages, the calls to the tracked APIs and the arguments sent to the functions.

I hope you enjoyed the post. In terms of future work I am currently working on a tool/script that will facilitate the entire process.

I would like to thank Sergi Martinez (@zlowram) for inspiring me on this technique.

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Written by: Adrian Villa

(https://twitter.com/share)

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