Securing Fixed and Wireless Networks

COMP4337/COMP9337

Lab #3

MITM Attack and Evil Twin AP

Use eng.cse.COMP4337@unsw.edu.au and WebCMS3 forum for all lab related communications

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Learning Objectives:

In this lab the students will learn:

1) How to exploit the vulnerability which allows an unauthenticated, adjacent attacker to terminate a valid user connection at layer 2
2) Hijacking the user at layer 3
3) Launching MiTM attack by
   a) Exploiting no encryption vulnerability
   b) Exploiting the vulnerability where the client accepts certificates from an untrustworthy certificate authority.

Overview:

This lab has two parts:

- **Part A**: MITM Attack on HTTP and HTTPS Traffic *[Lab 3 Assessment 1]*
- **Part B**: Evil Twin AP *[Lab 3 Assessment 2]*

During the lab:

1) Getting Started: We will be using Kali Linux VMWare images installed on lab machines.
   a) To run Kali Linux, open a terminal, type "vm", it will show you a list of VMs. Please choose the number for Comp4337
   b) Login with user "root", password "toor"
2) Each group is provided:
   a) An ALFA wireless adapter which will be connected to your Kali Linux through a USB port on your laptop.
   b) "Attendance sheet", to be signed and returned to the tutor.
   c) "Lab Assessment 1" and "Lab Assessment 2" will be available on Moodle.
3) **In the Assessments you need to provide the commands you use in the lab. So, keep them. "history" command in terminal might come to help.**

At the end of the lab:

1) Make sure you have returned "Attendance sheet", mentioning the Group and student Names and zID.
2) Students have 48 hours to complete Lab Assessment 1 & 2.

Marking of the labs

1) Labs are marked by lab tutors. The marks are submitted on Moodle and will be made available within 2 weeks of the lab date.
2) Breakdown:
   a) Total mark for Lab 3 is 100. This lab combined with marks for other labs will be scaled to 20 out of 100.
      1. Part A: Lab Performance (25)
      2. Part B: Lab Assessment 1, submission on Moodle (50)
      3. Part B: Lab Assessment 2, submission on Moodle (25)
   b) Students who do not attend the lab will lose ALL 100 marks for it.

Important:
Lab performance involves tutor asking question, feedback, and comment about the activity while the lab is in progress. Hence, if a group is found to be cheating or submitting a work that does not match what the tutor observes of the team performance, then NO MARK will be awarded for Part A.

Part A – MITM Attack on HTTP and HTTPS Traffic [Lab 3 Assessment 1]

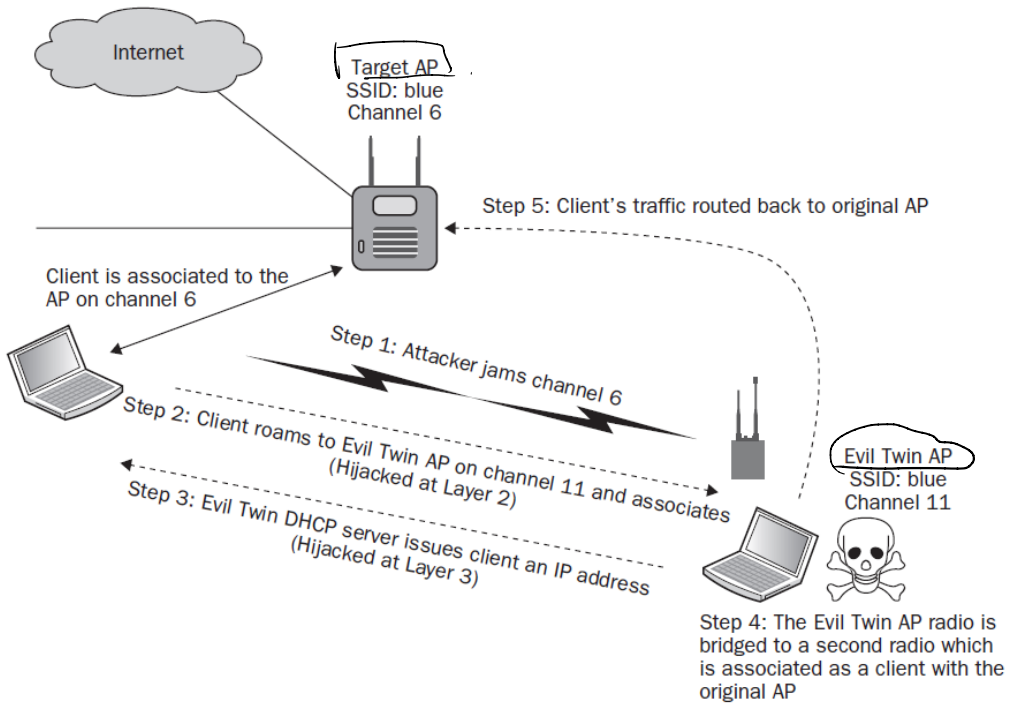


Figure 1: Wireless Hijacking/MITM Attack (Source: CWSP Book, Page: 318)

1. Prior to the attack the attacker configures access point on his laptop with client-card, with the same SSID as that of the Target AP ("blue" in above example). This way attacker's access point is now functioning as an evil twin AP of the Target AP.
   - Note that, the evil twin will be transmitting on a different channel than the public hotspot. (Channel 11 vs Channel 6 in above example)
2. **(Step 2)** In order to force clients to leave the Target AP and join this new evil twin, attacker then sends spoofed disassociation or de-authentication frames, forcing client stations associated with the Target AP to roam to the evil twin access point
   - The attacker has hijacked the client stations at Layer 2. 理解
   - Also note that, although de-authentication frames are usually used as one way to start a hijacking attack, **(Step 1)** RF jammers can also be used to force any clients to roam to an evil twin AP RF Jammer是另外一种攻击方式.
3. **(Step 3)** The evil twin AP will typically be configured with a Dynamic Host Configuration Protocol (DHCP) server available to issue IP addresses to the clients. Evil-twin从DHCP那里得到了IP地址.
   - The attacker has hijacked the client stations at Layer 3.
   - The user's computer could, during the process of connecting to the evil twin, fall victim to the DHCP attack (An attack that exploits the DHCP process to dump root kits or other malware onto the victim's computer in addition to giving them an IP address)
4. **(Step 4)** The attacker may also be using a second wireless card with their laptop to execute what is known as a man-in-the-middle attack, as shown in Figure 1.

因为现在user连上的是evil twin的AP. 3
只能通过该AP来向DHCP发送请求.
所以 evil twin AP 也可以借助(DHCP process)来 dump root kits or malware.

What is de-authentication attack:

The deauthentication (deauth) attack

Deauthentication frames fall under the category of the management frames. When a client wishes to disconnect from the AP, the client sends the deauthentication frame. The AP also sends the deauthentication frame in the form of a reply. This is the normal process, but an attacker can take advantage of this process.

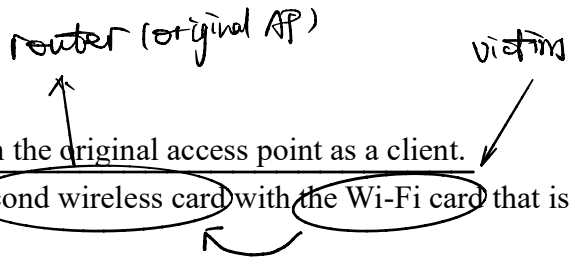
The attacker can spoof the MAC address of the victim and send the deauth frame to the AP on behalf of the victim; because of this, the connection to the client is dropped. The `aireplay-ng` program is the best tool to accomplish a deauth attack.

Toolsets [edit]

Aircrack-ng suite, MDK3, Void11, Scapy, and Zulu software can mount a WiFi deauthentication attack.[10] Aireplay-ng, an aircrack-ng suite tool, can run a deauthentication attack by executing a one-line command:

```
aireplay-ng -0 1 -a xx:xx:xx:xx:xx:xx -c yy:yy:yy:yy:yy:yy wlan0
```

1. `-0` arms deauthentication attack mode
2. `1` is the number of deauths to send; use 0 for infinite deauths
3. `-a xx:xx:xx:xx:xx:xx` is the AP (access point) MAC (Media Access Control) address
4. `-c yy:yy:yy:yy:yy:yy` is the target client MAC address; omit to deauthenticate all clients on AP
5. `wlan0` is the NIC (Network Interface Card)



- The second WLAN card is associated with the original access point as a client.
- The attacker has bridged together their second wireless card with the Wi-Fi card that is being used as the evil twin access point.

5. **(Step 5)** The traffic from the client is now routed from the evil twin access point through the second Wi-Fi card, right back to the original access point from which the users have just been hijacked.
   - The result is that the users remain hijacked; however, they still have a route back through the gateway to their original network, so they never know they have been hijacked.

The attacker can therefore sit in the middle and execute peer-to-peer attacks indefinitely while remaining completely unnoticed.

Mimproxy Overview:

Here is our network topology:

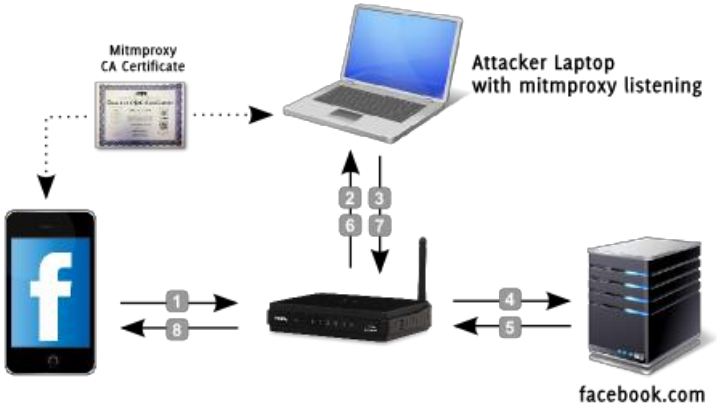


Figure 2: Our Network Topology

Mitmproxy is an open source proxy application that allows intercepting HTTP and HTTPS connections between any HTTP(S) client (such as a mobile or desktop browser) and a web server using a typical man-in-the-middle attack (MITM). Like other proxies (such as Squid), it accepts connections from clients and forwards them to the destination server. However, while other proxies typically focus on content filtering or speed optimization through caching, the goal of mitmproxy is to let an attacker monitor, capture and alter these connections in real-time.

1. HTTP Connection: For unencrypted HTTP connections, this is quite simple: mitmproxy accepts a connection from the HTTP client, say a mobile browser, displays the request to the attacker on the screen, and forwards the request to the destination web server as soon as the attacker confirms — maybe after adjusting the request payload a bit. mitmproxy simply acts as a middle man:
   - To the client, it looks like as if the mitmproxy server was simply relaying its connection (like your router or your ISP's servers do).
   - To the server, it looks like the mitmproxy server is the client.
2. HTTPS Connection: Unlike unencrypted HTTP traffic, here the transferred data is encrypted with a shared secret, a middle man (or a proxy) cannot decipher the exchanged data packets. When the client opens an SSL/TLS connection to the secure web server, it verifies the server's identity by checking two conditions:
   1. Trusted CA: it checks whether its certificate was signed by a CA known to the client
   2. Same CA: it makes sure that the common name (CN, also: host name) of the server matches the one it connects to.

If both conditions are true, the client assumes the connection is secure.

In order to be able to sniff into the connection, mitmproxy acts as a certificate authority (not a trustworthy one though). Instead of issuing certificates to actual persons or organizations, mitmproxy dynamically generates certificates to whatever hostname is needed for a connection.

- For example, if a client wants to connect to https://www.facebook.com, mitmproxy generates a certificate for "www.facebook.com" and signs it with its own CA.
- Provided that the client trusts this CA, both of the above-mentioned conditions are true (Trusted CA, same CN) — meaning that the client believes that the mitmproxy server is in fact "www.facebook.com". Figure 2 shows the request/response flow for this scenario.

For this attack to work, there are a few conditions that must be met:

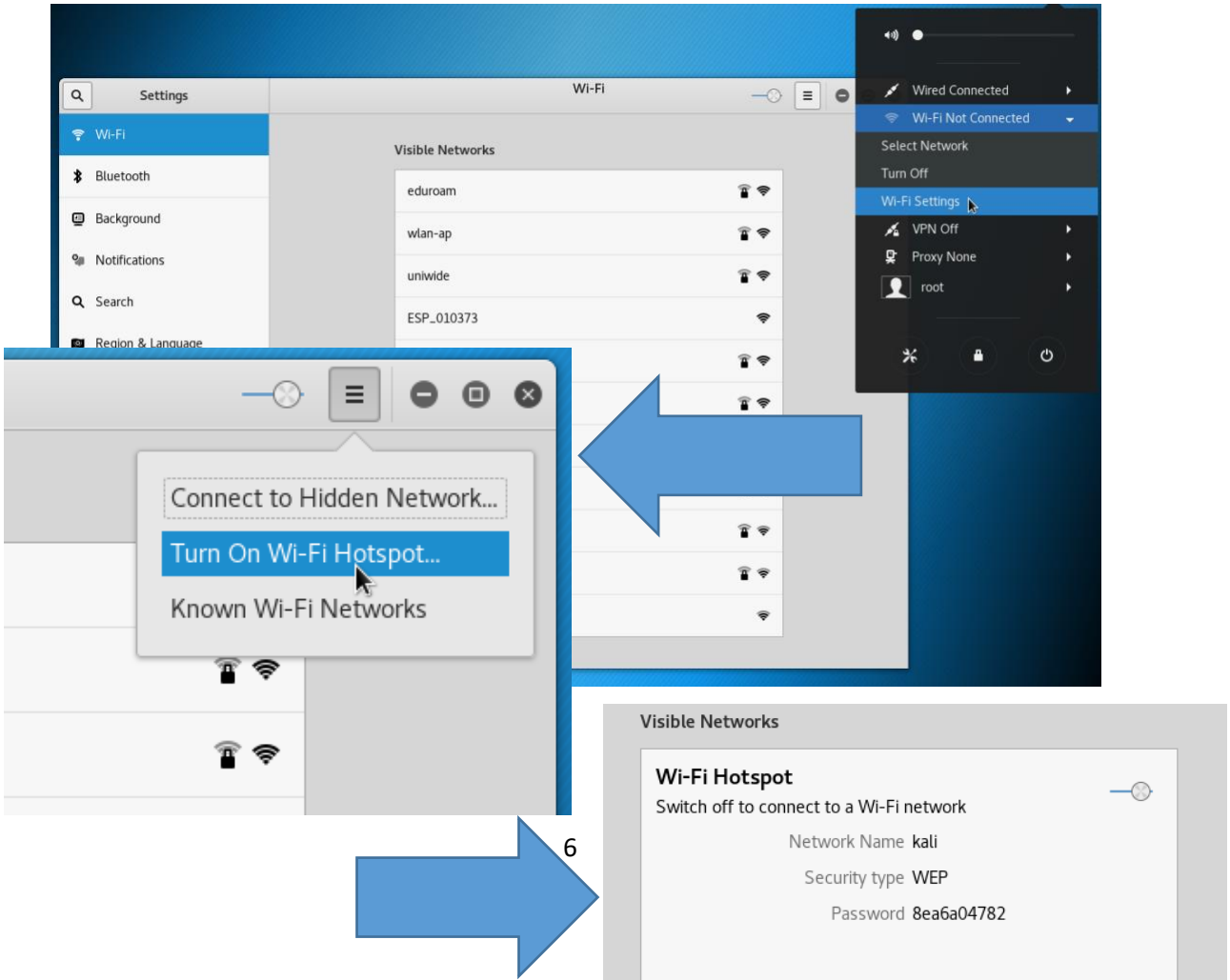
- **Mitmproxy as standard gateway (HTTP and HTTPS)**: For both HTTP and HTTPS proxying, the server running mitmproxy must be able to intercept the IP packets — meaning that it must be somewhere along the way of the packet path. The easiest way to achieve this is to change the default gateway in the client device to the mitmproxy server address.
- **Trusted mitmproxy CA (HTTPS only)**: For the HTTPS proxying to work, the client must know (and trust!) the mitmproxy CA, i.e. the CA key file must be added to the trust store of the client.

Tools we will be using for this lab:

1. Kali Linux on CSE Machines,
    a. Mitmproxy (included in Kali),
    b. ALFA wireless device,
2. Your own Laptop/Andorid/iOS device.

Step 1: Quickest way to setup WiFi access point on Kali is through visual interface of Network Manager.

Plug-in your ALFA device and then "Turn on Wi-Fi Hotspot" (see below on how to do this).



What is Gateway:

A gateway is a node (router) in a computer network, a key *stopping point* for data on its way to or from other networks. Thanks to gateways, we are able to communicate and send data back and forth. The Internet wouldn't be any use to us without gateways (as well as a lot of other hardware and software).

In a workplace, the gateway is the computer that routes traffic from a workstation to the outside network that is serving up the Web pages. For basic Internet connections at home, the gateway is the Internet Service Provider that gives you access to the entire Internet.

A node is simply a physical place where the data stops for either transporting or reading/using. (A computer or modem is a node; a computer cable isn't.) Here are a few node notes:

- On the Internet, the node that's a stopping point can be a gateway or a host node.
- A computer that controls the traffic your Internet Service Provider (ISP) receives is a node.

If you have a wireless network at home that gives your entire family access to the Internet, your gateway is the modem (or modem-router combo) your ISP provides so you can connect to their network. On the other end, the computer that controls all of the data traffic your Internet Service Provider (ISP) takes and sends out is itself a node.

When a computer-server acts as a gateway, it also operates as a firewall and a proxy server. A firewall keeps out unwanted traffic and outsiders off a private network. A proxy server is software that "sits" between programs on your computer that you use (such as a Web browser) and a computer server—the computer that serves your network. The proxy server's task is to make sure the real server can handle your online data requests.

Step 2: **Transparent proxy-ing:** When a transparent proxy is used, traffic is redirected into a proxy at the network layer, without any client configuration being required. This makes transparent proxy-ing ideal for those situations where you can't change client behaviour - proxy-oblivious mobile applications being a common example.

To set up transparent proxy-ing, we need two new components. The first is a redirection mechanism that transparently reroutes a TCP connection destined for a server on the Internet to a listening proxy server. This usually takes the form of a firewall on the same host as the proxy server - iptables on Linux. When the proxy receives a redirected connection, it sees a vanilla HTTP request, without a host specification. This is where the second new component comes in - a host module that allows us to query the redirector for the original destination of the TCP connection.

```
root@kali:~# sysctl -w net.ipv4.ip_forward=1

root@kali:~# iptables -t nat -A PREROUTING -i wlan0 -p tcp -
-dport 80 -j REDIRECT --to-port 8080

root@kali:~# iptables -t nat -A PREROUTING -i wlan0 -p tcp -
-dport 443 -j REDIRECT --to-port 8080
```

Step 3: **Run mitmproxy**. It has been added as a standard tool to Kali recently so no need for installation.

```
root@kali:~# mitmproxy -T --host
```

(For newer versions use *mitmproxy --mode transparent --showhost*) Keep the terminal window open and do not close it.

Step 4: Connect to the hotspot you have created using your Andorid/iOS device. Browse the following page using a browser (Google Chrome is suggested):

http://www.testyou.in/Login.aspx

Try to login using the you group name as username and "kali" as password. (Don't be upset if you are not able to login :-))

Step 5: Return to Kali and revisit mitmproxy terminal window. (You'll see a list of http messages). Type "?" in the window and find the command to "set interception pattern". Use the relevant command and set "testyou" as the "intercept filter". Press 'q' to return back. Browse through the POST and GET commands. Press ENTER to view in detail and press 'q' to return back to the list. Try to find the POST command containing the username and password you have provided.

**** Important: Assessment point ****

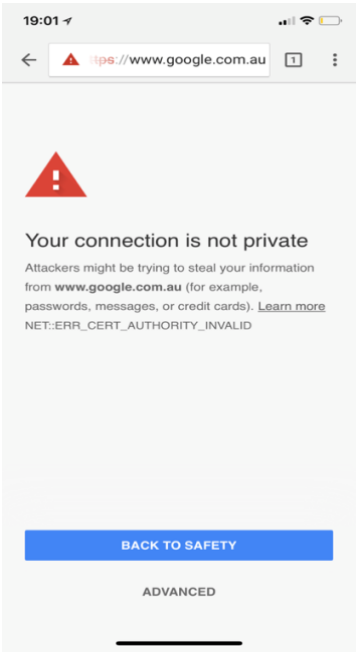
Raise your hand for the attention of you tutor who will come and verify that you have correctly located the username and password exchanged using HTTP.

**** Important: Assessment point ****

Step 6: Try to access the following page using a browser on your Andorid/iOS device.

https://www.google.com

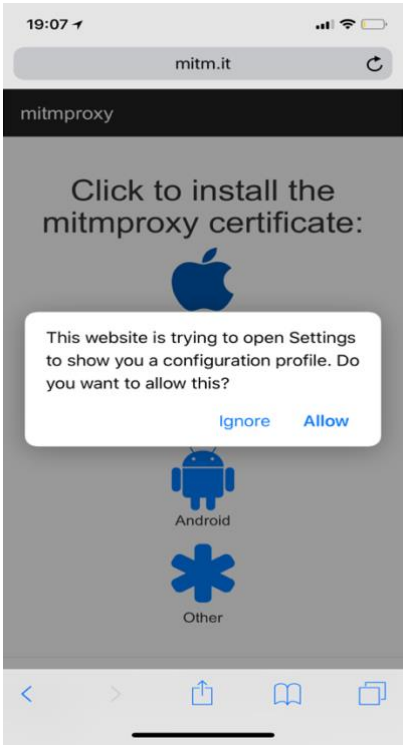
You should see an error like this or something similar to this.

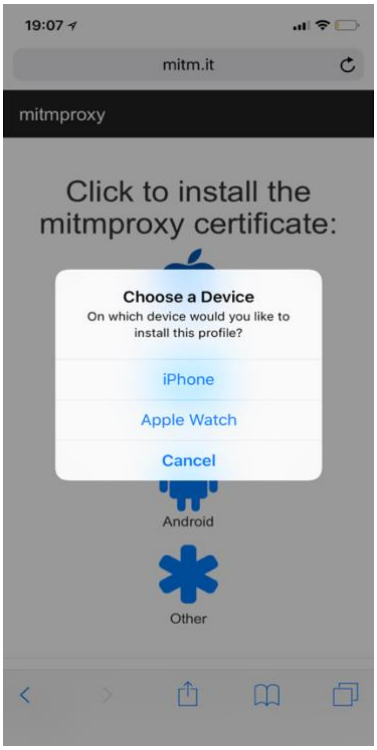


Step 7a: To fix this issue, do the following. On your browser (if iOS use Safari) and browse the following link (please note that for newer iOS versions this might not help, in that case move to Step 7b):

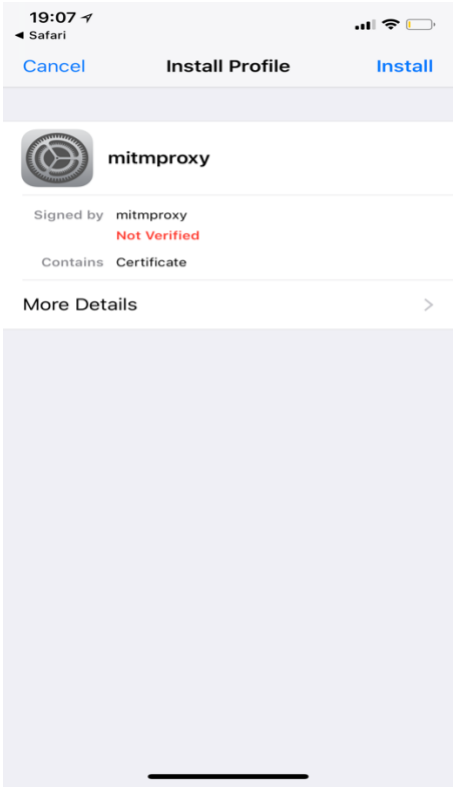
`mitm.it`

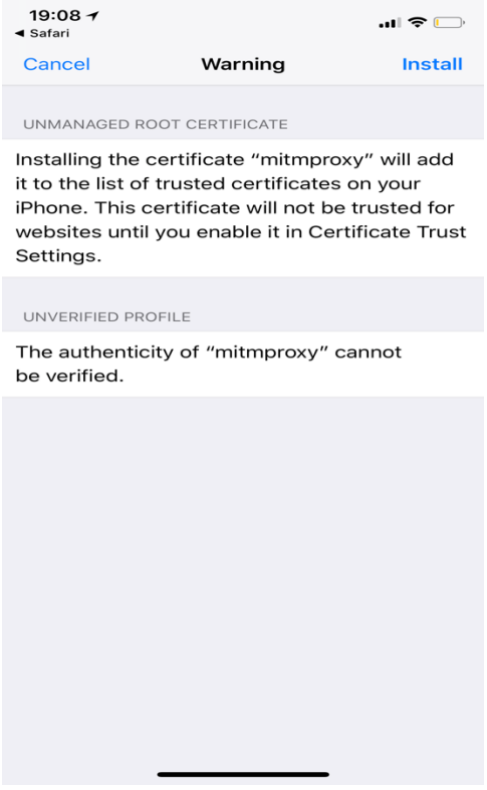
Download the mitm certificate matching your device operating system. Here, we assume you are using an iOS device. The process is very similar for Android.



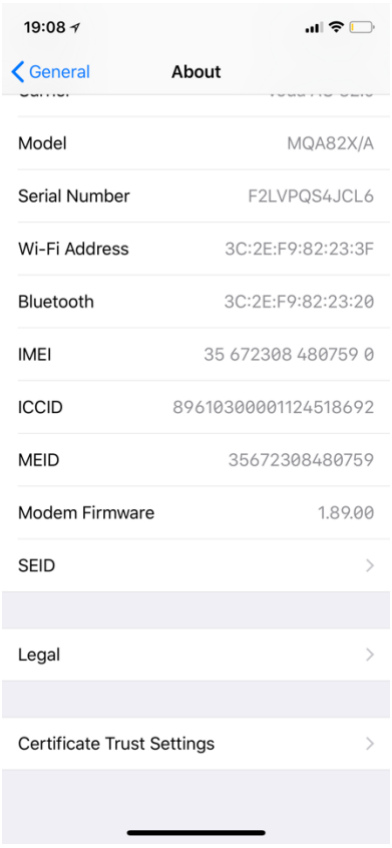


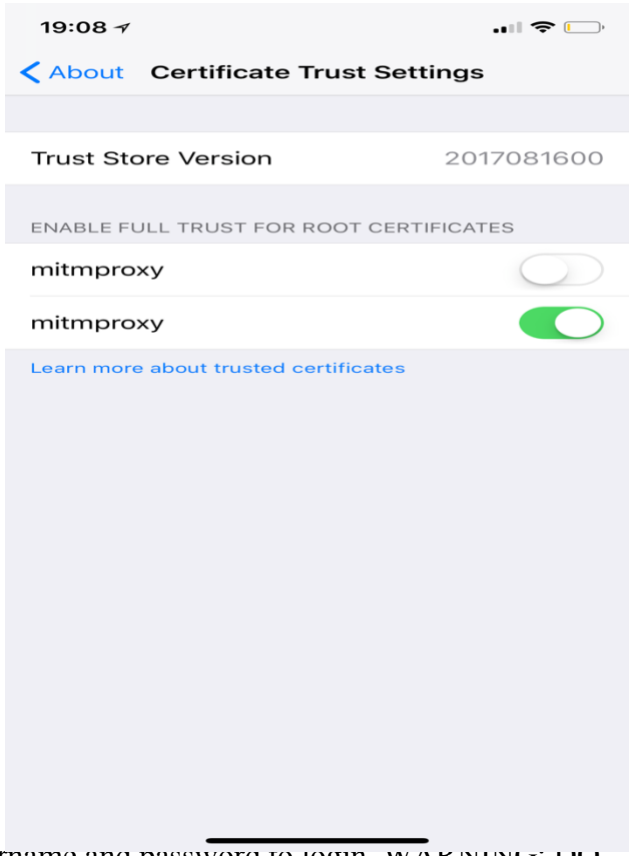
If you have an Apple Watch then the third image may show as well. Please choose iPhone and proceed. Click on “Install” twice.





You need to trust the certificate for websites you will be browsing. Go to "Settings">"General">"About">"Certificate Trust Settings". Find "mitmproxy" and change its status to green to enable it.





Browse to Facebook.com and enter fake username and password to login. WARNING: DO NOT ENTER YOUR REAL USERNAME and PASSWORD for Facebook.

Step 7b: If you are able to install certificate and open login page of facebook please move to Step 8. The browsers in new iOS versions do not allow to install mitmproxy certificates. To work around we can try to log in to facebook without using a browser. If

working from a desktop/laptop computer, you can try the following command in terminal. WARNING: DO NOT ENTER YOUR REAL USERNAME and PASSWORD for Facebook.

```
wget "https://www.facebook.com/login.php?login_attempt=1" --
post-data "email=<your_lab_group_name>&pass=<some_password>"
--no-check-certificate --keep-session-cookies --save-
cookies=cookies --load-cookies=cookies -U "Mozilla/5.0
(Windows NT 5.2; rv:2.0.1) Gecko/20100101 Firefox/4.0.1" -S
```

If connected via your phone, you can use some app that provides shell. Use this link to install shell on iphone https://osxdaily.com/2018/12/11/ish-linux-shell-ios/

Step 8: Return to Kali and revisit mitmproxy terminal window. Type "?" in the window and find the command to "set interception pattern". Use the relevant command and set "facebook" as the "intercept filter". Browse through the POST and GET commands and find the POST command containing the username and password you have provided.

**** Important: Assessment point ****

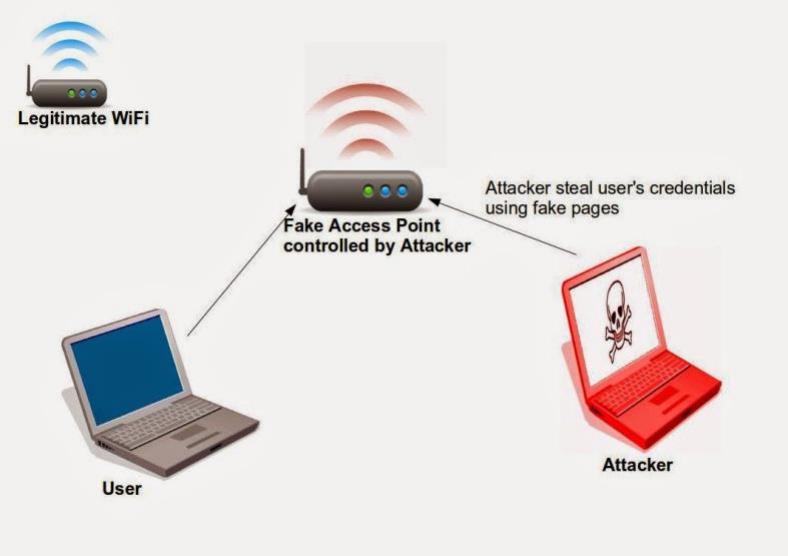
Raise your hand for the attention of you tutor who will come and verify that you have correctly located the username and password exchanged using HTTPS.

**** Important: Assessment point ****

You just extracted username and passwords exchanged over an HTTPS connection ;-)

Now, please go to "Lab Assessment 1" on Moodle and answer the questions.

Part 2– Evil Twin Attack [Lab 3 Assessment 2]



In Part A, we used a hotspot as our AP. As you may have noticed this is easily noticeable as not being an actual AP and is hard to convince our target to connect to it. So, in Part 2 your task is to find a way to setup your very own AP. This AP must route the user traffic to Internet so the target would not notice connection to fake AP.

AP name: Starbucks
Channel: 2
Encryption: None

You will also need to disconnect clients connected to the real "Starbucks" AP so on reconnect they associate to your Evil Twin AP.

You will be required to provide all commands used to setup this working Evil Twin AP as part of one of the "Lab 3 Assessment 2" questions on Moodle.

Acknowledgements & Version History:
This lab was originally developed by Arash Shaghaghi, PhD Candidate at CySPri Lab of UNSW Sydney in 2015. It has undergone major refinement in 2018 by Arash Shaghaghi. It has benefited from revision and improvements by other CySPRi Lab students including Chitra Javali, Girish Revadigar and Mohsen Rezvani.

Content in Part A has been extracted from the following sources:
- CWSP – Certified Wireless Security Professional Official Study Guide
- https://blog.heckel.xyz/2013/07/01/how-to-use-mitmproxy-to-read-and-modify-https-traffic-of-your-phone/
- https://www.trustwave.com/Resources/SpiderLabs-Blog/Intercepting-SSL-And-HTTPS-Traffic-With-mitmproxy-and-SSLsplit/
- https://docs.mitmproxy.org/stable/howto-transparent/

Document Version is 1.0.