TrustFLEX Step by Step Guide IP/Firmware Protection

Table of Contents

1 Introduction

This document gives a detailed walk through of the IP Protection use case implementation. If familiar with Jupyter Notebook, can skip this section and move to Section 2.

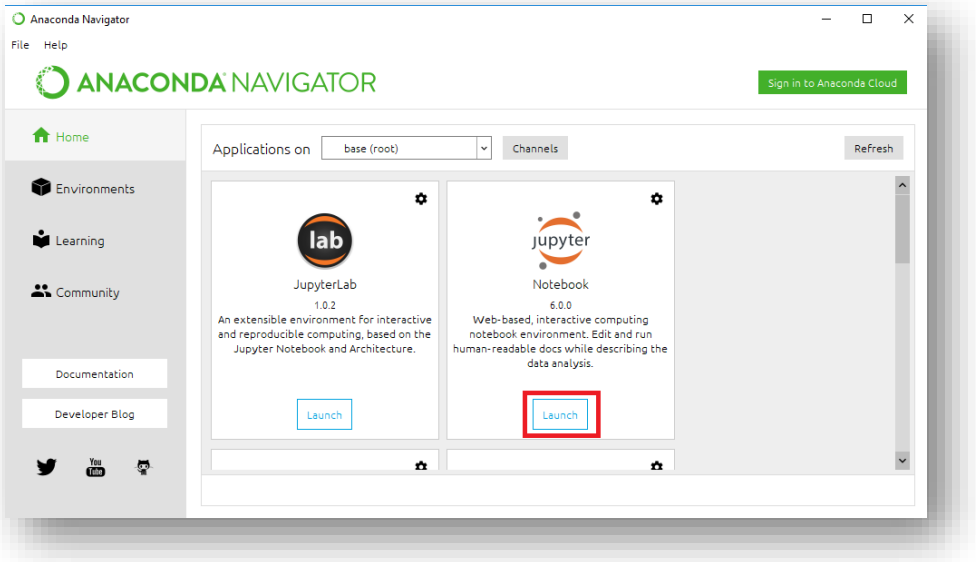
1.1 Getting started with Jupyter Notebook Tutorials

Jupyter Notebook is open source web application which allows you to create documents that contain code that you can execute in place as well as narrative text. It provides GUI elements, ability to execute code in place, ability to add images and gives it the look and feel that normal code files lack.

Jupyter notebooks are mainly used to explain/evaluate code in an interactive way.

1.1.1 Starting Jupyter Notebook

Jupyter notebook can be launched from the Anaconda Navigator main window.



1.2 Jupyter Notebook Basics

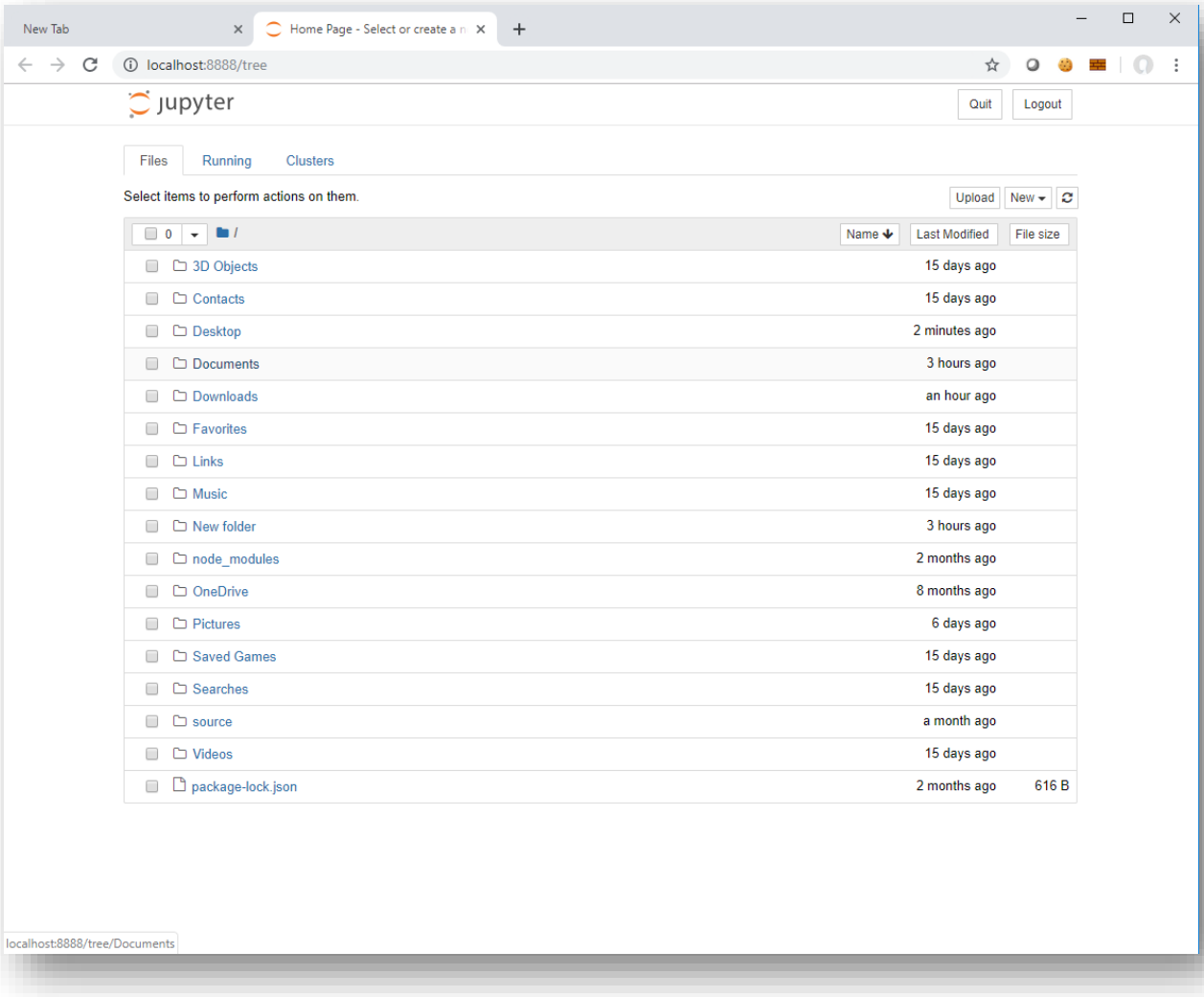
It is recommended to become familiar with Jupyter basic concepts with the online documentation, https://jupyter-notebook.readthedocs.io/en/stable/examples/Notebook/Notebook%20Basics.html

Some of the content is duplicated here for convenience. The online documentation should always be used as a reference.

1.2.1 The Notebook dashboard

When you first start the notebook server, your browser will open to the notebook dashboard. The dashboard serves as a home page for the notebook. Its main purpose is to display the notebooks and files in the current directory.

For example, here is a screenshot of the Jupyter dashboard. The top of the notebook list displays clickable breadcrumbs of the current directory. By clicking on these breadcrumbs or on sub-directories in the notebook list, you can navigate your file system.

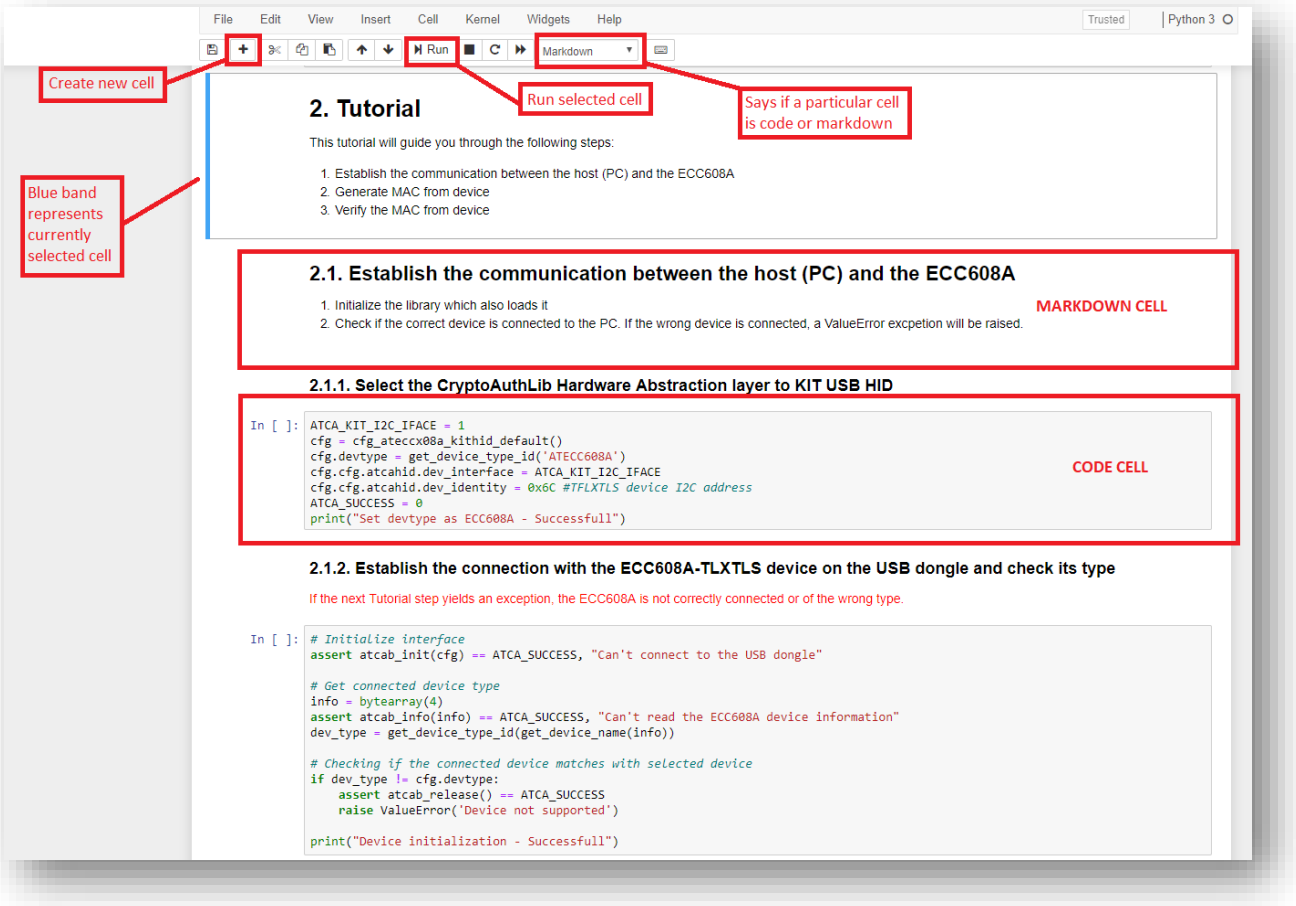


1.3 Introduction to Jupyter Notebook GUI.

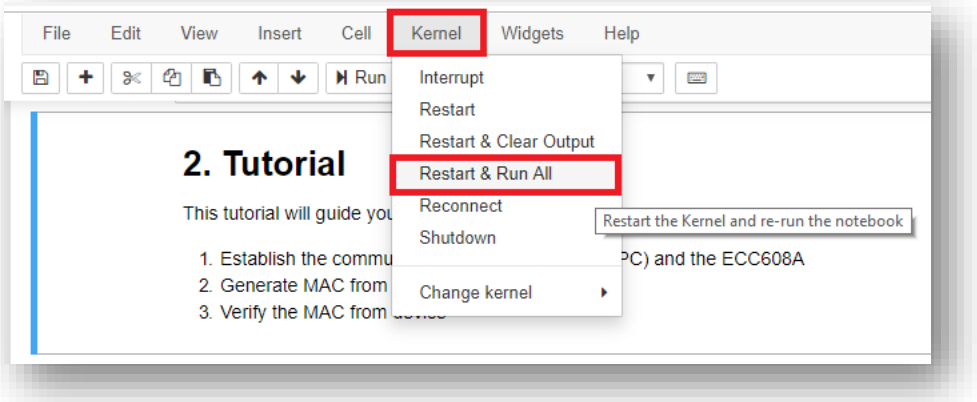
Jupyter Notebooks contain cells where you can either write code or markdown text. Notebooks contain multiple cells, some set as code and others markdown. Code cells contain code that can be executed live, and markdown contains text and images to explain the code.

Below image shows some options in a typical Jupyter Notebook. Individual cells can be executed by pressing on the RUN button as shown in the below image.

All cells in the Notebook can be executed in order by **Kernel->Restart & Run All**.



To run all cells in sequence.



2 Jupyter Notebook Tutorials

The TrustPlatform Design Suite comes with a Notebook Tutorials to easily prototype popular use cases for TrustFLEX devices. Here is the Jupyter Notebook Tutorials.

Jupyter Notebook Tutorials	**Relative Path**	**Applicable Devices**
Manifest Generation	TrustnGO\00_resource_generation\TNGTLS_manifest_file_generation.ipynb	TrustnGO
Resource Generation	TrustFLEX\00_resource_generation\TFLXTLS_resource_generator.ipynb	TrustFLEX
Accessory Authentication	TrustFLEX\01_accessory_authentication\notebook\ TFLXTLS_accessory_authentication.ipynb	TrustFLEX
Firmware Validation	TrustFLEX\02_firmware_validation\notebook\ TFLXTLS_firmware_validation.ipynb	TrustFLEX
GCP Connect	TrustFLEX\03_gcp_connect\notebook\TFLXTLS_GCP_connect.ipynb	TrustFLEX
IP Protection	TrustFLEX\04_ip_protection\notebook\ TFLXTLS_IP_protection.ipynb	TrustFLEX
Secure Public Key Rotation	TrustFLEX\05_public_key_rotation\notebook\ TFLXTLS_public_key_rotation.ipynb	TrustFLEX
AWS Custom PKI	TrustFLEX\06_custom_pki_aws\notebook\ TFLXTLS_aws_connect.ipynb	TrustFLEX
Azure Connect	TrustFLEX\07_custom_pki_azure\notebook\ TLFXTLS_azure_connect.ipynb	TrustFLEX

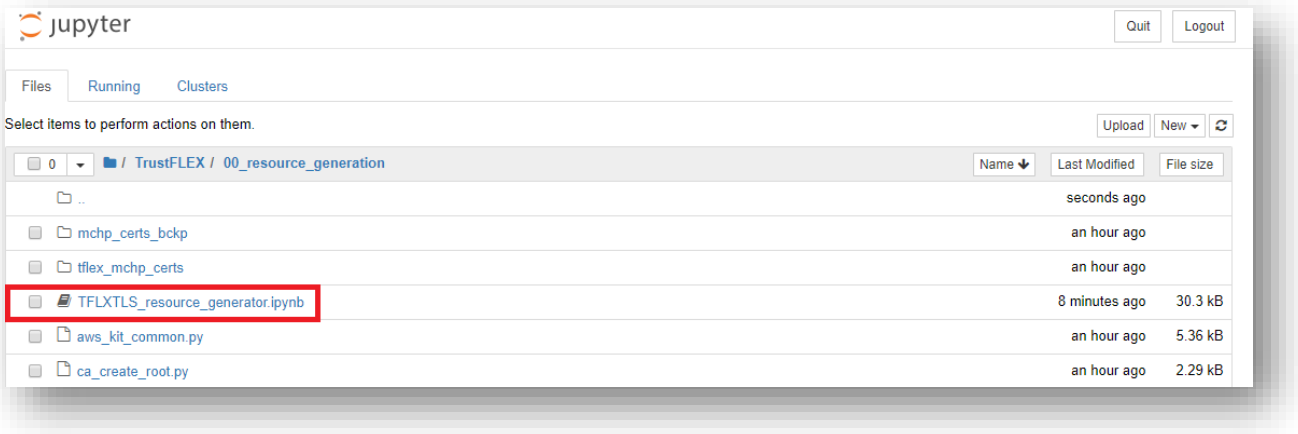
3 Resource Generation Notebook

TFLXTLS device is one of the three devices available in the Trust Platform USB Dongle Board.

TrustFLEX devices come with pre-programmed certificates in slots 10, 11 and 12, also slots 0-4 have pre-generated private keys, other than the mentioned slots all the other slots have no data in them.

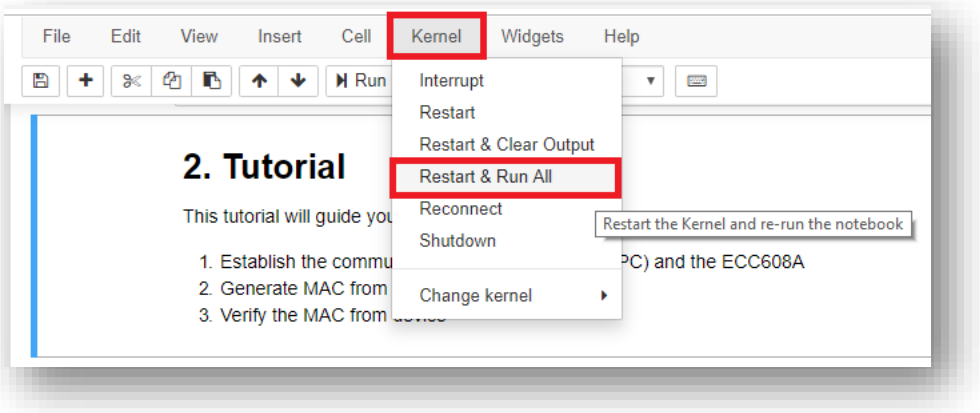
The Resource Generator Notebook will create development keys and certificates for all slots that can be further customized. Keys and Certificate chains are stored in the PC filesystem. These keys should never be used for production purposes as their generation is not handled in a secure environment. These development keys will be later used by the other notebooks to implement the various pre-defined use cases.

Within the Jupyter Dashboard, navigate **TrustFLEX\00_resource_generation** folder to open **TFLXTLS_resource_generator.ipynb** notebook



Run all cells of the Crypto Resource Generator Notebook: Kernel->Restart & Run All

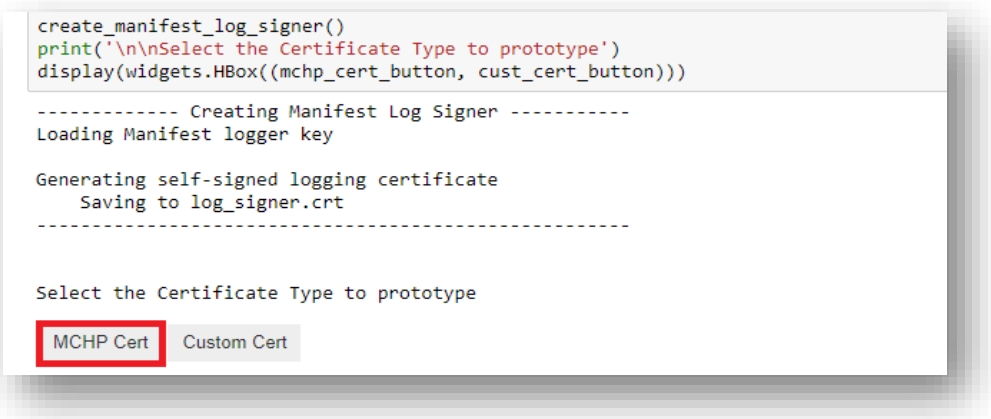
Note: Before executing the cells on Crypto Trust Platform, its required to have factory default program running on SAMD21 of Trust Platform. Refer to 4.3 CryptoAuth TrustPlatform Factory reset section for reloading default program.



Crypto Resource Generator notebook is common for all the use case which comes with option to load the signer certificate and device certificate.

So it will execute and prompt you to choose between MCHP certificate and a custom certificate chain, press "MCHP Cert" option for this use case.

The Notebook will generate several keys and certificates. Make sure you have an error free output before continuing to the next steps of the training.



The output log should look like this.

```
----------------------------------------
MCHP Certs processing...
MCHP certificates found in the device

Backing up certificates from device

Backing up certificates from device - Success

-----------------------------------------------------
Root Certificate:
Certificate:
   Data:
      Version: 3 (0x2)
      Serial Number:
         77:d3:6d:95:6e:c8:ae:62:05:e5:8e:3a:cb:98:5a:81
      Signature Algorithm: ecdsa-with-SHA256
      Issuer: O = Microchip Technology Inc, CN = Crypto Authentication Root CA 002
      Validity
         Not Before: Nov  8 19:12:19 2018 GMT
         Not After : Nov  8 19:12:19 2058 GMT
      Subject: O = Microchip Technology Inc, CN = Crypto Authentication Root CA 002
      Subject Public Key Info:
         Public Key Algorithm: id-ecPublicKey
            Public-Key: (256 bit)
            pub:
               04:bd:54:e6:6d:e3:87:54:84:00:6b:53:ae:15:80:
               d5:0a:a0:69:e7:8a:df:55:78:d8:5c:e2:d5:4d:d5:
               b8:30:29:6b:ff:dd:6e:6f:72:56:fb:d9:9e:f1:a1:
               16:b1:1d:33:ad:49:10:3a:a1:85:87:39:dc:fa:e4:
               37:e1:9d:63:4e
            ASN1 OID: prime256v1
            NIST CURVE: P-256
      X509v3 extensions:
         X509v3 Subject Key Identifier:
            7A:ED:7D:6D:C6:B7:78:9D:B2:38:01:A5:E8:4A:8C:B0:A4:0E:2A:8C
         X509v3 Authority Key Identifier:
            keyid:7A:ED:7D:6D:C6:B7:78:9D:B2:38:01:A5:E8:4A:8C:B0:A4:0E:2A:8C

         X509v3 Basic Constraints: critical
            CA:TRUE
   Signature Algorithm: ecdsa-with-SHA256
       30:45:02:21:00:a1:dc:63:45:90:ec:81:9e:e1:de:5b:81:12:
       65:51:ad:d4:c2:c4:f8:e5:95:28:2e:e0:4b:e7:68:ec:7c:02:
       73:02:20:3e:6b:a7:4e:9e:4c:0a:d6:8c:24:b0:fb:2e:e7:93:
       d2:e6:be:94:65:ca:15:d0:ea:5b:c8:7f:55:79:99:5c:ad
-----BEGIN CERTIFICATE-----
MIIB8TCCAZegAwIBAgIQd9NtlW7IrmIF5Y46y5hagTAKBggqhkjOPQQDAjBPMSEw
HwYDVQQKDBhNaWNyb2NoaXAgVGVjaG5vbG9neSBJbmMxKjAoBgNVBAMMIUNyeXB0
byBBdXRoZW50aWNhdGlvbiBSb290IENBIDAwMjAgFw0xODExMDgxOTEyMTlaGA8y
MDU4MTEwODE5MTIxOVowTzEhMB8GA1UECgwYTWljcm9jaGlwIFRlY2hub2xvZ3kg
SW5jMSowKAYDVQQDDCFDcnlwdG8gQXV0aGVudGljYXRpb24gUm9vdCBDQSAwMDIw
```

```
WTATBgcqhkjOPQIBBggqhkjOPQMBBwNCAAS9VOZt44dUhABrU64VgNUKoGnnit9V
eNhc4tVN1bgwKWv/3W5vclb72Z7xoRaxHTOtSRA6oYWHOdz65DfhnWNOo1MwUTAd
BgNVHQ4EFgQUeu19bca3eJ2yOAGl6EqMsKQOKowwHwYDVR0jBBgwFoAUeu19bca3
eJ2yOAGl6EqMsKQOKowwDwYDVR0TAQH/BAUwAwEB/zAKBggqhkjOPQQDAgNIADBF
AiEAodxjRZDsgZ7h3luBEmVRrdTCxPjllSgu4EvnaOx8AnMCID5rp06eTArWjCSw
+y7nk9LmvpRlyhXQ6lvIf1V5mVyt
-----END CERTIFICATE-----

Validate Root Certificate:
OK

Signer Certificate:
Certificate:
    Data:
        Version: 3 (0x2)
        Serial Number:
            79:0a:a7:d5:7d:73:dc:e9:6d:65:db:66:8b:76:b2:5e
        Signature Algorithm: ecdsa-with-SHA256
        Issuer: O = Microchip Technology Inc, CN = Crypto Authentication Root CA 002
        Validity
            Not Before: Dec 14 19:00:00 2018 GMT
            Not After : Dec 14 19:00:00 2049 GMT
        Subject: O = Microchip Technology Inc, CN = Crypto Authentication Signer F600
        Subject Public Key Info:
            Public Key Algorithm: id-ecPublicKey
                Public-Key: (256 bit)
                pub:
                    04:76:47:41:70:b2:63:e7:99:54:bc:85:bb:12:e9:
                    fe:70:0c:5b:8d:d4:d6:93:45:98:c2:29:a7:68:02:
                    0e:4e:0b:6d:48:75:d0:ed:a1:ee:f6:5f:91:5f:c6:
                    b1:16:46:c5:a1:ca:63:1f:62:55:68:74:47:69:c5:
                    de:83:b5:89:6a
                ASN1 OID: prime256v1
                NIST CURVE: P-256
        X509v3 extensions:
            X509v3 Key Usage: critical
                Digital Signature, Certificate Sign, CRL Sign
            X509v3 Basic Constraints: critical
                CA:TRUE, pathlen:0
            X509v3 Subject Key Identifier:
                FB:DC:AA:12:8A:FA:C1:B5:92:8F:CD:AB:11:DB:09:3E:CF:4D:BE:F6
            X509v3 Authority Key Identifier:
                keyid:7A:ED:7D:6D:C6:B7:78:9D:B2:38:01:A5:E8:4A:8C:B0:A4:0E:2A:8C

    Signature Algorithm: ecdsa-with-SHA256
         30:46:02:21:00:c6:30:31:e9:a9:8b:30:4e:68:7e:06:c5:39:
         79:2a:c5:7a:5c:01:4d:30:17:de:dc:d2:7d:d5:1d:cd:86:37:
         ff:02:21:00:c6:a2:2c:6e:b1:ae:5f:85:91:49:cb:5d:e7:77:
         8b:a3:f3:0b:e9:3d:9b:80:6f:94:bf:3d:90:a5:84:78:61:dc
-----BEGIN CERTIFICATE-----
MIICBTCCAaqgAwIBAgIQeQqn1X1z3OltZdtmi3ayXjAKBggqhkjOPQQDAjBPMSEw
HwYDVQQKDBhNaWNyb2NoaXAgVGVjaG5vbG9neSBJbmMxKjAoBgNVBAMMIUNyeXB0
byBBdXRoZW50aWNhdGlvbiBSb290IENBIDAwMjAgFw0xODEyMTQxOTAwMDBaGA8y
```



```
MDQ5MTIxNDE5MDAwMFowTzEhMB8GA1UECgwYTWljcm9jaGlwIFRlY2hub2xvZ3kg
SW5jMSowKAYDVQQDDCFDcnlwdG8gQXV0aGVudGljYXRpb24gU2lnbmVyIEY2MDAw
WTATBgcqhkjOPQIBBggqhkjOPQMBBwNCAAR2R0FwsmPnmVS8hbsS6f5wDFuN1NaT
RZjCKadoAg5OC21IddDtoe72X5FfxrEWRsWhymMfYlVodEdpxd6DtYlqo2YwZDAO
BgNVHQ8BAf8EBAMCAYYwEgYDVR0TAQH/BAgwBgEB/wIBADAdBgNVHQ4EFgQU+9yq
Eor6wbWSj82rEdsJPs9NvvYwHwYDVR0jBBgwFoAUeu19bca3eJ2yOAGl6EqMsKQO
KowwCgYIKoZIzj0EAwIDSQAwRgIhAMYwMempizBOaH4GxTl5KsV6XAFNMBfe3NJ9
1R3Nhjf/AiEAxqIsbrGuX4WRSctd53eLo/ML6T2bgG+Uvz2QpYR4Ydw=
-----END CERTIFICATE-----

Validate Signer Certificate:
OK

Device Certificate:
Certificate:
   Data:
      Version: 3 (0x2)
      Serial Number:
         5a:cb:a3:f7:cf:bf:c5:28:92:cd:e1:9f:a3:ac:9d:17
      Signature Algorithm: ecdsa-with-SHA256
      Issuer: O = Microchip Technology Inc, CN = Crypto Authentication Signer F600
      Validity
         Not Before: Aug 21 22:00:00 2019 GMT
         Not After : Aug 21 22:00:00 2047 GMT
      Subject: O = Microchip Technology Inc, CN = 0123867D566FFB7701 ATECC
      Subject Public Key Info:
         Public Key Algorithm: id-ecPublicKey
            Public-Key: (256 bit)
            pub:
               04:fc:57:67:b6:fb:ae:50:60:ca:96:5a:ef:41:b1:
               c5:d6:a1:60:61:87:8e:a4:78:f4:4d:18:d0:76:9d:
               ad:62:24:b3:68:c2:1a:62:cb:0a:fd:ef:f5:b4:0c:
               e3:55:ec:f0:40:bb:41:83:61:02:ef:20:3c:63:93:
               32:d4:90:41:ab
            ASN1 OID: prime256v1
            NIST CURVE: P-256
      X509v3 extensions:
         X509v3 Basic Constraints: critical
            CA:FALSE
         X509v3 Key Usage: critical
            Digital Signature, Key Agreement
         X509v3 Subject Key Identifier:
            43:9E:4F:45:79:35:CE:DC:D4:35:B9:4F:4A:23:69:E1:2D:89:33:04
         X509v3 Authority Key Identifier:
            keyid:FB:DC:AA:12:8A:FA:C1:B5:92:8F:CD:AB:11:DB:09:3E:CF:4D:BE:F6

   Signature Algorithm: ecdsa-with-SHA256
       30:45:02:21:00:83:32:78:25:9c:5a:07:7c:4a:04:f8:b5:c4:
       57:d6:08:70:ee:c3:d4:79:9c:b6:14:8e:5e:86:54:38:50:cf:
       ec:02:20:58:e1:cf:e1:f6:e2:17:08:c3:5a:fc:86:91:31:ef:
       65:09:e0:e4:ba:7e:02:8e:4c:49:d1:4b:e3:ac:35:33:f7
-----BEGIN CERTIFICATE-----
MIIB9TCCAZugAwIBAgIQWsuj98+/xSiSzeGfo6ydFzAKBggqhkjOPQQDAjBPMSEw
```

HwYDVQQKDBhNaWNyb2NoaXAgVGVjaG5vbG9neSBJbmMxKjAoBgNVBAMMIUNyeXB0
byBBdXRoZW50aWNhdGlvbiBTaWduZXIgRjYwMDAgFw0xOTA4MjEyMjAwMDBaGA8y
MDQ3MDgyMTIyMDAwMFowRjEhMB8GA1UECgwYTWljcm9jaGlwIFRlY2hub2xvZ3kg
SW5jMSEwHwYDVQQDDBgwMTIzODY3RDU2NkZGQjc3MDEgQVRFQ0MwWTATBgcqhkjO
PQIBBggqhkjOPQMBBwNCAAT8V2e2+65QYMqWWu9BscXWoWBhh46kePRNGNB2na1i
JLNowhpiywr97/W0DONV7PBAu0GDYQLvIDxjkzLUkEGro2AwXjAMBgNVHRMBAf8E
AjAAMA4GA1UdDwEB/wQEAwIDiDAdBgNVHQ4EFgQUQ55PRXk1ztzUNblPSiNp4S2J
MwQwHwYDVR0jBBgwFoAU+9yqEor6wbWSj82rEdsJPs9NvvYwCgYIKoZIzj0EAwID
SAAwRQIhAIMyeCWcWgd8SgT4tcRX1ghw7sPUeZy2FI5ehlQ4UM/sAiBY4c/h9uIX
CMNa/IaRMe9lCeDkun4CjkxJ0UvjrDUz9w==
-----END CERTIFICATE-----

Validate Device Certificate:
OK

Generated the manifest file 0123867d566ffb7701_manifest.json
MCHP Certificate processing completed successfully

The Notebook will also generate a manifest file to be uploaded into the public cloud of your choice (Google GCP, AWS IoT and Microsoft Azure).

After running this Notebook, it generates the required resources and program data zone with required secrets, keys and certificates. For this use case, Secret key is loaded into TrustFLEX device (ATECC608A) in slot 5.

4 Use Case Prototyping

This hands-on lab is intended to demonstrate the usage of IP protection by authenticating the TrustFLEX device connected to host. It uses symmetric authentication where both host and TrustFLEX device shares a common secret.

This process uses a challenge-response model. In this model, host authenticates the TrustFLEX device based on MAC response. MAC is calculated on the TrustFLEX device to prove that it holds the secret key that is shared by the host. Then the calculated MAC will be verified by the host to continue using IP.

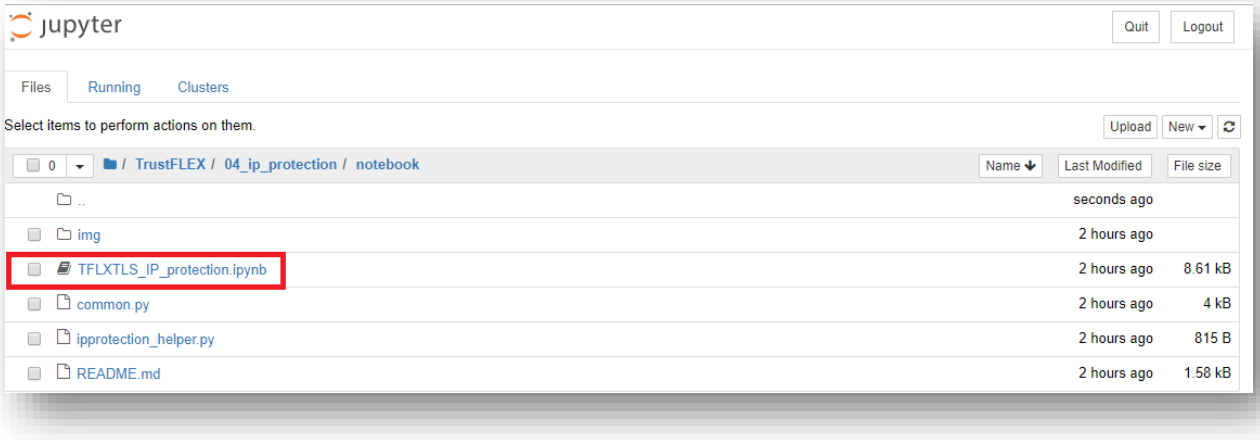
MAC calculation on TrustFLEX includes device serial number, nonce (number used once) and shared secret key. By including serial number and nonce, host can get unique MAC from each TrustFLEX every time, thereby avoiding the replay attacks.

TrustFLEX device Slot5 being used to store the shared secret. The resource generation for TrustFLEX device will load a prototyping symmetric key to Slot5 of TrustFLEX device.

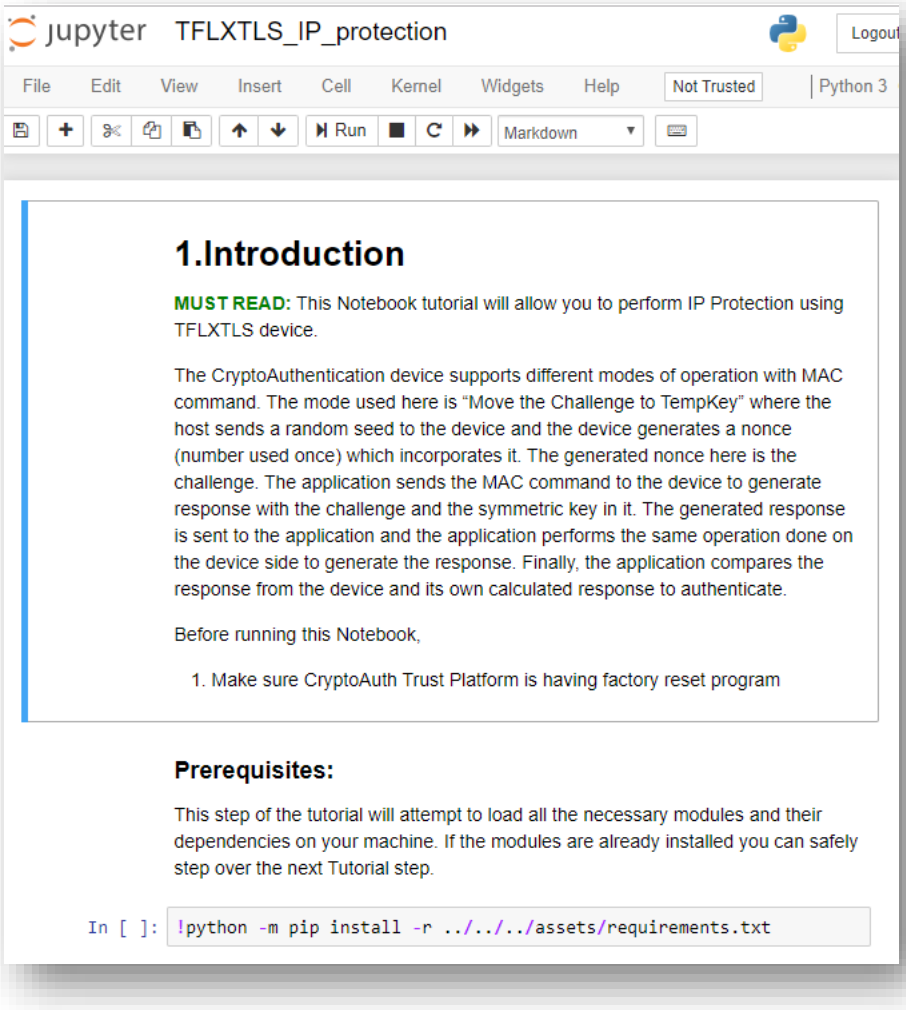
Following sections provides detail steps to execute the usecase both on Jupyter Notebook and on Embedded project

4.1 Running IP Protection example on Jupyter Notebook:

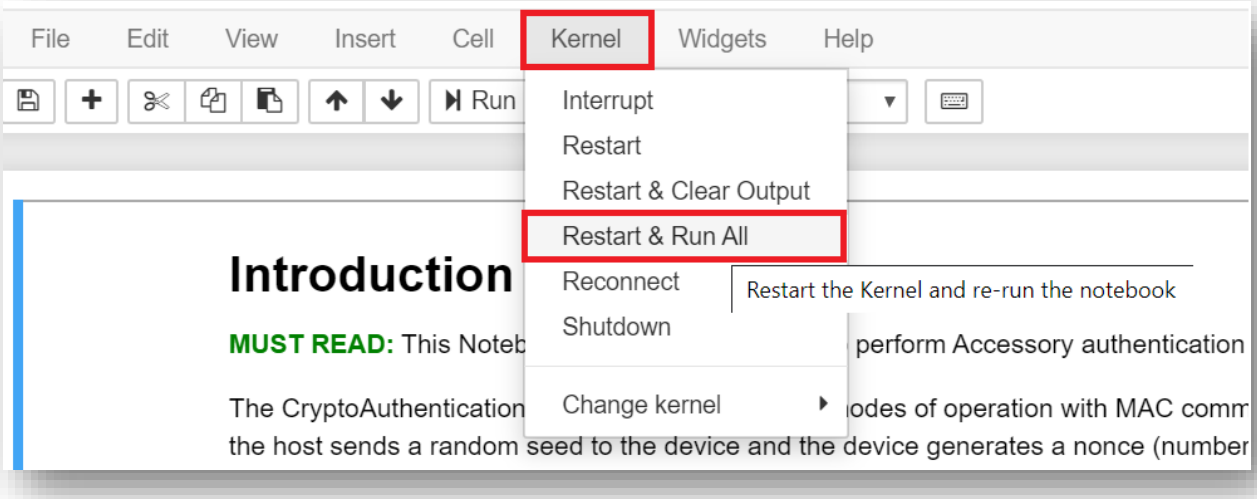
1. From the Jupyter Home page, navigate to **TrustFLEX\04_ip_protection\notebook\TFLXTLS_IP_protection.ipynb** notebook file and open it.



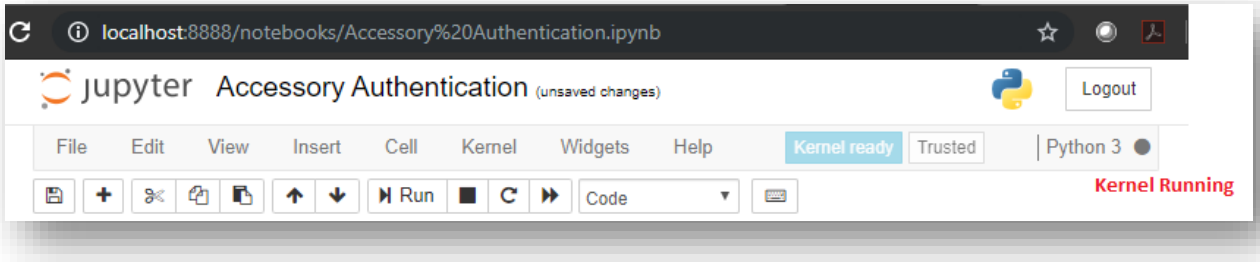
Opening the notebook from Jupyter home page should load the following on the browser,

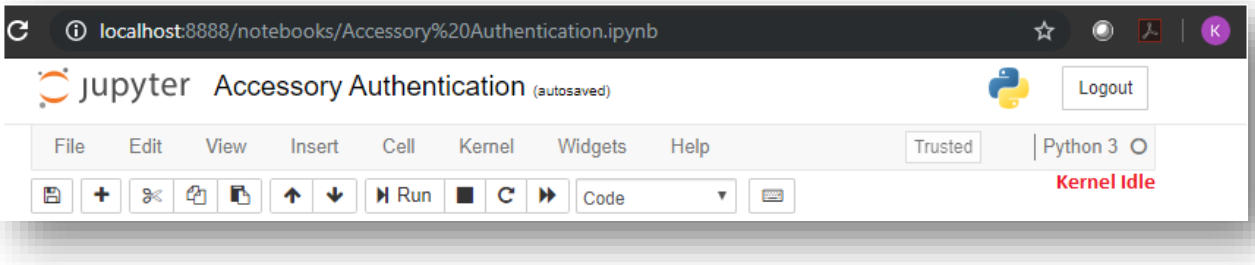


2. Run All Cells by using Kernel -> Restart & Run All



3. It may take a while to complete, wait for the kernel to complete all processing i.e. from Kernel Running to Kernel Idle state (Check circle above **RED** text)





4. Navigate through different cells output for the description of the step and result from the execution.

5. There are 2 major steps in this lab
   Generate MAC from TFLXTLS part
   Code block of this step generates a random challenge and expects TrustFLEX to provide the MAC for this challenge. Accessory calculates the MAC value by including its serial number, shared secret and the challenge received from host.

   Calculate Nonce
   To calculate MAC, nonce is considered. Nonce is calculated based on the challenge which is initiated by host. Then calculated nonce will be stored in tempkey of TrustFLEX.

   Calculate MAC on TrustFLEX device
   MAC is calculated on TrustFLEX device is to prove that the this has the secret key shared by host. TrustFLEX device MAC is calculated with its serial number, calculated nonce and secret key.

   Then calculated MAC will send to the host to authenticate the TrustFLEX device.

   Below screenshot display the accessory device MAC.

```
# Generate the nonce in device and return the random number
assert atcab_nonce_rand(seed_in,rand_out) == ATCA_SUCCESS, "Random nonce from device failed"

# Calculate the nonce value on the host side
nonce.extend(rand_out[0:32])
nonce.extend(seed_in[0:20])
nonce.append(0x16)
nonce.append(0)
nonce.append(0)
digest = hashes.Hash(hashes.SHA256(), backend=default_backend())
digest.update(bytes(nonce))
nonce = digest.finalize()

# Calculate the mac in device with its symmetric diversified key in slot
assert atcab_mac(MAC_MODE,SHARED_SECRET_SLOT,0,device_mac) == ATCA_SUCCESS, "MAC from device failed"
print("MAC Received from device:")
print(pretty_print_hex(device_mac, indent='    '))
```

```
MAC Received from device:
    A9 58 C0 EE 00 AA BA 6E FC E0 19 2D 4D CE F6 CE
    57 61 65 CA C7 77 B3 73 DE 6D 94 45 DB F2 FF A4
```

Verify Expected MAC on Host

Code block of this step generates Verify MAC button. Clicking the button repeats the MAC calculation process on host by including its challenge, TrustFLEX serial number and shared secret key. If any of this mismatch, calculated MAC will be different resulting in authentication failure.

```
    print("MAC calculated on host:")
    print(pretty_print_hex(host_mac, indent='    '))

    if (device_mac == host_mac):
        print('\nApplication authenticated successfully!')
        mac_verify.button_style = 'success'
    else:
        mac_verify.button_style = 'danger'
        print('\nApplication not authenticated...')

mac_verify = widgets.Button(description = "Verify MAC", tooltip = 'MAC & MAC-Response Verify')
mac_verify.on_click(mac_mac_resp_verify)
display(mac_verify)
```


```
MAC calculated on host:
    A9 58 C0 EE 00 AA BA 6E FC E0 19 2D 4D CE F6 CE
    57 61 65 CA C7 77 B3 73 DE 6D 94 45 DB F2 FF A4

Application authenticated successfully!
```

6. In Jupyter notebook, run cells till the end of notebook, you will see a “Verify MAC” button will appear. Press the button, it will turn green if TrustFLEX device gets authenticated by MCU or it will turn red.

Pressing the button, turns it Green or Red. Green indicates that the device is authenticated by host and Red indicates the authentication is failed.

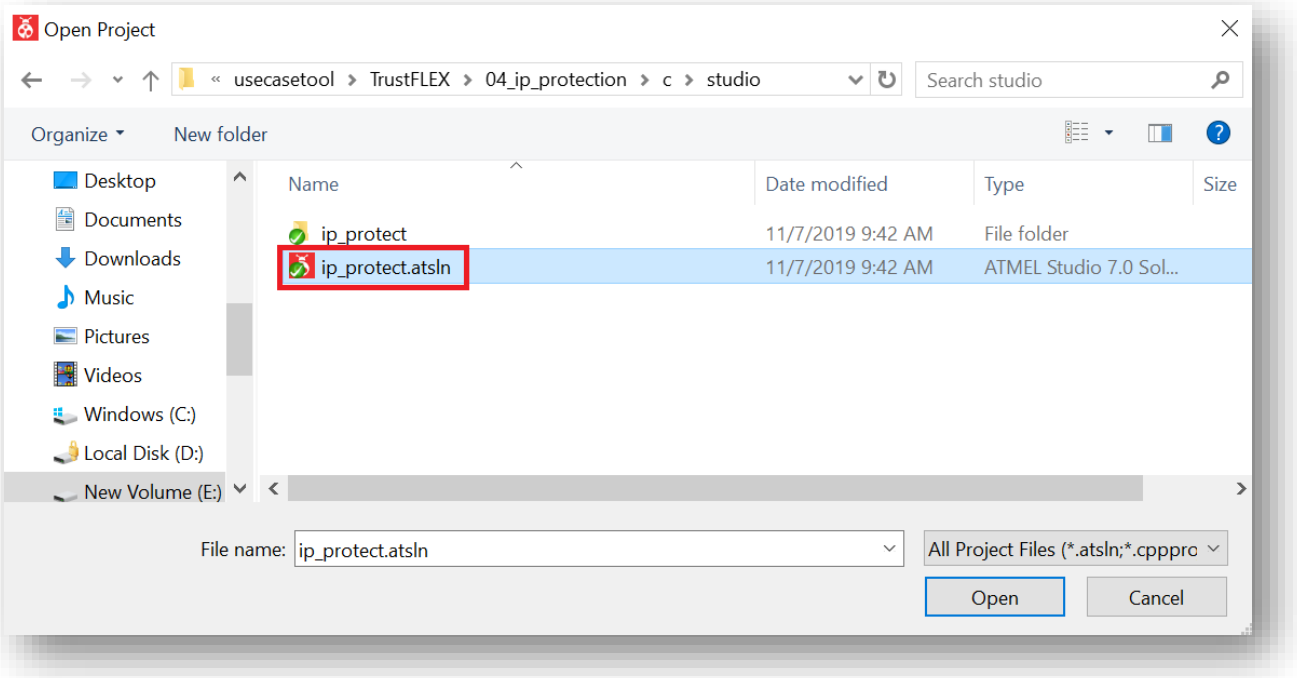
4.2 Running IP Protection on Embedded Platform

This usecase can also be executed on Embedded platform. Once the resources are generated, both Atmel Studio and MPLAB projects provided can be used to run the application on CryptoAuth Trust Platform.

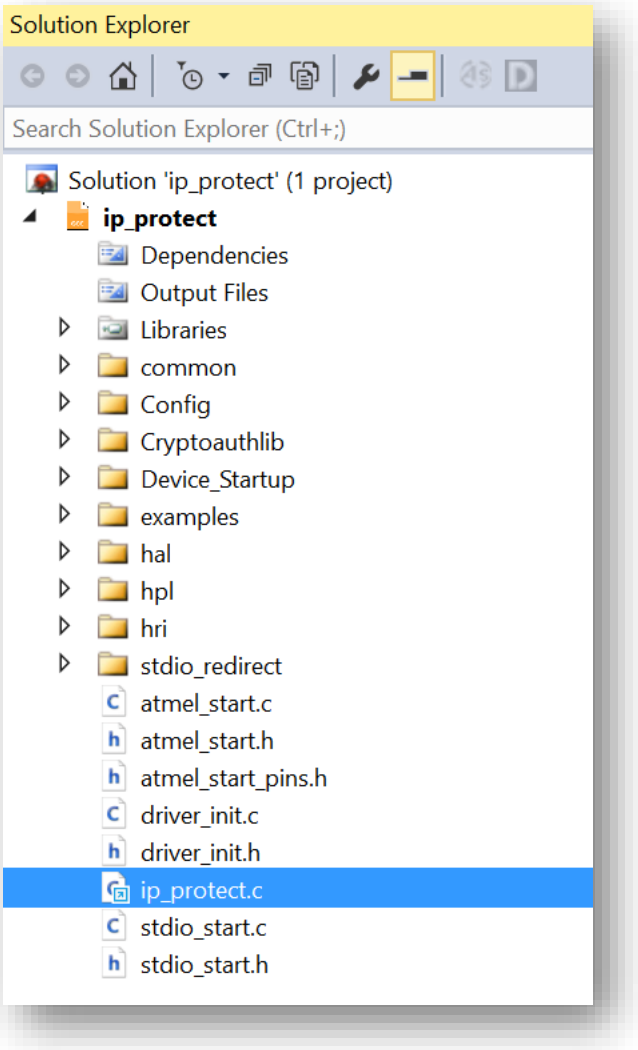
Note: This usecase requires resource generation notebook executed prior to using embedded projects.

4.2.1 Atmel Studio

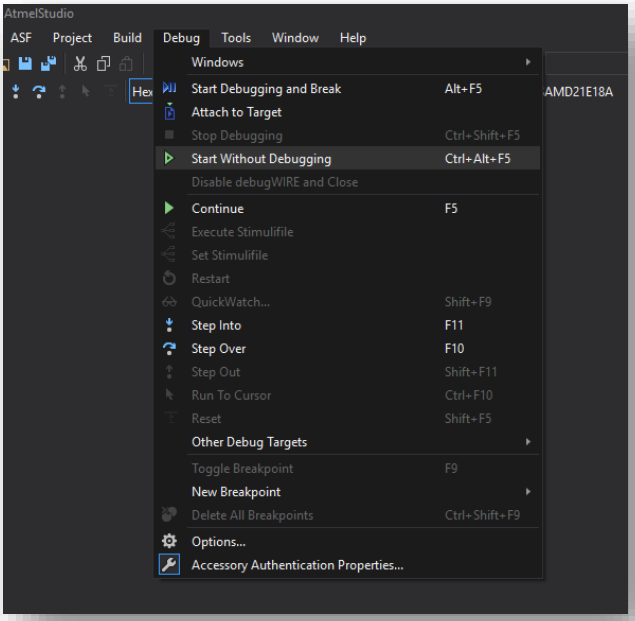
1. Open **ip_protect.atsln** project by navigating to Atmel Studio -> File -> open -> **TrustFLEX\04_ip_protection\c\studio\ip_protect.atsln**



2. The application source code **ip_protect.c** is available at **TrustFLEX\04_ip_protection\c\ip_protect.c** Other supporting files can be found under **assets\dependencies**



3. Program the Crypto Trust platform by navigating to **Debug -> Start Without Debugging**

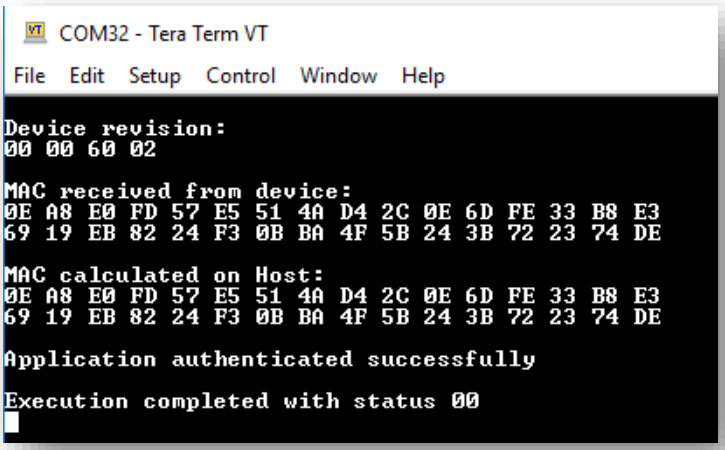


This step may take some time, wait for Atmel Studio to compile and program the device.

Once the programming is done, the firmware will do IP Protection operation. Depending on the IP Protection operation's output, the Cryptoauth Trust Platform board's Status LED will blink at different rates.

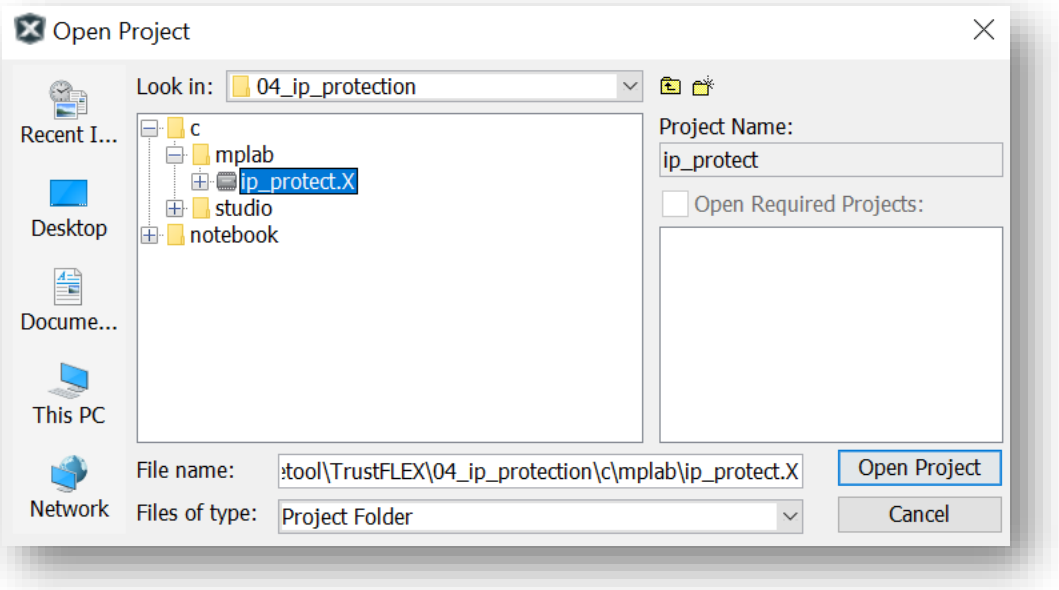
If IP Protection operation succeeds, LED blinks once every second.
If IP Protection operation fails, LED blinks five times every second.

It is also possible to view the Console messages by using applications like TeraTerm. Open the application with the COM related to CryptoAuth TrustPlatform with 115200-8-N-1 settings

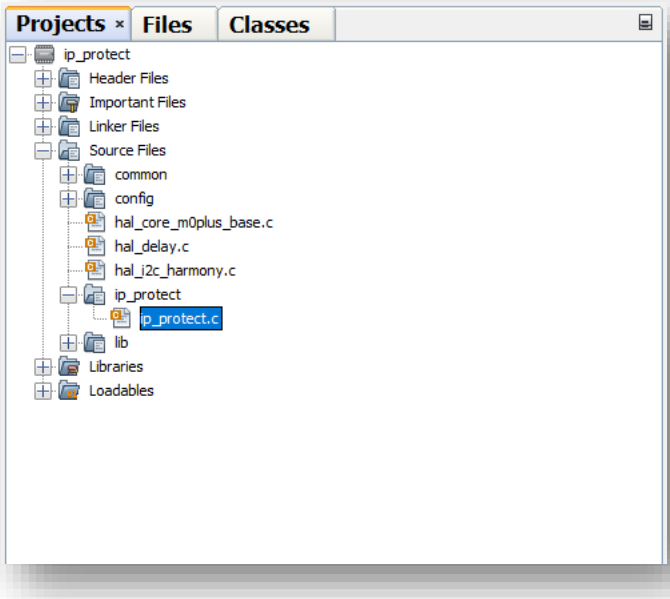


4.2.2 MPLAB:

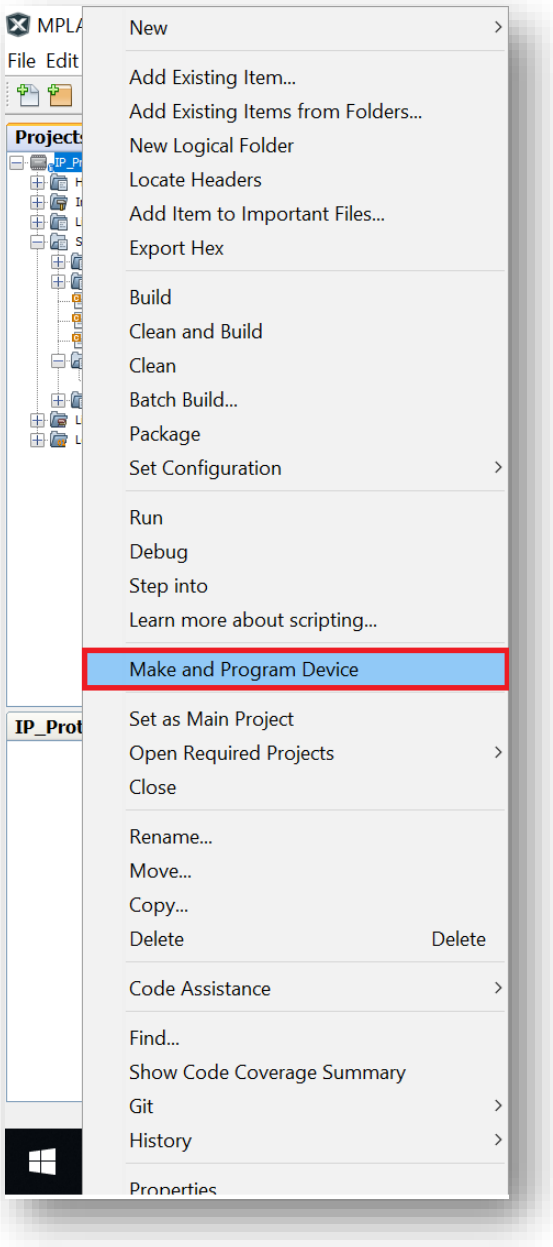
1. Open **ip_protect.X** project by navigating to MPLAB -> File -> Open Project -> **TrustFLEX\04_ip_protection\c\mplab\ip_protect.X**



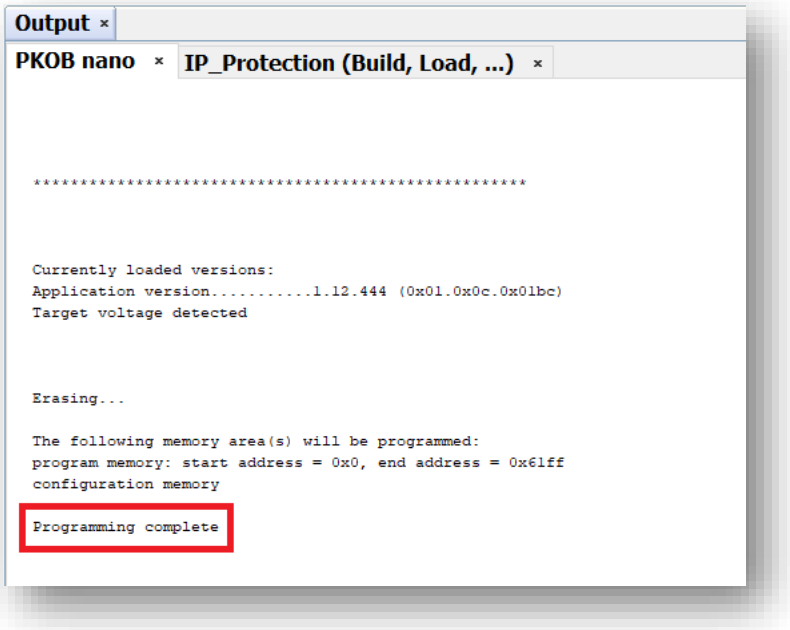
2. The application source code **ip_protect.c** is available at **TrustFLEX\04_ip_protection\c \ip_protect.c.** Other supporting files can be found under **assets\ dependencies**



3. Program the Crypto Trust platform by navigating to **ip_protect -> Make and Program Device**



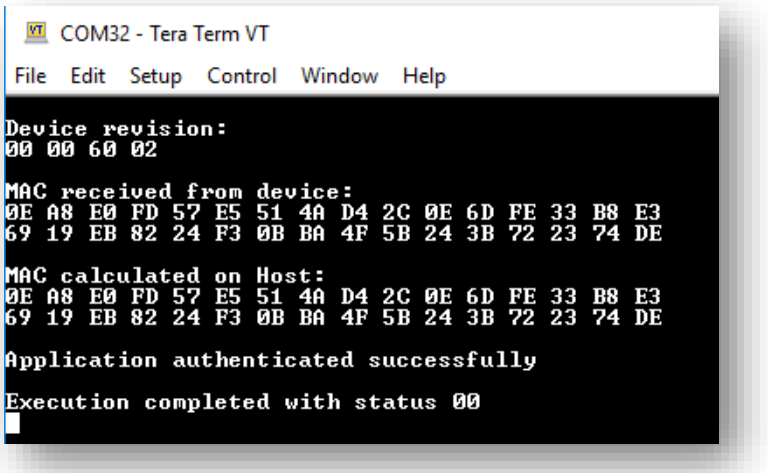
This step may take some time, wait for MPLAB to program the device. Once it is done programming you will see "**Programming complete**" message in Output Window.



Once the programming is done, the firmware will do IP Protection operation. Depending on the IP Protection operation's output, the Cryptoauth Trust Platform board's Status LED will blink at different rates.

If IP Protection operation succeeds, LED blinks once every second.
If IP Protection operation fails, LED blinks five times every second.

It is also possible to view the Console messages by using applications like TeraTerm. Open the application with the COM related to CryptoAuth TrustPlatform with 115200-8-N-1 settings



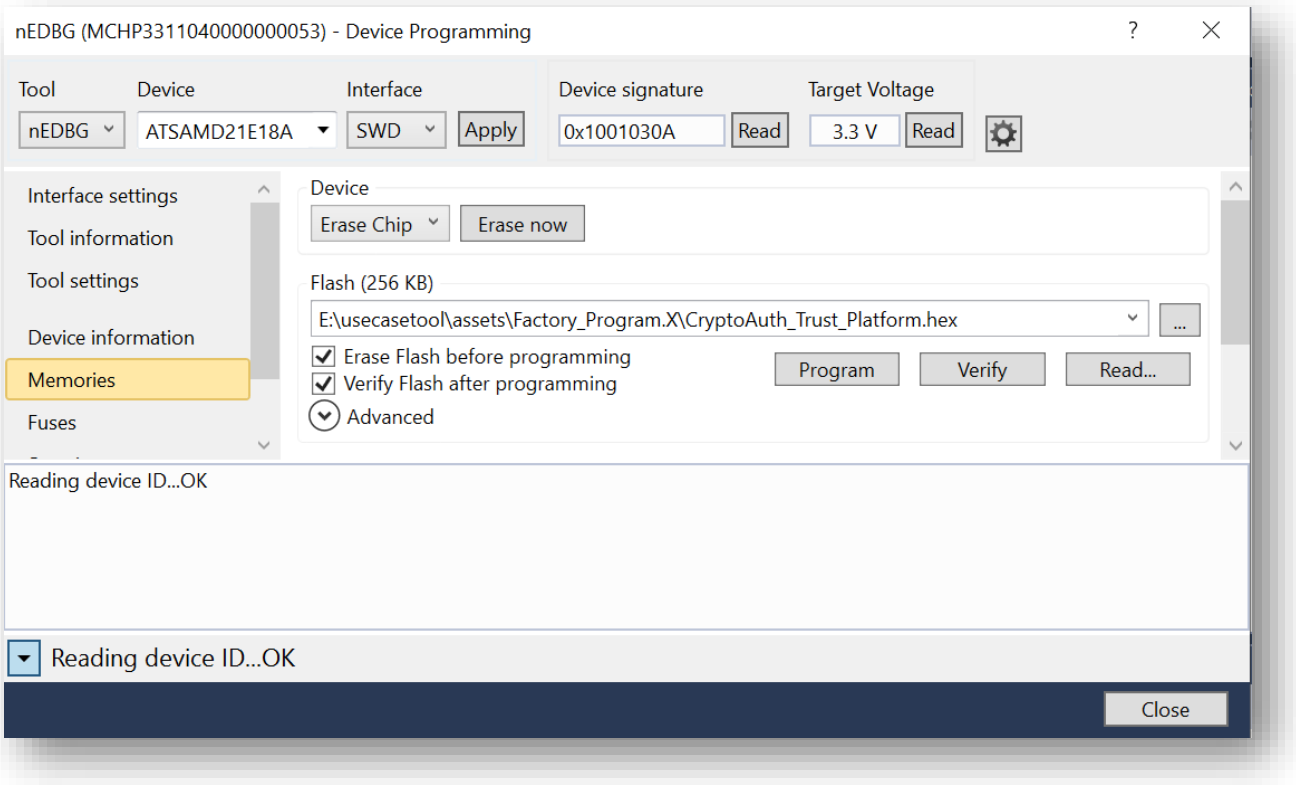
4.3 CryptoAuth TrustPlatform Factory reset

Once any of the embedded project is loaded to CrytoAuth TrustPlatform, the default program that enables interaction with TrustPlatform tools will be erased.

Before using the Platform with any other notebook or tools on PC, its required to reprogram the default .hex file. Default hex file is available at **assets\Factory_Program.X\CryptoAuth_Trust_Platform.hex**

To reprogram using Atmel Studio:

1. Navigate to AtmelStudio -> Tools -> Device Programming
2. Select Tool as nEDBG and Apply
3. Go to Memories and navigate to above path under Flash dropdown
4. Check both Erase Flash and Verify Flash
5. Click on Program



To reprogram using MPLAB:

1. Open **assets\Factory_Program.X** project in MPLAB IDE
2. Program the Crypto Trust platform by navigating to **CryptoAuth_Trust_Platform_Factory_Program -> Make and Program Device**

Now, Crypto Trust Platform contains factory programmed application that enables interactions with Notebooks and/or PC tools.

5 FAQ

1. **What are the reasons for "AssertionError: Can't connect to the USB dongle" error?**
   There are many possibilities like,
   1. Crypto Trust Platform is having different application than factory reset firmware. Refer to "CryptoAuth TrustPlatform Factory reset" section any usecase TrustFLEX Guide for reloading it
   2. Check the switch positions on Crypto Trust Platform and/or ATECC608A Trust board
      a. Correct Trust device should be connected and only one device of that type is allowed on the I2C bus. Multiple devices with same address results in error
   3. Check USB connections to Crypto Trust Platform

2. **How to reload factory default application to Crypto Trust Platform?**
   Refer to "CryptoAuth TrustPlatform Factory reset" section any usecase TrustFLEX Guide for reloading it.

3. **Why does my C projects generates No such file or directory with ../../../ TFLXTLS_resource_generation/?**
   C project generates this error when the resources are not generated prior to using embedded projects. Running the resource generation notebook ensures these files and secrets are generated.

4. **Before running any use case notebook and/or C project, why is it mandate to execute resource generation?**
   When resource generation notebook is executed, it generates and programs the required resources like secrets, keys and certificates. These are only prototyping keys and cannot be used for production. These keys will be used part of Usecase notebooks and C projects

5. **How to know the resources being used in a use case?**
   Refer to individual Usecase description html for details on transaction diagrams, resources being used and other details. The resources required for given use case is mentioned in INFER CRYPTOGRAPHIC ASSETS section.

6. **When should I select Custom certificates while doing resource generation?**
   Custom certificates are required when user wants to have their own root, signer instead of MCHP provided. The difference would be organization name, common name and validity are configurable

7. **How to know whether C project is executing on Trust Platform or not after programming?**
   Once the programming is done, the firmware will do use case operation. Depending on the use case operation's output, the Crypto Trust Platform board's status LED will blink at different rates.
   If use case operation succeeds, LED blinks once every second. If it fails, LED blinks five times every second.

It is also possible to view the Console messages by using applications like TeraTerm. Open the application with the COM related to Crypto Trust Platform with 115200-8-N-1 settings

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