Trust&GO Step by Step Guide - Azure Cloud Platform Connect

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1 Introduction

This document explains step by step process involved in uploading a manifest file to AWS cloud. If you are already familiar with Jupyter Notebook you can skip this section and move to Section 2.

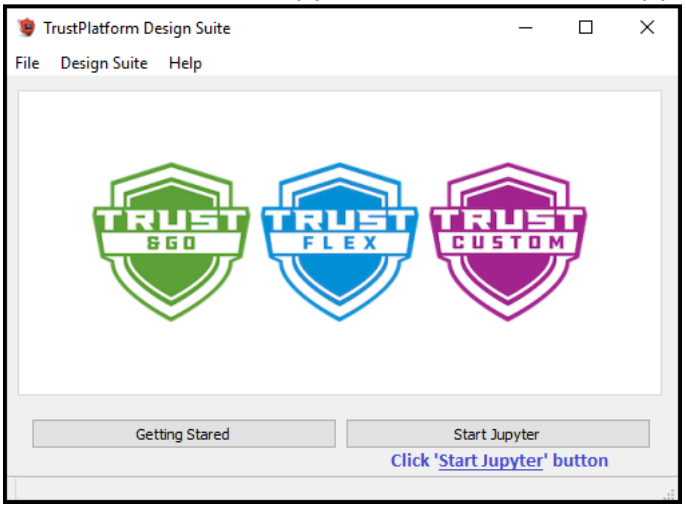
1.1 Getting started with Jupyter Notebook Tutorials

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.

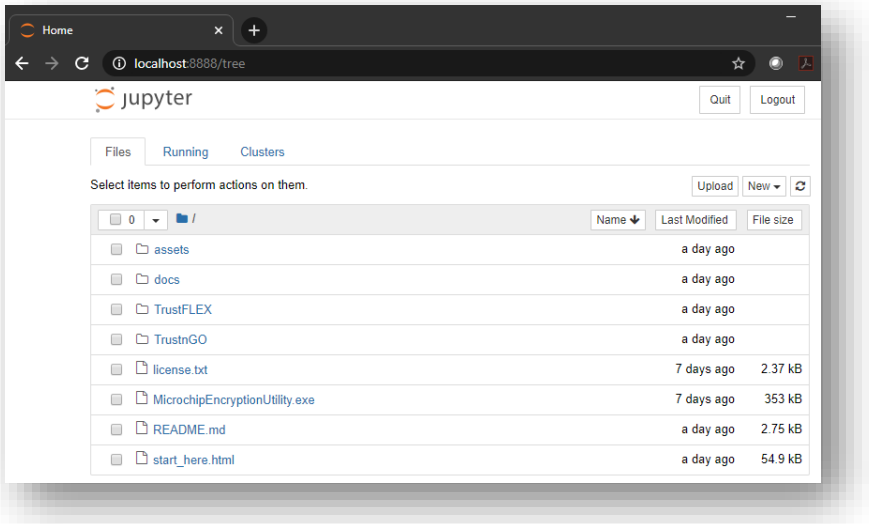
Jupyter notebooks are mainly used to explain/evaluate code in an interactive way.

1.1.1 Starting Jupyter Notebook

Jupyter notebook can be launched from Trust Platform GUI Main window. Run START -> Trust Platform x.x.x icon. Click on 'Start Jupyter' button to launch Jupyter local server.



Clicking on Start Jupyter should be web browser tab like below,



2 Jupyter Notebook Basics

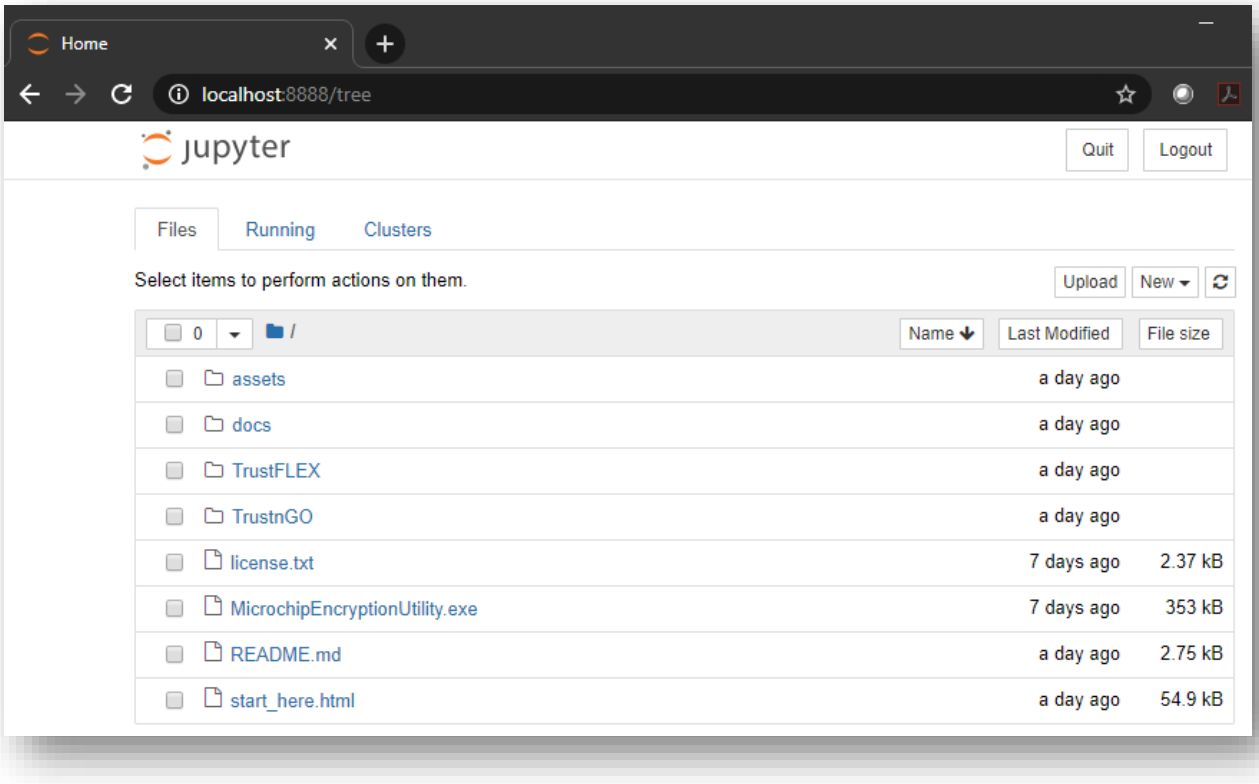
It is recommended to become familiar with Jupyter basic concepts with the online documentation, https://jupyter-notebook.readthedocs.io/en/stable/examples/Notebook/Notebook%20Basics.html

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

2.1.1 The Notebook dashboard

When you first start the notebook server, your browser will open 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.

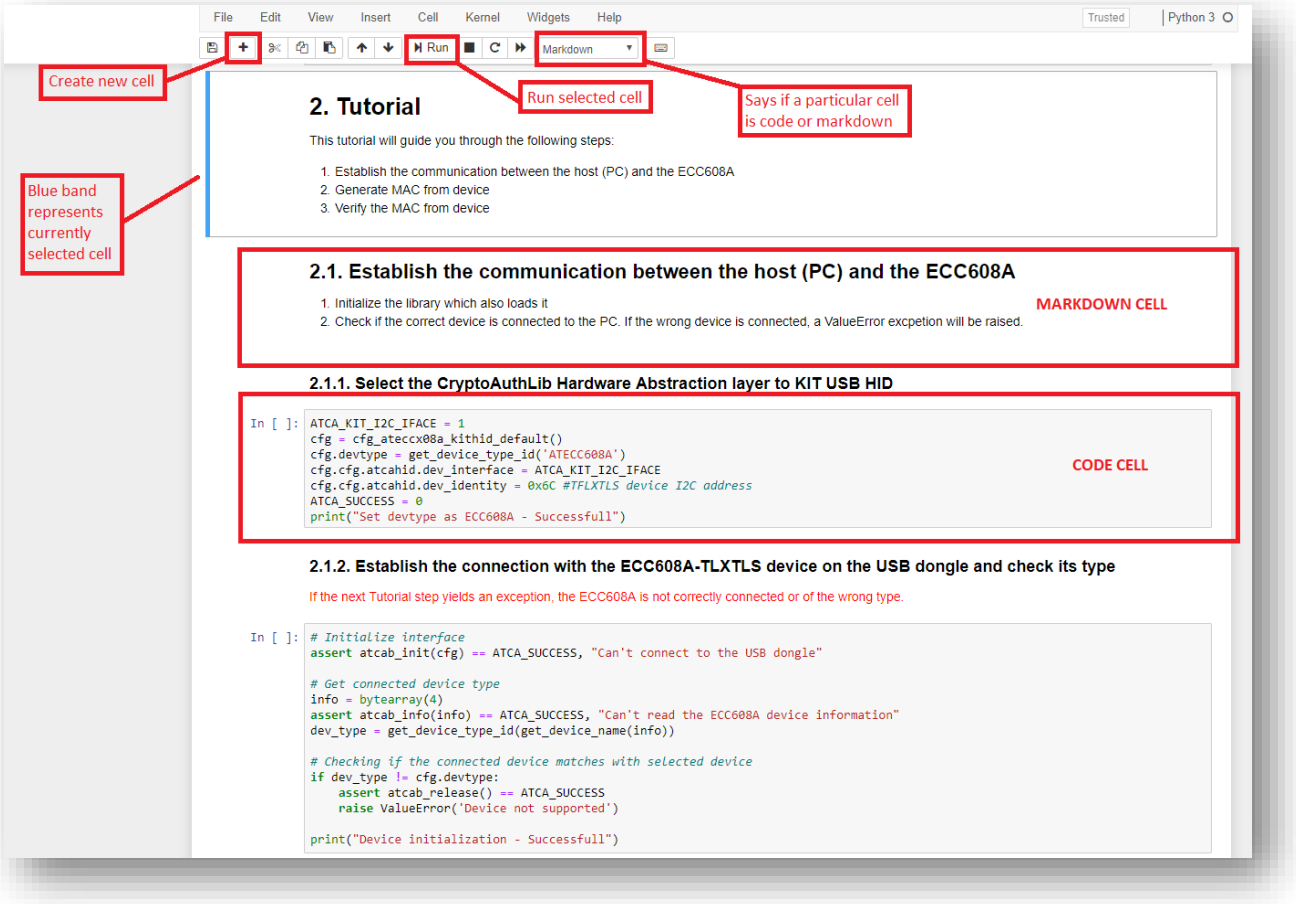


2.2 Introduction to Jupyter Notebook GUI.

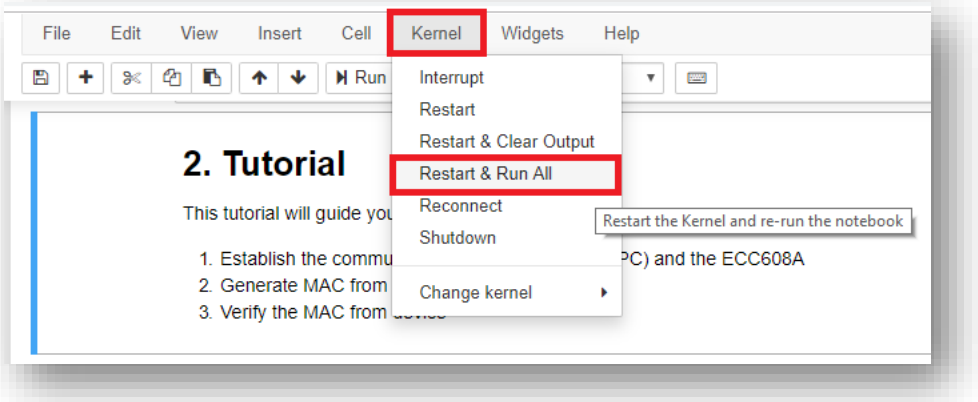
Jupyter Notebooks contain cells where you can either write code or markdown text. Notebooks contain multiple cells, some set as code and others markdown. Code cells contain code that can be executed live, and markdown contains text and images to explain the code.

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.



3 Jupyter Notebook Tutorials

The TrustPlatform Design Suite comes with a Notebook Tutorials to easily prototype popular use cases for Trust&GO devices. Here are the available Jupyter Notebook Tutorials.

Jupyter Notebook Tutorials	**Relative Path**	**Applicable Devices**
Manifest Generation	TrustnGO\00_resource_generation\TNGTLS_manifest_file_generation.ipynb	Trust&GO
GCP Connect	TrustnGO\05_cloud_connect\notebook\gcp\TNGTLS_GCP_connect.ipynb	Trust&GO
AWS Connect	TrustnGO\05_cloud_connect\notebook\aws\TNGTLS_aws_connect.ipynb	Trust&GO
Azure Connect	TrustnGO\05_cloud_connect\notebook\azure\ TNGTLS_azure_connect.ipynb	Trust&GO
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
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
Asymmetric authentication	08_asymmetric_authentication\notebook\ TFLXTLS_asymmetric_authentication.ipynb	TrustFLEX
GCP Connect	TrustFLEX\10_cloud_connect\notebook\gcp\TFLXTLS_GCP_connect.ipynb	TrustFLEX
AWS Custom PKI	TrustFLEX\10_cloud_connect\notebook\aws\ TFLXTLS_aws_connect.ipynb	TrustFLEX
Azure Connect	TrustFLEX\10_cloud_connect\notebook\azure\ TLFXTLS_azure_connect.ipynb	TrustFLEX

4 Manifest Generation Notebook

Trust&GO device is one of the three devices available in the Crypto Auth Trust Platform Board.

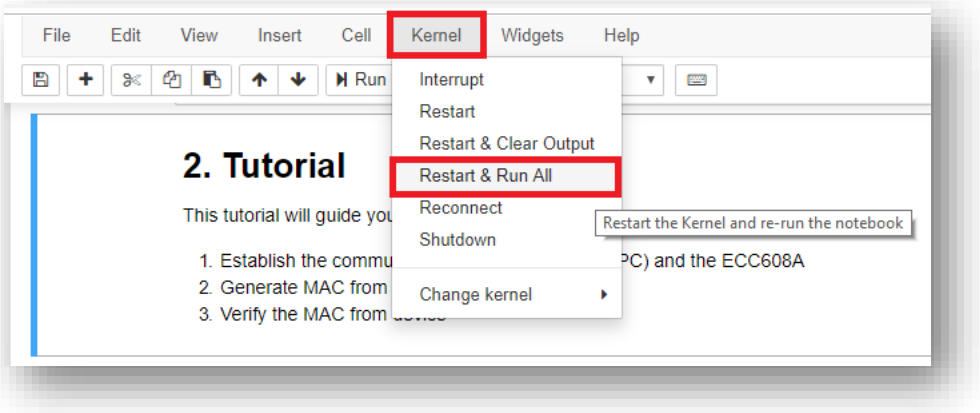
Trust&GO devices come with pre-programmed certificates in slots 10, 11 and 12, also slots 0-4 have pre-generated private keys. Other than the previously mentioned slots all the other slots are locked.

The secure element manifest format is designed to convey the unique information about a device including its unique ID (e.g. serial number), public keys, and certificates. The manifest file generated can be used to register the device to cloud providers.

Within the Jupyter Dashboard, navigate **TrustnGO\00_resource_generation** folder to open **TNGTLS_manifest_file_generation.ipynb**

Run all cells of the TNGTLS_manifest_file_generation 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 Crypto Auth Trust Platform Factory reset section for reloading default program.



If all the steps ran without errors, you will see result as shown below.

```
Root Certificate loading from Device...OK
-----BEGIN CERTIFICATE-----
MIIB8TCCAZegAwIBAgIQd9NtlW7IrmIF5Y46y5hagTAKBggqhkjOPQQDAjBPMSEw
HwYDVQQKDBhNaWNyb2NoaXAgVGVjaG5vbG9neSBJbmMxKjAoBgNVBAMMIUNyeXB0
byBBdXRoZW50aWNhdGlvbiBSb290IENBIDAwMjAgFw0xODExMDgxOTEyMTlaGA8y
MDU4MTEwODE5MTIxOVowTzEhMB8GA1UECgwYTWljcm9jaGlwIFRlY2hub2xvZ3kg
SW5jMSowKAYDVQQDDCFDcnlwdG8gQXV0aGVudGljYXRpb24gUm9vdCBDQSAwMDIw
WTATBgcqhkjOPQIBBggqhkjOPQMBBwNCAAS9VOZt44dUhABrU64VgNUKoGnnit9V
eNhc4tVN1bgwKWv/3W5vclb72Z7xoRaxHTOtSRA6oYWHOdz65DfhnWNOo1MwUTAd
BgNVHQ4EFgQUeu19bca3eJ2yOAGl6EqMsKQOKowwHwYDVR0jBBgwFoAUeu19bca3
eJ2yOAGl6EqMsKQOKowwDwYDVR0TAQH/BAUwAwEB/zAKBggqhkjOPQQDAgNIADBF
AiEAodxjRZDsgZ7h3luBEmVRrdTCxPjllSgu4EvnaOx8AnMCID5rp06eTArWjCSw
+y7nk9LmvpRlyhXQ6lvIf1V5mVyt
-----END 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


Validate Root Certificate...OK
-----------------------------------------------------
Signer Certificate loading from Device...OK
-----BEGIN CERTIFICATE-----
MIICBTCCAaqgAwIBAgIQfDEW4DQGWyXgU7+wniYaZjAKBggqhkjOPQQDAjBPMSEw
HwYDVQQKDBhNaWNyb2NoaXAgVGVjaG5vbG9neSBJbmMxKjAoBgNVBAMMIUNyeXB0
byBBdXRoZW50aWNhdGlvbiBSb290IENBIDAwMjAgFw0xODEyMTQxOTAwMDBaGA8y
MDQ5MTIxNDE5MDAwMFowTzEhMB8GA1UECgwYTWljcm9jaGlwIFRlY2hub2xvZ3kg
SW5jMSowKAYDVQQDDCFDcnlwdG8gQXV0aGVudGljYXRpb24gU2lnbmVyIEY2NDAw
WTATBgcqhkjOPQIBBggqhkjOPQMBBwNCAAQOfzKV8utGQPSqOUzl5SDX2bULuVT1
w/i7bz8sGFpNuZCRvK9J6gb8S8xcKifI0AIrGpvwG/RG3ZrFYjBMejh2o2YwZDAO
BgNVHQ8BAf8EBAMCAYYwEgYDVR0TAQH/BAgwBgEB/wIBADAdBgNVHQ4EFgQU62ID
K4yBWBZCmhyr8b6MIh63pskwHwYDVR0jBBgwFoAUeu19bca3eJ2yOAGl6EqMsKQO
KowwCgYIKoZIzj0EAwIDSQAwRgIhAOB47QYnFfAxMvDvMZcipUni4YYoc7Xyt18o
PuN9E268AiEA32h2vgUirn/pFYSC+ghFjdqc8wgXL9ZgdPwRkHowR3s=
-----END CERTIFICATE-----

Certificate:
    Data:
        Version: 3 (0x2)
        Serial Number:
            7c:31:16:e0:34:06:5b:25:e0:53:bf:b0:9e:26:1a:66
        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 F640
        Subject Public Key Info:
            Public Key Algorithm: id-ecPublicKey
                Public-Key: (256 bit)
                pub:
                    04:0e:7f:32:95:f2:eb:46:40:f4:aa:39:4c:e5:e5:
                    20:d7:d9:b5:0b:b9:54:f5:c3:f8:bb:6f:3f:2c:18:
                    5a:4d:b9:90:91:bc:af:49:ea:06:fc:4b:cc:5c:2a:
                    27:c8:d0:02:2b:1a:9b:f0:1b:f4:46:dd:9a:c5:62:
                    30:4c:7a:38:76
                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:
                EB:62:03:2B:8C:81:58:16:42:9A:1C:AB:F1:BE:8C:22:1E:B7:A6:C9
```

```
            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:e0:78:ed:06:27:15:f0:31:32:f0:ef:31:97:
         22:a5:49:e2:e1:86:28:73:b5:f2:b7:5f:28:3e:e3:7d:13:6e:
         bc:02:21:00:df:68:76:be:05:22:ae:7f:e9:15:84:82:fa:08:
         45:8d:da:9c:f3:08:17:2f:d6:60:74:fc:11:90:7a:30:47:7b


Validate Signer Certificate...OK
----------------------------------------------------
Device Certificate loading from Device...OK
-----BEGIN CERTIFICATE-----
MIIB9TCCAZugAwIBAgIQc0PaLGk8Q6DyF0sMb9xx7TAKBggqhkjOPQQDAjBPMSEw
HwYDVQQKDBhNaWNyb2NoaXAgVGVjaG5vbG9neSBJbmMxKjAoBgNVBAMMIUNyeXB0
byBBdXRoZW50aWNhdGlvbiBTaWduZXIgRjY0MDAgFw0xOTA3MzEyMzAwMDBaGA8y
MDQ3MDczMTIzMDAwMFowRjEhMB8GA1UECgwYTWljcm9jaGlwIFRlY2hub2xvZ3kg
SW5jMSEwHwYDVQQDDBgwMTIzOUE2REYyRUNFQ0RDMDEgQVRFQ0MwWTATBgcqhkjO
PQIBBggqhkjOPQMBBwNCAAQYjmZv6hNvOGfiXtqRPqKJr7hnh0Hf6AI68KjrRy8/
93zhXWIzlG2VexKLeER97Y6wU2fysMJ4rWQjUgQ54iX5o2AwXjAMBgNVHRMBAf8E
AjAAMA4GA1UdDwEB/wQEAwIDiDAdBgNVHQ4EFgQUnbEcKNb3ZxBz/s1zs0GfTC95
UfEwHwYDVR0jBBgwFoAU62IDK4yBWBZCmhyr8b6MIh63pskwCgYIKoZIzj0EAwID
SAAwRQIhAMG4O+JnJdJ+4qwg6HEyZu/sHkqSUqnbmW5jfSCsSQjSAiB3rimVHLb9
bIheMqsIbK2tXTjtLhCs5s15WvpNvKev1Q==
-----END CERTIFICATE-----

Certificate:
    Data:
        Version: 3 (0x2)
        Serial Number:
            73:43:da:2c:69:3c:43:a0:f2:17:4b:0c:6f:dc:71:ed
        Signature Algorithm: ecdsa-with-SHA256
        Issuer: O=Microchip Technology Inc, CN=Crypto Authentication Signer F640
        Validity
            Not Before: Jul 31 23:00:00 2019 GMT
            Not After : Jul 31 23:00:00 2047 GMT
        Subject: O=Microchip Technology Inc, CN=01239A6DF2ECECDC01 ATECC
        Subject Public Key Info:
            Public Key Algorithm: id-ecPublicKey
                Public-Key: (256 bit)
                pub:
                    04:18:8e:66:6f:ea:13:6f:38:67:e2:5e:da:91:3e:
                    a2:89:af:b8:67:87:41:df:e8:02:3a:f0:a8:eb:47:
                    2f:3f:f7:7c:e1:5d:62:33:94:6d:95:7b:12:8b:78:
                    44:7d:ed:8e:b0:53:67:f2:b0:c2:78:ad:64:23:52:
                    04:39:e2:25:f9
                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:
                9D:B1:1C:28:D6:F7:67:10:73:FE:CD:73:B3:41:9F:4C:2F:79:51:F1
            X509v3 Authority Key Identifier:
                keyid:EB:62:03:2B:8C:81:58:16:42:9A:1C:AB:F1:BE:8C:22:1E:B7:A6:C9

    Signature Algorithm: ecdsa-with-SHA256
         30:45:02:21:00:c1:b8:3b:e2:67:25:d2:7e:e2:ac:20:e8:71:
         32:66:ef:ec:1e:4a:92:52:a9:db:99:6e:63:7d:20:ac:49:08:
         d2:02:20:77:ae:29:95:1c:b6:fd:6c:88:5e:32:ab:08:6c:ad:
```

```
         ad:5d:38:ed:2e:10:ac:e6:cd:79:5a:fa:4d:bc:a7:af:d5


Validate Device Certificate...OK
-------------------------------------------------
-----------------------------------------
Generating manifest data...OK (saved to TNGTLS_devices_manifest.json)
-----------------------------------------
```

By default, TNGTLS_devices_manifest.json, manifest_ca.key and manifest_ca.crt files will be created. manifest_ca.crt to be used as cert to verify the content while providing manifest file.

The Notebook will be used to generate a manifest file which can be uploaded into the public cloud provider of your choice (Google GCP, AWS IoT and Microsoft Azure). TNGTLS Manifest Generation notebook needs to be run for all Trust&Go example Notebooks that require a Manifest file.

5 Use Case Prototyping

This hands-on lab is intended to demonstrate the usage of TrustnGO to secure an Azure IoT connection based on TNGTLS device.

The Azure IoT device reference implementation is provided as an MPLAB X project and the manifest generation is achieved through the execution of Jupyter Notebook Tutorials.

Here are the steps that will be required to complete this Tutorial:

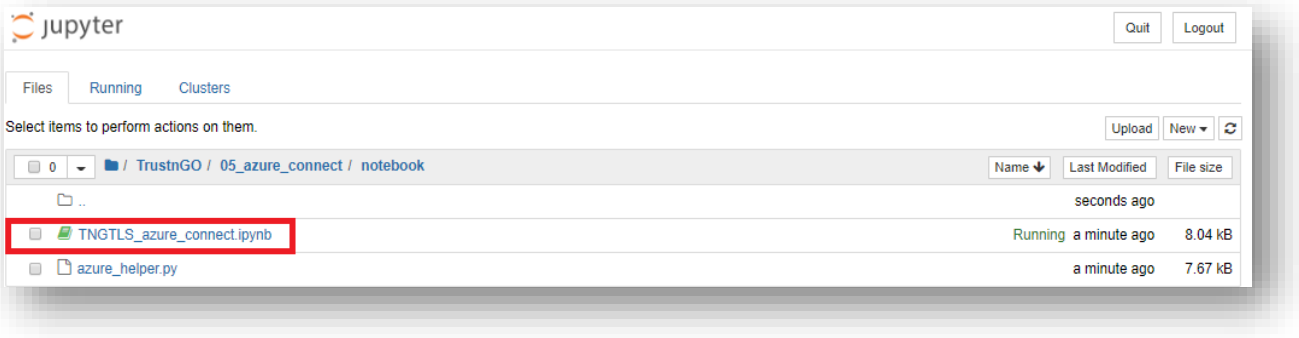
- Configure Azure CLI
- Register device
- Build the Azure IoT device source code and flash it to Crypto Auth Trust Platform Board

Note: It is required to have an Azure IoT test account setup. Instruction to setup the account quickly is provided in **docs\TrustFLEX_guide_Azure_demo_account_setup.pdf**. Once the account is setup, IoT hub HostName should be updated in **docs\Azure_iot_hub_details.csv**

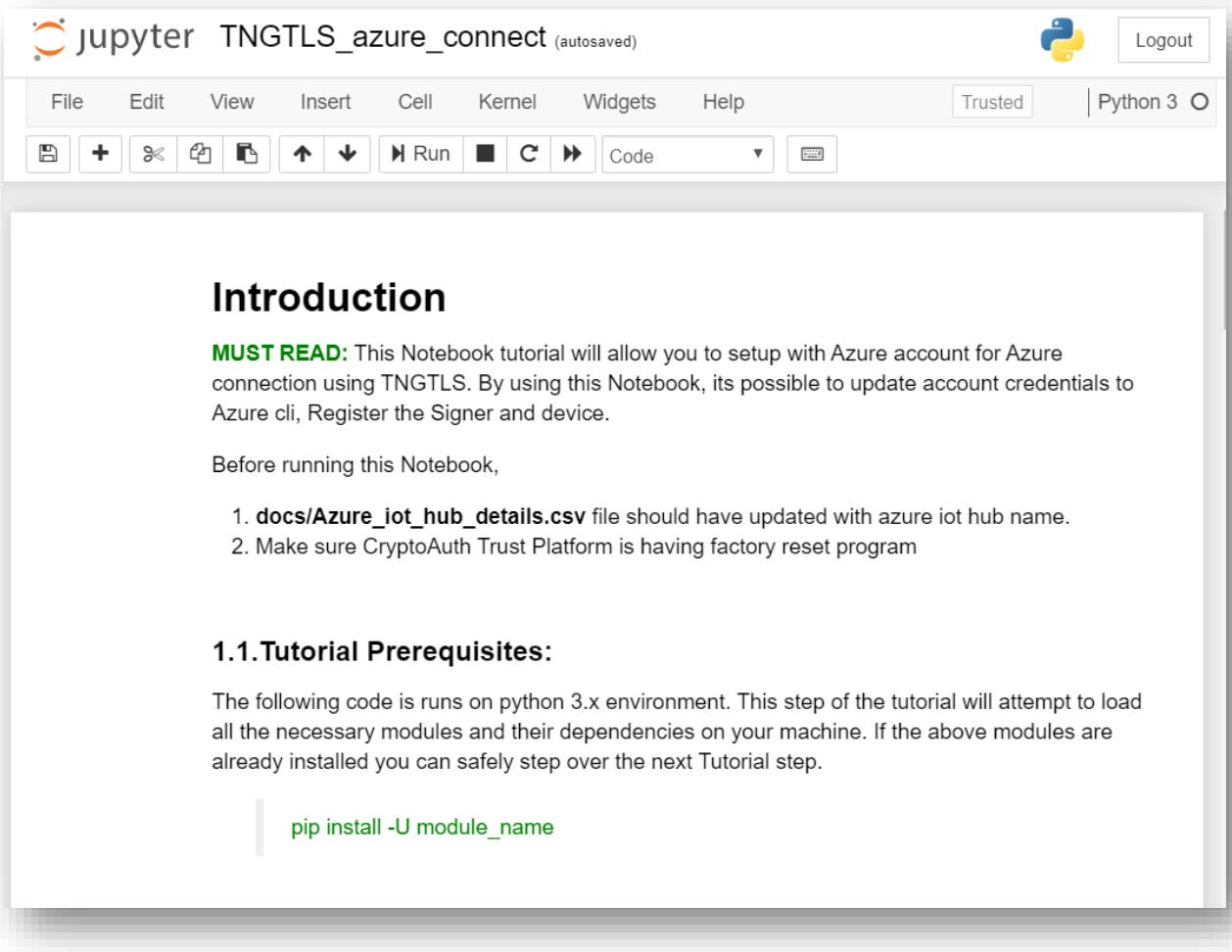
5.1 Running Azure connect example on Jupyter Notebook

By running this following step, we can configure the Azure command line with Azure credentials, register the device certificate to Azure IoT.

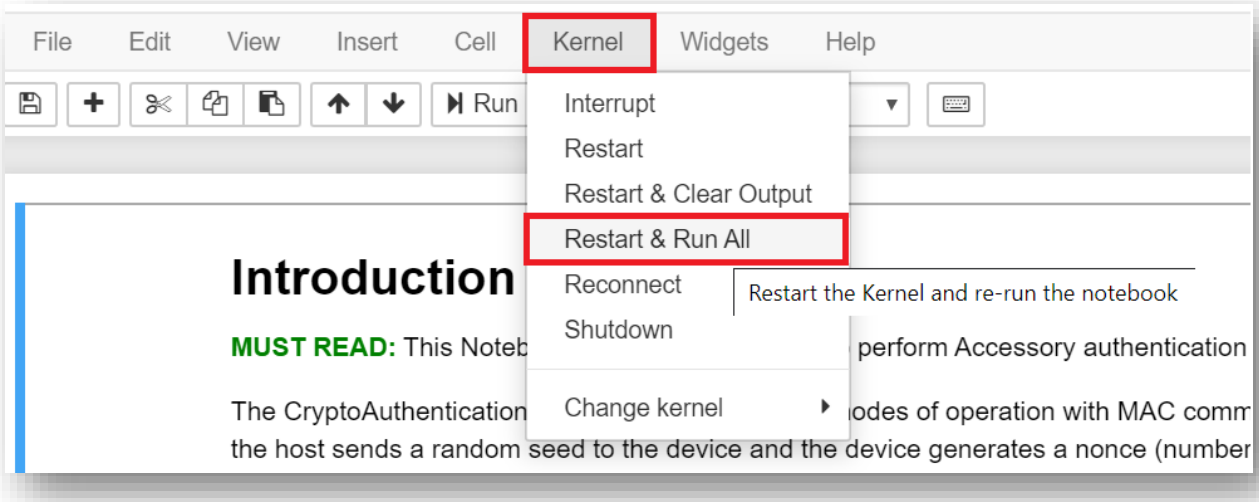
1. From the Jupyter Home page, navigate to **TrustnGO\05_cloud_connect\notebook\azure\TNGTLS_azure_connect.ipynb** notebook file and open it.



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



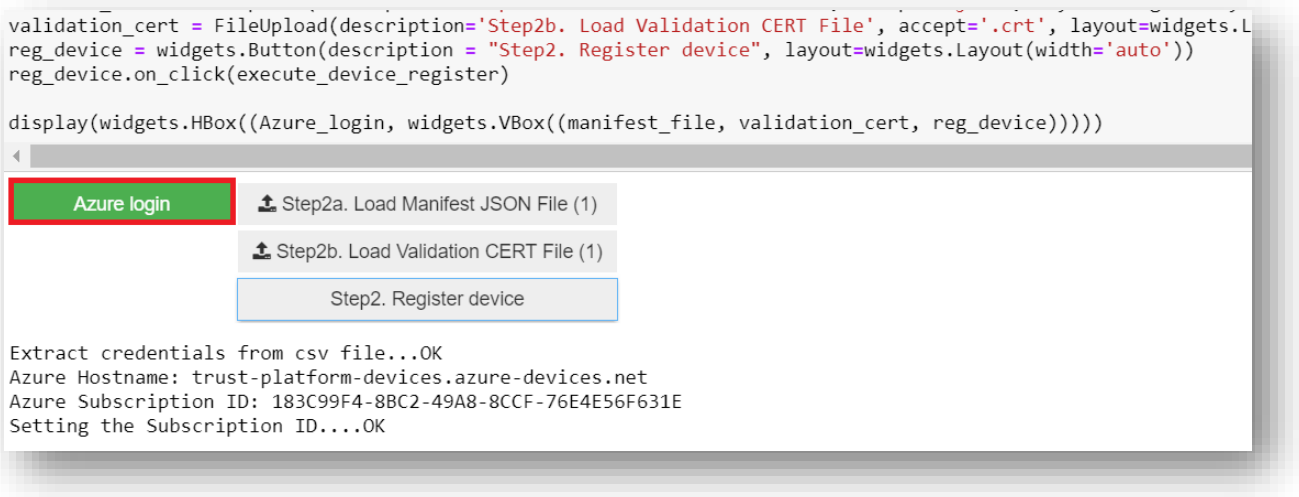
2. Run All cells by using Kernel -> Restart & Run all



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

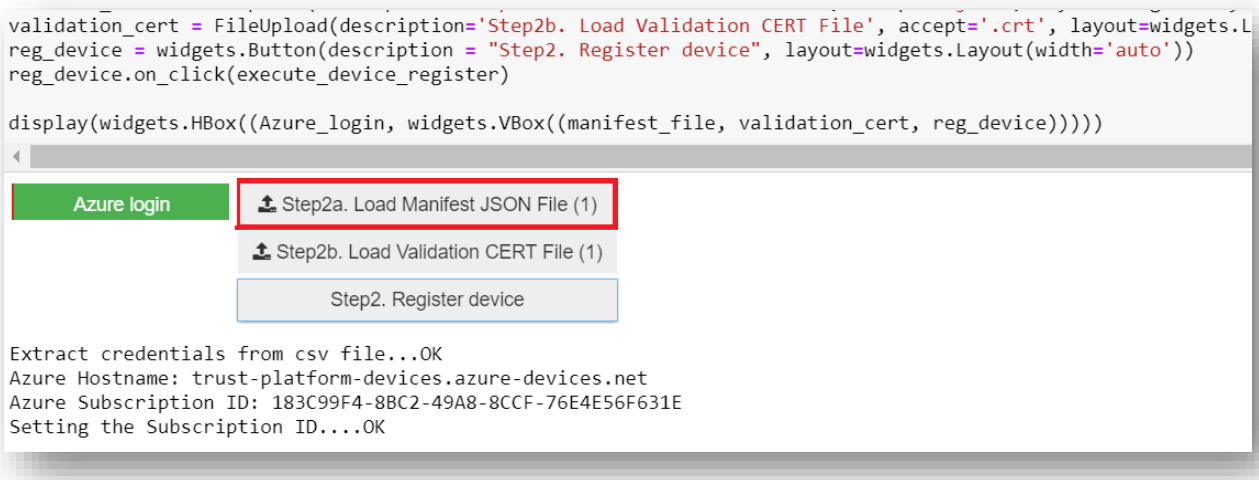
4. There are 2 major steps:
   Login to Azure account:
   Before we can interact with Azure, we need to login with the appropriate Azure credentials. These credentials are composed of the **azure account login**. Clicking the button will open azure login portal in new tab in browser. Enter the credentials of your account.

   Upon successful login, the log should appear like below screenshot.

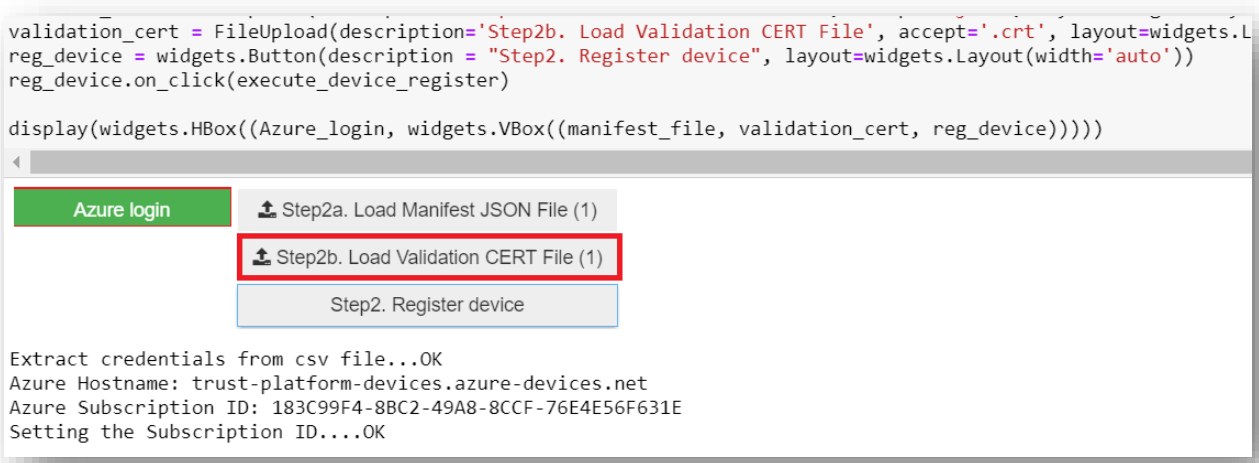


   Register Device:
   To register a device to Azure cloud, its required to have its manifest file and validation certificate. Both these will be generated as part of Trust&GO resource/manifest generation.

   1. Press "**Load Manifest JSON File**" button, it will open file explorer window, there you need to navigate **TrustnGO\00_resource_generation** and choose the manifest file generated using TNG Manifest Generation Notebook.



2. Press "**Load Validation CERT File**" button, it will open file explorer window, there you need to navigate **TrustnGO\00_resource_generation** and choose the validation certificate file generated using TNG Manifest Generation Notebook.

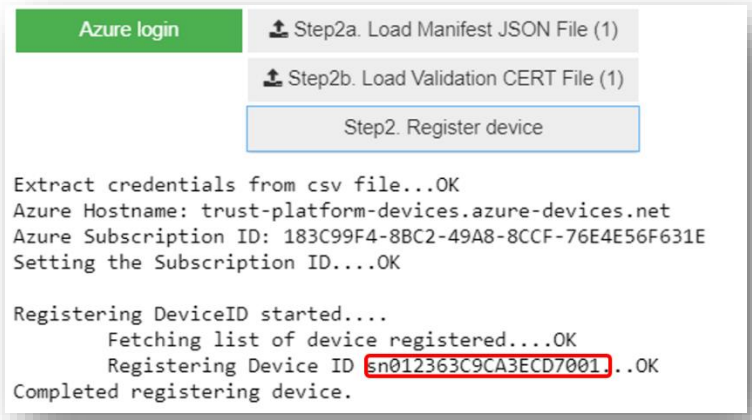


3. Press "**Register device**" button to register device using the information in Manifest file.

```
validation_cert = FileUpload(description='Step2b. Load Validation CERT File', accept='.crt', layout=widgets.L
reg_device = widgets.Button(description = "Step2. Register device", layout=widgets.Layout(width='auto'))
reg_device.on_click(execute_device_register)

display(widgets.HBox((Azure_login, widgets.VBox((manifest_file, validation_cert, reg_device)))))
```

Once it is successfully uploaded and registered device, the result will be as shown below.



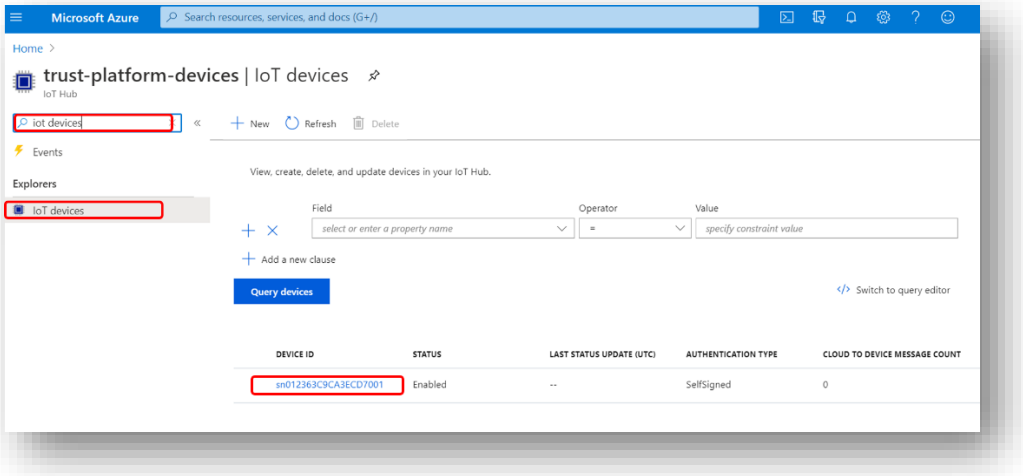
NOTE: Make sure that you executed C project successfully before executing the next step .To execute C project, refer "Running Azure connect example on Embedded platform" section.

Control Crypto Auth Trust Platform board LED from Azure Cloud

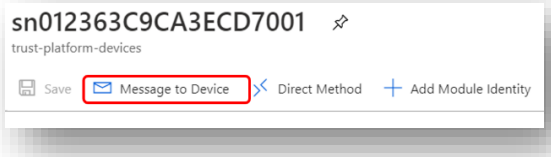
In this section we are going to control the status led on the Trust platform device from the Azure cloud.

1. In the https://portal.azure.com/ select your IoT hub created, search for "iot device" and select **IoT devices** from Explorers.

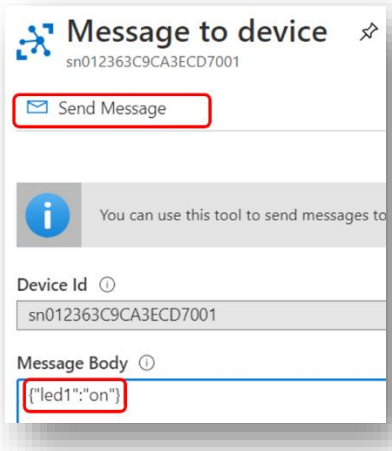
2. From the Device ID select the device id that want to be controlled. The Device ID Should be same as the highlighted one previous step **Register Device**

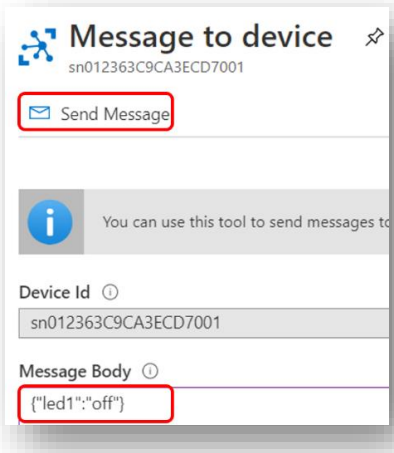


3. In the Device ID window, select the Message to Device



4. Now to Turn the led on or off the Trust platform board, paste the message ***{"led1":"on"}*** or ***{"led1":"off"}*** to the message body and click Send Message.





5.2 Running Azure connect example on Embedded platform

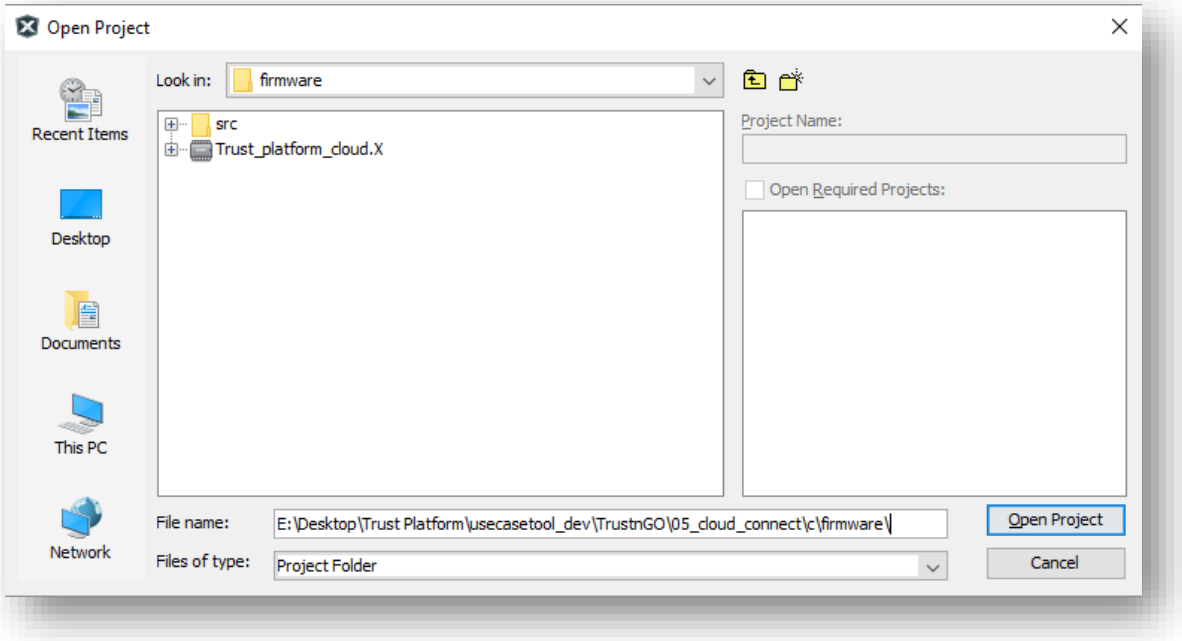
Once the device is registered MPLAB projects provided can be used to run the use case on Crypto Auth Trust Platform.

This project can configure the Wi-Fi credentials, establish a TLS connection, subscribe to MQTT. It is required to use the Azure IoT Jupyter notebook to register the signer module.

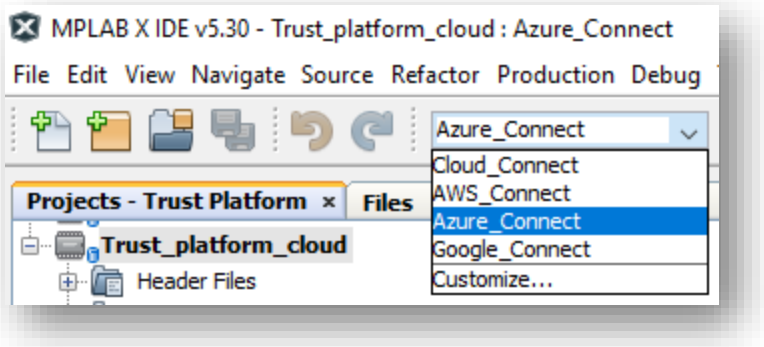
Prerequisite: It is required that WINC firmware is updated to latest version / version that is available in this package. Update the WINC firmware using package available in cloned repository at **assets\winc_firmware_upgrade**

5.2.1 MPLAB:

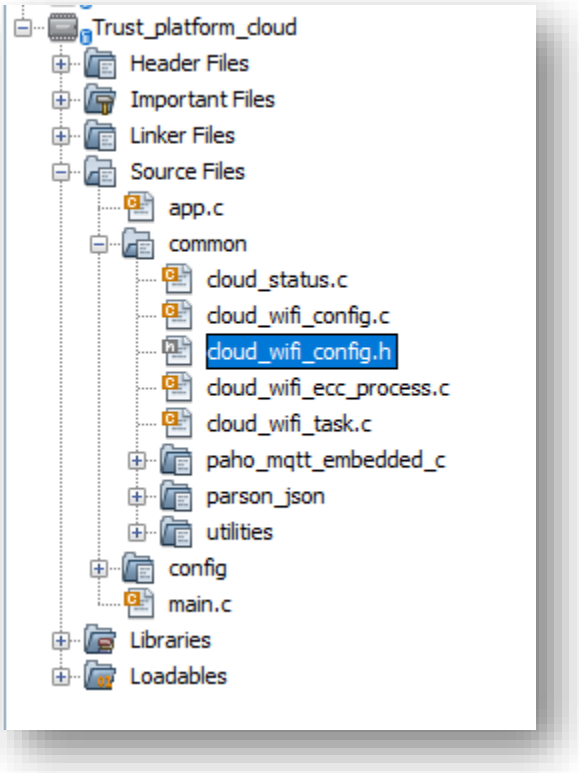
1. Open **Trust_platform_cloud.X** project by navigating to MPLAB -> File -> Open Project -> **TrustnGO\05_cloud_connect\firmware**



2. Select the Build configuration as Azure_Connect



3. Open **cloud_wifi_config.h file** by navigating to **Trust_patform_cloud-> Source Files ->common**

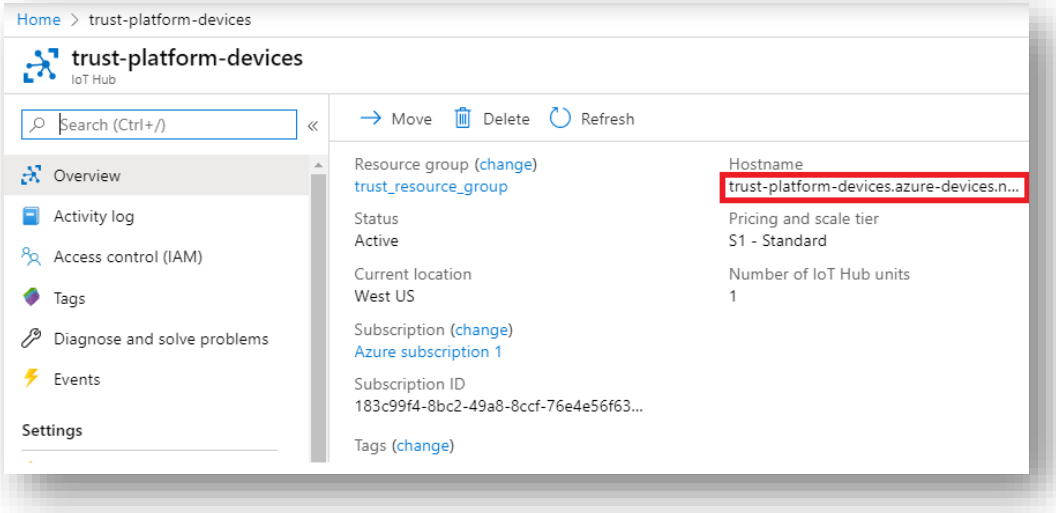


Update the following constants before building the project:

- MAIN_WLAN_SSID
- MAIN_WLAN_PSK
- CLOUD_ENDPOINT for CLOUD_CONFIG_AZURE

```
//#define WLAN_AUTH_OPEN
#define WLAN_AUTH_WPA_PSK
#define WLAN_SSID                       "xxxxxxxxxxxxxx"
#define WLAN_PSK                        "xxxxxxxxxxxxxx"
```

CLOUD_ENDPOINT string should be same as your account Hostname. Refer to following image for reference of this data.

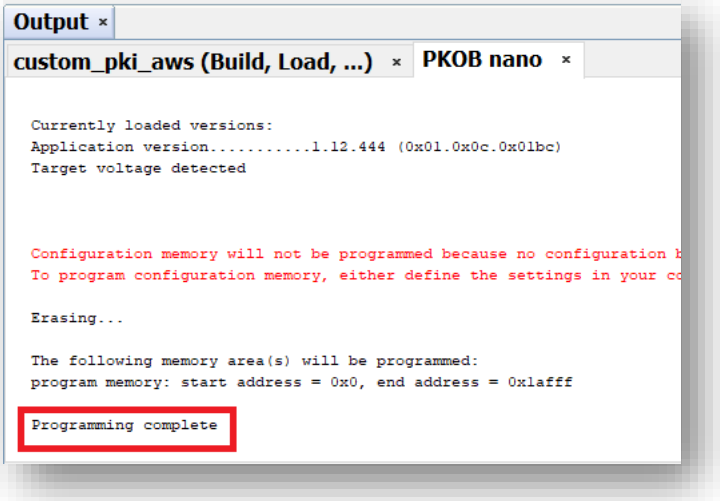


Update CLOUD_ENDPOINT with Hostname from above screen.

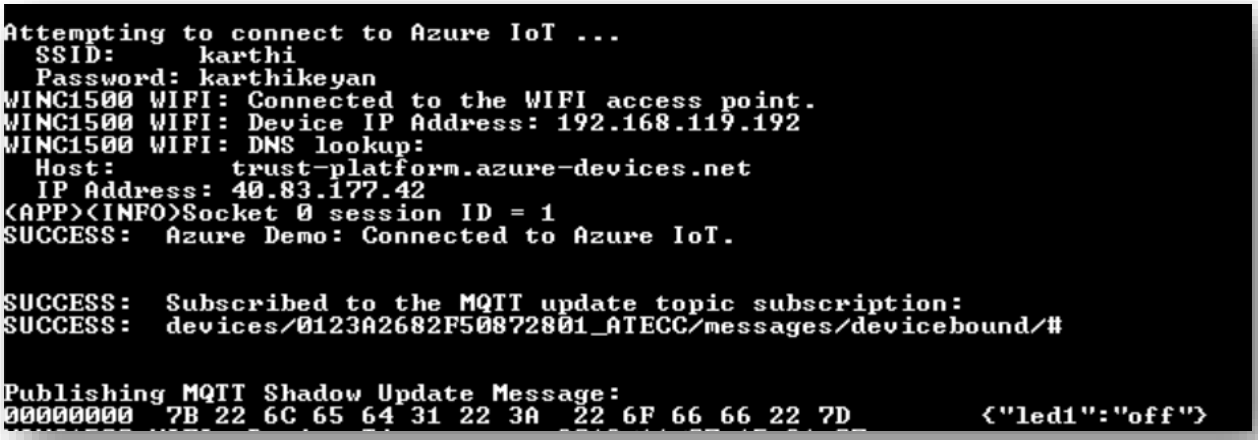
```
#elif defined(CLOUD_CONFIG_AZURE)
    #define SSL_CIPHER_SUITE_SELECTION      SSL_ECC_ALL_CIPHERS
    #define CLOUD_ENDPOINT                  "xxxxxxxxxxxxxx.azure-devices.net"
```

4. Program the CryptoAuth Trust platform by navigating to **Trust_platform_cloud -> 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, reset the hardware (press the reset button) and view the Console messages by using applications like 'Tera Term'. Open the application with the COM related to CryptoAuth Trust Platform with 115200-8-N-1 settings.



Once the device is connected go to Azure portal to control the LED status. Refer to DeviceControl for details.

5.3 Crypto Auth Trust Platform Factory reset

Once any of the embedded project is loaded to Crypto Auth Trust Platform, the default program that enables interaction with Trust Platform 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 in cloned repository at **assets\Factory_Program.X\CryptoAuth_Trust_Platform.hex**

If Trust Platform GUI is provided with MPLAB X IDE installation location, notebooks can program the Factory reset hex file if its not available by default.

This can also be done manually by MPLAB

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

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