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# TrustFLEX Step by Step Guide

## Google Cloud Platform Connect

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# 1 Introduction

This document gives a detailed walk through of connecting securely to Google Cloud Platform. If familiar with Jupyter Notebook, can skip this section and move to Section 2.

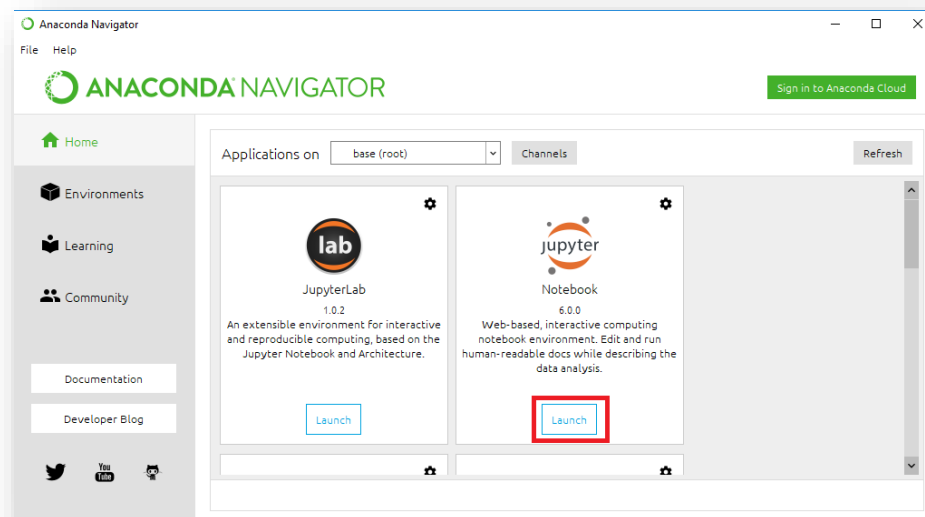
## 1.1 Getting started with Jupyter Notebook Tutorials

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 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 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 that explains 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 several Notebook Tutorials to easily prototype popular use cases for TrustFLEX and Trust&Go devices. Here is the list of Jupyter Notebook Tutorials.

<b>Jupyter Notebook Tutorials</b>	<b>Relative Path</b>	<b>Applicable devices</b>
Manifest Generation	TNGTLS_Manifest_Generation\notebooks\TNGTLS Manifest File Generation.ipynb	Trust&GO
Resource Generation	TFLXTLS_resource_generation\Crypto Resource Generator.ipynb	TrustFLEX
Accessory Authentication	TFLXTLS_Use_Cases\notebooks\accessory-authentication\Accessory Authentication.ipynb	TrustFLEX
AWS Custom PKI	TFLXTLS_Use_Cases\notebooks\aws-iot\aws-iot with ECC608A-TLFXTLS.ipynb	TrustFLEX
Firmware Validation	TFLXTLS_Use_Cases\notebooks\firmware-validation\Firmware Validation with ECC608A-TFLXTLS Tutorial.ipynb	TrustFLEX
IP Protection	TFLXTLS_Use_Cases\notebooks\ipprotection\IP Protection with ECC608A-TFLXTLS Tutorial.ipynb	TrustFLEX
Secure Public Key Rotation	TFLXTLS_Use_Cases\notebooks\public-key-rotation\Public Key Rotation with ECC608A-TFLXTLS Tutorial.ipynb	TrustFLEX
GCP Connect	TFLXTLS_Use_Cases\notebooks\gcp-iot\gcp-iot with ECC608A-TLFXTLS.ipynb	TrustFLEX

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## 3 Generate Manifest files

In the real scenarios, the Manifest files for Trust&GO and TrustFLEX should be downloaded from microchipDirect. Once devices have shipped, you will be able to download the Manifest file from your Microchip Purchasing & Client Services Account. The file can then be uploaded into your cloud service account.

Kits, demonstration boards do not ship with a Manifest file.

The following sections provide steps to generate manifest files for Trust&GO and TrustFLEX devices during prototyping the Usecases.

**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.

### 3.1 TrustFLEX – Manifest file generation

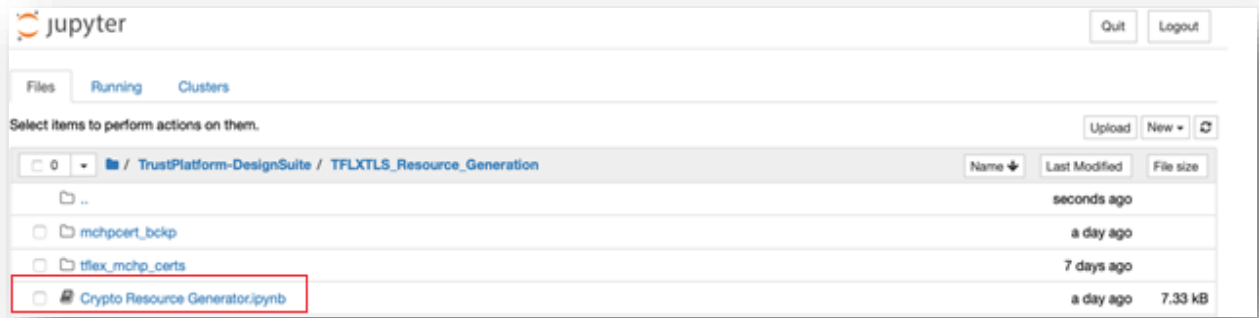
TFLXTLS device is one of the three devices available in the Trust Platform USB Dongle Board.

TrustFLEX devices come pre-programmed with 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 meaningful 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.

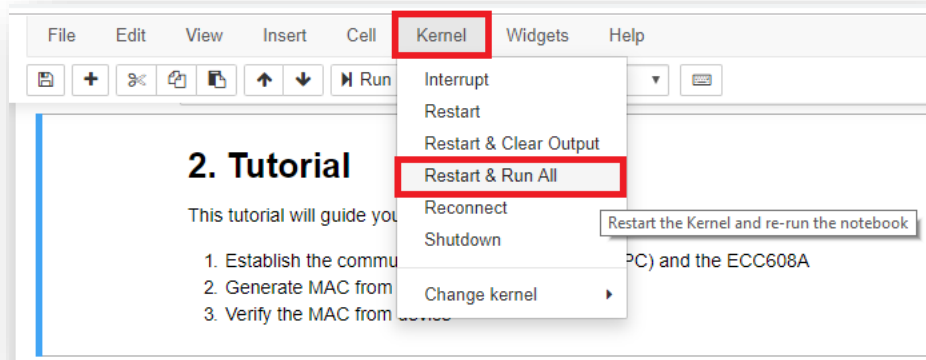
By default, Jupyter starts in Users directory (\$HOME for MacOS or Linux systems). For the remainder of this document, it will be assumed that the trust\_platform folder is contained in Users directory. If this is not the case, please move trust\_platform folder to your Users directory

Within the Jupyter Dashboard, navigate trust\_platform\DesignTools\TFLXTLS\_Resource\_Generation folder to open Crypto Resource Generator.ipynb notebook





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



It will execute and prompt you to choose between MCHP certificate and a custom certificate chain, enter '1' (default) and press Enter key.

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 resemble this:

Choose certificate type

- 1 - MCHP standard certificate
- 2 - Custom certificate

Enter certificate type

1

MCHP certificate related files are pre-generated

## MCHP certificates found in the device

## Backing up certificates from device

### Backing up certificates from device - Success

TFLXTLS Root Certificate:

Crypto Authentication Root CA 002

-----BEGIN CERTIFICATE-----

MIIB8TCCAqAwIBAgIQd9NtIW7IrmIF5Y46y5hagTAKBgqgghkJPQDDAjBPMSEw  
HwYDVQQKDBhNaWNyb2NoaXAqVGVjaG5vbG9neSBjb2N0aW9uX2NyeXB0

byBBdXRozW50aWNhdGlvbiBSb290IENBIDAwmJAgFw0xODExMDgxOTEyMTIlaGA8y  
MDU4MTEwODE5MTIxOVowTzEhMB8GA1UECgwYTWljcm9jaGlwIFRIY2hub2xvZ3kg  
SW5jMSowKAYDVQDDCFDcnlwdG8gQXV0aGVudGljYXRpb24gUm9vdCBDQSAwMDIw  
WTATBgcqhkJOPQIBBggqhkjOPQMBBwNCAAS9VOZt44dUhaBrU64VgNUKOGnnit9V  
eNhc4tVN1bgwKWv/3W5vclb72Z7xoRaxHTOtSRA6oYWHODz65DfhnWNOo1MwUTAd  
BgNVHQ4EFgQUeu19bca3eJ2yOAGI6EqMsKQOKowwHwYDVR0jBBgwFoAUeu19bca3  
eJ2yOAGI6EqMsKQOKowwHwYDVR0TAQH/BAUwAwEB/zAKBggqhkjOPQQDAgNIADBF  
AiEAodxjRZDsgZ7h3luBEmVRrdTCxPjllSgu4EvnaOx8AnMCID5rp06eTArWjCSw  
+y7nk9LmvpRlyhXQ6lvIf1V5mVyt  
-----END CERTIFICATE-----

TFLXTLS Root Public Key:

-----BEGIN PUBLIC KEY-----

MFkwEwYHKOZIZj0CAQYIKoZIZj0DAQcDQgAEvVTmbeOHVIQAa1OuFYDVCqBp54rf  
VXjYXOLVTdW4MClr/91ub3JW+9me8aEWsR0zrUkQOqGFhznC+uQ34Z1jTg==

-----END PUBLIC KEY-----

Validate Root Certificate:

OK

TFLXTLS Signer Certificate:

Crypto Authentication Signer F630

-----BEGIN CERTIFICATE-----

MIIcBTCCAaaggAwIBAgIQRcJ1QIEEuMwF/Gi5b8JPqjAKBggqhkjOPQQDAjBPMSEw  
HwYDVQKDBhNaWNyb2NoaXAgaGVudGljYXRpb24gU2lnbmVvIEY2MzAw  
byBBdXRozW50aWNhdGlvbiBSb290IENBIDAwmJAgFw0xODEyMTQxOTAwMDBaGA8y  
MDQ5MTIxNDE5MDAwMFowTzEhMB8GA1UECgwYTWljcm9jaGlwIFRIY2hub2xvZ3kg  
SW5jMSowKAYDVQDDCFDcnlwdG8gQXV0aGVudGljYXRpb24gU2lnbmVvIEY2MzAw  
WTATBgcqhkJOPQIBBggqhkjOPQMBBwNCAAR8oS1bpUPChuYczcWZTuxiSzPpkzes  
7M4I2mewk6bwN/1p1NR0P/JFIKrOfcGuSKh0HUhd5c0PKdpGzA9jz2+Fo2YwZDAO  
BgNVHQ8BAf8EBAMCAYYwEgYDVR0TAQH/BAgwBgEB/wIBADAdBgNVHQ4EFgQUUuHOL  
JSono8MbKMMSEhWEP9UsE0QwHwYDVR0jBBgwFoAUeu19bca3eJ2yOAGI6EqMsKQO  
KowwCgYIKoZIZj0EAWIDSQAwwRgIhAL9CT/kQFEpVZnSdjZKvE59yrkKh9GwIYerh  
EmFrKTIAMiEA4BdsNsIGQwSFAecmt1vRqWWPP7DxVssCevcwOgTbE7Y=  
-----END CERTIFICATE-----

TFLXTLS Signer Public Key:

-----BEGIN PUBLIC KEY-----

MFkwEwYHKOZIZj0CAQYIKoZIZj0DAQcDQgAEfKEtW6VDwobmHM3FmU7sYksZ8ZM3  
rOzOCNpnsJOm8Df9adTUdD/yRSCqzhXBrkiodB1IXeXNDynaRswPY89vhQ==

-----END PUBLIC KEY-----

Validate Signer Certificate:

OK

TNG Device Certificate:

0123B667EC7AC4DA01 ATECC

-----BEGIN CERTIFICATE-----

MIIIB9TCCAzuAwIBAgIQV94yUCHK+/wNLP3DIVdzBDAKBggqhkjOPQQDAjBPMSEw  
HwYDVQKDBhNaWNyb2NoaXAgaGVudGljYXRpb24gU2lnbmVvIEY2MzAw  
byBBdXRozW50aWNhdGlvbiBTaWduZXIgaRjYzMDAgFw0xOTA3MzEwMDAwMDBaGA8y  
MDQ3MDczMTAwMDAwMFowRjEhMB8GA1UECgwYTWljcm9jaGlwIFRIY2hub2xvZ3kg  
SW5jMSEwHwYDVQDDBgwMTIzQjY2N0VDN0FDNERBMDEgQVRFRQ0MwWTATBgcqhkJOPQIBBggqhkjOPQMBBwNCAASsxZ5jWD6Jf0GJiAnti875Gr6thjscngIJjb2JwIXW

---

```
Z8CM9FUKcV7cQudAjWfeRn2vmXfZUicUXiLX6ZpeTpDgo2AwXjAMBgNVHRMBAf8E
AjAAMA4GA1UdDwEB/wQEAwIDiDAdBgNVHQ4EFgQUjtfazq7y8JxjZOL8XH00O1Aj
XwIwHwYDVR0jBBgwFoAUUhOLJSono8MbkMMSEhwEP9UsE0QwCgYIKoZIzj0EAwID
SAAwRQIgEXG+riBBipRRJPhdd8AKlj4vFs0q8dswVv3sTk8LIOUCIQCvQYjNb2cR
hRCvAh50ZawONNAxGfdgJMYvyZHK8E2/xg==
-----END CERTIFICATE-----
```

```
TFLXTLS Device Public Key:
-----BEGIN PUBLIC KEY-----
MFkwEwYHKoZIzj0CAQYIKoZIzj0DAQcDQgAErMWeY1g+iX9BiYgJ7YvO+Rq+rYY7
HJ4CCY29icCF1mfAjPRVCnFe3ELnQI1n3kZ9r5I32VInFF4i1+maXk6Q4A==
-----END PUBLIC KEY-----
```

```
Validate Device Certificate:
OK
```

```
reading slot 0 public key
reading slot 1 public key
reading slot 2 public key
reading slot 3 public key
reading slot 4 public key
```

```
Generated the manifest file 0123b667ec7ac4da01_manifest.json
```

```
-----
```

```
Certificate related steps completed successfully
```

```
-----
```

The Notebook has also generated a manifest file (xxxxxxx\_manifest.json) to be uploaded into the public cloud of your choice (Google GCP, AWS IoT and soon to be supported Microsoft Azure).

## 4 Use Case Prototyping

This hands-on lab is intended to demonstrate the usage of TrustFLEX/Trust&GO to secure a Google Cloud Platform connection.

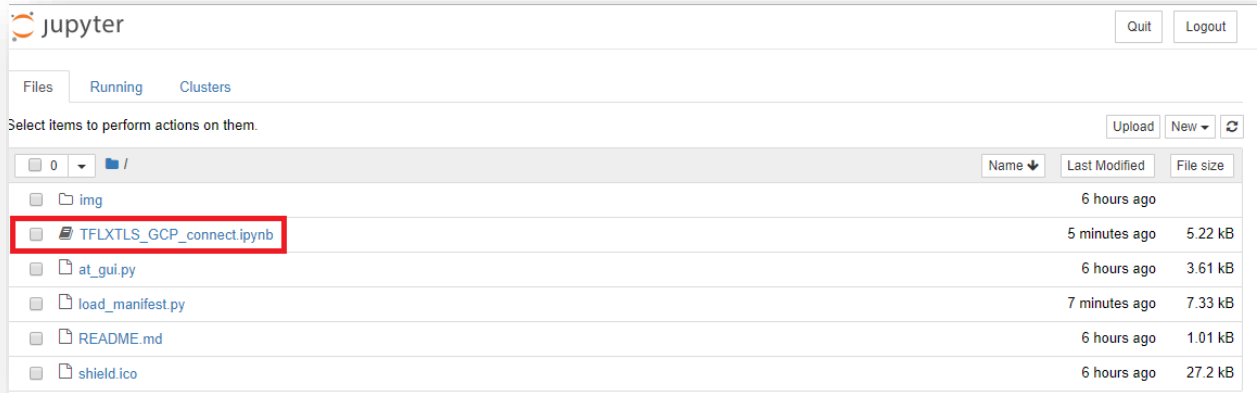
The reference implementation is provided with Embedded projects and Notebooks. The generation of manifest can be achieved through the execution of Jupyter Notebook Tutorials.

**Note:** It is required to have Google account test account setup prior to running this. Instruction to setup the account is provided in **Docs\TrustFLEX GCP Account setup instructions.pdf**.

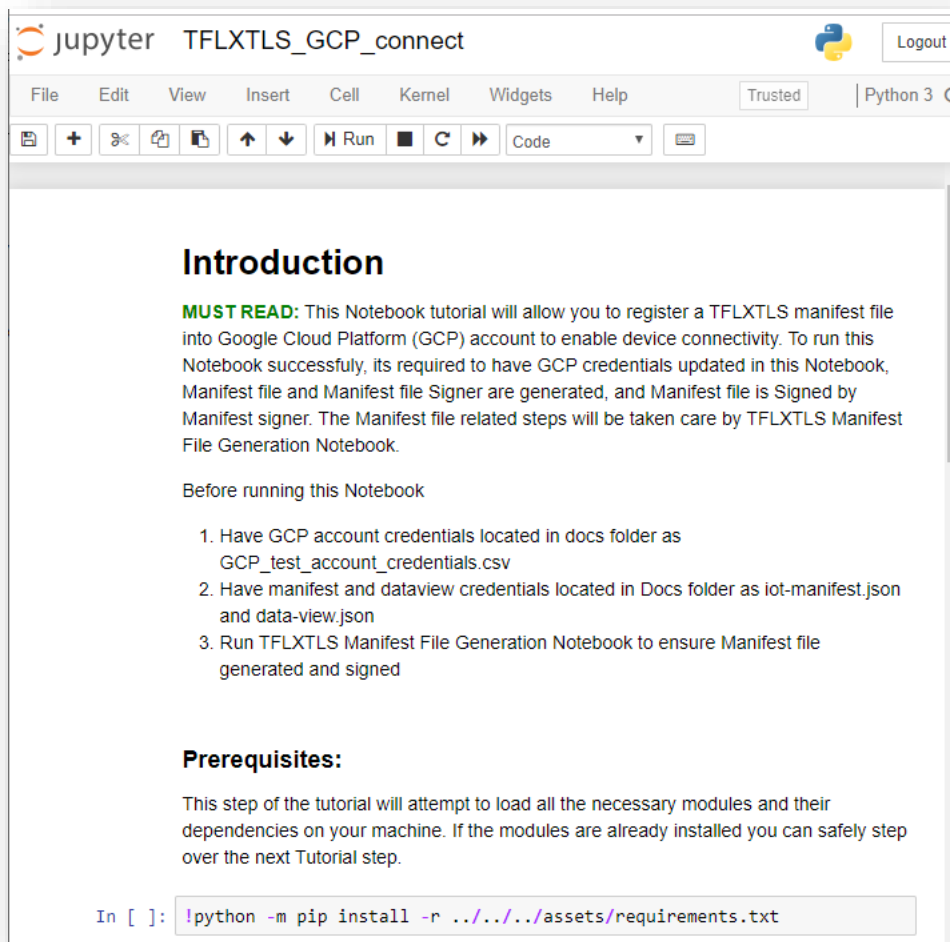
### 4.1 Running GCP example on Jupyter Notebook

By running this step, one should be able to register the secure element to Google account by uploading device manifest file generated in the previous section. To run this Notebook, its required to have device manifest file (generated in previous section), google account credentials for manifest and data view (saved as part of GCP account setup).

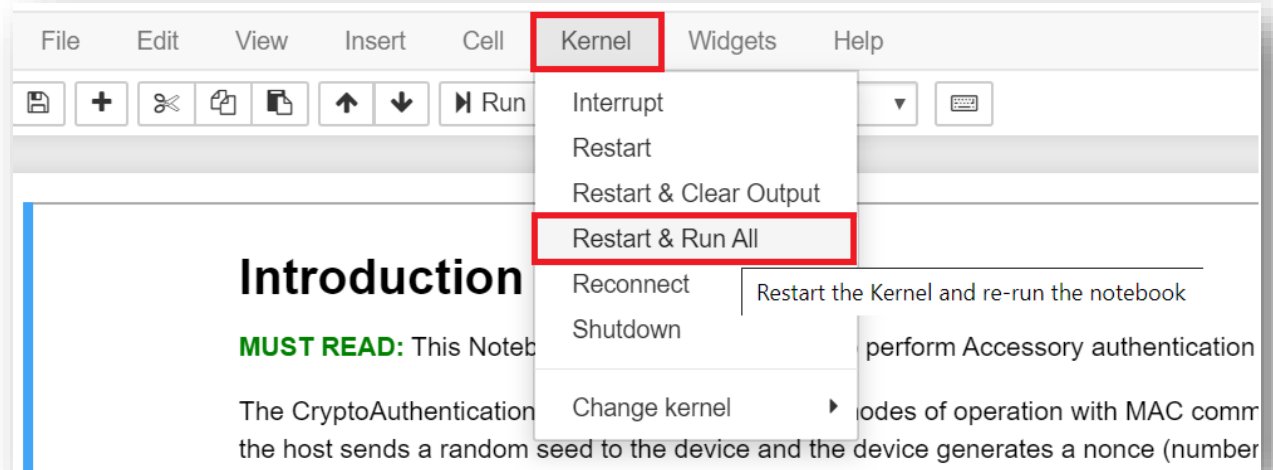
1. From the Jupyter Home page, navigate to **TrustFLEX\03\_gcp\_connect\notebook\TFLXTLS\_GCP\_connect.ipynb** notebook file and open it.



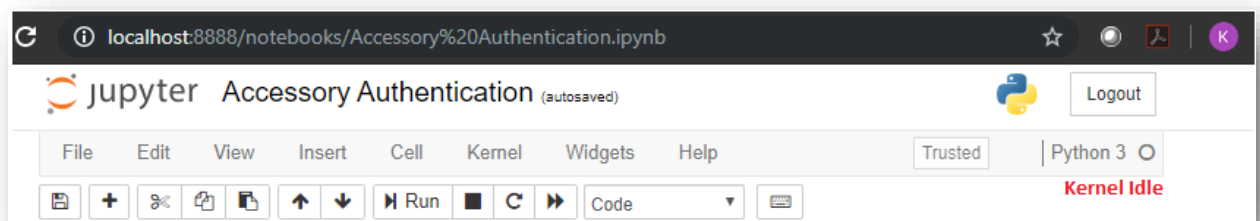
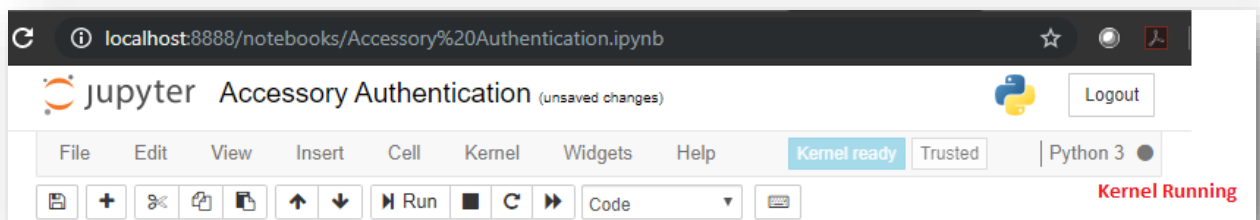
Opening the Jupyter notebook example should load the following on the browser.



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



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)



3. Navigate through different cells output for the description of the step and result from the execution.
4. There are 3 major steps:  
Load Manifest File:  
Under the section **Upload Manifest File**, click the button '**Load Manifest JSON File**' and select the manifest file generated from the TrustFlex Resource generation notebook.

---

Step1a. Load Manifest JSON File (1)

Load validation certificate:

click the button '**Load Validation CERT File**' and select the validation certificate which signed the manifest file and it should be present in the following folder with name log\_signer.crt

For TrustFLEX – TrustFLEX\00\_resource\_generation\

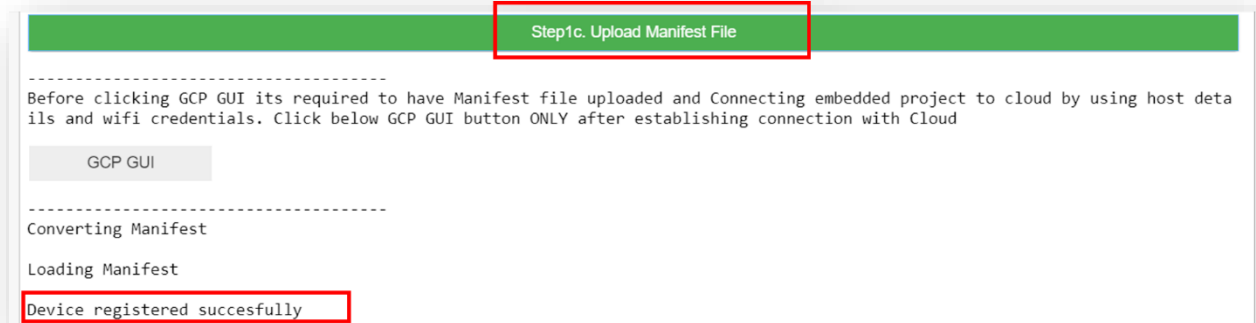
For Trust&GO - TrustnGO\00\_resource\_generation\

Step1b. Load Validation CERT File (1)

Register device manifest file:

Code block of this step generates "**Upload manifest File**" button. Clicking the button, it registers the device manifest file to the GCP account. Once the manifest file is registered, the gcp cloud authorizes the Trust Platform device and it will be able to communicate to them.

Upon successful execution, the log should look like this.



**WARNING:** It is required to execute C project successfully before executing the next step in the Jupyter notebook. To execute C project, refer "[Running GCP IoT example on Embedded platform](#)" next section.

GCP GUI:

Code block of this step generates "**GCP GUI**" button. Clicking the button, it will create a very basic graphical interface that will display the trust platform board LED status.

Below screenshot display the graphical interface

Microchip GCP Example		
Project	karthi-demo	
Registry	karthi_regid	
Region	us-central1	
2019-10-10 18:12:09	d01230F56F23B90ED01	Led_Status: ON
2019-10-10 18:12:14	d01230F56F23B90ED01	Led_Status: OFF
2019-10-10 18:12:19	d01230F56F23B90ED01	Led_Status: ON
2019-10-10 18:12:24	d01230F56F23B90ED01	Led_Status: OFF

This GUI displays the packets exchanged between CryptoAuth Trust Platform and GCP.



---

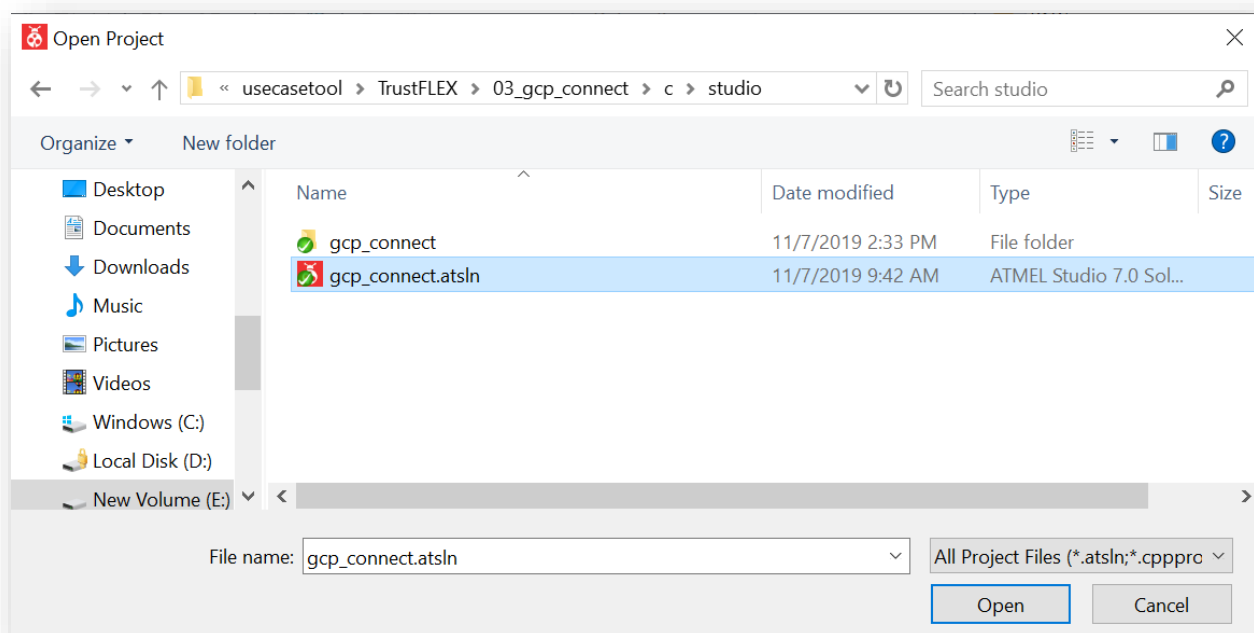
## 4.2 Running GCP example on Embedded platform

Once the resources are generated and manifest file uploaded to GCP account, both Atmel Studio and MPLAB projects provided can be used to run the use case on CryptoAuth Trust Platform.

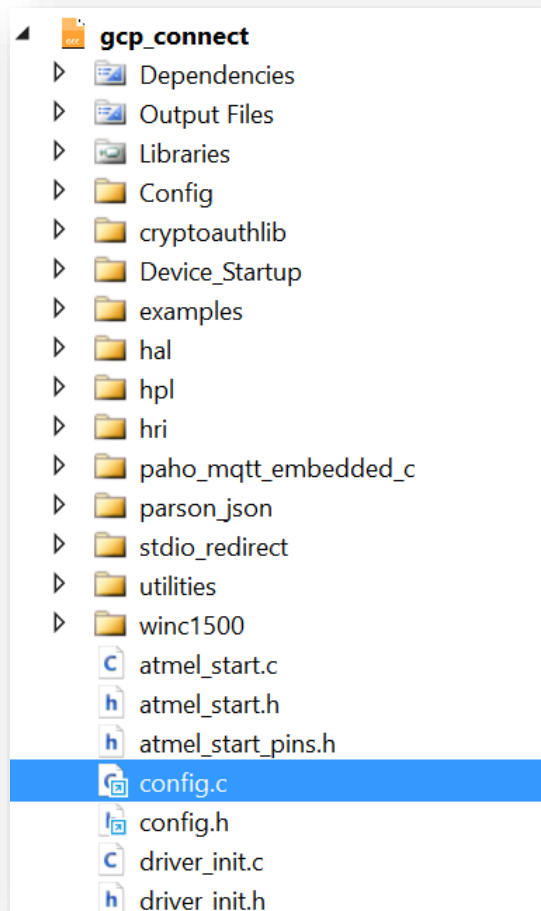
This project establishes a TLS connection and subscribe to MQTT. It is required to use the GCP IoT Jupyter notebook to register the device through manifest file. Prior to executing the application, it is required to update Wifi credentials, GCP account details. Following steps provides the instructions for the same,

### 4.2.1 Atmel Studio:

1. Open **gcp\_connect.atsln** project by navigating **TrustFLEX\03\_gcp\_connect\c\studio\gcp\_connect.atsln**



2. In the project navigate to **gcp\_connect -> config.c** file



update the following constants before building the project:

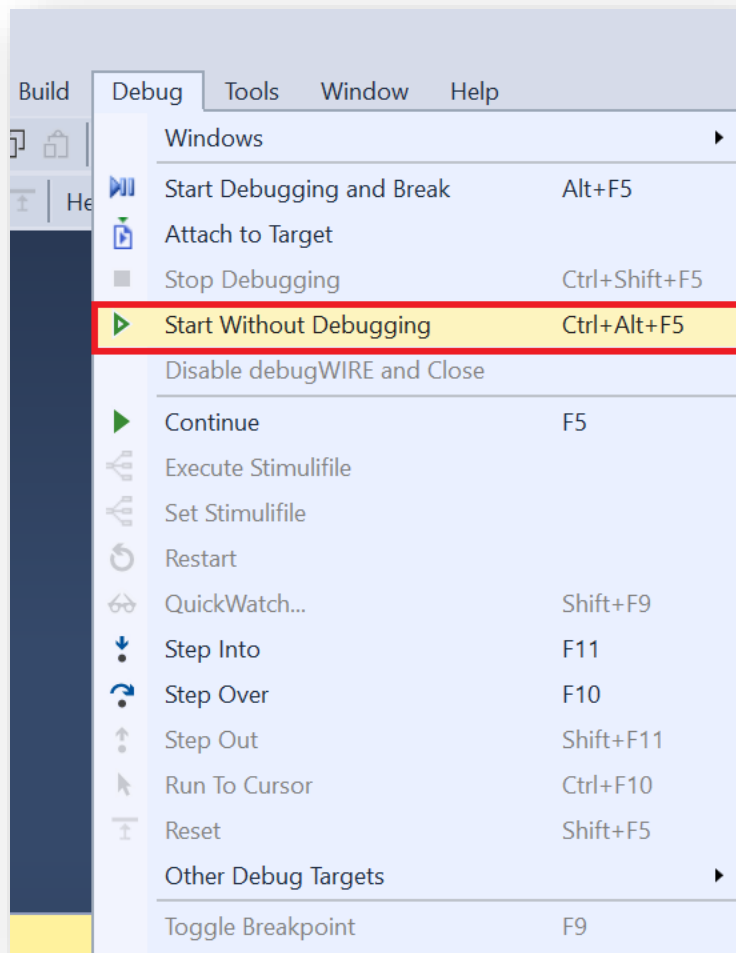
The project id, region id and registry id should be same as in the gcp account setup.

- config\_demo\_ssid
- config\_demo\_pass
- config\_gcp\_project\_id
- config\_gcp\_region\_id
- config\_gcp\_registry\_id

```
/* Example Configuration Data Global Variables */
const char config_demo_ssid[] = "xxxxxxxxx";
const char config_demo_pass[] = "xxxxxxxxx";

const char config_gcp_project_id[] = "xxxxxxxxx";
const char config_gcp_region_id[] = "xxxxxxxxx";
const char config_gcp_registry_id[] = "xxxxxxxxx";
```

- 
3. Program the CryptoAuth 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, 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.

```

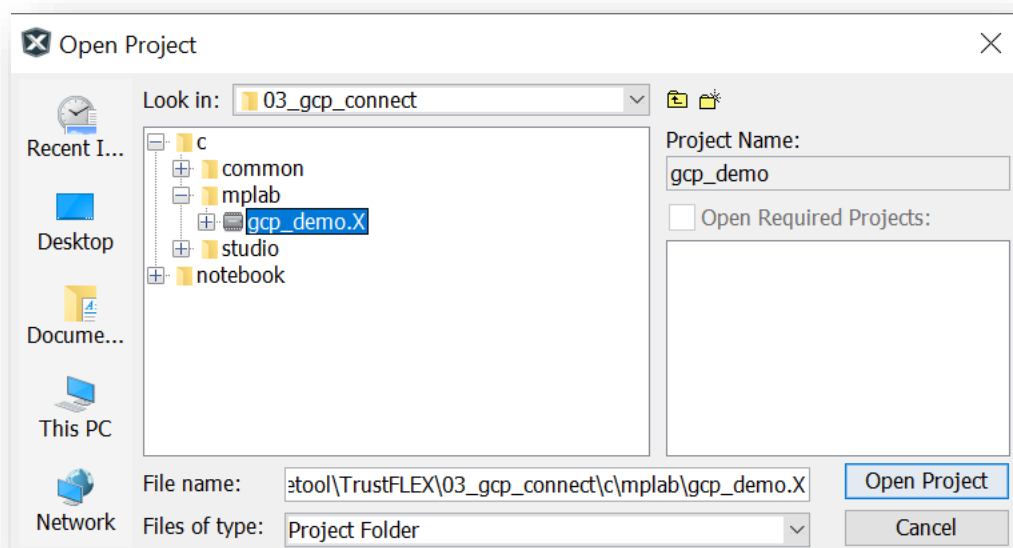
COM35 - Tera Term VT
File Edit Setup Control Window Help
00000000 7B 20 22 74 69 6D 65 73 74 61 6D 70 22 3A 20 31 < "timestamp": 1
00000010 35 37 30 37 31 31 38 33 35 2C 20 22 4C 65 64 5F 570711835, "Led_
00000020 53 74 61 74 75 73 22 3A 20 22 4F 4E 22 7D Status": "ON">
Publishing MQTT Shadow Update Message:
00000000 7B 20 22 74 69 6D 65 73 74 61 6D 70 22 3A 20 31 < "timestamp": 1
00000010 35 37 30 37 31 31 38 34 30 2C 20 22 4C 65 64 5F 570711840, "Led_
00000020 53 74 61 74 75 73 22 3A 20 22 4F 46 46 22 7D Status": "OFF">
Publishing MQTT Shadow Update Message:
00000000 7B 20 22 74 69 6D 65 73 74 61 6D 70 22 3A 20 31 < "timestamp": 1
00000010 35 37 30 37 31 31 38 34 35 2C 20 22 4C 65 64 5F 570711845, "Led_
00000020 53 74 61 74 75 73 22 3A 20 22 4F 4E 22 7D Status": "ON">

```

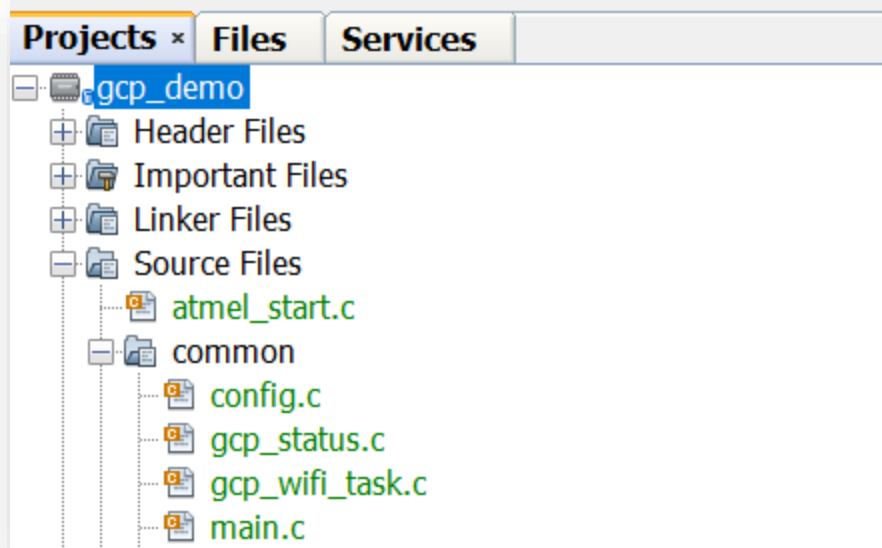
Once successfully programmed the CryptoAuth Trust Platform, navigate to previous section 1.7 to run the [last step \(GCP GUI\)](#) in the Jupyter Notebook.

#### 4.2.2 MPLAB:

1. Open **gcp\_demo.X** project by navigating to MPLAB -> File -> Open Project -> **TrustFLEX\03\_gcp\_connect\c\mplab\gcp\_demo.X**



2. Open **config.c** file by navigating to **gcp\_demo-> Source Files ->common->config.c**

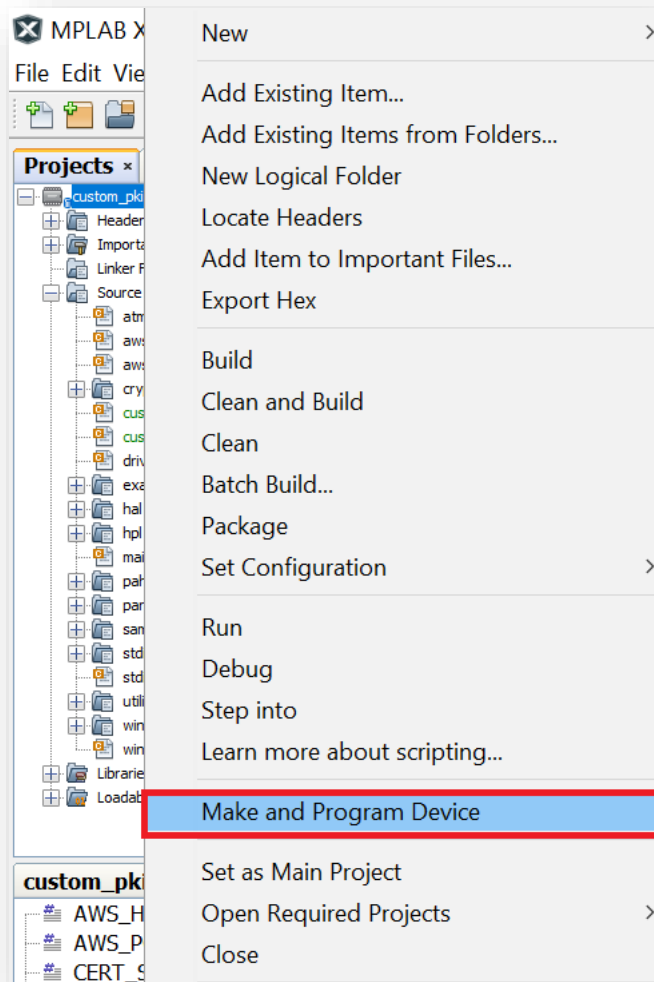


update the following constants before building the project:  
The project id, region id and registry id should be same as in the gcp account setup.

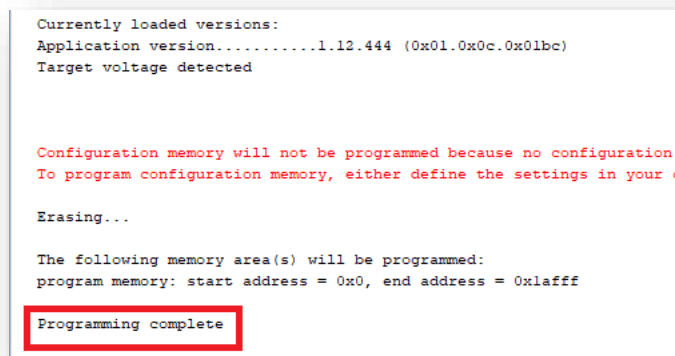
- config\_demo\_ssid
- config\_demo\_pass
- config\_gcp\_project\_id
- config\_gcp\_region\_id
- config\_gcp\_registry\_id

```
/* Example Configuration Data Global Variables */  
const char config_demo_ssid[] = "xxxxxxxxx";  
const char config_demo_pass[] = "xxxxxxxxx";  
  
const char config_gcp_project_id[] = "xxxxxxxxx";  
const char config_gcp_region_id[] = "xxxxxxxxx";  
const char config_gcp_registry_id[] = "xxxxxxxxx";
```

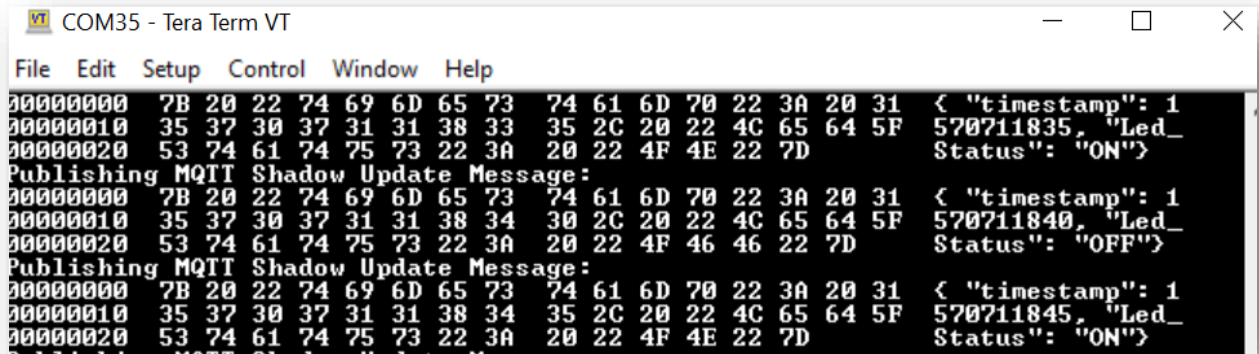
3. Program the CryptoAuth Trust platform by navigating to **gcp\_connect -> Make and Program Device**



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.



The screenshot shows a Tera Term window titled 'COM35 - Tera Term VT'. The window displays a series of MQTT Shadow Update messages. Each message is preceded by a hex dump of the raw data. The messages are as follows:

```
00000000 7B 20 22 74 69 6D 65 73 74 61 6D 70 22 3A 20 31 < "timestamp": 1
00000010 35 37 30 37 31 31 38 33 35 2C 20 22 4C 65 64 5F 570711835, "Led_
00000020 53 74 61 74 75 73 22 3A 20 22 4F 4E 22 7D Status": "ON">
Publishing MQTT Shadow Update Message:
00000000 7B 20 22 74 69 6D 65 73 74 61 6D 70 22 3A 20 31 < "timestamp": 1
00000010 35 37 30 37 31 31 38 34 30 2C 20 22 4C 65 64 5F 570711840, "Led_
00000020 53 74 61 74 75 73 22 3A 20 22 4F 46 46 22 7D Status": "OFF">
Publishing MQTT Shadow Update Message:
00000000 7B 20 22 74 69 6D 65 73 74 61 6D 70 22 3A 20 31 < "timestamp": 1
00000010 35 37 30 37 31 31 38 34 35 2C 20 22 4C 65 64 5F 570711845, "Led_
00000020 53 74 61 74 75 73 22 3A 20 22 4F 4E 22 7D Status": "ON">
```

Once successfully programmed the CryptoAuth Trust Platform, navigate to previous section 1.7 to run the [last step \(GCP GUI\)](#) in the Jupyter Notebook.

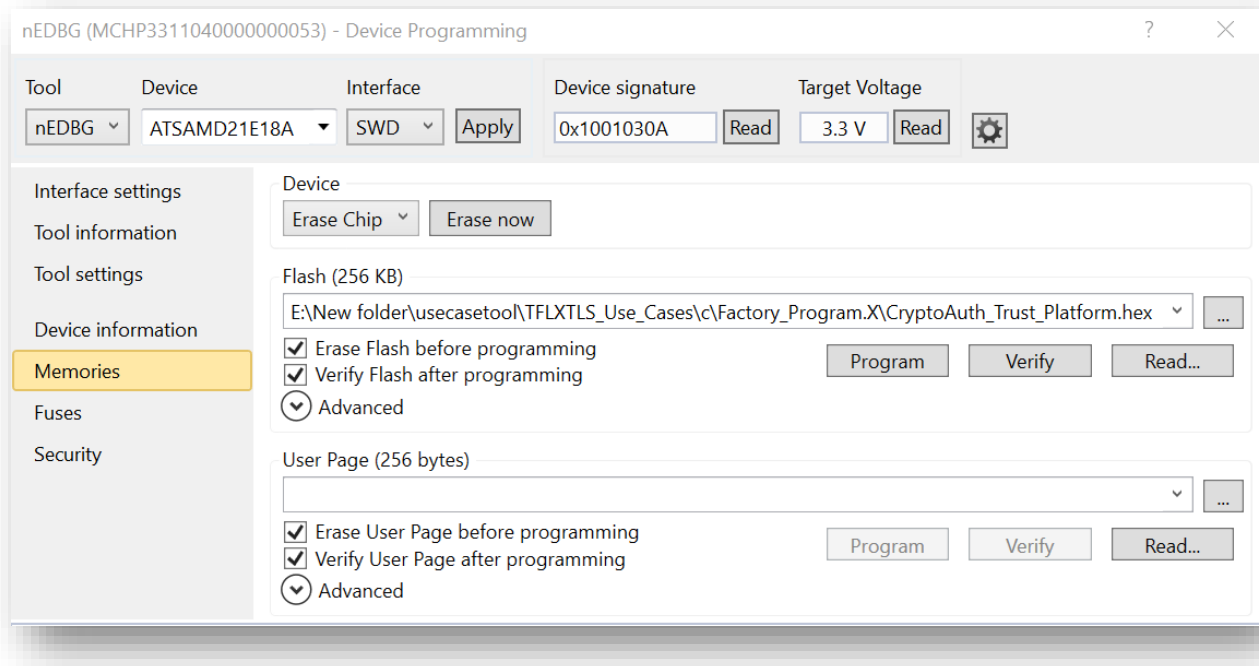
### 4.3 CryptoAuth Trust Platform Factory reset

If any embedded project is loaded to CryptoAuth Trust Platform, the default program that enables interaction with CryptoAuth Trust Platform tools will be erased.

Before using the CryptoAuth Trust Platform with any other notebook or tools on PC, its required to reprogram the default firmware. Default hex file is available at **TFLXTLS\_Use\_Cases\c\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 **TFLXTLS\_Use\_Cases\c\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, CryptoAuth Trust Platform contains factory application that enables interactions with Notebooks and/or PC tools.



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## 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.

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