TrustFLEX Step by Step Guide
Firmware Validation

Table of Contents

1 Introduction

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

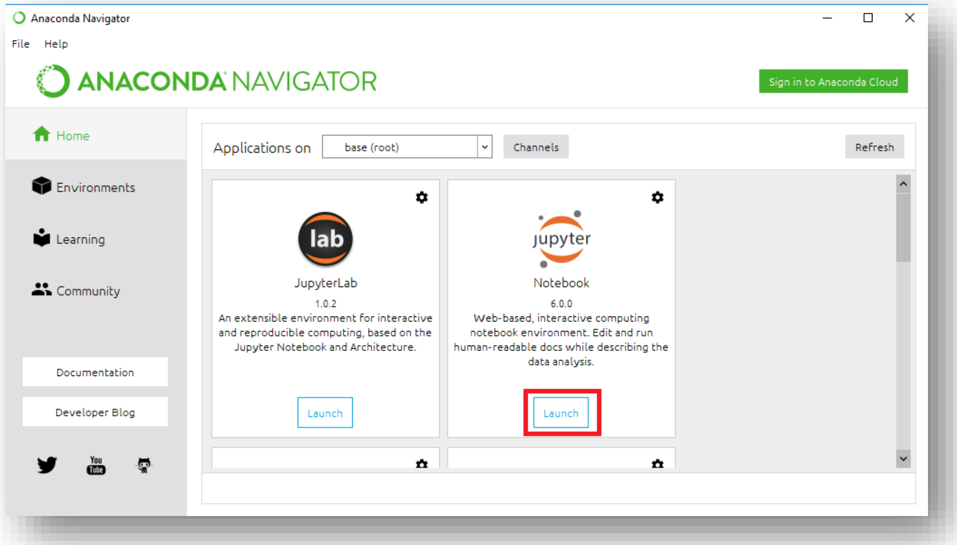
1.1 Getting started with Jupyter Notebook Tutorials

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.



An extensible environment for interactive and reproducible computing, based on the Jupyter Notebook and Architecture.

Web-based, interactive computing notebook environment. Edit and run human-readable docs while describing the data analysis.

1.2 Jupyter Notebook Basics

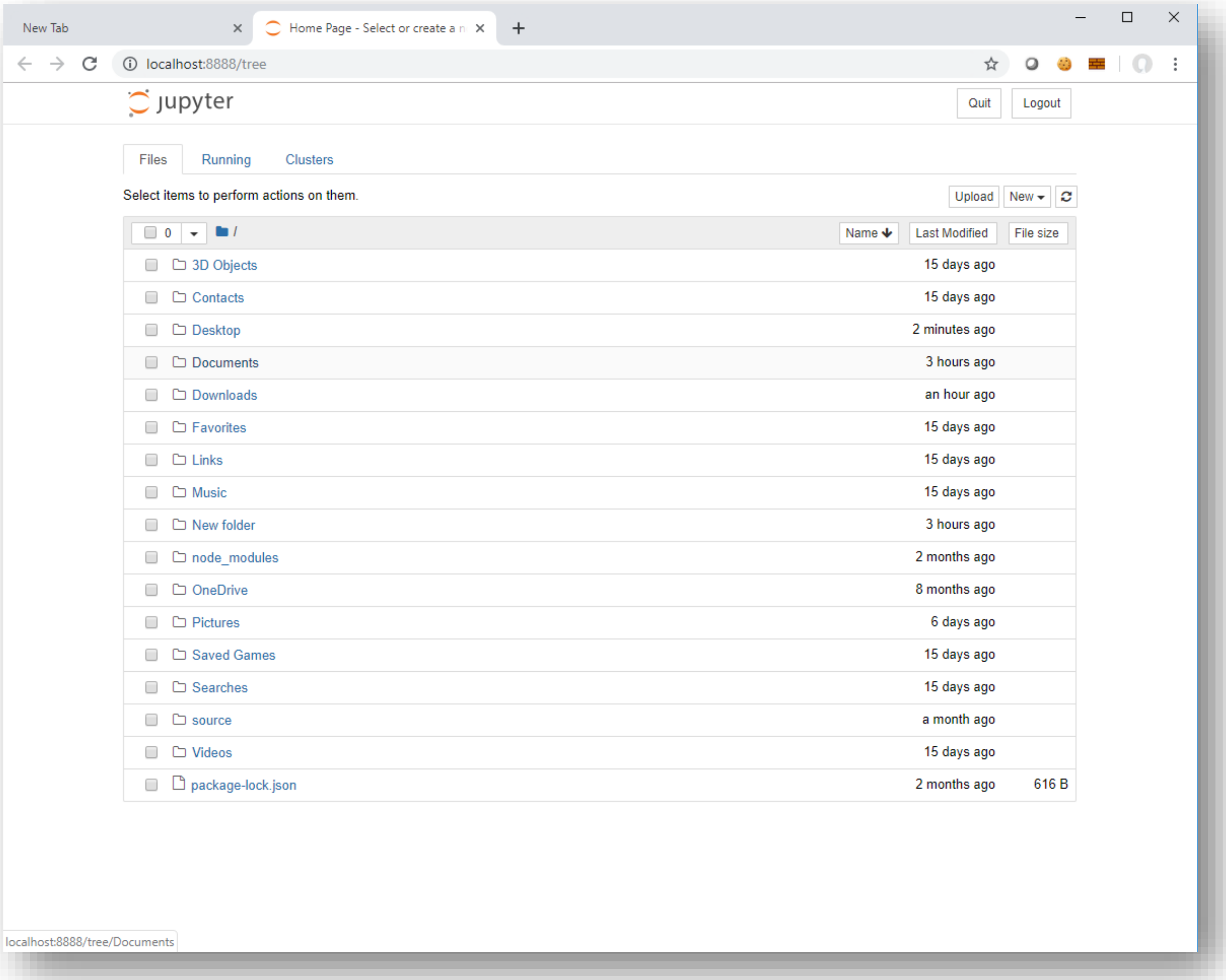
It is recommended to become familiar with Jupyter basic concepts with the online documentation, https://jupyter-notebook.readthedocs.io/en/stable/examples/Notebook/Notebook%20Basics.html

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.



Select items to perform actions on them.

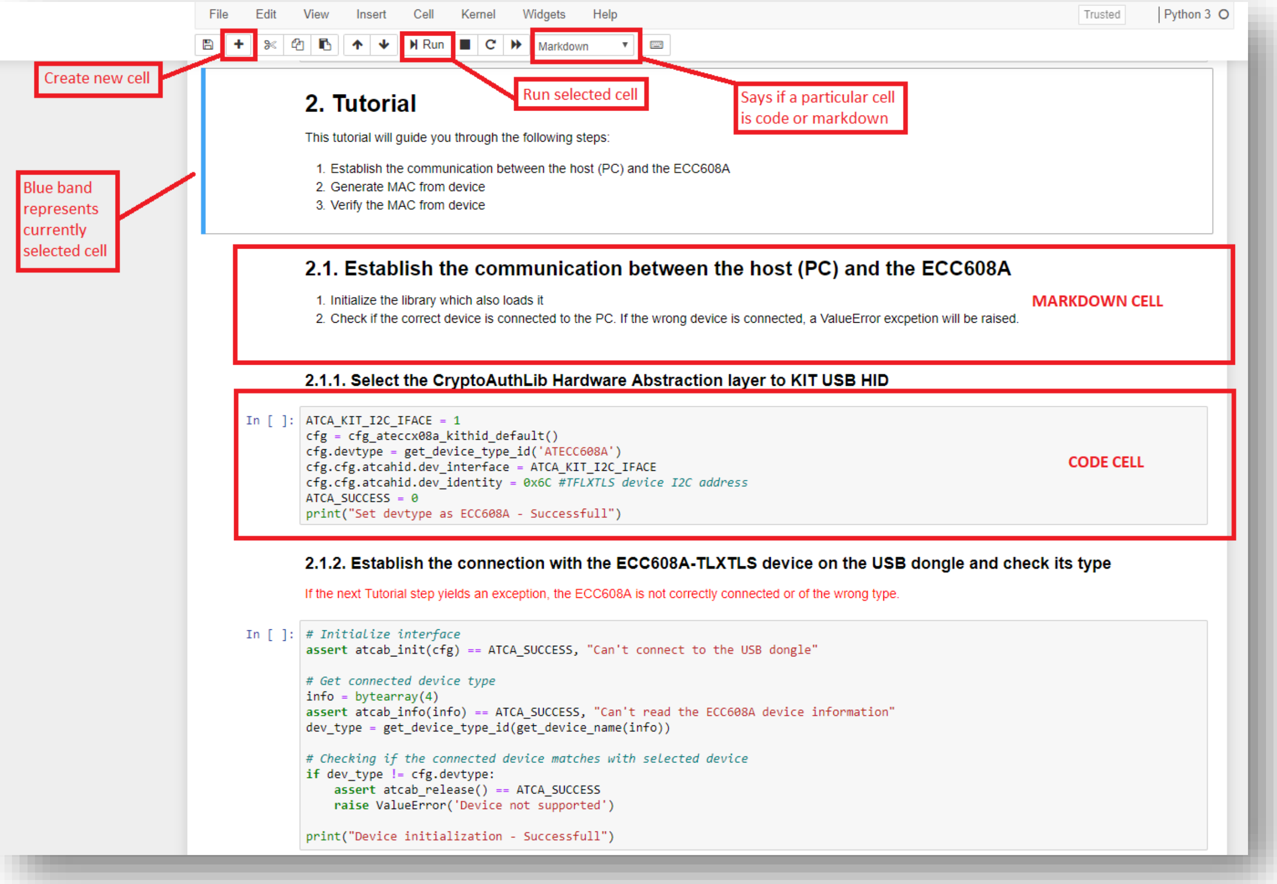
Name	Last Modified	File size
3D Objects	15 days ago	
Contacts	15 days ago	
Desktop	2 minutes ago	
Documents	3 hours ago	
Downloads	an hour ago	
Favorites	15 days ago	
Links	15 days ago	
Music	15 days ago	
New folder	3 hours ago	
node_modules	2 months ago	
OneDrive	8 months ago	
Pictures	6 days ago	
Saved Games	15 days ago	
Searches	15 days ago	
source	a month ago	
Videos	15 days ago	
package-lock.json	2 months ago	616 B

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**.



Create new cell

Run selected cell

Says if a particular cell is code or markdown

Blue band represents currently selected cell

MARKDOWN CELL

CODE CELL

2. Tutorial

This tutorial will guide you through the following steps:

1. Establish the communication between the host (PC) and the ECC608A
2. Generate MAC from device
3. Verify the MAC from device

2.1. Establish the communication between the host (PC) and the ECC608A

1. Initialize the library which also loads it
2. Check if the correct device is connected to the PC. If the wrong device is connected, a ValueError excpetion will be raised.

2.1.1. Select the CryptoAuthLib Hardware Abstraction layer to KIT USB HID

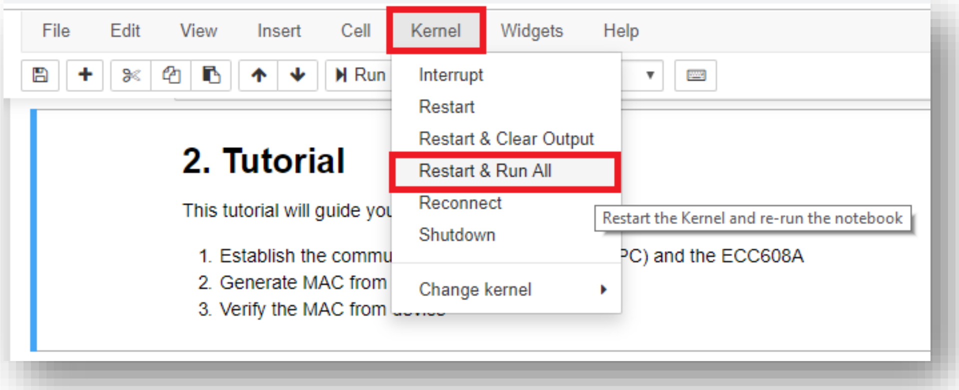
```
In [ ]: ATCA_KIT_I2C_IFACE = 1
        cfg = cfg_ateccx08a_kithid_default()
        cfg.devtype = get_device_type_id('ATECC608A')
        cfg.cfg.atcahid.dev_interface = ATCA_KIT_I2C_IFACE
        cfg.cfg.atcahid.dev_identity = 0x6C #TFLXTLS device I2C address
        ATCA_SUCCESS = 0
        print("Set devtype as ECC608A - Successfull")
```

2.1.2. Establish the connection with the ECC608A-TLXTLS device on the USB dongle and check its type

If the next Tutorial step yields an exception, the ECC608A is not correctly connected or of the wrong type.

```
In [ ]: # Initialize interface
        assert atcab_init(cfg) == ATCA_SUCCESS, "Can't connect to the USB dongle"

        # Get connected device type
        info = bytearray(4)
        assert atcab_info(info) == ATCA_SUCCESS, "Can't read the ECC608A device information"
        dev_type = get_device_type_id(get_device_name(info))

        # Checking if the connected device matches with selected device
        if dev_type != cfg.devtype:
            assert atcab_release() == ATCA_SUCCESS
            raise ValueError('Device not supported')

        print("Device initialization - Successfull")
```

To run all cells in sequence.



2 Jupyter Notebook Tutorials

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

Jupyter Notebook Tutorials	Relative Path	Applicable devices
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\secureboot\ 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

3 Resource Generation Notebook

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

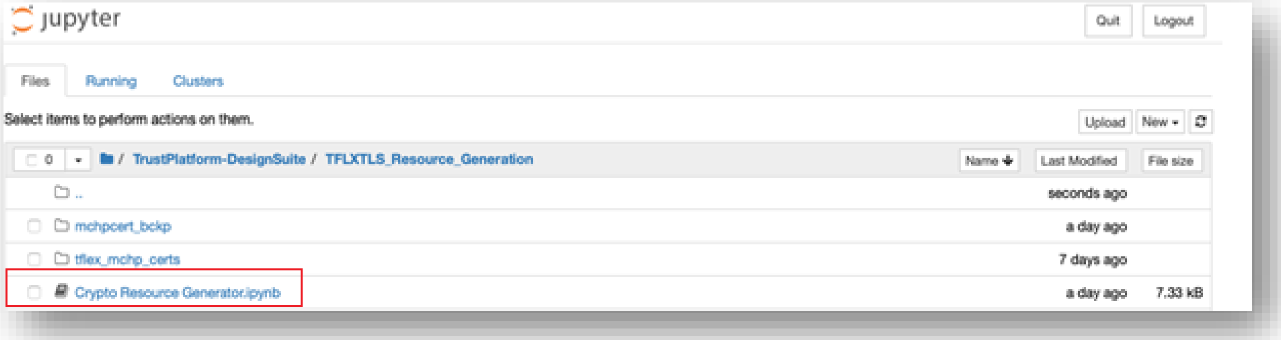
TrustFlex devices come with pre-programmed certificates in slots 10, 11 and 12, also slots 0-4 have pre-generated private keys, other than the mentioned slots all the other slots have no data in them.

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.

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 TrustPlatform-DesignSuite folder is contained in the Documents folder. If this is not the case, please move the TrustPlatform-DesignSuite folder to your Documents folder…

Within the Jupyter Dashboard, navigate to Documents/TrustPlatform-DesignSuite/TFLXTLS_Resource_Generation folder

Select the Crypto Resource Generator.ipynb notebook



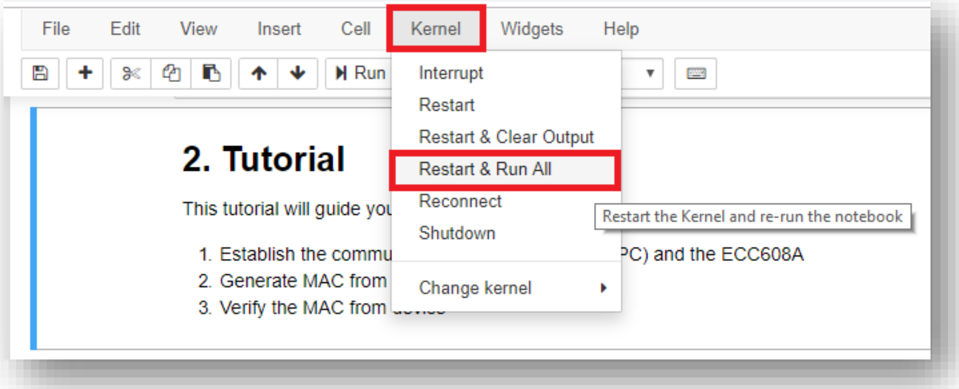
Select items to perform actions on them.

/ TrustPlatform-DesignSuite / TFLXTLS_Resource_Generation

Name	Last Modified	File size
..	seconds ago	
mchpcert_bckp	a day ago	
tflex_mchp_certs	7 days ago	
Crypto Resource Generator.ipynb	a day ago	7.33 kB

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

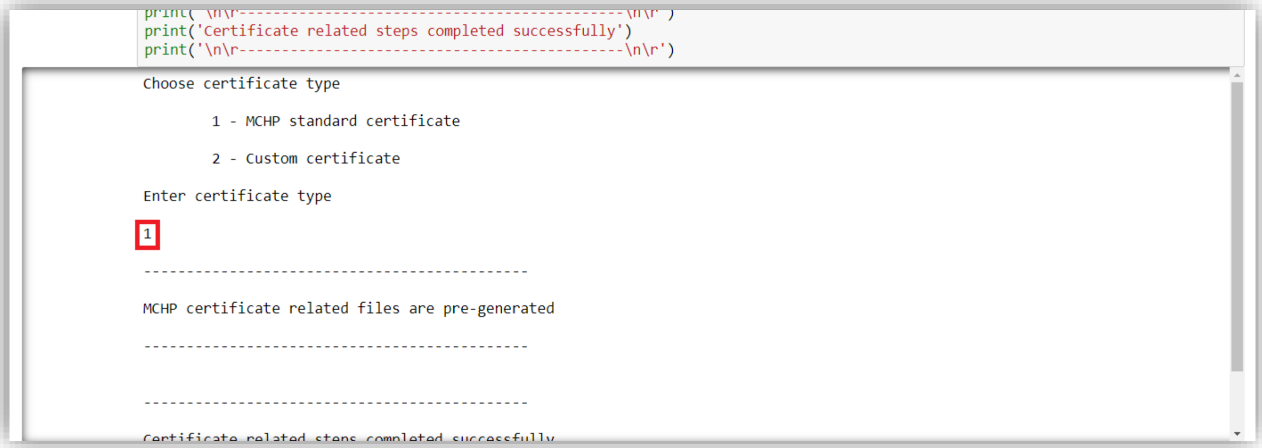
Note: Before executing the cells on Crypto Trust Platform, its required to have factory default program running on SAMD21 of Trust Platform. Refer to 4.3 CryptoAuth TrustPlatform Factory reset section for reloading default program.



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

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



```
print('\n\r-----------------------------------------------\n\r')
print('Certificate related steps completed successfully')
print('\n\r-----------------------------------------------\n\r')
```

```
Choose certificate type

        1 - MCHP standard certificate

        2 - Custom certificate

Enter certificate type

1

---------------------------------------------

MCHP certificate related files are pre-generated

---------------------------------------------


---------------------------------------------

Certificate related steps completed successfully
```

The output log should look like this.

```
Choose certificate type

       1 - MCHP standard certificate

       2 - Custom certificate

Enter certificate type

1

---------------------------------------------

MCHP certificate related files are pre-generated

---------------------------------------------


---------------------------------------------

Certificate related steps 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 soon to be supported 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, IO protection key and firmware validation public key are loaded into TrustFLEX device in the slot 6 and 15 respectively.

4 Use Case Prototyping

This hands-on lab is intended to demonstrate the usage of TrustFLEX device to validate firmware that going to run on HostMCU. It uses asymmetric authentication.

To validate the firmware, following steps to be followed

1. Generating a firmware Signing Key pair
2. Signing the firmware
3. Updating the firmware to product
4. Verifying the firmware image

OEM to take care of first 2 things in a controlled environment. To have firmware validation functionality, once the firmware implementation is completed it will be signed by the OEM signer to make the image authentic. Typically, firmware signer's public key will be loaded to secure element and locked permanently.

On the product side, the digest and signature generated in the previous step will be provided to secure element using Secure boot command. Secure boot command will be executed on secure element with option set to store (Full Copy) on successful validation of the digest and signature.

In this use case, we set secure boot configuration as "FullDig", which stores the firmware digest on the device and on subsequent boots, just the digest is compared without ECC verify operations. Firmware digest will be loaded into TrustFLEX device of slot 7. While sending the digest to TrustFLEX device, the digest is encrypted with IO protection key to avoid man in the middle attack.

The resource generation for TurstFLEX device will load

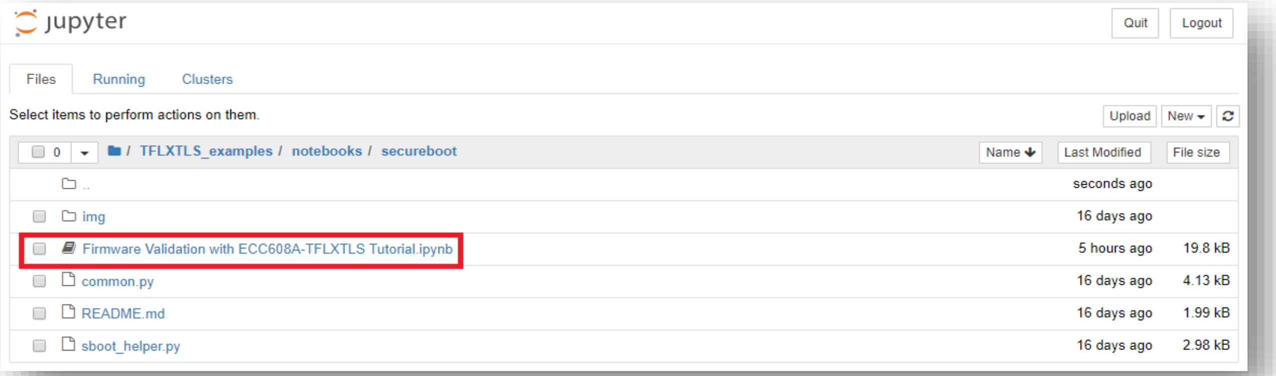
1. A prototyping firmware signing key
2. A prototyping IO protection key to Slot6
3. Signers public key to Slot15 respectively

This lab is setup such a way firmware sign and update operations taken care notebook and verify operation can be done both in notebook and embedded project. Firmware sign and update operations are NOT done in embedded project as it's the role of OEM but not the product.

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

4.1 Running Firmware Validation example on Jupyter Notebook:

1. From the Jupyter Home page, navigate to **TFLXTLS_Use_Cases\notebooks\ firmware-validation\ Firmware Validation with ECC608A-TFLXTLS tutorial.ipynb** notebook file and open it.

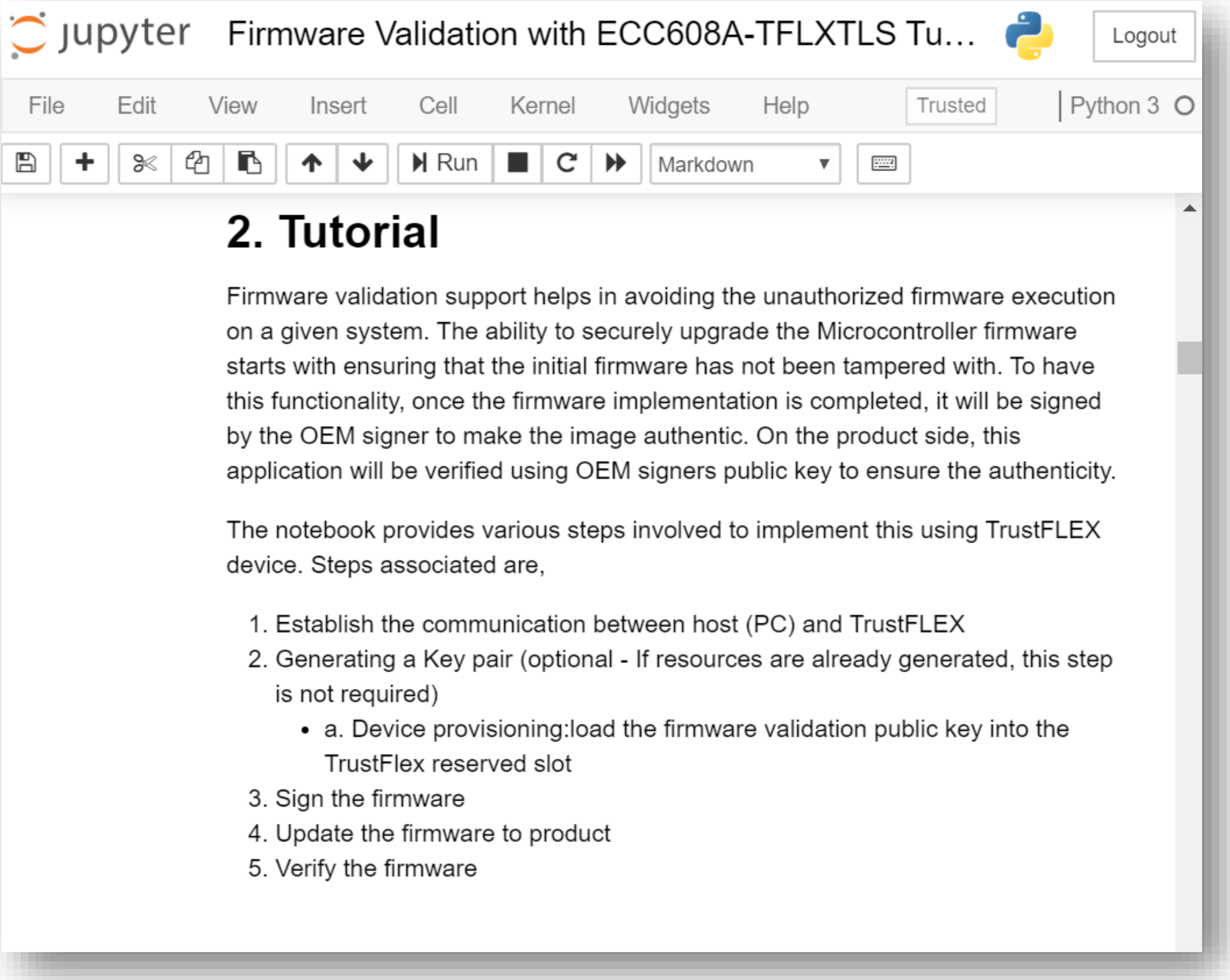


Select items to perform actions on them.

/ TFLXTLS_examples / notebooks / secureboot

Name	Last Modified	File size
..	seconds ago	
img	16 days ago	
Firmware Validation with ECC608A-TFLXTLS Tutorial.ipynb	5 hours ago	19.8 kB
common.py	16 days ago	4.13 kB
README.md	16 days ago	1.99 kB
sboot_helper.py	16 days ago	2.98 kB

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



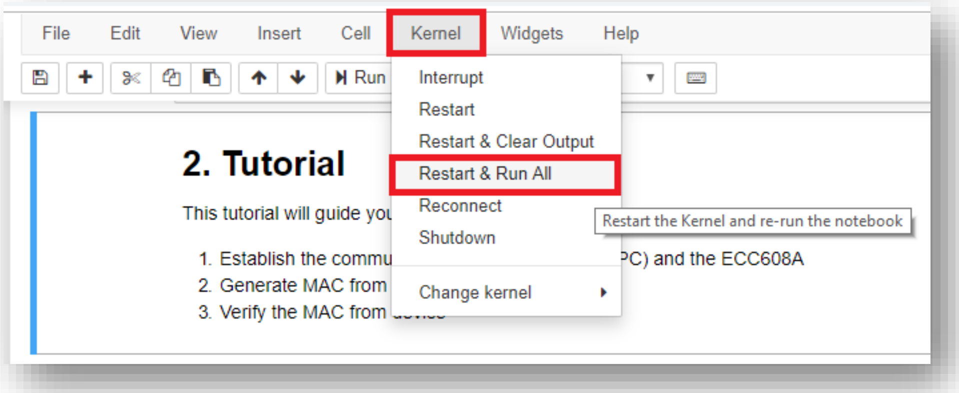
2. Tutorial

Firmware validation support helps in avoiding the unauthorized firmware execution on a given system. The ability to securely upgrade the Microcontroller firmware starts with ensuring that the initial firmware has not been tampered with. To have this functionality, once the firmware implementation is completed, it will be signed by the OEM signer to make the image authentic. On the product side, this application will be verified using OEM signers public key to ensure the authenticity.

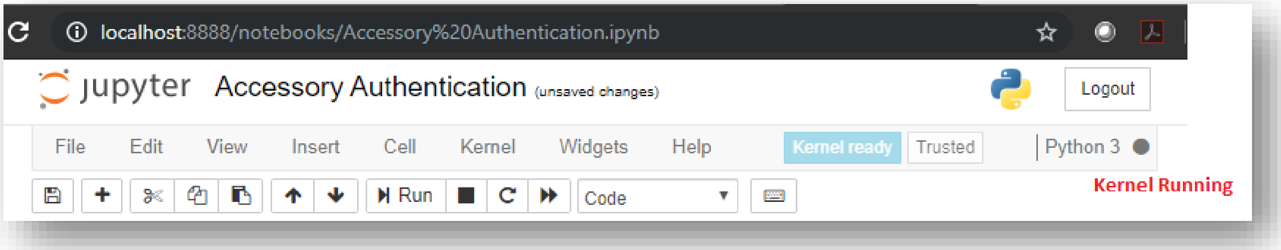
The notebook provides various steps involved to implement this using TrustFLEX device. Steps associated are,

1. Establish the communication between host (PC) and TrustFLEX
2. Generating a Key pair (optional - If resources are already generated, this step is not required)
   - a. Device provisioning:load the firmware validation public key into the TrustFlex reserved slot
3. Sign the firmware
4. Update the firmware to product
5. Verify the firmware

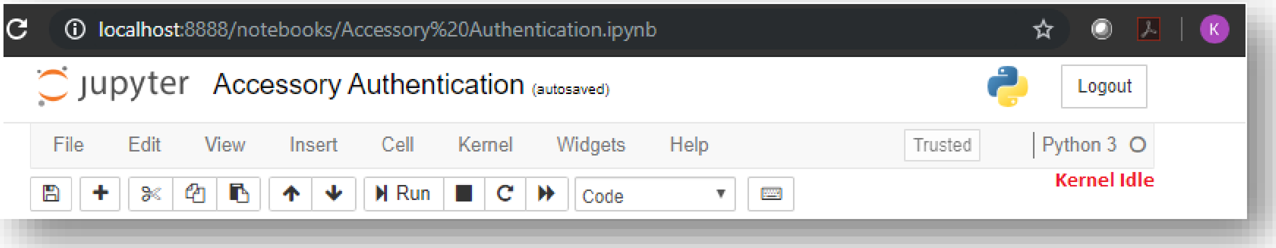
2. Run All Cells by using Kernel -> Restart & Run All



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)


localhost:8888/notebooks/Accessory%20Authentication.ipynb
jupyter
Accessory Authentication (unsaved changes)
Logout
File
Edit
View
Insert
Cell
Kernel
Widgets
Help
Kernel ready
Trusted
Python 3 ●
Run
Code

Kernel Running


localhost:8888/notebooks/Accessory%20Authentication.ipynb
K
jupyter
Accessory Authentication (autosaved)
Logout
File
Edit
View
Insert
Cell
Kernel
Widgets
Help
Trusted
Python 3 ○
Run
Code

Kernel Idle

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

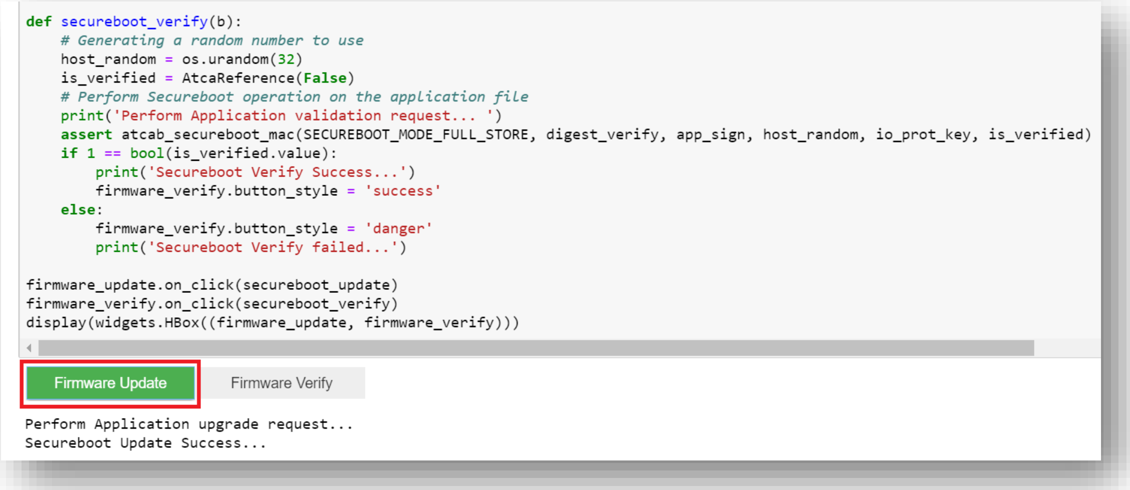
5. There are 4 major steps in this lab
   Generating a Firmware Validation key pair
   This step setups a temporary firmware signer to perform firmware validation process. This key generation is already taken care part of resource generation.

   Sign the Firmware
   This step generates firmware digest by hash the sample firmware image with SHA 256 algorithm and get it signed with firmware signer's private key. Then digest will be encrypted with IO protection key to avoid man in the middle attack before host send digest to the device.

An example bin (secureboot_test_app.bin) is considered as a firmware. Digest and Sign operations are carried out on this bin file content.

Update the firmware to product

Before verifying the firmware's validity, the firmware digest should be verified and stored to secure element. In this step host sends the encrypted firmware digest and signature to device to validate the firmware. Here the firmware is validated by verifying the signature using firmware signer's public key. Upon successful validation, the device stores the digest to Secureboot digest slot i.e. slot7.



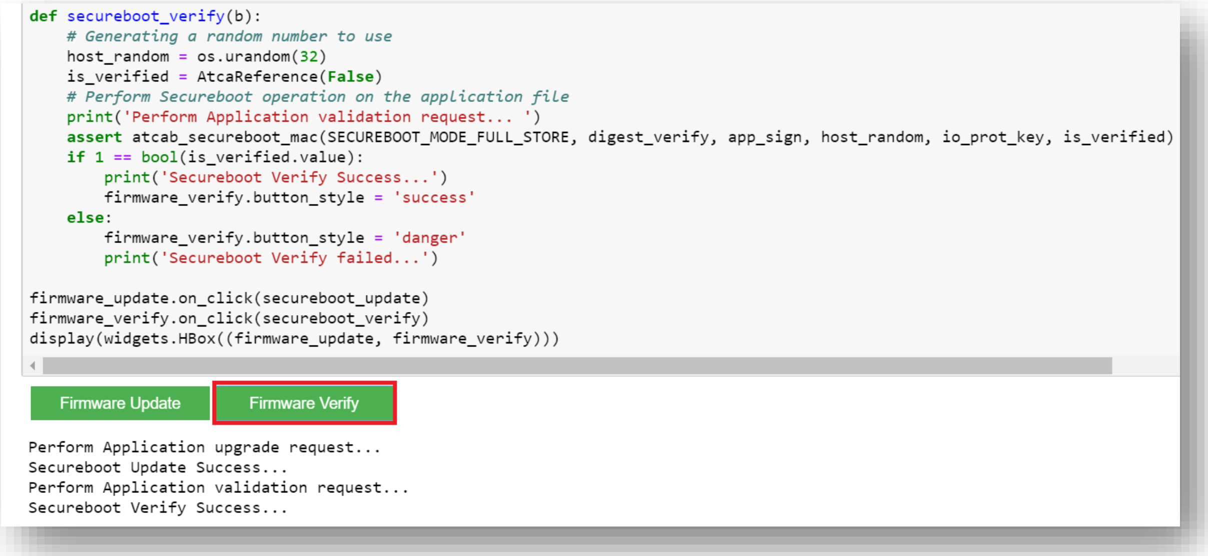
```
def secureboot_verify(b):
    # Generating a random number to use
    host_random = os.urandom(32)
    is_verified = AtcaReference(False)
    # Perform Secureboot operation on the application file
    print('Perform Application validation request... ')
    assert atcab_secureboot_mac(SECUREBOOT_MODE_FULL_STORE, digest_verify, app_sign, host_random, io_prot_key, is_verified)
    if 1 == bool(is_verified.value):
        print('Secureboot Verify Success...')
        firmware_verify.button_style = 'success'
    else:
        firmware_verify.button_style = 'danger'
        print('Secureboot Verify failed...')

firmware_update.on_click(secureboot_update)
firmware_verify.on_click(secureboot_verify)
display(widgets.HBox((firmware_update, firmware_verify)))
```

```
Perform Application upgrade request...
Secureboot Update Success...
```

Clicking on "**Firmware Update"** will perform the above steps between host (PC) and the TrustFLEX device. Once firmware update is completed successfully, current firmware digest will be stored in the Secureboot digest slot.

Verifying the firmware image

This step recalculates the digest from the example bin (secureboot_test_app.bin). The encrypted digest will be sent to TrustFLEX. Upon successful validation, the device returns MAC value corresponding to this verify request.



```
def secureboot_verify(b):
    # Generating a random number to use
    host_random = os.urandom(32)
    is_verified = AtcaReference(False)
    # Perform Secureboot operation on the application file
    print('Perform Application validation request... ')
    assert atcab_secureboot_mac(SECUREBOOT_MODE_FULL_STORE, digest_verify, app_sign, host_random, io_prot_key, is_verified)
    if 1 == bool(is_verified.value):
        print('Secureboot Verify Success...')
        firmware_verify.button_style = 'success'
    else:
        firmware_verify.button_style = 'danger'
        print('Secureboot Verify failed...')

firmware_update.on_click(secureboot_update)
firmware_verify.on_click(secureboot_verify)
display(widgets.HBox((firmware_update, firmware_verify)))
```

```
Perform Application upgrade request...
Secureboot Update Success...
Perform Application validation request...
Secureboot Verify Success...
```

Clicking on “**Firmware Verify”** will perform the above steps between host (PC) and the TrustFLEX device.

Pressing “Firmware Update” and “Firmware Verify” should turn to green to indicate successful firmware update and verify operations.

4.2 Running Accessory-Authentication on Embedded platform

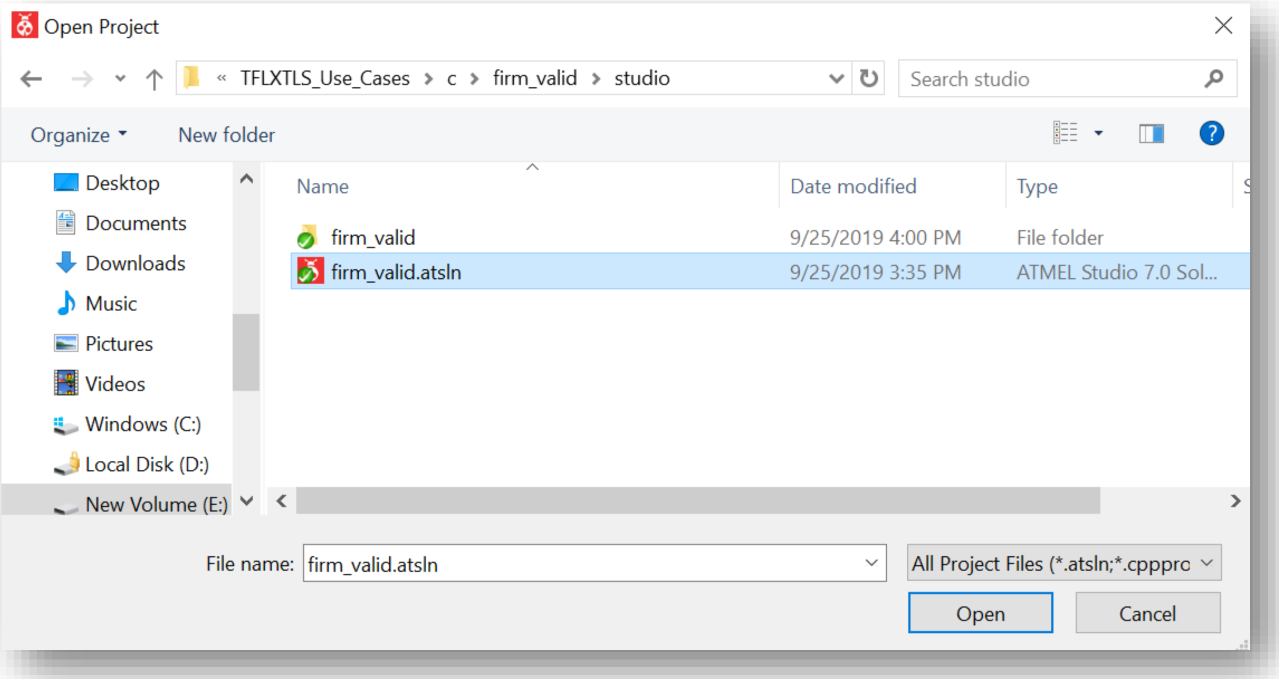
This usecase can also be executed on Embedded platform. Once the resources are generated, both Atmel Studio and MPLAB projects provided can be used to run the usecase on CryptoAuth Trust Platform.

This project can only perform firmware verify steps, but not firmware update. It is **required** to use the Firmware Validation Notebook to generate the keys, sign the firmware and securely update the digest to TrustFLEX. This notebook generates supporting data files like firmware image and signatures for C projects.

Once the digest is updated to TrustFLEX, these embedded projects can be used to verify the firmware image.

4.2.1 Atmel Studio:

1. Open **firm_valid.atsln** project by navigating Atmel Studio -> File -> open -> **TFLXTLS_Use_Cases\c\firm_valid\studio\firm_valid.atsln**

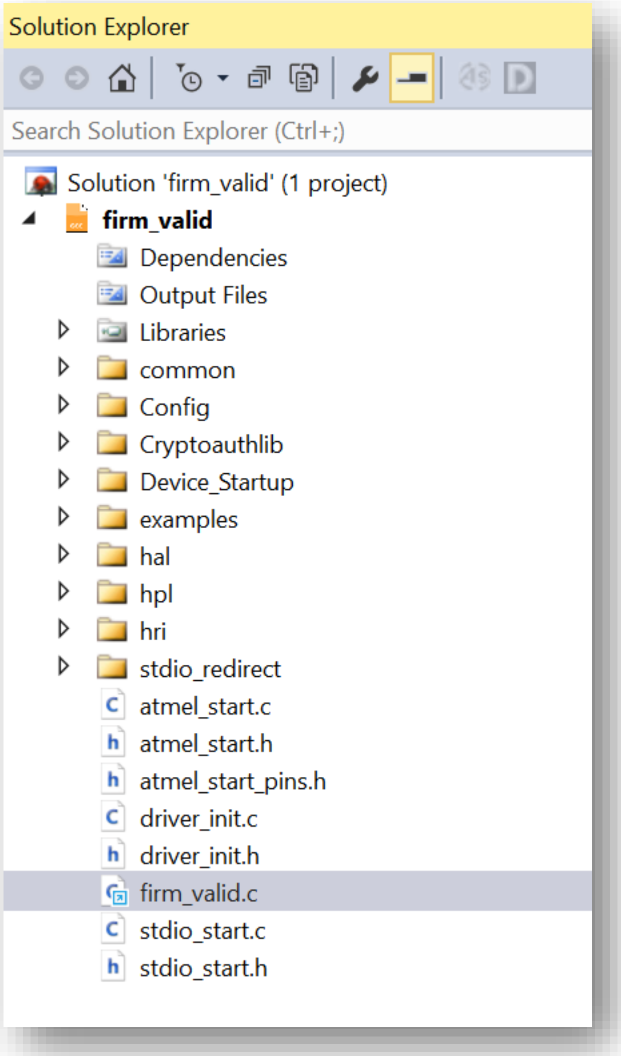


Name	Date modified	Type
firm_valid	9/25/2019 4:00 PM	File folder
firm_valid.atsln	9/25/2019 3:35 PM	ATMEL Studio 7.0 Sol...

File name: firm_valid.atsln

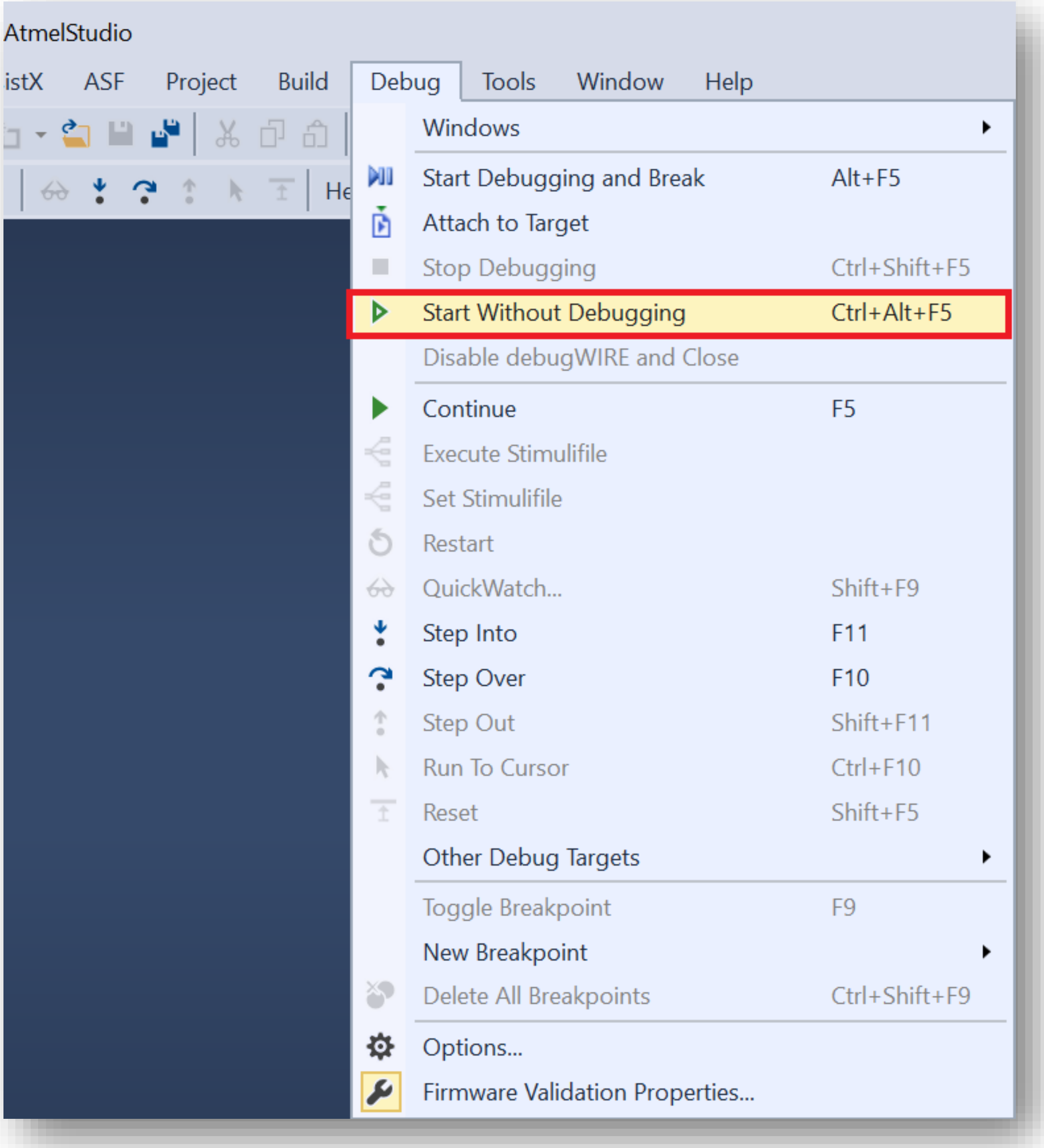
All Project Files (*.atsln;*.cppprc

2. The application source code firm_valid.c is available at **TFLXTLS_Use_Cases\c\firm_valid\firm_valid.c** Other supporting files can be found under **TFLXTLS_Use_Cases\c\dependencies**



```
Solution 'firm_valid' (1 project)
  firm_valid
    Dependencies
    Output Files
    Libraries
    common
    Config
    Cryptoauthlib
    Device_Startup
    examples
    hal
    hpl
    hri
    stdio_redirect
    atmel_start.c
    atmel_start.h
    atmel_start_pins.h
    driver_init.c
    driver_init.h
    firm_valid.c
    stdio_start.c
    stdio_start.h
```

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

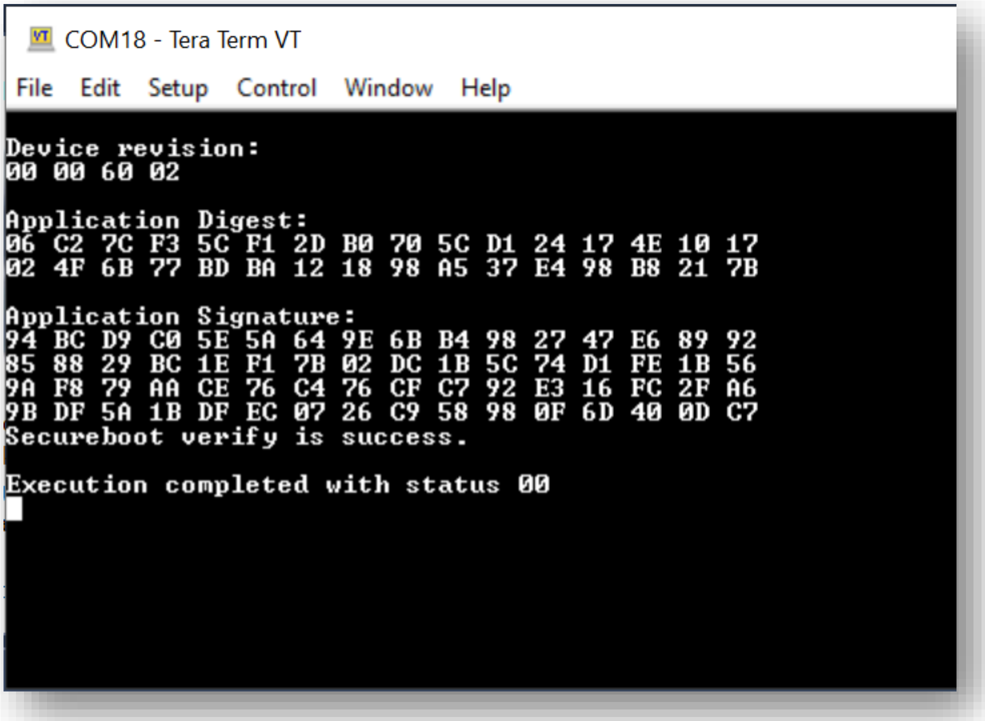


This step may take some time, wait for Atmel Studio to compile and program the device.

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

If firmware validation operation succeeds, LED blinks once every second.
If firmware validation operation fails, LED blinks five times every second.

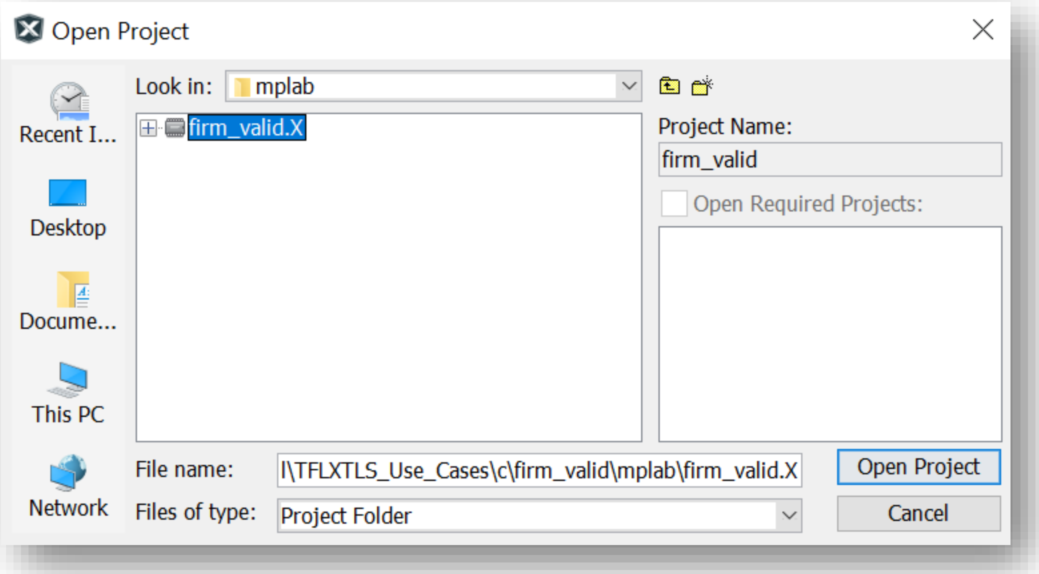
It is also possible to view the Console messages by using applications like TeraTerm. Open the application with the COM related to CryptoAuth TrustPlatform with 115200-8-N-1 settings



```
Device revision:
00 00 60 02

Application Digest:
06 C2 7C F3 5C F1 2D B0 70 5C D1 24 17 4E 10 17
02 4F 6B 77 BD BA 12 18 98 A5 37 E4 98 B8 21 7B

Application Signature:
94 BC D9 C0 5E 5A 64 9E 6B B4 98 27 47 E6 89 92
85 88 29 BC 1E F1 7B 02 DC 1B 5C 74 D1 FE 1B 56
9A F8 79 AA CE 76 C4 76 CF C7 92 E3 16 FC 2F A6
9B DF 5A 1B DF EC 07 26 C9 58 98 0F 6D 40 0D C7
Secureboot verify is success.

Execution completed with status 00
```

4.2.2 MPLAB:

1. Open **firm_valid.X** project by navigating to MPLAB -> File -> Open Project -> **TFLXTLS_Use_Cases\c\firm_valid\mplab\firm_valid.X**



Look in: mplab

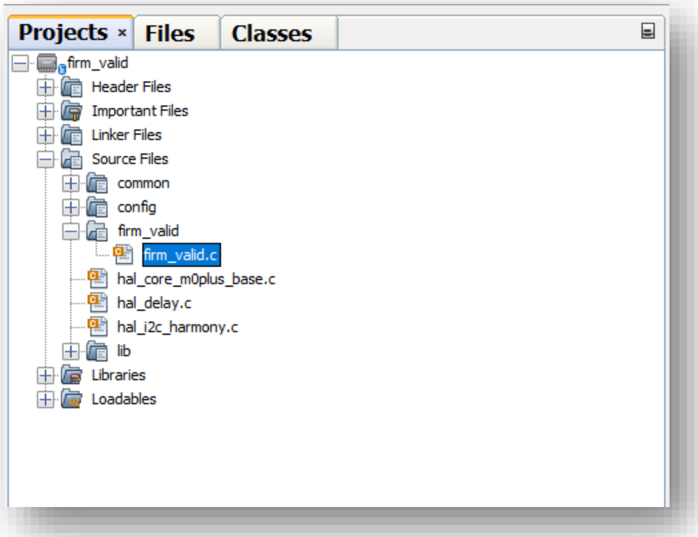
firm_valid.X

Project Name: firm_valid

File name: l\TFLXTLS_Use_Cases\c\firm_valid\mplab\firm_valid.X

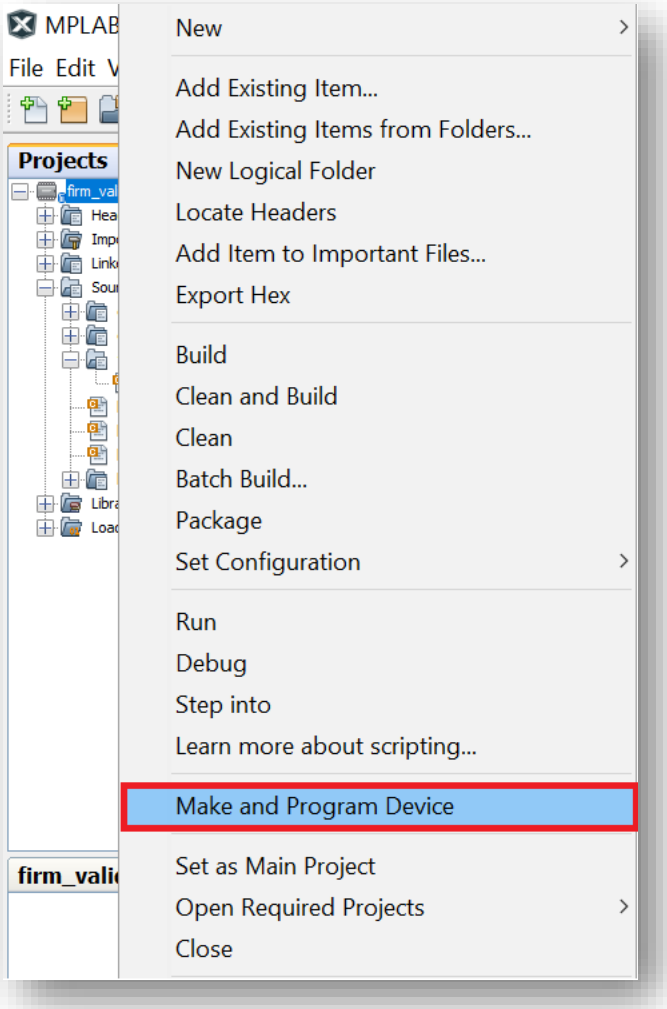
Files of type: Project Folder

2. The application source code **firm_valid**.c is available at **TFLXTLS_Use_Cases\c\firm_valid\firm_valid.c.** Other supporting files can be found under **TFLXTLS_Use_Cases\c\ dependencies**

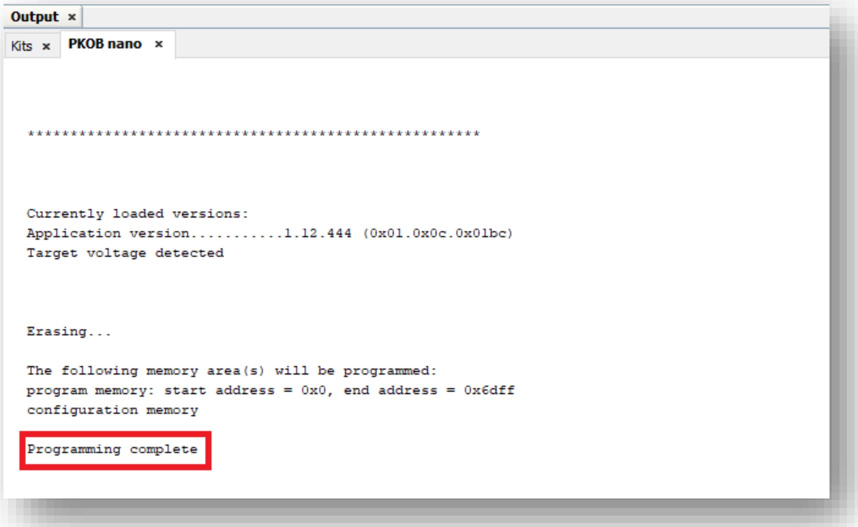


```
firm_valid
    Header Files
    Important Files
    Linker Files
    Source Files
        common
        config
        firm_valid
            firm_valid.c
        hal_core_m0plus_base.c
        hal_delay.c
        hal_i2c_harmony.c
        lib
    Libraries
    Loadables
```

3. Program the Crypto Trust platform by navigating to **firm_valid -> 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.

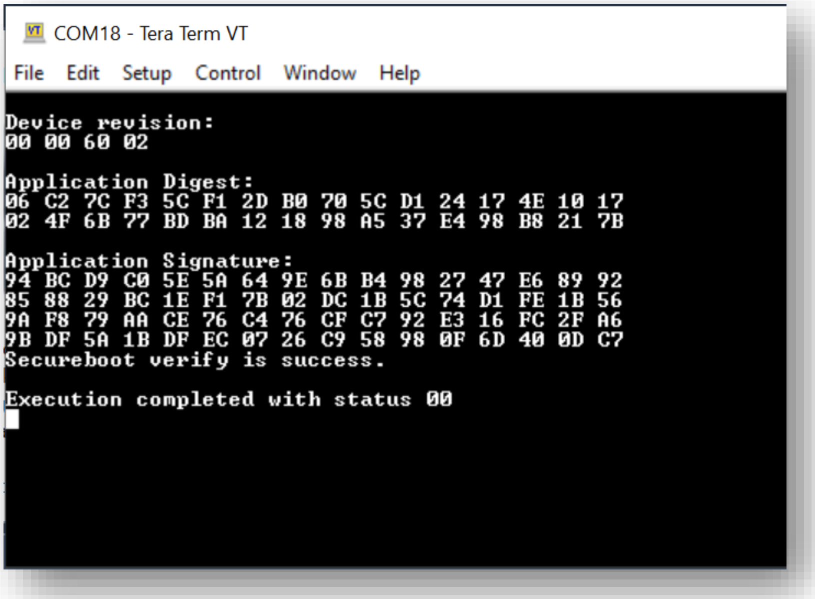


```
*****************************************************



Currently loaded versions:
Application version...........1.12.444 (0x01.0x0c.0x01bc)
Target voltage detected



Erasing...

The following memory area(s) will be programmed:
program memory: start address = 0x0, end address = 0x6dff
configuration memory

Programming complete
```

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

If firmware validation operation succeeds, LED blinks once every second.
If firmware validation 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



```
Device revision:
00 00 60 02

Application Digest:
06 C2 7C F3 5C F1 2D B0 70 5C D1 24 17 4E 10 17
02 4F 6B 77 BD BA 12 18 98 A5 37 E4 98 B8 21 7B

Application Signature:
94 BC D9 C0 5E 5A 64 9E 6B B4 98 27 47 E6 89 92
85 88 29 BC 1E F1 7B 02 DC 1B 5C 74 D1 FE 1B 56
9A F8 79 AA CE 76 C4 76 CF C7 92 E3 16 FC 2F A6
9B DF 5A 1B DF EC 07 26 C9 58 98 0F 6D 40 0D C7
Secureboot verify is success.

Execution completed with status 00
```

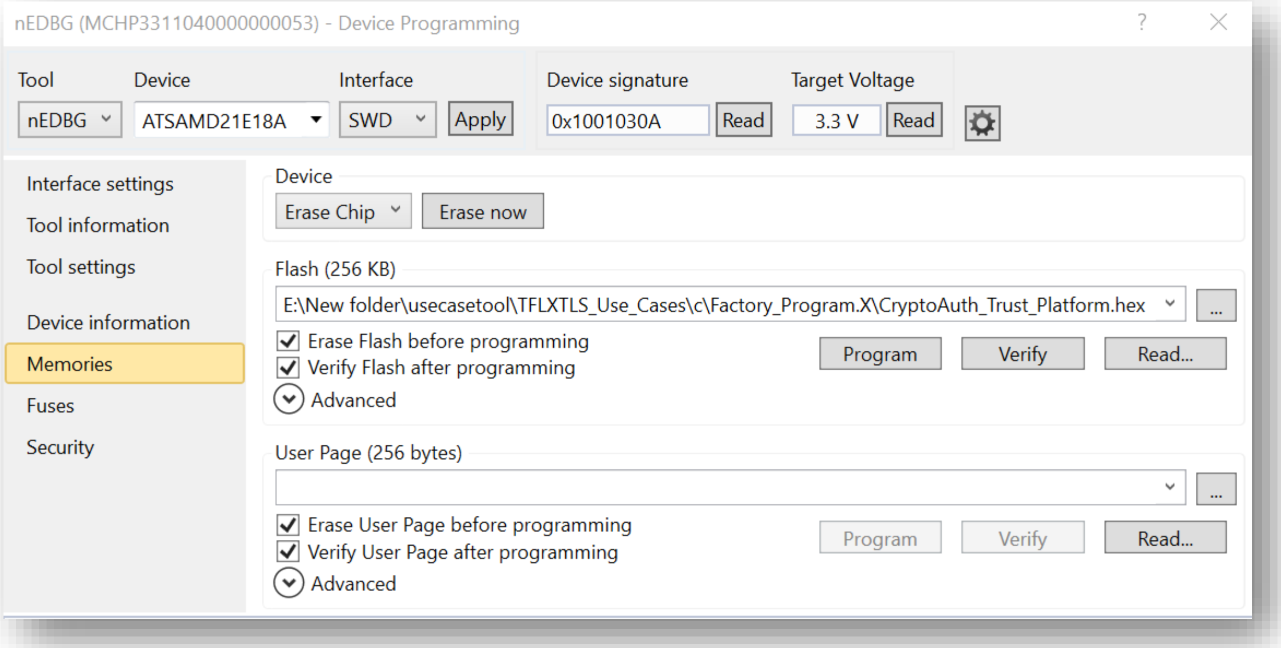
4.3 CryptoAuth TrustPlatform Factory reset

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
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



nEDBG (MCHP3311040000000053) - Device Programming

Tool: nEDBG
Device: ATSAMD21E18A
Interface: SWD
Device signature: 0x1001030A
Target Voltage: 3.3 V

Device: Erase Chip

Flash (256 KB)
E:\New folder\usecasetool\TFLXTLS_Use_Cases\c\Factory_Program.X\CryptoAuth_Trust_Platform.hex
☑ Erase Flash before programming
☑ Verify Flash after programming

User Page (256 bytes)
☑ Erase User Page before programming
☑ Verify User Page after programming

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, 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

8. **Why is firmware validation project fails with error "Firmware validation is failed! with status 01"?**
   There are many possibilities like,
   a. The resources on TrustFLEX device and on the host (PC) could be different. Rerun "Resource Generation Notebook" section for reloading it.
   b. Firmware digest is not matched. Make sure that firmware Update step is exec uted using Notebook prior to running C project

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