TrustFLEX Step by Step Guide Secure Public key Rotation

Table of Contents

1 Introduction

This document helps in running Secure Public Key rotation use case example provided in TrustFLEX package. If familiar with Jupyter Notebook, can skip this section and move to Section 2.

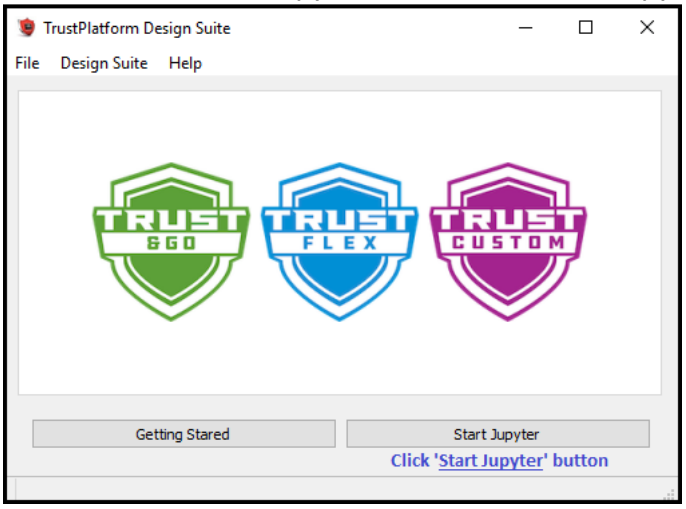
1.1 Getting started with Jupyter Notebook Tutorials

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.

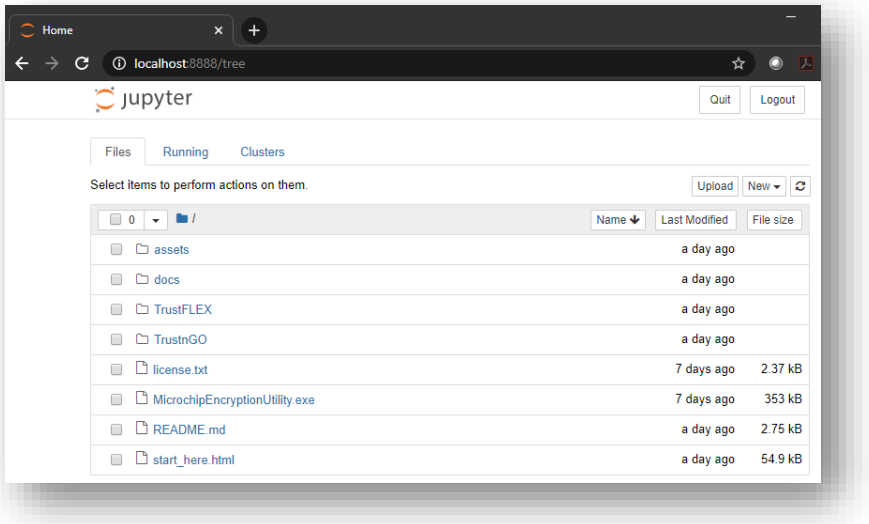
Jupyter notebooks are mainly used to explain/evaluate code in an interactive way.

1.1.1 Starting Jupyter Notebook

Jupyter notebook can be launched from 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,



1.2 Jupyter Notebook Basics

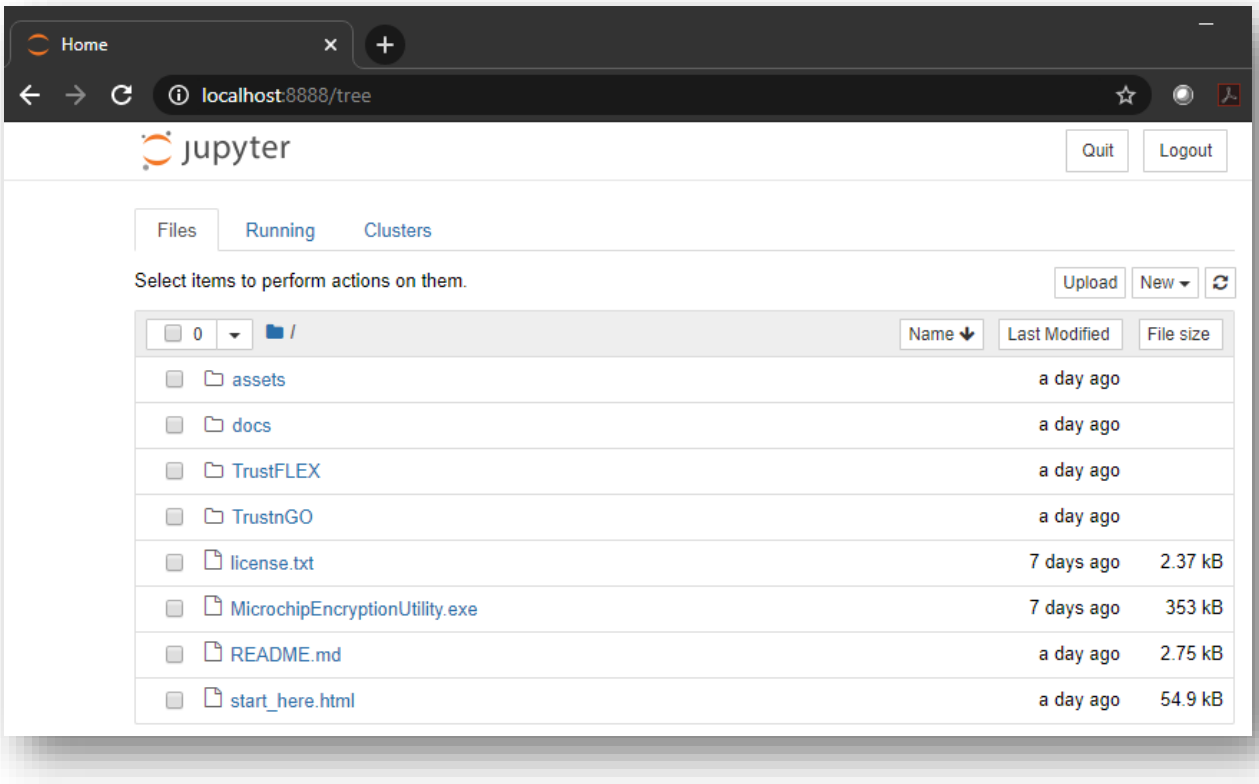
It is recommended to become familiar with Jupyter basic concepts with the online documentation, https://jupyter-notebook.readthedocs.io/en/stable/examples/Notebook/Notebook%20Basics.html

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.

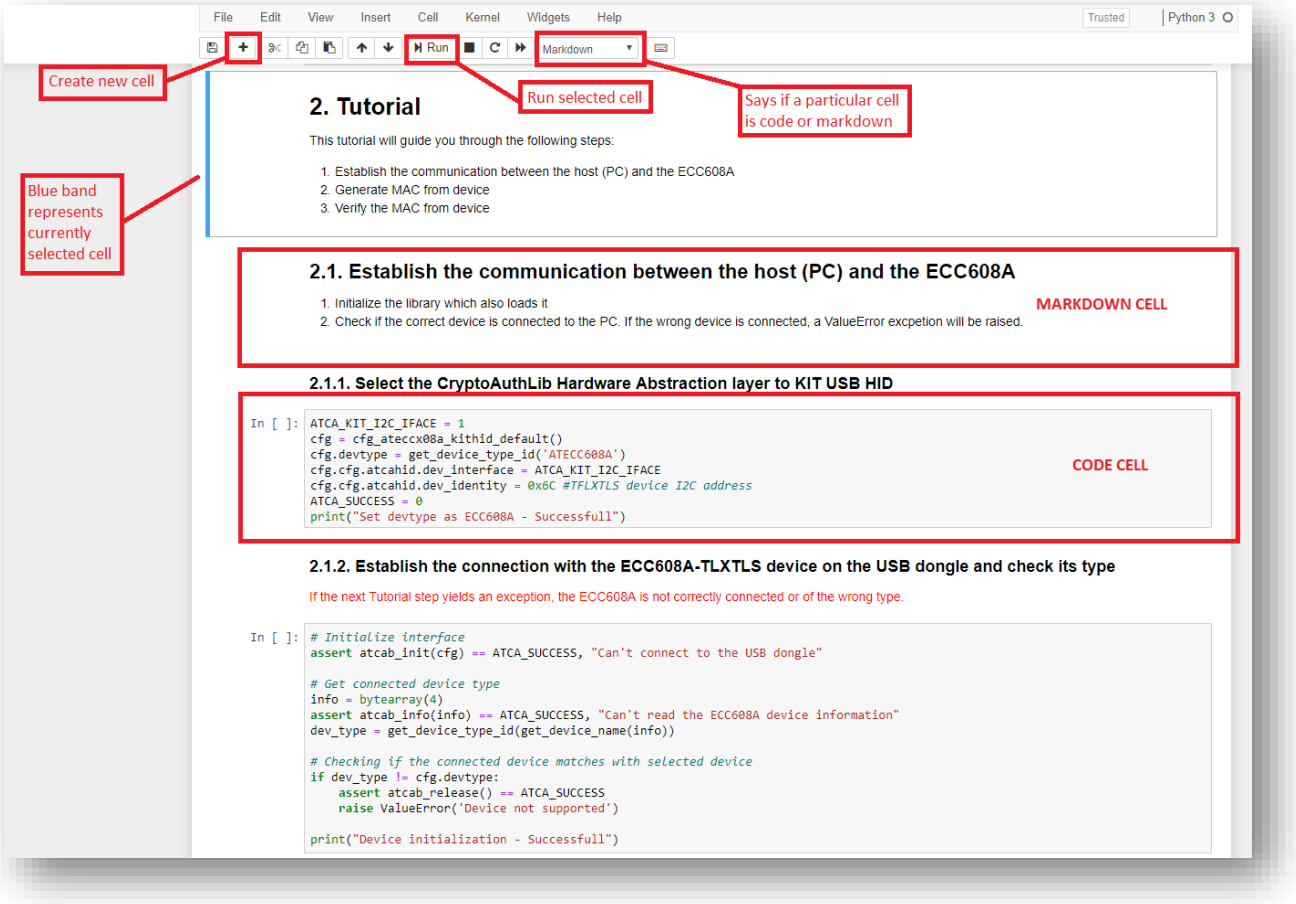


1.3 Introduction to Jupyter Notebook GUI.

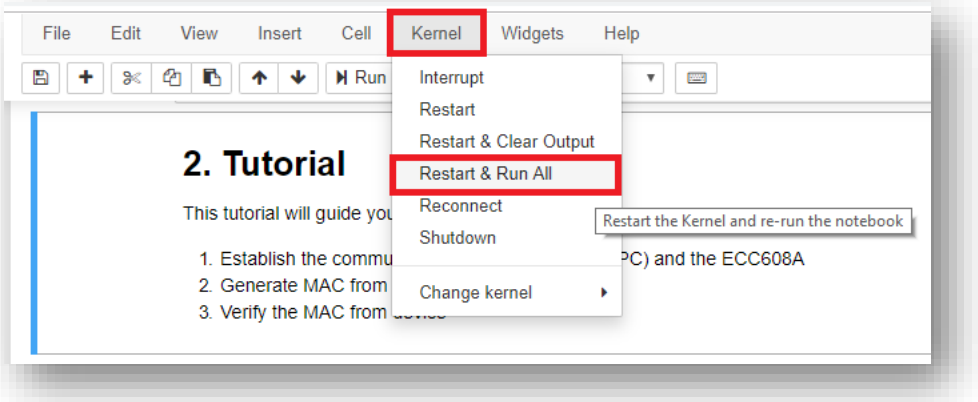
Jupyter Notebooks contain cells where you can either write code or markdown text. Notebooks contain multiple cells, some set as code and others markdown. Code cells contain code that can be executed live, and markdown contains text and images to explain the code.

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 Trust Platform 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	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

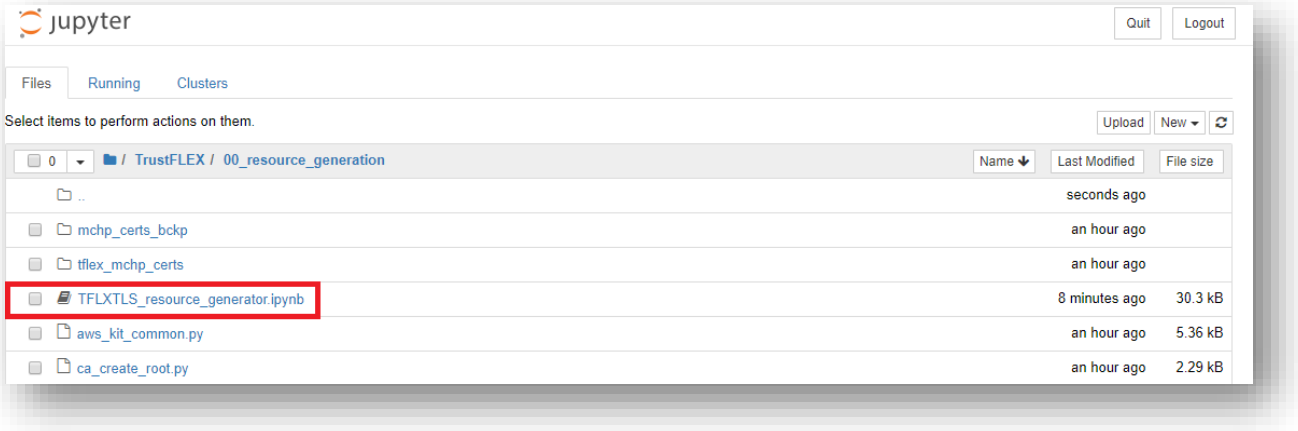
3 Resource Generation Notebook

TFLXTLS device is one of the three devices available on the Crypto Auth Trust Platform 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.

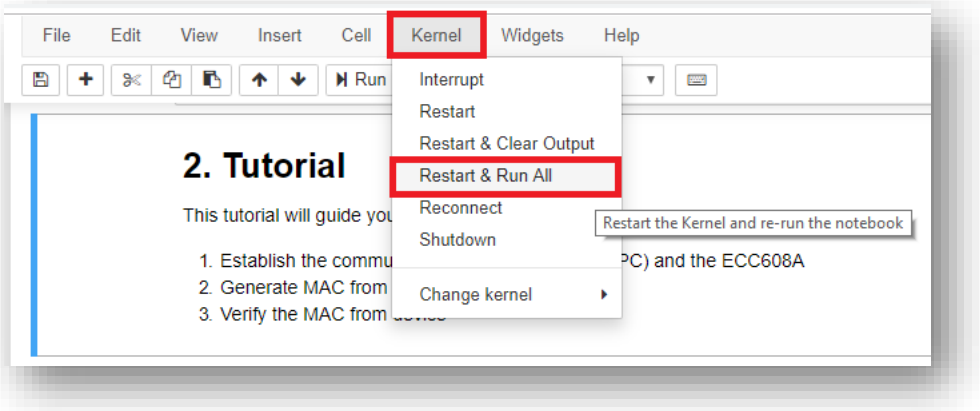
The Resource Generator Notebook will create development keys and certificates for all slots that can be further customized. Keys and Certificate chains are stored in the PC filesystem. These keys should never be used for production purposes as their generation is not handled in a secure environment. 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 Crypto Auth Trust Platform 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. 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. Following are 3 different things can be performed,

1. Generating resources to general key slots

The output log should resemble this:

Slot 0 is a private key slot, no action required
Slot 1 is a private key slot, no action required
Slot 2 is a private key slot, no action required
Slot 3 is a private key slot, no action required
Slot 4 is a private key slot, no action required
Slot 6 is a secret key, created slot_6_secret_key.pem and programmed

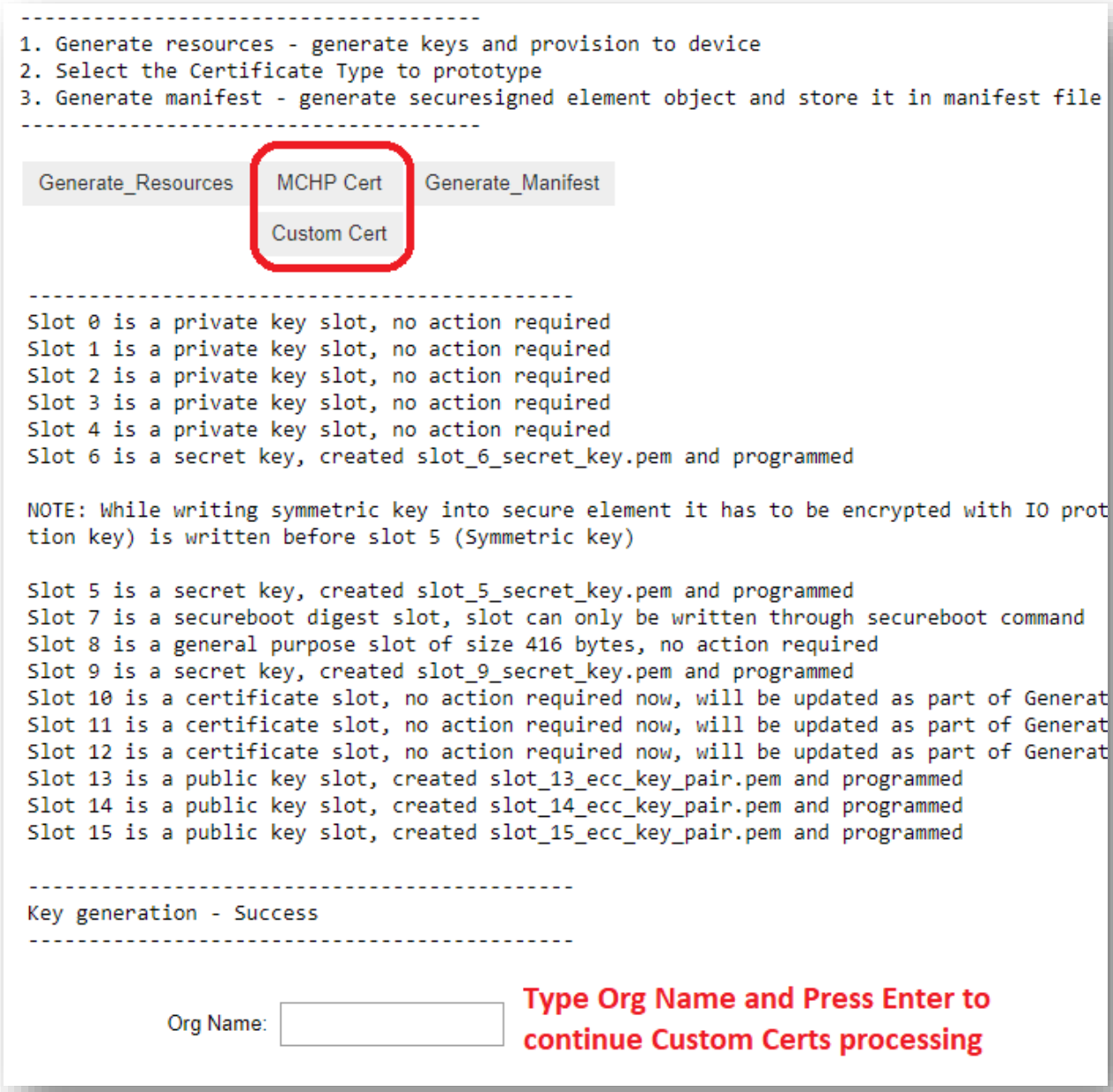
NOTE: While writing symmetric key into secure element it has to be encrypted with IO prote ction key. So here, Slot 6 (IO protection key) is written before slot 5 (Symmetric key)

Slot 5 is a secret key, created slot_5_secret_key.pem and programmed
Slot 7 is a secureboot digest slot, slot can only be written through secureboot command
Slot 8 is a general purpose slot of size 416 bytes, no action required
Slot 9 is a secret key, created slot_9_secret_key.pem and programmed
Slot 10 is a certificate slot, no action required now, will be updated as part of Generate Certi ficates
Slot 11 is a certificate slot, no action required now, will be updated as part of Generate Certi ficates
Slot 12 is a certificate slot, no action required now, will be updated as part of Generate Certi ficates
Slot 13 is a public key slot, created slot_13_ecc_key_pair.pem and programmed
Slot 14 is a public key slot, created slot_14_ecc_key_pair.pem and programmed
Slot 15 is a public key slot, created slot_15_ecc_key_pair.pem and programmed

---
Key generation - Success
---

2. Generating MCHP or Custom Certificates

   On selecting Custom certificates, it prompts to enter the organization name, enter the name that will be used as an Organization Name in the certificate template. The name length is limited to 24 characters.



The output log should resemble this:

Custom Certs processing...
Device contains custom device and signer certificates
Building new root certificate
Building new signer csr certificate
Building new signer certificate
Read device serial number...OK (SN: 01233E8A1491F2A601)

Read device public key from slot 0...OK (Public Key: CF1988BC3A6C252026FE70FB34397AD
85A39AE811C722BFA6E5EC1E9CDA9133B3F0E91FD3877F25B8C893B311BAF0203CB5100C
4CDABEBAFDAF3EBD550B00125)
Generating device certificate...OK (saved to device_01233E8A1491F2A601.crt)
Saving signer certificate to device...OK
Saving device certificate to device...OK
Thing ID eabc56113c70227a18c0a62f7c285fc68d75f9cd

Custom certificate generation and provisioning - SUCCESS

Validate root certificate...OK
-----BEGIN CERTIFICATE-----
MIIByjCCAW+gAwIBAgIQeoueybRh8XWwzOkoixtW1jAKBggqhkjOPQQDAjA7MQ0w
CwYDVQQKDAR0ZXN0MSowKAYDVQQDDCFDcnlwdG8gQXV0aGVudGljYXRpb24gUm9v
dCBDQSAwMDIwIBcNMjAwNzAxMDgwNTE5WhgPMjA2MDA2MjEwODA1MTlaMDsxDTAL
BgNVBAoMBHRlc3QxKjAoBgNVBAMMIUNyeXB0byBBdXRoZW50aWNhdGlvbiBSb290
IENBIDAwMjBZMBMGByqGSM49AgEGCCqGSM49AwEHA0IABFf6qcSyPv8iY0uccoTX
SlSstaz0ECCUxXUoqky8Xo40vsOCbPPt5QtlvNHnyy8tAbwza6DsAiz2sGLzDI5h
QhqjUzBRMB0GA1UdDgQWBBRHVPQoljiq65JOG4vu5l32JzmkSTAfBgNVHSMEGDAW
gBRHVPQoljiq65JOG4vu5l32JzmkSTAPBgNVHRMBAf8EBTADAQH/MAoGCCqGSM49
BAMCA0kAMEYCIQCB7FKx5K33xK9E0PsWGKZRaaQxxSRypC66y4hVqWVmMAIhAMlG
22zNUKPHccHQxfQssYH5LfR5SVE+WC3Hyxem/EVj
-----END CERTIFICATE-----

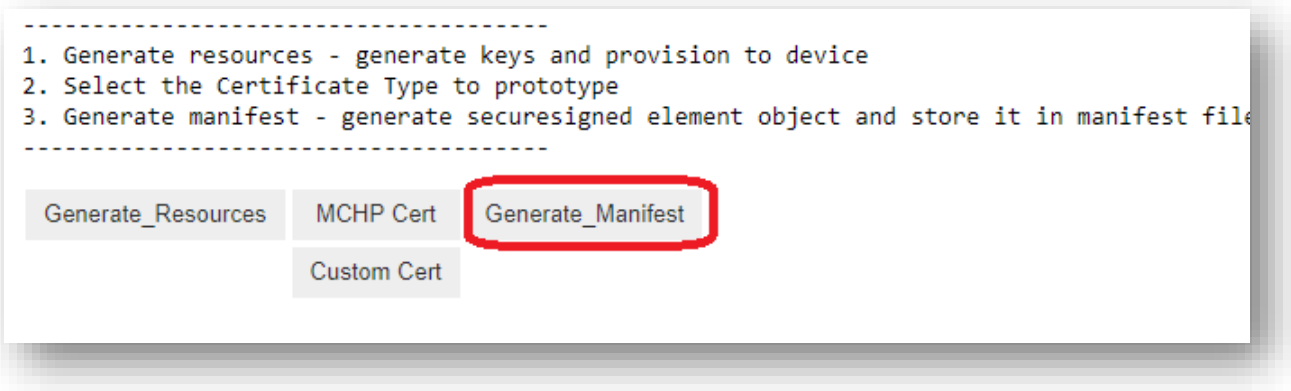
Certificate:
    Data:
        Version: 3 (0x2)
        Serial Number:
            7a:8b:9e:c9:b4:61:f1:75:b0:cc:e9:28:8b:1b:56:d6
        Signature Algorithm: ecdsa-with-SHA256
        Issuer: O=test, CN=Crypto Authentication Root CA 002
        Validity
            Not Before: Jul 1 08:05:19 2020 GMT
            Not After : Jun 21 08:05:19 2060 GMT
        Subject: O=test, CN=Crypto Authentication Root CA 002
        Subject Public Key Info:
            Public Key Algorithm: id-ecPublicKey
                Public-Key: (256 bit)
                pub:
                    04:57:fa:a9:c4:b2:3e:ff:22:63:4b:9c:72:84:d7:
                    4a:54:ac:b5:ac:f4:10:20:94:c5:75:28:aa:4c:bc:
                    5e:8e:34:be:c3:82:6c:f3:ed:e5:0b:65:bc:d1:e7:

```
                cb:2f:2d:01:bc:33:6b:a0:ec:02:2c:f6:b0:62:f3:
                0c:8e:61:42:1a
            ASN1 OID: prime256v1
            NIST CURVE: P-256
        X509v3 extensions:
            X509v3 Subject Key Identifier:
                47:54:F4:28:96:38:AA:EB:92:4E:1B:8B:EE:E6:5D:F6:27:39:A4:49
            X509v3 Authority Key Identifier:
                keyid:47:54:F4:28:96:38:AA:EB:92:4E:1B:8B:EE:E6:5D:F6:27:39:A4:49

            X509v3 Basic Constraints: critical
                CA:TRUE
    Signature Algorithm: ecdsa-with-SHA256
        30:46:02:21:00:81:ec:52:b1:e4:ad:f7:c4:af:44:d0:fb:16:
        18:a6:51:69:a4:31:c5:24:72:a4:2e:ba:cb:88:55:a9:65:66:
        30:02:21:00:c9:46:db:6c:cd:50:a3:c7:71:c1:d0:c5:f4:2c:
        b1:81:f9:2d:f4:79:49:51:3e:58:2d:c7:cb:17:a6:fc:45:63


Validate signer certificate...OK
-----BEGIN CERTIFICATE-----
MIIB3TCCAYKgAwIBAgIQV/RpeXxWfquIIYFCFTDc/TAKBggqhkjOPQQDAjA7MQ0w
CwYDVQQKDAR0ZXN0MSowKAYDVQQDDCFDcnlwdG8gQXV0aGVudGljYXRpb24gUm9v
dCBDQSAwMDIwIBcNMjAwNzAxMDgwMDAwWhgPMjA0MDA3MDEwODAwMDBaMDsxDTAL
BgNVBAoMBHRlc3QxKjAoBgNVBAMMIUNyeXB0byBBdXRoZW50aWNhdGlvbiBTaWdu
ZXIgRkZGRjBZMBMGByqGSM49AgEGCCqGSM49AwEHA0IABCEubbOfXDakettxvfKu
kfG5UhQNDHrPrZiURytSZmQ8p38VacZ682akSAC6XQYDzhiy5/5O4eAHBCuN5rOt
vnOjZjBkMA4GA1UdDwEB/wQEAwIBhjASBgNVHRMBAf8ECDAGAQH/AgEAMB0GA1Ud
DgQWBBRycA/sc+NWXwp0wLudepyPtQtzFzAfBgNVHSMEGDAWgBRHVPQoljiq65JO
G4vu5l32JzmkSTAKBggqhkjOPQQDAgNJADBGAiEA1ThacjiYboKYh69+NllQKiX2
wb7Jztq8zMsY61H/NkYCIQDQc2TQfOl9HBDUoDzUtTZNgIksElkU7ysiSgBhumAA
zQ==
-----END CERTIFICATE-----

Certificate:
    Data:
        Version: 3 (0x2)
        Serial Number:
            57:f4:69:79:7c:56:7e:ab:88:21:81:42:15:30:dc:fd
        Signature Algorithm: ecdsa-with-SHA256
        Issuer: O=test, CN=Crypto Authentication Root CA 002
        Validity
            Not Before: Jul  1 08:00:00 2020 GMT
            Not After : Jul  1 08:00:00 2040 GMT
```

```
        Subject: O=test, CN=Crypto Authentication Signer FFFF
        Subject Public Key Info:
            Public Key Algorithm: id-ecPublicKey
                Public-Key: (256 bit)
                pub:
                    04:21:2e:6d:b3:9f:5c:36:a4:7a:db:71:bd:f2:ae:
                    91:f1:b9:52:14:0d:0c:7a:cf:ad:98:94:47:2b:52:
                    66:64:3c:a7:7f:15:69:c6:7a:f3:66:a4:48:00:ba:
                    5d:06:03:ce:18:b2:e7:fe:4e:e1:e0:07:04:2b:8d:
                    e6:b3:ad:be:73
                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:
                72:70:0F:EC:73:E3:56:5F:0A:74:C0:BB:9D:7A:9C:8F:B5:0B:73:17
            X509v3 Authority Key Identifier:
                keyid:47:54:F4:28:96:38:AA:EB:92:4E:1B:8B:EE:E6:5D:F6:27:39:A4:49

    Signature Algorithm: ecdsa-with-SHA256
        30:46:02:21:00:d5:38:5a:72:38:98:6e:82:98:87:af:7e:36:
        59:50:2a:25:f6:c1:be:c9:ce:da:bc:cc:cb:18:eb:51:ff:36:
        46:02:21:00:d0:73:64:d0:7c:e9:7d:1c:10:d4:a0:3c:d4:b5:
        36:4d:80:89:2c:12:59:14:ef:2b:22:4a:00:61:ba:60:00:cd


Validate device certificate...OK
-----BEGIN CERTIFICATE-----
MIIByDCCAW+gAwIBAgIQdxkpBswUT+e4dShL6tp00jAKBggqhkjOPQQDAjA7MQ0w
CwYDVQQKDAR0ZXN0MSowKAYDVQQDDCFDcnlwdG8gQXV0aGVudGljYXRpb24gU2ln
bmVyIEZGRkYwIBcNMjAwNzAxMDYwMDAwWhgPMjA0ODA3MDEwNjAwMDBaMC4xDTAL
BgNVBAoMBHRlc3QxHTAbBgNVBAMMFHNuMDEyMzNFOEExNDkxRjBNjAxMFkwEwYH
KoZIzj0CAQYIKoZIzj0DAQcDQgAEzxmIvDpsJSAm/nD7NDl62Fo5roEcciv6bl7B
6c2pEzs/DpH9OHfyW4yJOzEbrwIDy1EAxM2r66/a8+vVULABJaNgMF4wDAYDVR0T
AQH/BAIwADAOBgNVHQ8BAf8EBAMCA4gwHQYDVR0OBBYEFOq8VhE8cCJ6GMCmL3wo
X8aNdfnNMB8GA1UdIwQYMBaAFHJwD+xz41ZfCnTAu516nI+1C3MXMAoGCCqGSM49
BAMCA0cAMEQCIANn/QrqxwmwrRsrcYyQpWJ0o4AxLzGoeCZjfJ5o0FAbAiBFne67
iEzuh6dqwrdQYvgB6+qTxfLyei1kwoFcfVnHvA==
-----END CERTIFICATE-----

Certificate:
```

```
Data:
    Version: 3 (0x2)
    Serial Number:
        77:19:29:06:cc:14:4f:e7:b8:75:28:4b:ea:da:74:d2
    Signature Algorithm: ecdsa-with-SHA256
    Issuer: O=test, CN=Crypto Authentication Signer FFFF
    Validity
        Not Before: Jul  1 06:00:00 2020 GMT
        Not After : Jul  1 06:00:00 2048 GMT
    Subject: O=test, CN=sn01233E8A1491F2A601
    Subject Public Key Info:
        Public Key Algorithm: id-ecPublicKey
            Public-Key: (256 bit)
            pub:
                04:cf:19:88:bc:3a:6c:25:20:26:fe:70:fb:34:39:
                7a:d8:5a:39:ae:81:1c:72:2b:fa:6e:5e:c1:e9:cd:
                a9:13:3b:3f:0e:91:fd:38:77:f2:5b:8c:89:3b:31:
                1b:af:02:03:cb:51:00:c4:cd:ab:eb:af:da:f3:eb:
                d5:50:b0:01:25
            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:
            EA:BC:56:11:3C:70:22:7A:18:C0:A6:2F:7C:28:5F:C6:8D:75:F9:CD
        X509v3 Authority Key Identifier:
            keyid:72:70:0F:EC:73:E3:56:5F:0A:74:C0:BB:9D:7A:9C:8F:B5:0B:73:17

Signature Algorithm: ecdsa-with-SHA256
     30:44:02:20:03:67:fd:0a:ea:c7:09:b0:ad:1b:2b:71:8c:90:
     a5:62:74:a3:80:31:2f:31:a8:78:26:63:7c:9e:68:d0:50:1b:
     02:20:45:9d:ee:bb:88:4c:ee:87:a7:6a:c2:b7:50:62:f8:01:
     eb:ea:93:c5:f2:f2:7a:2d:64:c2:81:5c:7d:59:c7:bc
```

3. Generating Manifest file



The output log should resemble this:

Generating manifest data...OK (saved to TFLXTLS_devices_manifest.json)

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, Validation Authority public key and a public key are loaded into TrustFLEX device in slot 13 and 14 respectively.

4 Use Case Prototyping

This hands-on lab is intended to demonstrate how to securely rotate public key in the TrustFLEX device. This uses the PubInvalid feature of the Slot configuration.

Secure Public Key Rotation is sequence of steps for host to update the public key in the TrustFLEX device securely. The basic flow to update the rotating public key is as follows:

1. Invalidate existing public key
2. Update (write) New rotating public key
3. Validate new rotating public key

To perform a validation/invalidation process, its required to have a validation authority. Typically, Validation Authority public key will be loaded to secure element and locked permanently.

This validation/invalidation process includes the authority signing the public key's digest and generating the signature. Authority's public key will be used for verifying the signature with second slot public key's digest.

To update a new rotating public key in the TrustFLEX device, first we need to invalidate the existing public key. By invalidating it, the slot becomes available for write operation and a new public key can be written to it. However, the slot cannot be used for cryptographic operations until its validated.

TrustFLEX device two slots being used for key rotation sequence,

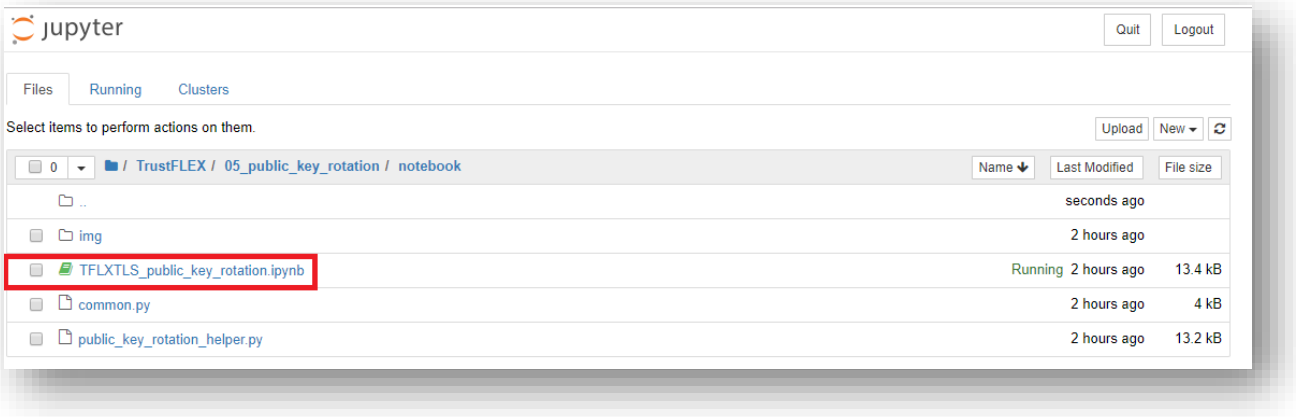
- Validation Authority public key – slot 13
- Rotating public key – slot 14

The resource generation for TrustFLEX device will generate and load prototyping validation authority and required public keys to TrustFLEX device.

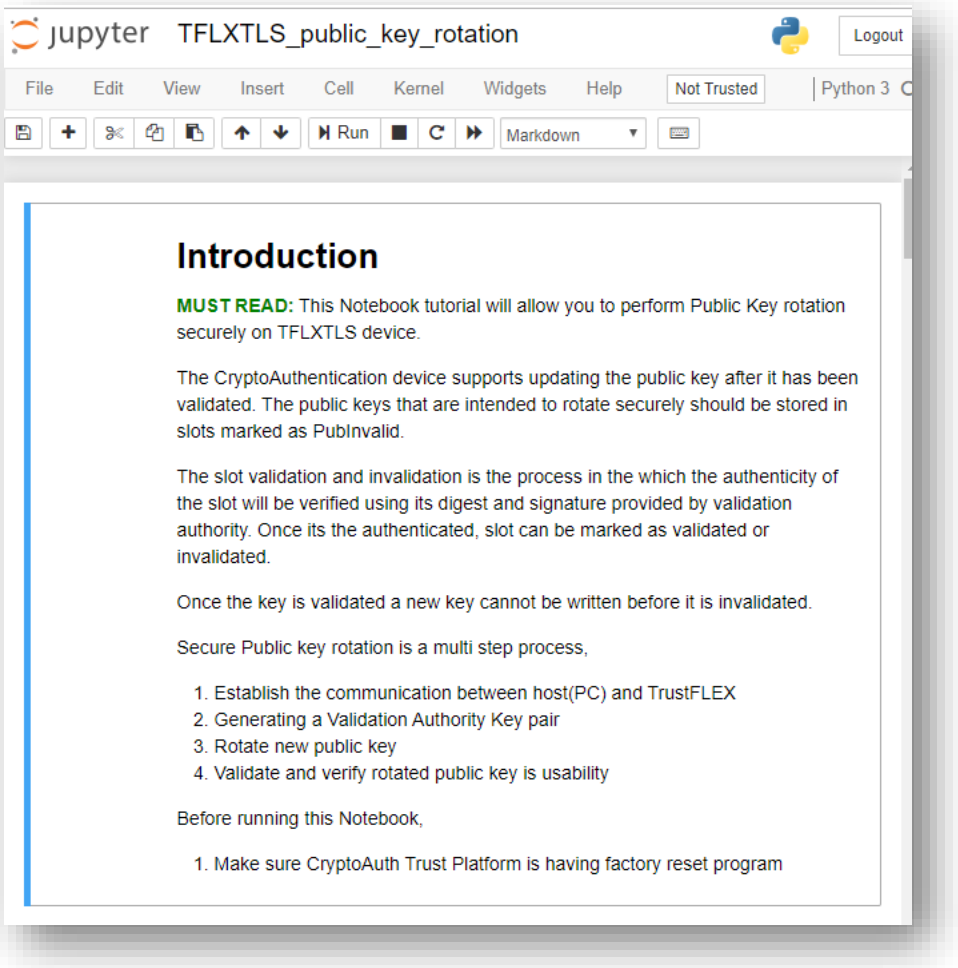
Following sections provide detail steps to execute the usecase both on Jupyter Notebook and on Embedded project.

4.1 Running Public Key Rotation example on Jupyter Notebook:

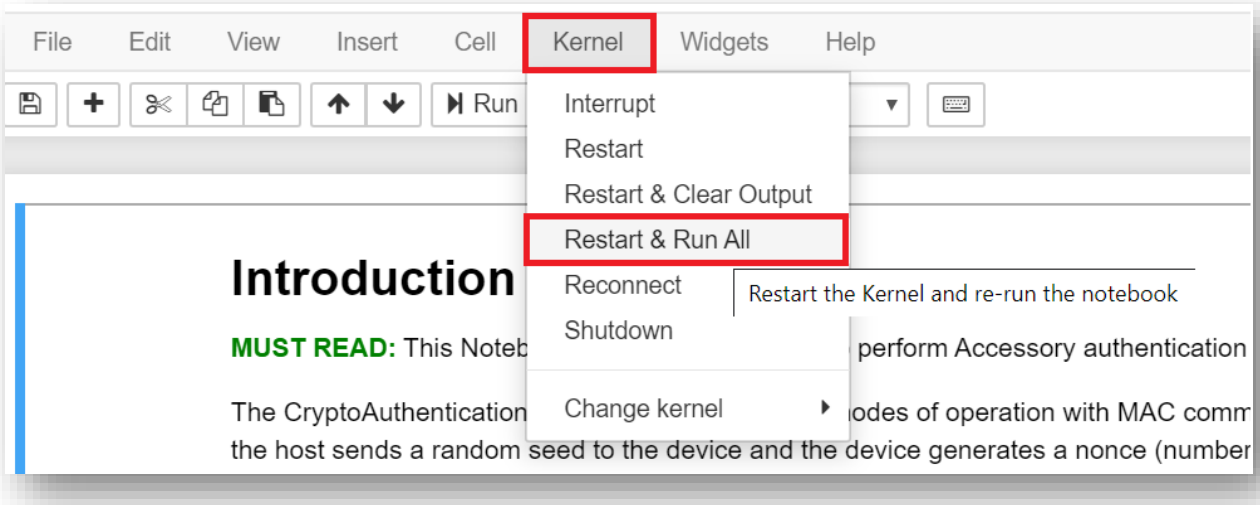
1. From the Jupyter Home page, navigate to **TrustFLEX\05_public_key_rotation\notebook\TFLXTLS_public_key_rotation.ipynb** notebook file and open it.



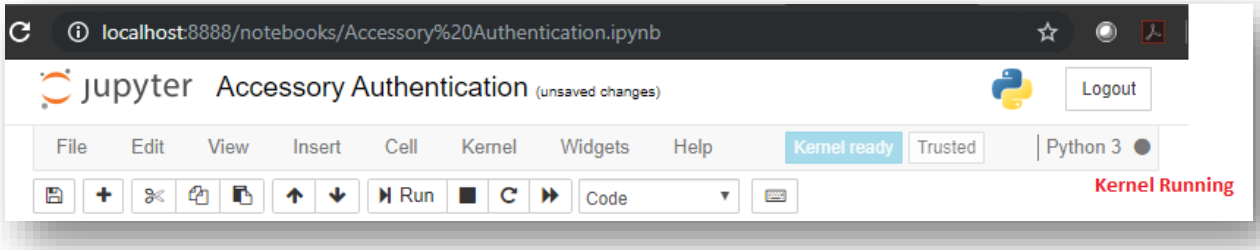
Opening the notebook from Jupyter home page should load the following on the browser,

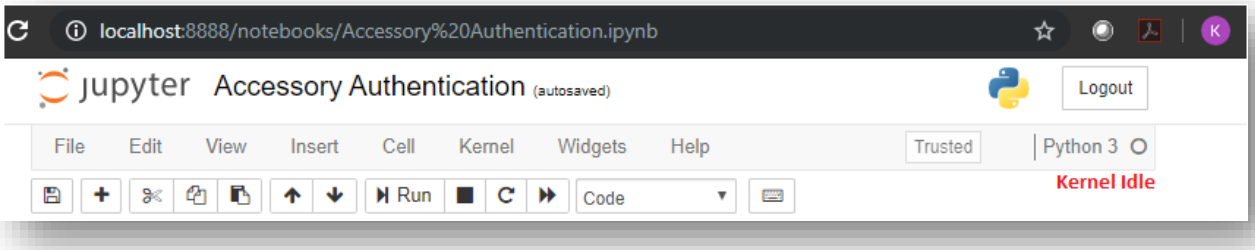


2. Run All Cells by using Kernel -> Restart & Run All



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)





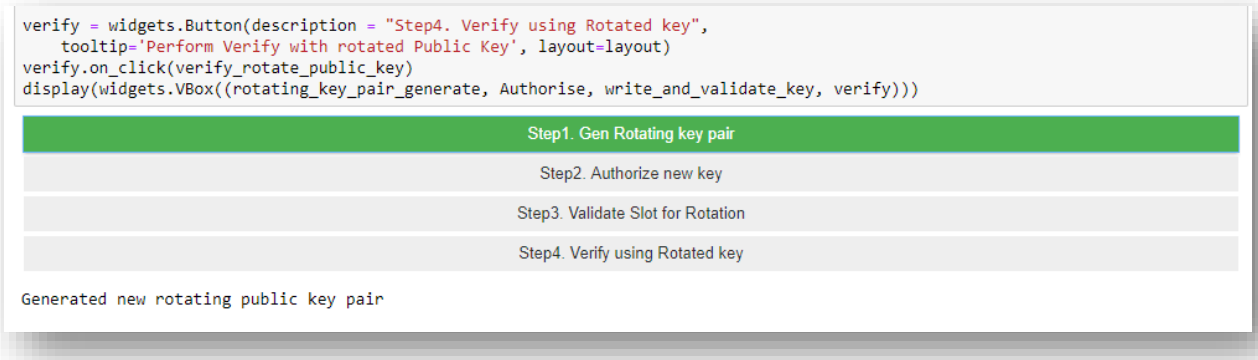
4. Navigate through different cells output for the description of the step and result from the execution.
5. There are 6 major steps in this lab
   This lab is setup to generate multiple button at the end of the example. These buttons perform the tasks listed below.

   <u>Generating a Validation Authority key pair</u>
   This step setups a temporary validation authority to perform slot validation and validation process. This is already taken care part of resource generation

   <u>Generating a new public key</u>

This step generates a new key pair to rotate the existing public key in the slot. This will be the new public key attempted to load in to PubInvalid slot i.e. for secure public key rotation.

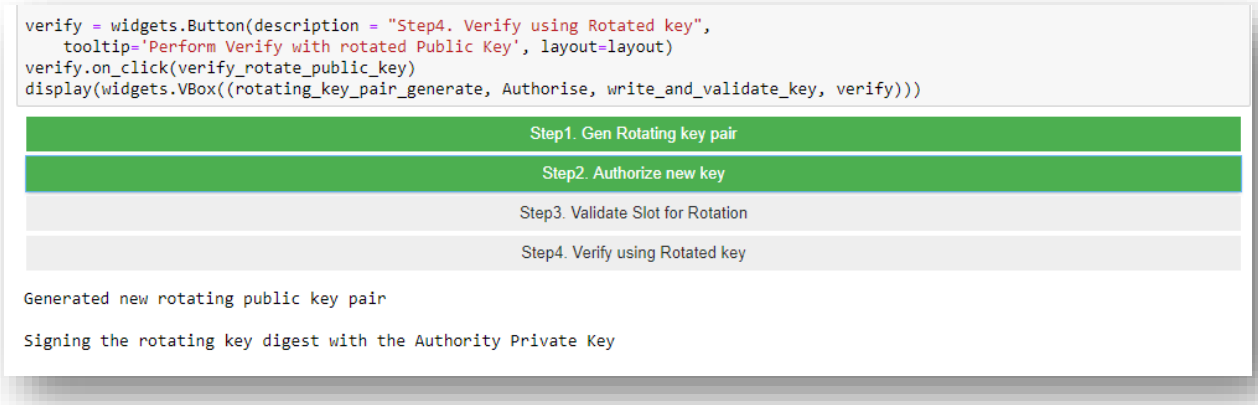
Click on "Gen Rotating Key Pair" button at the bottom of the Notebook. This generates new key to update the existing slot. The button turns RED if there is any error in the execution.



Authorize public key

Before the new key to be used for writing into the slot, this should be validated by validation authority. In this step, validation authority calculates the Pubkey's digest and signs using its private key.

Click on "Authorize new key" button at the bottom of the Notebook. This authorizes the new public key using validation authority. The button turns RED if there is any error in the execution.



Update public key

This is the step where actual slot update happens. Before updating the existing slot should be invalidated using existing public key digest and signature provided by the validation authority. This signature should be of existing (old) public key, but not new public key.

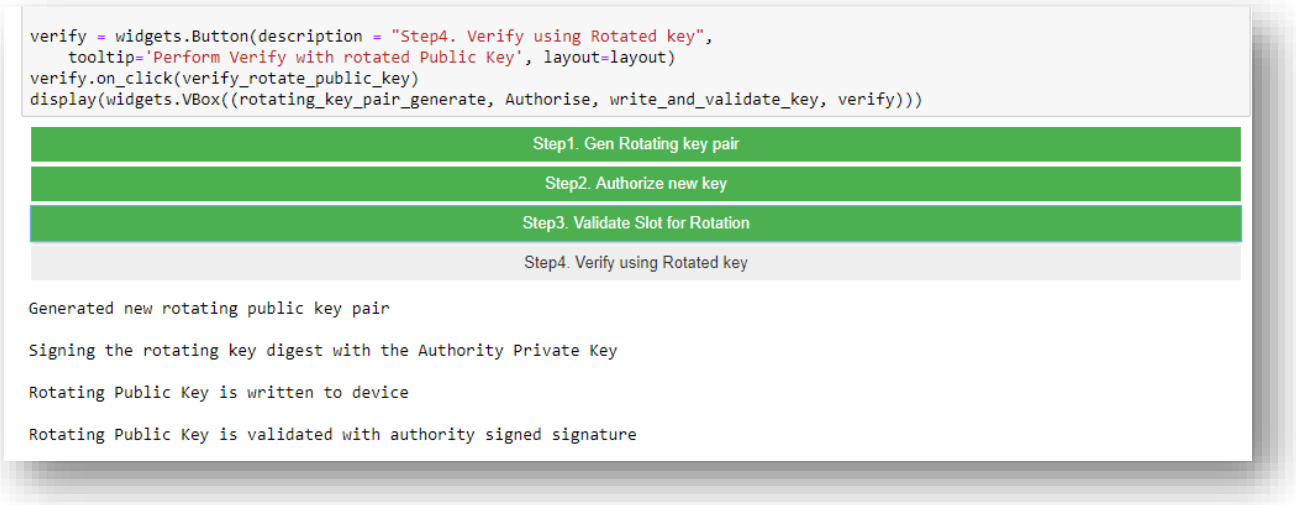
Once the slot is invalidated, new public key can be overwritten to this slot. After writing it successfully, the slot remains in invalidated state and doesn't allow any cryptographic operations.

Validate the rotating public key

This step does the slot validation after writing the new public key into PubInvalid slot i.e. slot14. Unless the slot is validated this cannot be used for cryptographic operations like Verify.

The process of validation involves the Public Key digest, Signature provided by validation authority. During this process, TrustFLEX device initiates internal Public key digest calculation on Slot14. Once the Digest is generated atcab_verify_validate will be issued with Slot number and Signature as parameters. On the successful match of digest and signature, the slot will be marked as PubInvalid. This restricts further writes to slot, but enables cryptographic operations using this slot.

Click on "Validate Slot for Rotation Key" button at the bottom of the Notebook to perform Public key authorization, updating to slot and validating the new public key. The button turns RED if there is any error in the execution.



Verify the rotating public key

Once rotating public key is validated, then the rotating public key can be used for ECC operations. To verify that rotating public key availability for ECC operations, here we perform a sign and verify ECC operation.

First generate a temporary message digest and sign by private key corresponding to new/rotated public key. Then the signature is verified by using rotating public key. If it is verified, then the rotating public key is available for ECC operations or else not.

Click on "Verify Key" button at the bottom of the Notebook to perform verify operation using rotated key. The button turns green if rotated public key can be used for ECC operations or it will turn RED.

```
verify = widgets.Button(description = "Step4. Verify using Rotated key",
    tooltip='Perform Verify with rotated Public Key', layout=layout)
verify.on_click(verify_rotate_public_key)
display(widgets.VBox((rotating_key_pair_generate, Authorise, write_and_validate_key, verify)))
```

Step1. Gen Rotating key pair

Step2. Authorize new key

Step3. Validate Slot for Rotation

Step4. Verify using Rotated key

```
Generated new rotating public key pair

Signing the rotating key digest with the Authority Private Key

Rotating Public Key is written to device

Rotating Public Key is validated with authority signed signature

Signing with the Rotating Private Key

Verified the Rotating Public key
```

4.2 Running Public Key Rotation on Embedded platform

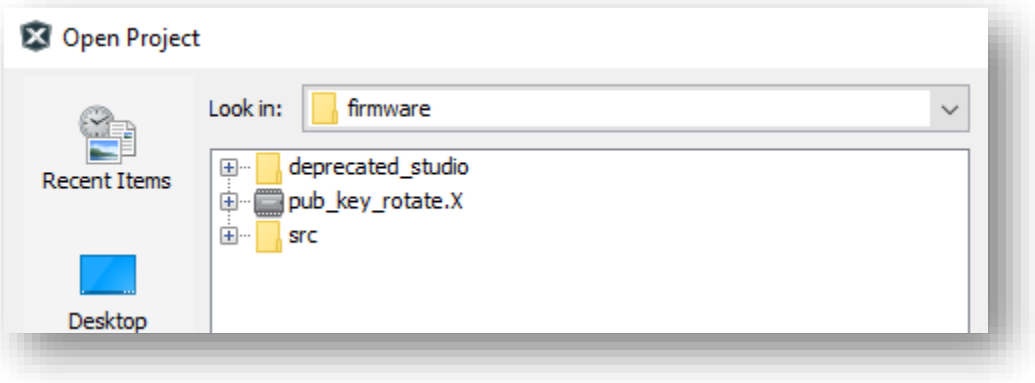
This usecase can also be executed on Embedded platform. Once the resources are generated, both Atmel Studio and MPLAB projects provided can be used to run the application on CryptoAuth Trust Platform.

This project can only perform Public key rotation steps, but not key generations for validation authority and new public key. It is **required** to use Public Key Rotation Notebook to generate new public key and get it authorized by validation authority. This notebook generates supporting data files like public keys, signatures and nonces for C projects.

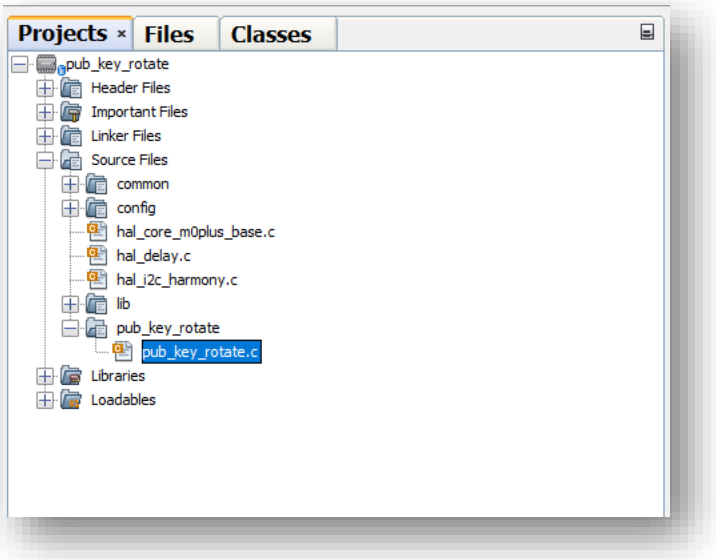
Once the new public key is generated and authorized, these embedded projects can be used to rotate the current public key to the new one.

4.2.1 MPLAB:

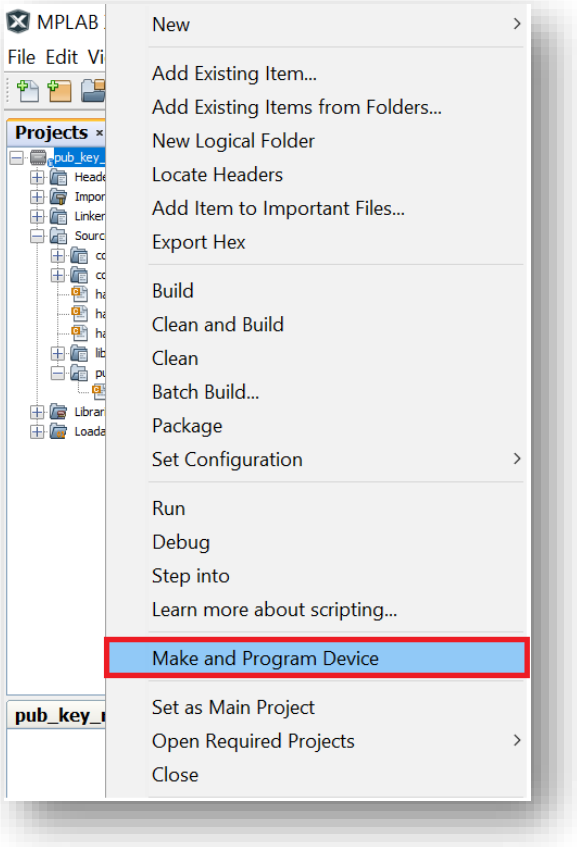
1. Open **pub_key_rotate.X** project by navigating to MPLAB -> File -> Open Project -> **TrustFLEX\05_public_key_rotation\firmware\pub_key_rotate.X**



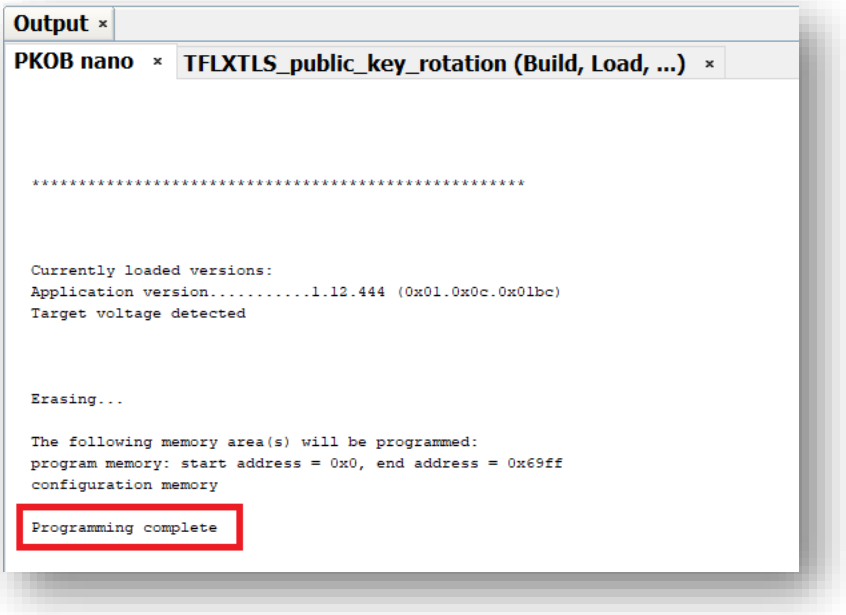
2. The application source code **pub_key_rotate.c** is available at **TrustFLEX\05_public_key_rotation\firmware\pub_key_rotate.c.** Other supporting files can be found under **assets\dependencies**.



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



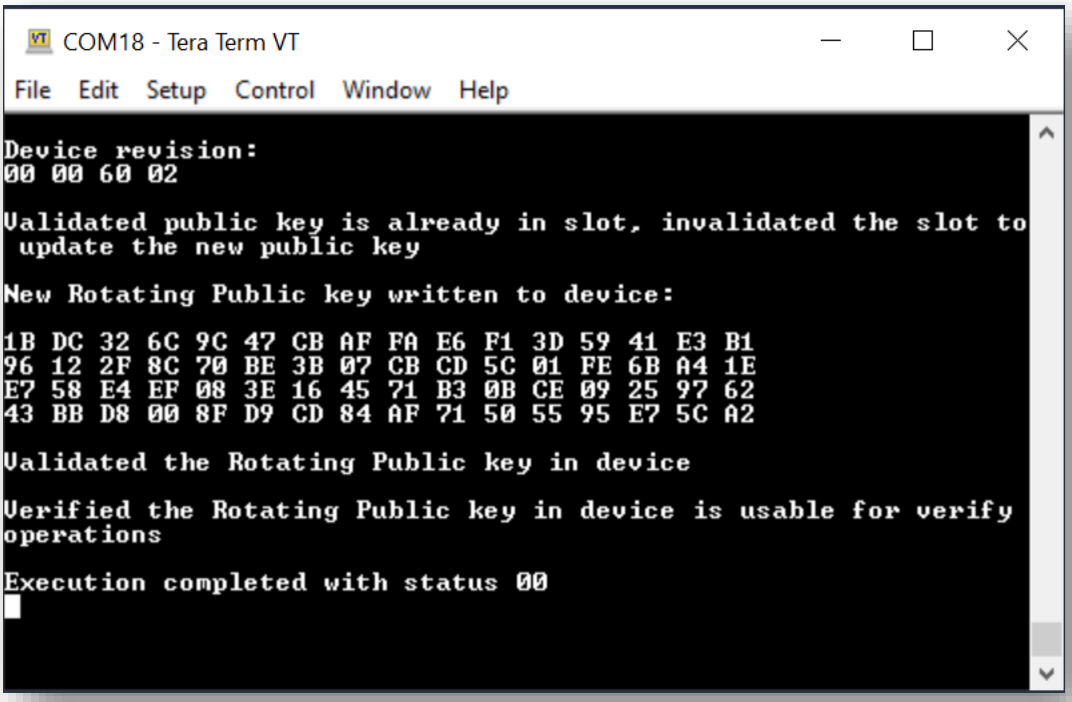
This step may take some time, wait for MPLAB to program the device. Once it is done programming you will see "**Programming complete**" message in Output Window.



Once the programming is done, the firmware will do public key rotation operation. Depending on the public key rotation operation's output, the Crypto Auth Trust Platform board's Status LED will blink at different rates.

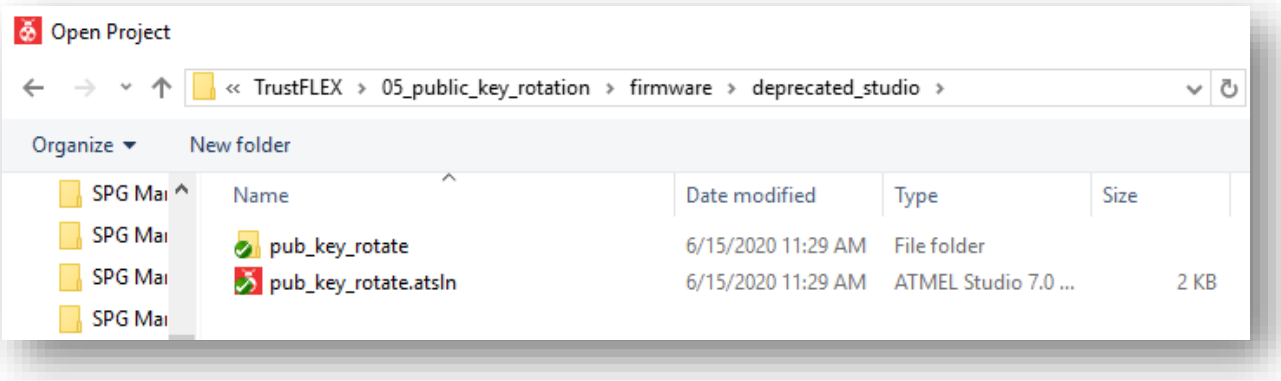
If public key rotation operation succeeds, LED blinks once every second.
If public key rotation operation fails, LED blinks five times every second.

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

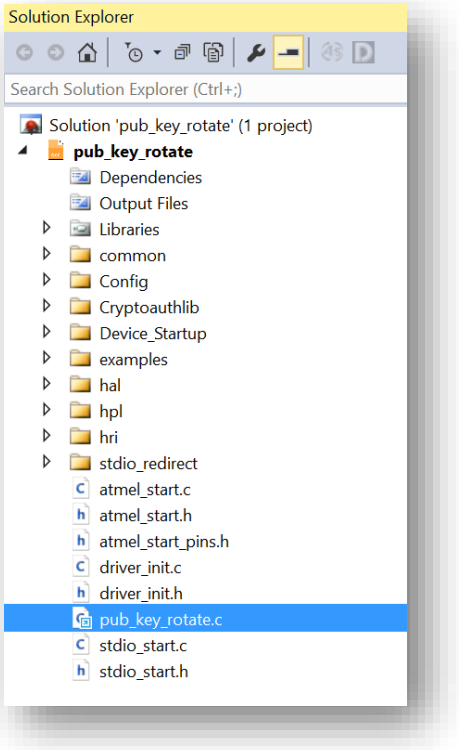


4.2.2 Atmel Studio (Deprecated)

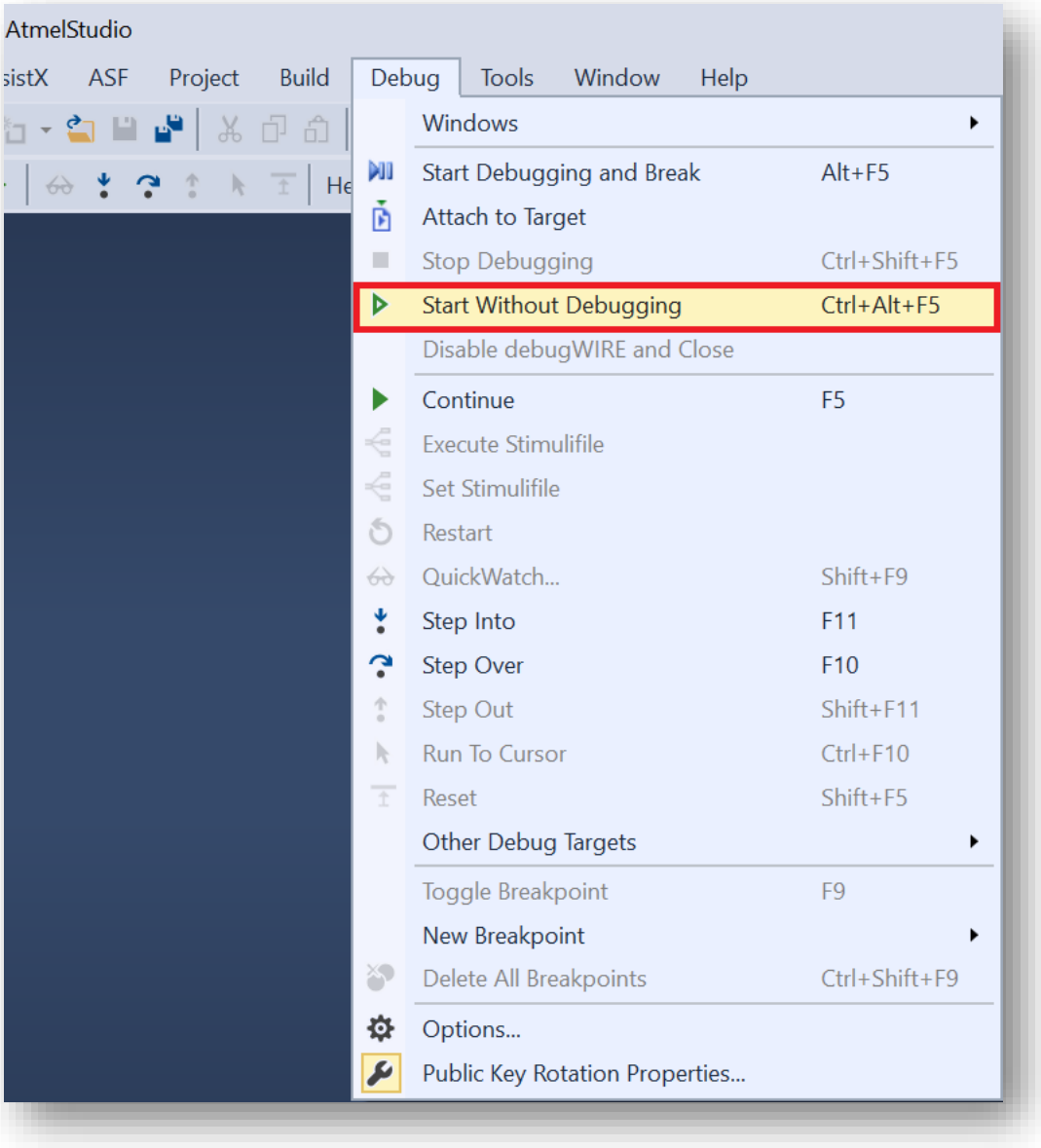
1. Open **pub_key_rotate.atsln** project by navigating to Atmel Studio -> File -> open-> **TrustFLEX\05_public_key_rotation\ deprecated_studio \ pub_key_rotate.atsln**



2. The application source code **pub_key_rotate.c** is available at **TrustFLEX\05_public_key_rotation\firmware\pub_key_rotate.c.** Other supporting files can be found under **assets\dependencies**



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

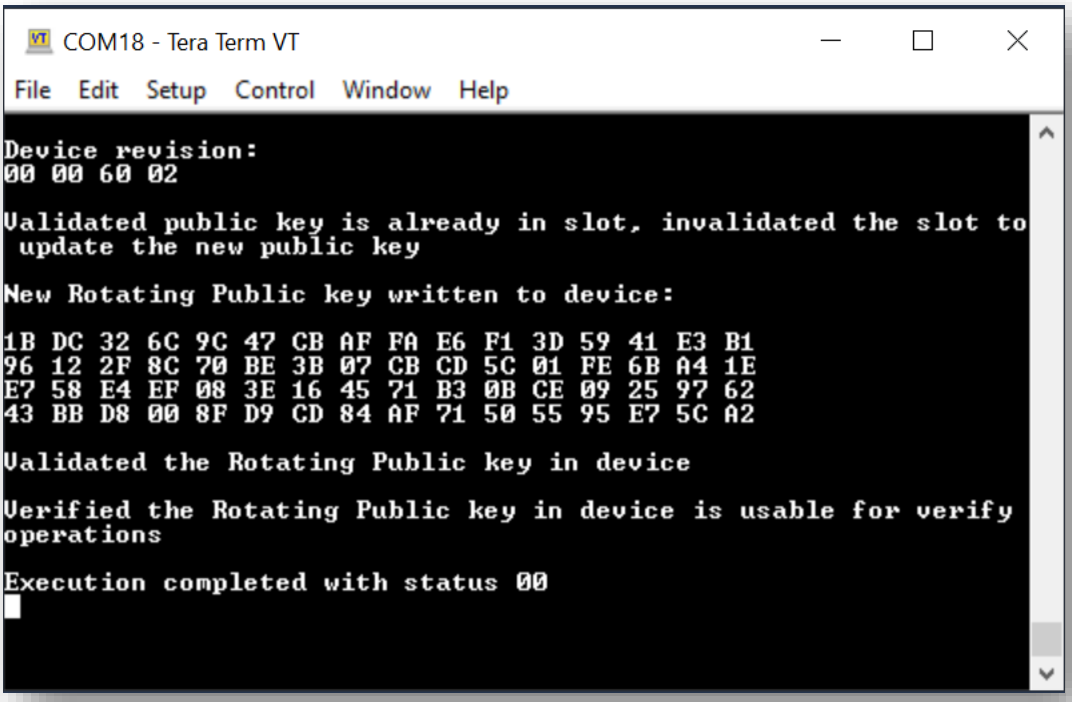


This step may take some time, wait for Atmel Studio to compile and program the device.

Once the programming is done, the firmware will do public key rotation operation. Depending on the public key rotation operation's output, the Crypto Auth Trust Platform board's Status LED will blink at different rates.

If public key rotation operation succeeds, LED blinks once every second.
If public key rotation 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 Crypto Auth Trust Platform with 115200-8-N-1 settings.


COM18 - Tera Term VT
File Edit Setup Control Window Help
Device revision:
00 00 60 02
Validated public key is already in slot, invalidated the slot to
update the new public key
New Rotating Public key written to device:
1B DC 32 6C 9C 47 CB AF FA E6 F1 3D 59 41 E3 B1
96 12 2F 8C 70 BE 3B 07 CB CD 5C 01 FE 6B A4 1E
E7 58 E4 EF 08 3E 16 45 71 B3 0B CE 09 25 97 62
43 BB D8 00 8F D9 CD 84 AF 71 50 55 95 E7 5C A2
Validated the Rotating Public key in device
Verified the Rotating Public key in device is usable for verify
operations
Execution completed with status 00

4.3 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 directory 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.

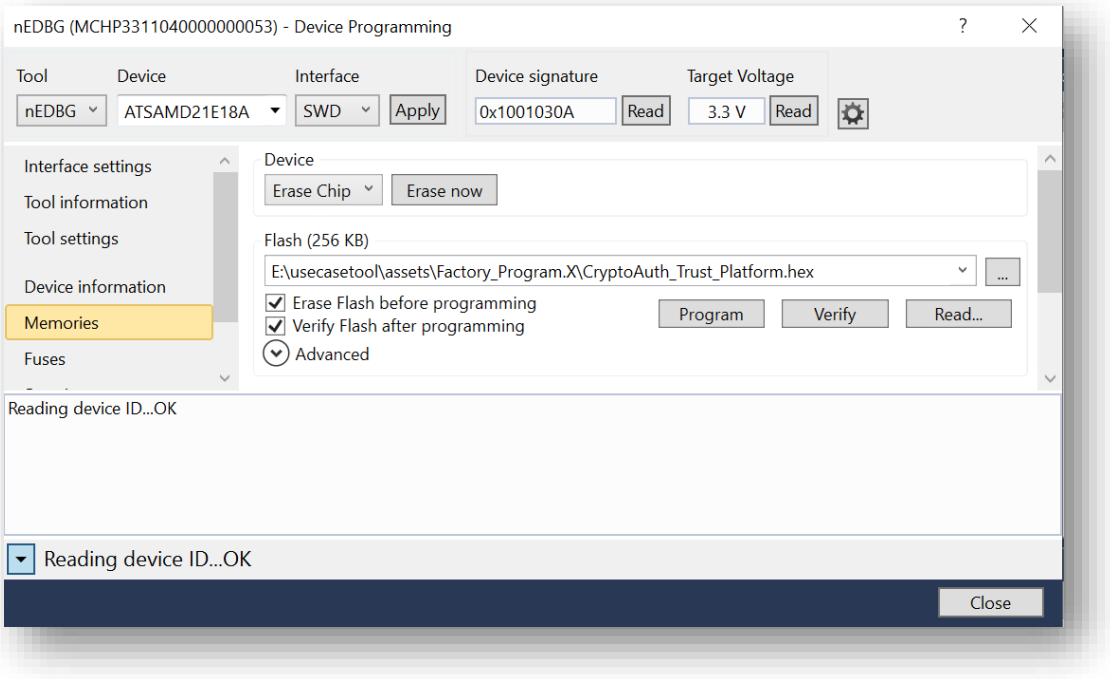
This can also be done manually by MPLAB and Atmel Studio

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**

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



Now, Crypto Auth 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 "Crypto Auth Trust Platform Factory reset" section any usecase TrustFLEX Guide for reloading it
   2. Check the switch positions on Crypto Trust Platform and/or ATECC608B 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 "Crypto Auth Trust Platform Factory reset" section any usecase TrustFLEX Guide for reloading it.

3. **Why does my C projects generates No such file or directory with ../../../00_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 public key rotation project fails with error "Rotating Public key verification failed"?**

   There are many possibilities like,

   a. Signer registration is not done to the right account
   b. aws client region is select incorrectly
   c. WiFi credentials are not populated or in correct in C project
   d. aws-iot endpoint is not populated or in-correct in C project

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