Developer Guide

Security Starter Kit with STM32WB55 and OPTIGA™ Trust M

Date: December 3, 2020 | Version 1.0
FINAL

CONTENTS

DEFINITION, ACRONYMS AND ABBREVIATIONS

Definition/Acronym/Abbreviation	Description
AWS	Amazon Web Services
AWS CLI	AWS Command Line Interface
BLE	Bluetooth Low Energy
DFU	Device Firmware Update
FUS	Firmware Update Service
MQTT	Message Queuing Telemetry Transport
OTA	Over-the-Air
SSK	Security Starter Kit
STM	STMicroelectronics

1 INTRODUCTION

1.1 Purpose of the Document

This document describes how to integrate the AWS FreeRTOS, BLE, MQTT and OPTIGA™ Trust M stack on STM32WB55 board. The AWS basic demo is also enabled, which securely communicates with AWS Cloud using OPTIGA™ Trust M chip. This document will also guide the user through the AWS IoT console features to understand the Amazon IoT web services.

1.2 Architecture

The STM32WB55 board has Bluetooth Low Energy (BLE) as the wireless interface. A proxy or gateway will be required to access AWS services to gain internet connectivity via Wi-Fi or Ethernet. In this case, a mobile device (either Android or iOS) having BLE and 4G (or Wi-Fi) connectivity will facilitate as gateway. An Android or iOS Mobile application will act as a proxy between BLE and another network.

Figure 1: Hardware Setup

1.3 SSK Suit Package Contents

1. Download the SSK STM32WB55 release package (STM32WB55_SSK_Pkg_Rel.zip) from the Arrow Electronics Github portal; https://github.com/ArrowElectronics/Security-Starter-Kits
2. Extract the STM32WB55_SSK_Pkg_Rel.zip
   - Extracting the tar file, one will find the below contents:
     - Developer_Guide_STM32WB55_SSK.pdf
     - Quick_Start_Guide_STM32WB55_SSK.pdf
     - Firmware_Images
     - Source_Code
     - SSK_Cert_And_Config
     - RELEASE_NOTES.txt, information about the release

2 SETTING UP THE DEVELOPMENT ENVIRONMENT

2.1 Hardware setup

The following hardware is needed for this project:

- STM32WB55 board from ST's P-NUCLEO-WB55 package
- Infineon's Shield2Go OPTIGA™ Trust M
- Custom cable to connect the OPTIGA™ Trust M to the STM32WB55 board
- Micro USB cables to Power on the Board. The same cable is used for debugging
- IOS or Android Mobile Device (As a Proxy or Gateway)
- A development PC or Mac for either Android or iOS application compilation.

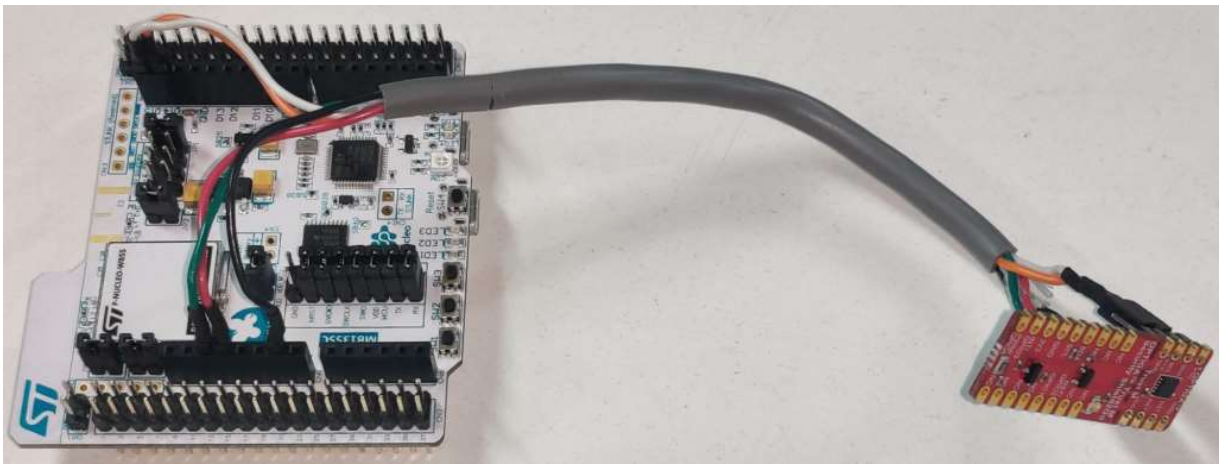
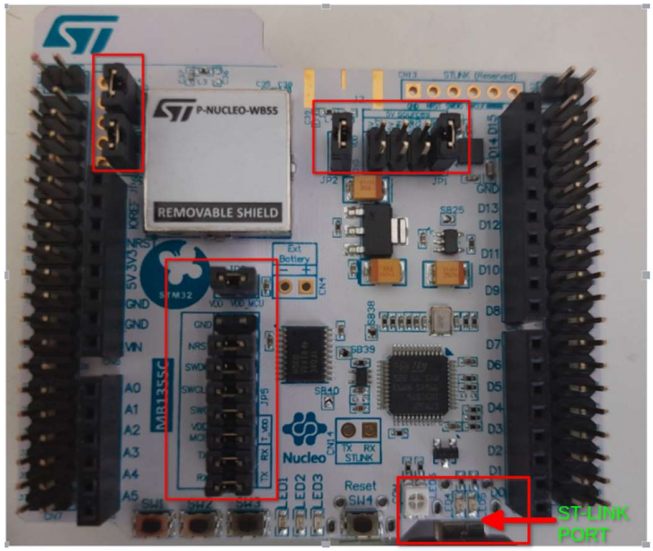


Figure 2: Hardware Setup

1. Please make sure that the below shown jumpers are connected on STM32WB55 board.



2. Connection between OPTIGA™ Trust M with STM32WB55 board using the ribbon cable as per below table.

Connections No	OPTIGA™ TrustM	STM32WB55
1(Red)	VCC	CN6.4 (+3v3)
2(Black)	GND	CN6.6 (GND)
3(Green)	RST	CN6.3 (NRST)
4(White)	SCL	CN5.10(D15)
5(Orange)	SDA	CN5.9(D14)

3. Connect Micro USB cable to ST-LINK(port) as show in figure to power on the board and same for debugging purpose.

2.2 Software Setup

2.2.1 STM32CubeIDE

STM32CubeIDE is software tool to compile the source code and generate the binary to flash on the STM32WB55.

- Download and Install STM32CubeIDE from ST site https://www.st.com/en/development-tools/stm32cubeide.html

2.2.2 STM32CubeProgrammer

STM32CubeProgrammer is required to program the Flash memory of STM32WB55 board.

- Install STM32CubeProgrammer from ST site: https://www.st.com/en/development-tools/stm32cubeprog.html

2.2.3 OpenSSL

OpenSSL is needed for certificate creation if you want to do OTA update.

2.2.4 AWS CLI

AWS CLI is needed to automate various tasks and import OTA certificate in AWS.

2.2.5 Terminal emulator

A serial terminal software like **Putty or Minicom** is needed for debugging the Amazon FreeRTOS application running on STM32WB55 (using USB virtual COM port).

2.2.6 Android studio or Xcode

The software development tool like Android Studio to manage Android app or Xcode for IOS Mobile is needed to compile the Amazon FreeRTOS BLE gateway Mobile application.
[Note: Source code are available under Source_Code/Mobile_App_Source.zip]

2.3 OTA configuration in AWS

To perform OTA, user should have to configure the below listed items on AWS console

- Check the Prerequisites for OTA updates using MQTT.
- Create an Amazon S3 bucket to store your update.
- Create an OTA Update service role.
- Create an OTA user policy.
- Create a code-signing certificate.
- Grant access to code signing for AWS IoT

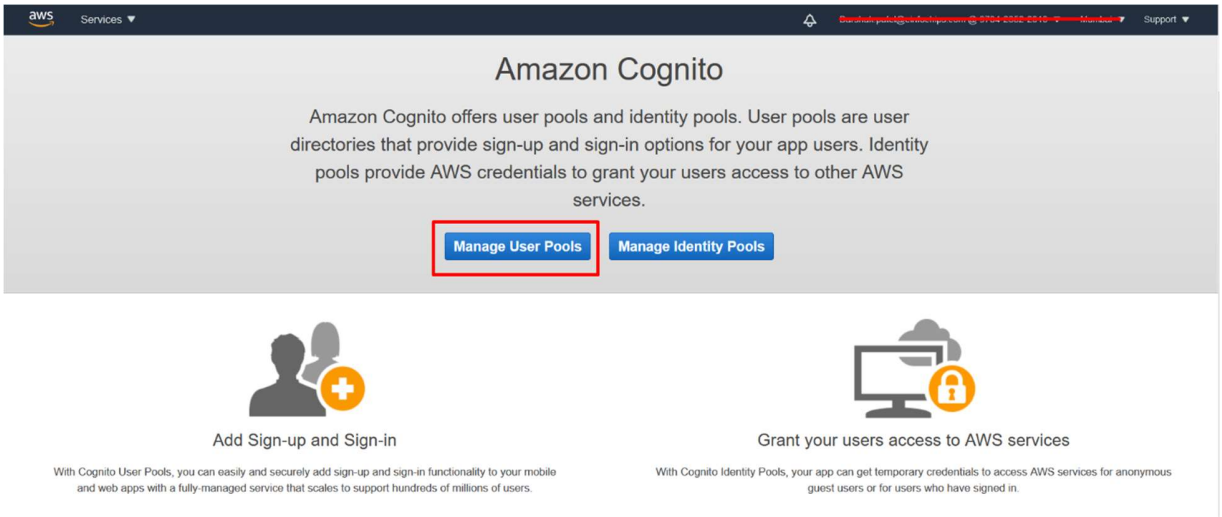
Detailed configuration and steps available on AWS document.
https://docs.aws.amazon.com/freertos/latest/userguide/ota-prereqs.html

2.4 Mobile App setup

Please follow below steps to create AWS Cognito user. This is needed to login into the Mobile APP. It is presumed that the User has AWS Account Login - https://aws.amazon.com/console/

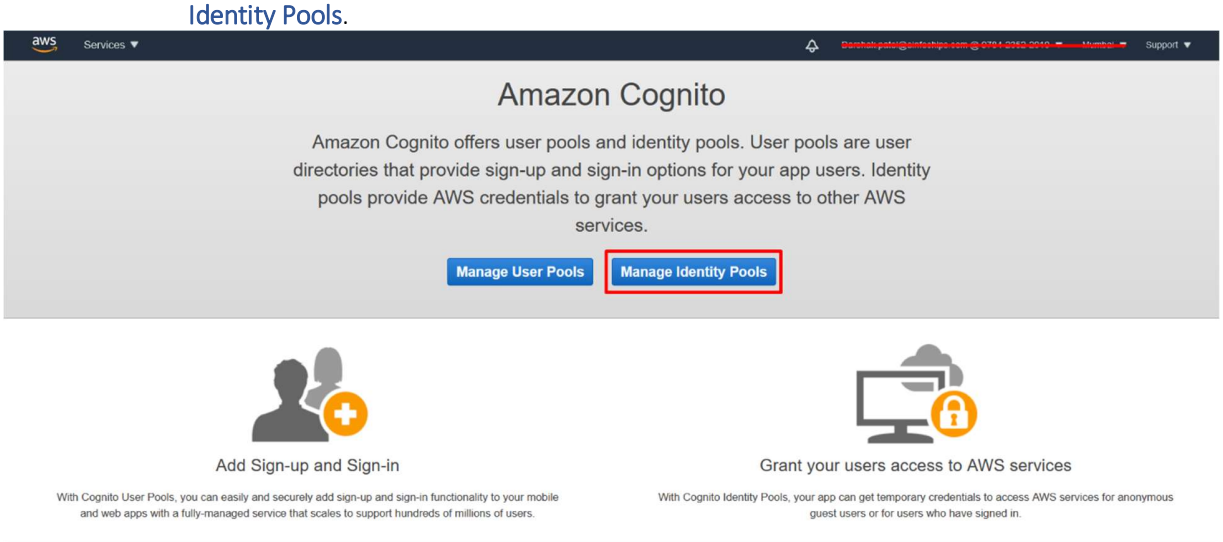
.

1. In case if you have created the Amazon Cognito user pool in AWS console then go to step 6, otherwise continue with step 2
2. To create an Amazon Cognito user pool in AWS Console
   - In AWS console, Open the Amazon Cognito console (Service), and choose Manage User Pools.



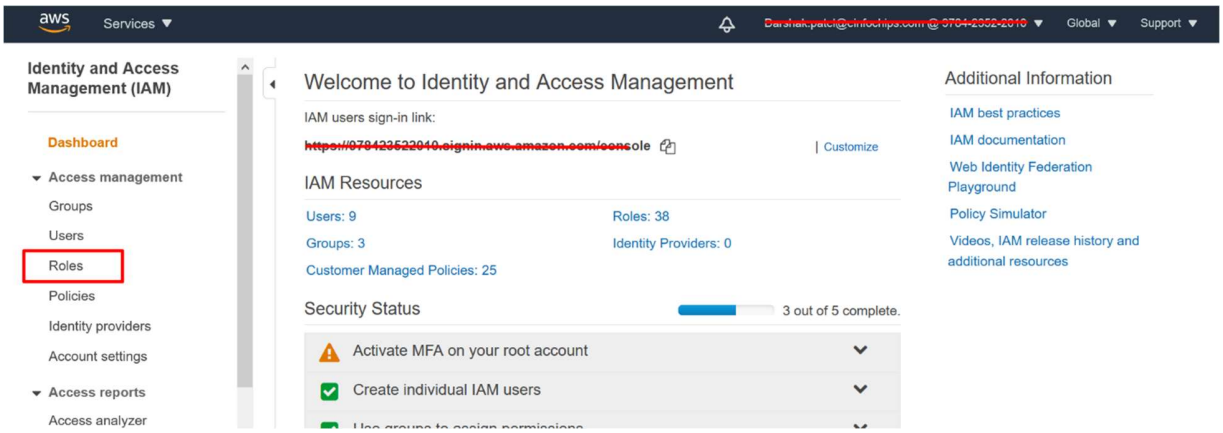
   - Choose Create a user pool.
   - Give the user pool a name, and then choose Review defaults.
   - From the navigation pane, choose App clients, and then choose Add an app client.
   - Enter a name for the app client, and then choose Create app client.
   - From the navigation pane, choose Review, and then choose Create pool.
   - Make a note of the pool ID that appears on the General Settings page of your user pool.
   - From the navigation pane, choose App clients, and then choose Show details.
   - Make a note of the app client ID and app client secret.

3. To create an Amazon Cognito identity pool in AWS Console
   - In AWS Console, Open the Amazon Cognito console (Service), and choose Manage Identity Pools.



   - Choose Create new identity pool
   - Enter a name for your identity pool.
   - Expand Authentication providers, choose the Cognito tab, and then enter your user pool ID and app client ID.
   - Choose Create Pool.
   - Expand View Details, and make a note of the two IAM role names. Choose Allow to create the IAM roles for authenticated and unauthenticated identities to access Amazon Cognito.
   - Choose Edit identity pool. Make a note of the identity pool ID. It should be of the form us-west-2:12345678-1234-1234-1234-123456789012.

4. To create and attach an IAM policy to the authenticated identity
   - In AWS console, Open the IAM console, and from the navigation pane, choose Roles.



   - Find and choose your authenticated identity's role, choose Add inline policy.

- Choose the JSON tab, and paste the following JSON:

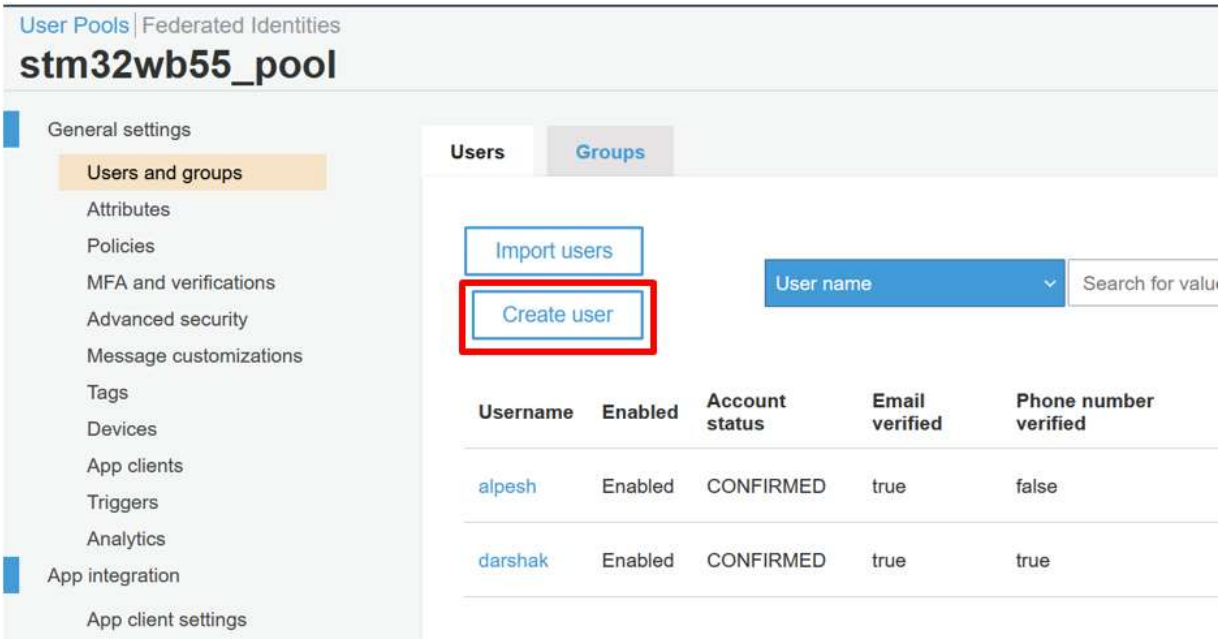
```
{
  "Version":"2012-10-17",
  "Statement":[
    {
      "Effect":"Allow",
      "Action":[
        "iot:AttachPolicy",
        "iot:AttachPrincipalPolicy",
        "iot:Connect",
        "iot:Publish",
        "iot:Subscribe",
        "iot:Receive",
        "iot:GetThingShadow",
        "iot:UpdateThingShadow",
        "iot:DeleteThingShadow"
      ],
      "Resource":[
        "*"
      ]
    }
  ]
}
```

- Choose Review policy, enter a name for the policy, and then choose Create policy.

5. Create New User in Cognito User pool

This can be done either from the Android application (login screen) or from the AWS console. In case, if a confirmation is needed this can be done from the AWS Cognito console (in Users and groups).

- Login AWS console - https://aws.amazon.com/console/
- AWS Console >> Cognito Service >> Manage User pool >> Select created user pool
- General Settings >> Users and groups >> Create user
- Make a note of created Username and Password, which is used for login into the Mobile APP.


User Pools | Federated Identities
stm32wb55_pool
General settings
Users and groups
Attributes
Policies
MFA and verifications
Advanced security
Message customizations
Tags
Devices
App clients
Triggers
Analytics
App integration
App client settings
Users
Groups
Import users
Create user
User name
Search for valu
Username
Enabled
Account status
Email verified
Phone number verified
alpesh
Enabled
CONFIRMED
true
false
darshak
Enabled
CONFIRMED
true
true

6. Create an AWS IoT policy
   - Open the AWS IoT console.
   - In the navigation pane, choose Secure, choose Policies, and then choose Create. Enter a name (STM32WB55-policy) to identify your policy. In the Add statements section, choose Advanced mode. Copy and paste the following JSON into the policy editor window.

```
{
 "Version": "2012-10-17",
 "Statement": [
  {
   "Effect": "Allow",
   "Action": "iot:*",
   "Resource": "*"
  }
 ]
}
```

   - Choose Create.

[Note: Keep your AWS IoT and Amazon Cognito information on hand. You need the endpoint and IDs to authenticate your mobile application with the AWS Cloud]

7. Create a new txt file with the following name AWS_Config.txt and enter the above noted parameters in the file i.e.
   AWS_REGION#<Enter-Region>
   AWS_IOT_POLICY#STM32WB55-policy
   AWS_COGNITO_IDENTITY_POOLID#<Enter-Identity-Pool-ID>
   AWS_COGNITO_USER_POOLID#<Enter-User-Pool-ID>
   AWS_COGNITO_USER_APPCLIENTID#<Enter-User-App-ID>
   AWS_COGNITO_USER_APPCLIENTSECRET#<Enter-User-App-SECRET>

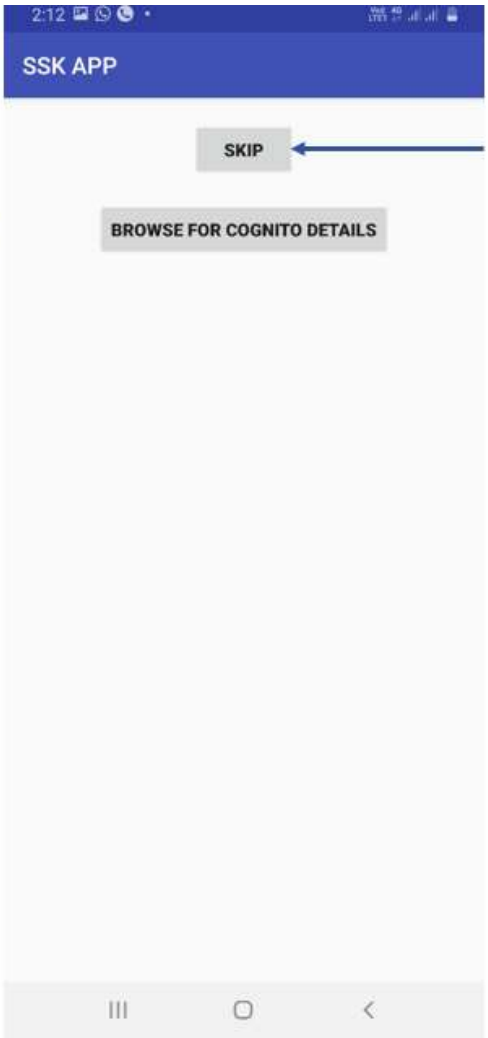
8. Install provided Mobile APK from the Github site below and run.
   https://github.com/ArrowElectronics/Security-Starter-Kits

9. Follow for FIRST TIME SETUP ONLY otherwise press "SKIP"

   Click on "Browse for the Cognito details" and upload the AWS_Config.txt file, verify the configurations, and then Press "Save" button on screen as shown - First Time configuration screen

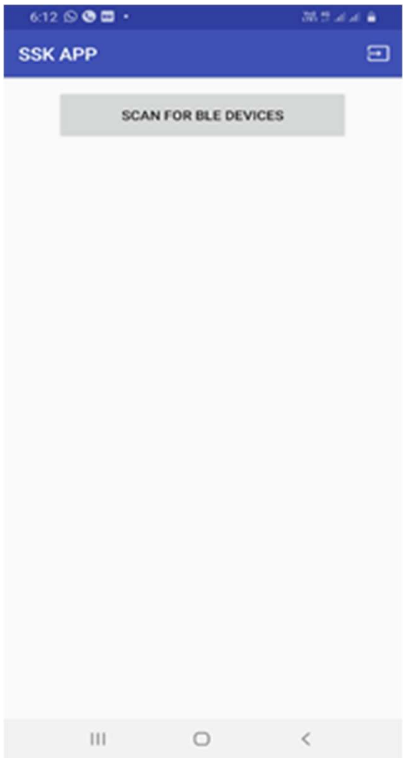
First Time configuration screen

Press Skip or reconfigure if required



10. Login in the App using the Cognito user credentials

11. After Successful Login, It shows below screen.



3 INTEGRATION OF AWS FREERTOS AND OPTIGA™ TRUST M

3.1 AWS Sources

The Amazon FreeRTOS for STM32WB55.Nucleo software package is an extension of Amazon FreeRTOS and is available at the Github repository;

- It is provided as a Souce_Code/STM32WB55_SSK_AWS_Rel with mandatory SLA0078 license acceptation.

- aws_demos: Provides the MQTT and OTA demo. User can select demos using compilation flags, more details are described in section 6.1 and section 7.1

3.2 OPTIGA™ Trust M Source

The OPTIGA™ Trust M is a high-end security solution that provides an anchor of trust for connecting IoT devices to the cloud, giving every IoT device its own unique identity. This pre-personalized turnkey solution offers secured, zero-touch onboarding and the high performance needed for quick cloud access.
OPTIGA™ Trust M security chip Software Framework is ported In provided package, available at location: https://github.com/Infineon/OPTIGA-trust-m

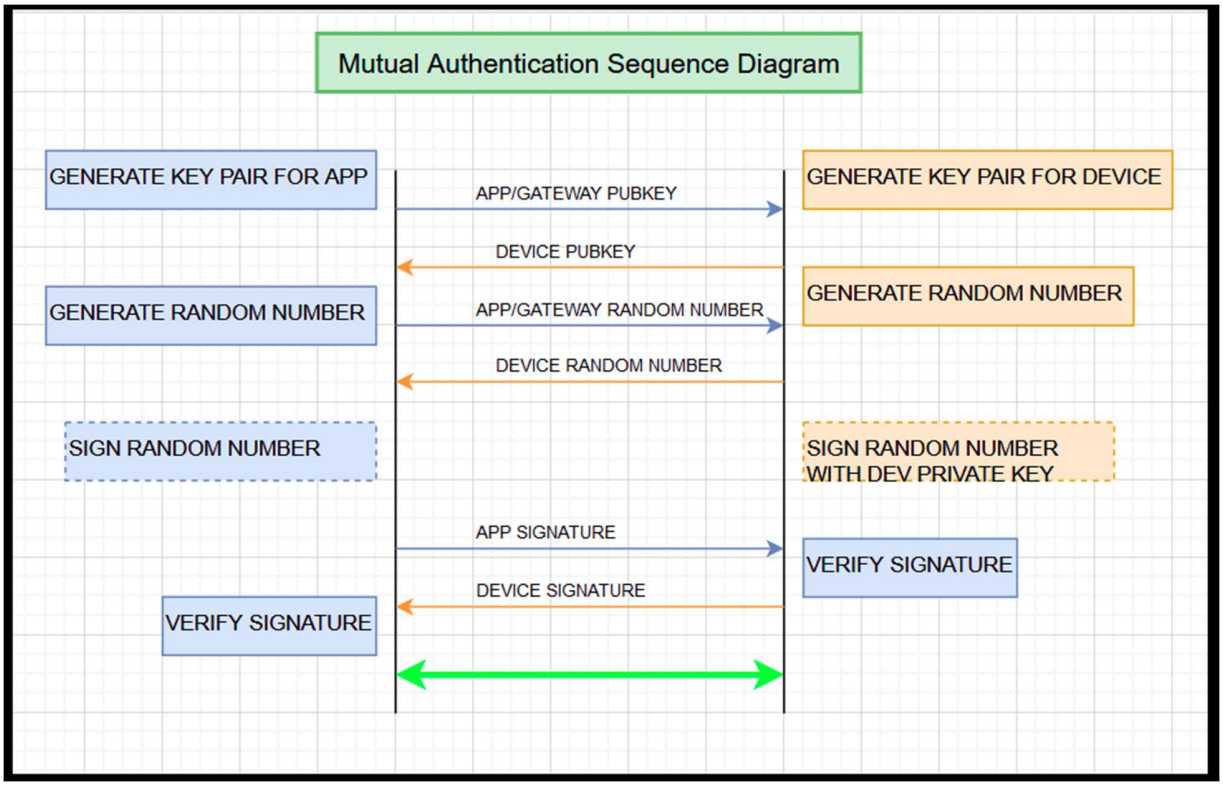
To port software framework template files shown below has to be updated based on your Hardware platform.

1. pal_ifx_i2c_config.c
2. pal_i2c.c
3. pal_gpio.c
4. pal_os_timer.c
5. pal_os_event.c

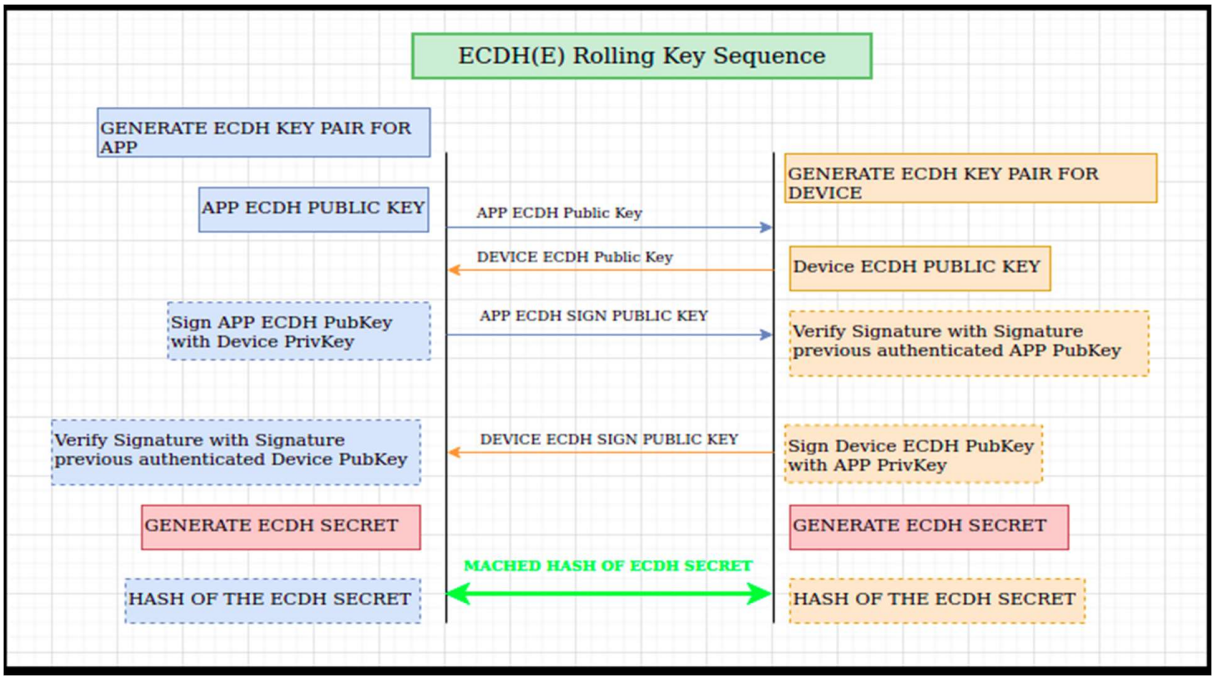
Refer link for reference: https://github.com/Infineon/OPTIGA-trust-m/wiki/Porting-Guide

3.3 Mutual Authentication Source

Mutual Authentication is the device authentication process, which has to be executed before Application begins to communicate with AWS cloud. It fails if any unauthenticated devices try to communicate with the mobile app.



- After completing mutual authentication, the kit generates one secret key, which uses a AES 256 symmetric key to encrypt and decrypt for all the communications.



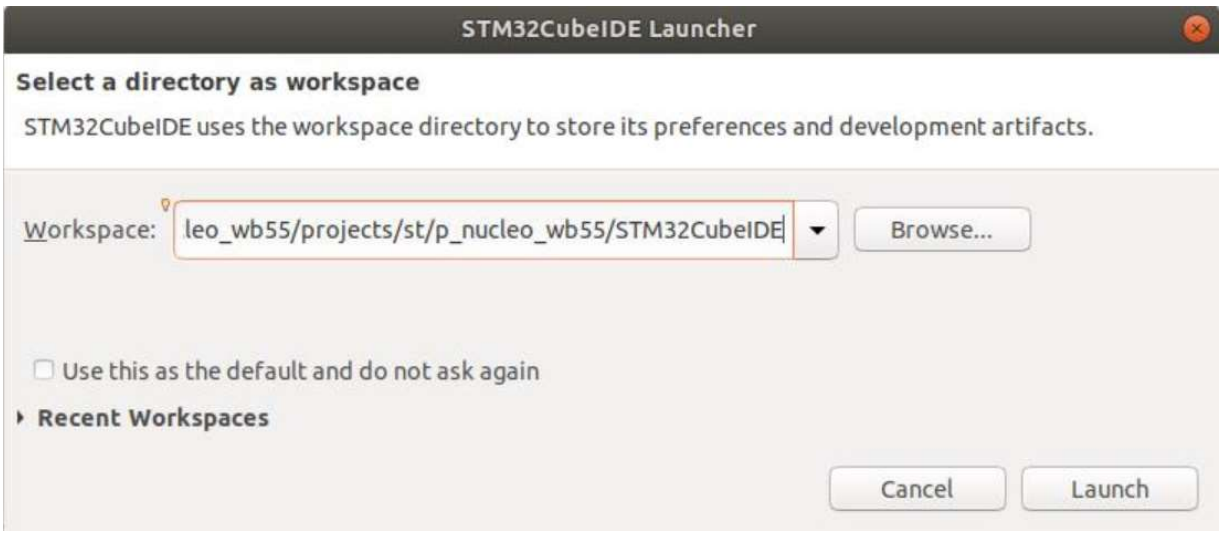
- The SSK uses OPTIGA™ Trust M security chip to store the secrets e.g. certificates, keys etc. Also, it uses hardware crypto. Library provided by OPTIGA™ Trust M software stack.

- To implement mutual authentication, add one custom BLE service in STM32WB55 AWS source code available at SSK_SUIT_EVAL_STM32WB55_Rel_[Release]/Source_code / STM32_SSK_AWS_Rel_[version]/demos/ble/aws_ble_mutual_auth.c

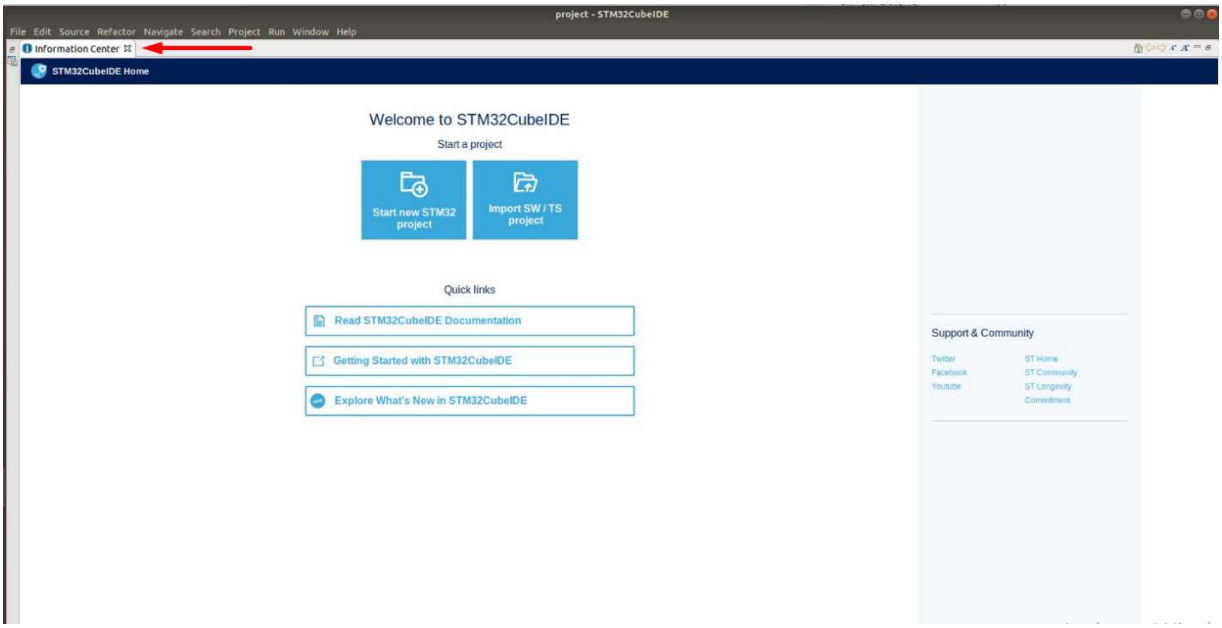
4 CODE COMPILATION AND BINARY FLASHING

4.1 Code Compilation Steps

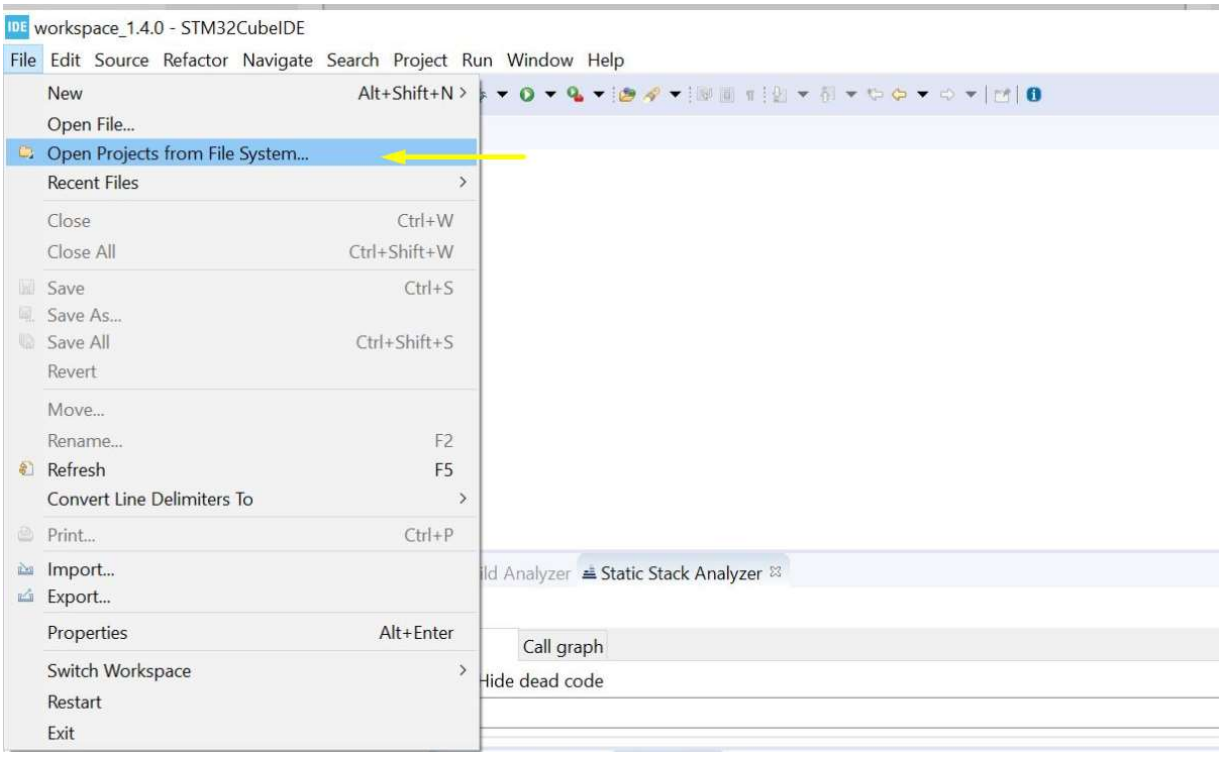
1. Download and extract the SSK STM32WB55 release package (STM32WB55_SSK_Pkg_Rel.zip) from the Arrow Electronics Github portal; https://github.com/ArrowElectronics/Security-Starter-Kits
2. In the extracted directory, project available under Source_Code/STM32_SSK_AWS_Rel_[version]/projects/st/p_nucleo_wb55/STM32CubeIDE.
3. Launch STM32CubeIDE application.
4. Open a workspace under "projects\st\p_nucleo_wb55\STM32CubeIDE".



5. Close the Information Center to view the C/C++ perspective.

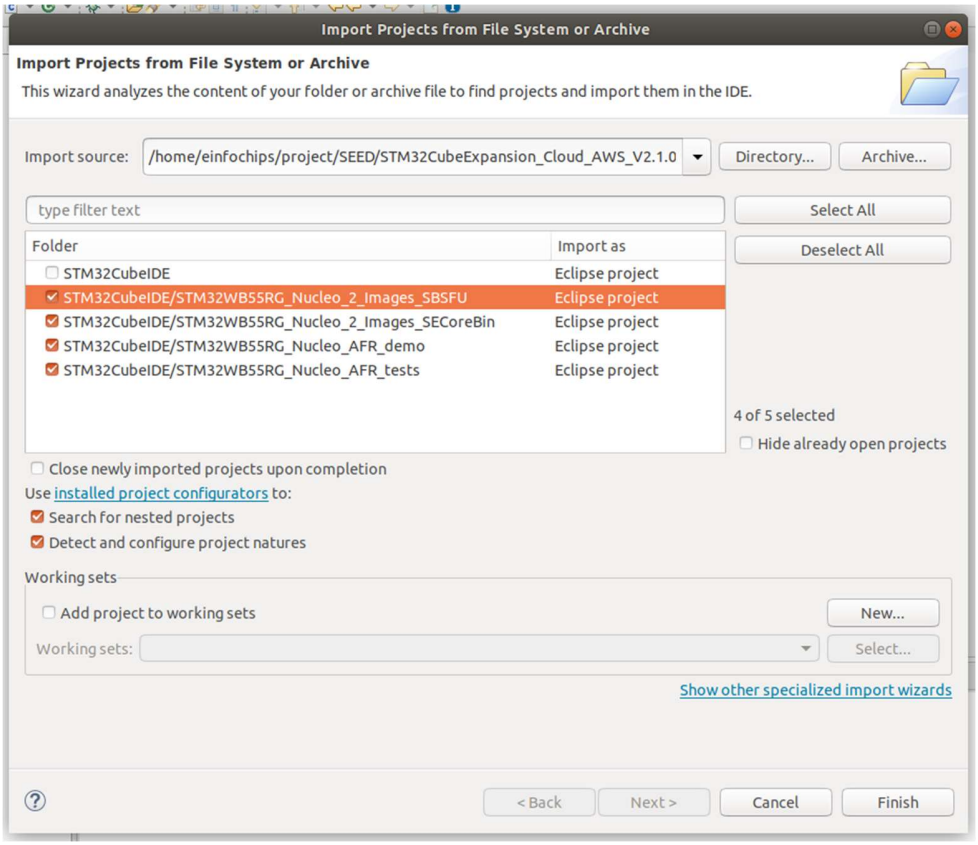


6. Select menu File >> Open project from File system... >> Finish.

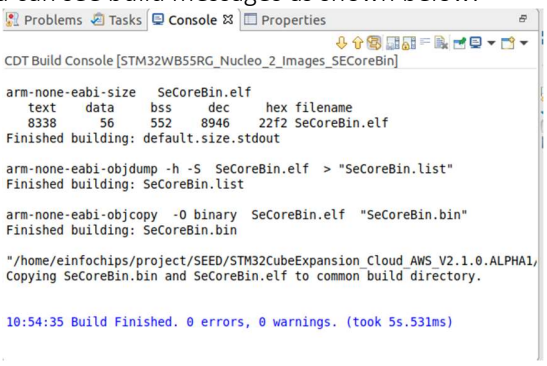


7. In "Select directory" browse to projects/st/ p_nucleo_wb55/STM32CubeIDE folder.

8. Import the four projects:
   - STM32WB55RG_Nucleo_2_Images_SECoreBin
   - STM32WB55RG_Nucleo_2_Images_SBSFU
   - STM32WB55RG_Nucleo_AFR_demo
   - STM32WB55RG_Nucleo_AFR_tests



9. For Compilation, you need to follow below sequence.
10. Compile SECoreBin first, then SBSFU. And then AFR_demo projects.to avoid the build conflict. Its open console and you can see build messages as shown below.

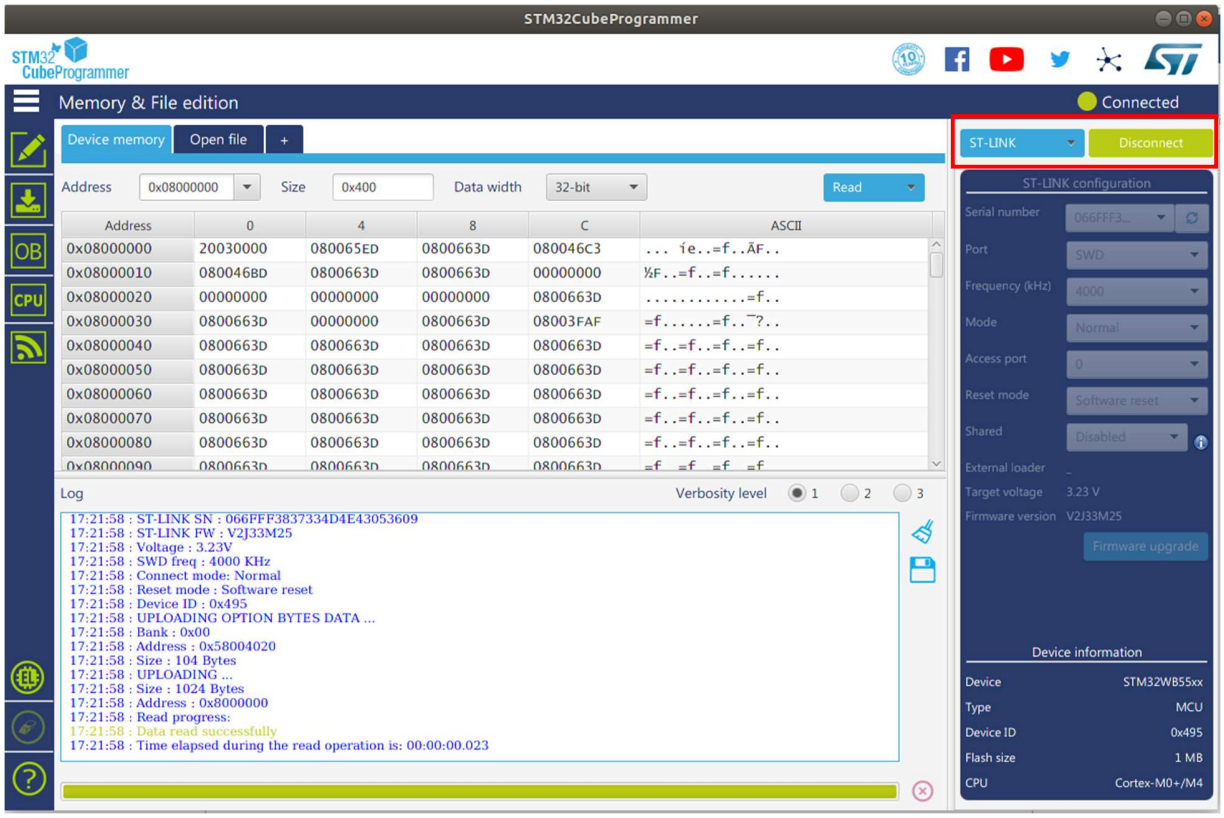


4.2 Binary flashing

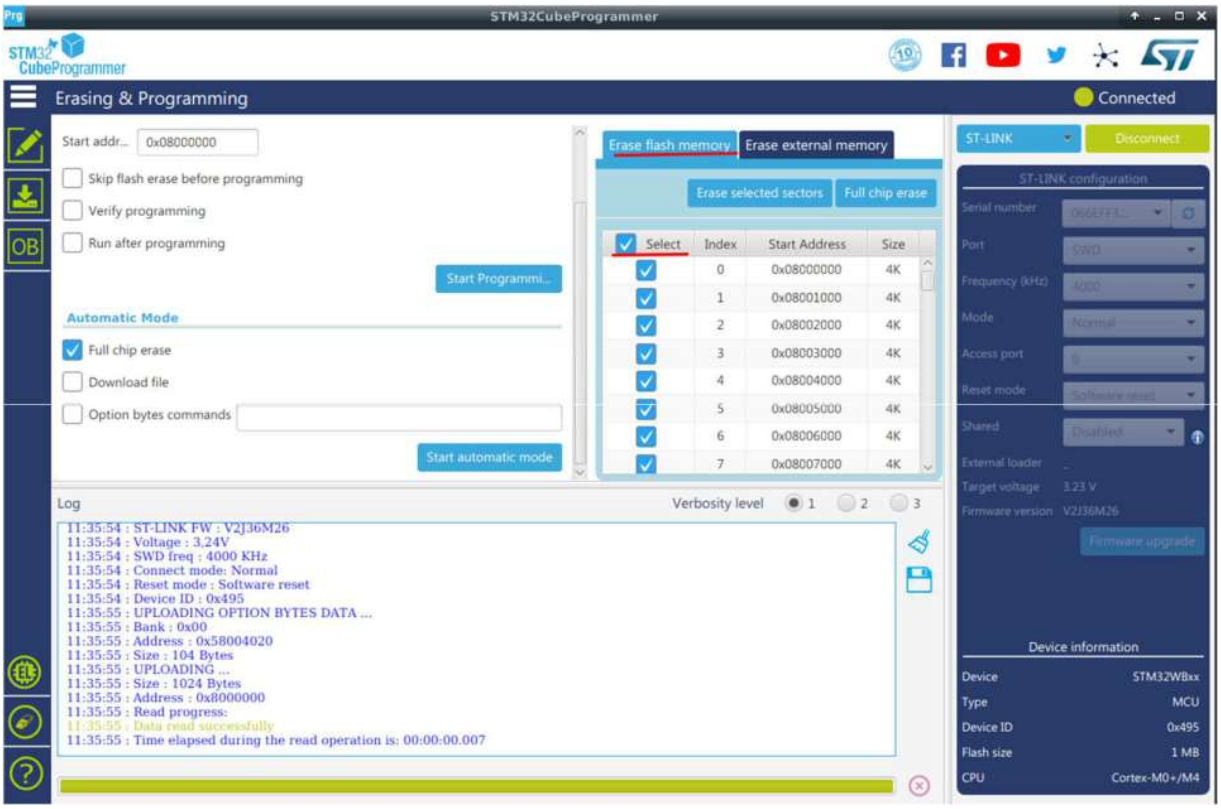
Final binaries are located in “Source_Code/STM32_SSK_AWS_Rel_[version]/build” directory.

- SBSFU_aws_demos.bin - bootloader + demo application
- aws_demos.sfb - demo application + OTA update header

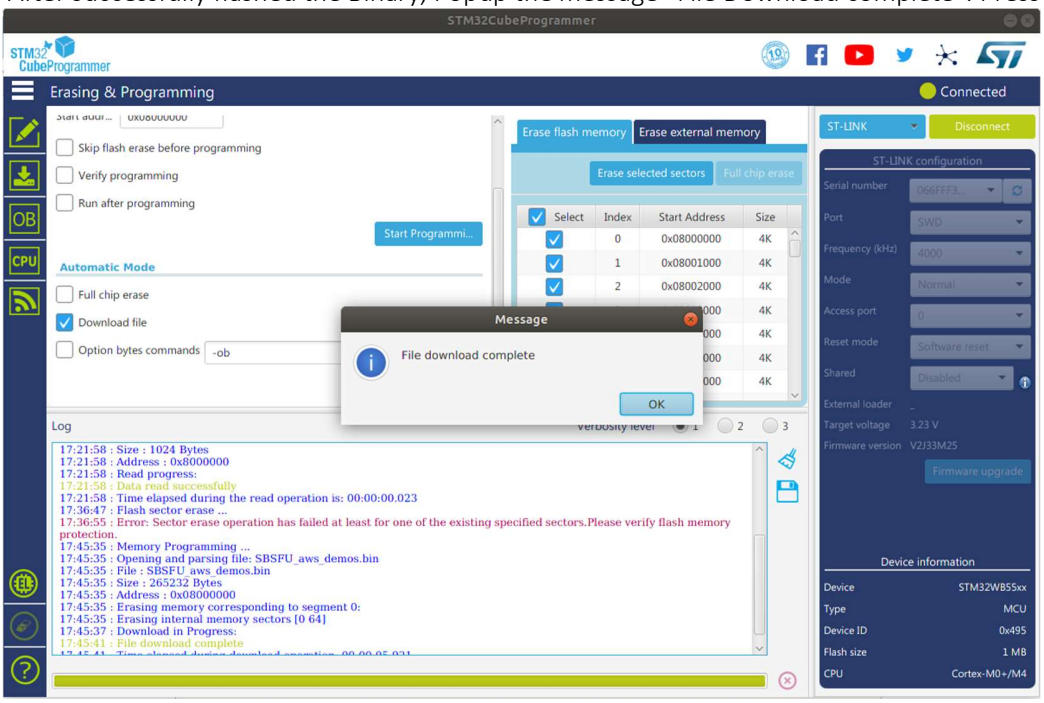
1. Plug a USB cable from PC to the STM32WB55 board (Board backside, named as "ST-LINK")
2. Open STM32CubeProgrammer and click on connect button to connect the board as shown below.



3. First, the Flash memory must be entirely erased as depicted in the screenshot below.

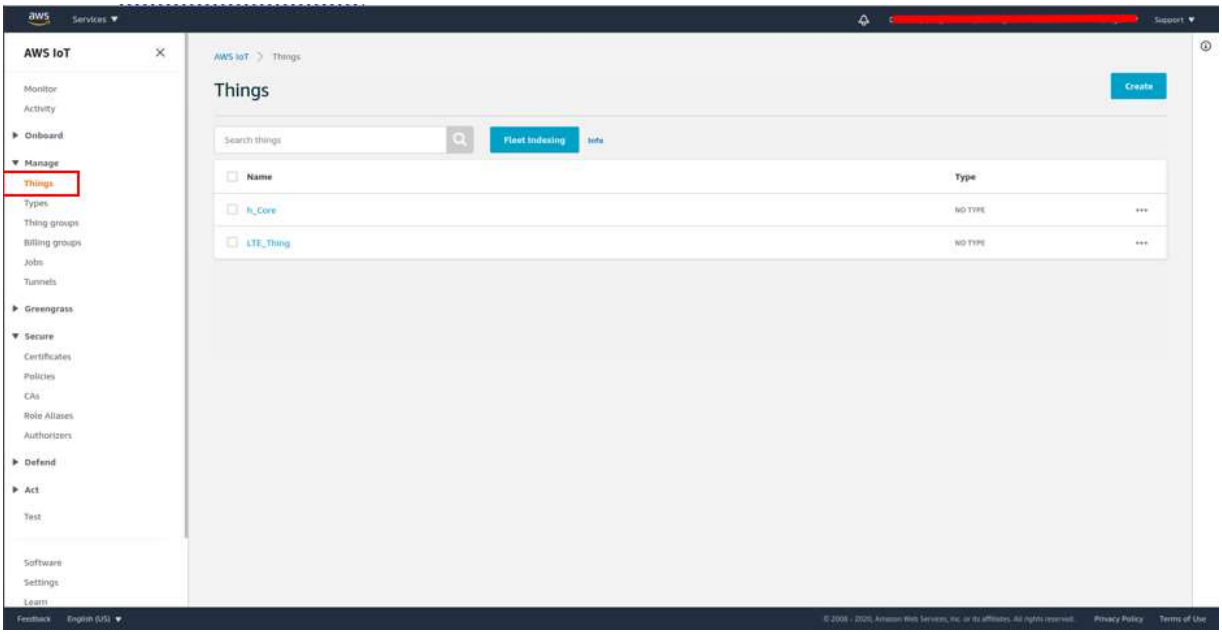


4. Flash the binary (e.g. build\ SBSFU_aws_demos.bin) using STM32CubeProgrammer (address 0x08000000).
5. After successfully flashed the Binary, Popup the message “File Download complete”. Press OK

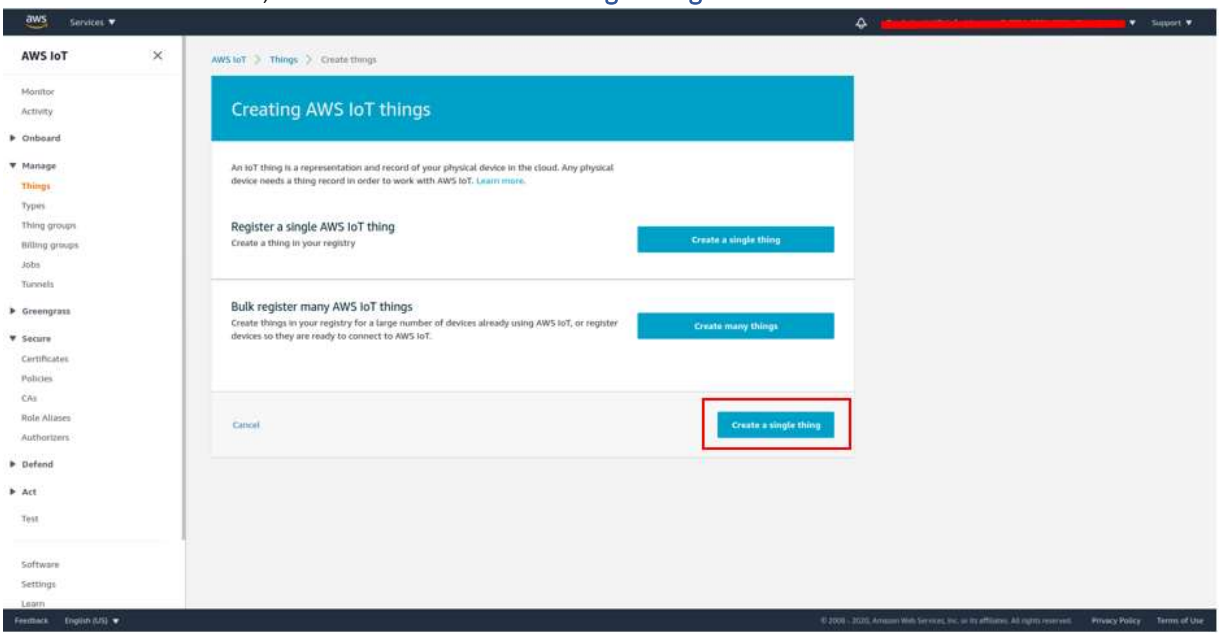


5 SETUP AWS IOT THING ON AWS CONSOLE

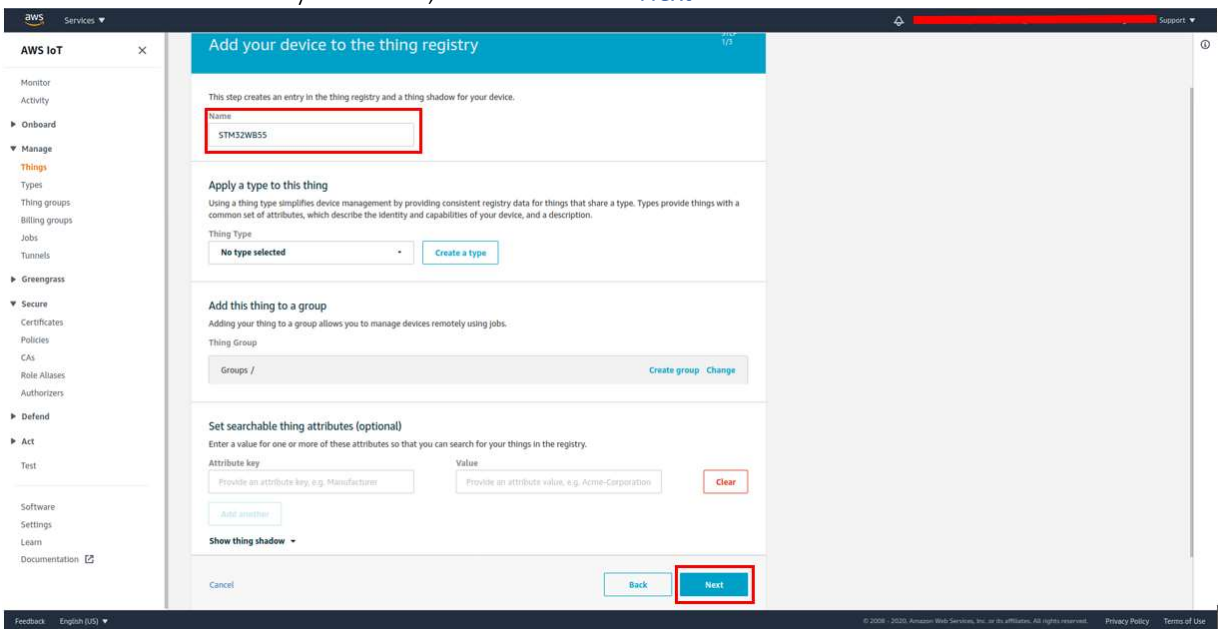
1. Open the AWS IoT console, and from the navigation pane, choose **Manage**, and then choose **Things**.



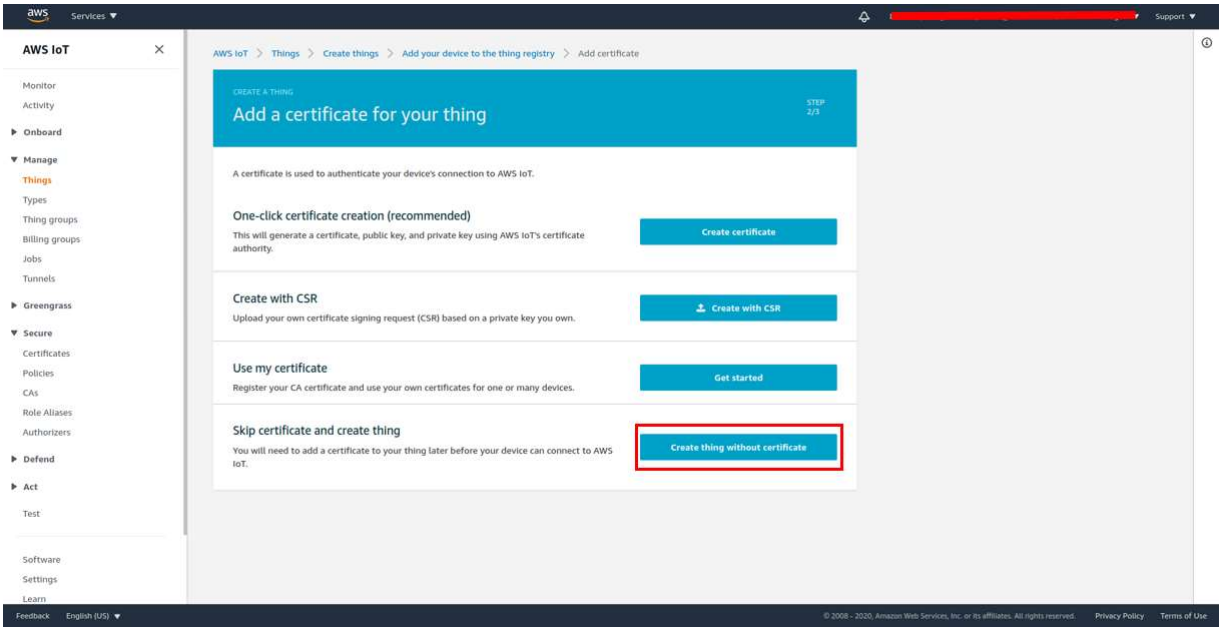
2. Choose **Create**, and then choose **Create a single thing**.

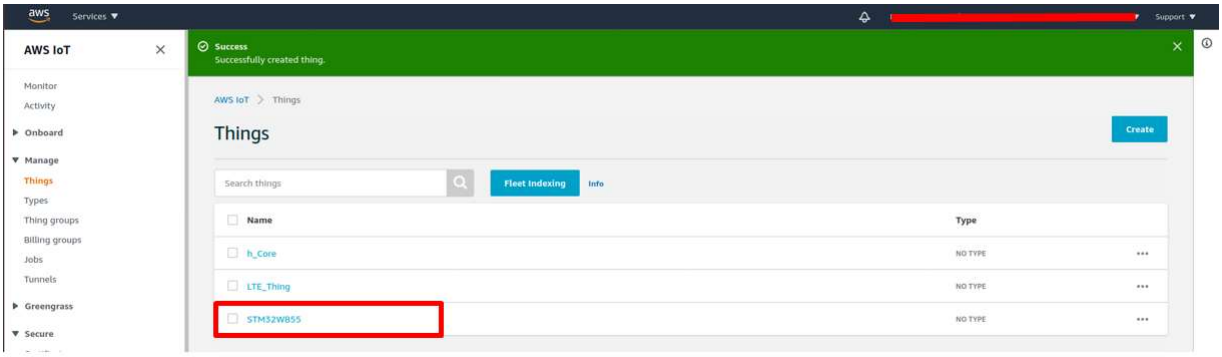


3. Enter a name for your device, and then choose **Next**.

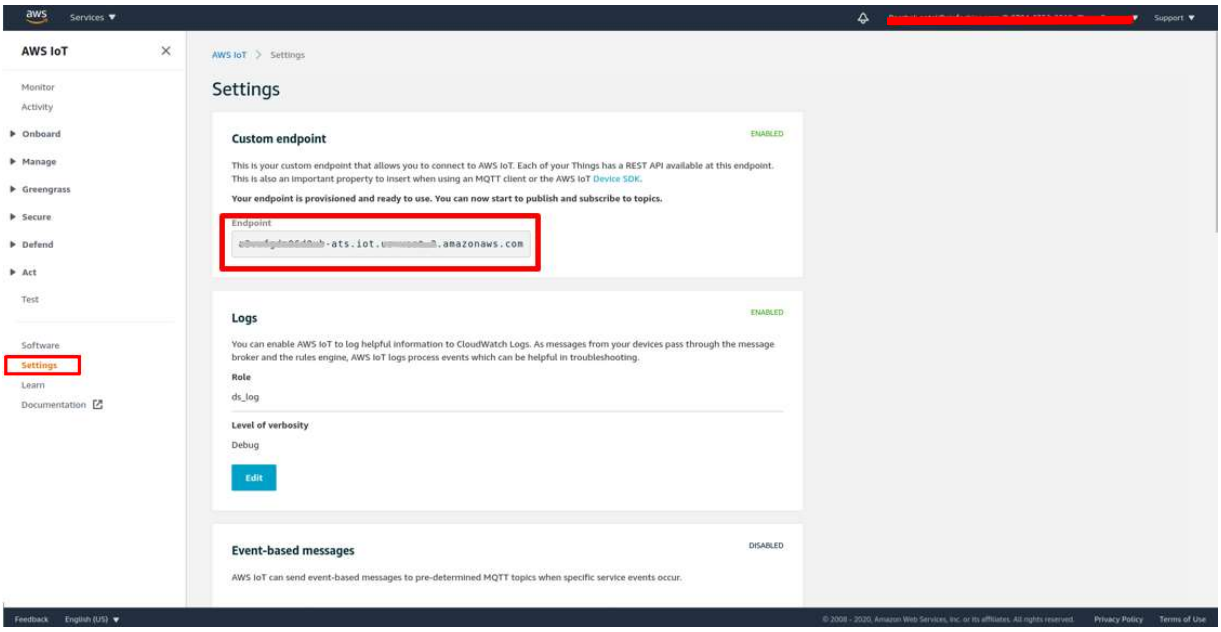


4. If you are connecting your microcontroller to the cloud through a mobile device, choose **Create thing without certificate**. Because the Mobile SDKs use Amazon Cognito for device authentication, you do not need to create a device certificate for demos that use Bluetooth Low Energy.

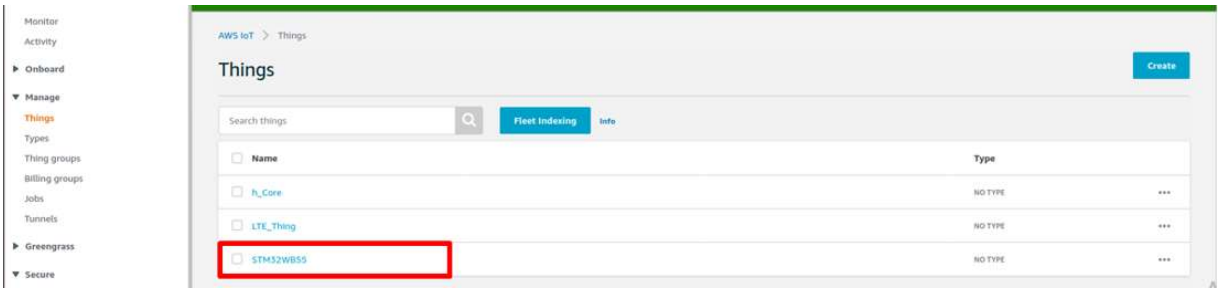




5. In the left navigation panel, choose Settings. Your AWS IoT endpoint is displayed in Endpoint. It should be like *<accountID>*-ats.iot.*<region>*.amazonaws.com. Record the endpoint it required when you first time start the board.



6. In the left navigation pane, choose Manage >> Things. Your device should have an AWS IoT thing name. Record this name.



6 MQTT DEMO

6.1 Setup AWS config in the STM32WB55 Source Code

1. Configure AWS IoT thing name into demos/include/aws_clientcredential.h file in IDE, and specify values for the following #define clientcredentialIOT_THING_NAME "ST32WB55" (Thing name, created in AWS console).

```
aws_clientcredential.h
39  * @todo Set this to the unique name of your IoT Thing.
40  */
41 #define clientcredentialIOT_THING_NAME              "sskwb55"
42
43 /*
44  * @brief Port number the MQTT broker is using.
45  */
46 #define clientcredentialMQTT_BROKER_PORT            8883
47
48 /*
49  * @brief Port number the Green Grass Discovery use for JSON retrieval from cloud is using.
50  */
51 #define clientcredentialGREENGRASS_DISCOVERY_PORT   8443
52
```

2. Make sure aws_demos are configured for MQTT demo in config_files\aws_demo_config.h in CubeIDE (or vendors\st\boards\p_nucleo_wb55\aws_demos\config_files\aws_demo_config.h):

#define CONFIG_MQTT_DEMO_ENABLED

```
aws_demo_config.h
24  */
25
26 #ifndef _AWS_DEMO_CONFIG_H_
27 #define _AWS_DEMO_CONFIG_H_
28
29 /* To run a particular demo you need to define one of these.
30  * Only one demo can be configured at a time
31  *
32  *          CONFIG_MQTT_DEMO_ENABLED
33  *          CONFIG_SHADOW_DEMO_ENABLED
34  *          CONFIG_GREENGRASS_DISCOVERY_DEMO_ENABLED
35  *          CONFIG_TCP_ECHO_CLIENT_DEMO_ENABLED
36  *          CONFIG_DEFENDER_DEMO_ENABLED
37  *          CONFIG_POSIX_DEMO_ENABLED
38  *          CONFIG_OTA_UPDATE_DEMO_ENABLED
39  *          CONFIG_HTTPS_SYNC_DOWNLOAD_DEMO_ENABLED
40  *          CONFIG_HTTPS_ASYNC_DOWNLOAD_DEMO_ENABLED
41  *          CONFIG_HTTPS_SYNC_UPLOAD_DEMO_ENABLED
42  *          CONFIG_HTTPS_ASYNC_UPLOAD_DEMO_ENABLED
43  *
44  *  These defines are used in iot_demo_runner.h for demo selection */
45
46 //#define CONFIG_OTA_UPDATE_DEMO_ENABLED
47 #define CONFIG_MQTT_DEMO_ENABLED
48
```

[Note: In addition, all the other CONFIG_*_ENABLED flags are commented.]

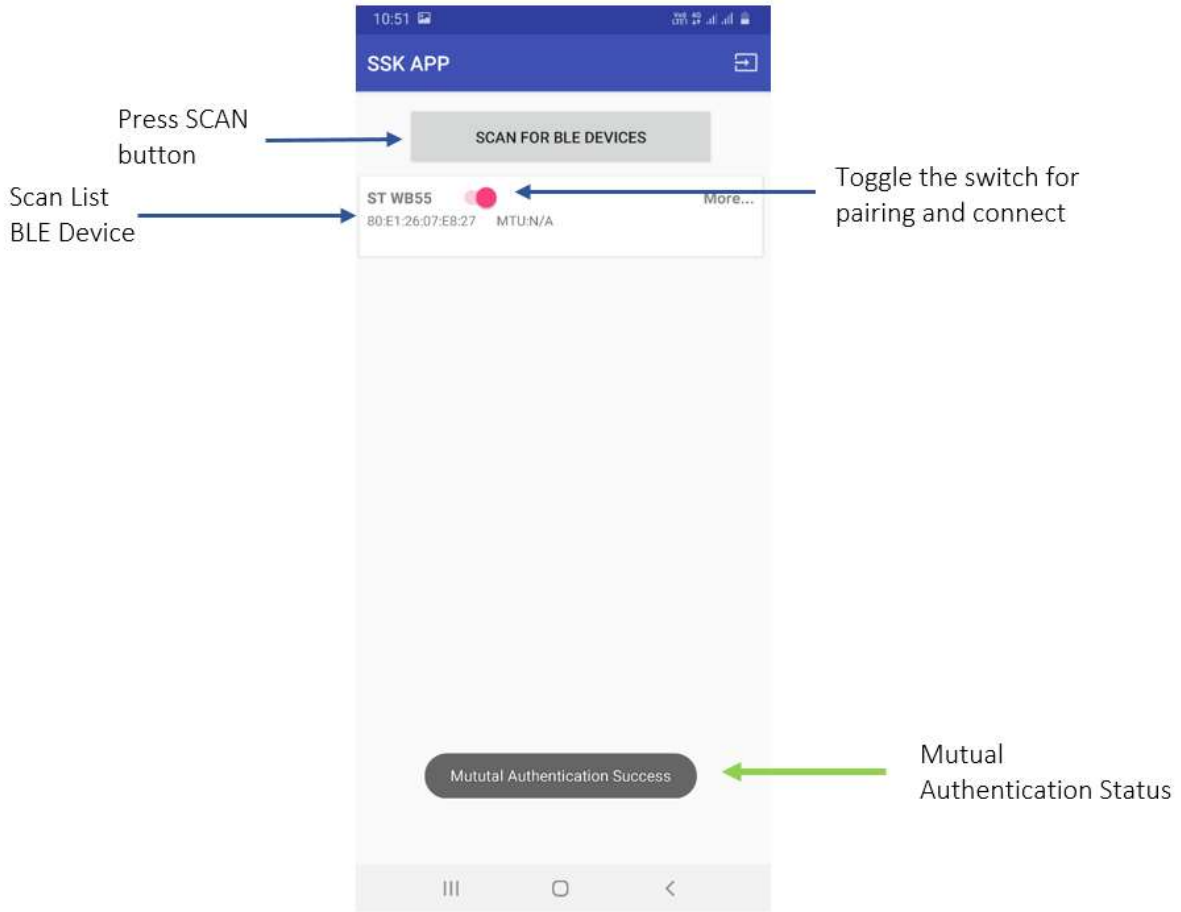
3. Then compile the STM32WB55RG_Nucleo_AFR_demo project as mentioned in the section 4.1 and Flash the binary on the STM32WB55 board as mentioned in the section 4.2

6.2 Run MQTT Demo

1. If you want to modify the Endpoint URL, then follow the step 2 otherwise Reset the board and jump to step 3.
2. Press the SW2 button and Reset the board (By Pressing "Reset" button as shown in figure 2). It will ask to enter endpoint URL on Serial console screen as below.
   Paste the Endpoint URL here and press the "Enter" key on keyboard. (Note: Default Echo is OFF, so cannot see your Endpoint URL value.)
   So, to verify that the correct endpoint URL was entered, on the serial console it will display the URL as shown above (with yellow marked).

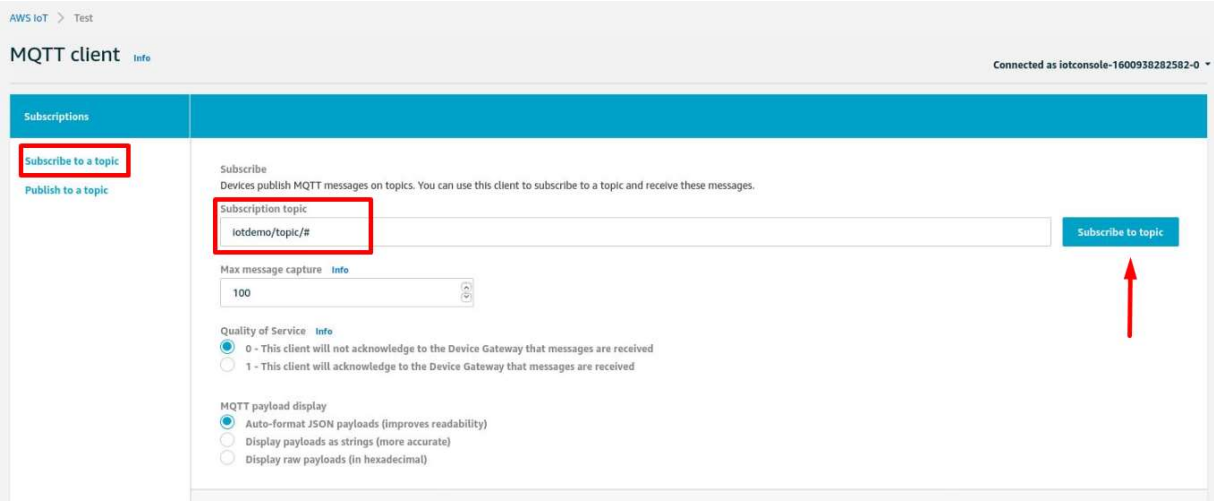
```
========== Please Enter Your Endpoint URL ==========
e.g- xxxxxxxxxxx-ats.iot.xx-xxx-x.amazonaws.com

Entered Endpoint URL=[illegible]-ats.iot.[illegible].amazonaws.com
====================================================
```

3. Click on the SCAN FOR BLE DEVICES button. Connect and Pair with STM32WB55 device. On the serial console Press "Y" if passkey matches with mobile pair key.

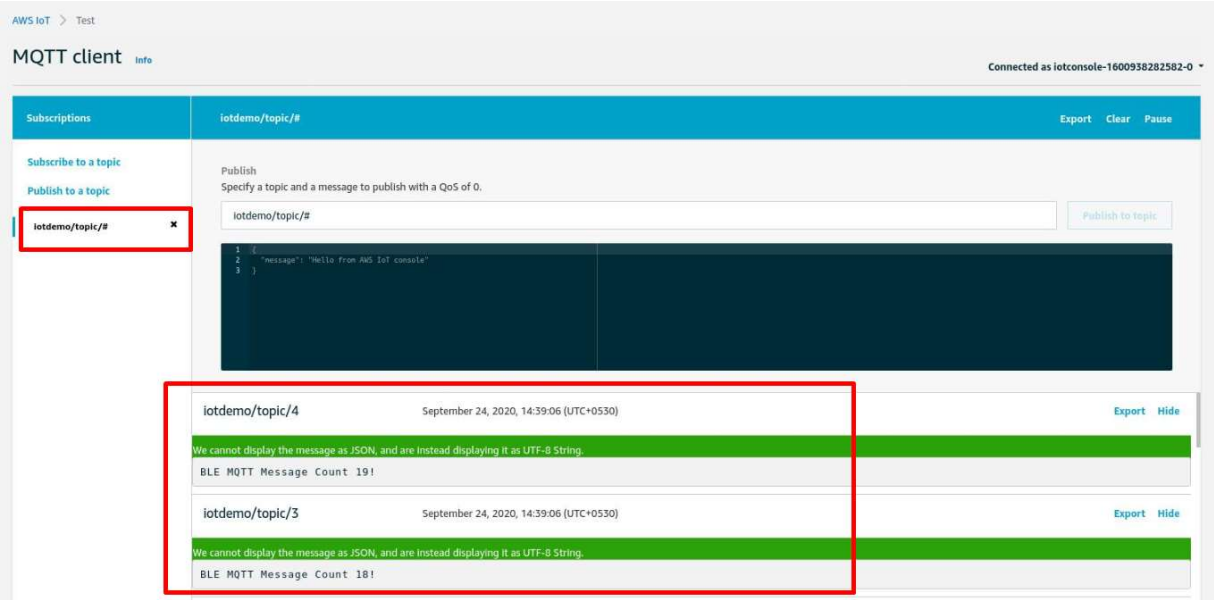


4. During this demo, Mutual Authentication is enabled between the Mobile Device and STM32WB55. Only provisioning device can start communication else Mutual Authentication fails and logs out from the AWS Cognito Session in Mobile APP.

5. To see the MQTT message on AWS console, Open AWS Console >> IoT Service >> Test page and Subscribe the Topic: iotdemo/topic/#



MQTT Messages on AWS console,



6. MQTT Message will display on the screen i.e. BLE MQTT Message Count 2!

```
40 16521 [iot_thread] Incoming PUBLISH received:
Subscription topic filter: iotdemo/topic/2
Publish topic name: iotdemo/topic/2
Publish retain flag: 0
Publ41 16536 [iot_thread] (MQTT connection 0x200116b8) MQTT PUBLISH operation queued.
42 16545 [iot_thread] Acknowledgment message for PUBLISH 1 will b◆Y◆◆X◆g◆◆;/R◆f◆◆◆◆◆s◆◆◆◆◆o◆<#=3E◆[illegible]◆U◆◆A[illegible]c◆|◆◆sDv,◆◆N [illegible]OI◆◆0t ha◆?[illegible](
43 16557 [iot_thread] [SECURITY][SEND] CIPHER TEXT = ◆V◆cJWH◆:Q#◆
44 16571 [iot_thread] 2 publishes received.
45 16575 [iot_thread] Publishing messages 2 to 3.
46 16580 [iot_thread] Plain Text=BLE MQTT Message Count 2!

47 16591 [iot_thread] [SECURITY][SEND] CIPHER TEXT = ◆V◆cJW_&◆◆-◆|◆U◆'◆◆P◆◆◆\◆◆(◆◆G◆◆◆◆k◆nS◆Q J◆T◆MW
                                                                                                    ◆

48 16601 [iot_thread] (MQTT connection 0x200116b8) MQTT PUBLISH operation queued.
49 16609 [iot_thread] Plain Text=BLE MQTT Message Count 3!

Z◆d◆◆◆*◆$◆}◆◆w◆?◆d◆◆0![SECURITY][SEND] CIPHER TEXT = ◆V◆cJW_&◆◆-◆|◆U◆'◆◆P◆◆eN◆Q◆◆[illegible]◆◆◆
```

7 OTA DEMO

7.1 Setup AWS config in the STM32WB55 Source Code

1. The aws_demos application configured for OTA demonstrates an Over the Air update of the application firmware. The new firmware is downloaded via BLE to the STM32WB55 device and installed securely with the SBSFU bootloader.

2. Make sure aws_demos are configured for OTA demo in config_files\aws_demo_config.h in CubeIDE (or vendors\st\boards\p_nucleo_wb55\aws_demos\config_files\aws_demo_config.h):

#define CONFIG_OTA_UPDATE_DEMO_ENABLED

```
aws_demo_config.h
 * http://www.FreeRTOS.org
 */

#ifndef _AWS_DEMO_CONFIG_H_
#define _AWS_DEMO_CONFIG_H_

/* To run a particular demo you need to define one of these.
 * Only one demo can be configured at a time
 *
 *          CONFIG_MQTT_DEMO_ENABLED
 *          CONFIG_SHADOW_DEMO_ENABLED
 *          CONFIG_GREENGRASS_DISCOVERY_DEMO_ENABLED
 *          CONFIG_TCP_ECHO_CLIENT_DEMO_ENABLED
 *          CONFIG_DEFENDER_DEMO_ENABLED
 *          CONFIG_POSIX_DEMO_ENABLED
 *          CONFIG_OTA_UPDATE_DEMO_ENABLED
 *          CONFIG_HTTPS_SYNC_DOWNLOAD_DEMO_ENABLED
 *          CONFIG_HTTPS_ASYNC_DOWNLOAD_DEMO_ENABLED
 *          CONFIG_HTTPS_SYNC_UPLOAD_DEMO_ENABLED
 *          CONFIG_HTTPS_ASYNC_UPLOAD_DEMO_ENABLED
 *
 *  These defines are used in iot_demo_runner.h for demo selection */

#define CONFIG_OTA_UPDATE_DEMO_ENABLED
//#define CONFIG_MQTT_DEMO_ENABLED
```

[Note: In addition, all the other CONFIG_*_ENABLED flags are commented.]

3. Make sure you have configured the aws_demos (especially the code signing certificate in demos\include\aws_ota_codesigner_certificate.h).

4. To create the code-signing certificate refer below link.
https://docs.aws.amazon.com/freertos/latest/userguide/ota-code-sign-cert-win.html

5. For OTA: Replace "signingcredentialSIGNING_CERTIFICATE_PEM" variable value in demos\include\aws_ota_codesigner_certificate.h with created certificate content (beginning with "-----BEGIN CERTIFICATE-----");

```
aws_ota_codesigner_certificate.h
11  *
12  * The above copyright notice and this permission notice shall be included in all
13  * copies or substantial portions of the Software.
14  *
15  * THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR
16  * IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY, FITNESS
17  * FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE AUTHORS OR
18  * COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER LIABILITY, WHETHER
19  * IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM, OUT OF OR IN
20  * CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.
21  *
22  * http://aws.amazon.com/freertos
23  * http://www.FreeRTOS.org
24  */
25
26 #ifndef __AWS_CODESIGN_KEYS__H__
27 #define __AWS_CODESIGN_KEYS__H__
28
29 /*
30  * PEM-encoded code signer certificate
31  *
32  * Must include the PEM header and footer:
33  * "-----BEGIN CERTIFICATE-----\n"
34  * "...base64 data...\n"
35  * "-----END CERTIFICATE-----\n";
36  */
37 static const char signingcredentialSIGNING_CERTIFICATE_PEM[] =
38 "-----BEGIN CERTIFICATE-----\n"
39 [redacted]jOPQQDAjAZ\n"
40 "MRcwFQYDVQQDDA5zZWVkQGFycm93LmNvbTAeFw0yMDA5MDYwNjQ5NDBaFw0zOTEx\n"
41 "MDYwNjQ5NDBaMBkxFzA[redacted]QC\n"
42 "AQYIKoZIzj0DAQcDQgAEJNhvWb/fa9zedCEwvL5fRNCJT8go3FxxpMYfNw0dSBaC\n"
43 "zKsjthjTf2Npch[redacted]AQDAgeA\n"
44 "MBMGA1UdJQQMMAoGCCsGAQUFBwMDMAoGCCqGSM49BAMCA0gAMEUCIEO5KKBo4f0F\n"
45 "[redacted]CZ\n"
46 "xHTC6/Cd+XaQVnU=\n"
47 "-----END CERTIFICATE-----\n";
48 #endif
49
```

6. Then compile the STM32WB55RG_Nucleo_AFR_demo project as mentioned in the section 4.1 and Flash the binary on the STM32WB55 board as mentioned in the section 4.2

7.1.1 OTA Firmware Version upgrade

1. OTA update process, Firmware version needs to be upgrade in the STM32WB55 code and generate new *.sfb file to upload it on AWS S3 bucket. Detailed steps are mentioned below:

2. Presuming that the current version of the application is flashed to the STM32WB55 board. Now upgrade the firmware version in demos/include/aws_application_version.h as shown below:

```
26 #ifndef _AWS_APPLICATION_VERSION_H_
27 #define _AWS_APPLICATION_VERSION_H_
28
29 #include "iot_appversion32.h"
30 extern const AppVersion32_t xAppFirmwareVersion;
31
32 #define APP_VERSION_MAJOR    0
33 #define APP_VERSION_MINOR    9
34 #define APP_VERSION_BUILD    2
35
36 #endif
```

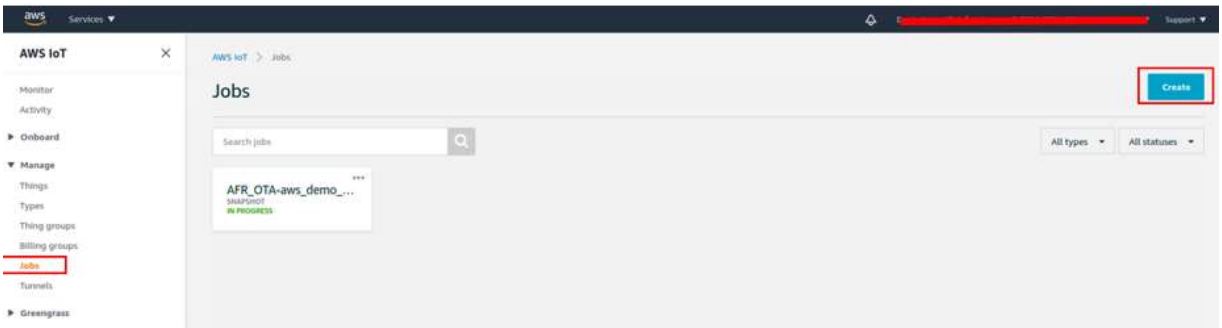
3. Now compile it again the STM32WB55RG_Nucleo_AFR_demo project as mentioned in the section 4.1 and Don't Flash the binary on the STM32WB55 board

4. Please collect firmware from under build\aws_demos.sfb file. Keep this firmware binary on the AWS S3 bucket (step mentioned in section 2.3)

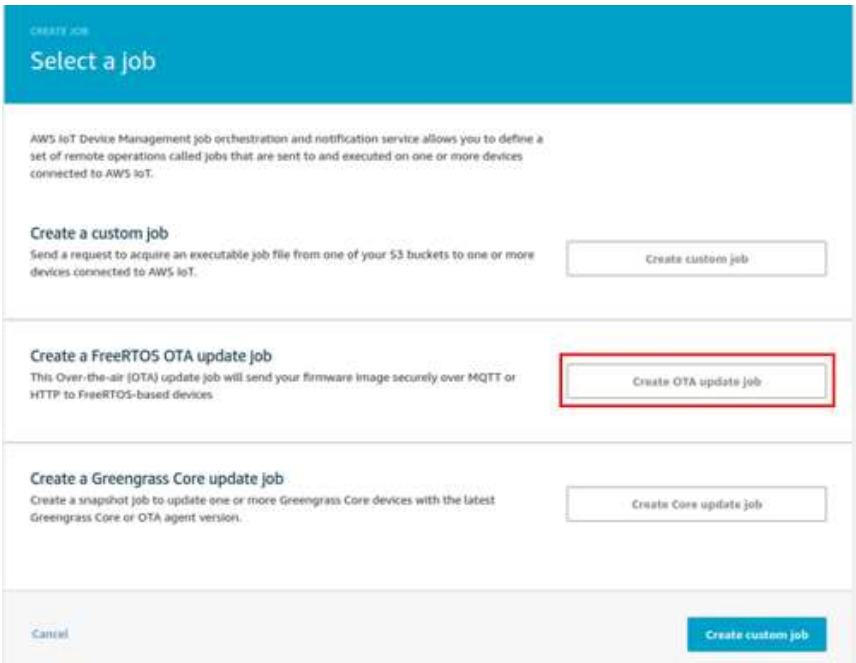
5. The aws_demos project must be running on STM32WB55.Nucleo board and be connected to the mobile application.

7.1.2 AWS configuration for OTA Job

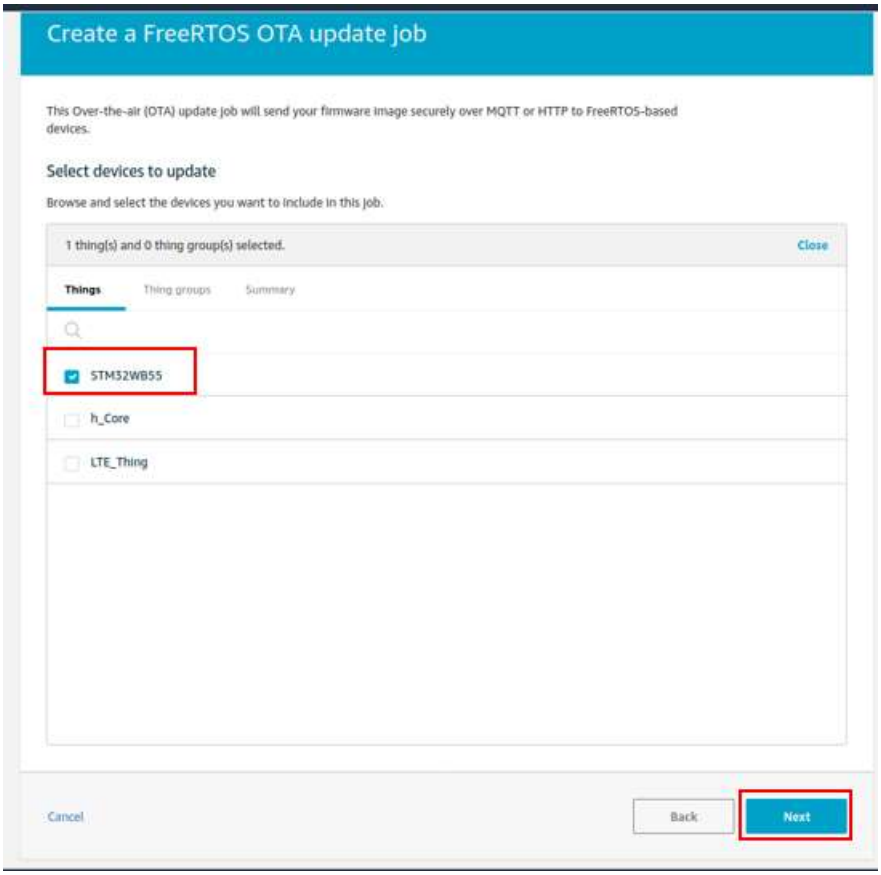
1. On AWS console, create a FreeRTOS OTA update job (IoT Core / Manage / Jobs / Create):



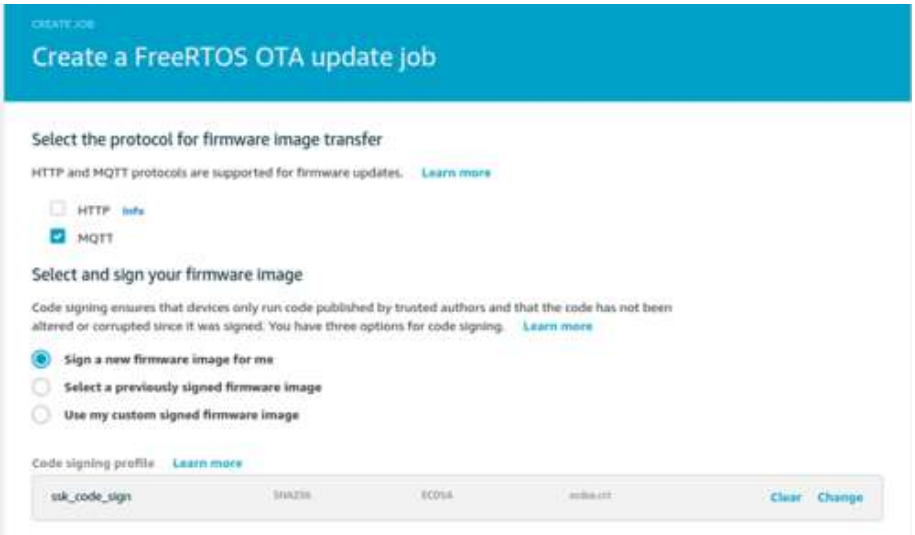
2. Select the create OTA update job



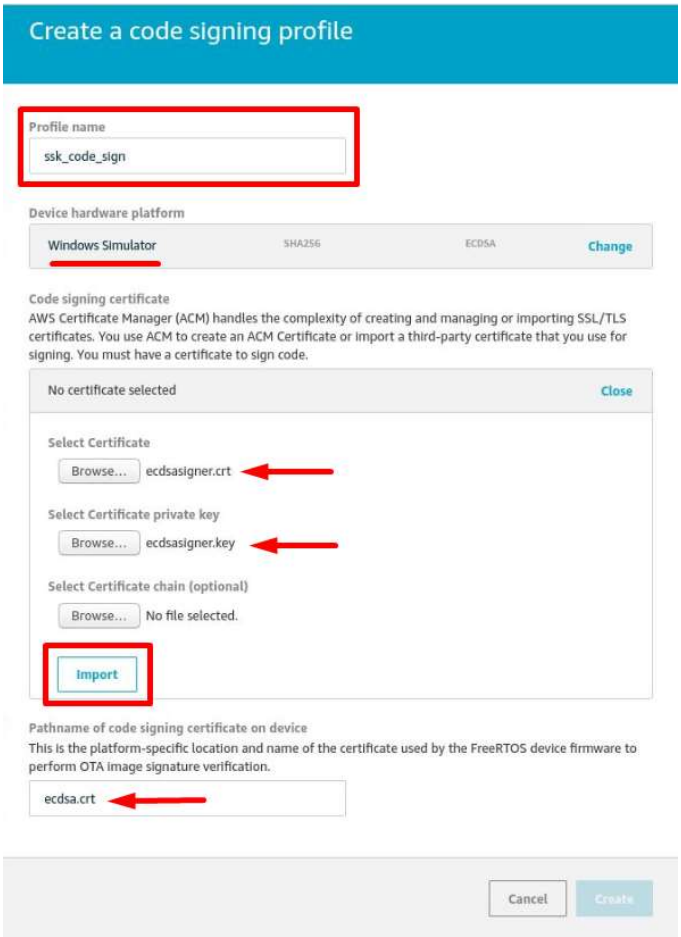
3. Select your "thing name" ST32WB55 and press Next.



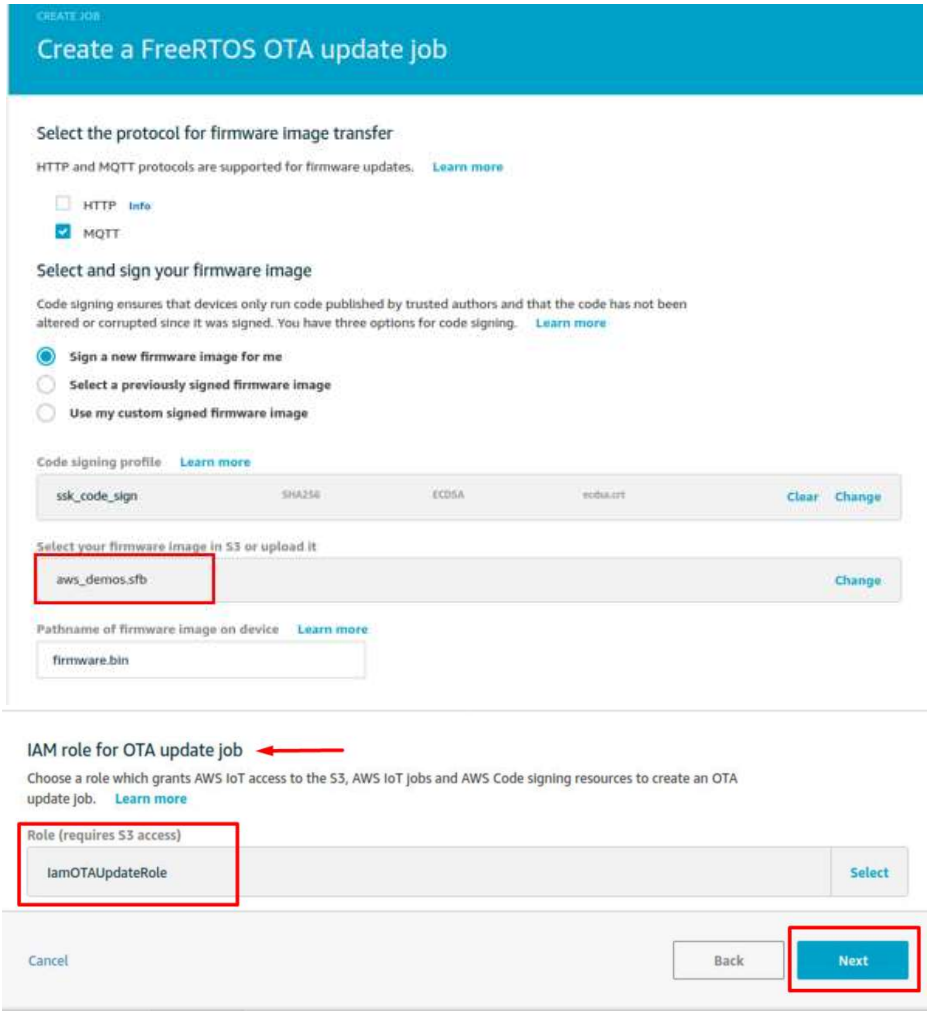
4. MQTT protocol for image transfer, (HTTP is not supported)
5. Select Sign a new firmware for me option



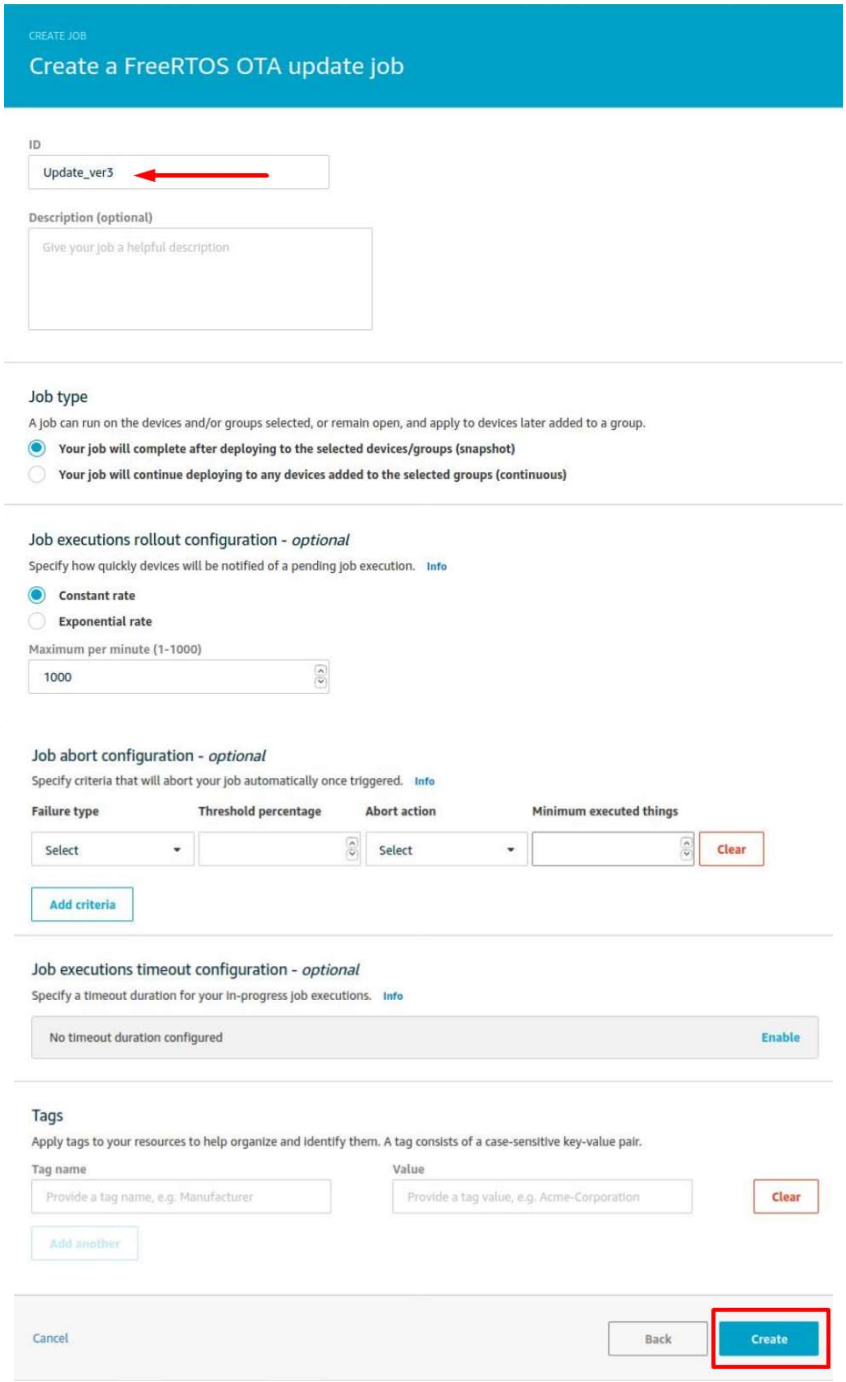
6. Create code signing profile, Enter Profile Name (e.g. ssk_code_sign) , Device Hardware Platform select Windows Simulator, code signing certificate press "Import" and browser the created code signing certificate and private key , Enter the pathname of code signing certificate on device (e.g. ecdsa.crt).



7. Select the aws_demos.sfb firmware file which was uploaded on S3 bucket, and enter the destination pathname (e.g. firmware.bin)
8. Select the IAM role for OTA update Job which was created in section 2.3 and click on Next



9. Enter Unique Job ID (e.g. Update_ver3) and Click on Create Button, Successful message displayed on TOP.

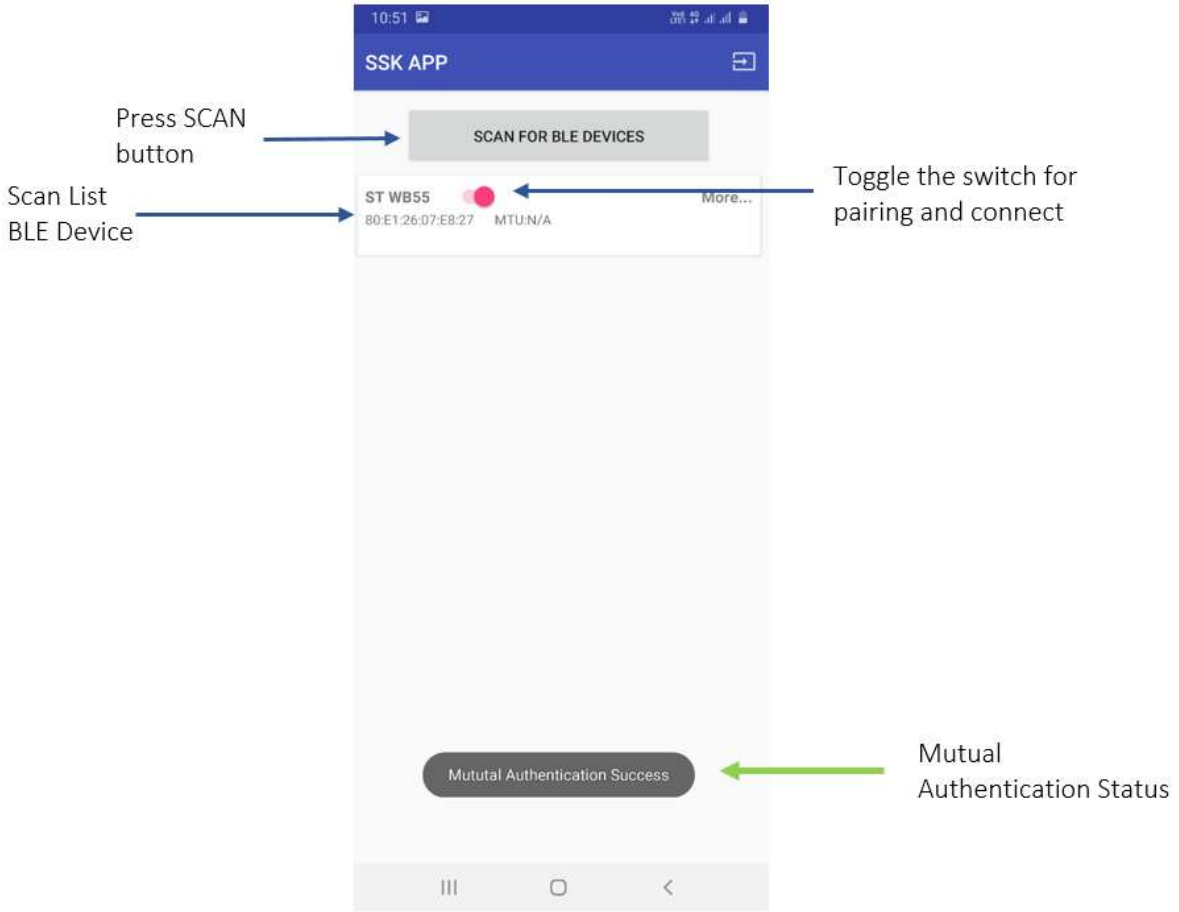


7.2 Run OTA Demo

1. If you want to modify the Endpoint URL, then follow the step 2 otherwise Reset the board and jump to step 3.
2. Press the SW2 button and Reset the board (By Pressing "Reset" button as shown in figure 2). It will ask to enter endpoint URL on Serial console screen as below.
   Paste the Endpoint URL here and press the "Enter" key on keyboard. (Note: Default Echo is OFF, so cannot see your Endpoint URL value.)
   So, to verify that the correct endpoint URL was entered, on the serial console it will display the URL as shown above (with yellow marked).

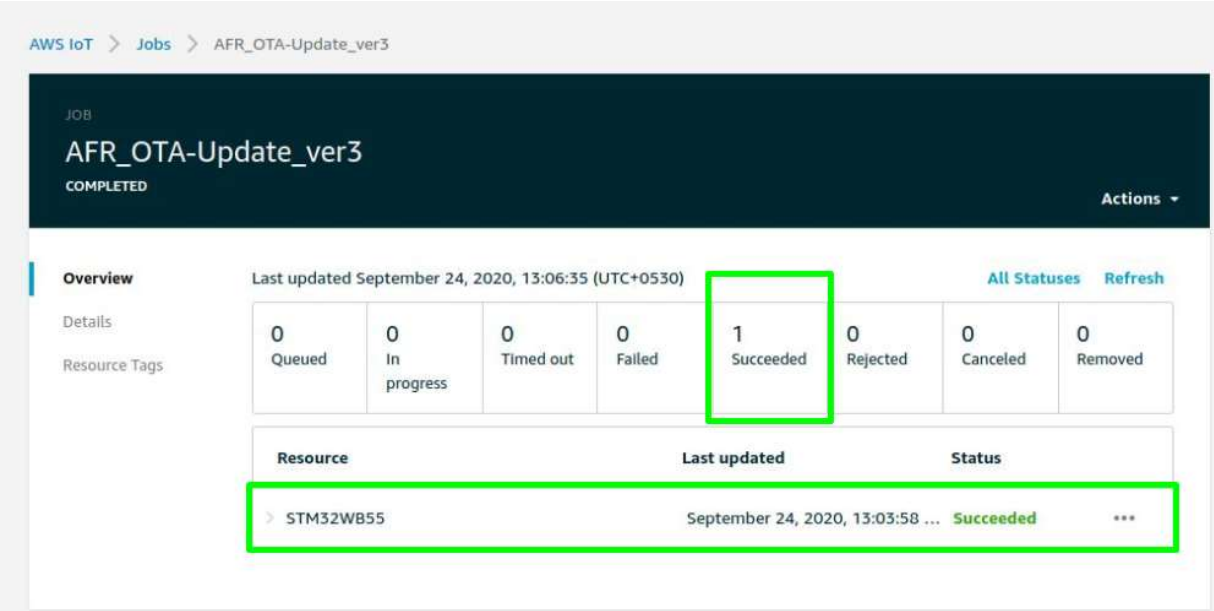
```
========== Please Enter Your Endpoint URL ==========
e.g- xxxxxxxxxxx-ats.iot.xx-xxx-x.amazonaws.com

Entered Endpoint URL=[illegible]-ats.iot.[illegible].amazonaws.com
====================================================
```

3. Click on the SCAN FOR BLE DEVICES button. Connect and Pair with STM32WB55 device. On the serial console to Press "Y" if passkey matches with mobile pair key.



4. During this demo, Mutual Authentication is enabled between the Mobile Device and STM32WB55. Only provisioning device can start communication else Mutual Authentication fails and logs out from the AWS Cognito Session in Mobile APP.

5. To see the OTA Job status on AWS console, Open AWS Console >> IoT Service >> Manage >> Jobs >> Select created Job (i.e. AFR_OTA-Update_ver3)



6. OTA Job and its packets shown in below screen

```
37 27516 [OTA Agent Task] (MQTT connection 0x20011b18, PUBLISH operation 0x200129e0) Wait complete with result SUCCESS.
38 27526 [OTA Agent Task] [prvOTAAgentTask] Called handler. Current State [RequestingJob] Event [RequestJobDocument] New state [WaitingForJob]
39 27867 [RF_STACK] [SECURITY][SEND] CIPHER TEXT = S◆,◆◆J◆ x[illegible]@

0 27874 [OTA Agent Task] [prvParseJobDoc] Size of OTA_FileContext_t [64]
1 27882 [OTA Agent Task] [prvParseJSONbyModel] Extracted parameter [ clientToken: 0:STM32WB55 ]
2 27891 [iot_thread] State: RequestingJob  Received: 1   Queued: 0   Processed: 0   Dropped: 0
3 27900 [OTA Agent Task] [prvParseJSONbyModel] Extracted parameter [ jobId: AFR_OTA-Update_ver3 ]
4 27910 [OTA Agent Task] [prvParseJSONbyModel] Extracted parameter [ protocols: ["MQTT"] ]
5 27918 [OTA Agent Task] [prvParseJSONbyModel] Extracted parameter [ streamname: AFR_OTA-8bc48aaf-992b-4b17-91c9-4f5976324ffc ]
6 27930 [OTA Agent Task] [prvParseJSONbyModel] Extracted parameter [ filepath: firmware.bin ]
7 27938 [OTA Agent Task] [prvParseJSONbyModel] Extracted parameter [ filesize: 222048 ]
8 27947 [OTA Agent Task] [prvParseJSONbyModel] Extracted parameter [ fileId: 0 ]
9 27955 [OTA Agent Task] [prvParseJSONbyModel] Extracted parameter [ certfile: /home/certificate/ecdsasigner.crt ]
0 27966 [OTA Agent Task] [prvParseJSONbyModel] Extracted parameter [ sig-sha256-ecdsa: MEUCIQDLNtVN3rD7g9mwY0mWbw502rej... ]
1 27977 [OTA Agent Task] [prvParseJobDoc] Job was accepted. Attempting to start transfer.
62 28900 [iot_thread] State: WaitingForJob  Received: 1   Queued: 0   Processed: 0   Dropped: 0
63 29488 [OTA Agent Task] [prvSetDataInterface] Data interface is set to MQTT.
64 29496 [OTA Agent Task] [prvProcessJobHandler] Setting OTA data inerface.
65 29503 [OTA Agent Task] [prvOTAAgentTask] Called handler. Current State [WaitingForJob] Event [ReceivedJobDocument] New state [CreatingFile]
66 29524 [iot_thread] [SECURITY][SEND] CIPHER TEXT = U[illegible]d◆◆X◆◆◆ ◆◆◆[illegible]IK[illegible]◆-◆◆◆◆B{Y1◆<' ◆y◆U◆(J◆M◆◆[illegible]  ◆◆[illegible]◆>◆◆[illegible]◆6◆)◆◆[illegible]S[illegible]◆◆◆◆C◆◆◆}[illegible]v&◆◆◆Pg

67 29538 [OTA Agent Task] (MQTT connection 0x20011b18) SUBSCRIBE operation scheduled.
68 29546 [OTA Agent Task] (MQTT connection 0x20011b18, SUBSCRIBE operation 0x20012fd8) Waiting for operation completion.
69 29908 [iot_thread] State: WaitingForJob  Received: 1   Queued: 0   Processed: 0   Dropped: 0
60 30140 [RF_STACK] [SECURITY][RECEIVED] CIPHER TEXT = R◆◆4◆S◆ ◆
◆◆B

61 30149 [OTA Agent Task] (MQTT connection 0x20011b18, SUBSCRIBE operation 0x20012fd8) Wait complete with result SUCCESS.
62 30160 [OTA Agent Task] [prvInitFileTransfer_Mqtt] OK: $aws/things/STM32WB55/streams/AFR_OTA-8bc48aaf-992b-4b17-91c9-4f5976324ffc/data/cbor
63 30173 [OTA Agent Task] [prvOTAAgentTask] Called handler. Current State [CreatingFile] Event [CreateFile] New state [RequestingFileBlock]
64 30197 [iot_thread] [SECURITY][SEND] CIPHER TEXT = U[illegible]o◆◆t=◆◆Eg◆7M[illegible]".◆◆◆◆lb◆l◆◆[illegible]#[@[illegible]◆◆q_◆c◆◆◆◆◆◆[illegible]H◆*z◆8&C◆RjX◆A◆◆◆Z`[illegible][◆NRTo8W0◆3    P*r◆-◆S?◆65 30211 [OTA Agent
18) MQTT PUBLISH operation queued.
66 30219 [OTA Agent Task] [prvRequestFileBlock_Mqtt] OK: $aws/things/STM32WB55/streams/AFR_OTA-8bc48aaf-992b-4b17-91c9-4f5976324ffc/get/cbor
67 30232 [OTA Agent Task] [prvOTAAgentTask] Called handler. Current State [RequestingFileBlock] Event [RequestFileBlock] New state [WaitingForFileBlock]
68 30916 [iot_thread] State: CreatingFile  Received: 1   Queued: 0   Processed: 0   Dropped: 0
69 31089 [OTA Agent Task] [prvIngestDataBlock] Received file block 1, size 1024
70 31112 [OTA Agent Task] [prvPAL_WriteBlock] Write 1024 bytes at 1024 address
71 31119 [OTA Agent Task] [prvIngestDataBlock] Remaining: 216
72 31125 [OTA Agent Task] [prvOTAAgentTask] Called handler. Current State [WaitingForFileBlock] Event [ReceivedFileBlock] New state [WaitingForFileBlock]
73 31674 [OTA Agent Task] [prvIngestDataBlock] Received file block 4, size 1024
74 31696 [OTA Agent Task] [prvPAL_WriteBlock] Write 1024 bytes at 4096 address
75 31704 [OTA Agent Task] [prvIngestDataBlock] Remaining: 215
76 31710 [OTA Agent Task] [prvOTAAgentTask] Called handler. Current State [WaitingForFileBlock] Event [ReceivedFileBlock] New state [WaitingForFileBlock]
77 31924 [iot_thread] State: WaitingForFileBlock  Received: 3   Queued: 0   Processed: 0   Dropped: 0
78 32259 [OTA Agent Task] [prvIngestDataBlock] Received file block 2, size 1024
79 32281 [OTA Agent Task] [prvPAL_WriteBlock] Write 1024 bytes at 2048 address
```

7. Verify the received Firmware and its signature as shown in below screen

```
1065 151582 [OTA Agent Task] [prvPAL_WriteBlock] Write 864 bytes at 221184 address
1066 151590 [OTA Agent Task] [prvIngestDataBlock] Remaining: 1
1067 151596 [OTA Agent Task] [prvOTAAgentTask] Called handler. Current State [WaitingForFileBlock] Event [ReceivedFileBlock] New state [WaitingForFileBlock]

1069 152104 [OTA Agent Task] [prvIngestDataBlock] Received file block 180, size 1024
1070 152127 [OTA Agent Task] [prvPAL_WriteBlock] Write 1024 bytes at 184320 address
1071 152135 [OTA Agent Task] [prvIngestDataBlock] Received final expected block of file.
1072 152143 [OTA Agent Task] [prvStopRequestTimer] Stopping request timer.
1073 153022 [iot_thread] State: WaitingForFileBlock  Received: 218   Queued: 0   Processed: 0   Dropped: 0
1074 153304 [OTA Agent Task] [prvIngestDataBlock] File receive complete and signature is valid.
1075 153313 [OTA Agent Task] [prvStopRequestTimer] Stopping request timer.
1076 153320 [OTA Agent Task] [prvUpdateJobStatus_Mqtt] Msg: {"status":"IN_PROGRESS","statusDetails":{"self_test":"ready","updatedBy":"0x90002"}}
```

8. On Next reboot Board will power up with newly upgraded firmware

```
1346 [iot_thread] [INFO ][DEMO][lu] Successfully initialized the demo. Network type for the demo: 2
1355 [iot_thread] [INFO ][MQTT][lu] MQTT library successfully initialized.
1362 [iot_thread] OTA demo version 0.9.3
1366 [iot_thread] Creating MQTT Client...
```

8 REFERENCES

[1] https://aws.amazon.com/freertos/

[2] https://github.com/Infineon/OPTIGA™-trust-m

[3] https://www.infineon.com/cms/en/product/security-smart-card-solutions/OPTIGA™-embedded-security-solutions/OPTIGA™-trust/OPTIGA™-trust-m-sls32aia/

[4] https://www.st.com/en/evaluation-tools/p-nucleo-wb55.html