AmebaPro2 Amazon FreeRTOS-LTS - Getting Started Guide

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1 Configure AWS IoT Core

1.1 Set up your AWS account and Permissions

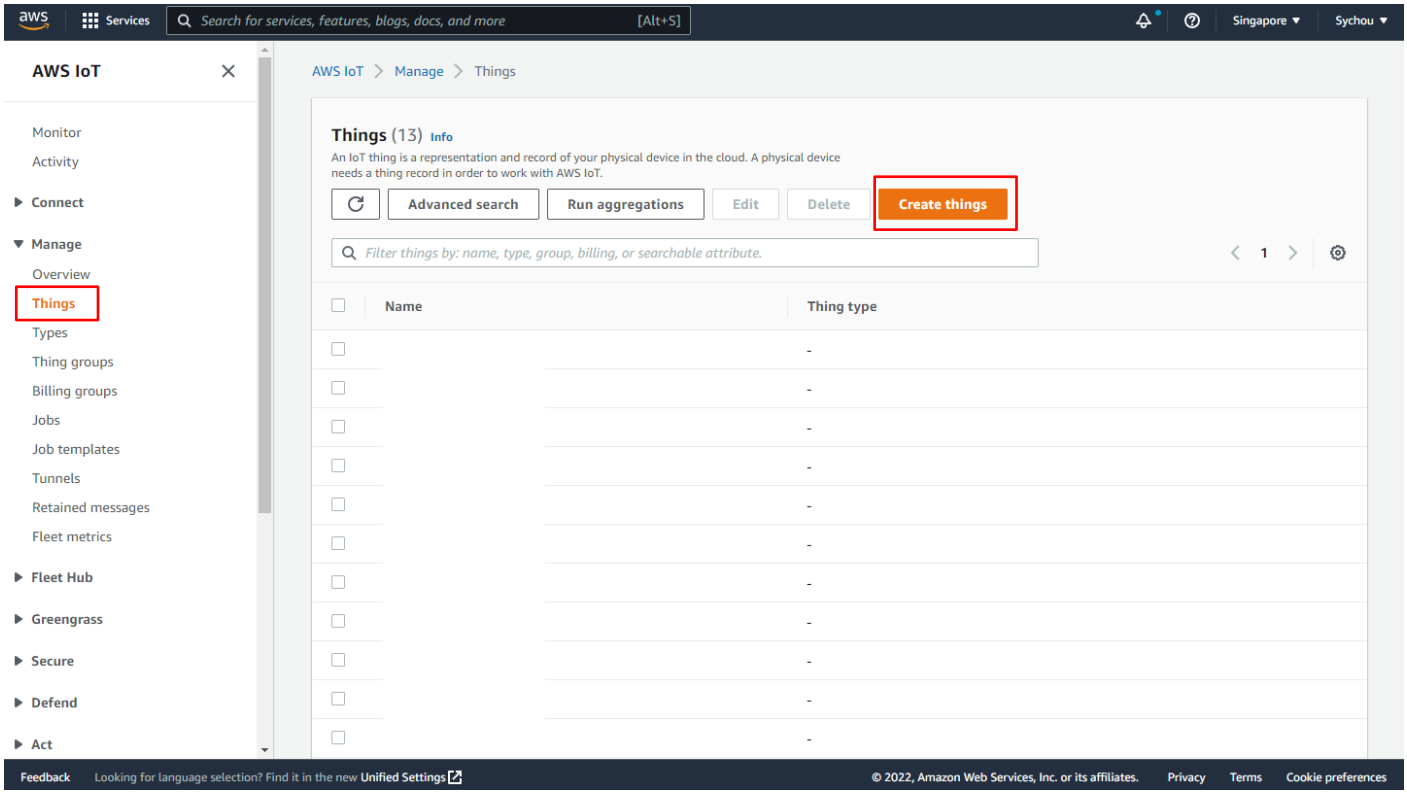
Refer to the instructions at Set up your AWS Account https://docs.aws.amazon.com/iot/latest/developerguide/setting-up.html. Follow the steps outlined in these sections to create your account and a user and get started:

- Sign up for an AWS account
- Create a user and grant permissions
- Open the AWS IoT console

Please pay special attention to the Notes in AWS webpage.

1.2 Create a New Device

To create a new device, navigate to Manage -> Things in the left-hand navigation menu. Then click “Create things”.



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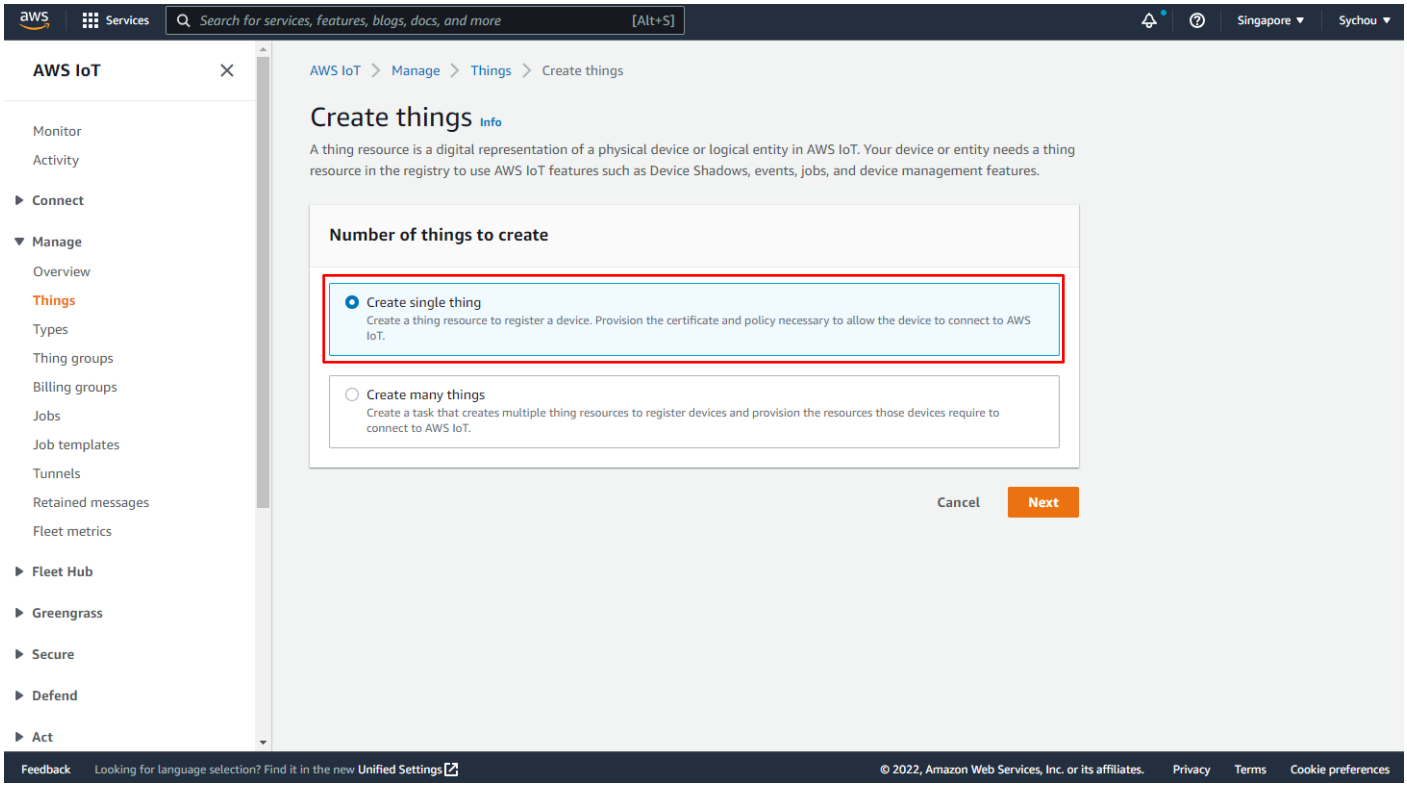
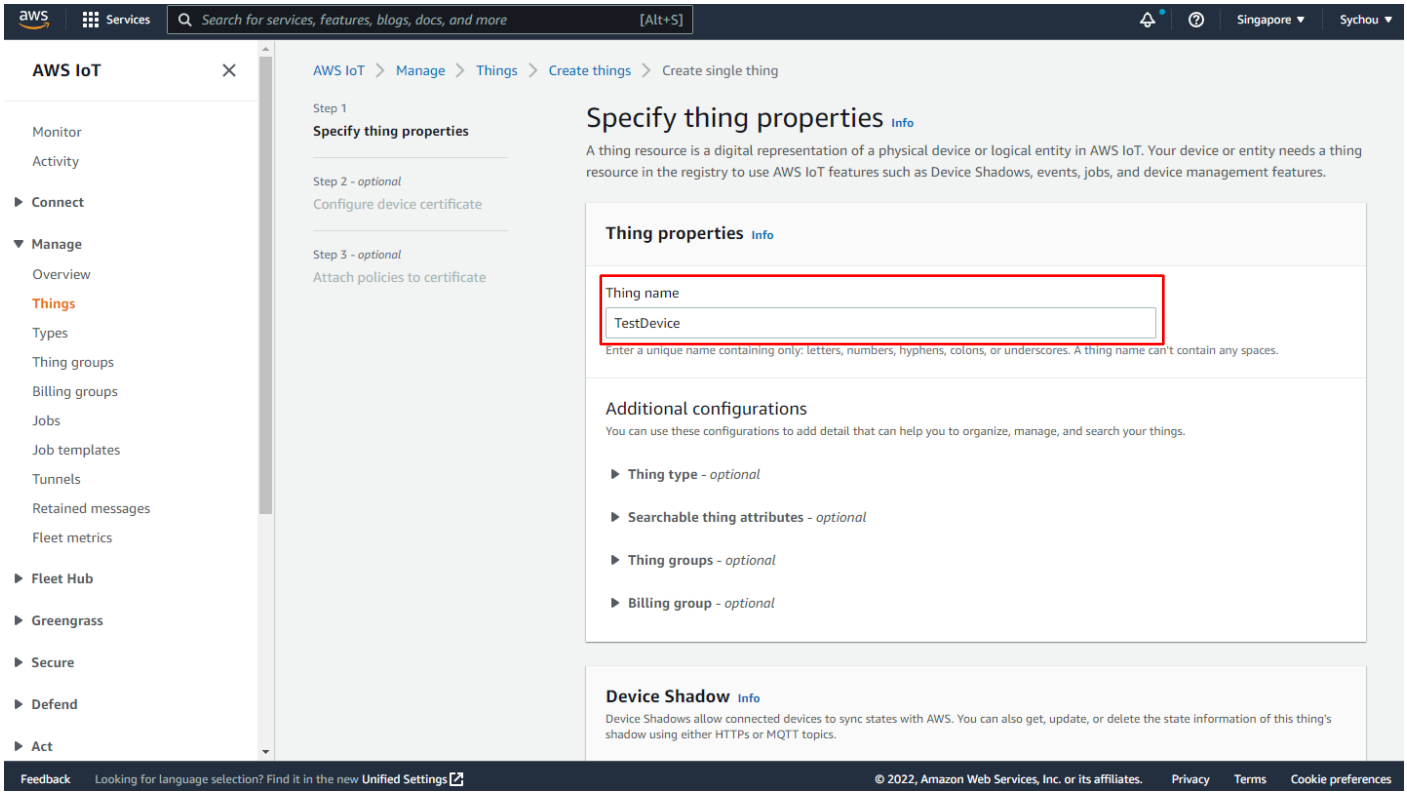


Then, name the new device. This example uses the name TestDevice.



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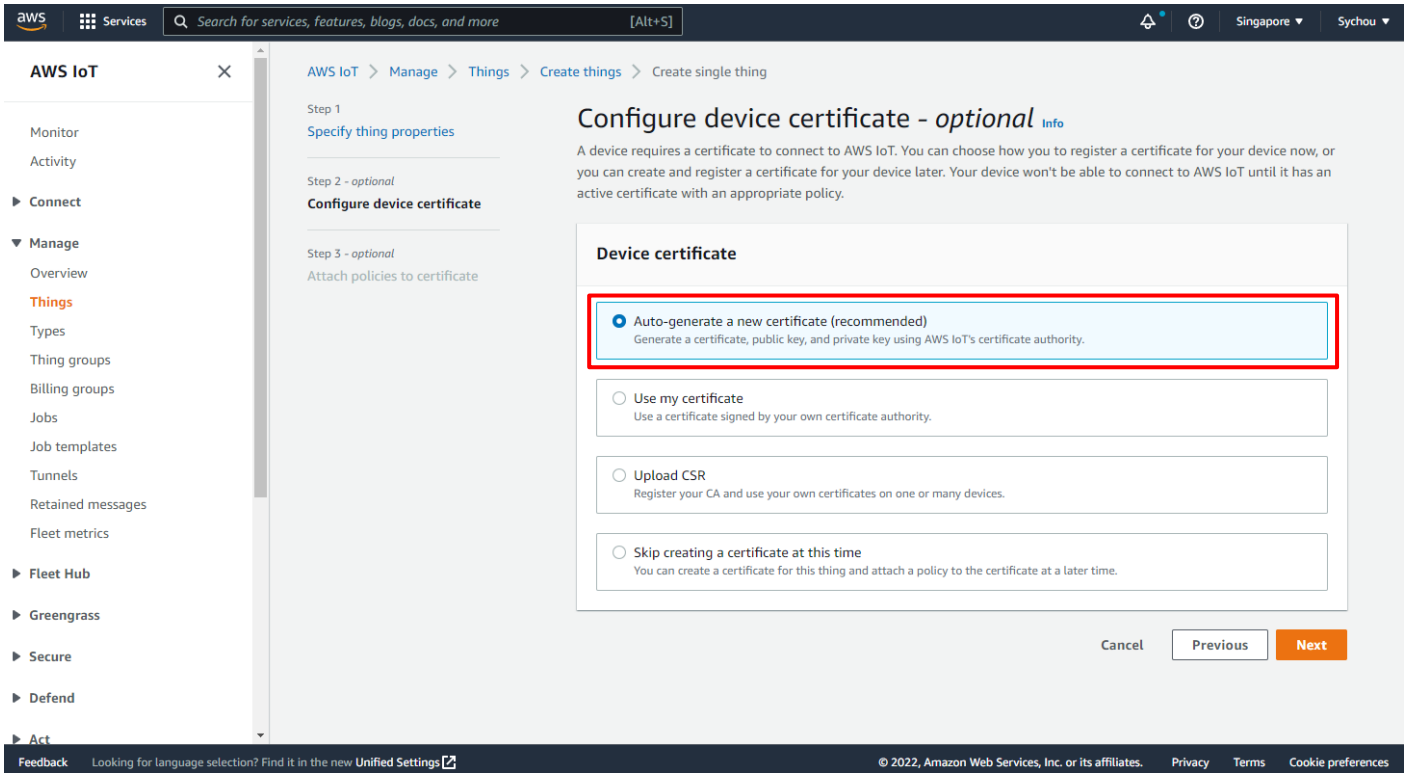
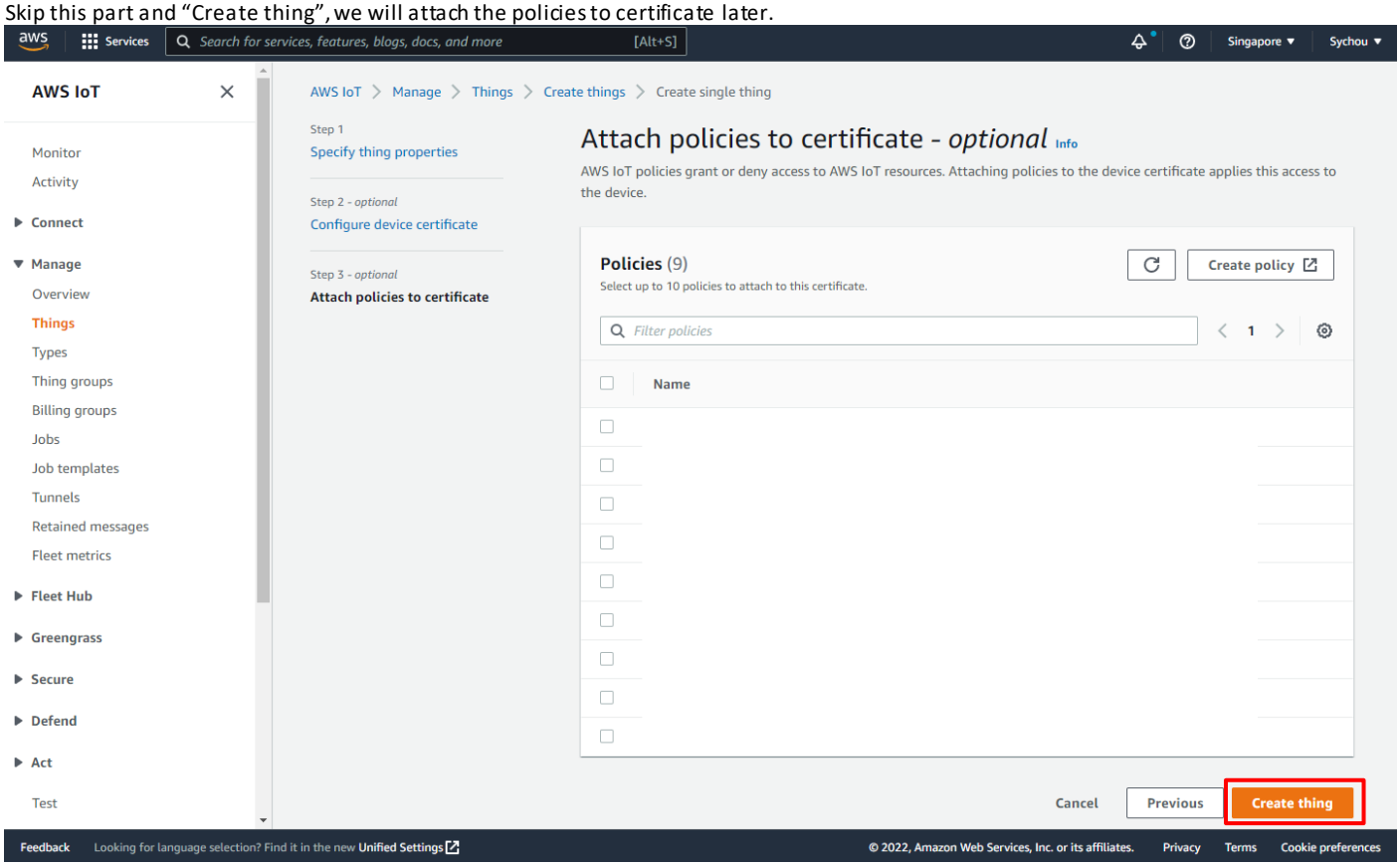


Skip this part and “Create thing”, we will attach the policies to certificate later.



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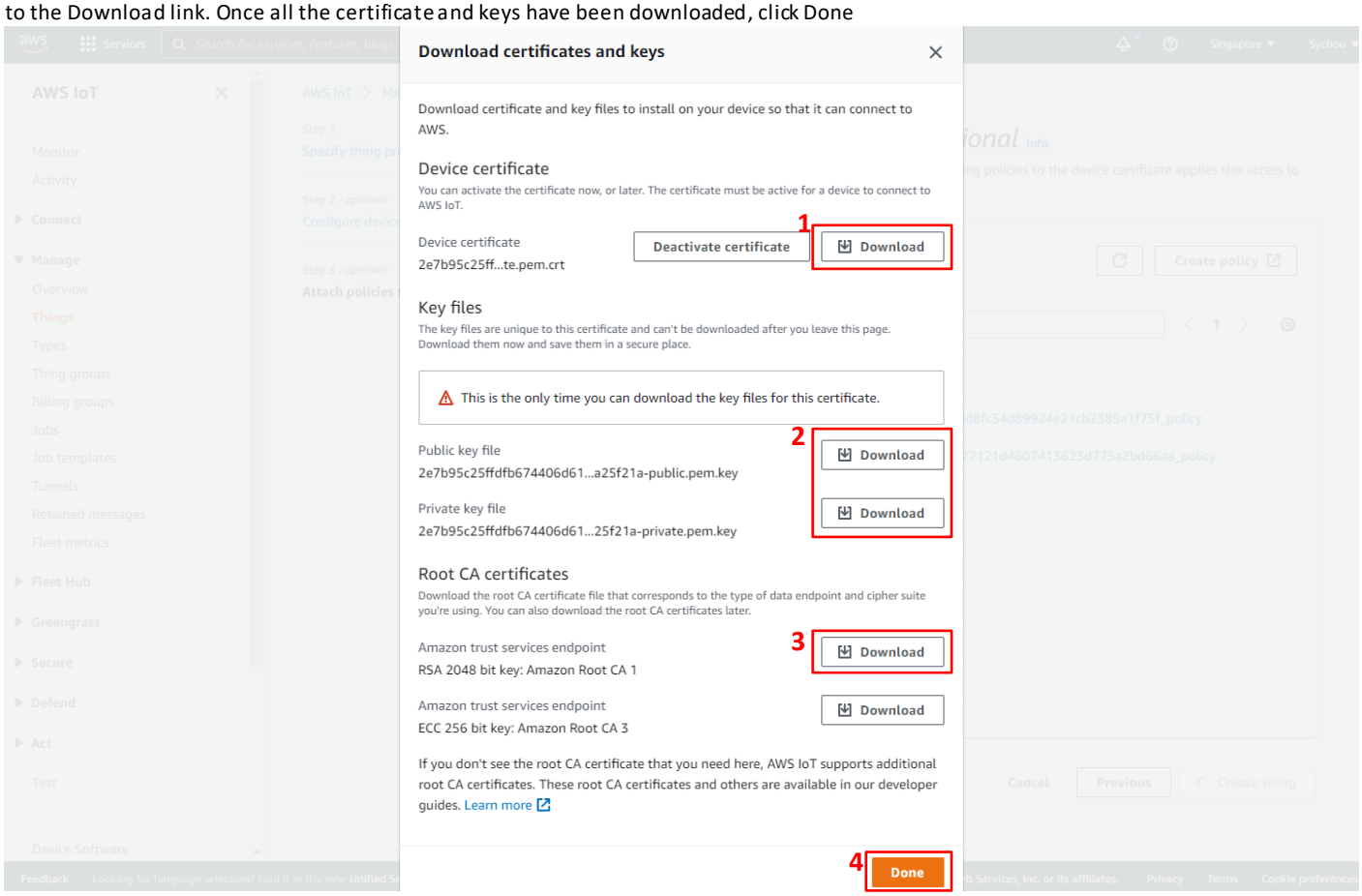
Download the certificate, public key, and private key for the device by clicking Download. Next, download the root CA for AWS IoT by clicking to the Download link. Once all the certificate and keys have been downloaded, click Done



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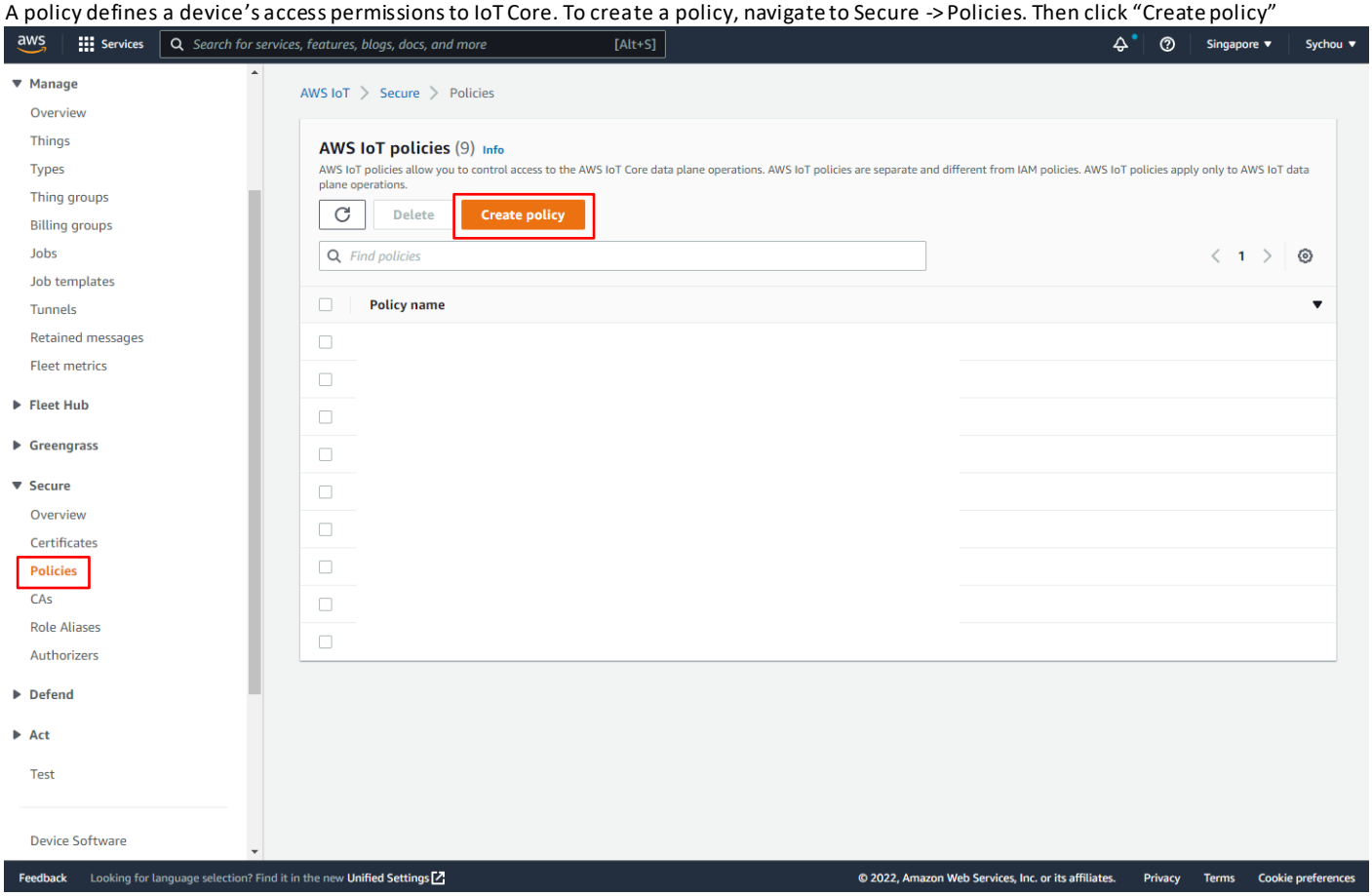
1.3 Create a policy

A policy defines a device's access permissions to IoT Core. To create a policy, navigate to Secure -> Policies. Then click "Create policy"



NOTE – this policy grants unrestricted access for all iot operations, and is to be used only in a development environment. For non-dev environments, all devices in your fleet must have credentials with privileges that authorize intended actions only, which include (but not limited to) AWS IoT MQTT actions such as publishing messages or subscribing to topics with specific scope and context. The specific permission policies can vary for your use cases. Identify the permission policies that best meet your business and security requirements.
For sample policies, refer to https://docs.aws.amazon.com/iot/latest/developerguide/example-iot-policies.html.
Also refer to https://docs.aws.amazon.com/iot/latest/developerguide/security-best-practices.html

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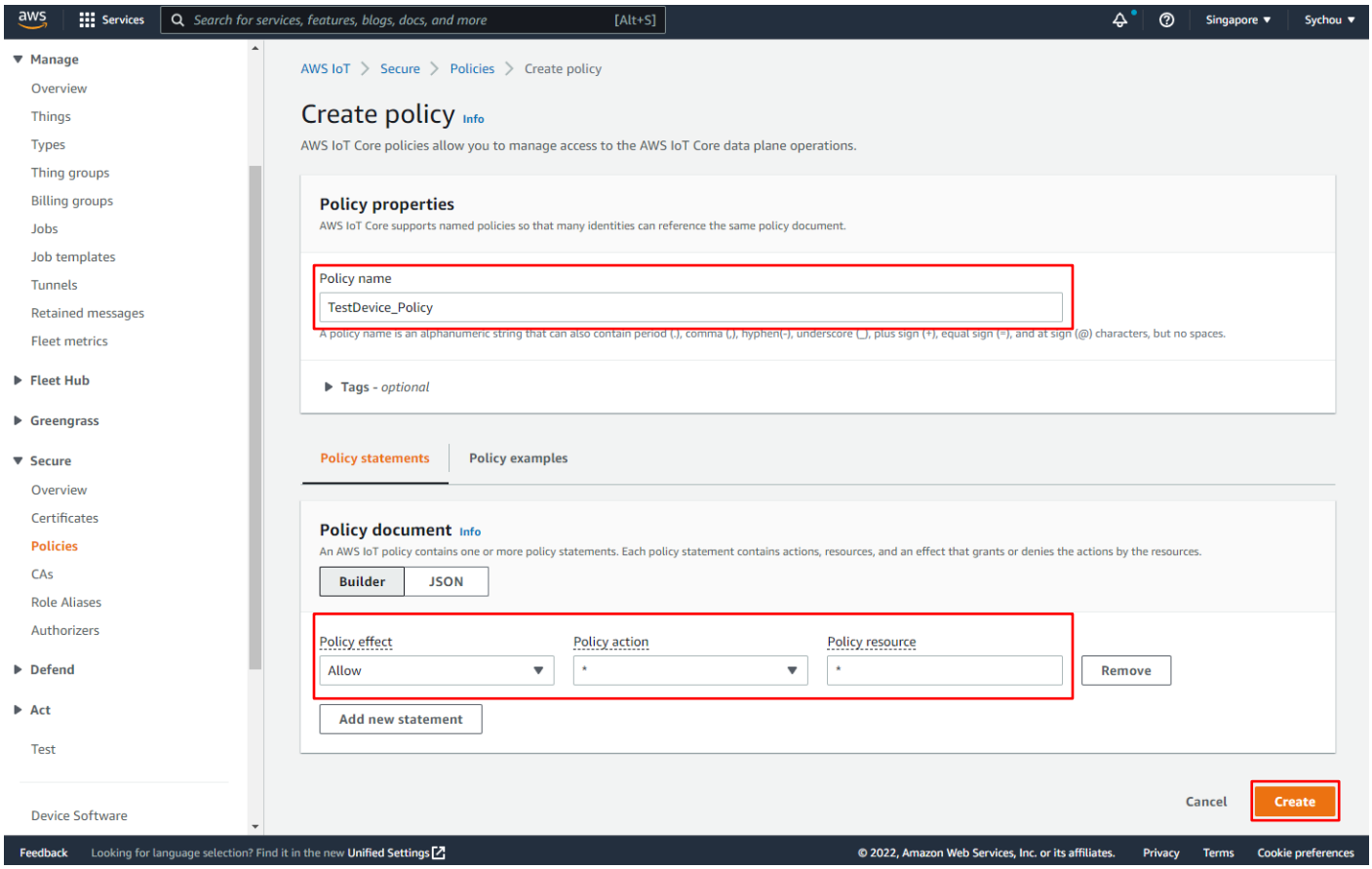

1.4 Attach Policy

The last step to configuring the device is attaching a policy. To attach a policy to new device, navigate to Manage -> Things. Then click on the device which was created.

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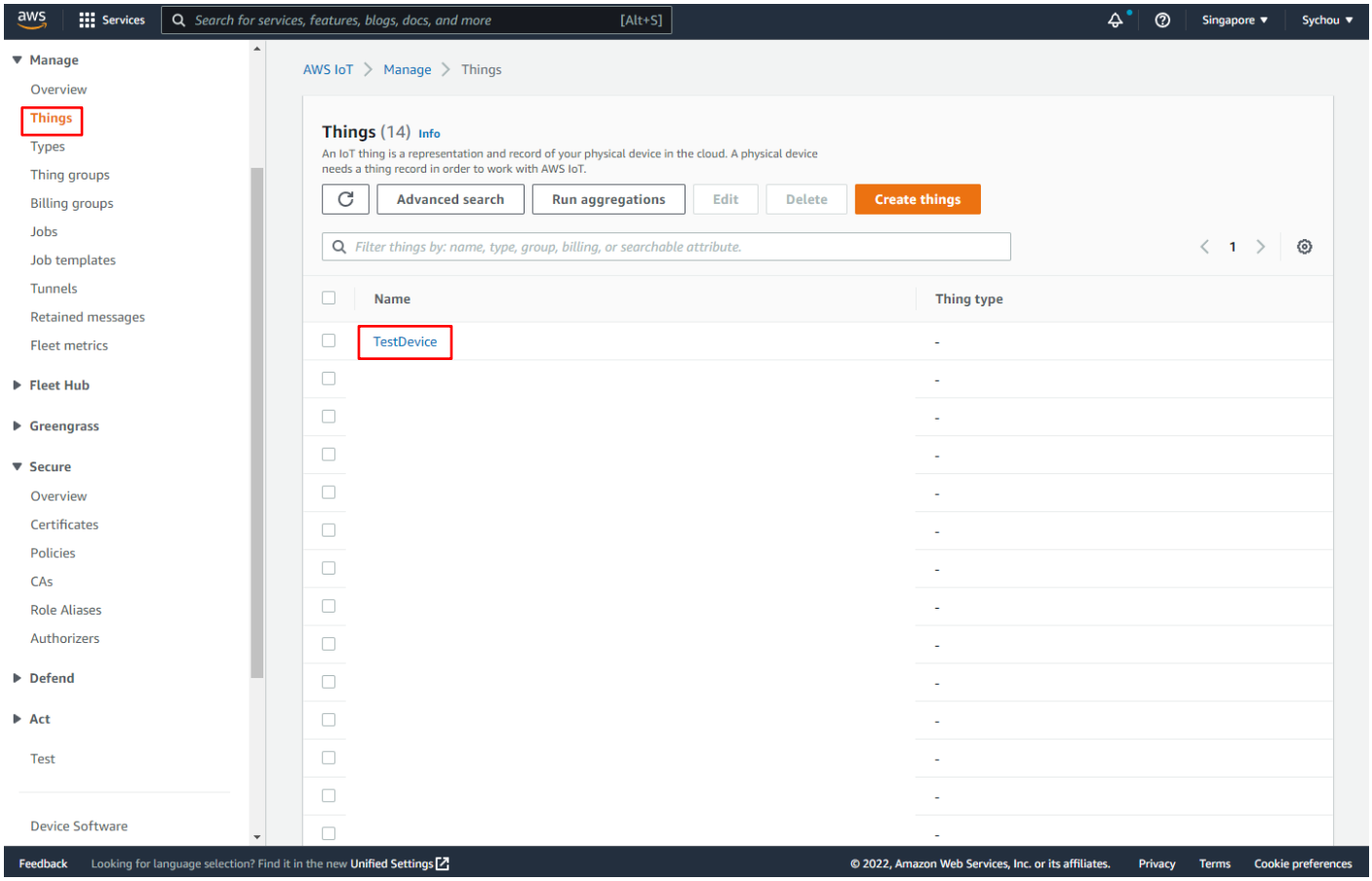
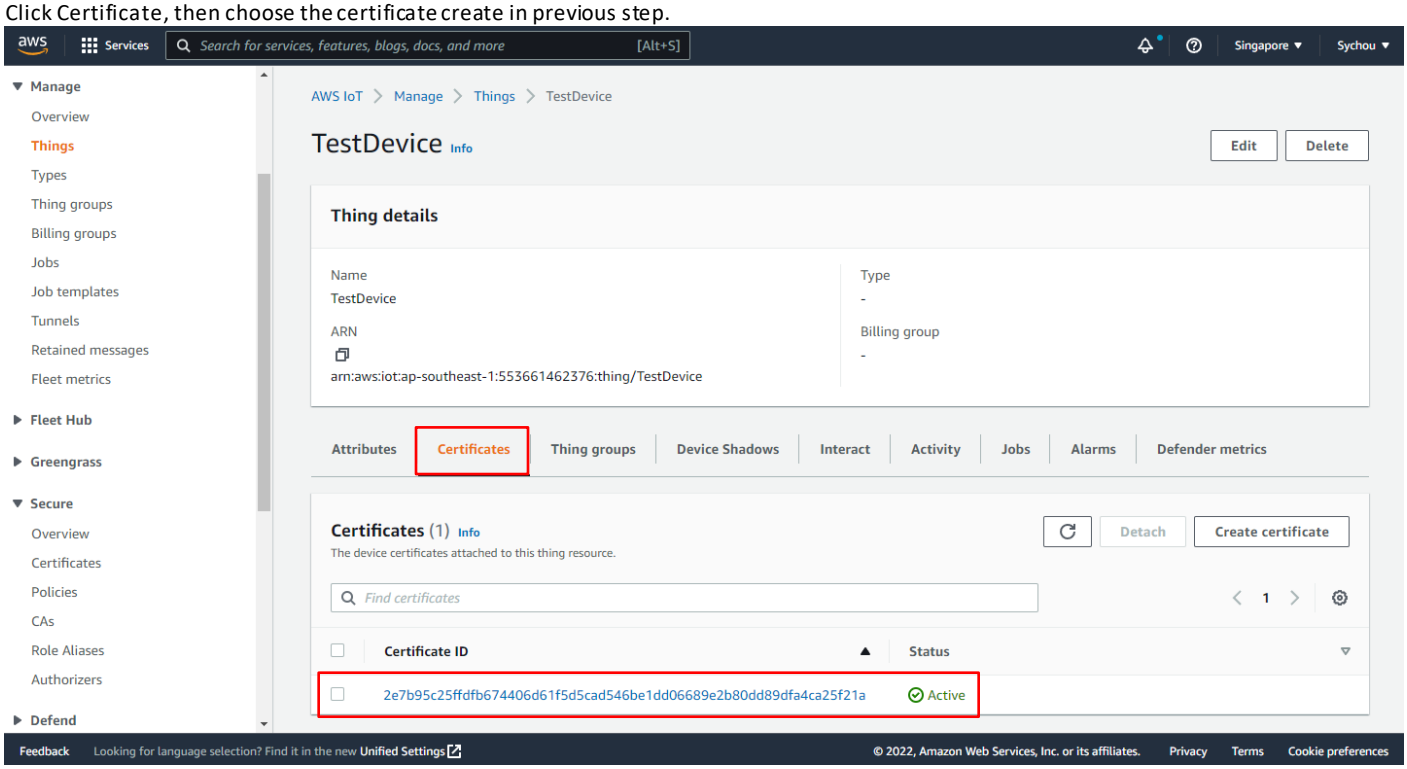


Click Certificate, then choose the certificate create in previous step.



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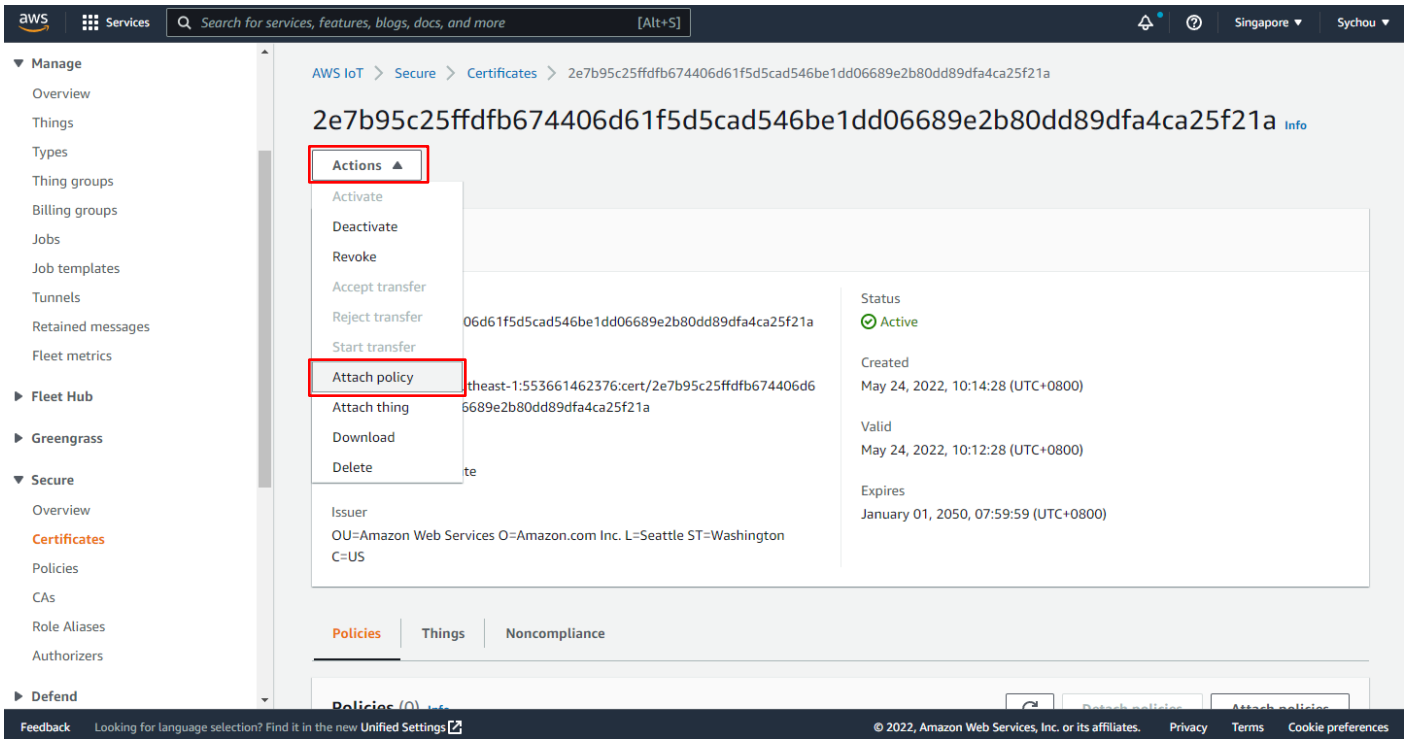

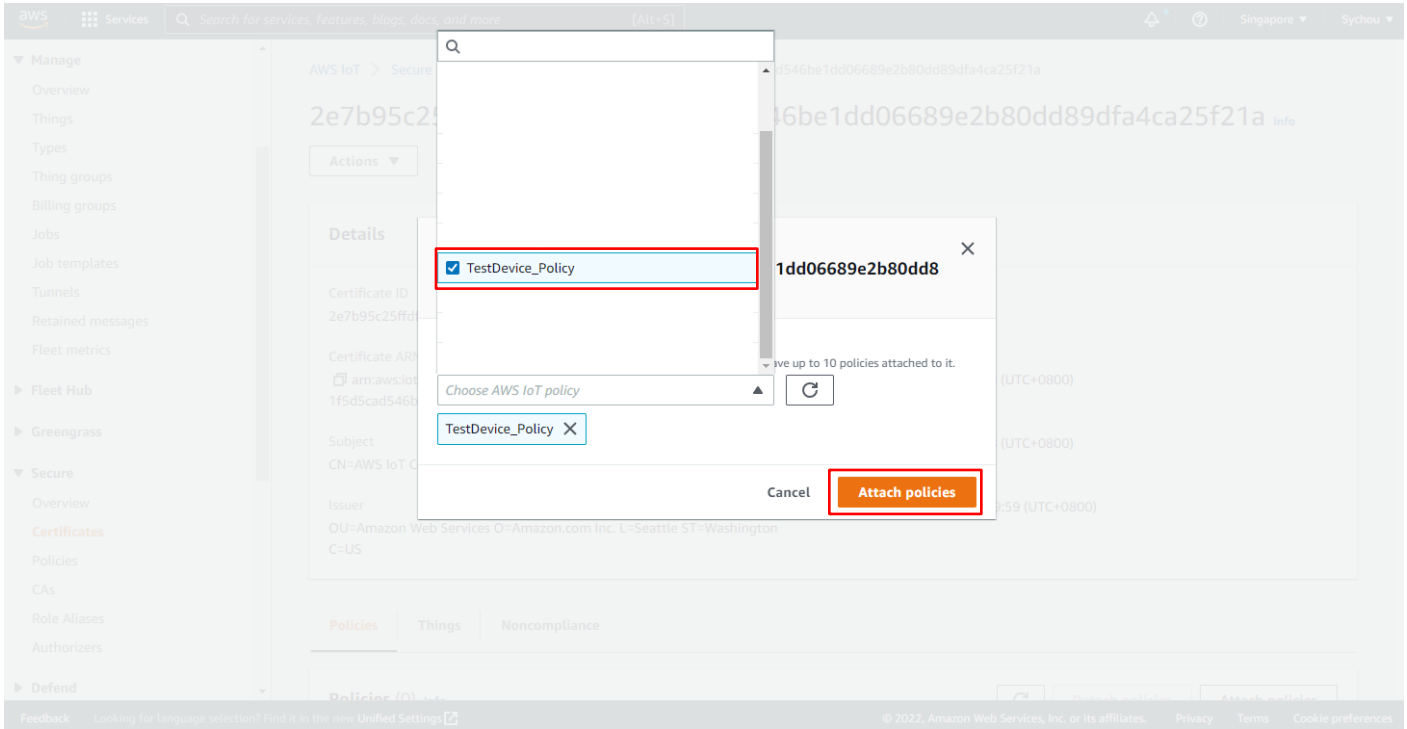

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2 Configure AmebaPro2 Amazon FreeRTOS

2.1 Download FreeRTOS-LTS Library Source Code from Github

Open source link: https://github.com/ambiot/amazon-freertos/tree/amebaPro2-9.x-202107.00-LTS
branch: **amebaPro2-9.x-202107.00-LTS**

2.1.1 Download Source Code of Required Libraries to SDK

Go to "AmebaPro2_SDK/project/realtek_amebapro2_v0_example/src":

$ cd project/realtek_amebapro2_v0_example/src
$ git clone --recurse-submodules -b amebaPro2-9.x-202107.00-LTS https://github.com/ambiot/amazon-freertos.git aws_iot_freertos_lts

2.1.2 Modify FreeRTOSConfig.h

Copy & paste below configurations to the end of FreeRTOSConfig.h in "project\realtek_amebapro2_v0_example\inc":

```
/* Sets the length of the buffers into which logging messages are written - so
 * also defines the maximum length of each log message. */
#define configLOGGING_MAX_MESSAGE_LENGTH            512

/* Set to 1 to prepend each log message with a message number, the task name,
 * and a time stamp. */
#define configLOGGING_INCLUDE_TIME_AND_TASK_NAME    1

/* Map the FreeRTOS printf() to the logging task printf. */
/* The function that implements FreeRTOS printf style output, and the macro
 * that maps the configPRINTF() macros to that function. */
#define configPRINTF( X )    vLoggingPrintf X

/* Non-format version thread-safe print. */
#define configPRINT( X )     vLoggingPrint( X )

/* Map the logging task's printf to the board specific output function. */
#define configPRINT_STRING( X )        printf( X )

#define iotconfigUSE_PORT_SPECIFIC_HOOKS
```

2.1.3 Configure Mbedtls Setting

In this project, we use mbedtls-2.16.6, same as KVS webrtc. Set mbedtls version to 2.16.6 in "project/realtek_amebapro2_v0_example/GCC-RELEASE/config.cmake"

set(mbedtls "mbedtls-2.16.6")

You have to modify some mbedtls config before running aws-iot demo, go to "component/ssl/mbedtls-2.16.6/include/mbedtls/config_rsa.h" check the following setting:

#define MBEDTLS_THREADING_ALT
//#define MBEDTLS_DEBUG_C
#define MBEDTLS_THREADING_C

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The default mbedtls version of AmebaPro2 is 3.0.0. However, for the aws iot demo, we use mbedtls version 2.16.6 in default. It might be easier for user to use it with AWS KVS service now.
If user want to use the aws-iot with mbedtls-3.0.0 or mbedtls-2.4.0, user can compare the config file between mbedtls-2.16.6 and mbedtls-3.0.0, mbedtls-2.4.0

2.1.4 Multiple Definition Issue

There might be multiple definition of "vApplicationGetIdleTaskMemory" and "vApplicationGetTimerTaskMemory".
Since aws demo runner have the same function that have been defined in SDK, so we should comment one of them, go to "component\os\freertos\freertos_cb.c" and comment these two functions

```
//void vApplicationGetIdleTaskMemory(...)
//{
//    ...
//}

//void vApplicationGetTimerTaskMemory(...)
//{
//    ...
//}
```

2.1.5 Configure NVM interface for PKCS11

User should select a non-volatile memory (NVM) interface such as SD card and flash for the PKCS11 library

1. **SD card**: used by default, so please insert a SD card to the device
2. **Flash**: user can select the flash for pkcs11 in "aws_iot_freertos_lts/vendors/realtek/boards/amebaPro2/ports/pkcs11"

```
#define PKCS11_NVM_INTERFACE  PKCS11_AMEBA_FLASH
```

If using flash as NVM for PKCS11, please arrange a proper flash address(AWSIOT_PKCS11_DATA) in platform_opt.h to store pkcs11 data .

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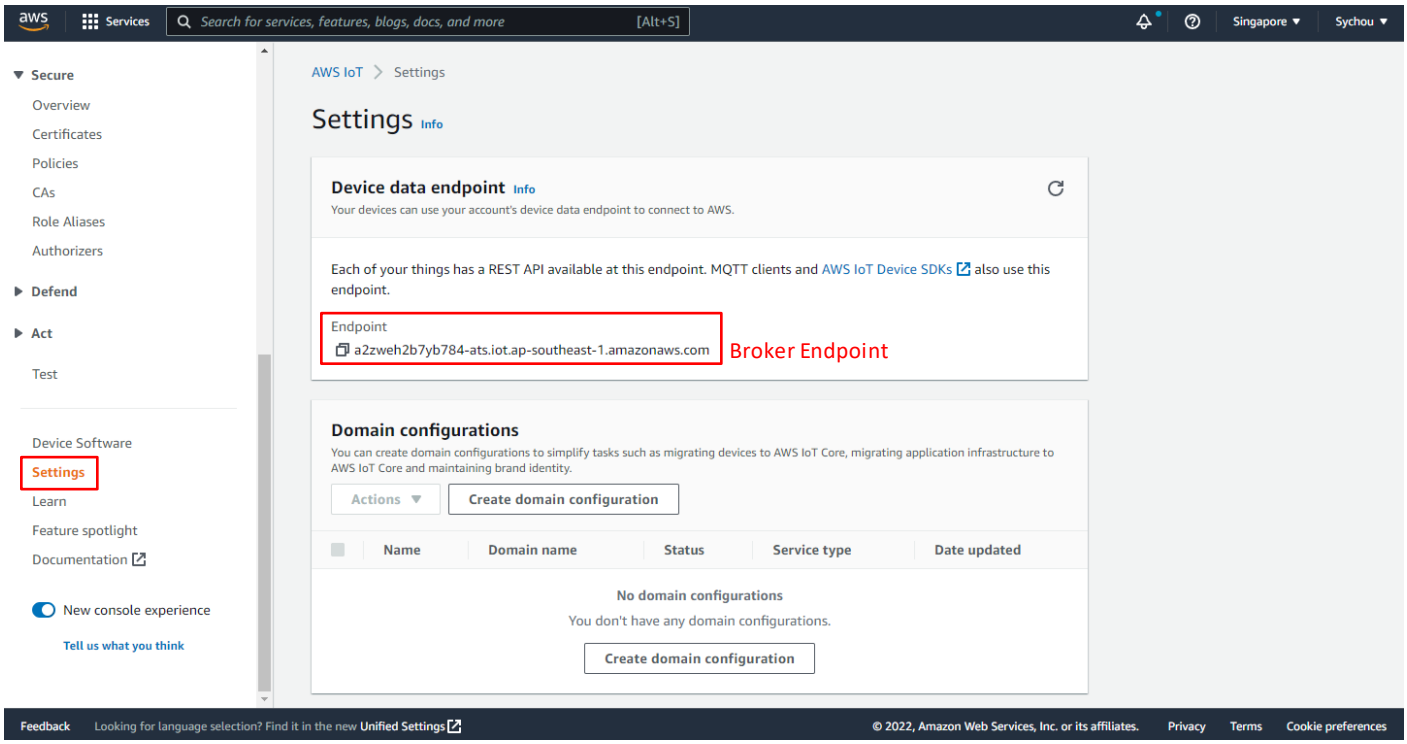
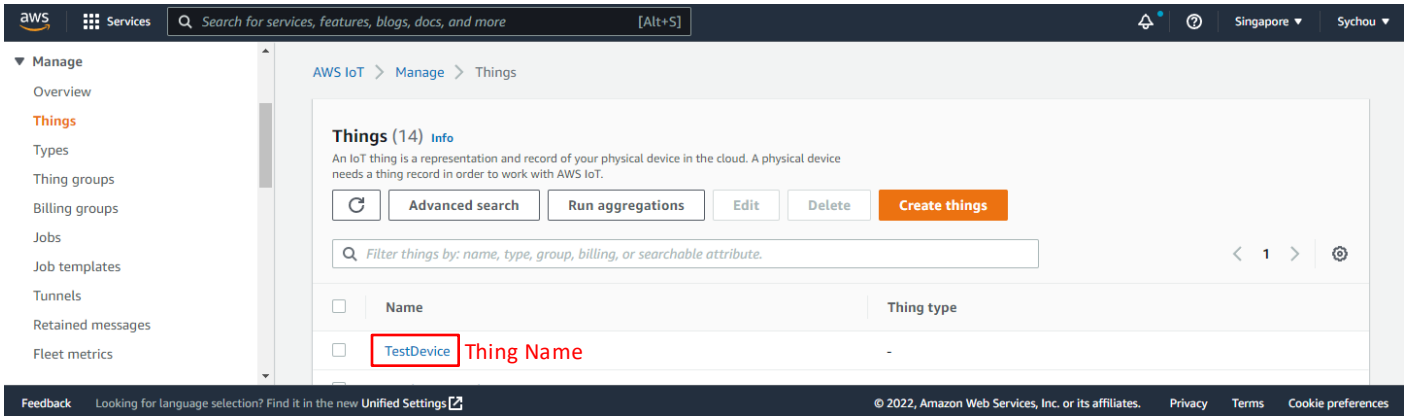
2.2 Get Broker Endpoint by AWS IoT Core



2.3 Get Thing Name



2.4 Setup IoT Core Information with AmebaPro2 Amazon FreeRTOS

Setup BROKER_ENDPOINT, THING_NAME, WIFI_SSID, PASSWORD in "project/realtek_amebapro2_v0_example/src/aws_iot_freertos_lts/demos/include/aws_clientcredential.h"

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```
#define clientcredentialMQTT_BROKER_ENDPOINT         "xxxxxxxxxxxxxx.amazonaws.com"

/*
 * @brief Host name.
 *
 * @todo Set this to the unique name of your IoT Thing.
 */
#define clientcredentialIOT_THING_NAME               "TestDevice"

/*
 * @brief Port number the MQTT broker is using.
 */
#define clientcredentialMQTT_BROKER_PORT             8883

/*
 * @brief Port number the Green Grass Discovery use for JSON retrieval from cloud is using.
 */
#define clientcredentialGREENGRASS_DISCOVERY_PORT    8443

/*
 * @brief Wi-Fi network to join.
 *
 * @todo If you are using Wi-Fi, set this to your network name.
 */
#define clientcredentialWIFI_SSID                    "TestAP"

/*
 * @brief Password needed to join Wi-Fi network.
 * @todo If you are using WPA, set this to your network password.
 */
#define clientcredentialWIFI_PASSWORD                "password"

/*
 * @brief Wi-Fi network security type.
 *
 * @see WIFISecurity_t.
 *
 * @note Possible values are eWiFiSecurityOpen, eWiFiSecurityWEP, eWiFiSecurityWPA,
 * eWiFiSecurityWPA2 (depending on the support of your device Wi-Fi radio).
 */
#define clientcredentialWIFI_SECURITY                eWiFiSecurityWPA2

#endif /* ifndef __AWS_CLIENTCREDENTIAL__H__ */
```

2.4.1 Setup Thing's Private Key and Certificate

Fill keyCLIENT_CERTIFICATE_PEM and keyCLIENT_PRIVATE_KEY_PEM in "project/realtek_amebapro2_v0_example/src/aws_iot_freertos_lts/demos/include/aws_clientcredential_keys.h" by xxxxxxxx-certifiacte.pem and xxxxxxxx-private.pem.key.

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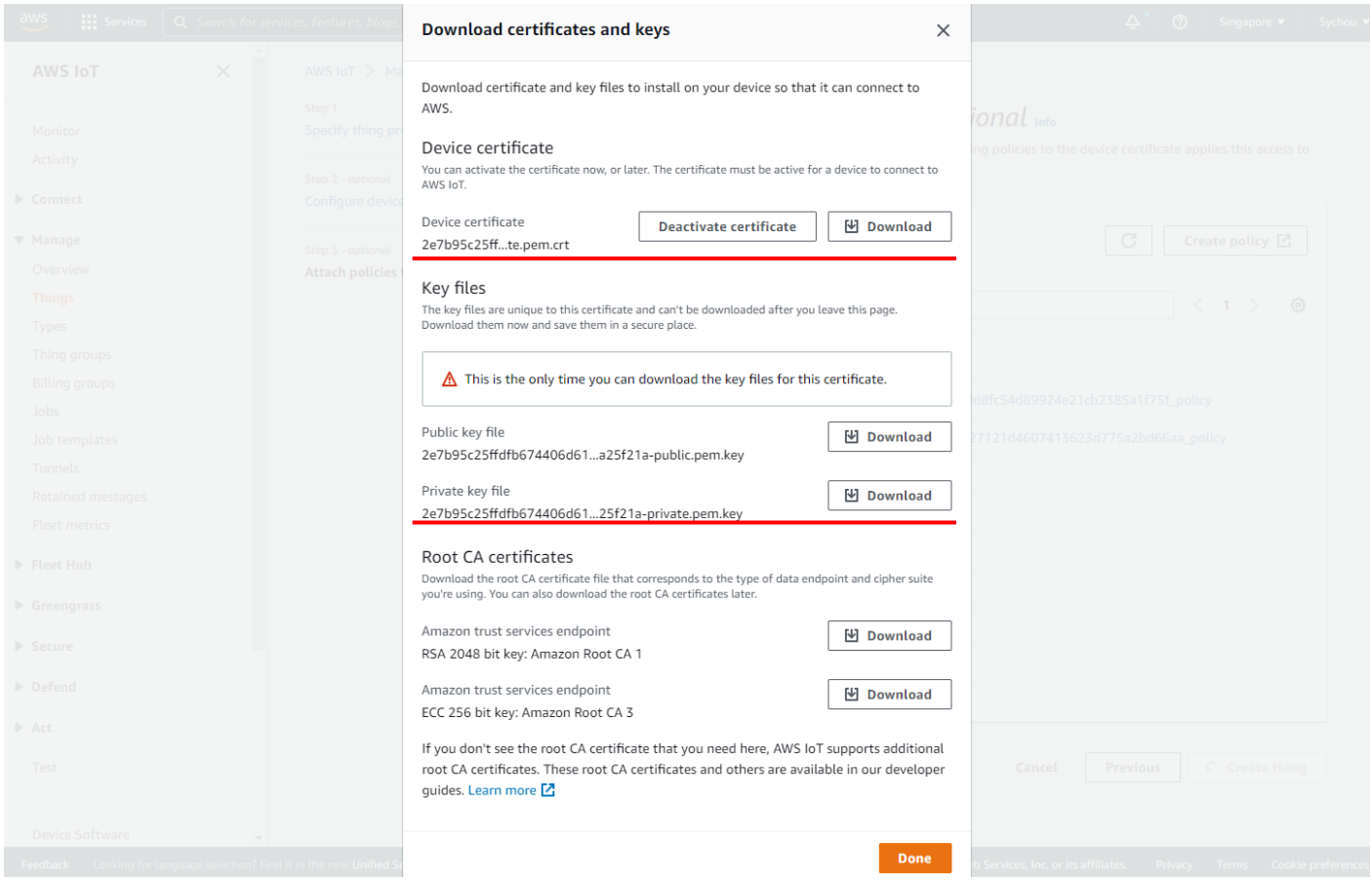

It can done by CertificateConfigurator.html and it can be downloaded from https://raw.githubusercontent.com/aws/amazon-freertos/202107.00/tools/certificate_configuration/CertificateConfigurator.html. Please download it before using.

Final aws_clientcredential_keys.h overview.

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```
/*
 * @brief PEM-encoded client certificate.
 *
 * @todo If you are running one of the FreeRTOS demo projects, set this
 * to the certificate that will be used for TLS client authentication.
 *
 * @note Must include the PEM header and footer:
 * "-----BEGIN CERTIFICATE-----\n"\
 * "...base64 data...\n"\
 * "-----END CERTIFICATE-----\n"
 */
#define keyCLIENT_CERTIFICATE_PEM \
"-----BEGIN CERTIFICATE-----\n"\
"MIIDWjCCAkKgAwIBAgIVAIDLSSoG+EARSbBprT4Im1uu8j2vMA0GCSqGSIb3DQEB\n"\
"                                                                \n"\
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"k5+NsBroU/YdvOUmzKn6XfI4nX4hLQJ2TbhAT8aq1ounGk6ZGqCbxt4mg5bB0w==\n"\
"-----END CERTIFICATE-----"
```

```
/*
 * @brief PEM-encoded client private key.
 *
 * @todo If you are running one of the FreeRTOS demo projects, set this
 * to the private key that will be used for TLS client authentication.
 *
 * @note Must include the PEM header and footer:
 * "-----BEGIN RSA PRIVATE KEY-----\n"\
 * "...base64 data...\n"\
 * "-----END RSA PRIVATE KEY-----\n"
 */
#define keyCLIENT_PRIVATE_KEY_PEM \
"-----BEGIN RSA PRIVATE KEY-----\n"\
"MIIEpAIBAAKCAQEAwop96WNucGebARFjD8O+CLsqcBNn/AHyhEcozLZC8qoECUOn\n"\
"                                                                \n"\
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"pOWEuLUuz2FAv1noAbN/6OQ8H/PTOAFJT/ghA04GnIUF0kjSzY60ehS2mVp6neP+\n"\
"AZjzZ6QJYlb5/PFz9oES448kpyaAoS2ke86+R4r4YOMBK+I5RVbfSQ==\n"\
"-----END RSA PRIVATE KEY-----\n"
```

2.4.2 Enable FreeRTOS demo on AmebaPro2

For example, if you would like to run MQTT mutual authentication demo, please find aws_demo_config.h in "project/realtek_amebapro2_v0_example/src/aws_iot_freertos_lts/vendors/realtek/boards/amebaPro2/aws_demos/config_files" and enable **CONFIG_CORE_MQTT_MUTUAL_AUTH_DEMO_ENABLED**

```
//#define CONFIG_CORE_HTTP_MUTUAL_AUTH_DEMO_ENABLED
#define CONFIG_CORE_MQTT_MUTUAL_AUTH_DEMO_ENABLED
//#define CONFIG_DEVICE_SHADOW_DEMO_ENABLED
//#define CONFIG_JOBS_DEMO_ENABLED
```

Now you can start to compile Ameba Pro2 Amazon FreeRTOS project !

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3 Compile AmebaPro2 Amazon FreeRTOS

3.1 Compile Program with GCC Toolchain

Run following commands to build the image with option `-DEXAMPLE=amazon_freertos`

```
$ cd project/realtek_amebapro2_v0_example/GCC-RELEASE
$ mkdir build
$ cd build
$ cmake .. -G"Unix Makefiles" -DCMAKE_TOOLCHAIN_FILE=../toolchain.cmake  -DEXAMPLE=amazon_freertos
$ cmake --build . --target flash -j4
```

After successfully build, there should be an image file **flash_ntz.bin** located in "build/" directory.

3.2 Download image to AmebaPro2

Use image tool to download the image to AmebaPro2.

4 MQTT Demo

4.1 Run MQTT Demo

Default setting of SDK are enable MQTT demo. Once the AmebaPro2 EVB has rebooted, the application will automatically start run MQTT demo and communicate to IoT Core.

```
[Driver]: set ssid [RealEZ]
                          [RF] [RFK] Tx pause!!
[RF] [RFK] Tx pause!!
[Driver]: start auth to [redacted]
[Driver]: auth alg = 2
[Driver]: auth success, start assoc
[Driver]: association success(res=28)
[Driver]: wlan0: DL RSVD page success! DLBcnCount:1, poll:1
                                                    0 301 [example_ama] Write certificate...
1 408 [iot_thread] [INFO ][DEMO][408] ---------STARTING DEMO---------

2 414 [iot_thread] [INFO ][INIT][414] SDK successfully initialized.
```

...

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```
Interface 0 IP address : 192.168.[redacted]
                                    3 53555 [iot_thread] [INFO ][DEMO][53555] Successfully initialized the demo. N
etwork type for the demo: 1

4 53564 [iot_thread] [INFO] Creating a TLS connection to [redacted]-ats.iot.ap-southeast-1.amazonaws.com:8883.
5 54778 [iot_thread] [INFO] Creating an MQTT connection to [redacted]-ats.iot.ap-southeast-1.amazonaws.com.
6 54909 [iot_thread] [INFO] Packet received. ReceivedBytes=2.
7 54913 [iot_thread] [INFO] CONNACK session present bit not set.
8 54919 [iot_thread] [INFO] Connection accepted.
9 54924 [iot_thread] [INFO] Received MQTT CONNACK successfully from broker.
10 54930 [iot_thread] [INFO] MQTT connection established with the broker.
11 54937 [iot_thread] [INFO] An MQTT connection is established with [redacted]-ats.iot.ap-southeast-1.amazonaws.c
om.
12 54949 [iot_thread] [INFO] Attempt to subscribe to the MQTT topic ameba-ota/example/topic.
13 54956 [iot_thread] [INFO] SUBSCRIBE sent for topic ameba-ota/example/topic to broker.
14 55070 [iot_thread] [INFO] Packet received. ReceivedBytes=3.
15 55074 [iot_thread] [INFO] Subscribed to the topic ameba-ota/example/topic with maximum QoS 1.
16 56082 [iot_thread] [INFO] Publish to the MQTT topic ameba-ota/example/topic.
17 56087 [iot_thread] [INFO] Attempt to receive publish message from broker.
18 56241 [iot_thread] [INFO] Packet received. ReceivedBytes=2.
19 56246 [iot_thread] [INFO] Ack packet deserialized with result: MQTTSuccess.
20 56252 [iot_thread] [INFO] State record updated. New state=MQTTPublishDone.
21 56259 [iot_thread] [INFO] PUBACK received for packet Id 2.
22 56265 [iot_thread] [INFO] Packet received. ReceivedBytes=39.
23 56270 [iot_thread] [INFO] De-serialized incoming PUBLISH packet: DeserializerResult=MQTTSuccess.
24 56280 [iot_thread] [INFO] State record updated. New state=MQTTPubAckSend.
25 56286 [iot_thread] [INFO] Incoming QoS : 1
```

…

```
248 122674 [iot_thread] [INFO] Demo run is successful with 3 successful loops out of total 3 loops.
249 123681 [iot_thread] [INFO ][DEMO][123681] Demo completed successfully.


Deinitializing WIFI ...
WIFI deinitialized250 123809 [iot_thread] [INFO ][INIT][123809] SDK cleanup done.

251 123813 [iot_thread] [INFO ][DEMO][123813] -------DEMO FINISHED-------
```

4.2 Monitoring MQTT Messages on the Cloud

To subscribe to the MQTT topic with the AWS IoT MQTT client

1. Sign in to the AWS IoT console.
2. In the navigation pane, choose Test to open the MQTT client.
3. In Subscription topic, enter “+/example/topic”, and then choose Subscribe to topic.

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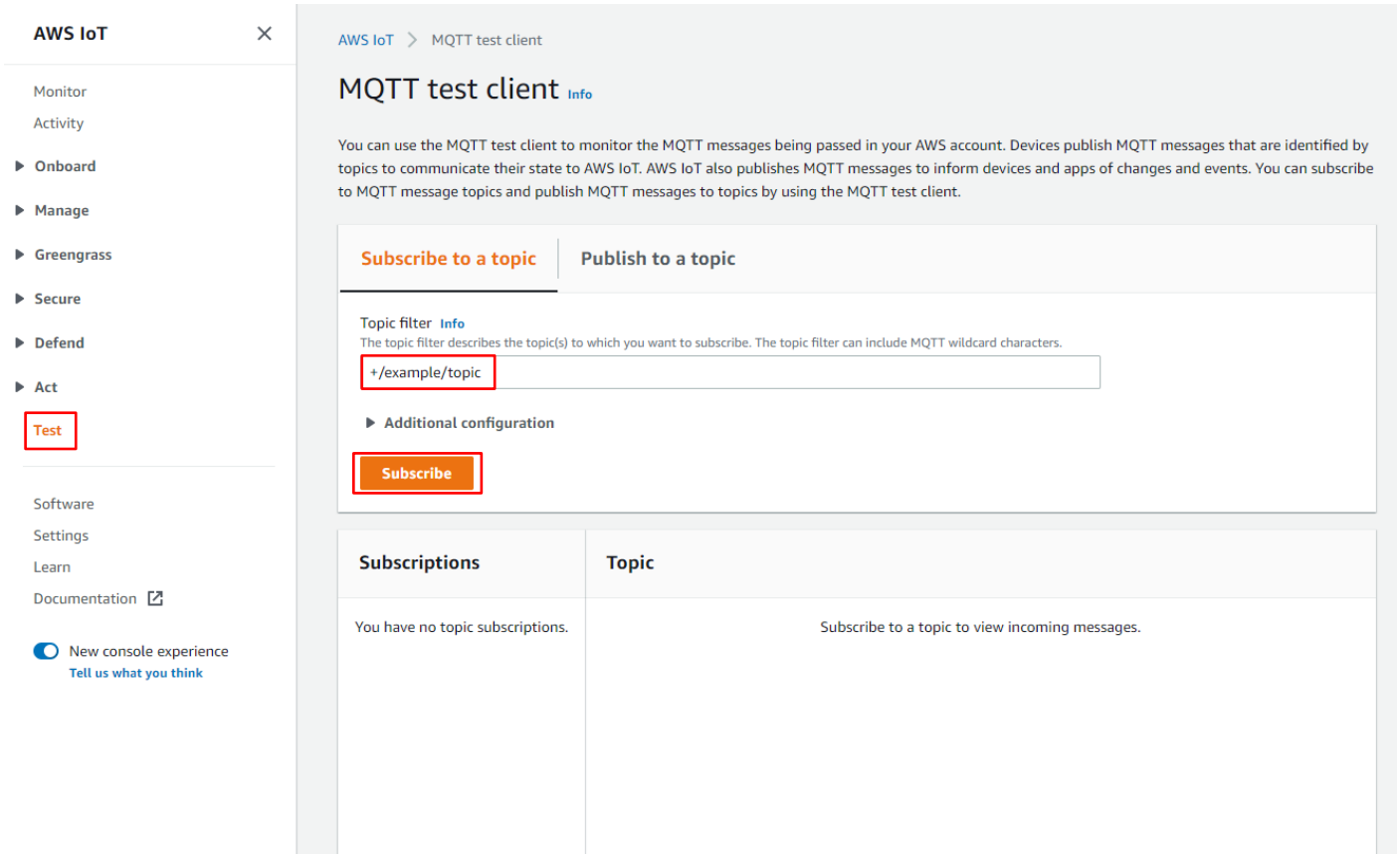

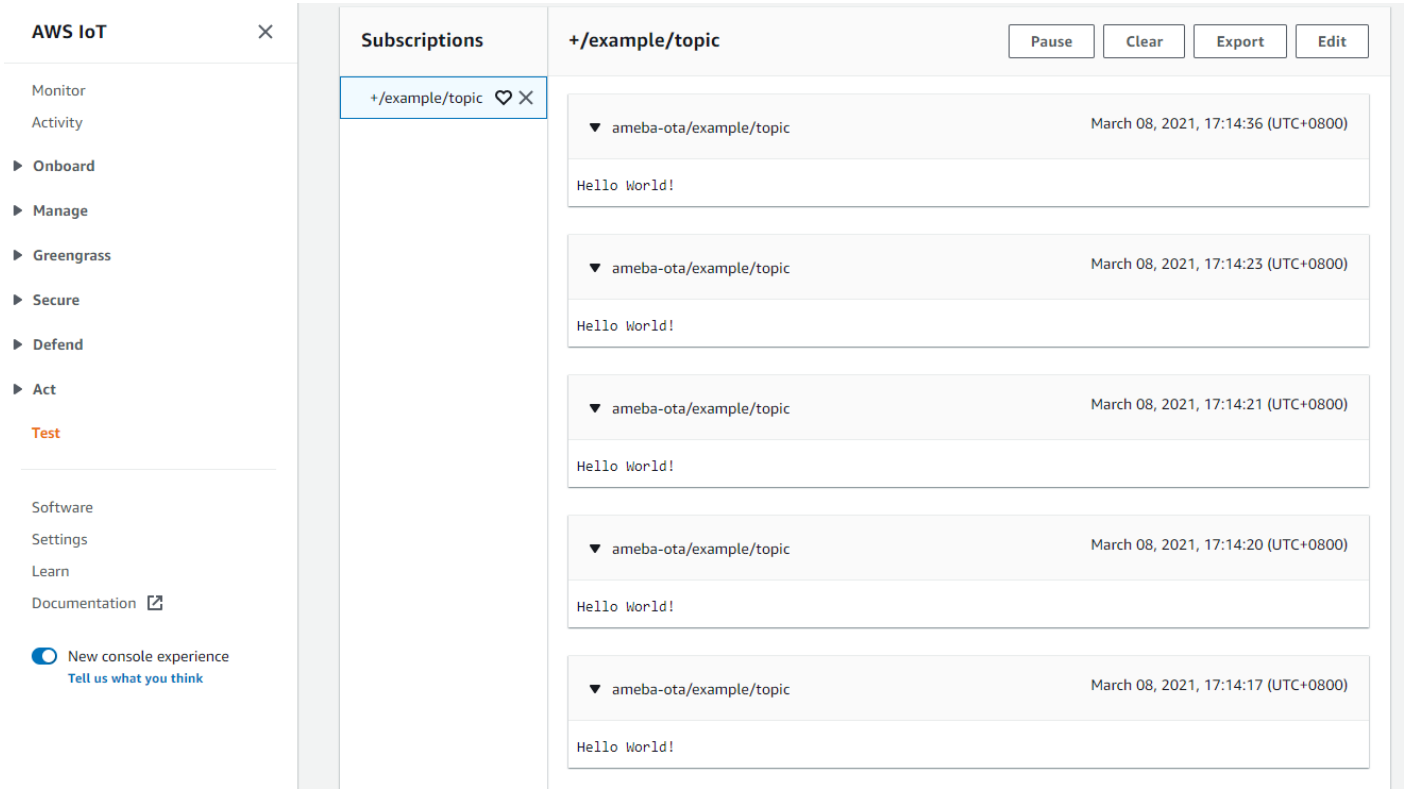

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5 Troubleshooting

If these steps don't work, look at the device log in the serial terminal. You should see some text that indicates the source of the problem.

For general troubleshooting information about Getting Started with FreeRTOS, see Troubleshooting getting started.

5.1 ERROR: Invalid Key

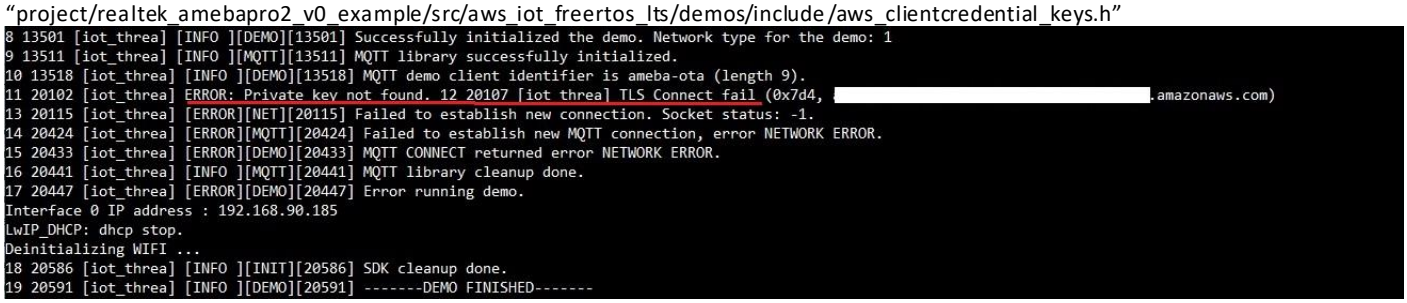
Please check **WIFI_SSID** and **WIFI_PASSWORD** in in "project/realtek_amebapro2_v0_example/src/aws_iot_freertos_lts/demos/include /aws_clientcredential.h"

5.2 Failed to establish new MQTT connection

Please check **clientcredentialMQTT_BROKER_ENDPOINT** in "project/realtek_amebapro2_v0_example/src/aws_iot_freertos_lts/demos/include/aws_clientcredential.h"

5.3 TLS_Connect fail

Please check **keyCLIENT_CERTIFICATE_PEM** and **keyCLIENT_PRIVATE_KEY_PEM** in "project/realtek_amebapro2_v0_example/src/aws_iot_freertos_lts/demos/include/aws_clientcredential_keys.h"



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