R01QS0046EJ0101

Getting Started with the Renesas GR-MANGO

Required Resources
To build and run the GR-MANGO example, you will need following resources:

Development tools & software

- e^{2}studio IDE 2021-04 (e^{2}studio download)
- GNU ARM Embedded 6-2016q2-update (can be installed during installing e^{2}studio 2021-04)

Hardware

- Renesas GR-MANGO, (https://www.renesas.com/products/gadget-renesas/boards/gr-mango)
- PC running Windows 10; the Tera Term console, or similar application; and an installed web browser (Google Chrome, Internet Explorer, Microsoft Edge, or Mozilla Firefox).
- Ethernet LAN internet access

Before you begin, see Prerequisites.

If you do not have an GR-MANGO, you can order one from some distributors.

Setting Up Your Environment

FreeRTOS for the GR-MANGO uses e^{2}studio IDE and GNU ARM Embedded compiler. Before you begin, install the IDE and compiler to your machine:

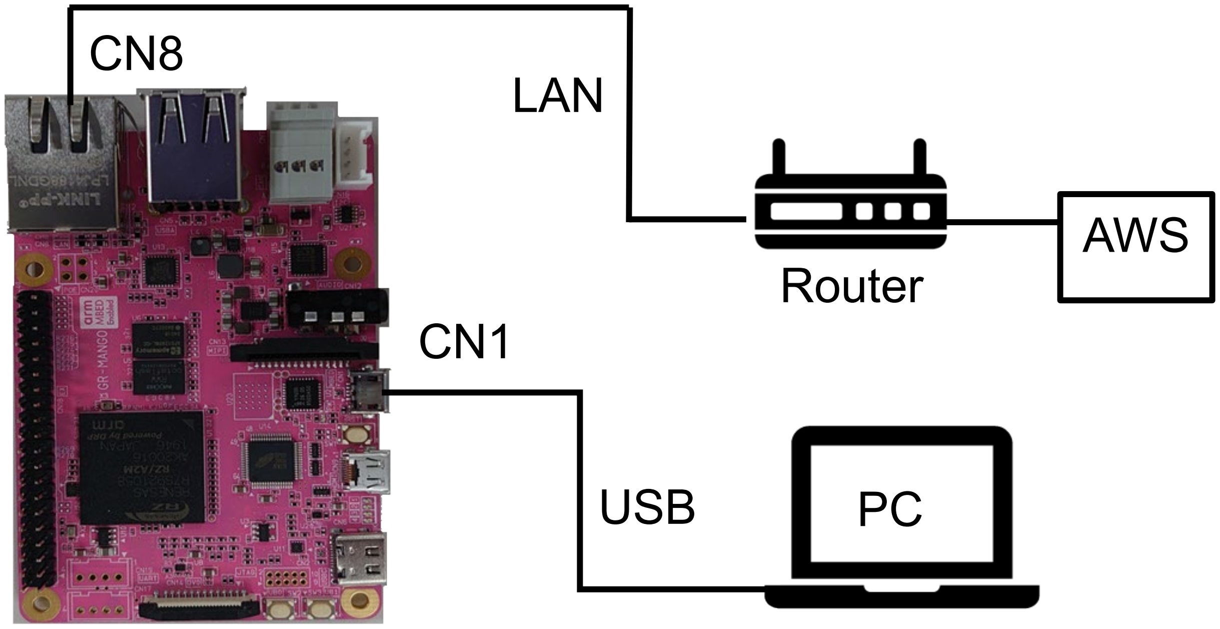
To install e^{2}studio:

1. Browse to e^{2}studio and choose **Download Software. Make sure to use** e^{2}studio version 7.8.0 or later.
2. Unzip and run the installer. Follow the prompts for the section 2.1 and 2.2 of the e^{2}studio Getting Started Guide.

In this document, **Wired Ethernet** and **SX-SDMAC** are indicated to the part needed different settings.

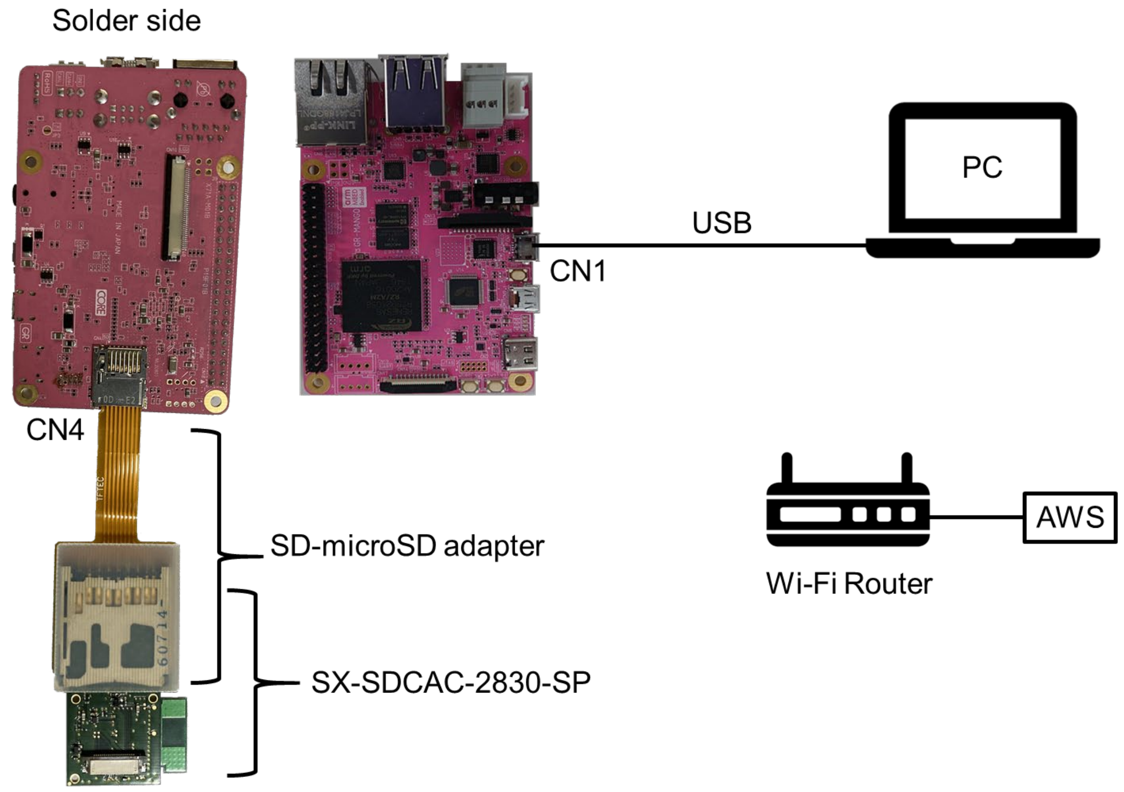
Connecting a Debugger

Wired Ethernet



1. Connect USB cable form CN1 to a spare USB port on your PC.
2. Connect LAN cable from CN8 to a router can access AWS.

SX-SDMAC



1. Connect USB cable form CN1 to a spare USB port on your PC.
2. Insert SX-SDCAC to CN4.

Download and Build FreeRTOS

After your environment is set up, you can download ‘Renesas GR-MANGO Application Example' and run the demo code.

Download FreeRTOS

1. Browse to the GitHub Page and download the code.
2. Unzip the downloaded file to a folder and make a note of the folder path. In this tutorial, this folder is referred to as `BASE_FOLDER`.

Note: The e^{2}studio doesn’t support long path names. To accommodate the files in the FreeRTOS projects, make sure the path to the directory is less than 260 characters and does not contain spaces or special characters.

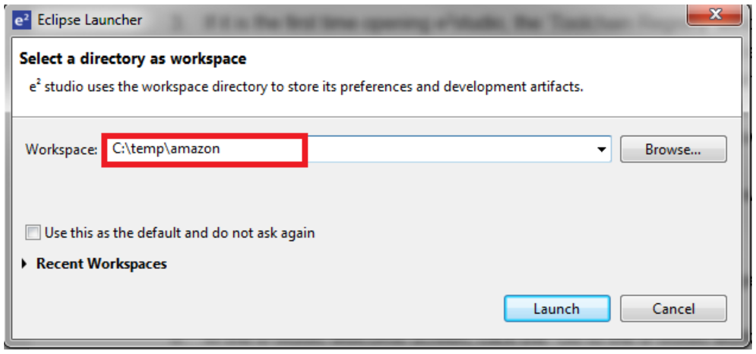
Import the FreeRTOS Demo Code into Your IDE

To import the FreeRTOS demo code into e^{2}studio IDE

1. e^{2}studio integrates various tools such as compiler, an assembler, debugger and an editor into a common graphical user interface. Start e^{2}studio:

   ```
   Windows™ 10: Start Menu>All Apps> Renesas Electronics e2studio>e2studio
   ```

2. In the ‘Select a workspace’ folder that appears, browse to the folder “…`BASE_FOLDER`\amazon”. Click ‘OK’ to continue.



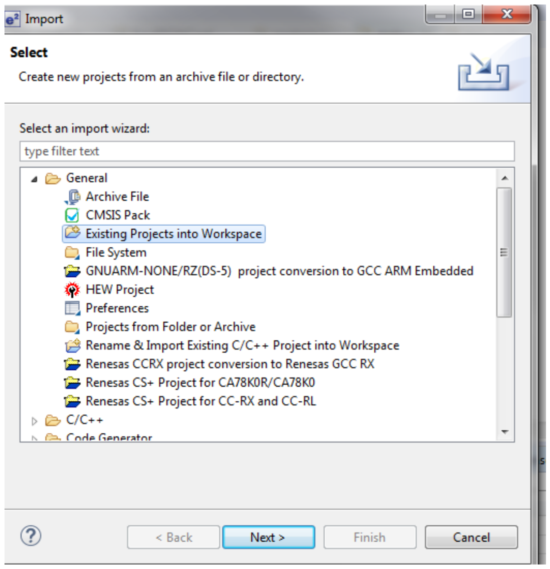
Eclipse Launcher

Select a directory as workspace

e² studio uses the workspace directory to store its preferences and development artifacts.

Workspace: C:\temp\amazon

3. If it is the first time opening e^{2}studio, the ‘Toolchain Registry’ window will open. In the ‘Toolchain Registry’ dialog select GCC ARM Embedded and ensure that ‘6.3.1.20170620’ is selected. Click ‘Register’. A dialog will appear "Selected Toolchains were successfully integrated with e^{2}studio ". Click ‘OK’.
4. In the ‘Code Generator Registration’ dialog click ‘OK’. This window opens up first time only after installation.
5. A ‘Code Generator COM component register’ dialog will pop-up with the text “Please restart e^{2}studio to use Code Generator”. Click ‘OK’.
6. In the ‘Restart e^{2}studio dialog, click ‘OK’.
7. Once e^{2}studio is restarted, then ‘Select a workspace’ window appears again with the folder path selected in step 2. Click ‘OK’.
8. In the e^{2}studio welcome screen, click ‘Go to the e^{2}studio workbench’ arrow icon, on the far right.
9. Right click in the Project Explorer window, and select ‘Import’.
10. In the import wizard, select General > Existing Projects into Workspace, and click ‘Next’.


Import
Select
Create new projects from an archive file or directory.
Select an import wizard:
type filter text
General
Archive File
CMSIS Pack
Existing Projects into Workspace
File System
GNUARM-NONE/RZ(DS-5) project conversion to GCC ARM Embedded
HEW Project
Preferences
Projects from Folder or Archive
Rename & Import Existing C/C++ Project into Workspace
Renesas CCRX project conversion to Renesas GCC RX
Renesas CS+ Project for CA78K0R/CA78K0
Renesas CS+ Project for CC-RX and CC-RL
C/C++
Code Generator
< Back
Next >
Finish
Cancel

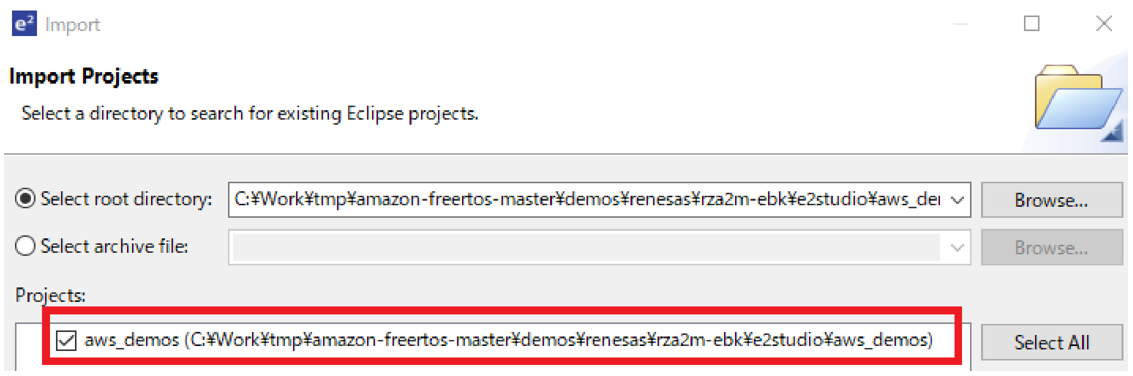
11. Click the ‘Browse’ button, and locate the following directory

    Wired Ethernet

    ‘*<BASE_FOLDER>*`\projects\renesas\rza2m-gr-mango\e2studio\aws_demos`’.

    SX-SDMAC

    ‘*<BASE_FOLDER>*`\projects\renesas\rza2m-gr-mango-sdio-sx-sdmac\e2studio\aws_demos`’.



Import

Import Projects

Select a directory to search for existing Eclipse projects.

Select root directory: C:¥Work¥tmp¥amazon-freertos-master¥demos¥renesas¥rza2m-ebk¥e2studio¥aws_de

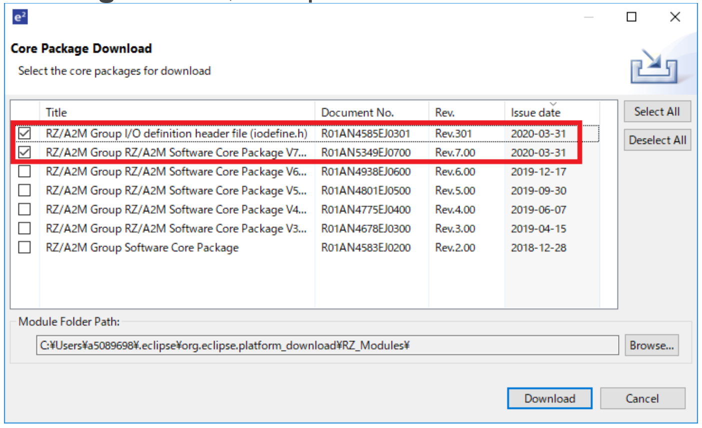
Select archive file:

Projects:

☑ aws_demos (C:¥Work¥tmp¥amazon-freertos-master¥demos¥renesas¥rza2m-ebk¥e2studio¥aws_demos)

12. Click “Finish”.

13. SX-SDMAC requires extra settings below. Steps a. to i. are required only once:
    a. Download RZ/A2M SDIO Wi-Fi Package.
    b. Add SILEX SX-SDMAC driver component to your PC by following the section 4 of the release note of the package.
    c. Doble click `aws_demos.scfg`.
    d. Select **Components** tag.
    e. Press icon.
    f. Software Component Selection dialog will be appaired. Click **Download more software components**.
    g. Region Setting dialog will be appaired. Select your region and click OK.
    h. Select **RZ/A2M I/O definition header file** and **RZ/A2M Software Core Package V8.10**, and press download.



Core Package Download

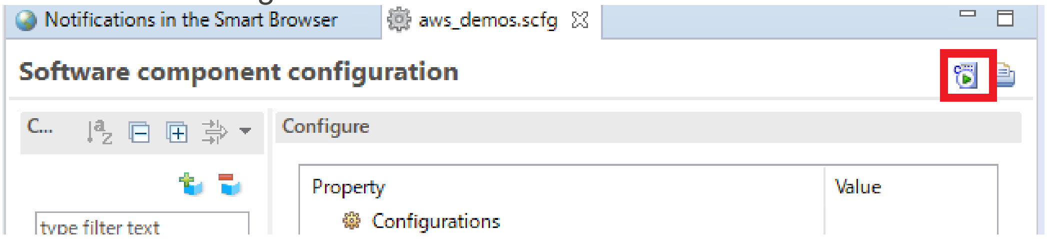
Select the core packages for download

	Title	Document No.	Rev.	Issue date
✓	RZ/A2M Group I/O definition header file (iodefine.h)	R01AN4585EJ0301	Rev.301	2020-03-31
✓	RZ/A2M Group RZ/A2M Software Core Package V7...	R01AN5349EJ0700	Rev.7.00	2020-03-31
☐	RZ/A2M Group RZ/A2M Software Core Package V6...	R01AN4938EJ0600	Rev.6.00	2019-12-17
☐	RZ/A2M Group RZ/A2M Software Core Package V5...	R01AN4801EJ0500	Rev.5.00	2019-09-30
☐	RZ/A2M Group RZ/A2M Software Core Package V4...	R01AN4775EJ0400	Rev.4.00	2019-06-07
☐	RZ/A2M Group RZ/A2M Software Core Package V3...	R01AN4678EJ0300	Rev.3.00	2019-04-15
☐	RZ/A2M Group Software Core Package	R01AN4583EJ0200	Rev.2.00	2018-12-28

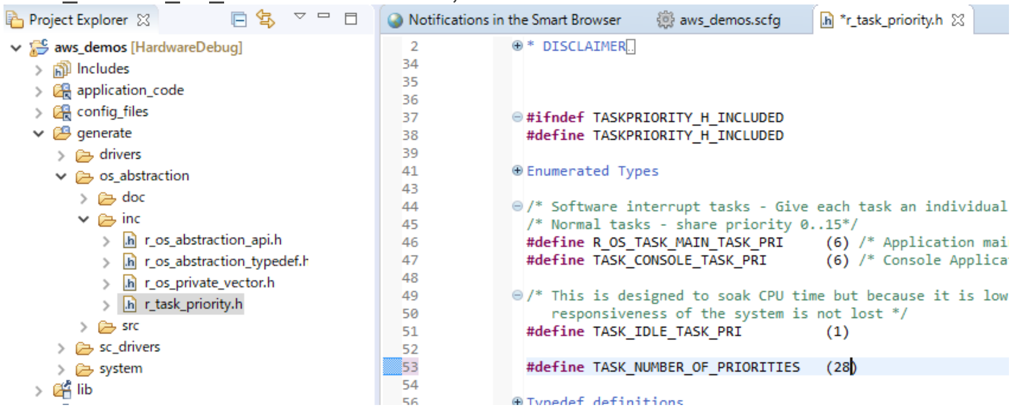
Module Folder Path:

C:¥Users¥a5089698¥.eclipse¥org.eclipse.platform_download¥RZ_Modules¥

    i. Close Software Component Selection dialog by pressing Cancel button.
    j. Press icon to generate drivers.

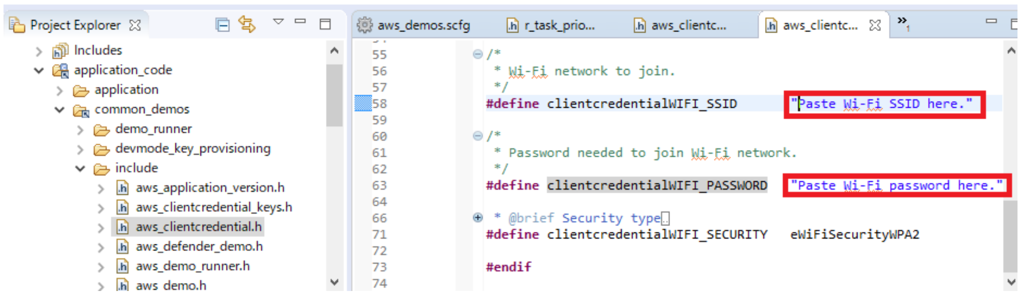


k. Open `generate\os_abstraction\inc\r_task_priority.h`, modify the value of `TASK_NUMBER_OF_PRIORITIES` to 28, and save the file.



```
* DISCLAIMER


#ifndef TASKPRIORITY_H_INCLUDED
#define TASKPRIORITY_H_INCLUDED

Enumerated Types

/* Software interrupt tasks - Give each task an individual
/* Normal tasks - share priority 0..15*/
#define R_OS_TASK_MAIN_TASK_PRI     (6) /* Application mai
#define TASK_CONSOLE_TASK_PRI       (6) /* Console Applica

/* This is designed to soak CPU time but because it is low
   responsiveness of the system is not lost */
#define TASK_IDLE_TASK_PRI          (1)

#define TASK_NUMBER_OF_PRIORITIES   (28)

Typedef definitions
```

l. Open `application_code\common_demos\include\aws_clientcredential.h`, modify the value of clientcredentialWIFI_SSID and clientcredentialWIFI_PASSWORD, and save the file.



```
/*
 * Wi-Fi network to join.
 */
#define clientcredentialWIFI_SSID       "Paste Wi-Fi SSID here."

/*
 * Password needed to join Wi-Fi network.
 */
#define clientcredentialWIFI_PASSWORD   "Paste Wi-Fi password here."

 * @brief Security type
#define clientcredentialWIFI_SECURITY    eWiFiSecurityWPA2

#endif
```

14. In the **Project** menu, choose **Project->Build All**. The project should build with no errors.

Configure Your Project

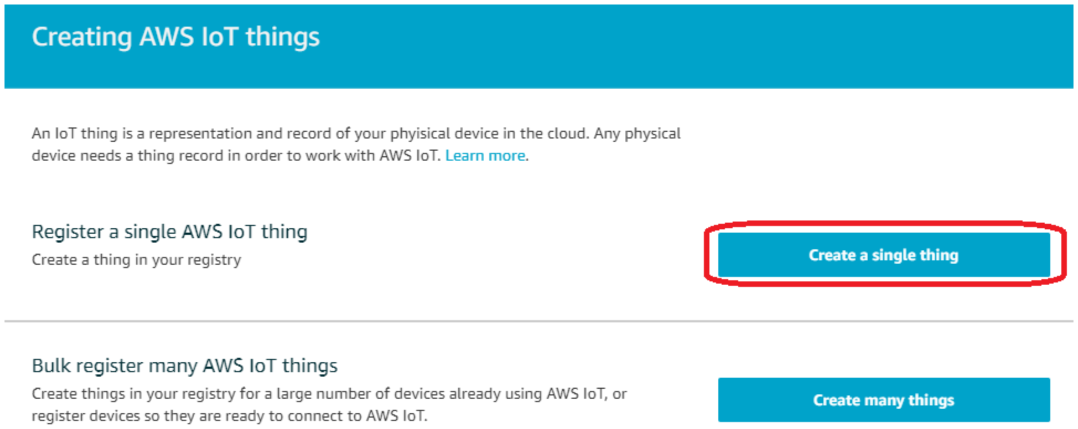
To configure your project, you need to know your AWS IoT endpoint and Thing name that represents your board.

Configure AWS IoT endpoint

1. Login to aws account and Click on IoT Core services.
2. In the left navigation pane, choose **Settings**.
3. Copy your AWS IoT endpoint from the **Endpoint** text box. It should look like `<1234567890123>.iot.<us-east-1>.amazonaws.com`.
4. Open `aws_demos/application_code/common_demos/include/aws_clientcredential.h` and set `clientcredentialMQTT_BROKER_ENDPOINT` to your AWS IoT endpoint.

   ```
   static const char clientcredentialMQTT_BROKER_ENDPOINT[] = "Paste AWS IoT Broker endpoint here.";
   ```

5. In the left navigation pane, Click on Manage-> Things, and then Click on 'Create" to create a new Thing.
6. In the next window, click on "Create a single thing".



Creating AWS IoT things

An IoT thing is a representation and record of your phyisical device in the cloud. Any physical device needs a thing record in order to work with AWS IoT. Learn more.

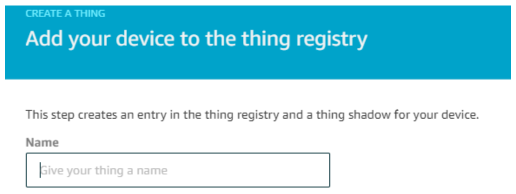
Register a single AWS IoT thing
Create a thing in your registry

Create a single thing

Bulk register many AWS IoT things
Create things in your registry for a large number of devices already using AWS IoT, or register devices so they are ready to connect to AWS IoT.

Create many things

7. Enter thing Name for your IoT board.



CREATE A THING
Add your device to the thing registry

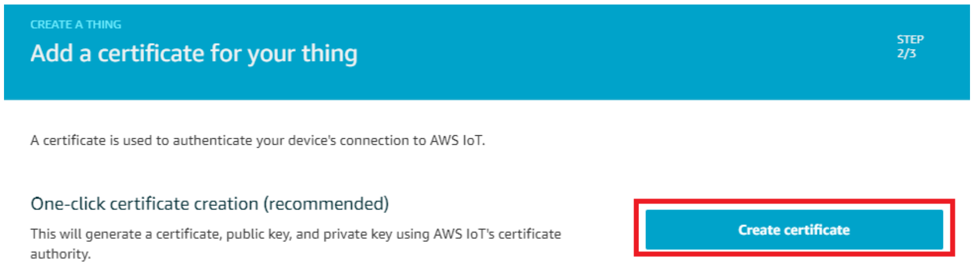
This step creates an entry in the thing registry and a thing shadow for your device.

Name
Give your thing a name

8. Open `aws_demos\application_code\common_demos\include\aws_clientcredential.h`. Specify AWS IoT thing for your board in the following `#define` constants from **Thing** pane in AWS IoT console.

```
#define clientcredentialIOT_THING_NAME "Paste AWS IoT Thing name here."
```

9. Click next. In next window click on “Create Certificate”


CREATE A THING

Add a certificate for your thing

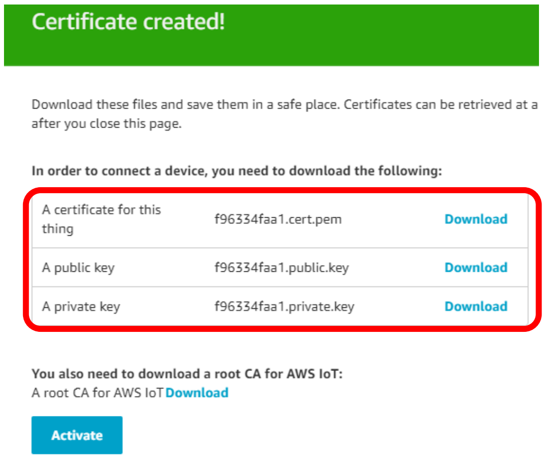
STEP 2/3

A certificate is used to authenticate your device's connection to AWS IoT.

One-click certificate creation (recommended)

This will generate a certificate, public key, and private key using AWS IoT's certificate authority.

10. Download the certificate.


Certificate created!

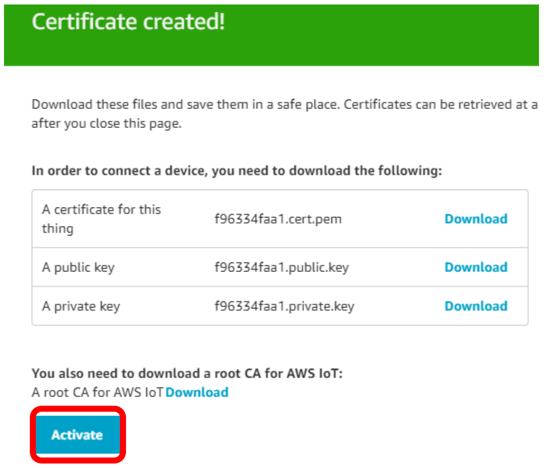
Download these files and save them in a safe place. Certificates can be retrieved at a after you close this page.

In order to connect a device, you need to download the following:

A certificate for this thing	f96334faa1.cert.pem	Download
A public key	f96334faa1.public.key	Download
A private key	f96334faa1.private.key	Download

You also need to download a root CA for AWS IoT:
A root CA for AWS IoT Download

11. Activate the certificate.


Certificate created!

Download these files and save them in a safe place. Certificates can be retrieved at a after you close this page.

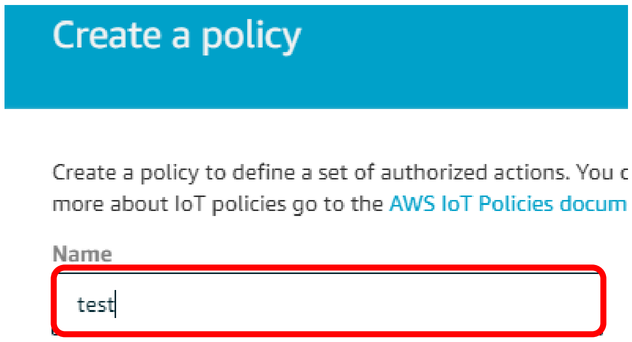
In order to connect a device, you need to download the following:

A certificate for this thing	f96334faa1.cert.pem	Download
A public key	f96334faa1.public.key	Download
A private key	f96334faa1.private.key	Download

You also need to download a root CA for AWS IoT:
A root CA for AWS IoT Download

Create AWS IoT policy

1. In the left navigation pane, Click on **Secure**-> **Policies**, and then Click on "**Create a policy**" or "**Create**" to create a new policy.
2. Enter Policy name for your test.



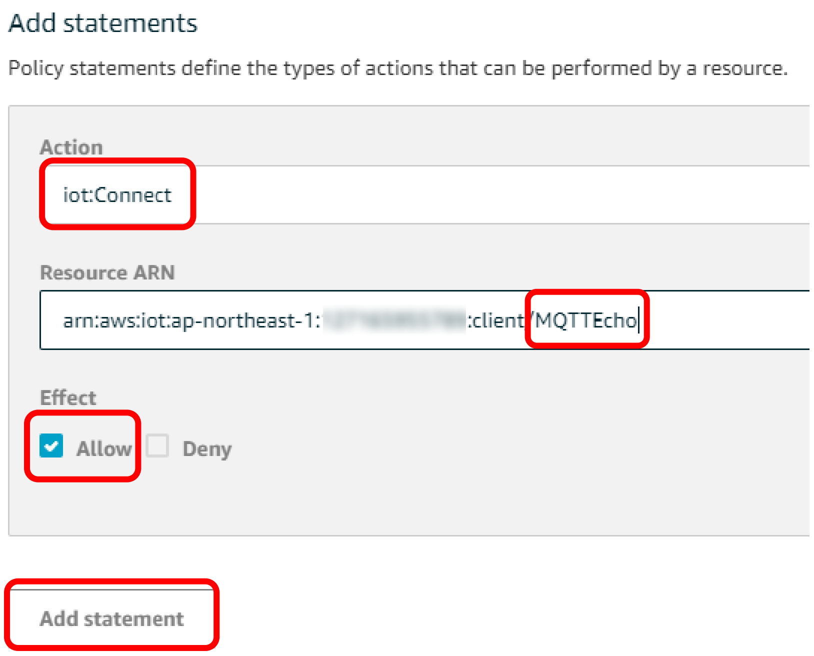
Create a policy

Create a policy to define a set of authorized actions. You c
more about IoT policies go to the AWS IoT Policies docum

Name

test

3. Enter **iot:Connect** in Action box, replace replaceWithAClientId with **MQTTEcho** in Resource ARN box, check **Allow** in Effect, and click on **Add statement**.



Add statements

Policy statements define the types of actions that can be performed by a resource.

Action

iot:Connect

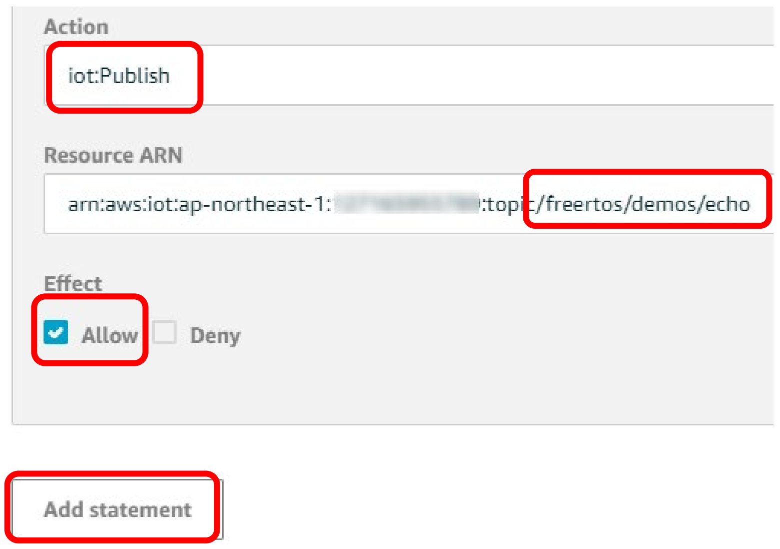
Resource ARN

arn:aws:iot:ap-northeast-1:[redacted]:client/MQTTEcho

Effect

[✓ Allow] Deny

4. Enter **iot:Publish** in Action box, replace replaceWithATopic with **freertos/demos/echo** in Resource ARN box, check **Allow** in Effect, and click on **Add statement**.



Action

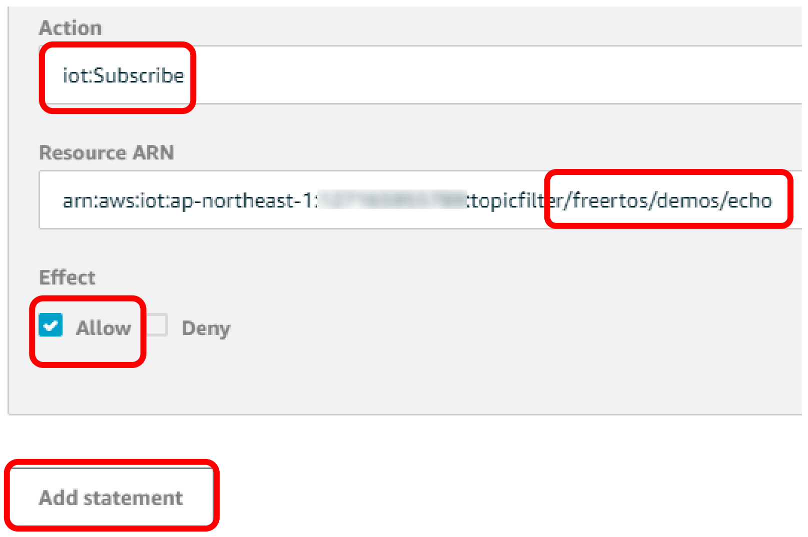
iot:Publish

Resource ARN

arn:aws:iot:ap-northeast-1:[redacted]:topic/freertos/demos/echo

Effect

5. Enter **iot:Subscribe** in Action box, replace replaceWithATopicFilter with **freertos/demos/echo** in Resource ARN box, check **Allow** in Effect, and click on **Add statement**.



Action

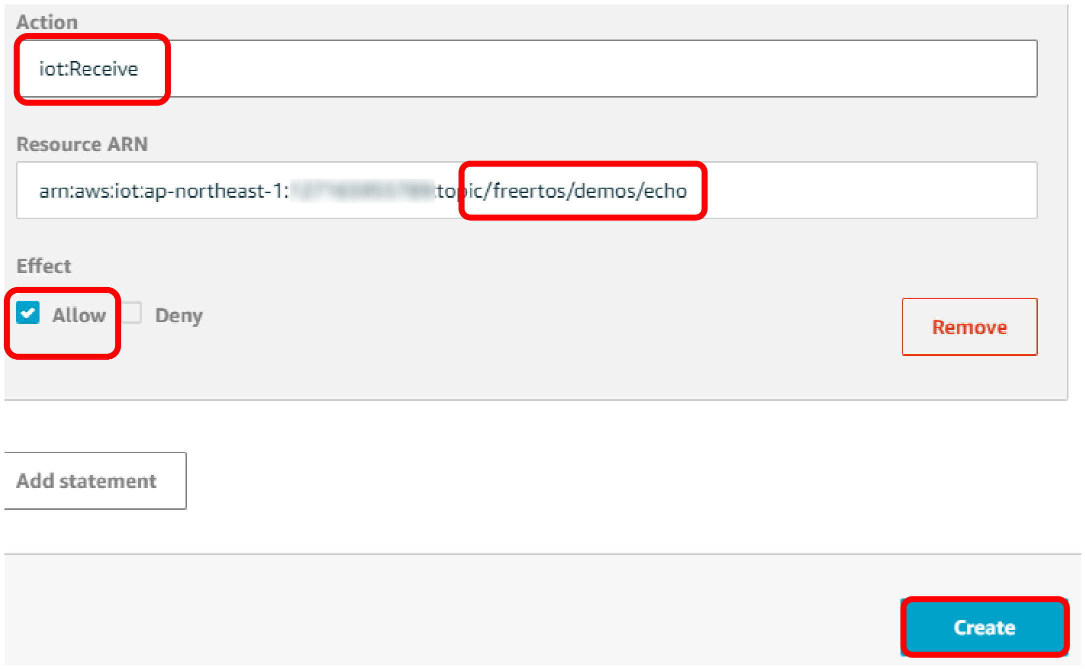
iot:Subscribe

Resource ARN

arn:aws:iot:ap-northeast-1:[redacted]:topicfilter/freertos/demos/echo

Effect

6. Enter **iot:Receive** in Action box, replace replaceWithATopic with **freertos/demos/echo** in Resource ARN box, check **Allow** in Effect, and click on **Create**.

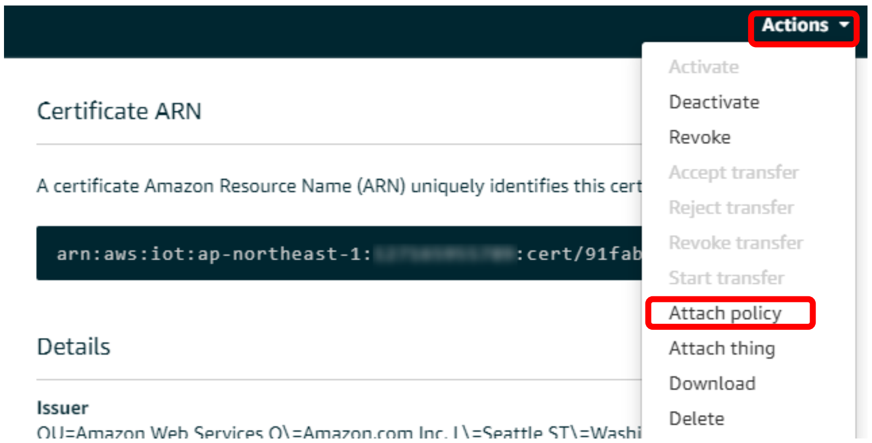


Action: iot:Receive

Resource ARN: arn:aws:iot:ap-northeast-1:[redacted]topic/freertos/demos/echo

Effect: [✓ Allow] Deny

7. In the left navigation pane, Click on **Secure**-> **Certificates**, and then Click on certificate created in the sequence 10 of **Configure AWS IoT endpoint** section above.
8. Click on Actions and select **Attach policy**.



Certificate ARN

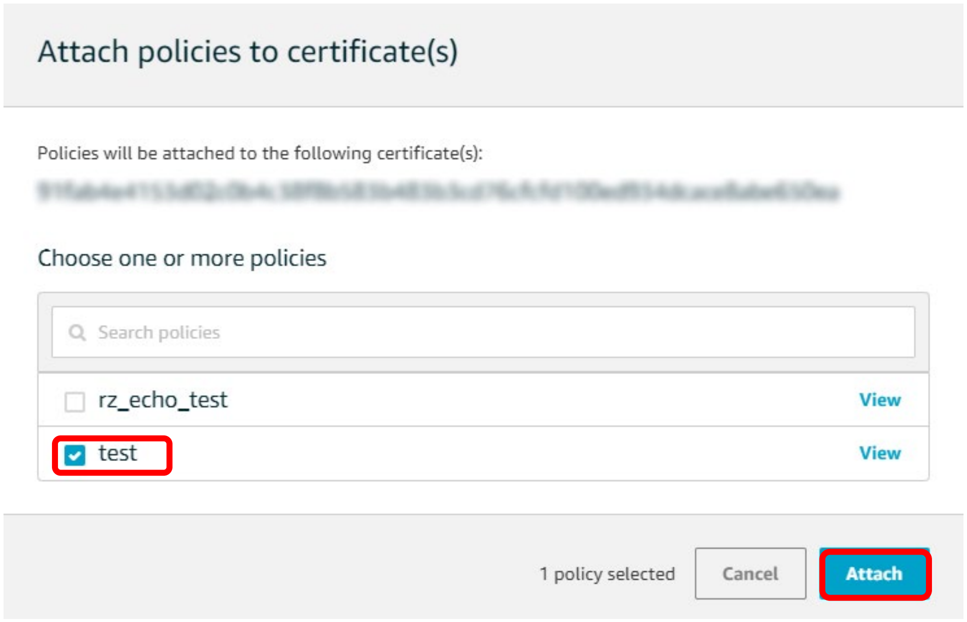
A certificate Amazon Resource Name (ARN) uniquely identifies this cert

```
arn:aws:iot:ap-northeast-1:[redacted]:cert/91fab
```

Details

Issuer
OU=Amazon Web Services O\=Amazon.com Inc. L\=Seattle ST\=Washi

9. Check the policy you created, then click on **Attach**.



Attach policies to certificate(s)

Policies will be attached to the following certificate(s):

[redacted]

Choose one or more policies

☐	rz_echo_test	View
✓	test	View

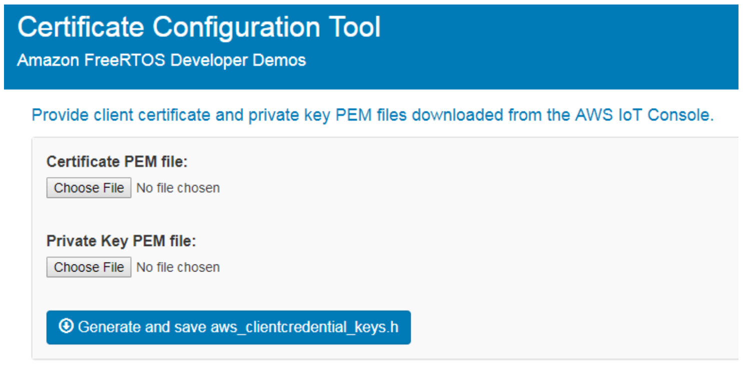
1 policy selected

Configure certificate and private key

The certificate and private key must be hard-coded into the FreeRTOS demo code. This is for demo purposes only. Production level applications should store these files in a secure location. FreeRTOS is a C language project, and the certificate and private key must be specially formatted to be added to the project.

To format your certificate and private key

1. In a browser window, open certificate configuration tool from project `<BASE_FOLDER>\tools\certificate_configuration\CertificateConfigurator.html`.



Certificate Configuration Tool
Amazon FreeRTOS Developer Demos

Provide client certificate and private key PEM files downloaded from the AWS IoT Console.

Certificate PEM file:
Choose File No file chosen

Private Key PEM file:
Choose File No file chosen

Generate and save aws_clientcredential_keys.h

2. Under **Certificate PEM file**, choose `certificate.pem.crt` you downloaded from the AWS IoT console in previous step.
3. Under **Private Key PEM file**, choose `private.pem.key` you downloaded from the AWS IoT console in previous step.
4. Choose **Generate and save aws_clientcredential_keys.h**, and then save the file in`<BASE_FOLDER>\demos\common\include`. This overwrites the file aws_clientcredential_keys.h in the directory.

Configure MAC address

Wired Ethernet

MAC address is NOT stored in the storage memory on the board. Therefore, you need to set MAC address to your project.

1. Get your MAC address.

   GR-MANGO does not include MAC address. Please get MAC address.

2. Set MAC address in your code.

   Edit **configMAC_ADDR**N (N=0, 1, ... ,5) macros defined in **FreeRTOSConfig.h** to the MAC address printed on CN9. Ethernet driver is configured to use CN9.

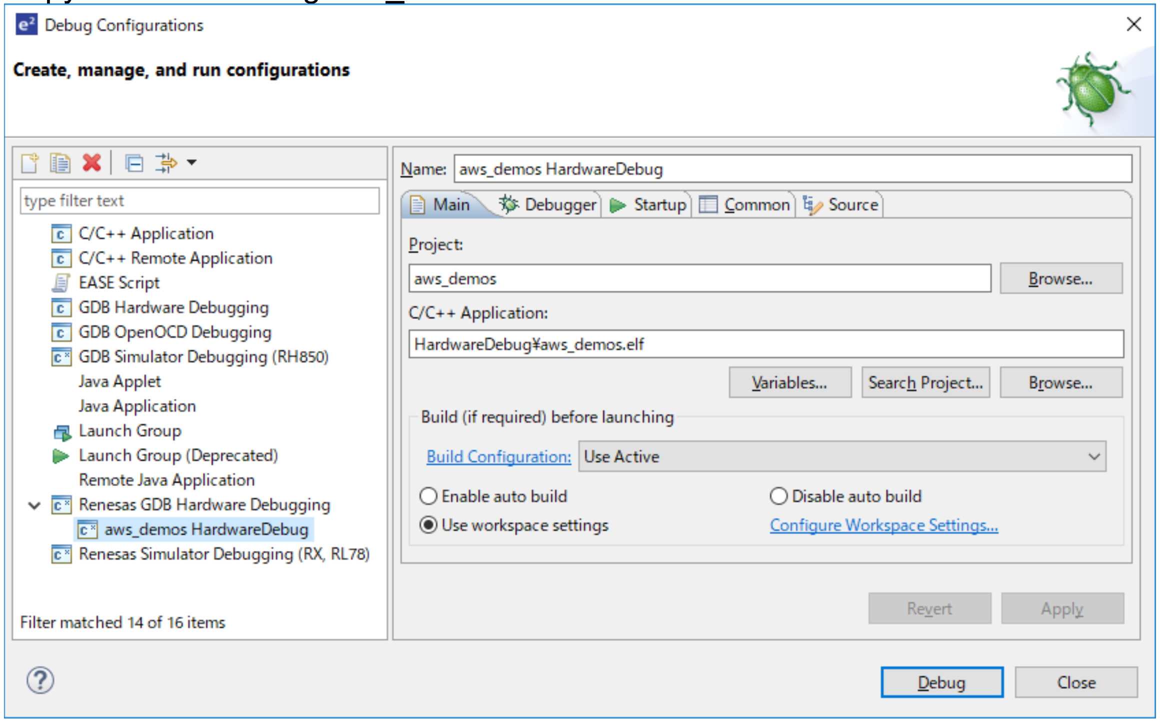
   In the case your MAC address is 01:23:45:67:89:AB, set macros as follows:

```
#define configMAC_ADDR0                         0x01
#define configMAC_ADDR1                         0x23
#define configMAC_ADDR2                         0x45
#define configMAC_ADDR3                         0x67
#define configMAC_ADDR4                         0x89
#define configMAC_ADDR5                         0xAB
```

Run the FreeRTOS Demo

To run the FreeRTOS demos on the GR-MANGO:

1. Sign in to the AWS IoT console.
2. In the left navigation pane, choose **Test** to open the MQTT client.
3. In the **Subscription topic** text box, type '**freertos/demos/echo**', and then choose **Subscribe to topic**.
4. Rebuild the project, "**Project->Build All**".
5. Connect USB cable from CN1. MBED drive will be mounted.
6. Copy HardwareDebug\aws_demo.bin to mbed drive.


Debug Configurations

Create, manage, and run configurations

type filter text

- C/C++ Application
- C/C++ Remote Application
- EASE Script
- GDB Hardware Debugging
- GDB OpenOCD Debugging
- GDB Simulator Debugging (RH850)
- Java Applet
- Java Application
- Launch Group
- Launch Group (Deprecated)
- Remote Java Application
- Renesas GDB Hardware Debugging
  - aws_demos HardwareDebug
- Renesas Simulator Debugging (RX, RL78)

Filter matched 14 of 16 items

Name: aws_demos HardwareDebug

Main | Debugger | Startup | Common | Source

Project:
aws_demos [Browse...]

C/C++ Application:
HardwareDebug¥aws_demos.elf

[Variables...] [Search Project...] [Browse...]

Build (if required) before launching

Build Configuration: Use Active

○ Enable auto build ○ Disable auto build
● Use workspace settings Configure Workspace Settings...

[Revert] [Apply]

[Debug] [Close]

7. **SX-SDMAC** Remove SX-SDMAC module and re-insert it to the board.
   This procedure is specific to GR-MANGO which can’t stop power supply to SDIO.
8. Press RST button on the board.

In the AWS IOT console MQTT client, you should see the MQTT messages sent by your device.

Note:

Refer to the following website for debugging:
https://os.mbed.com/teams/Renesas/wiki/How-to-debug-with-e2-studio

Note:

Please visit the following GitHub repository to get the latest projects (prototype), but not yet certified for other Renesas devices, compilers, and target boards.

https://github.com/renesas-rz/amazon-freertos

Troubleshooting

If no messages appear in the AWS IoT console, try the following:

1. Check that your network credentials are valid.
2. Verify the switch settings on your board.

Test OTA demonstration

Before testing OTA demonstration, it is recommended to test FreeRTOS Demo.

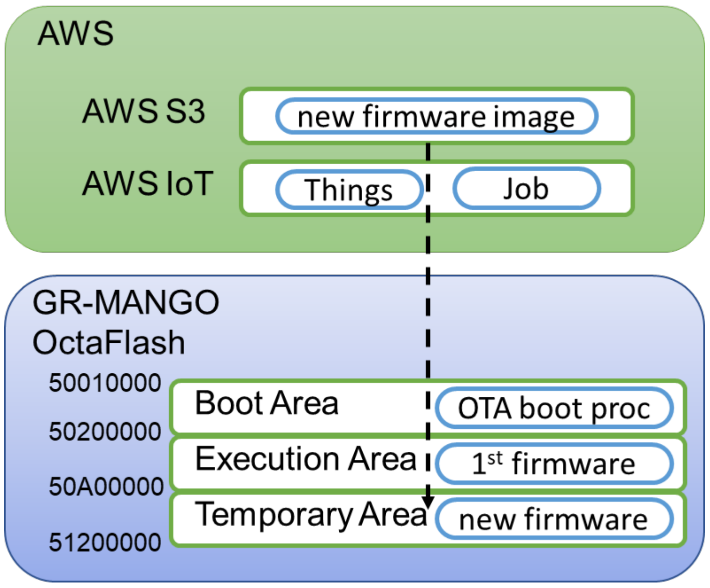
To realize OTA function, Octa Flash on the GR-MANGO Board is treated to split to 3 area stated below:

Boot Area – OTA boot proc is stored. OTA boot proc decides the firmware to execute.

Execution Area – Firmware to execute.

Temporary Area – Downloaded new firmware. If firmware exists in this area, OTA boot proc checks the firmware and copy it to Execution Area.

New firmware image is stored in AWS S3 Services, and is downloaded via AWS IoT Services.



In this section following steps are described:

1. Install needed software into PC.
2. Prepare settings by AWS console.
3. Generate the certificate used in OTA update.
4. Create firmware.
5. Create OTA job.
6. Execute OTA.

Install needed software into PC

Following software are needed to test OTA demonstration.

- OpenSSL
  - Windows Download site
    Light version is OK.
  - Add path to `openssl.exe`.

- Python3.7
  - Download site
  - ECDSA is needed to install by following command:
    ```
    $ pip install ecdsa
    ```

      -

Prepare settings by AWS console

This section shows how to create S3 bucket to store the new firmware image, and create a role and policies required for OTA update.

This section is based on the following document:

https://docs.aws.amazon.com/freertos/latest/userguide/ota-prereqs.html

Create S3 bucket to store the new firmware image by following steps:

1. Launch web browser, and sign in to AWS console.
2. Go to S3 console by inputting **S3** in **Find Services** in **AWS Management Console**.
3. Press **Create bucket** button.
4. Input **Bucket name** (in this document *rz-ota* is named as an example), and press **Create bucket** button.
5. Click created bucket.
6. Select **properties** tag.
7. Enable **Versioning**.

Create a role and policies required for OTA update by following steps:

8. Go to IAM console by pressing **Services** at the top of the screen, and inputting **IAM**.
9. Click Roles in the navigation pain at the left of the screen.
10. Press **Create role** button.
11. Choose **IoT** in the service list, select **IoT** in the use case list, and press **Next:Permissions** button.
12. Confirm 3 policies are displayed, and press **Next:Tags** button.
13. Input any keys if needed, and press **Next:Review** button.
14. Input Role name (in this document *role_rz-ota* is named as an example), and press **Create role** button.
15. Click created role in the role list.
16. Press **Attach policies** button.
17. Check the box at the left of **AmazonFreeRTOSOTAUpdate**, and press **Attach policy**.

18. Press **Add inline policy** at the right of Attach policies button.
19. Select **JSON** tab, copy following text to the text box, and press **Review policy** button:

```
{
    "Version": "2012-10-17",
    "Statement": [
        {
            "Effect": "Allow",
            "Action": [
                "iam:GetRole",
                "iam:PassRole"
            ],
            "Resource": "arn:aws:iam::nnnnnnnnnnnn:role/role_rz-ota"
        }
    ]
}
```

Replace ***nnnnnnnnnnnn*** to your AWS account ID composed of 12 numbers.
Replace ***role_rz-ota*** to the name you named at step 14.

20. Input Name (in this document *policy_rz-ota* is named as an example), and press **Create policy** button.
21. Press **Add inline policy** at the right of Attach policies button.
22. Select **JSON** tab, copy following text to the text box, and press **Review policy** button:

```
{
    "Version": "2012-10-17",
    "Statement": [
        {
            "Effect": "Allow",
            "Action": [
                "s3:GetObjectVersion",
                "s3:GetObject",
                "s3:PutObject"
            ],
            "Resource": [
                "arn:aws:s3:::rz-ota/*"
            ]
        }
    ]
}
```

Replace ***rz-ota*** to the name you named at step 4.

23. Input Name (in this document *policy_rz-ota-S3* is named as an example), and press **Create policy** button.

Modify policy

24. Go to **IoT Core** console by pressing **Services** at the top of the screen, and inputting **IoT Core**.
25. In the left navigation pane, Click on **Secure**-> **Policies**, and then Click on the policy you created.
26. Click Edit policy document. And overwrite by following text:
    Then press **Save as new version**.

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

Generate the certificate used in OTA update

This section shows how to generate certificate required for OTA update using OpenSSL.

Launch command prompt, go to your work folder, and enter following commands:

```
$ openssl ecparam genkey name secp256r1 out ca.key
$ openssl req x509 sha256 new nodes key ca.key days 3650 out ca.crt
        Input Country Name, State or Province Name, and other required information.
$ openssl ecparam genkey name secp256r1 out secp256r1.keypair
$ openssl req new sha256 key secp256r1.keypair > secp256r1.csr
        Input Country Name, State or Province Name, and other required information.
$ openssl x509 req sha256 days 3650 in secp256r1.csr CA ca.crt CAkey ca.key CAcreateserial out secp256r1.crt
$ openssl ec in secp256r1.keypair outform PEM out secp256r1.privatekey
$ openssl ec in secp256r1.keypair outform PEM pubout out secp256r1.publickey
```

Create firmware

This section shows how to create ota_boot_proc, initial firmware, and new firmware.

Create ota_boot_proc by following steps:

1. Launch e^2 studio. If aws_demos project already exists, delete it. Import following 2 projects.

   Wired Ethernet

   - aws_demos (`<BASE_FOLDER>\projects\renesas\rza2m-gr-mango\e2studio\aws_demos`)
   - ota_boot_proc (`<BASE_FOLDER>\projects\renesas\rza2m-gr-mango\e2studio\ota_boot`)

   SX-SDMAC

   - aws_demos (`<BASE_FOLDER>\projects\renesas\rza2m-gr-mango-sdio-sx-sdmac\e2studio\aws_demos`)
   - ota_boot_proc (`<BASE_FOLDER>\projects\renesas\rza2m-gr-mango-sdio-sx-sdmac\e2studio\ota_boot`)
2. Open `secp256r1.publickey` generated at the last section by text editor.
3. Open `ota_boot_proc\src\key\code_signer_public_key.h`.
4. Copy public key described in `secp256r1.publickey` to `CODE_SIGNENR_PUBLIC_KEY_PEM` in `code_signer_public_key.h` like below:

```
#define CODE_SIGNENR_PUBLIC_KEY_PEM "-----BEGIN PUBLIC KEY-----"\
"ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz012345678901"\
"ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz012345=="\
"-----END PUBLIC KEY-----"
```

   Note that red character is needed to add.

5. Build **ota_boot_proc** project.

Create initial firmware by following steps:

6. Copy your AWS IoT endpoint from the Endpoint text box. It should look like `<1234567890123>.iot.<us-east-1>.amazonaws.com`.
7. Open `aws_demos/application_code/common_demos/include/aws_clientcredential.h` and set `clientcredentialMQTT_BROKER_ENDPOINT` to your AWS IoT endpoint.

```
static const char clientcredentialMQTT_BROKER_ENDPOINT[] = "Paste AWS IoT Broker endpoint
here.";
```

8. Open `aws_demos\application_code\common_demos\include\aws_clientcredential.h`. Specify AWS IoT thing for your board in the following `#define` constants from **Thing** pane in AWS IoT console.

```
#define clientcredentialIOT_THING_NAME "Paste AWS IoT Thing name here."
```

9. Format your certificate and private key following the way described in *To format your certificate and private key*.
10. Open `<BASE_FOLDER>\lib\third_party\mcu_vendor\renesas\rz_mcu_boards\core_package\generate\linker_script_gr_mango.ld` by a test editor.
11. Modify `ROM (rx):ORIGIN` to **0x50200300** from **0x50010000**, erase following section, and save the file, and close. 0x50010000 is the start address for the environment in which ota_boot_proc is not used, or for debugging. 0x50200300 is the start address for the environment using ota_boot_proc.

```
        .boot 0x50000000 :
        {
            KEEP(*(.boot_loader))
        } > BOOT_LOADER
```

12. Open `<BASE_FOLDER>\lib\third_party\mcu_vendor\renesas\rz_mcu_boards\core_package\generate\sc_drivers\r_octabus\inc\ r_octabus_drv_sc_cfg.h` by a test editor.
13. Modify the second value of `OCTABUS_SC_TABLE` to **OCTABUS_INIT_AT_LOADER** from **OCTABUS_INIT_AT_APP**, save the file, and close. ota_boot_proc initializes OctaBus. To avoid initialize OctaBus twice, this modification is needed.
14. Open `aws_demos/application_code/common_demos/include/aws_ota_codesigner_certificate.h` and copy the content of `secp256r1.crt` like below:

```
static const char signingcredentialSIGNING_CERTIFICATE_PEM[] = "-----BEGIN CERTIFICATE-----\n"
"ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz012345678901\n"
"ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz012345678901\n"
"-----END CERTIFICATE-----";
```

15. Open aws_demos/application_code/common_demos/include/demo_runner/aws_demo_runner.c. And modify the file to disable vStartMQTTEchoDemo() and enable vStartOTAUpdateDemoTask() like below:

```
    /* Demo declarations. */
    /* extern void vStartMQTTEchoDemo( void ); */
    extern void vStartOTAUpdateDemoTask( void );

    void DEMO_RUNNER_RunDemos( void )
    {
        /*vStartMQTTEchoDemo();*/
        vStartOTAUpdateDemoTask();
    }
```

16. SX-SDMAC requires extra settings described in step13 of *Import the FreeRTOS Demo Code into Your IDE*.
17. In the Project menu, choose Project->Build All. The project should build with no errors.
18. Confirm HardwareDebug\aws_demos.bin is generated.
19. Copy following 3 files to your work folder.
    a. HardwareDebug\aws_demos.bin
    b. *<BASE_FOLDER>*\lib\third_party\mcu_vendor\renesas\rz_mcu_boards\tools\initial-image-gen-gr-mango.py
    c. secp256r1.privatekey generated at the last section.
    d. ota_boot_proc\HardwareDebug\ota_boot_proc.bin
20. Launch command prompt and go to your work folder.
21. Open initial-image-gen-gr-mango.py by a text editor, and confirm filename:

```
    # Input Filename
    input_file              = 'aws_demos.bin'
    # boot Filename
    boot_file               = 'ota_boot_proc.bin'
    # Output Filename
    output_file             = 'userprog.bin'
    # Input Key
    input_key_file          = 'secp256r1.privatekey'
```

22. Enter following command to generate initial firmware named userprog.bin:

```
$ python initial-image-gen-gr-mango.py
```

Create new firmware by following steps:

23. Open `aws_demos/application_code/common_demos/include/aws_application_version.h` and modify the value of `APP_VERSION_BUILD` macro to 3 from 2.
24. In the Project menu, choose Project->Build All. The project should build with no errors.
25. Confirm **HardwareDebug\aws_demos.bin** is generated.
26. Copy following 3 files to your work folder.
    e. HardwareDebug\aws_demos.bin
    f. *<BASE_FOLDER>*\lib\third_party\mcu_vendor\renesas\rz_mcu_boards\tools\update-image-gen.py
    g. secp256r1.privatekey generated at the last section.
27. Launch command prompt and go to your work folder.
28. Enter following command to generate new firmware named `userprog.rsu`:

```
$ python update-image-gen.py
```

Note that the name of the generated file is the same as initial firmware and the old file will be overwritten.

You can change the file name and sequence number by modifying update-image-gen.py.

```
# Input Filename
input_file                = 'aws_demos.bin'
# Output Filename
output_file               = 'userprog.rsu'
# Input Key
input_key_file            = 'secp256r1.privatekey'
# Firmware version (sequence number)
sequence_number           = 1
```

Create OTA job

In this section, upload the new firmware, and create AWS IoT job by AWS console.

Upload the new firmware to Amazon S3 by following steps:

1. Launch web browser, and sign in to AWS console.
2. Go to Amazon **S3** console.
3. Click **buckets** at the left of the screen.
4. Click the created bucket (*rz-ota* is named in this document).
5. Press **Upload**.
6. Drag and drop the generated new firmware (*useprog.rsu* is named in this document), and press **Next** button.
7. Manage users is displayed. Press **Next** button.
8. Storage class is displayed. Press **Next** button.
9. Press **Upload** button.

Create AWS IoT job by following steps. They are based on the document below:

https://docs.aws.amazon.com/freertos/latest/userguide/ota-console-workflow.html

10. Go to AWS **IoT** console by searching **iot core**.
11. Select **Manage** at the left of screen.
12. Select **Jobs** at the left of screen.
13. Press **Create** button.
14. Press **Create OTA update job** button.
15. Click **Select**, check the generated thing, and press **Next** button.
16. Click **Create** in the Code signing profile box.
17. **Create a code signing profile** dialog will be appaired.
18. Enter **Profile name**.
19. Click **Select** in Device hardware platform box, click **Select** at the right of **Windows Simulator**.
20. Click Import in Code signing certificate, select following files generated at *Generate the certificate used in OTA update* section:
    a. Select Certificate - `secp256r1.crt`
    b. Select Certificate private key - `secp256r1.privatekey`
    c. Select Certificate chain (optional) - `ca.crt`
21. Press **Import** button, enter **Pathname of code signing certificate on device**, and click **Create** button.
22. Click **Select** in Select your firmware image in S3 or upload it, click S3 bucket (*rz-ota* is named in this document), and click **Select** at the right of uploaded new firmware.
23. Enter **Pathname of firmware image on device**.
24. Click **Select** in the Role (requires S3 access), click **Select** at the right of the created role (*role_rz-ota* is named in this document), and press **Next** button.
25. Enter a job name in the box under the **ID**, and press **Create** button. It is recommended to name with unique number.

Execute OTA

In this section, download the firmware in which ota_boot_proc and download initial firmware are combined, and update to the new firmware.

Download ota_boot_proc by the following steps:

1. Copy userprog.bin to mbed drive.
2. **SX-SDMAC** Remove SX-SDMAC module and re-insert it to the board. Then press RST button.
   This procedure is specific to GR-MANGO which can’t stop power supply to SDIO.

3. Confirm **OTA demo version 0.9.2** is displayed.

```
0 1 [IP-task] prvIPTask started
1 513 [Tmr Svc] recover retry count = 4.
2 513 [Tmr Svc] EEPROM(main) hash check...
3 515 [Tmr Svc] NG
4 515 [Tmr Svc] EEPROM(mirror) hash check...
5 517 [Tmr Svc] NG
6 517 [Tmr Svc] write EEPROM(main)...
7 1502 [Tmr Svc] OK
8 1503 [Tmr Svc] write EEPROM(mirror)...
9 2488 [Tmr Svc] OK
10 2488 [Tmr Svc] EEPROM setting OK.
11 2488 [Tmr Svc] EEPROM(main) hash check...
12 2490 [Tmr Svc] OK
13 2490 [Tmr Svc] EEPROM(mirror) hash check...
14 2492 [Tmr Svc] OK
15 2501 [Tmr Svc] Write certificate...
45 8864 [OTA] OTA demo version 0.9.2
```

4. Confirm starting OTA update automatically.
5. Confirm ota_boot_proc is executed after downloading the new firmware image.

```
2076 51267 [OTA Task] [prvPAL_ActivateNewImage] Changing the Startup Bank
2082 56267 [OTA Task] [prvPAL_ResetDevice] Resetting the device.
-------------------------------------------------
RZ/A2M secure boot program
-------------------------------------------------
Checking flash ROM status.
bank 0 status = 0xfc [LIFECYCLE_STATE_VALID]
bank 1 status = 0xfe [LIFECYCLE_STATE_TESTING]
integrity check scheme = sig-sha256-ecdsa
bank1(temporary area) on code flash integrity check...OK
update LIFECYCLE_STATE from [LIFECYCLE_STATE_TESTING] to [LIFECYCLE_STATE_VALID]
bank1(temporary area) block0 erase (to update LIFECYCLE_STATE)...bank1(temporary area) block0
write (to update LIFECYCLE_STATE)...swap bank...
-------------------------------------------------
RZ/A2M secure boot program
-------------------------------------------------
Checking flash ROM status.
bank 0 status = 0xfc [LIFECYCLE_STATE_VALID]
bank 1 status = 0xff [LIFECYCLE_STATE_BLANK]
integrity check scheme = sig-sha256-ecdsa
bank0(execute area) on code flash integrity check...OK
jump to user program
```

6. Confirm OTA demo version is changed. Confirm the version number is changed to 0.9.3 from 0.9.2. This indicates firmware has been updated.

```
0 1 [IP-task] prvIPTask started
1 513 [Tmr Svc] recover retry count = 4.
2 513 [Tmr Svc] EEPROM(main) hash check...
3 515 [Tmr Svc] OK
4 515 [Tmr Svc] EEPROM(mirror) hash check...
5 517 [Tmr Svc] OK
6 517 [Tmr Svc] EEPROM(main) hash check...
7 519 [Tmr Svc] OK
8 519 [Tmr Svc] EEPROM(mirror) hash check...
9 521 [Tmr Svc] OK
10 530 [Tmr Svc] Write certificate...
11 943 [Tmr Svc] recover retry count = 4.
12 943 [Tmr Svc] EEPROM(main) hash check...
13 945 [Tmr Svc] OK
14 945 [Tmr Svc] EEPROM(mirror) hash check...
15 947 [Tmr Svc] OK
40 6920 [OTA] OTA demo version 0.9.3
```