The applications discussed in this document provide a brief on using Talaria TWO board and the FreeRTOS SDK with Amazon Web Services (AWS) IoT Core.

More information on the AWS IoT developer guide can be found at: <https://docs.aws.amazon.com/iot/latest/developerguide/>.

# AWS IoT Device SDK Embedded C On Talaria TWO Platform

Version v3.1.5 of aws-iot-device-sdk-embedded-C is ported on Talaria TWO platform. The port along with the sample applications, is available as a public Github repository here: <https://github.com/InnoPhaseIoT/talaria_two_aws>

More information on aws-iot-device-sdk-embedded-C release tag v3.1.5 is available here: <https://github.com/aws/aws-iot-device-sdk-embedded-C/tree/v3.1.5>

API Documentation and other details specific to AWS IoT Device SDK Embedded C release tag V3.1.5 is available here: <http://aws-iot-device-sdk-embedded-c-docs.s3-website-us-east-1.amazonaws.com/index.html>

Follow the instructions in the subsequent sections to clone, patch and compile the repository with Talaria TWO FreeRTOS SDK.

## Cloning talaria\_two\_aws Repository

Create a new folder in any location and clone the talaria\_two\_aws repository using the following command:

|  |
| --- |
| git clone --recursive https://github.com/InnoPhaseIoT/talaria\_two\_aws.git |

**Note**: This repository uses [Git Submodules](https://git-scm.com/book/en/v2/Git-Tools-Submodules) for its dependencies. The option --recursive is required to clone the Git Submodule repository, further required by talaria\_two\_aws repository.

## Patching AWS IoT Device SDK Embedded C for Talaria TWO SDK Compatibility

After the clone is complete as described in section: Cloning talaria\_two\_aws Repository, move the folder talaria\_two\_aws to the following path: *<freertos\_sdk\_path>\apps\*.

Go to (cd) the following directory: *<freertos\_sdk\_path>\apps\talaria\_two\_aws\aws-iot-device-sdk-embedded-C* and execute the following command to patch AWS IoT Device SDK for Talaria TWO compatibility.

|  |
| --- |
| <freertos\_sdk\_path>/apps/talaria\_two\_aws/aws-iot-device-sdk-embedded-C$ git apply ../patches/t2\_compatibility.patch |

**Note**: Patching needs to be done only once after cloning is successful.

## Compiling AWS IoT FreeRTOS SDK and Sample Applications

1. Once the patch is applied successfully, running Make from *<freertos\_sdk\_path>/apps/talaria\_two\_aws* will compile the AWS IoT SDK along with the Talaria TWO specific Platform Adaptation Layer and Sample Applications ported to Talaria TWO.
2. On running Make, the binaries for the various sample applications will be created in the out folder in their individual paths: *<freertos\_sdk\_path>/apps/talaria\_two\_aws/samples/<application\_folder>/out*.
3. Applications can have their own custom configurations for FreeRTOS SDK, based on their own needs, and the customized aws\_iot\_config.h file can be included by individual applications at the time of compiling the AWS IoT FreeRTOS SDK.
4. All the sample applications use their own individually customizable aws\_iot\_config.h file at the following path: *<freertos\_sdk\_path>/apps/talaria\_two\_aws/samples/<application\_folder>/src/aws\_iot\_config.h*.

## Folder Structure talaria\_two\_aws Repository

talaria\_two\_aws repository includes the following directories/files:

|  |  |
| --- | --- |
| **Directory/File** | **Description** |
| *aws-iot-device-sdk-embedded-C* | AWS IoT Device SDK Embedded-C Release Tag v3.1.5 |
| *patches* | Patch file t2\_compatibility.patch for AWS IoT Device SDK V3.1.5 for Talaria TWO compatibility |
| *talaria\_two\_pal* | Platform Adaptation Layer with Talaria TWO platform specific porting for all supported OS, needed to adapt to AWS IoT SDK |
| *sample\_apps* | Samples provided by the AWS IoT SDK covering Thing Shadow, Jobs and Subscribe/Publish which are ported to Talaria TWO for all the supported OS. Changes done for porting the sample applications are related to APIs used to connect to the network, passing connection params as boot arguments and using dataFS for storing the certs and keys.  A sensor2cloud-aws app for INP301x EVB's onboard sensors is also available here |
| *data* | Provides the sample dataFS folder structure to be used while programming the AWS certs and keys to EVB-A for talaria\_two\_aws Sample Applications. |
| *Makefile* | Generates the sample application executable binaries and AWS IoT SDK libraries, using AWS IoT SDK source files, sample application source files and *<sdk\_path>/apps/talaria\_two\_aws/sample\_apps/<os>/<application\_folder>/src/aws\_iot\_config.h*. |

Table : talaria\_two\_aws repository contents

# Overview of Sample Applications

Sample Applications ported onto the Talaria TWO platform are available at: \talaria\_two\_aws\sample\_apps\<os>.

A brief overview of these applications is provided in this section.

## Subscribe-Publish Sample

This example takes the parameters from the aws\_iot\_config.h file and Talaria TWO boot arguments and establishes a connection to the AWS IoT MQTT Platform.

It then subscribes and publishes to the topics provided as bootargs subscribe\_topic and publish\_topic.

If the topic bootArgs are not provided, then it defaults to inno\_test/ctrl as the subscribe\_topic and inno\_test/data as the publish\_topic.

If all the certs/keys are correct, alternate QoS0 and QoS1 messages being published to publish\_topic by the application in a loop is seen on the Talaria TWO console.

If publishCount in code is given a non-zero value, then it defines the number of times the publish should happen. With publishCount as 0, it keeps publishing in a loop.

*AWS IoT Console->Test* page can be used to subscribe to inno\_test/data (or Talaria TWO's publish\_topic provided as the bootArg to the application) to observe the messages published by the application.

*AWS IoT Console->Test* page can be used to publish the message to inno\_test/ctrl (or Talaria TWO's subscribe\_topic provided as the bootArg to the application), and Talaria TWO application will receive the messages which will be visible on the Talaria TWO console.

Following JSON formatted text should be used for publishing to Talaria TWO:

|  |
| --- |
| {  "from": "AWS IoT console"  "to": "T2"  "msg": "Hello from AWS IoT console"  } |

The application takes SSID, passphrase, aws host name, aws port and thing name (as client-id) as mandatory bootArgs and publish\_topic, subscribe\_topic and suspend as optional bootargs.

Certs and keys are stored in dataFS and read from application specific paths defined in the sample code.

**Note**: For Subscribe Publish sample, it is not necessary to create a Thing in the AWS IoT Core. However, it is required that the Client ID be unique. Any string can be given if it is unique. If two devices with same Client ID are connected, AWS IoT Core keeps only the latest device connected, and disconnects the device connected earlier. To enforce the unique Client ID and avoid disconnects, Thing Name is used as Client ID for sample applications.

## Shadow Sample

The goal of this sample application is to demonstrate the capabilities of aws iot thing shadow service.

This example takes the parameters from the aws\_iot\_config.h file and Talaria TWO boot arguments and establishes a connection to the AWS IoT Shadow Service.

This device acts as a Connected Window and periodically reports (once every 3 seconds) the following parameters to the Thing's Classic Shadow :

1. Temperature of the room (double)

**Note**: Temperature changes are simulated.

1. Open/close status of the window (bool). Open or close as windowOpen true/false

The device also listens for a shadow state change for windowOpen to act on commands from the cloud. Two variables from a device's perspective are,

1. Double temperature
2. Bool windowOpen

Hence, the corresponding Shadow Json Document in the cloud would be as follows:

|  |
| --- |
| { "reported": {  "temperature": 32,  "windowOpen": false  },  "desired": {  "windowOpen": false  }  } |

The device opens or closes the window based on json object windowOpen data (true/false) received as part of shadow delta callback. Hence, a jsonStruct\_t object windowActuator is created with pKey = "windowOpen" of type = SHADOW\_JSON\_BOOL and a delta callback windowActuate\_Callback.

The application then registers for a Delta callback for windowActuator and receives a callback whenever a state change happens for this object in Thing Shadow.

For example: Based on temperature reported, a logic running in the AWS cloud infra can either automatically decide when to open or close the window, and thereby control it by changing the desired state of windowOpen or a manual input by the end-user using a web/phone application can change the desired state of windowOpen.

For the sample application, change in desired section can be done manually as shown:

Assume the reported and desired states of windowOpen are false as shown in the above JSON. From AWS IoT Web Console's Thing Shadow, if the desired section is edited/saved as shown, then a delta callback will be received by the application as there is a difference between desired vs reported.

|  |
| --- |
| "desired":  {       "windowOpen": false     } |

Received Delta message

|  |
| --- |
| "delta": {       "windowOpen": true     } |

This delta message implies that the desired windowOpen variable has changed to true. The application will act on this delta message and publish back windowOpen as true as part of the reported section of the shadow document from the device when the next periodic temperature value is reported.

|  |
| --- |
| "reported":  {       "temperature": 28,       "windowOpen": true     } |

This update reported message will remove the delta that was created, as the desired and reported states will now match. If this delta message is not removed, then the AWS IoT Thing Shadow is always going to have a delta, and will keep sending delta callback anytime an update is applied to the Shadow.

**Note**: Ensure the buffer sizes in aws\_iot\_config.h are big enough to receive the delta message. The delta message will also contain the metadata with the timestamps.

The application takes SSID, passphrase, AWS host name, AWS port and thing name as must provide bootargs and suspend as optional bootArgs.

Certs and keys are stored in dataFS and read from app specific paths defined in the sample code.

## Jobs Sample

This example takes the parameters from aws\_iot\_config.h file and Talaria TWO boot arguments and establishes a connection to the AWS IoT MQTT Platform.

It performs several operations to demonstrate the basic capabilities of the AWS IoT Jobs platform.

If all the certs/keys are correct, a list of pending Job Executions printed out by the iot\_get\_pending\_callback\_handler can be seen.

If there are any existing pending job executions, each will be processed one at a time in the iot\_next\_job\_callback\_handler.

After all of the pending jobs have been processed, the program will wait for notifications for new pending jobs and process them one at a time as they come in.

In the main body, registration of each callback for each corresponding Jobs topic can be seen.

The application takes SSID, passphrase, AWS host name, AWS port and thing name as must provide boot arguments and suspend as an optional boot argument. Certs and keys are stored in dataFS and read from app specific paths defined in the sample code.

## Sensor2Cloud- AWS

This application is a reference example of sensor2cloud-aws for sensors available onboard in INP301x EVB-A. It is similar to the Shadow Sample application, which uses the same boot arguments and data from sensors available onboard in INP301x EVB-A instead of simulated data. Boot arguments are also similar to the Shadow Sample application with an additional boot-arg added, named sensor\_poll\_interval.

The application takes SSID, passphrase, aws host name, aws port thing name (as client-id) and sensor\_poll\_interval as mandatory boot arguments and suspend as optional boot arguments.

Certs and keys are stored in dataFS and read from application specific paths defined in the sample code.

Following are the shadow attributes used by this application:

1. temperature
2. pressure
3. humidity
4. opticalPower
5. sensorPollInterval
6. sensorSwitch

If sensorSwitch is ON, sensor values are read periodically every sensorPollInterval (in seconds) and sent to AWS IoT Thing Shadow associated with the thing\_name passed in the boot argument. If sensorSwitch is OFF, no values are sent, but the application waits for incoming delta callbacks for sensorSwitch and sensorPollInterval.

On boot, sensorSwitch is forced to be ON ('true') and sensorPollInterval is forced to be the value passed using boot arguments for sensor\_poll\_interval (in seconds). This can be later controlled by changing these attributes values from the cloud and it takes effect on Talaria TWO running via shadow delta callbacks.

# AWS Set-up

1. Create an AWS IoT account

An AWS account is needed to run the sample applications. AWS accounts include twelve months of Free Tier Access.

More information on: <https://portal.aws.amazon.com/billing/signup#/start>

1. Create and register device/thing

Device/thing must be registered onto the AWS IoT registry.

Use the following link to AWS IoT user guide to download the necessary certificates and private key: <https://docs.aws.amazon.com/iot/latest/developerguide/create-iot-resources.html>.

**Note**:

* Ensure the downloaded certificates and private key are saved in a secure location as it allows the user to download only once.
* To determine your custom AWS, download location, go to AWS IoT Console -> Settings

1. Save Certificate and Private Key onto the device

There are four certificates that will be downloaded from AWS for the created Thing. Out of which Public Key will not be used in this example.

Save the certificates (as there is a need to install these in the device) and rename them as per the following table to create file system and write it into Talaria TWO using the download tool:

|  |  |
| --- | --- |
| **File Name** | **Rename** |
| private.pem.key | aws\_device\_pkey |
| device.pem.crt | aws\_device\_cert |
| amazon-root-CA-1.pem | aws\_root\_ca |
| Public Key | Not used in these examples |

Table : AWS Certificates

1. Create and attach a Policy to the certificate associated with the device/thing. To allow interaction with all the topics and other resources used in the example codes, a wildcard policy is set and attached to the thing’s certificate. Please edit and update the policy as shown below:

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

# Programming VM-based applications

## Programming Talaria TWO Board with Certificates

The default path for sample AWS should be: \data\certs\aws\app.

The default path for sensor2cloud-aws application: \data\certs\sensor2aws

### Show File System Contents

Click on Show File System Contents field to see the currently available files in the file system.

### Write Files

To write files into Talaria TWO, user must create a folder with the name data and place all certificates either directly into the data or they can create multiple subfolders (for example: /data/iot\_aws) and place the certificates inside the sub-directory and update the path as per the file system in the .c file.

The default path is \data\certs\aws\app. If the user writes into data\iot\_aws\cert\_names then the path should be updated in the .c file accordingly.

**Note**: The default path for sensor2cloud-aws application is \data\certs\sensor2aws

All the files/folders inside data will be written to Talaria TWO dataFS.

For reference, an example data folder is provided in the talaria\_two\_aws repo, in the following path: /talaria\_two\_aws/data.

For more information on using the Download Tool, refer: UG\_Download\_Tool.pdf (path: *freertos\_sdk\_x.y/pc\_tools/Download\_Tool/doc*).

**Note**: x and y refer to the FreeRTOS SDK release version. For example: freertos\_sdk\_3.0/doc.

## Programming Talaria TWO board with ELF

Program the generated ELFs onto Talaria TWO using the Download Tool freertos\_sdk\_x.y\pc\_tools\Download\_Tool)provided with InnoPhase Talaria TWO FreeRTOS SDK.

Launch the Download tool.

1. In the GUI window:
   1. Boot Target: Select the appropriate EVK from the drop-down.
   2. ELF Input: Load the appropriate ELF by clicking on Select ELF File.
   3. AP Options: Provide the SSID and Passphrase under AP Options to connect to an Access Point.
   4. Boot arguments: Pass the following boot arguments:

sensor2cloud-aws application:

|  |
| --- |
| aws\_host=xxxxxx.amazonaws.com,aws\_port=8883,thing\_name=xxxxx,sensor\_poll\_interval=<interval\_in\_seconds> |

All other applications:

|  |
| --- |
| aws\_host=xxxxxx.amazonaws.com, aws\_port=8883,thing\_name=xxxxx |

**Note**: Replace the xxxxxx with the appropriate details.

Ensure correct boot parameters are supplied of your Wi-Fi network and the information from the device/thing created previously on AWS.

* + 1. aws\_host is the custom AWS location.
    2. thing\_name is the name of the device/thing we created earlier.
  1. Programming: Prog RAM or Prog Flash as per requirement.

# MQTT Publish and Subscribe

**Note**: All AWS IoT Console screenshots might not look exactly as shown in the figures but might be a variation of the same. This is in-line with the ever-evolving console and its layouts.

## Subscribe

1. In the AWS IoT Console, go to Test->MQTT test client.
2. In the Subscription topic text box, type inno\_test/data and click on Subscribe.

Table

Description automatically generated

Figure : Subscribe to topic

1. In the Publish to a topic tab, click on inno\_test/data.

Graphical user interface, application

Description automatically generated

Figure : Subscriptions – inno\_test/data

## Running the Sample Application

1. Program the Talaria TWO board with sample\_pub\_sub.elf using the process described in section: Programming Talaria TWO board with ELF.
2. Upon successful execution, the following console output will be provided:

|  |
| --- |
| UART:SNWWWWAE  4 DWT comparators, range 0x8000  Build $Id: git-ef87896f9 $  hio.baudrate=921600  flash: Gordon ready!  [8.538,997] partitions mounted  UART:SNWWWWAE  4 DWT comparators, range 0x8000  Build $Id: git-ef87896f9 $  hio.baudrate=921600  flash: Gordon ready!  Y-BOOT 208ef13 2019-07-22 12:26:54 -0500 790da1-b-7  ROM yoda-h0-rom-16-0-gd5a8e586  FLASH:PNWWWWWWAE  Build $Id: git-831e563 $  Flash detected. flash.hw.uuid: 394b3437-3802-004d-00e2-ffffffffffff  Bootargs: aws\_host=a3th11zq4plemm-ats.iot.us-east-2.amazonaws.com aws\_port=8883 thing\_name=ble\_new np\_conf\_path=/data/nprofile.json ssid=FASTFIBER passphrase=MD123456  AWS IoT SDK Version 3.1.5-  Mounting file system  read\_certs() success  [0.083,964] rfdrv: unknown module type (0)  addr 02:03:04:57:4d:04  added network profile successfully, will try connecting..  [2.787,785] CONNECT:8c:c7:c3:50:31:3f Channel:1 rssi:-81 dBm  wcm\_notify\_cb to App Layer - WCM\_NOTIFY\_MSG\_LINK\_UP  wcm\_notify\_cb to App Layer - WCM\_NOTIFY\_MSG\_ADDRESS  [3.007,860] MYIP 192.168.1.34  [3.008,025] IPv6 [fe80::3:4ff:fe57:4d04]-link  wcm\_notify\_cb to App Layer - WCM\_NOTIFY\_MSG\_CONNECTED  Connecting...  heap[230488] max contentlen[16384] sizeof IoT\_Publish\_Message\_Params (16)  . Seeding the random number generator...  . Loading the CA root certificate...  Root Done (0 skipped)  . Loading the client cert and key. size TLSDataParams:2080  Loading the client cert done.... ret[0]  Loading the client pkey done.... ret[0]  ok  . Connecting to a3th11zq4plemm-ats.iot.us-east-2.amazonaws.com/8883...  ok  . Setting up the SSL/TLS structure...  SSL state connect : 0  ok  SSL state connect : 0  . Performing the SSL/TLS handshake...  Verify requested for (Depth 2):  This certificate has no flags  Verify requested for (Depth 1):  This certificate has no flags  Verify requested for (Depth 0):  This certificate has no flags  SSL/TLS Handshake DONE.. ret:0  ok  [ Protocol is TLSv1.2 ]  [ Ciphersuite is TLS-ECDHE-RSA-WITH-AES-128-GCM-SHA256 ]  [ Record expansion is 29 ]  . Verifying peer X.509 certificate...  ok  Subscribing...  Subscribed to topic [inno\_test/ctrl] ret[0] qos[0]  sleep  ---> Publishing with 'Message QoS0' to Topic [inno\_test/data]  msg[{"from":"Talaria T2","to":"AWS","msg":"Howdy Ho","msg\_id":1}]  QoS0 Message Publish Successful for "msg\_id":1. Return Status [0]  ---> Publishing with 'Message QoS1' to Topic [inno\_test/data]  msg[{"from":"Talaria T2","to":"AWS","msg":"Howdy Ho","msg\_id":2}]  QoS1 Message Publish Successful for "msg\_id":2. Return Status [0]  sleep  ---> Publishing with 'Message QoS0' to Topic [inno\_test/data]  msg[{"from":"Talaria T2","to":"AWS","msg":"Howdy Ho","msg\_id":3}]  QoS0 Message Publish Successful for "msg\_id":3. Return Status [0]  ---> Publishing with 'Message QoS1' to Topic [inno\_test/data]  msg[{"from":"Talaria T2","to":"AWS","msg":"Howdy Ho","msg\_id":4}]  QoS1 Message Publish Successful for "msg\_id":4. Return Status [0]  sleep  ---> Publishing with 'Message QoS0' to Topic [inno\_test/data]  msg[{"from":"Talaria T2","to":"AWS","msg":"Howdy Ho","msg\_id":5}]  QoS0 Message Publish Successful for "msg\_id":5. Return Status [0]  ---> Publishing with 'Message QoS1' to Topic [inno\_test/data]  msg[{"from":"Talaria T2","to":"AWS","msg":"Howdy Ho","msg\_id":6}]  QoS1 Message Publish Successful for "msg\_id":6. Return Status [0]  sleep  ---> Publishing with 'Message QoS0' to Topic [inno\_test/data]  msg[{"from":"Talaria T2","to":"AWS","msg":"Howdy Ho","msg\_id":7}]  QoS0 Message Publish Successful for "msg\_id":7. Return Status [0]  ---> Publishing with 'Message QoS1' to Topic [inno\_test/data]  msg[{"from":"Talaria T2","to":"AWS","msg":"Howdy Ho","msg\_id":8}]  QoS1 Message Publish Successful for "msg\_id":8. Return Status [0]  sleep  ---> Publishing with 'Message QoS0' to Topic [inno\_test/data]  msg[{"from":"Talaria T2","to":"AWS","msg":"Howdy Ho","msg\_id":9}]  QoS0 Message Publish Successful for "msg\_id":9. Return Status [0]  ---> Publishing with 'Message QoS1' to Topic [inno\_test/data]  msg[{"from":"Talaria T2","to":"AWS","msg":"Howdy Ho","msg\_id":10}]  QoS1 Message Publish Successful for "msg\_id":10. Return Status [0]  sleep |

1. The AWS IoT dashboard will appear as in Figure 3.

Graphical user interface, text, website

Description automatically generated

Figure : AWS IoT Dashboard

## Publish

1. Program the Talaria TWO board with sample\_pub\_sub.elf using the process described in section: Programming Talaria TWO board with ELF.
2. In the AWS IoT Console, go to Test.
3. On the Publish topic text box, enter inno\_test/ctrl.

Graphical user interface, application

Description automatically generated

Figure : Publish to topic

1. Copy and paste the following json formatted text into the colored console as shown in Figure 4.

|  |
| --- |
| {  "from": "AWS IoT console"  "to": "T2"  "msg": "Hello from AWS IoT console"  } |

1. On clicking Publish to topic, the following output is displayed in the console:

|  |
| --- |
| UART:SNWWWWAE  4 DWT comparators, range 0x8000  Build $Id: git-ef87896f9 $  hio.baudrate=921600  flash: Gordon ready!  Y-BOOT 208ef13 2019-07-22 12:26:54 -0500 790da1-b-7  ROM yoda-h0-rom-16-0-gd5a8e586  FLASH:PNWWWWWWAE  Build $Id: git-831e563 $  Flash detected. flash.hw.uuid: 394b3437-3802-004d-00e2-ffffffffffff  Bootargs: aws\_host=a3th11zq4plemm-ats.iot.us-east-2.amazonaws.com aws\_port=8883 thing\_name=ble\_new np\_conf\_path=/data/nprofile.json ssid=FASTFIBER passphrase=MD123456  AWS IoT SDK Version 3.1.5-  Mounting file system  read\_certs() success  [0.083,964] rfdrv: unknown module type (0)  addr 02:03:04:4a:8d:6c  added network profile successfully, will try connecting..  [2.884,395] CONNECT:8c:c7:c3:50:31:3f Channel:1 rssi:-80 dBm  wcm\_notify\_cb to App Layer - WCM\_NOTIFY\_MSG\_LINK\_UP  wcm\_notify\_cb to App Layer - WCM\_NOTIFY\_MSG\_ADDRESS  [3.127,409] MYIP 192.168.1.40  [3.127,457] IPv6 [fe80::3:4ff:fe4a:8d6c]-link  wcm\_notify\_cb to App Layer - WCM\_NOTIFY\_MSG\_CONNECTED  Connecting...  heap[230440] max contentlen[16384] sizeof IoT\_Publish\_Message\_Params (16)  . Seeding the random number generator...  . Loading the CA root certificate...  Root Done (0 skipped)  . Loading the client cert and key. size TLSDataParams:2080  Loading the client cert done.... ret[0]  Loading the client pkey done.... ret[0]  ok  . Connecting to a3th11zq4plemm-ats.iot.us-east-2.amazonaws.com/8883...  ok  . Setting up the SSL/TLS structure...  SSL state connect : 0  ok  SSL state connect : 0  . Performing the SSL/TLS handshake...  Verify requested for (Depth 2):  This certificate has no flags  Verify requested for (Depth 1):  This certificate has no flags  Verify requested for (Depth 0):  This certificate has no flags  SSL/TLS Handshake DONE.. ret:0  ok  [ Protocol is TLSv1.2 ]  [ Ciphersuite is TLS-ECDHE-RSA-WITH-AES-128-GCM-SHA256 ]  [ Record expansion is 29 ]  . Verifying peer X.509 certificate...  ok  Subscribing...  Subscribed to topic [inno\_test/ctrl] ret[0] qos[0]  <--- Message Received on Subscribed Topic [inno\_test/ctrl]  - from: AWS IoT console  - to: T2  - message: Hello from AWS IoT  sleep  ---> Publishing with 'Message QoS0' to Topic [inno\_test/data]  msg[{"from":"Talaria T2","to":"AWS","msg":"Howdy Ho","msg\_id":1}]  QoS0 Message Publish Successful for "msg\_id":1. Return Status [0]  ---> Publishing with 'Message QoS1' to Topic [inno\_test/data]  msg[{"from":"Talaria T2","to":"AWS","msg":"Howdy Ho","msg\_id":2}]  <--- Message Received on Subscribed Topic [inno\_test/ctrl]  - from: AWS IoT console  - to: T2  - message: HelloWorld from AWS IoT console Team\_BLE1  <--- Message Received on Subscribed Topic [inno\_test/ctrl]  - from: AWS IoT console  - to: T2  - message: HelloWorld from AWS IoT console Team\_BLE2  <--- Message Received on Subscribed Topic [inno\_test/ctrl]  - from: AWS IoT console  - to: T2  - message: HelloWorld from AWS IoT console Team\_BLE3  QoS1 Message Publish Successful for "msg\_id":2. Return Status [0]  sleep  ---> Publishing with 'Message QoS0' to Topic [inno\_test/data]  msg[{"from":"Talaria T2","to":"AWS","msg":"Howdy Ho","msg\_id":3}]  QoS0 Message Publish Successful for "msg\_id":3. Return Status [0]  ---> Publishing with 'Message QoS1' to Topic [inno\_test/data]  msg[{"from":"Talaria T2","to":"AWS","msg":"Howdy Ho","msg\_id":4}]  <--- Message Received on Subscribed Topic [inno\_test/ctrl]  - from: AWS IoT console  - to: T2  - message: HelloWorld from AWS IoT console Team\_BLE4  <--- Message Received on Subscribed Topic [inno\_test/ctrl]  - from: AWS IoT console  - to: T2  - message: HelloWorld from AWS IoT console Team\_BLE5  QoS1 Message Publish Successful for "msg\_id":4. Return Status [0]  sleep  ---> Publishing with 'Message QoS0' to Topic [inno\_test/data]  msg[{"from":"Talaria T2","to":"AWS","msg":"Howdy Ho","msg\_id":5}]  QoS0 Message Publish Successful for "msg\_id":5. Return Status [0]  ---> Publishing with 'Message QoS1' to Topic [inno\_test/data]  msg[{"from":"Talaria T2","to":"AWS","msg":"Howdy Ho","msg\_id":6}]  QoS1 Message Publish Successful for "msg\_id":6. Return Status [0]  sleep |

# Device Shadow

## Running the Sample Application

1. In the AWS IoT Console, go to Manage -> Things ->YourThingName -> Shadow.
2. Program the Talaria TWO board with shadow\_sample.elf using the process described in section: Programming Talaria TWO board with ELF.
3. On successful execution, the following console output will be provided:

|  |
| --- |
| UART:SNWWWWAE  4 DWT comparators, range 0x8000  Build $Id: git-ef87896f9 $  hio.baudrate=921600  flash: Gordon ready!  Y-BOOT 208ef13 2019-07-22 12:26:54 -0500 790da1-b-7  ROM yoda-h0-rom-16-0-gd5a8e586  FLASH:PNWWWWWWAE  Build $Id: git-831e563 $  Flash detected. flash.hw.uuid: 394b3437-3802-004d-00e2-ffffffffffff  Bootargs: aws\_host=a3th11zq4plemm-ats.iot.us-east-2.amazonaws.com aws\_port=8883 thing\_name=ble\_new np\_conf\_path=/data/nprofile.json ssid=FASTFIBER passphrase=MD123456  AWS IoT SDK Version 3.1.5-  Mounting file system  read\_certs() success  [0.083,925] rfdrv: unknown module type (0)  addr 02:03:04:63:1c:50  added network profile successfully, will try connecting..  [2.786,471] CONNECT:8c:c7:c3:50:31:3f Channel:1 rssi:-77 dBm  wcm\_notify\_cb to App Layer - WCM\_NOTIFY\_MSG\_LINK\_UP  wcm\_notify\_cb to App Layer - WCM\_NOTIFY\_MSG\_ADDRESS  [3.022,963] MYIP 192.168.1.41  [3.023,127] IPv6 [fe80::3:4ff:fe63:1c50]-link  wcm\_notify\_cb to App Layer - WCM\_NOTIFY\_MSG\_CONNECTED  Shadow InitShadow Connect  . Seeding the random number generator...  . Loading the CA root certificate...  Root Done (0 skipped)  . Loading the client cert and key. size TLSDataParams:2080  Loading the client cert done.... ret[0]  Loading the client pkey done.... ret[0]  ok  . Connecting to a3th11zq4plemm-ats.iot.us-east-2.amazonaws.com/8883...  ok  . Setting up the SSL/TLS structure...  SSL state connect : 0  ok  SSL state connect : 0  . Performing the SSL/TLS handshake...  Verify requested for (Depth 2):  This certificate has no flags  Verify requested for (Depth 1):  This certificate has no flags  Verify requested for (Depth 0):  This certificate has no flags  SSL/TLS Handshake DONE.. ret:0  ok  [ Protocol is TLSv1.2 ]  [ Ciphersuite is TLS-ECDHE-RSA-WITH-AES-128-GCM-SHA256 ]  [ Record expansion is 29 ]  . Verifying peer X.509 certificate...  ok  On Device: window state false  Update Shadow: {"state":{"reported":{"temperature":25.500000,"windowOpen":false}}, "clientToken":"ble\_new-0"}  Update Accepted !!  On Device: window state false  Update Shadow: {"state":{"reported":{"temperature":26.000000,"windowOpen":false}}, "clientToken":"ble\_new-1"}  Update Accepted !!  On Device: window state false  Update Shadow: {"state":{"reported":{"temperature":26.500000,"windowOpen":false}}, "clientToken":"ble\_new-2"}  Update Accepted !!  On Device: window state false  Update Shadow: {"state":{"reported":{"temperature":27.000000,"windowOpen":false}}, "clientToken":"ble\_new-3"}  Update Accepted !!  On Device: window state false  Update Shadow: {"state":{"reported":{"temperature":27.500000,"windowOpen":false}}, "clientToken":"ble\_new-4"}  Update Accepted !!  On Device: window state false  Update Shadow: {"state":{"reported":{"temperature":28.000000,"windowOpen":false}}, "clientToken":"ble\_new-5"}  Update Accepted !!  On Device: window state false  Update Shadow: {"state":{"reported":{"temperature":28.500000,"windowOpen":false}}, "clientToken":"ble\_new-6"}  Update Accepted !!  On Device: window state false  Update Shadow: {"state":{"reported":{"temperature":29.000000,"windowOpen":false}}, "clientToken":"ble\_new-7"}  Update Accepted !!  On Device: window state false  Update Shadow: {"state":{"reported":{"temperature":29.500000,"windowOpen":false}}, "clientToken":"ble\_new-8"}  Update Accepted !!  On Device: window state false  Update Shadow: {"state":{"reported":{"temperature":30.000000,"windowOpen":false}}, "clientToken":"ble\_new-9"}  Update Accepted !!  On Device: window state false  Update Shadow: {"state":{"reported":{"temperature":30.500000,"windowOpen":false}}, "clientToken":"ble\_new-10"}  Update Accepted !!  On Device: window state false  Update Shadow: {"state":{"reported":{"temperature":31.000000,"windowOpen":false}}, "clientToken":"ble\_new-11"} |

1. The AWS IoT dashboard will appear as shown in Figure 5.

Graphical user interface, application

Description automatically generated

Figure : AWS IoT Dashboard

# Running Jobs

## Creating a job in AWS

1. Create a new .json file.

|  |
| --- |
| { "operation": "customJob",  "otherInfo": "someValue" } |

1. Create a bucket to store files on your Amazon Simple Storage Service (Amazon S3).

More information on creating buckets on the Amazon S3 can be found here: <https://s3.console.aws.amazon.com>.

Graphical user interface, text, application, email

Description automatically generated

Figure : Creating a bucket to store files on Amazon S3

1. Upload the new .json file onto the Amazon S3 bucket.

Graphical user interface, text, application

Description automatically generated

Figure : Uploading .json file onto the Amazon S3 bucket

1. In the AWS IoT Console, go to Manage -> Jobs.
2. Click on Create and then on Create custom job.

Graphical user interface, application, email

Description automatically generated

Figure : Creating a custom job

1. Fill the Job ID and Description as per your requirement.
2. In Select devices to update, select your thing as the device to be included in the job.

**Note**: If your thing name is not found in the dropdown, then make sure to select the correct region available at the top right side of AWS IoT console.

Graphical user interface, text, application, email

Description automatically generated

Figure : Selecting devices to update

1. In Add a job file, go ahead, and select the job file uploaded into your S3 bucket.

Graphical user interface, text, application, email

Description automatically generated

Figure : Adding a job file

1. Click on Next. In the next window, click on Create.
2. The new job you created will now appear on the AWS IoT Console.

Graphical user interface, application

Description automatically generated

Figure : AWS IoT Console – new job created

## Running the Sample Application

1. Program the Talaria TWO board with jobs\_sample.elf using the process described in section: Programming Talaria TWO board with ELF.
2. Boot arguments: Pass the following boot arguments
3. On successful execution, the following console output will be provided:

|  |
| --- |
| UART:SNWWWWAE  4 DWT comparators, range 0x8000  Build $Id: git-ef87896f9 $  hio.baudrate=921600  flash: Gordon ready!  Y-BOOT 208ef13 2019-07-22 12:26:54 -0500 790da1-b-7  ROM yoda-h0-rom-16-0-gd5a8e586  FLASH:PNWWWWWWAE  Build $Id: git-831e563 $  Flash detected. flash.hw.uuid: 394b3437-3802-004d-00e2-ffffffffffff  Bootargs: aws\_host=a3th11zq4plemm-ats.iot.us-east-2.amazonaws.com aws\_port=8883 thing\_name=ble\_new np\_conf\_path=/data/nprofile.json ssid=FASTFIBER passphrase=MD123456  Mounting file system  read\_certs() success  [0.083,832] rfdrv: unknown module type (0)  addr 02:03:04:92:c7:65  added network profile successfully, will try connecting..  [2.787,325] CONNECT:8c:c7:c3:50:31:3f Channel:1 rssi:-79 dBm  wcm\_notify\_cb to App Layer - WCM\_NOTIFY\_MSG\_LINK\_UP  wcm\_notify\_cb to App Layer - WCM\_NOTIFY\_MSG\_ADDRESS  [3.078,714] MYIP 192.168.1.42  [3.078,879] IPv6 [fe80::3:4ff:fe92:c765]-link  wcm\_notify\_cb to App Layer - WCM\_NOTIFY\_MSG\_CONNECTED  AWS IoT SDK Version 3.1.5-  Connecting...  heap[228688] max contentlen[16384] sizeof IoT\_Publish\_Message\_Params (16)  . Seeding the random number generator...  . Loading the CA root certificate...  Root Done (0 skipped)  . Loading the client cert and key. size TLSDataParams:2080  Loading the client cert done.... ret[0]  Loading the client pkey done.... ret[0]  ok  . Connecting to a3th11zq4plemm-ats.iot.us-east-2.amazonaws.com/8883...  ok  . Setting up the SSL/TLS structure...  SSL state connect : 0  ok  SSL state connect : 0  . Performing the SSL/TLS handshake...  Verify requested for (Depth 2):  This certificate has no flags  Verify requested for (Depth 1):  This certificate has no flags  Verify requested for (Depth 0):  This certificate has no flags  SSL/TLS Handshake DONE.. ret:0  ok  [ Protocol is TLSv1.2 ]  [ Ciphersuite is TLS-ECDHE-RSA-WITH-AES-128-GCM-SHA256 ]  [ Record expansion is 29 ]  . Verifying peer X.509 certificate...  ok  Success subscribing JOB\_GET\_PENDING\_TOPIC: 0  Success subscribing JOB\_NOTIFY\_NEXT\_TOPIC: 0  Success subscribing JOB\_DESCRIBE\_TOPIC ($next): 0  Success subscribing JOB\_UPDATE\_TOPIC/accepted: 0  Success subscribing JOB\_UPDATE\_TOPIC/rejected: 0  Success calling aws\_iot\_jobs\_send\_query: 0  Success aws\_iot\_jobs\_describe: 0  JOB\_GET\_PENDING\_TOPIC callback  topic: $aws/things/ble\_new/jobs/get/accepted  payload: {"timestamp":1697702118,"inProgressJobs":[],"queuedJobs":[{"jobId":"AWS\_IoT\_Job","queuedAt":1697633280,"lastUpdatedAt":1697633280,"executionNumber":1,"versionNumber":1}]}  inProgressJobs: []  queuedJobs: [{"jobId":"AWS\_IoT\_Job","queuedAt":1697633280,"lastUpdatedAt":1697633280,"executionNumber":1,"versionNumber":1}]  JOB\_NOTIFY\_NEXT\_TOPIC / JOB\_DESCRIBE\_TOPIC($next) callback  topic: $aws/things/ble\_new/jobs/$next/get/accepted  payload: {"timestamp":1697702118,"execution":{"jobId":"AWS\_IoT\_Job","status":"QUEUED","queuedAt":1697633280,"lastUpdatedAt":1697633280,"versionNumber":1,"executionNumber":1,"jobDocument":{"operation":"customJob","otherInfo":"someValue"}}}  execution: {"jobId":"AWS\_IoT\_Job","status":"QUEUED","queuedAt":1697633280,"lastUpdatedAt":1697633280,"versionNumber":1,"executionNumber":1,"jobDocument":{"operation":"customJob","otherInfo":"someValue"}}  jobId: AWS\_IoT\_Job  jobDocument: {"operation":"customJob","otherInfo":"someValue"}  JOB\_UPDATE\_TOPIC / accepted callback  topic: $aws/things/ble\_new/jobs/AWS\_IoT\_Job/update/accepted  payload: {"timestamp":1697702119}  JOB\_NOTIFY\_NEXT\_TOPIC / JOB\_DESCRIBE\_TOPIC($next) callback  topic: $aws/things/ble\_new/jobs/notify-next  payload: {"timestamp":1697702119}  execution property not found, nothing to do  aws\_iot\_mqtt\_yield: 0 |

1. The AWS IoT Console will display as completed once the job is completed.

Graphical user interface, application

Description automatically generated

Figure : AWS IoT Console – Job Completed

1. You can continue creating new jobs which will be executed by your device/thing.

# Sensor2Cloud – AWS

## Hardware Settings and EVB Sensors

1. Install jumper on J8 and J7 of EVB-A to enable SCL and SDA I2C line
2. Install jumper on J1 header to supply 3.3v on vio\_sensor
3. There are 3 sensor chips available
   1. U10(SHTC)  --> Temperature/Humidity
   2. U11(BMP)   -->  Temperature/Pressure
   3. U12(OPT)   -->  Light (Optical Power)

## Running the Sample Application

1. Program the Talaria TWO board with sensor2cloud-aws\_inp301x\_app.elf using the process described in section: *Programming Talaria TWO board with ELF*.
2. Boot arguments: Pass the following boot arguments:

|  |
| --- |
| aws\_host=xxxxxx.amazonaws.com,aws\_port=8883,thing\_name=xxxxx,sensor\_poll\_interval=<interval\_in\_seconds> |

1. On successful execution, the following console output can be observed:

|  |
| --- |
| UART:SNWWWWAE  4 DWT comparators, range 0x8000  Build $Id: git-ef87896f9 $  hio.baudrate=921600  flash: Gordon ready!  [8.354,841] partitions mounted  UART:SNWWWWAE  4 DWT comparators, range 0x8000  Build $Id: git-ef87896f9 $  hio.baudrate=921600  flash: Gordon ready!  Y-BOOT 208ef13 2019-07-22 12:26:54 -0500 790da1-b-7  ROM yoda-h0-rom-16-0-gd5a8e586  FLASH:PNWWWWWWAE  Build $Id: git-831e563 $  Flash detected. flash.hw.uuid: 39483937-3207-00a6-00ad-ffffffffffff  Bootargs: aws\_host=a3t0o11ohwlo2h-ats.iot.us-east-2.amazonaws.com aws\_port=8883 thing\_name=InnoAWS2023 suspend=1 wifi.cloud\_pm=1 cloudpm.cpm\_period=60 sensor\_poll\_interval=20 np\_conf\_path=/data/nprofile.json ssid=Xiaomi\_Ax6000\_iop passphrase=InnoQA2023$  Mounting file system  read\_certs() success  Initializing bmp388...  Initializing opt3002...  Initializing shtc3...  bmp388 ID: 0x50  opt3002 ID: 0x5449  shtc3 ID: 0x803C01D7  addr e0:69:3a:00:16:e6  Connecting to WiFi...  added network profile successfully, will try connecting..  connecting to network status: 0  [2.248,021] Trying to connect in 1 seconds  [4.631,119] CONNECT:d4:da:21:54:d3:c6 Channel:11 rssi:-35 dBm  wcm\_notify\_cb to App Layer - WCM\_NOTIFY\_MSG\_LINK\_UP  wcm\_notify\_cb to App Layer - WCM\_NOTIFY\_MSG\_ADDRESS  [6.999,336] MYIP 192.168.31.172  [6.999,424] IPv6 [fe80::e269:3aff:fe00:16e6]-link  wcm\_notify\_cb to App Layer - WCM\_NOTIFY\_MSG\_CONNECTED  -----Timestamp: 7000716 uS-----  Pressure: 91387.7109 Pa  Temperature (bmp): 31.7900 C  Optical power: 239462.4062 nW/cm2  Humidity: 35.5169 %  Temperature (shtc): 32.1599 C  Shadow Connect  . Seeding the random number generator...  . Loading the CA root certificate...  Root Done (0 skipped)  . Loading the client cert and key. size TLSDataParams:2080  Loading the client cert done.... ret[0]  Loading the client pkey done.... ret[0]  ok  . Connecting to a3t0o11ohwlo2h-ats.iot.us-east-2.amazonaws.com/8883...  ok  . Setting up the SSL/TLS structure...  SSL state connect : 0  ok  SSL state connect : 0  . Performing the SSL/TLS handshake...  Verify requested for (Depth 2):  This certificate has no flags  Verify requested for (Depth 1):  This certificate has no flags  Verify requested for (Depth 0):  This certificate has no flags  SSL/TLS Handshake DONE.. ret:0  ok  [ Protocol is TLSv1.2 ]  [ Ciphersuite is TLS-ECDHE-RSA-WITH-AES-128-GCM-SHA256 ]  [ Record expansion is 29 ]  . Verifying peer X.509 certificate...  ok  Shadow Connected  init\_and\_connect\_aws\_iot. ret:0  Update Shadow: {"state":{"desired":{"sensorSwitch":true}}, "clientToken":"InnoAWS2023-0"}  Update Timeout--  Update Shadow: {"state":{"desired":{"sensorPollInterval":20}}, "clientToken":"InnoAWS2023-1"}  Registering for Delta callbacks on shadow attributes :sensorPollInterval  Update Accepted !!  Registering for Delta callbacks on shadow attributes :sensorSwitch  Update Shadow: {"state":{"reported":{"temperature":32.009998,"pressure":91384.617188,"humidity":35.054001,"opticalPower":244531.203125}}, "clientToken":"InnoAWS2023-2"}  Recieved Delta Callback for shadow attribute: sensorPollInterval, with desired state: 20  Update Accepted !!  Update Shadow: {"state":{"reported":{"sensorPollInterval":20}}, "clientToken":"InnoAWS2023-3"}  Update Accepted !!  Update Shadow: {"state":{"reported":{"temperature":32.080002,"pressure":91383.273438,"humidity":34.840000,"opticalPower":241152.000000}}, "clientToken":"InnoAWS2023-4"}  Update Accepted !!  Update Shadow: {"state":{"reported":{"temperature":32.099998,"pressure":91387.031250,"humidity":34.584000,"opticalPower":246067.203125}}, "clientToken":"InnoAWS2023-5"}  Update Accepted !! |