Azure IoTHub Integration User Guide

From 8.8 Aruba Controller and IAPs start to support Azure IoTHub integration, so far we support BleData and serialData related IoT devices. the serialData support both south bound and north bound messages.

Our Aruba devices are using DPS (Device Provisioning Service) to get iothub connection info like IoTHub URL, device ID, and device Key. which device connect to which IoTHub is controlled by DPS, and the DPS works to add device into the related IoTHub, which give more flexible to our customer to deploy IoT solution, and simplify the process and configuration model.

Pre-preparation:

this User Guide assume user already configured DPS and IoTHub, if not, please refer to Microsoft guide to create DPS and IoTHub.

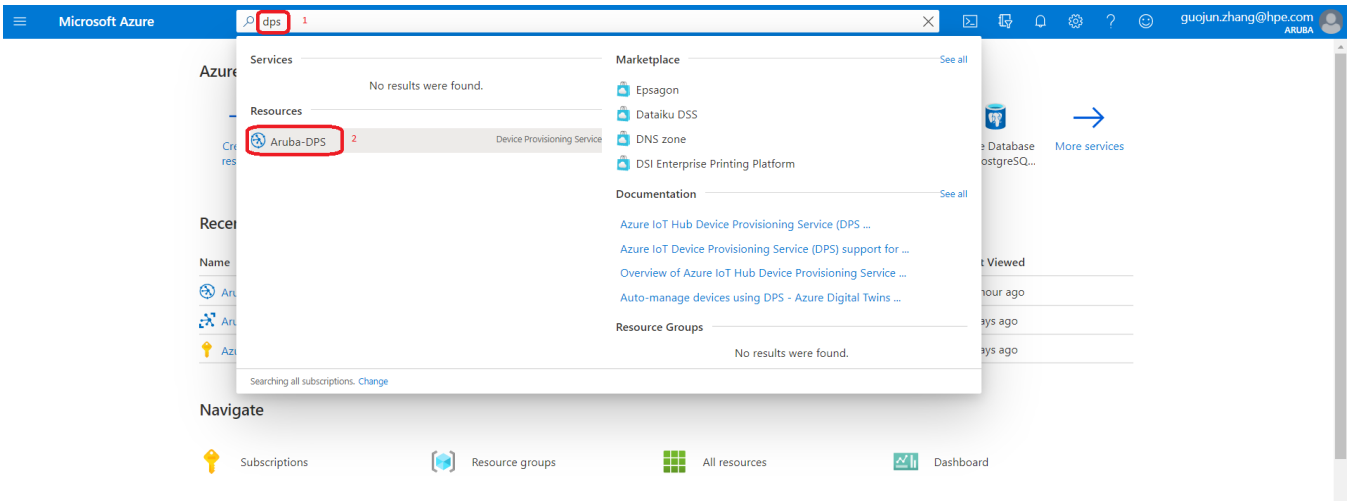
https://docs.microsoft.com/en-us/azure/iot-dps/quick-setup-auto-provision

And make sure your Controller/IAP are enabled NTP to get accurate clock. without the accurate clock the device will not be able to establish the connection with Azure IoTHub.

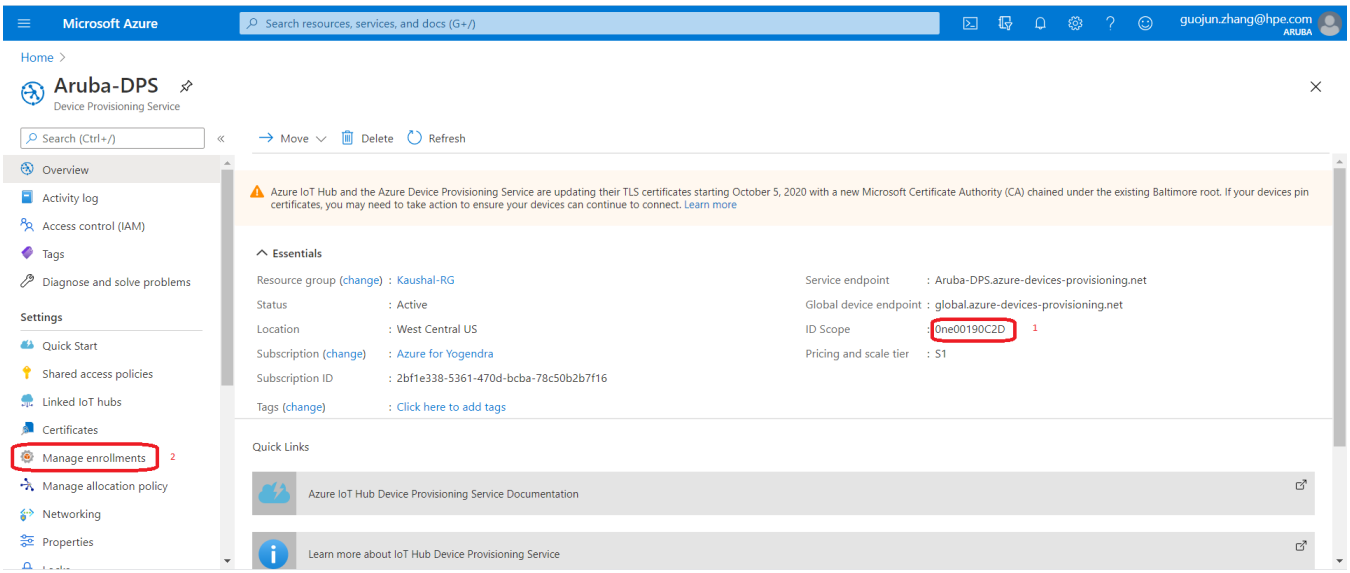
Create group device enrollment in the Azure DPS service:

Go to Azure portal https://portal.azure.com, you can search dps by enter the "dps" in the search bar, and you can see your configured DPS resource. otherwise you have to create your DPS service by previous pre-prepare step.

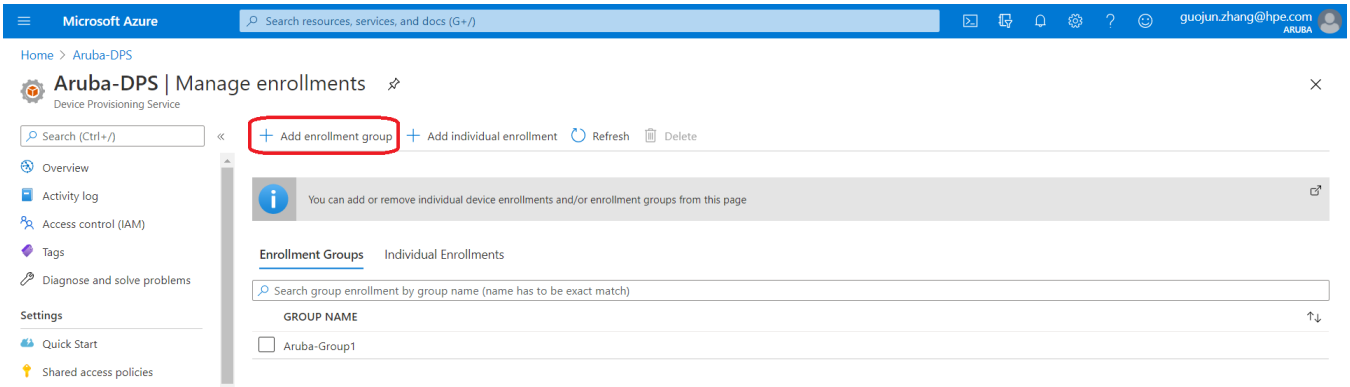
If the DPS is in your "recent resources" list, you can directly click it.



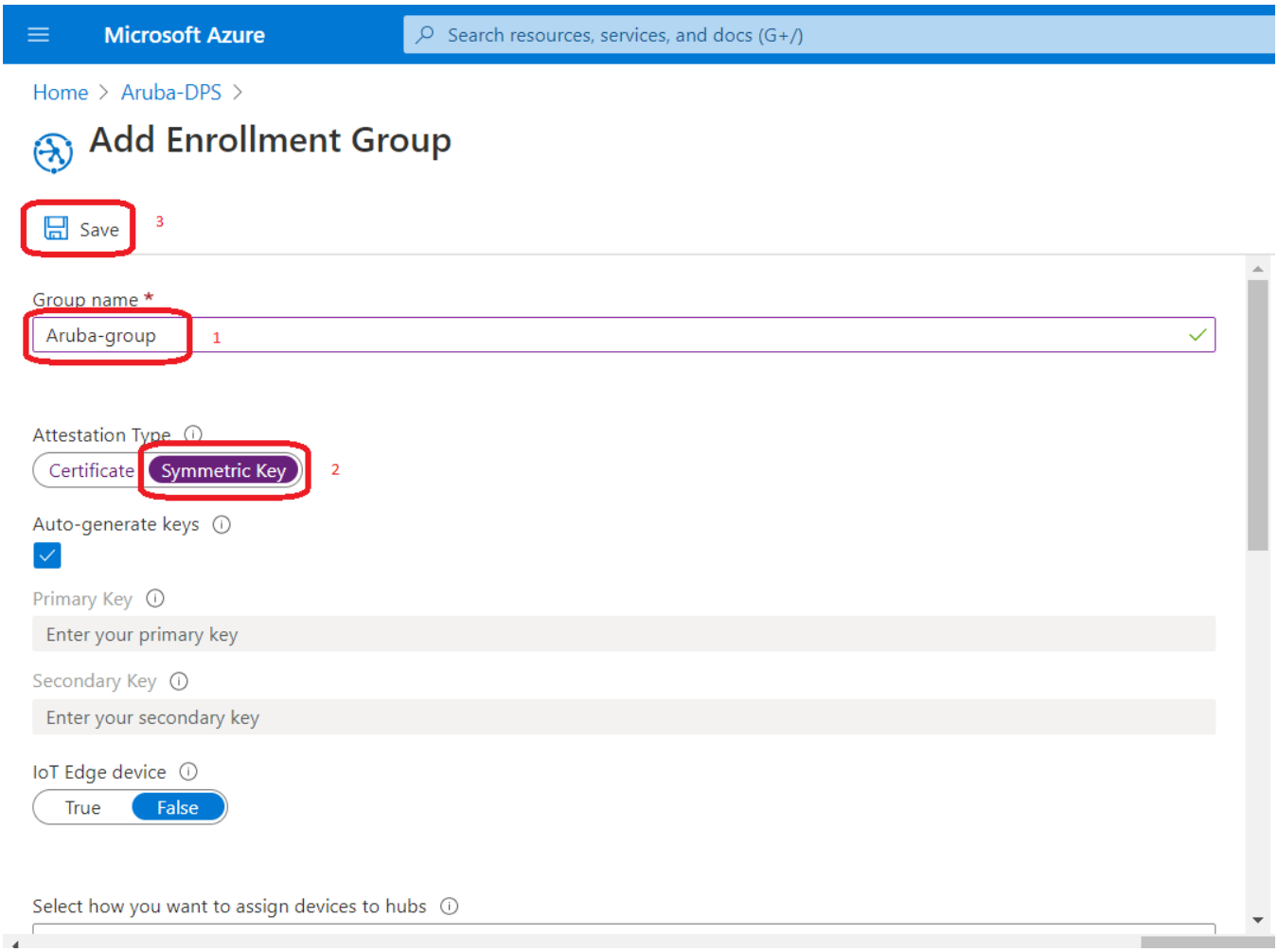
After enter the DPS service, in this example the DPS name is "Aruba-DPS", you need to record the "ID Scope" as highlight in below pictures. then click the left side "Manage enrollments" to start the device enrollment configuration.



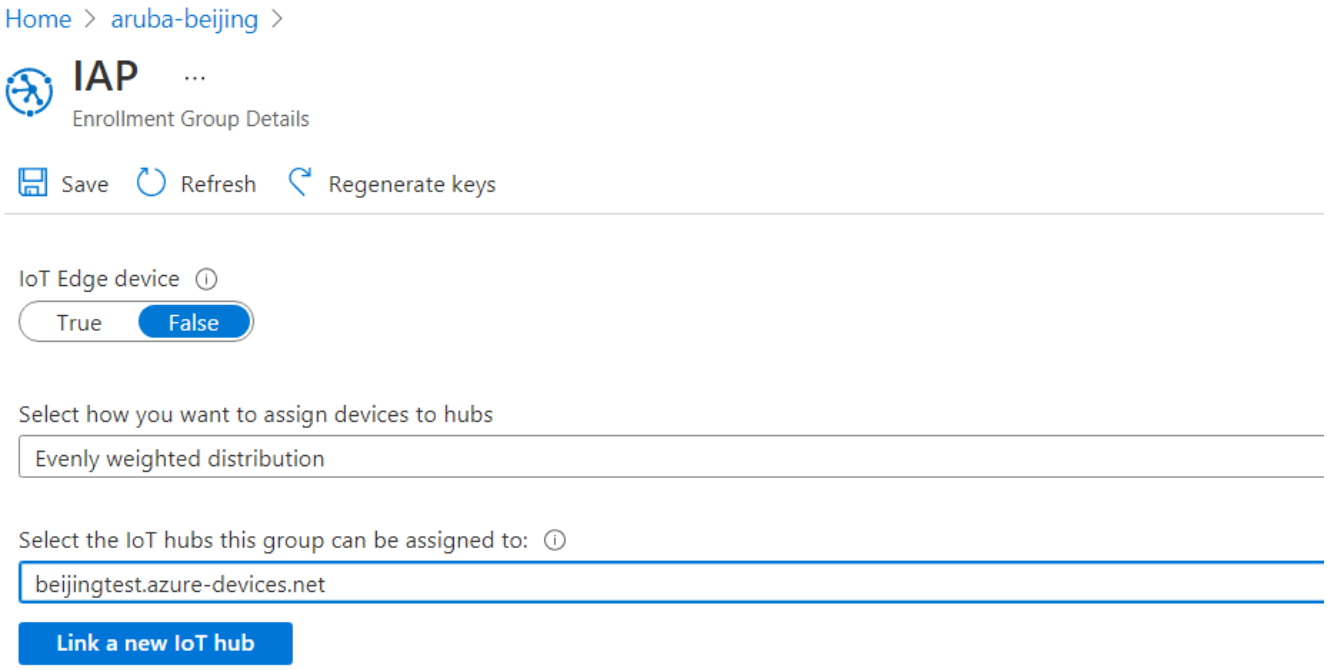
In the top of manage enrollments page, click the "Add enrollment group" to add a enrollment group for your group of device.



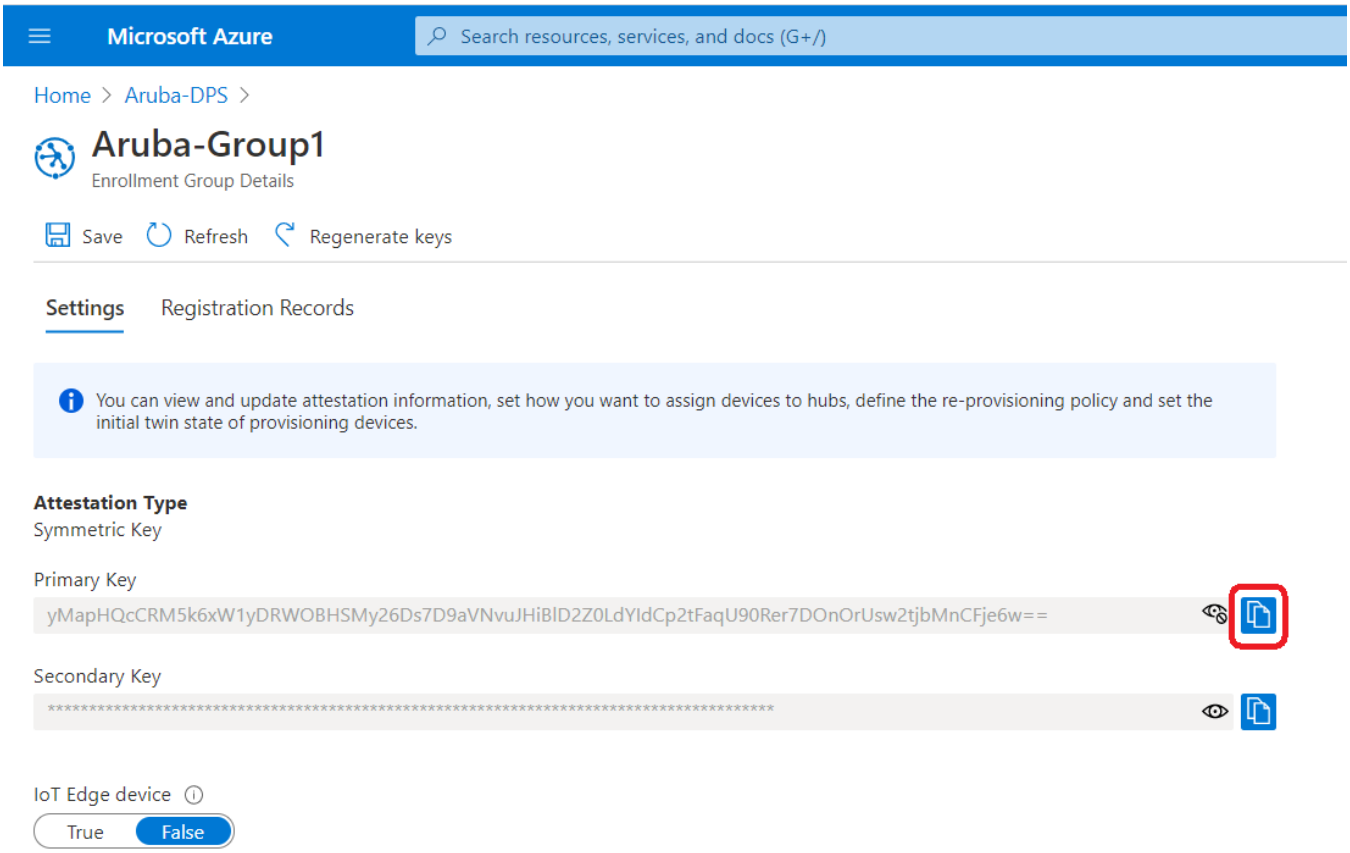
In the "Add Enrollment Group" page enter the "Group Name" and choose "Symmetric Key", leave the others options as default, and save it.



Select the IoT hubs this group can be assigned



Click the the group you create in the last step, copy the primary key, for later config in the Controller or IAP.



Config IAP

In the "create group device enrollment in the Azure DPS service" section, we already got "ID Scope" and "group enrollment key", we will need these two parameters to be configured in "`iot transportProfile`"

Following is a example. note, we introduce a new endpointType "Azure-IoTHub".

```
iot transportProfile azure-iothub-test
  endpointType Azure-IoTHub
  payloadContent serial-data
  azure-dps-id-scope 0ne00190XXX    -- Your ID Scope
  azure-dps-auth-type symmetric-key group-enroll-key
yMapHQcCRM5k6xW1yDRWOBHSMy26Ds7D9aVNvuJHiBlD2Z0LdYIdCp2tFaqU90Rer7DOnOrUsw2tjbMnCFje6XXX  -- Your group key
```

Check Azure connection

iot-profile in ble-daemon

```
70:3a:0e:cc:ed:f8# show ap debug ble-daemon iot-profile azure-iothub-test



BLE IoT Transport Context Config ID: 2
Last Sync Time: 2020-10-27 03:59:57



---------------------------Profile[azure-iothub-test]---------------------------



ServerType :Azure IoTHub
Last Update Sent :No Update Sent
ReportingInterval :600 second
DeviceClassFilter :Serial Data(22),All(5)
RSSI Reporting :Average
EnvironmentType :office
CustomFadingFactor :20
DataFilter :00 00
Server Connection State
--------------------------
DPS Id Scope :0ne00190C2D
DPS group key :*****************************
IoTHub provision type :DPS
IoTHub provision status :Provision success
DPS provision retry times :0
Last Provision Time :2020-10-27 03:59:42
IoTHub register id :703A0ECCEDF8
IoTHub URL :Aruba-IoT-Hub.azure-devices.net
IoTHub key :*****************************
IoTHub connection status :Connect success
IoTHub connect retry times :0
Last connect Time :2020-10-27 03:59:47
Current Time :2020-10-28 00:07:58
```

iot-profile in ble-relay

```
70:3a:0e:cc:ed:f8# show ap debug ble-relay iot-profile

ConfigID : 3

---------------------------Profile[azure-iothub-test]---------------------------

serverType : Azure IoTHub
deviceClassFilter : Serial Data,All
reportingInterval : 600 second
authentication-mode : none
rssiReporting : Average
environmentType : office
azure-dps-id-scope : 0ne00190C2D
azure-dps-group-key : ************
Server Connection State
--------------------------
TransportContext : Ready
Last Data Update : 2020-10-27 03:59:47
Last Send Time : 1969-12-31 17:00:00
TransType : Azure AMQP Over Websocket
Transport count : 1
--------------------------
----------------Azure Transport[Aruba-IoT-Hub.azure-devices.net]----------------
Transport url : Aruba-IoT-Hub.azure-devices.net
Transport created : Yes
--------------------------
Device MAC : 70:3a:0e:cc:ed:f8
Device id : 703A0ECCEDF8
Device created : Yes
Status : Connect success
--------------------------
```

Debugging log

ble-daemon log

```
70:3a:0e:cc:ed:f8# ble-init-action log-level-str Azure-IoTHub

log level parsed. log_level = 0x400000
```

```
70:3a:0e:cc:ed:f8# show ap debug ble-daemon

2020-10-27 03:55:15 (azure-iothub-test): Sending azure DPS provision request msg to ble_relay@localhost msglen:121
2020-10-27 03:55:15 az_prov_start_connect_timer:80 start azure prov connect timer.
2020-10-27 03:55:19 ble_ap_handle_az_iothub_prov:370 azure-iothub: Received Provision Message!
```

ble-relay log

```
70:3a:0e:cc:ed:f8# ble-init-action ble_relay set-attr br-loglvl 2048
```

```
70:3a:0e:cc:ed:f8# show ap debug ble-relay

[9856]2020-10-27 03:59:07 ble_parse_clid_message:1055 new name:azure-iothub-test

[9856]2020-10-27 03:59:07 Azure connect: Azure iothub init...

[9856]2020-10-27 03:59:07 Azure connect: Azure iothub init done
```

azure-iothub-log

```
70:3a:0e:cc:ed:f8# show ap debug ble-relay azure-iothub-log
2020-10-27 03:51:07 Azure connect: Azure iothub init done
2020-10-27 03:51:34 Azure connect: az_iot_connecting(114) Start azure iothub connecting thread.
2020-10-27 03:51:34 Azure connect: New connecting, iothub url Aruba-IoT-Hub.azure-devices.net, register id 703A0ECCEDF8, key ******
2020-10-27 03:51:34 az_iothub_creat_client_hash_entry(99): Created AP mac<70:3a:0e:cc:ed:f8>, id <703A0ECCEDF8>.
2020-10-27 03:51:34 Azure connect: az_iothub_create_device(265) creating client 703A0ECCEDF8
2020-10-27 03:51:34 Azure connect: az_iot_connecting(154) Create device handler done.
2020-10-27 03:51:34 Azure connect: No more Azure IoTHub connecting request in the queue, stop connecting.
2020-10-27 03:51:34 Azure connect: Azure iothub connecting thread end.
2020-10-27 03:51:35 Azure connect: The device client 703A0ECCEDF8 is connected to iothub
2020-10-27 03:51:35 Azure connect: Update azure connection status to daemon
```

Troubleshooting command

azure-clear-flash-provisioning

```
70:3a:0e:cc:ed:f8# ble-init-action azure-clear-flash-provisioning azure-iothub-test

70:3a:0e:cc:ed:f8# show ap debug ble-daemon iot-profile

BLE IoT Transport Context Config ID: 3
Last Sync Time: 2020-10-28 00:10:20

---------------------------Profile[azure-iothub-test]---------------------------

ServerType :Azure IoTHub
Last Update Sent :No Update Sent
ReportingInterval :600 second
DeviceClassFilter :Serial Data(22),All(5)
RSSI Reporting :Average
EnvironmentType :office
CustomFadingFactor :20
DataFilter :00 00
Server Connection State
--------------------------
DPS Id Scope :0ne00190C2D
DPS group key :******************************
IoTHub provision type :DPS
IoTHub provision status :Provisioning
DPS provision retry times :0
Last Provision Time :2020-10-28 00:21:44
IoTHub register id :
IoTHub URL :
IoTHub key :Null
IoTHub connection status :Connect fail
IoTHub connect retry times :0
IoTHub failure reason :IOTHUB_CLIENT_CONNECTION_OK
Last failure Time :2020-10-28 00:21:44
Last connect Time :2020-10-27 03:59:47
Current Time :2020-10-28 00:21:47
70:3a:0e:cc:ed:f8#
70:3a:0e:cc:ed:f8#
70:3a:0e:cc:ed:f8# show ap debug ble-daemon iot-profile

BLE IoT Transport Context Config ID: 3
Last Sync Time: 2020-10-28 00:10:20

---------------------------Profile[azure-iothub-test]---------------------------

ServerType :Azure IoTHub
Last Update Sent :No Update Sent
ReportingInterval :600 second
DeviceClassFilter :Serial Data(22),All(5)
RSSI Reporting :Average
EnvironmentType :office
CustomFadingFactor :20
DataFilter :00 00
Server Connection State
--------------------------
DPS Id Scope :0ne00190C2D
DPS group key :******************************
IoTHub provision type :DPS
IoTHub provision status :Provision success
DPS provision retry times :0
Last Provision Time :2020-10-28 00:21:44
IoTHub register id :703A0ECCEDF8
IoTHub URL :Aruba-IoT-Hub.azure-devices.net
IoTHub key :******************************
IoTHub connection status :Connect success
IoTHub connect retry times :0
Last connect Time :2020-10-28 00:21:50
Current Time :2020-10-28 00:21:53
```

azure-dps-provisioning

```
70:3a:0e:cc:ed:f8# ble-init-action azure-dps-provisioning azure-iothub-test

70:3a:0e:cc:ed:f8# show ap debug ble-daemon iot-profile

BLE IoT Transport Context Config ID: 3
Last Sync Time: 2020-10-28 00:10:20

--------------------------Profile[azure-iothub-test]--------------------------

ServerType :Azure IoTHub
Last Update Sent :No Update Sent
ReportingInterval :600 second
DeviceClassFilter :Serial Data(22),All(5)
RSSI Reporting :Average
EnvironmentType :office
CustomFadingFactor :20
DataFilter :00 00
Server Connection State
-------------------------
DPS Id Scope :0ne00190C2D
DPS group key :****************************
IoTHub provision type :DPS
IoTHub provision status :Provisioning
DPS provision retry times :0
Last Provision Time :2020-10-28 00:24:15
IoTHub register id :703A0ECCEDF8
IoTHub URL :Aruba-IoT-Hub.azure-devices.net
IoTHub key :****************************
IoTHub connection status :Connect success
IoTHub connect retry times :0
Last connect Time :2020-10-28 00:21:50
Current Time :2020-10-28 00:24:17
70:3a:0e:cc:ed:f8#
70:3a:0e:cc:ed:f8# show ap debug ble-daemon iot-profile

BLE IoT Transport Context Config ID: 3
Last Sync Time: 2020-10-28 00:10:20

--------------------------Profile[azure-iothub-test]--------------------------

ServerType :Azure IoTHub
Last Update Sent :No Update Sent
ReportingInterval :600 second
DeviceClassFilter :Serial Data(22),All(5)
RSSI Reporting :Average
EnvironmentType :office
CustomFadingFactor :20
DataFilter :00 00
Server Connection State
-------------------------
DPS Id Scope :0ne00190C2D
DPS group key :****************************
IoTHub provision type :DPS
IoTHub provision status :Provision success
DPS provision retry times :0
Last Provision Time :2020-10-28 00:24:15
IoTHub register id :703A0ECCEDF8
IoTHub URL :Aruba-IoT-Hub.azure-devices.net
IoTHub key :****************************
IoTHub connection status :Connect success
IoTHub connect retry times :0
Last connect Time :2020-10-28 00:21:50
Current Time :2020-10-28 00:24:24
```

azure-iothub-connect without connect parameters

```
70:3a:0e:cc:ed:f8# ble-init-action azure-iothub-connect azure-iothub-test

70:3a:0e:cc:ed:f8# show ap debug ble-daemon iot-profile

BLE IoT Transport Context Config ID: 3
Last Sync Time: 2020-10-28 00:10:20

--------------------------Profile[azure-iothub-test]--------------------------

ServerType :Azure IoTHub
Last Update Sent :No Update Sent
ReportingInterval :600 second
DeviceClassFilter :Serial Data(22),All(5)
RSSI Reporting :Average
EnvironmentType :office
CustomFadingFactor :20
DataFilter :00 00
Server Connection State
-------------------------
DPS Id Scope :0ne00190C2D
DPS group key :****************************
IoTHub provision type :DPS
IoTHub provision status :Provision success
DPS provision retry times :0
Last Provision Time :2020-10-28 00:24:15
IoTHub register id :703A0ECCEDF8
IoTHub URL :Aruba-IoT-Hub.azure-devices.net
IoTHub key :****************************
IoTHub connection status :Connect success
IoTHub connect retry times :0
Last connect Time :2020-10-28 00:26:29
Current Time :2020-10-28 00:26:30
```

azure-iothub-connect with connection parameters

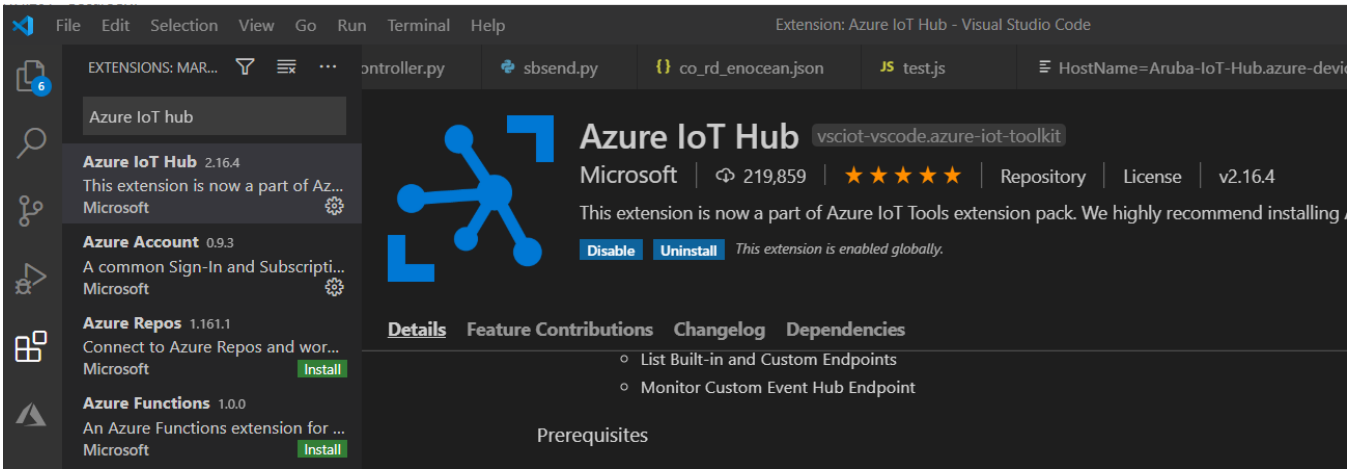
```
70:3a:0e:cc:ed:f8# ble-init-action azure-iothub-connect azure-iothub-test Aruba-IoT-Hub.azure-devices.net 703A0ECCEDF8
fouDREhrzSjSAYM+ud906lKZchwJC9946tduHwsxkZs=

70:3a:0e:cc:ed:f8# show ap debug ble-daemon iot-profile azure-iothub-test

BLE IoT Transport Context Config ID: 3
Last Sync Time: 2020-10-28 00:10:20

--------------------------Profile[azure-iothub-test]--------------------------

ServerType :Azure IoTHub
Last Update Sent :No Update Sent
ReportingInterval :600 second
DeviceClassFilter :Serial Data(22),All(5)
RSSI Reporting :Average
EnvironmentType :office
CustomFadingFactor :20
DataFilter :00 00
Server Connection State
-------------------------
DPS Id Scope :0ne00190C2D
DPS group key :****************************
IoTHub provision type :DPS
IoTHub provision status :Provision success
DPS provision retry times :0
Last Provision Time :2020-10-28 00:24:15
IoTHub register id :703A0ECCEDF8
IoTHub URL :Aruba-IoT-Hub.azure-devices.net
IoTHub key :****************************
IoTHub connection status :Connect success
IoTHub connect retry times :0
Last connect Time :2020-10-28 00:28:12
Current Time :2020-10-28 00:28:14
```

Back-end Application

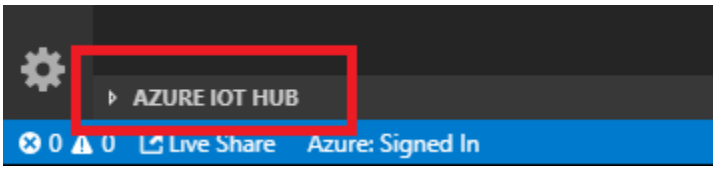
For the back-end application, we can use VSC Azure IoT Hub extension or python script.

Back-end Application-VSC Extension

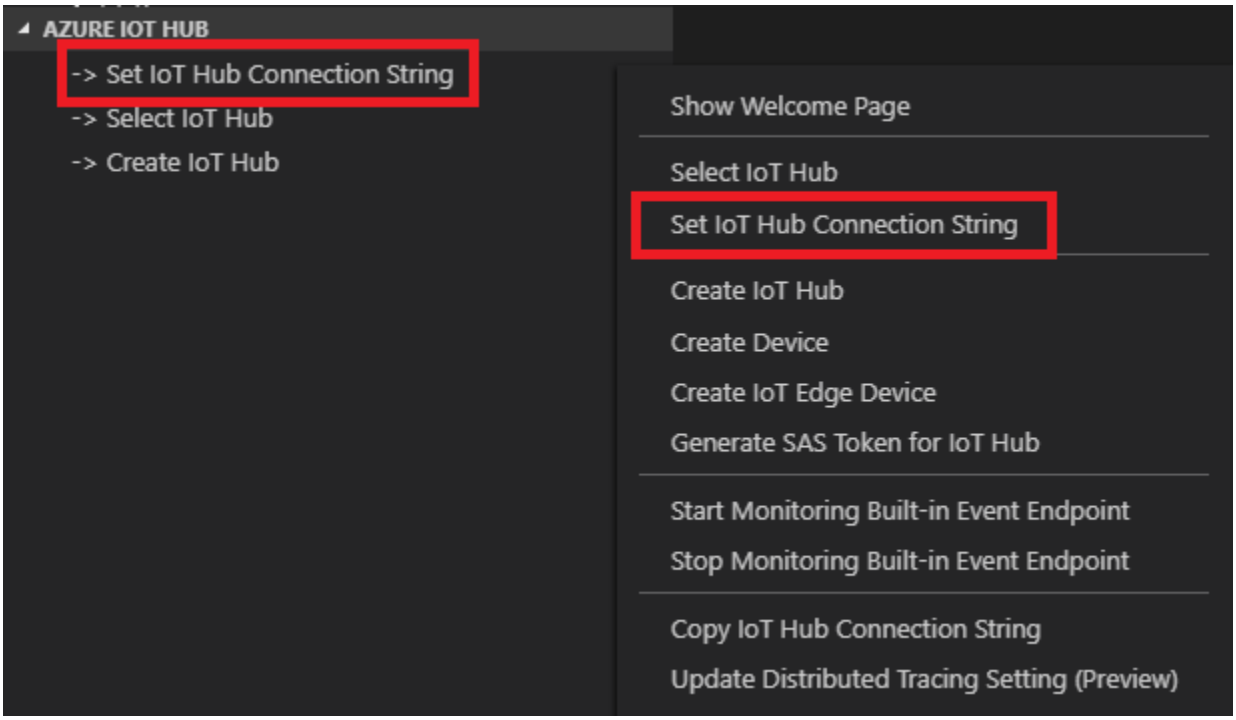
In the extensions of the VSC, search "Azure IoT Hub", and install it.



In Explorer of VS Code, click "Azure IoT Hub" in the bottom left corner.

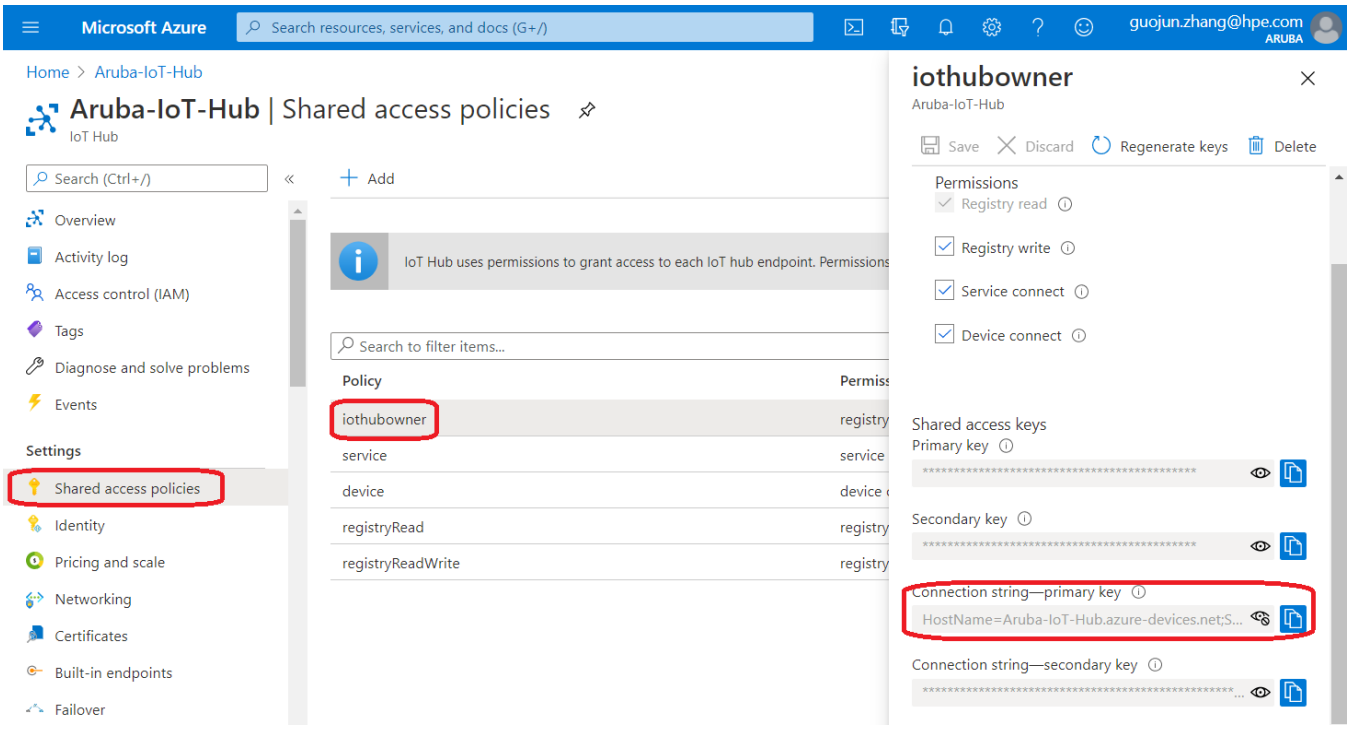


Click "Set IoT Hub Connection String" in context menu.

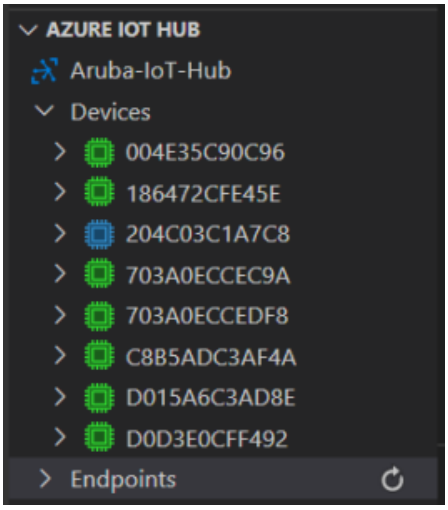


An input box will pop up, then enter your IoT Hub Connection String (It is one-time configuration, and please make sure it is IoT Hub Connection String not Device Connection String. The format is HostName=<my-hub>.azure-devices.net;SharedAccessKeyName=<my-policy>;SharedAccessKey=<my-policy-key>).

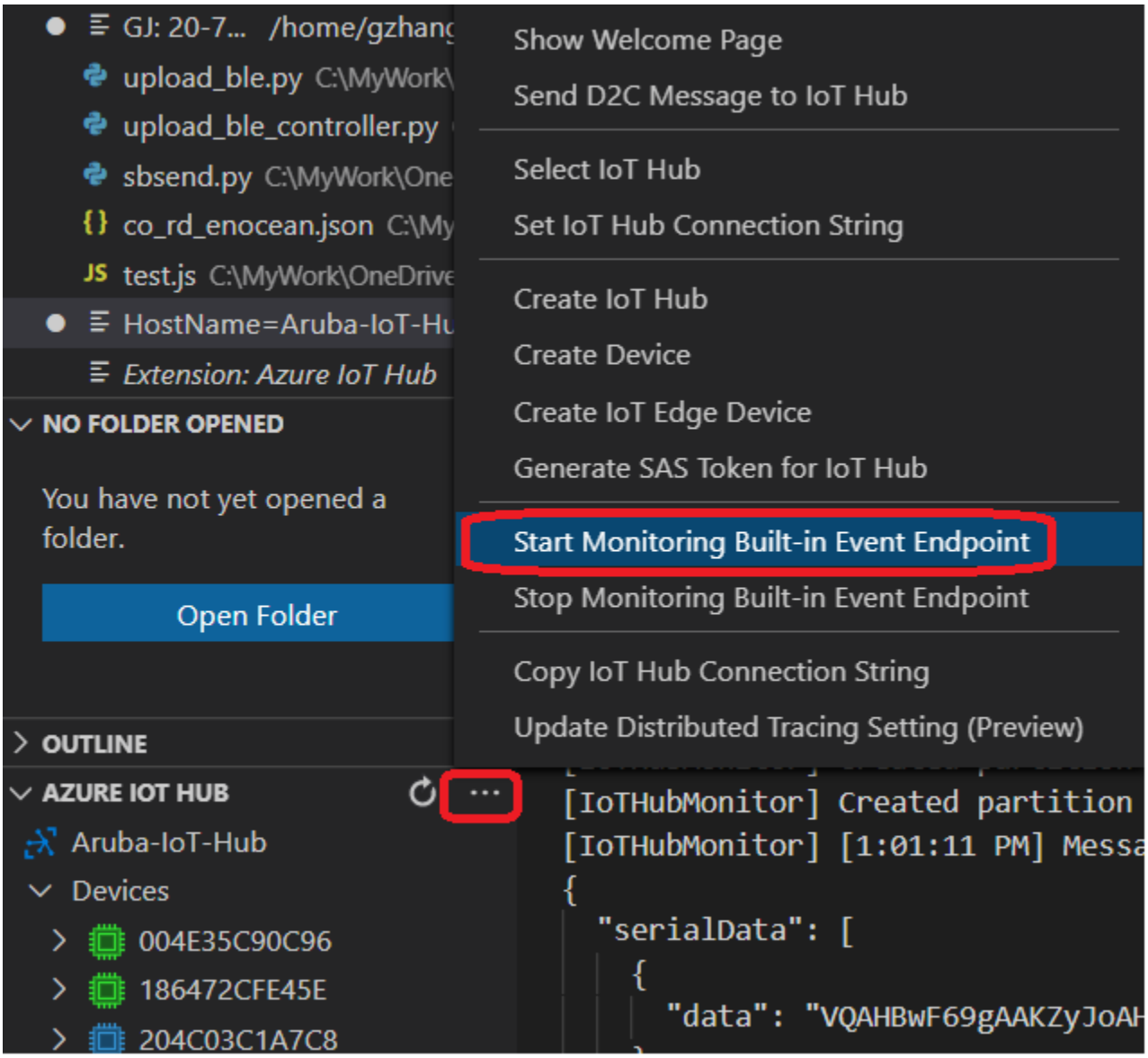
you can get iothub conntction string from your iothub



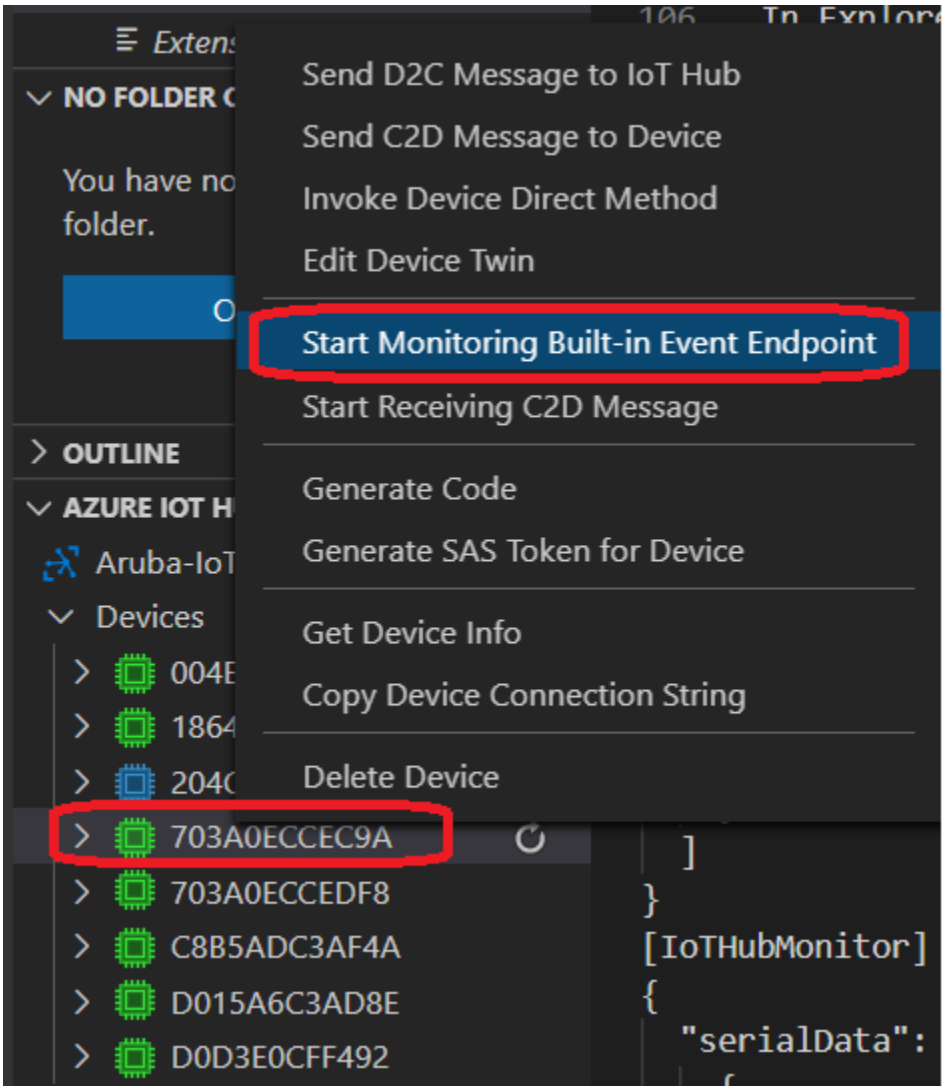
The devices list will be shown.



monitoring global message for your iothub

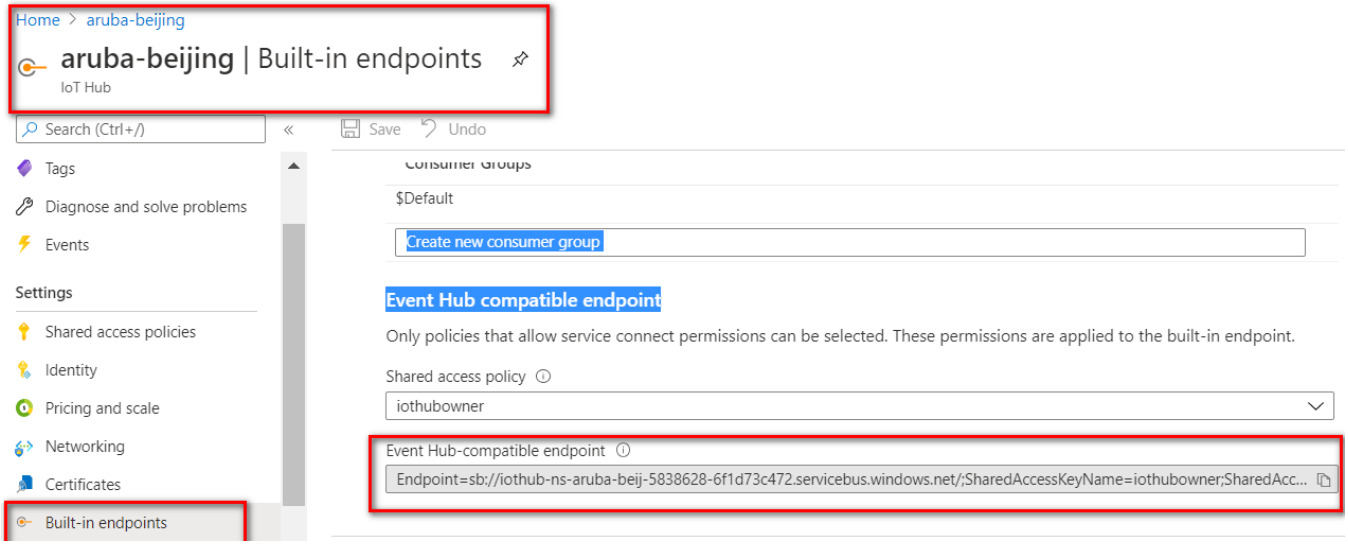


You can also monitor the specific device's message



Event Hub compatible endpoint

home----iot Hub-----Built-in endpoints



Output example

```
[IoTHubMonitor] Start monitoring message arrived in built-in endpoint for device [703A0ECCEC9A] ...
[IoTHubMonitor] Created partition receiver [0] for consumerGroup [$Default]
[IoTHubMonitor] Created partition receiver [1] for consumerGroup [$Default]
[IoTHubMonitor] Created partition receiver [2] for consumerGroup [$Default]
[IoTHubMonitor] Created partition receiver [3] for consumerGroup [$Default]
[IoTHubMonitor] [1:01:11 PM] Message received from [703A0ECCEC9A]:
{
"serialData": [
{
"data": "VQAHBwF69gAAKZyJoAH/////NABV"
}
]
}
[IoTHubMonitor] [1:01:11 PM] Message received from [703A0ECCEC9A]:
{
"serialData": [
{
"data": "VQAHBwF69lAAKZyJsAH/////LQAM"
}
]
}
[IoTHubMonitor] Stopping built-in event endpoint monitoring...
[IoTHubMonitor] Built-in event endpoint monitoring stopped.
```

Back-end Application-Python

We will use python samples to receive device-to-cloud messages and send cloud-to-device message.

download following samples from github to start with.

https://github.com/Azure-Samples/azure-iot-samples-python

you need to install your python in your system, require Python 3.6.x (or higher).

you also required to install "azure-iot-hub" and "azure-eventhub" module.

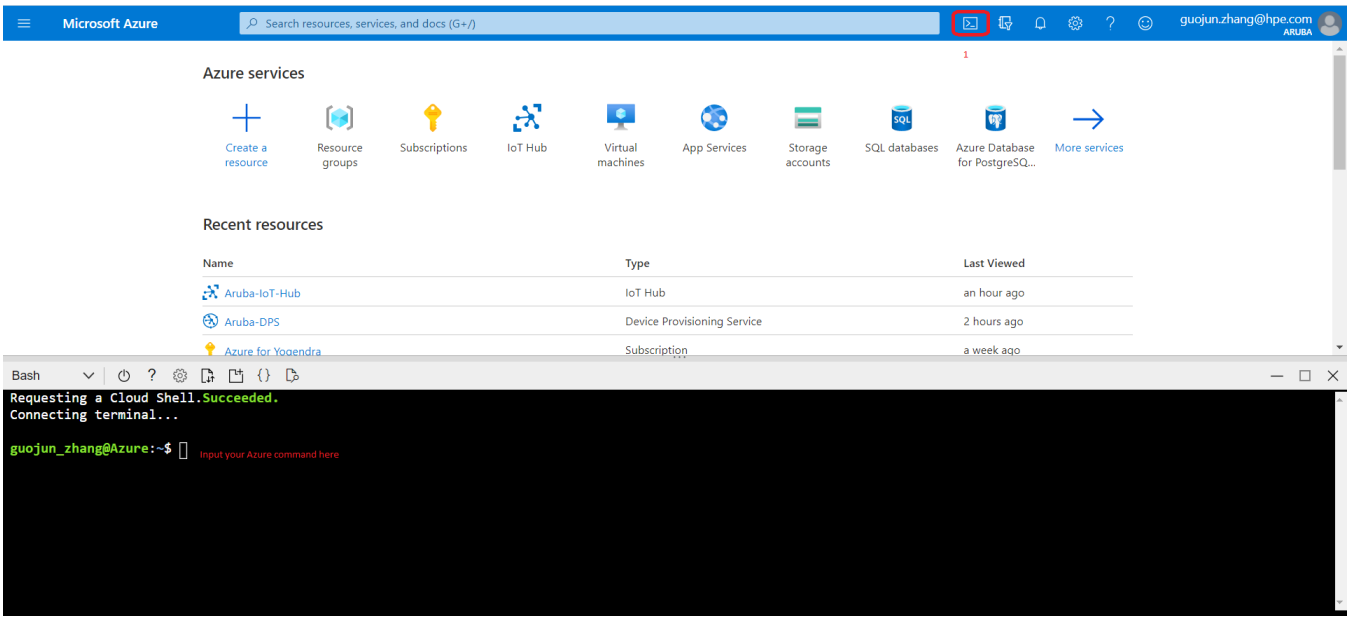
```
python3 -m pip install azure-iot-hub
```

```
python3 -m pip install azure-eventhub
```

Receive device to cloud messages

You also need the Event Hubs-compatible endpoint, Event Hubs-compatible path, and service primary key from your IoT hub to enable the back-end application to connect to your IoT hub and retrieve the messages.

You can open the Azure CLI from your azure account home page as displaied by following screenshot.



The following commands retrieve these values for your IoT hub:

Replace the "{YourIoTHubName}" below with the name you choose for your IoT hub.

```
az iot hub show --query properties.eventHubEndpoints.events.endpoint --name {YourIoTHubName}
az iot hub show --query properties.eventHubEndpoints.events.path --name {YourIoTHubName}
az iot hub policy show --name service --query primaryKey --hub-name {YourIoTHubName}
```

Navigate to the root folder of the sample Python project. Then navigate to the iot-hub\Quickstarts\read-d2c-messages folder.

Open the read_device_to_cloud_messages_sync.py file, and replace following three variables "EVENTHUB_COMPATIBLE_ENDPOINT", "EVENTHUB_COMPATIBLE_PATH", "IOTHUB_SAS_KEY".

Run the following command to receive the device to cloud message.

```
python3 read_device_to_cloud_messages_sync.py
```

The output example

```
Received event from partition: 0.
Telemetry received: {"serialData": [{"data": "VQAHBwF69gAAKZyJoAH/////NgB/"}]}
Properties (set by device): {b'version': b'1', b'messageType': b'serialDataNb'}
System properties (set by IoT Hub): {b'message-id': b'MSG_ID', b'correlation-id': b'CORE_ID', b'content-type': b'application%2fjson', b'content-encoding':
b'utf-8', b'iothub-connection-device-id': b'703A0ECCEC9A', b'iothub-connection-auth-method': b'{"scope":"device","type":"sas","issuer":"iothub","
acceptingIpFilterRule":null}', b'iothub-connection-auth-generation-id': b'637388596578496697', b'iothub-enqueuedtime': 1603904565349, b'iothub-
message-source': b'Telemetry', b'x-opt-sequence-number': 103, b'x-opt-offset': b'53576', b'x-opt-enqueued-time': 1603904565341}
```

Send cloud to device messages

To use cloud to device message, you need need a service connection string to enable the back-end application to connect to your IoT hub. The following command retrieves the service connection string for your IoT hub:

Replace the "{YourIoTHubName}" below with the name you choose for your IoT hub.

```
az iot hub show-connection-string --policy-name service --name {YourIoTHubName} --output table
```

The example give blow is based on Enocean usb device.

```
import random
import sys
from azure.iot.hub import IoTHubRegistryManager

MESSAGE_COUNT = 1

JSAON_TXT = "{\"sbDeviceId\":\"ENOCEAN_USB\",\"serialData\":[{\"data\":\"VQABAAVwAwk=\"}]}"

CONNECTION_STRING = "{CONNECTION_STRING}"

DEVICE_ID = "{DEVICE_ID}"

def iothub_messaging_sample_run():
  try:
      # Create IoTHubRegistryManager
      registry_manager = IoTHubRegistryManager(CONNECTION_STRING)

      for i in range(0, MESSAGE_COUNT):
          print ( 'Sending message: {0}'.format(i) )
          data = JSAON_TXT
          print ('data: %s' % data)

          props={}
          # optional: assign system properties
          props.update(messageId = "message_%d" % i)
          props.update(correlationId = "correlation_%d" % i)
          props.update(contentType = "application/json")

          # optional: assign application properties
          #prop_text = "PropMsg_%d" % i
          #props.update(testProperty = prop_text)
          props.update(messageType = "serialDataSb")
          props.update(deviceIdentifier = "11111111")
          print ('props: %s' % props)

          registry_manager.send_c2d_message(DEVICE_ID, data, properties=props)

      try:
          # Try Python 2.xx first
          raw_input("Press Enter to continue...\n")
      except:
          pass
          # Use Python 3.xx in the case of exception
          input("Press Enter to continue...\n")

  except Exception as ex:
      print ( "Unexpected error {0}" % ex )
      return
  except KeyboardInterrupt:
      print ( "IoT Hub C2D Messaging service sample stopped" )

if __name__ == '__main__':
  print ( "Starting the Python IoT Hub C2D Messaging service sample..." )

  iothub_messaging_sample_run()
```

Run SendCloudToDeviceMessage example:

```
swatch@swatch-XPS-L412Z:Send-Cloud-To-Device-Message$ python3 SendCloudToDeviceMessage.py
Starting the Python IoT Hub C2D Messaging service sample...
Sending message: 0
data: {"sbDeviceId":"ENOCEAN_USB","serialData":[{"data":"VQABAAVwAwk="}]}
props: {'messageId': 'message_0', 'correlationId': 'correlation_0', 'contentType': 'application/json', 'messageType': 'serialDataSb', 'deviceIdentifier':
'11111111'}
Press Enter to continue...
```

Trace messagess on the IAP

We need to enable ble_daemon and ble_relay logs for "Azure-IoTHub" specificly

```
70:3a:0e:cc:ec:9a# ble-init-action log-level-str Azure-IoTHub

log level parsed. log_level = 0x400000

70:3a:0e:cc:ec:9a# ble-init-action ble_relay set-attr br-loglvl 2048
```

North bound example:

Run "show ap debug ble-daemon" to check if ble-daemon forward data to Azure IoTHub

```
2020-10-28 21:03:29 ble_ap_fw_serial_data:5374 forward serial reporting to Azure for azure-iothub-test profile
2020-10-28 21:03:29 Send message to Azure IoTHub messageType serialDataNb, ID Null, data: {"serialData": [{"data": "VQAHBwF69gAAKZyJoAH
/////KgDU"}]}.
```

Run "show ap debug ble-relay" to check if ble_relay received the data to Azure IoTHub

```
[6346]2020-10-28 21:03:29 ble_relay_handle_azure_iothub_data_msg:135 Aruba Telemetry :1
[6346]2020-10-28 21:03:29 br_azure_iothub_msg:67 msg from 127.0.0.1:8514, len: 142.
```

Run "show ap debug ble-relay azure-iothub-log" to check if we send the data to Azure IoTHub

```
2020-10-28 21:03:29 Sending serialDataNb message (id ) to IoTHub
```

South bound example:

Run "show ap debug ble-relay azure-iothub-log" to check if the message is received by azure iothub library.

```
2020-10-28 19:07:07 Received Binary message
Message ID: message_0
Correlation ID: correlation_0
Data: <<<{"sbDeviceId":"ENOCEAN_USB","serialData":[{"data":"VQABAAVwAwk="}]}>>> & Size=67
2020-10-28 19:07:07 Message Properties:
2020-10-28 19:07:07 Key: messageType Value: serialDataSb
2020-10-28 19:07:07 Key: deviceIdentifier Value: 11111111
2020-10-28 19:07:07
2020-10-28 19:07:07 Azure SB MSG: send sb message to ble_relay messageType serialDataSb, deviceIdentifier 11111111..
```

Run "show ap debug ble-relay" to check if the ble_relay forward the SB message to ble_daemon.

```
[6346]2020-10-28 19:07:07 azure_iothub_forward_sbsdata_to_ble_daemon:665 Azure-IoTHub-SB-Data: receive sb data, messageType serialDataSb,
deviceIdentifier 11111111.
[6346]2020-10-28 19:07:07 azure_iothub_forward_sbsdata_to_ble_daemon:742 Azure-IoTHub-SB-Data: send sb data to 127.0.0.1, messageType
serialDataSb, deviceIdentifier 11111111.
```

Run "show ap debug ble-daemon" to check if the ble_daemon handled the SB message.

```
2020-10-28 19:07:07 Received SB message
Message ID: serialDataSb
device ID: 11111111
Data: <<<{"sbDeviceId":"ENOCEAN_USB","serialData":[{"data":"VQABAAVwAwk="}]}>>> & Size=67

2020-10-28 19:07:07 ble_ap_handle_az_iothub_sb_data:629 start to write message to device ENOCEAN_USB, data: VQABAAVwAwk=(base64 format).
2020-10-28 19:07:07 ble_ap_send_data_to_serial_device:5444 Send serial data to ENOCEAN_USB.
```