2023.12.28/v0.1

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Creating Petalinux Project

Create KV260 Petalinux Project from BSP

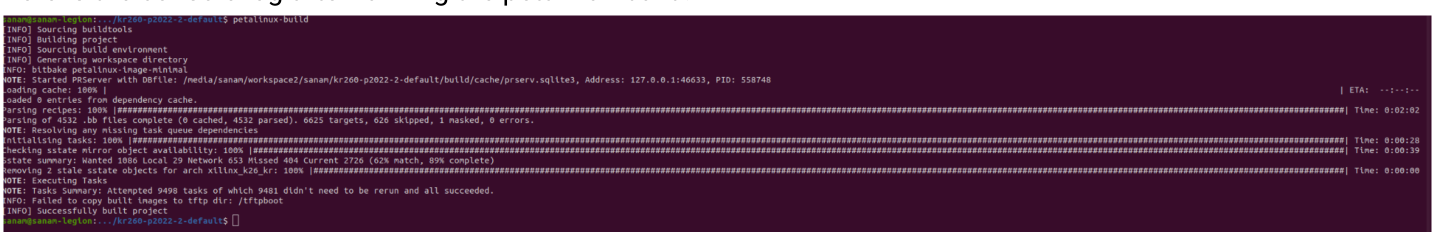
In host machine, create the petalinux project using BSP available at following download link: Run following commands to create petalinux project after sourcing the Petalinux 2023.1 environment:
https://www.xilinx.com/member/forms/download/xef.html?filename=xilinx-kv260-starterkit-v2023.1-05080224.bsp

```
source <Path to Petalinux 2023.1>/settings.sh
petalinux-create -t project -s xilinx-kv260-starterkit-v2023.1-05080224.bsp -n
kv260-2023_1-default
cd kv260-2023_1-default
```

Here “kv260-2023_1-default” is the directory created by petalinux-create command, you can change the name according to your need. This directory is the petalinux-project base directory, which we will be using in further steps.
Next build the project:

```
petalinux-config --silentconfig
petalinux-build
```

Here is the console log after running the petalinux-build.



Next create the SD card image with the following commands:

```
package --wic --images-dir images/linux/ --bootfiles
"ramdisk.cpio.gz.u-boot,boot.scr,Image,system.dtb,system-zynqmp-sck-kv-g-revB.dtb"
--disk-name "mmcblk1"
```

This will create the petalinux-sdimage.wic image at <petalinux project directory>/image/linux folder. Copy the created wic image to SD card using tools like Balena Etcher.

Installing hardware overlay

Get the KV260 firmware folder. It contains:

- kv260-gpio-i2c.bit.bin
- kv260-gpio-i2c.dtbo
- shell.json

Copy these file to the KV260 board. For firmware to be loaded using xmutil (FPGA manager), one has to copy these file at “/lib/firmware/xilinx”.
For this create the folder at “kv260-gpio-i2c” at “/lib/firmware/xilinx” and copy the files in “kv260-gpio-i2c” folder.

```
cd /lib/firmware/xilinx
sudo mkdir kv260-gpio-i2c
sudo cp <kv260-firmware directory>/kv260-gpio-i2c* ./
sudo cp <kv260-firmware directory>/shell.json ./
```

Next, check the available fpga firmware using `xmutil listapps` command. `kv260-gpio-i2c` will be available in the list.

```
          Accelerator          Accel_type                 Base        Base_type    #slots(PL+AIE)      Active_slot

       kd240-gpio-i2c            XRT_FLAT       kd240-gpio-i2c         XRT_FLAT             (0+0)               -1
     k24-starter-kits            XRT_FLAT     k24-starter-kits         XRT_FLAT             (0+0)               0,
```

Next load the `kv260-gpio-i2c` firmware, which contains necessary hardwares(gpio) and interfaces. In our Greengrass Demo we will be using these gpio to trigger the publishing data to AWS Greengrass IoT cloud server and also actuate GPIO on the message received from AWS cloud.

```
sudo xmutil unloadapp
sudo xmutil loadapp kv260-gpio-i2c
```

```
[  141.337484] OF: overlay: WARNING: memory leak will occur if overlay removed, property: /fpga-full/firmware-name
[  141.347670] OF: overlay: WARNING: memory leak will occur if overlay removed, property: /fpga-full/resets
[  141.357614] OF: overlay: WARNING: memory leak will occur if overlay removed, property: /__symbols__/afi0
[  141.367136] OF: overlay: WARNING: memory leak will occur if overlay removed, property: /__symbols__/clocking0
[  141.377081] OF: overlay: WARNING: memory leak will occur if overlay removed, property: /__symbols__/axi_intc_0
[  141.387107] OF: overlay: WARNING: memory leak will occur if overlay removed, property: /__symbols__/axi_intc_1
[  141.397141] OF: overlay: WARNING: memory leak will occur if overlay removed, property: /__symbols__/axi_gpio_0
[  141.407176] OF: overlay: WARNING: memory leak will occur if overlay removed, property: /__symbols__/axi_iic_0
kd240-gpio-i2c: loaded to slot 0
```

Now, check the available i2c channels available in the system using `i2cdetect` i2c utility tool.

```
sudo i2cdetect -l
```

```
i2c-1   i2c         Cadence I2C at ff030000          I2C adapter
i2c-2   i2c         xiic-i2c 80010000.i2c            I2C adapter
```

`i2c-2` channel will be used to connect to BMP180 sensor.

Connecting BMP180 to AXI I2C Bus

Connect BMP180 sensors, Vcc, GND, I2C SDA and I2C SCLK pins to PMOD as explained below:
PMOD1-> 3 - I2C SCLK

PMOD1-> 1 - I2C SDA
PMOD1-> GND - BMP180 GND
PMOD1->Vcc - BMP180 Vcc

11	9	7	5	3	1	PMOD UPPER
12	10	8	6	4	2	PMOD LOWER
Vcc	GND	I/O	I/O	I/O	I/O	

PMOD port numbering

After connecting BMP180 sensor to KV260 PMOD port, use i2c utility tools to scan for the available devices in i2c-8 channel.

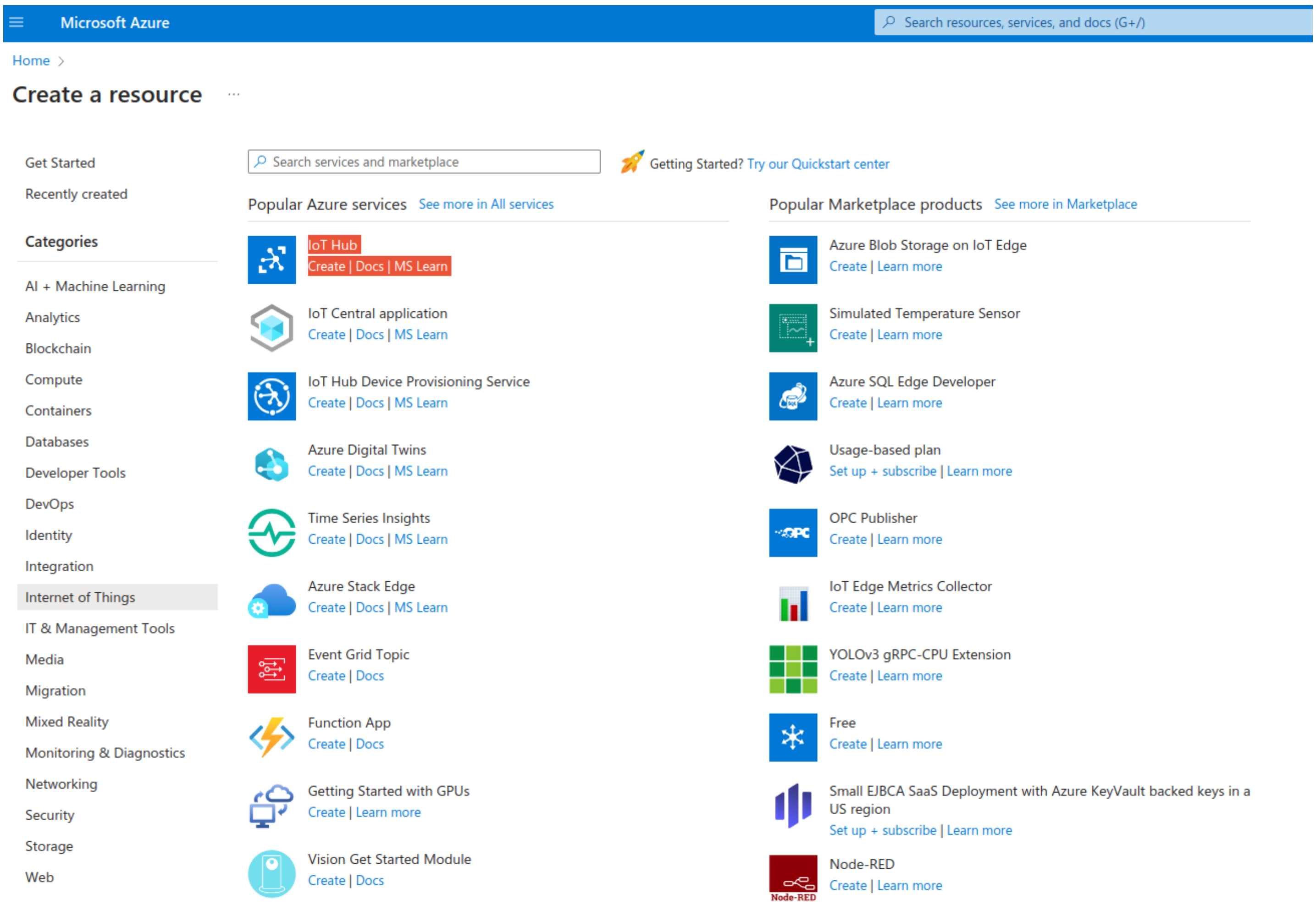
```
sudo i2cdetect -y 2
```

```
     0  1  2  3  4  5  6  7  8  9  a  b  c  d  e  f
00:                         -- -- -- -- -- -- -- --
10: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
20: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
30: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
40: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
50: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
60: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
70: -- -- -- -- -- -- -- 77
```

In i2c scan, we find a device is available at address ‘77’, which corresponds to BMP180 i2c sensor.
Next we will add the component for publishing BMP180 sensor data to the AWS IoT cloud.

Create IoT Hub in Azure Portal:

- Go to Azure portal " https://portal.azure.com ".
- Create a resource >> IoT Hub.



Next, create one IoT Hub Service and fill in the necessary details

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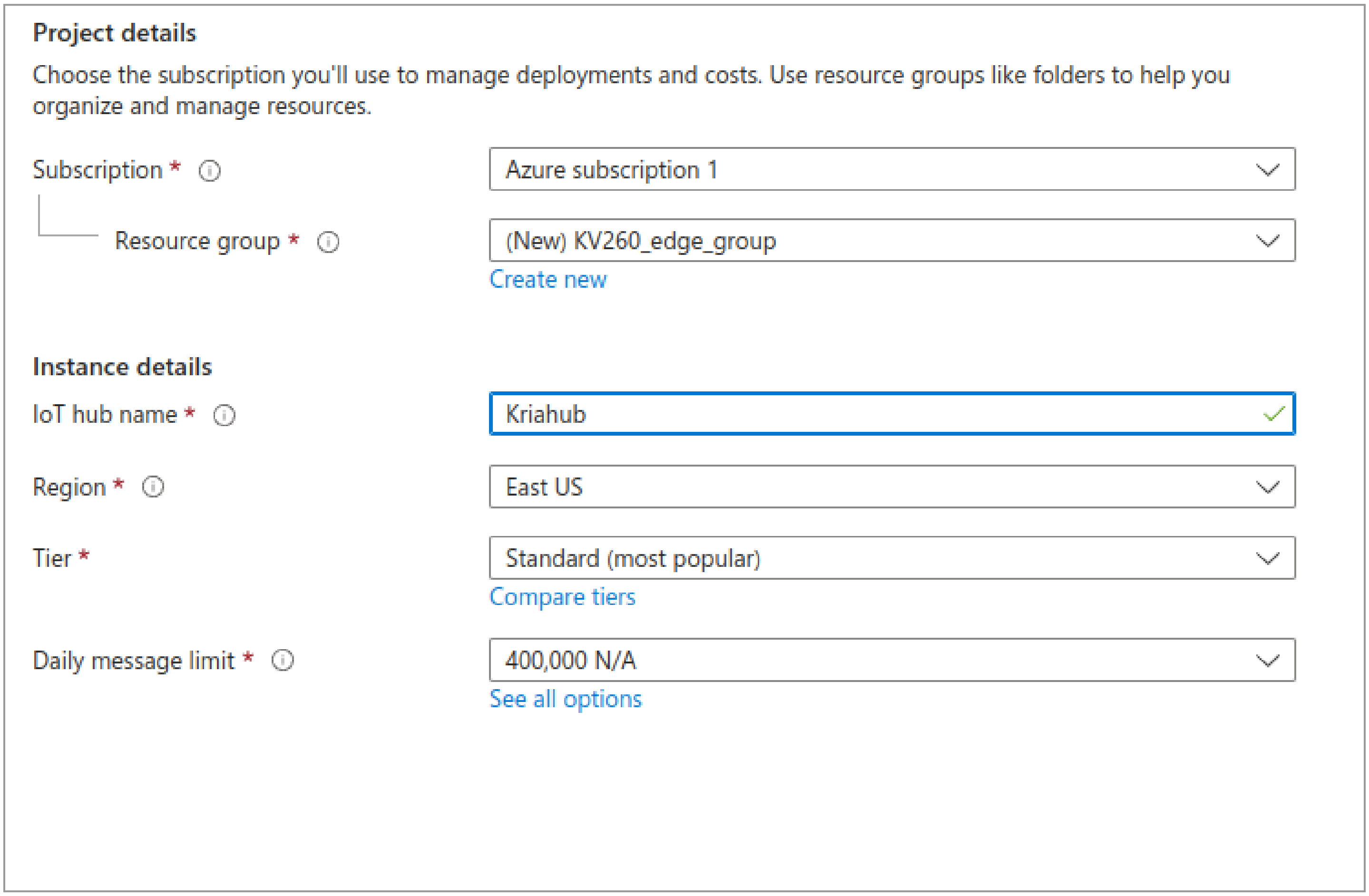
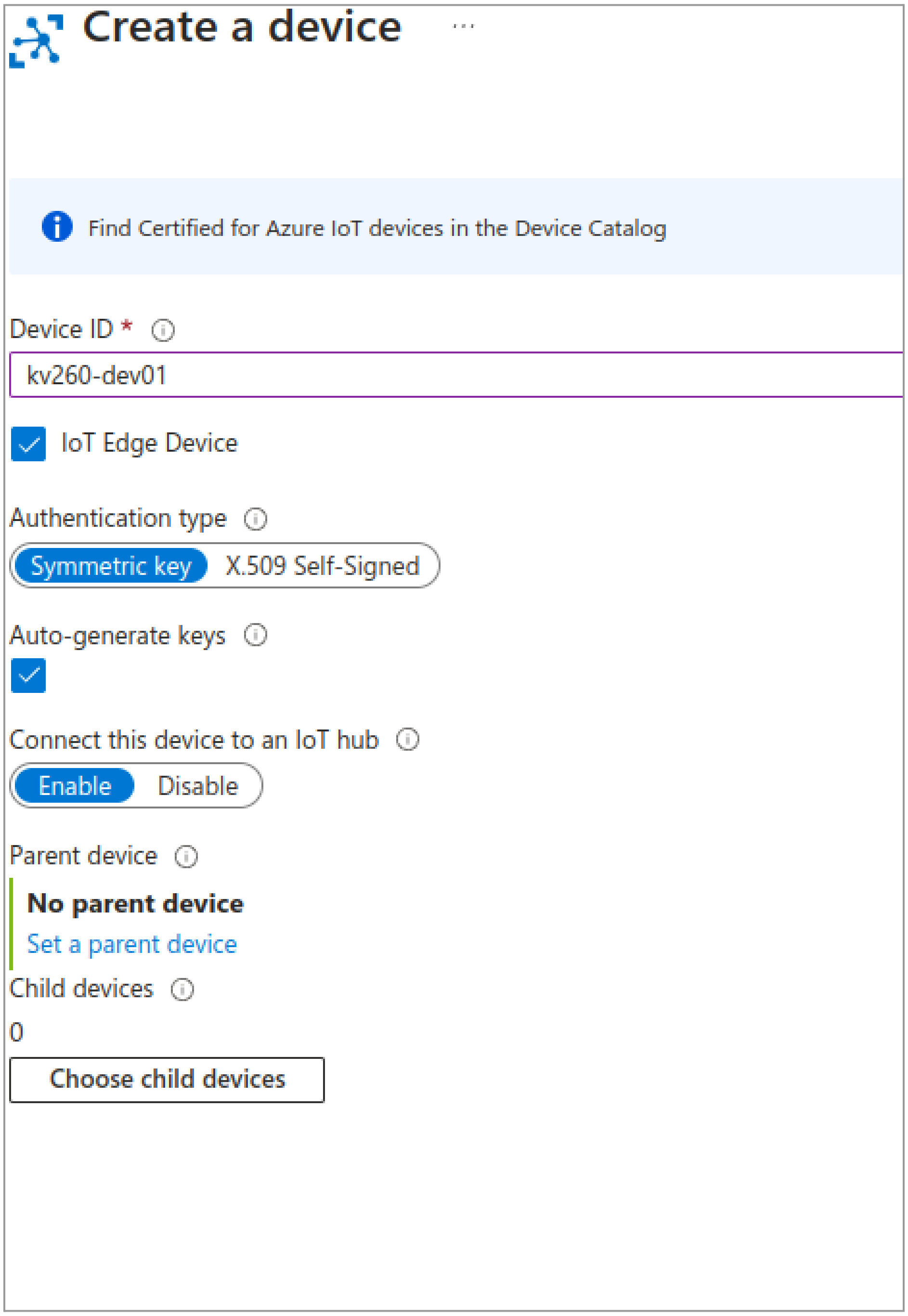


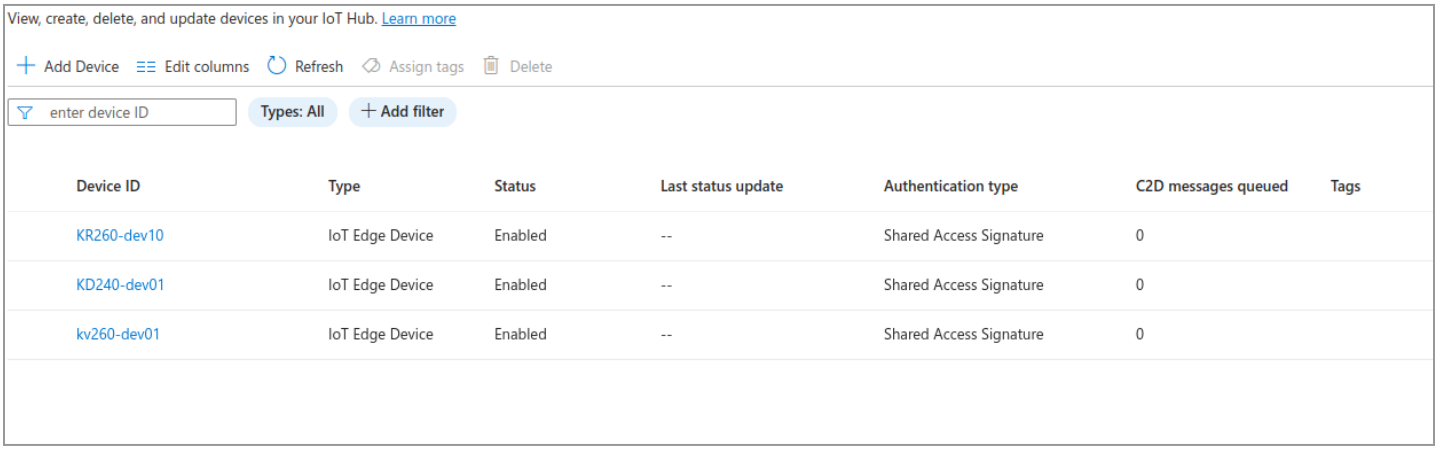
- Click on Review+ Create button to create the Azure IoT Hub.
- Next, create a device where you can actually receive some data from the hardware.

Create an IoT Device

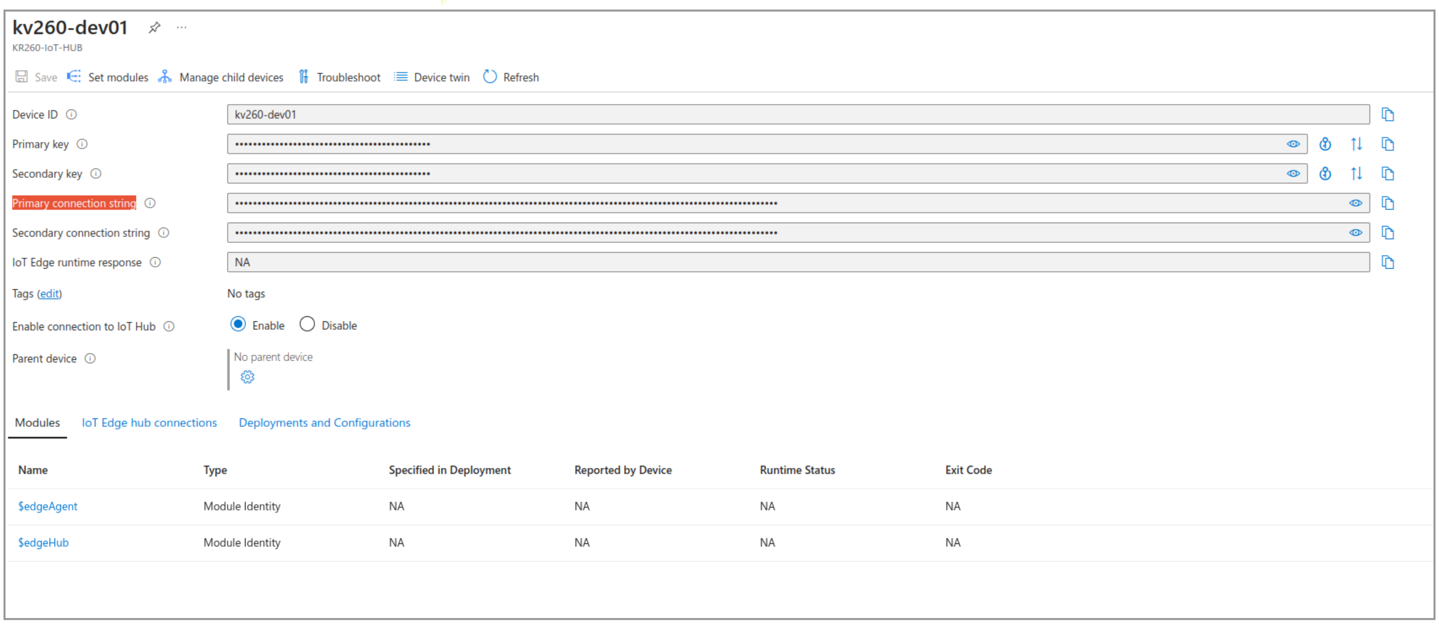
Go to the IoT Device and click on new, and give the device ID



After this device will be available in the IoT hub Device list.



Next, look into device information for getting the keys and connection string.



Copy the “Primary Connection String” which will be used in the python application for sending the sensor data to IoT hub.

Installing python packages

azure.iot.device python module is required to create a azure IoT device at the edge device. Install it using python pip3:

```
sudo pip3 install azure-iot-device
```

Further for getting ‘bmp180’ sensor data from i2c, install bmp180 python driver module from git. For installing, run following commands:

```
git clone https://github.com/m-rtijn/bmp180
cd bmp180
```

Update the ~/bmp180/bmp180/bmp180.py to use i2c-2 channel by changing following lines:

```
import smbus
import math
from time import sleep

class bmp180:
    # Global variables
    address = None
    bus = smbus.SMBus(2)
    mode = 1 # TODO: Add a way to change the mode

    # BMP180 registers
    CONTROL_REG = 0xF4
    DATA_REG = 0xF6

    # Calibration data registers
"bmp180.py" 225L, 6914B written
ubuntu@kria:~/bmp180/bmp180$
```

Install the bmp180 module by running:

```
sudo python3 setup.py install
```

Adding python application in KRIA

Copy the azure_bmp180.py example code to the KV260 board.
Next update the “CONNECTION STRING” with the above Primary Connection string.

mqtt.py

```
import random
import time
from bmp180 import bmp180

bmp = bmp180(0x77)


from azure.iot.device import IoTHubDeviceClient, Message

CONNECTION_STRING = "<Connection String>"

TEMPERATURE = 20.0
HUMIDITY = 60
MSG_TXT = '{{"temperature": {temperature},"humidity": {humidity}}}'

def iothub_client_init():
    client = IoTHubDeviceClient.create_from_connection_string(CONNECTION_STRING)
    return client

def iothub_client_telemetry_sample_run():

    try:
        client = iothub_client_init()
        print ( "IoT Hub device sending periodic messages, press Ctrl-C to exit" )
        while True:

            temperature = TEMPERATURE + (random.random() * 15)
            humidity = HUMIDITY + (random.random() * 20)
            msg_txt_formatted = MSG_TXT.format(temperature=bmp.get_temp(), humidity=humidity)
            message = Message(msg_txt_formatted)

```

Then run the application in console:

```
sudo python3 azure_bmp180.py
```

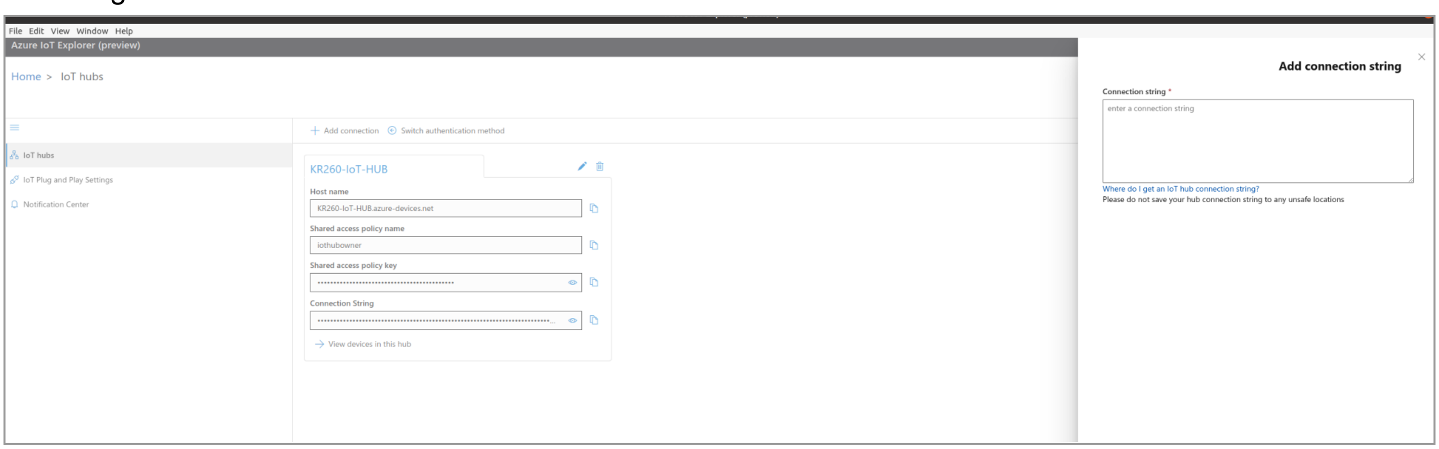
Here is the console log after a successful message send to Azure IoT hub.

```
Press Ctrl-C to exit
IoT Hub device sending periodic messages, press Ctrl-C to exit
Sending message: {"temperature": 39.75936867897661,"pressure": 87758.24057110936}
Message successfully sent
Sending message: {"temperature": 39.765232533114784,"pressure": 87737.39283234128}
Message successfully sent
Sending message: {"temperature": 39.75350468584645,"pressure": 87751.60383676378}
Message successfully sent
Sending message: {"temperature": 39.75936867897661,"pressure": 87751.60383676378}
Message successfully sent
Sending message: {"temperature": 39.765232533114784,"pressure": 87747.88433116772}
Message successfully sent
Sending message: {"temperature": 39.77695982453383,"pressure": 87754.5890678738}
Message successfully sent
Sending message: {"temperature": 39.765232533114784,"pressure": 87752.98531510356}
Message successfully sent
Sending message: {"temperature": 39.75936867897661,"pressure": 87754.52134913116}
Message successfully sent
Sending message: {"temperature": 39.75936867897661,"pressure": 87753.20754948346}
```

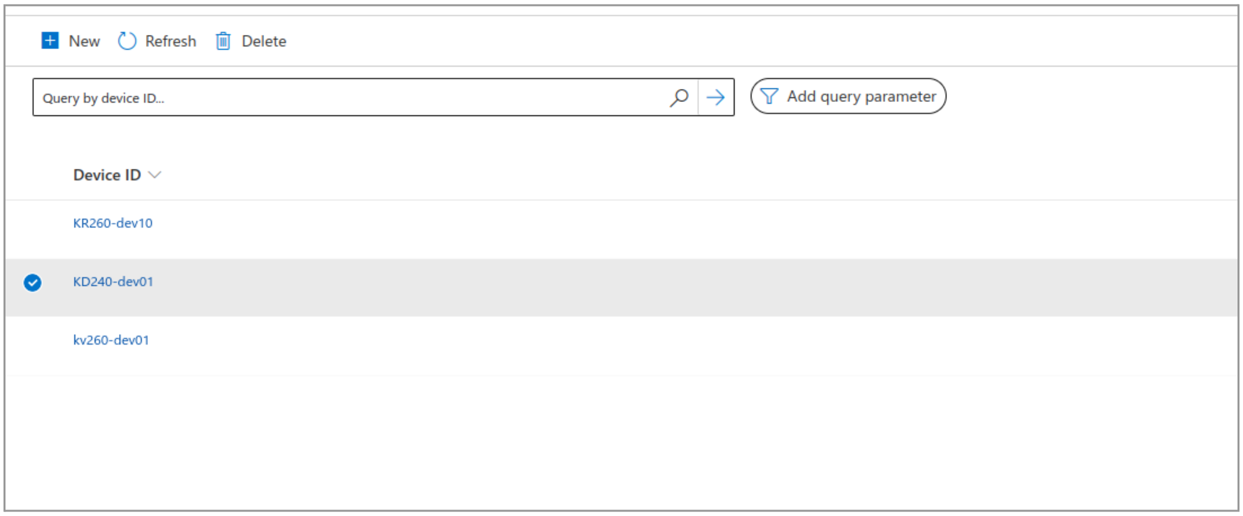
Viewing message in Host Machine

For viewing the message published by Azure IoT Device in KV260, one can use Azure IoT explorer available in following link:
https://github.com/Azure/azure-iot-explorer/releases

In IoT HUbs page of the application, in +Add connection copy the connection string for the IoT hub and save the configs:



One can find the corresponding device list in the IoT HuB page of Azure IoT explorer application.



Just click onto the device to view the device information and also the message send by python application running in the KV260 board.

For viewing the message send to device, go to Telemetry and click the >Start button.
After this one can view the message send to the device.