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Quick Solution

Azure IoT Workshop

The Workshop Manual

This book is the Workshop's Manual for the Azure IoT Course.

เทคโนโลยีพลิกโลกในยุคปัจจุบันที่ทุกอย่างเชื่อมโยง
ถึงกันหมด จะเปลี่ยนวิธีการดำเนินธุรกิจแบบเดิมๆ
อุตสาหกรรม และ การใช้ชีวิตประจำวัน ทุกวันนี้เราอยู่ใน โลกของ “smart products” และ “intelligent business services” เทคโนโลยีที่มี ความก้าวหน้ายิ่ง เช่น
Internet of Things (IoT), cloud computing, mobile, social และ big data ทำให้ทุกหน่วยงานจำเป็นต้องปรับกระบวนการ
ทำงานที่ทำอยู่ให้มีการเชื่อมโยงเข้ากับเครือข่าย
คอมพิวเตอร์มากขึ้น

คู่มือนี้ใช้ประกอบการอบรม เพื่อให้ผู้สนใจด้าน IoT มีโอกาส ได้เรียนรู้และสัมผัสกับพลังของ IoT ที่จะเชื่อมโยงอุปกรณ์ ของเรา
นำข้อมูลที่ไม่เคยสนใจในอดีตมาใช้ประโยชน์ เพื่อสะท้อนให้เราเห็นภาพของธุรกิจของเราอย่าง
ถ่องแท้ และเพิ่มมูลค่าให้กับธุรกิจ

Connect Raspberry Pi to Azure IoT Hub (Node.js)

In this tutorial, you begin by learning the basics of working with Raspberry Pi that's running Raspbian. You then learn how to seamlessly connect your devices to the cloud by using Azure IoT Hub. For Windows 10 IoT Core samples, go to the Windows Dev Center.

Don't have a kit yet? Try Raspberry Pi online simulator. Or buy a new kit here.

What you do

- Setup Raspberry Pi.
- Create an IoT hub.
- Register a device for Pi in your IoT hub.
- Run a sample application on Pi to send sensor data to your IoT hub.

Connect Raspberry Pi to an IoT hub that you create. Then you run a sample application on Pi to collect temperature and humidity data from a BME280 sensor. Finally, you send the sensor data to your IoT hub.

What you learn

- How to create an Azure IoT hub and get your new device connection string.
- How to connect Pi with a BME280 sensor.
- How to collect sensor data by running a sample application on Pi.
- How to send sensor data to your IoT hub.

What you need

- The Raspberry Pi 2 or Raspberry Pi 3 board.
- An active Azure subscription. If you don't have an Azure account, create a free Azure trial account in just a few minutes.
- A monitor, a USB keyboard, and mouse that connect to Pi.
- A Mac or a PC that is running Windows or Linux.
- An Internet connection.
- A 16 GB or above microSD card.
- A USB-SD adapter or microSD card to burn the operating system image onto the microSD card.
- A 5-volt 2-amp power supply with the 6-foot micro USB cable.

The following items are optional:

- An assembled Adafruit BME280 temperature, pressure, and humidity sensor.
- A breadboard.
- 6 F/M jumper wires.
- A diffused 10-mm LED.

> [!NOTE] These items are optional because the code sample support simulated sensor data.

[!INCLUDE iot-hub-get-started-create-hub-and-device]

Setup Raspberry Pi

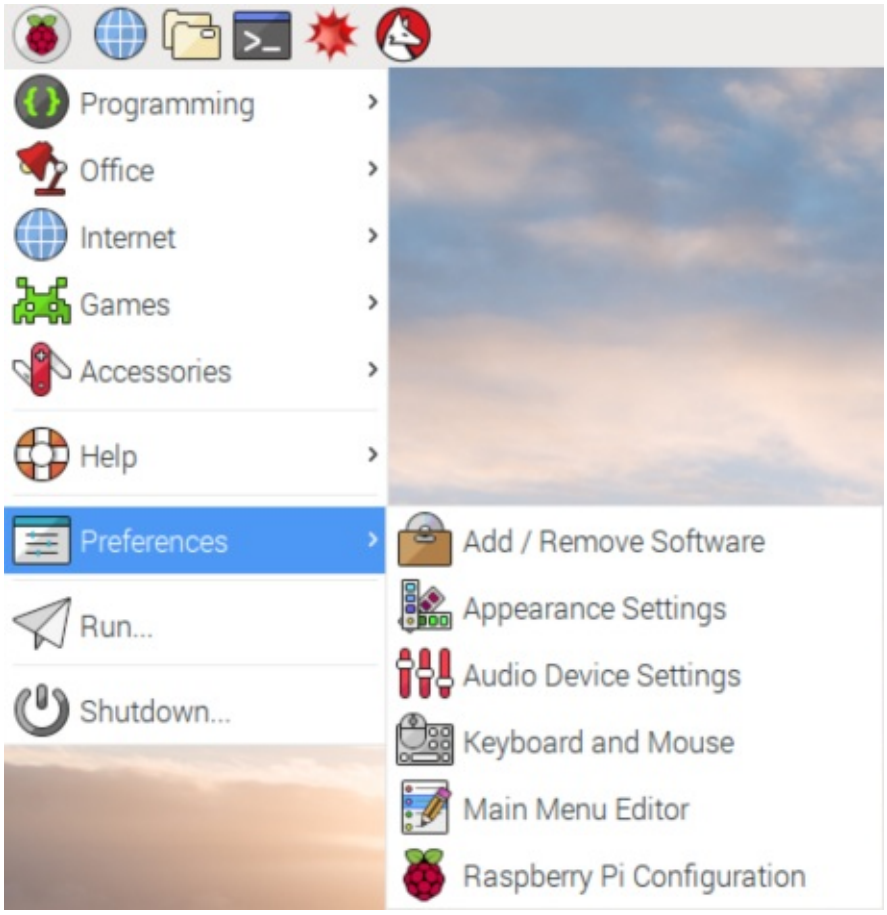
Install the Raspbian operating system for Pi

Prepare the microSD card for installation of the Raspbian image.

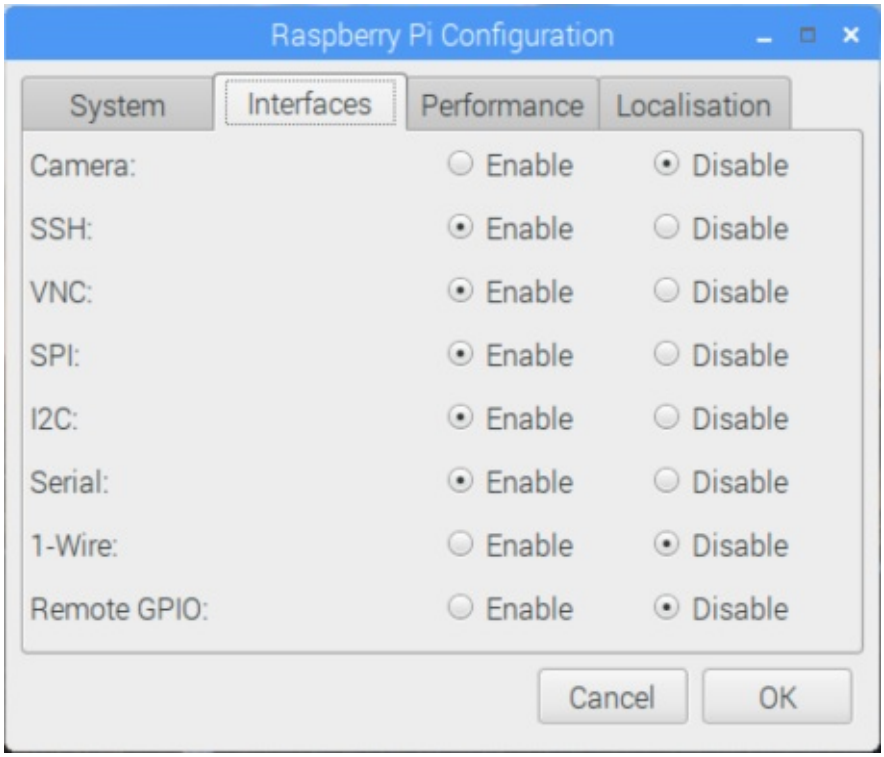
1. Download Raspbian.
    i. Download Raspbian Jessie with Pixel (the .zip file).
    ii. Extract the Raspbian image to a folder on your computer.
2. Install Raspbian to the microSD card.
    i. Download and install the Etcher SD card burner utility.
    ii. Run Etcher and select the Raspbian image that you extracted in step 1.
    iii. Select the microSD card drive. Note that Etcher may have already selected the correct drive.
    iv. Click Flash to install Raspbian to the microSD card.
    v. Remove the microSD card from your computer when installation is complete. It's safe to remove the microSD card directly because Etcher automatically ejects or unmounts the microSD card upon completion.
    vi. Insert the microSD card into Pi.

Enable SSH and I2C

1. Connect Pi to the monitor, keyboard and mouse, start Pi and then log in Raspbian by using `pi` as the user name and `raspberry` as the password.
2. Click the Raspberry icon > **Preferences** > **Raspberry Pi Configuration**.



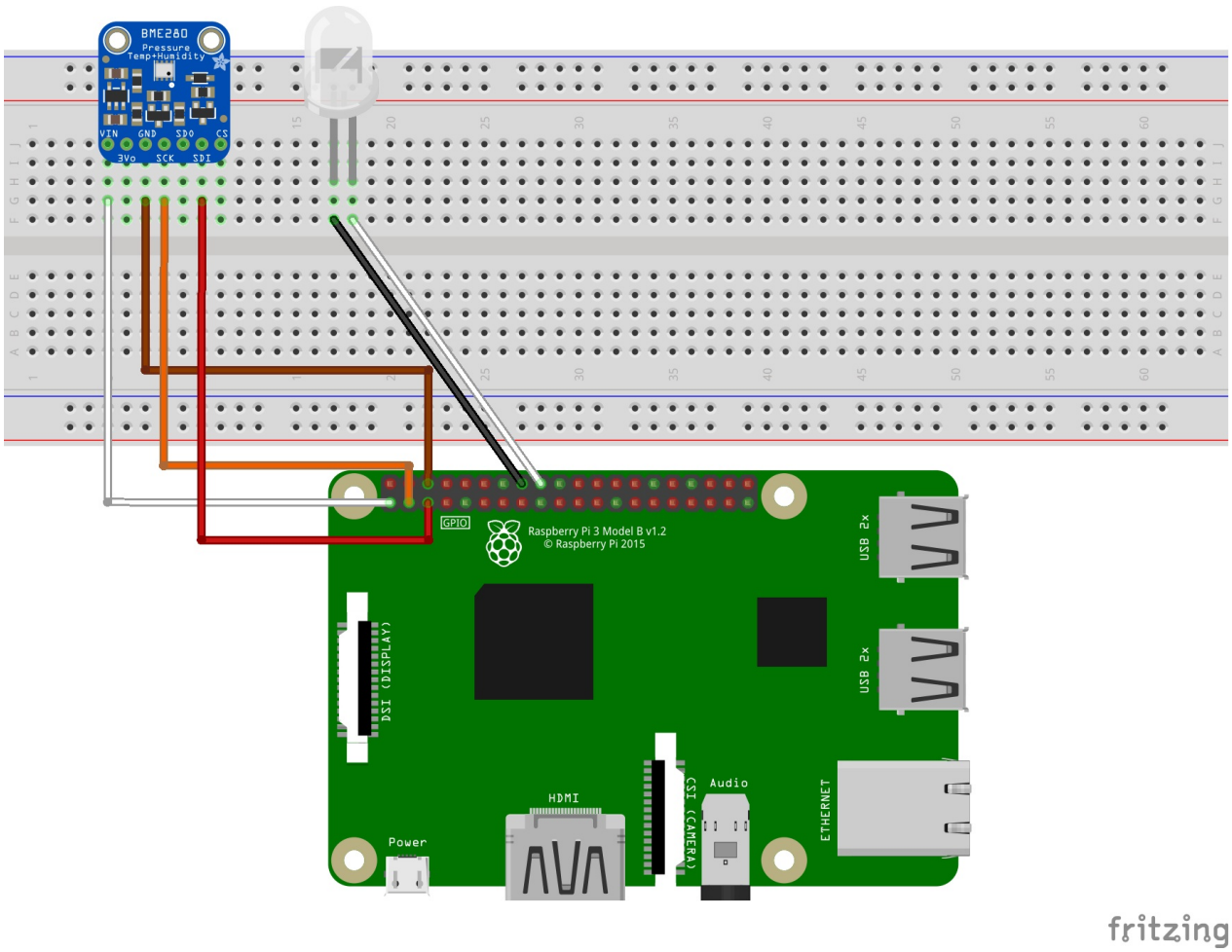
3. On the **Interfaces** tab, set **I2C** and **SSH** to **Enable**, and then click **OK**. If you don't have physical sensors and want to use simulated sensor data, this step is optional.



> [!NOTE] To enable SSH and I2C, you can find more reference documents on raspberrypi.org and Adafruit.com.

Connect the sensor to Pi

Use the breadboard and jumper wires to connect an LED and a BME280 to Pi as follows. If you don’t have the sensor, skip this section.



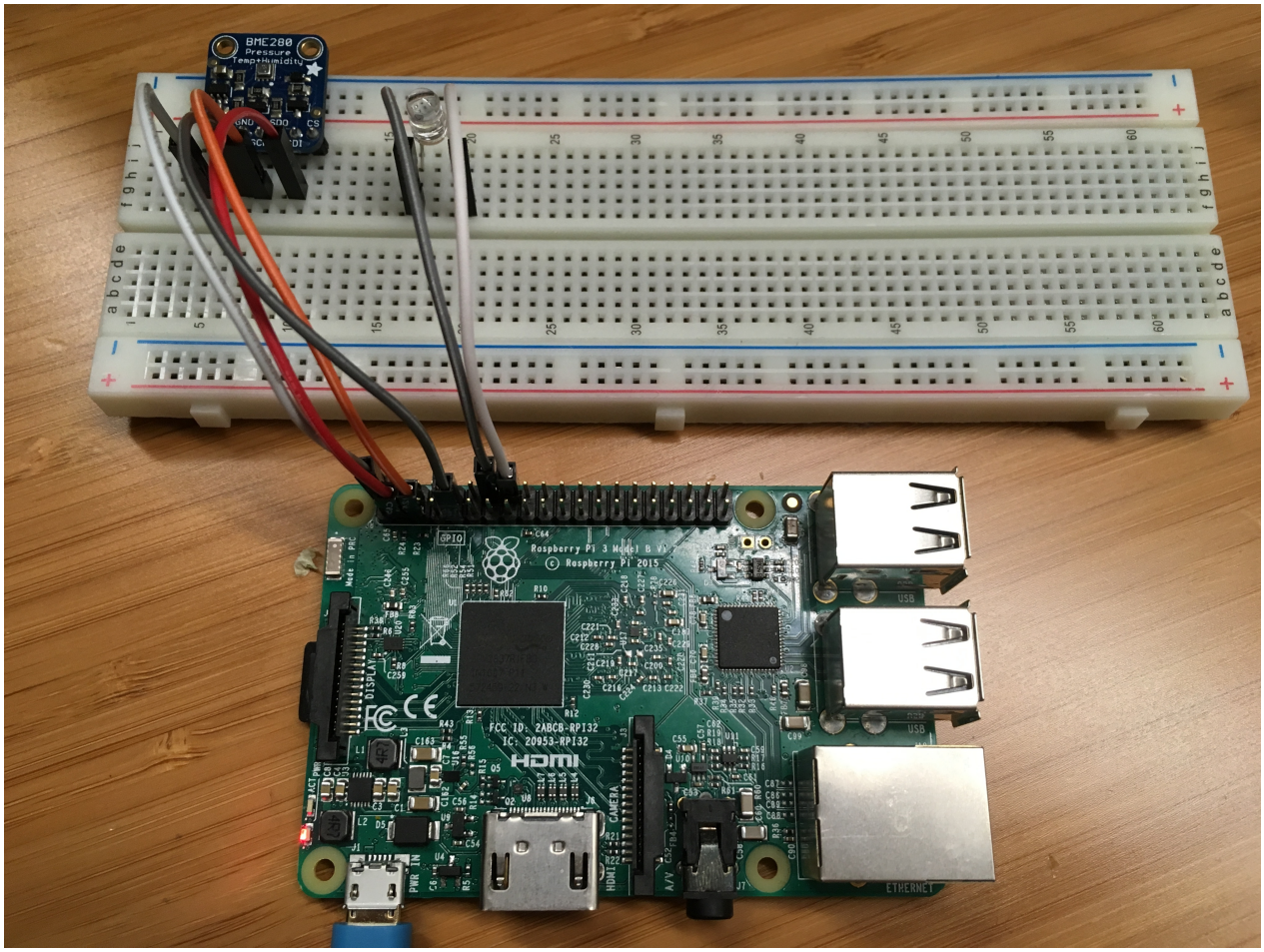
The BME280 sensor can collect temperature and humidity data. And the LED will blink if there is a communication between device and the cloud.

For sensor pins, use the following wiring:

Start (Sensor & LED)	End (Board)	Cable Color
VDD (Pin 5G)	3.3V PWR (Pin 1)	White cable
GND (Pin 7G)	GND (Pin 6)	Brown cable
SCK (Pin 8G)	I2C1 SDA (Pin 3)	Orange cable
SDI (Pin 10G)	I2C1 SCL (Pin 5)	Red cable
LED VDD (Pin 18F)	GPIO 24 (Pin 18)	White cable
LED GND (Pin 17F)	GND (Pin 20)	Black cable

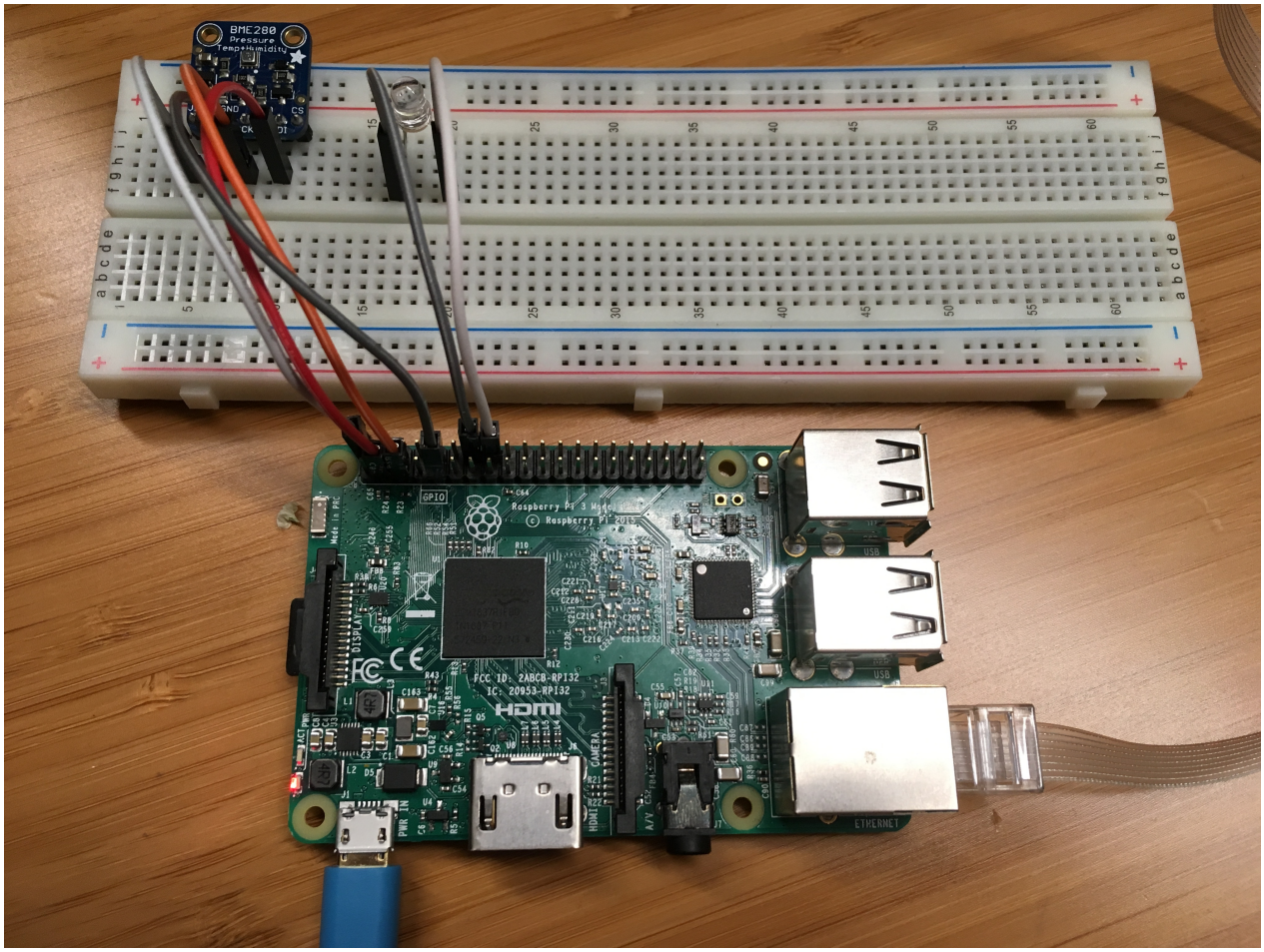
Click to view Raspberry Pi 2 & 3 Pin mappings for your reference.

After you've successfully connected BME280 to your Raspberry Pi, it should be like below image.



Connect Pi to the network

Turn on Pi by using the micro USB cable and the power supply. Use the Ethernet cable to connect Pi to your wired network or follow the instructions from the Raspberry Pi Foundation to connect Pi to your wireless network. After your Pi has been successfully connected to the network, you need to take a note of the IP address of your Pi.



> [!NOTE] Make sure that Pi is connected to the same network as your computer. For example, if your computer is connected to a wireless network while Pi is connected to a wired network, you might not see the IP address in the devdisco output.

Run a sample application on Pi

Clone sample application and install the prerequisite packages

1. Use one of the following SSH clients from your host computer to connect to your Raspberry Pi.
   - PuTTY for Windows. You need the IP address of your Pi to connect it via SSH.
   - The built-in SSH client on Ubuntu or macOS. You might need run `ssh pi@<ip address of pi>` to connect Pi via SSH.

   > [!NOTE] The default username is `pi` , and the password is `raspberry` .

2. Install Node.js and NPM to your Pi.

   First you should check your Node.js version with the following command.

```
node -v
```

If the version is lower than 4.x or there is no Node.js on your Pi, then run the following command to install or update Node.js.

```
curl -sL http://deb.nodesource.com/setup_4.x | sudo -E bash
sudo apt-get -y install nodejs
```

3. Clone the sample application by running the following command:

```
git clone https://github.com/Azure-Samples/iot-hub-node-raspberrypi-client-app
```

4. Install all packages by the following command. It includes Azure IoT device SDK, BME280 Sensor library and Wiring Pi library.

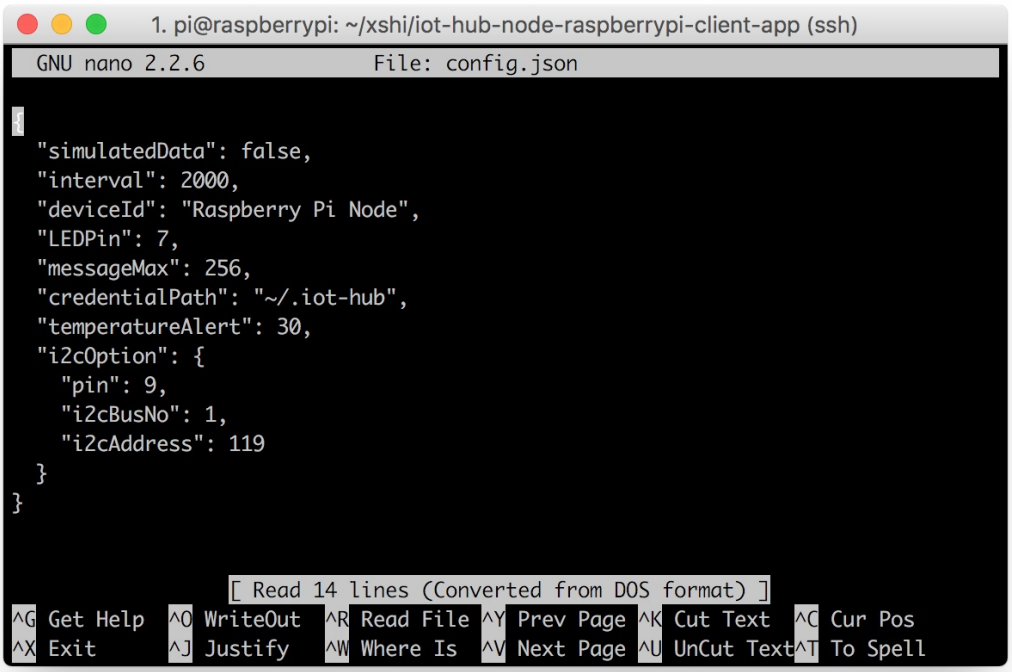
```
cd iot-hub-node-raspberrypi-client-app
sudo npm install
```

> [!NOTE] It might take several minutes to finish this installation process denpening on your network connection.

Configure the sample application

1. Open the config file by running the following commands:

```
nano config.json
```



There are two items in this file you can configurate. The first one is `interval`, which defines the time interval between two messages that send to cloud. The second one `simulatedData`,which is a Boolean value for whether to use simulated sensor data or not.

If you **don't have the sensor**, set the `simulatedData` value to `true` to make the sample application create and use simulated sensor data.

2. Save and exit by pressing Control-O > Enter > Control-X.

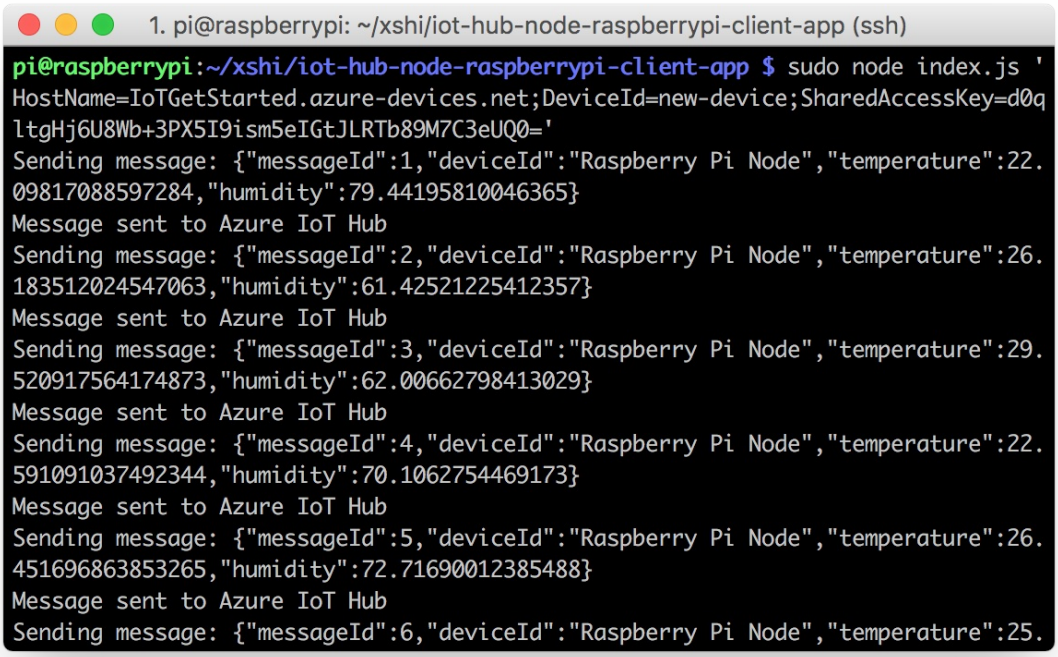
Run the sample application

1. Run the sample application by running the following command:

```
sudo node index.js '<your Azure IoT hub device connection string>'
```

> [!NOTE] Make sure you copy-paste the device connection string into the single quotes.

You should see the following output that shows the sensor data and the messages that are sent to your IoT hub.



Next steps

You've run a sample application to collect sensor data and send it to your IoT hub.

Connect Raspberry Pi online simulator to Azure IoT Hub (Node.js)

In this tutorial, you begin by learning the basics of working with Raspberry Pi online simulator. You then learn how to seamlessly connect the Pi simulator to the cloud by using Azure IoT Hub.

If you have physical devices, visit Connect Raspberry Pi to Azure IoT Hub to get started.

What you do

- Learn the basics of Raspberry Pi online simulator.
- Create an IoT hub.
- Register a device for Pi in your IoT hub.
- Run a sample application on Pi to send simulated sensor data to your IoT hub.

Connect simulated Raspberry Pi to an IoT hub that you create. Then you run a sample application with the simulator to generate sensor data. Finally, you send the sensor data to your IoT hub.

What you learn

- How to create an Azure IoT hub and get your new device connection string.
- How to work with Raspberry Pi online simulator.
- How to send sensor data to your IoT hub.

Overview of Raspberry Pi web simulator

Click the button to launch Raspberry Pi online simulator.

> [!div class="button"] Start Raspberry Pi simulator

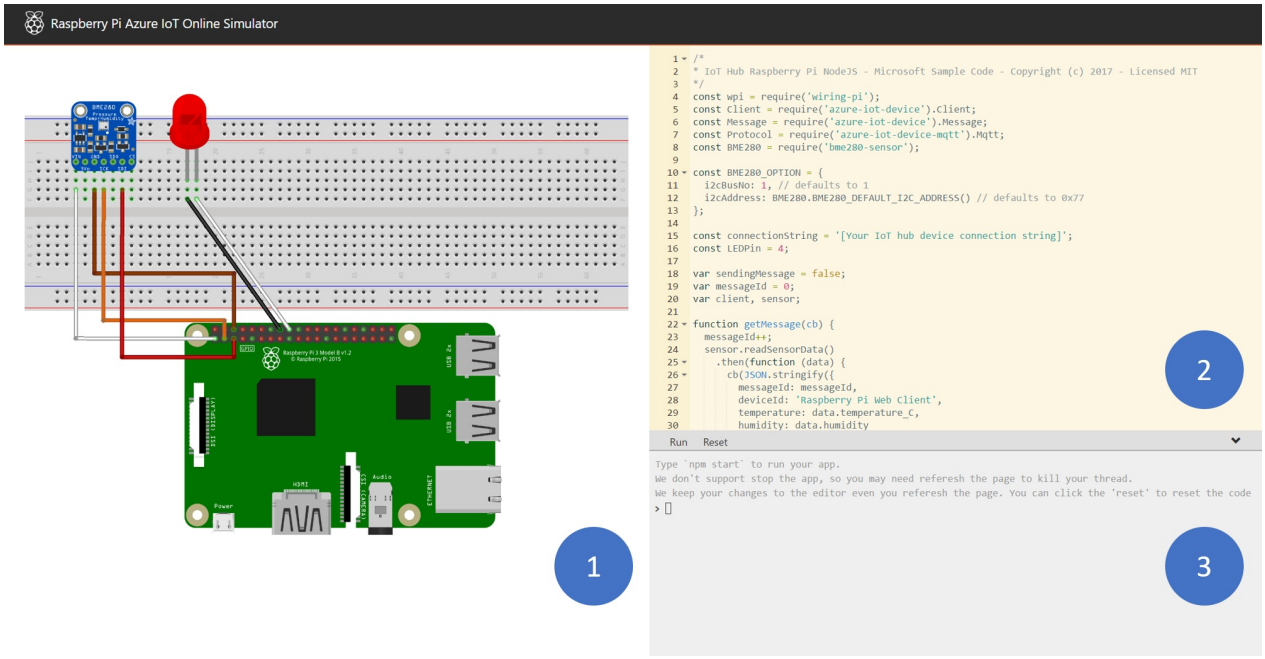
There are three areas in the web simulator.

- Assembly area - The default circuit is that a Pi connects with a BME280 sensor and an LED. The area is locked in preview version so currently you cannot do customization.
- Coding area - An online code editor for you to code with Raspberry Pi. The default sample application helps to collect sensor data from BME280 sensor and sends to your

Azure IoT Hub. The application is fully compatible with real Pi devices.

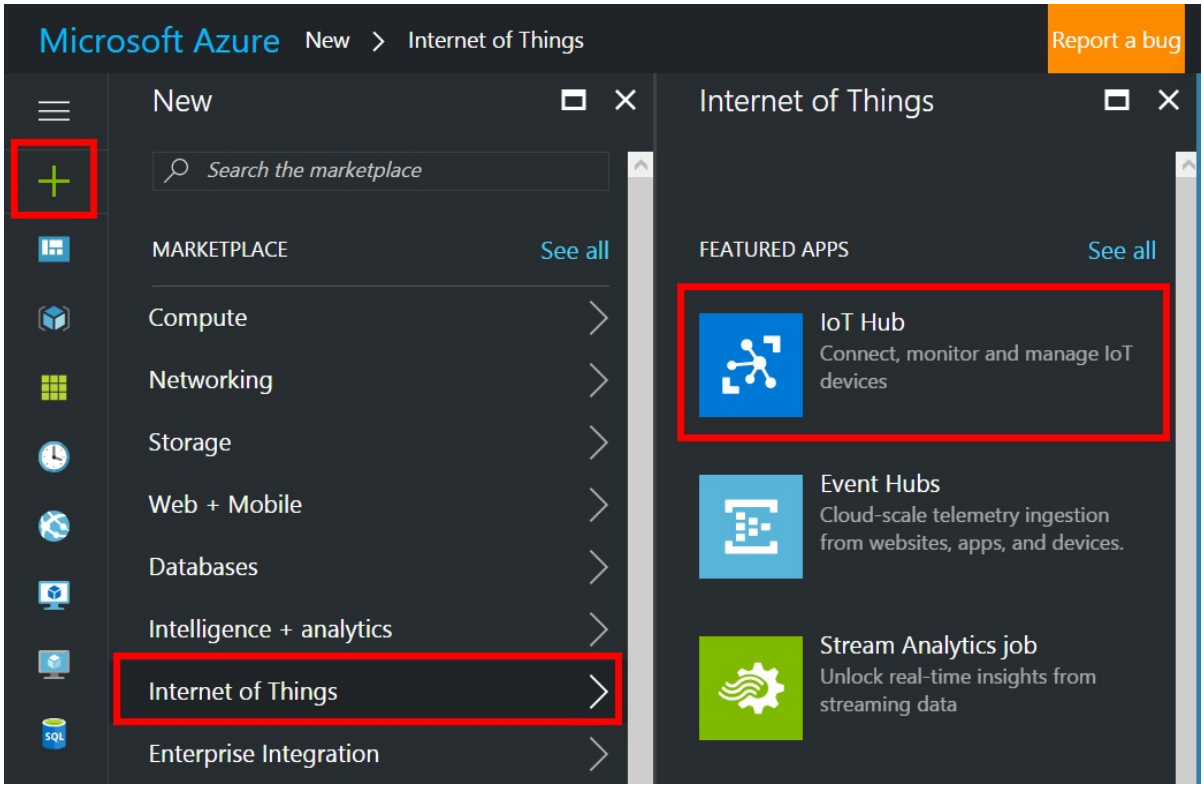
- Integrated console window - It shows the output of your code. At the top of this window, there are three buttons.
  - **Run** - Run the application in the coding area.
  - **Reset** - Reset the coding area to the default sample application.
  - **Fold/Expand** - On the right side there is a button for you to fold/expand the console window.

> [!NOTE] The Raspberry Pi web simulator is now available in preview version. We'd like to hear your voice in the Gitter Chatroom. The source code is public on Github.



Create an IoT hub

1. In the Azure portal, click **New** > **Internet of Things** > **IoT Hub**.



2. In the **IoT hub** pane, enter the following information for your IoT hub:

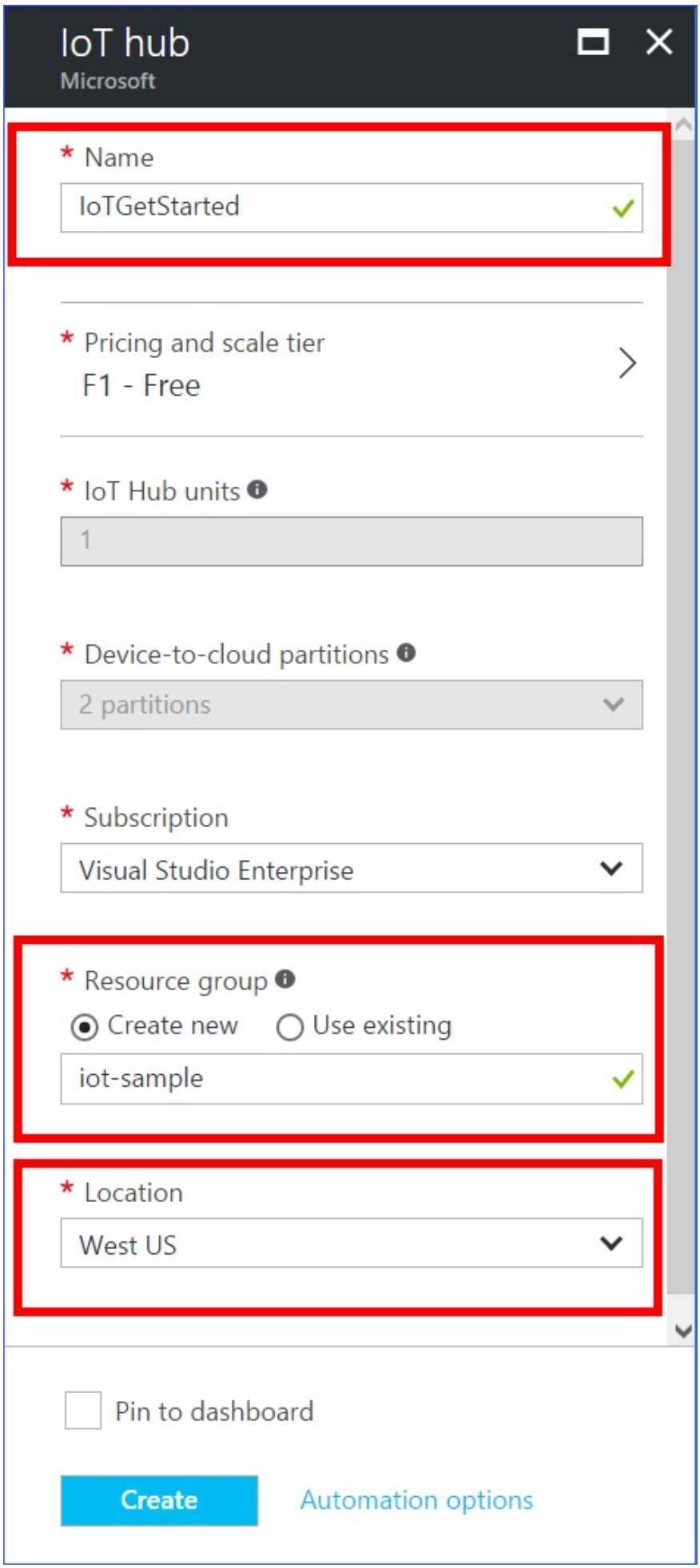
   Name: It is the name for your IoT hub. If the name you enter is valid, a green check mark appears.

   Pricing and scale tier: Select the free F1 tier. This option is sufficient for this demo. See pricing and scale tier.

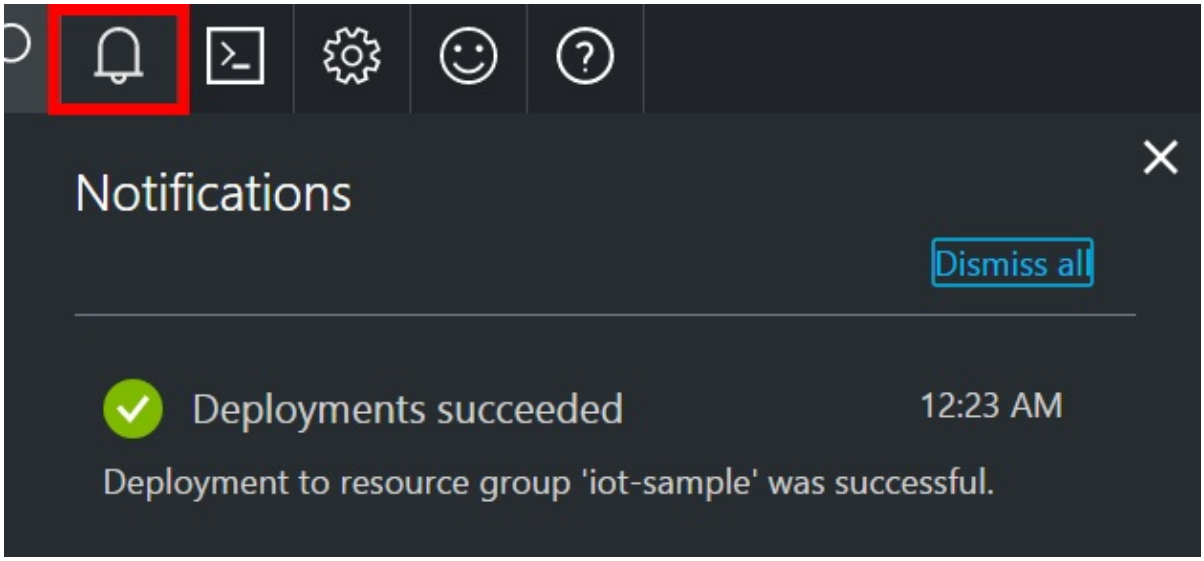
   Resource group: Create a resource group to host the IoT hub or use an existing one. See Using resource groups to manage your Azure resources.

   Location: Select the closest location to you where the IoT hub is created.

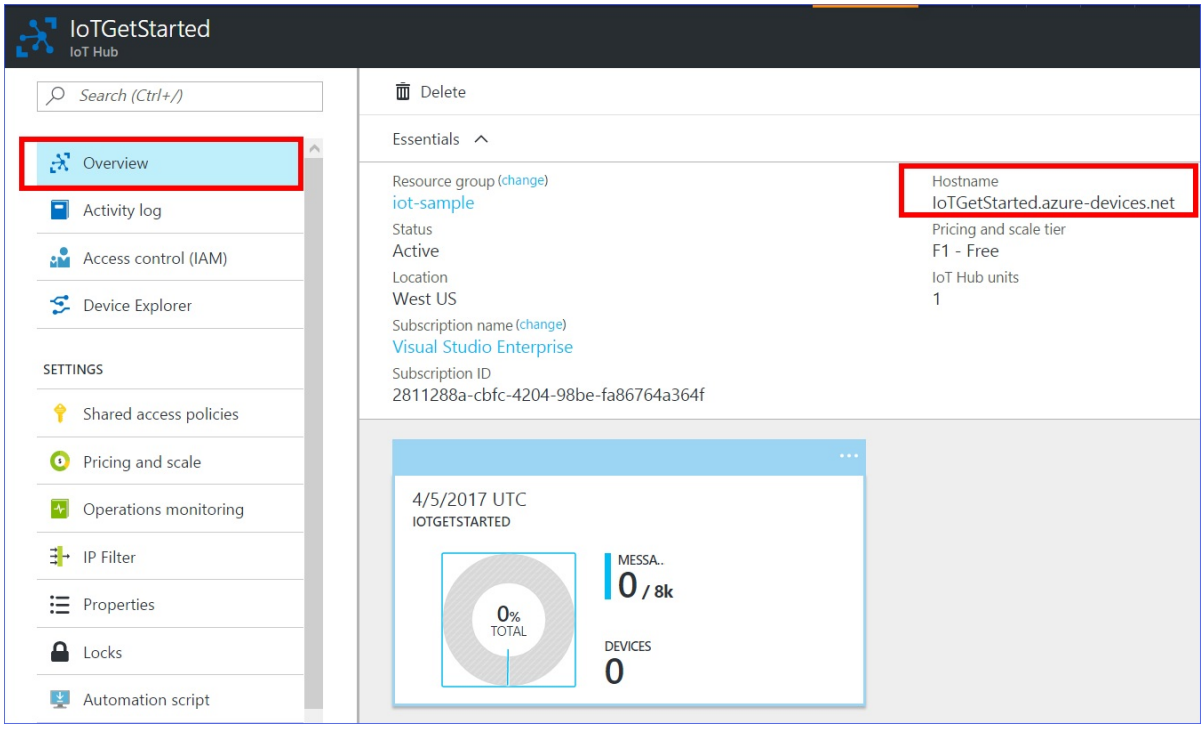
   Pin the dashboard: Check this option for easy access to your IoT hub from the dashboard.


IoT hub
Microsoft
* Name
IoTGetStarted
* Pricing and scale tier
F1 - Free
* IoT Hub units
1
* Device-to-cloud partitions
2 partitions
* Subscription
Visual Studio Enterprise
* Resource group
Create new
Use existing
iot-sample
* Location
West US
Pin to dashboard
Create
Automation options

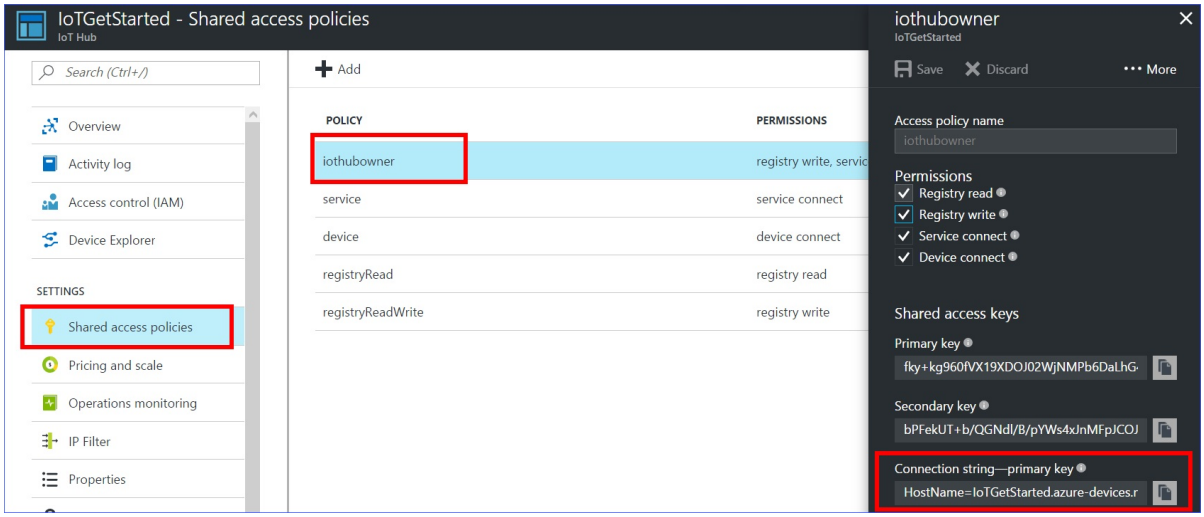
3. Click **Create**. It could take a few minutes for your IoT hub to be created. You can see progress in the **Notifications** pane.



4. Once your IoT hub is created, click it from the dashboard. Make a note of the **Hostname**, and then click **Shared access policies**.



5. In the **Shared access policies** pane, click the **iothubowner** policy, and then copy and make a note of the **Connection string** of your IoT hub. For more information, see Control access to IoT Hub.



Register a device in the IoT hub for the your device

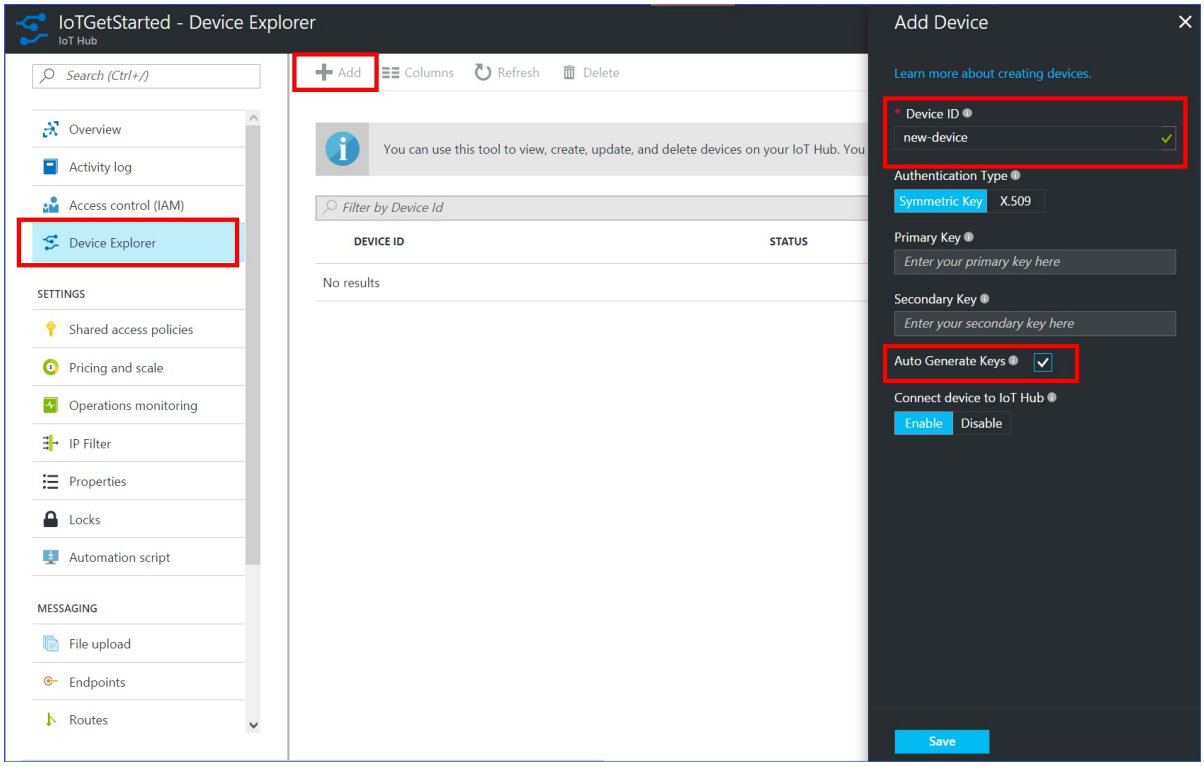
1. In the Azure portal, open your IoT hub.
2. Click **Device Explorer**.
3. In the Device Explorer pane, click **Add** to add a device to your IoT hub.

   Device ID: The ID of the new device. Device IDs are case sensitive.

   Authentication Type: Select **Symmetric Key**.

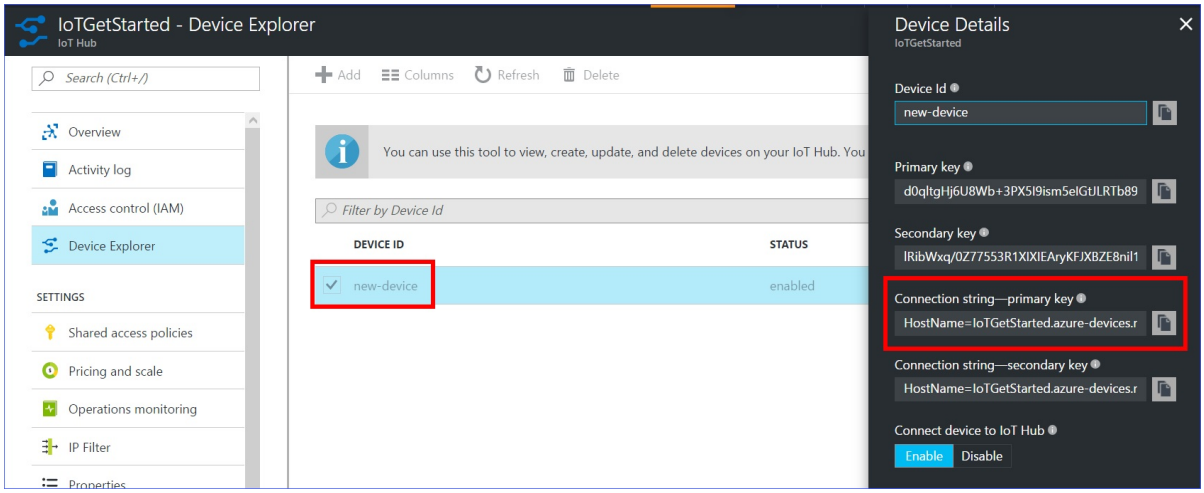
   Auto Generate Keys: Check this field.

   Connect device to IoT Hub: Click **Enable**.



4. Click **Save**.

5. After the device is created, open the device in the **Device Explorer** pane.
6. Make a note of the primary key of the connection string.



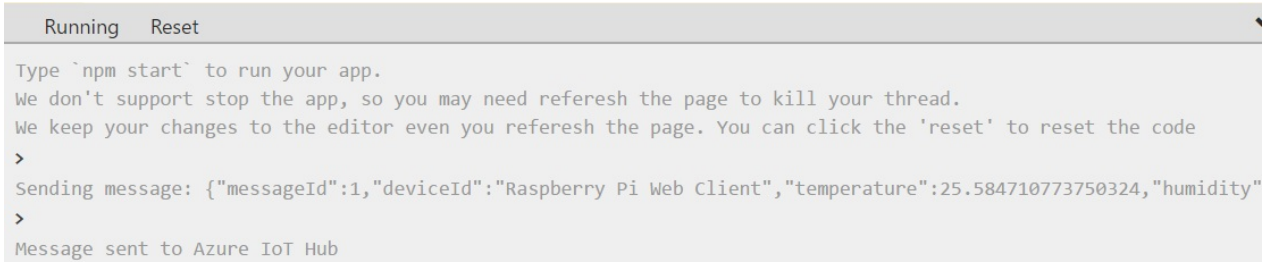
Run a sample application on Pi web simulator

1. In coding area, make sure you are working on the default sample application. Replace the placeholder in Line 15 with the Azure IoT hub device connection string.

```
14
15  const connectionString = '[Your IoT hub device connection string]';
16  const LEDPin = 4;
17
```

2. Click **Run** or type `npm start` to run the application.

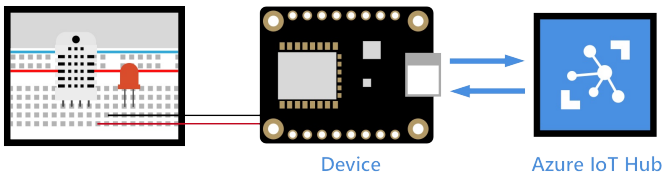
You should see the following output that shows the sensor data and the messages that are sent to your IoT hub



Next steps

You’ve run a sample application to collect sensor data and send it to your IoT hub.

Use iothub-explorer to send and receive messages between your device and IoT Hub



> [!NOTE] Before you start this tutorial, make sure you've completed Setup your device. By Setup your device, you set up your IoT device and IoT hub, and deploy a sample application to run on your device. The application sends collected sensor data to your IoT hub.

iothub-explorer has a handful of commands that makes IoT Hub management easier. This tutorial focuses on how to use iothub-explorer to send and receive messages between your device and your IoT hub.

What you will learn

You learn how to use iothub-explorer to monitor device-to-cloud messages and to send cloud-to-device messages. Device-to-cloud messages could be sensor data that your device collects and then sends to your IoT hub. Cloud-to-device messages could be commands that your IoT hub sends to your device to blink an LED that is connected to your device.

What you will do

- Use iothub-explorer to monitor device-to-cloud messages.
- Use iothub-explorer to send cloud-to-device messages.

What you need

- Tutorial Setup your device completed which covers the following requirements:

    - An active Azure subscription.
    - An Azure IoT hub under your subscription.
    - A client application that sends messages to your Azure IoT hub.
- iothub-explorer. (Install iothub-explorer)

Monitor device-to-cloud messages

To monitor messages that are sent from your device to your IoT hub, follow these steps:

1. Open a console window.
2. Run the following command:

```
iothub-explorer monitor-events <device-id> --login "<IoTHubConnectionString>"
```

> [!Note] Get `<device-id>` and `<IoTHubConnectionString>` from your IoT hub. Make sure you've finished the previous tutorial. Or you can try to use `iothub-explorer monitor-events <device-id> --login "HostName=<my-hub>.azure-devices.net;SharedAccessKeyName=<my-policy>;SharedAccessKey=<my-policy-key>"` if you have `HostName` , `SharedAccessKeyName` and `SharedAccessKey` .

Send cloud-to-device messages

To send a message from your IoT hub to your device, follow these steps:

1. Open a console window.
2. Start a session on your IoT hub by running the following command:

```
iothub-explorer login <IoTHubConnectionString>
```

3. Send a message to your device by running the following command:

```
iothub-explorer send <device-id> <message>
```

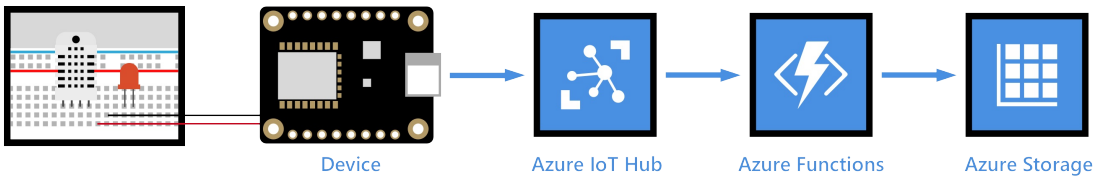
The command blinks the LED that is connected to your device and sends the message to your device.

> [!Note] There is no need for the device to send a separate ack command back to your IoT hub upon receiving the message.

Next steps

You’ve learned how to monitor device-to-cloud messages and send cloud-to-device messages between your IoT device and Azure IoT Hub.

Save IoT Hub messages that contain information like sensor data to Azure table storage



> [!NOTE] Before you start this tutorial, make sure you've completed Setup your device. By Setup your device, you set up your IoT device and IoT hub, and deploy a sample application to run on your device. The application sends collected sensor data to your IoT hub.

What you will learn

You learn how to create an Azure storage account and an Azure Function App to store IoT Hub messages in Azure table storage.

What you will do

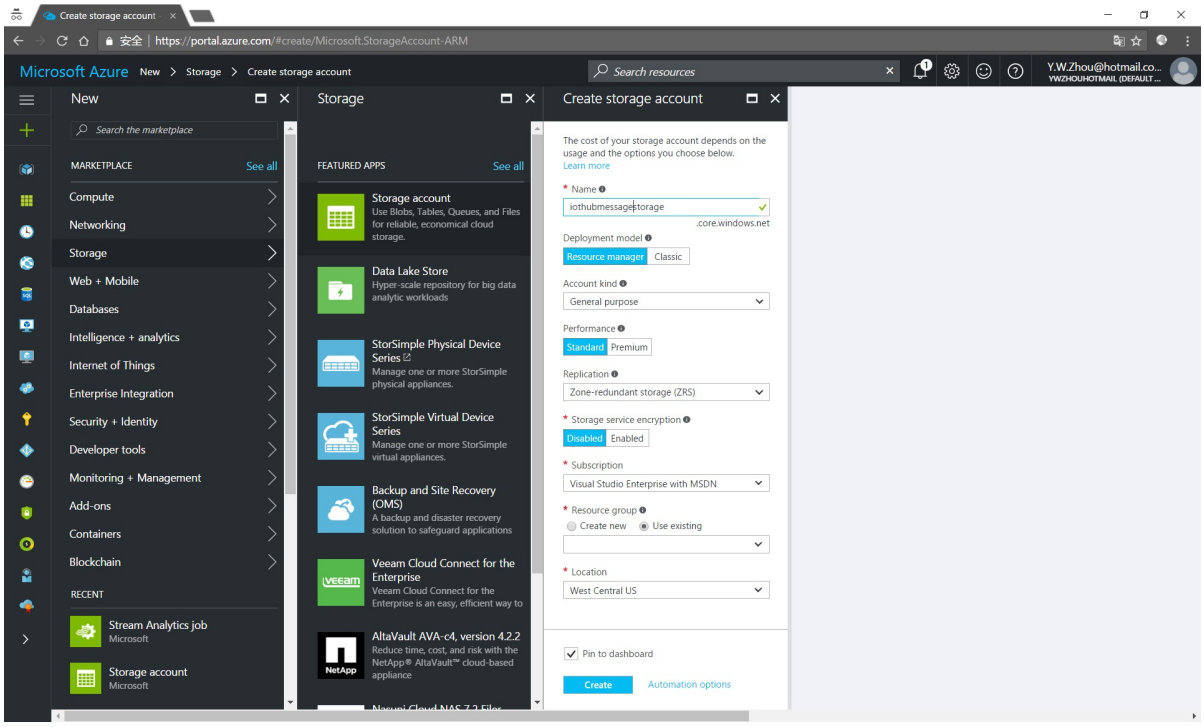
- Create an Azure storage account.
- Prepare for IoT Hub connection to read messages.
- Create and deploy an Azure Function App.

What you will need

- Tutorial Setup your device completed which covers the following requirements:
  - An active Azure subscription.
  - An Azure IoT hub under your subscription.
  - A running application that sends messages to your Azure IoT hub.

Create an Azure storage account

1. In the Azure portal, click **New** > **Storage** > **Storage account**.
2. Enter the necessary information for the storage acount:



Name: The name of the storage account. The name must be globally unique.

Resource group: Use the same resource group that your IoT hub uses.

Pin to dashboard: Check this option for easy access to your IoT hub from the dashboard.

3. Click **Create**.

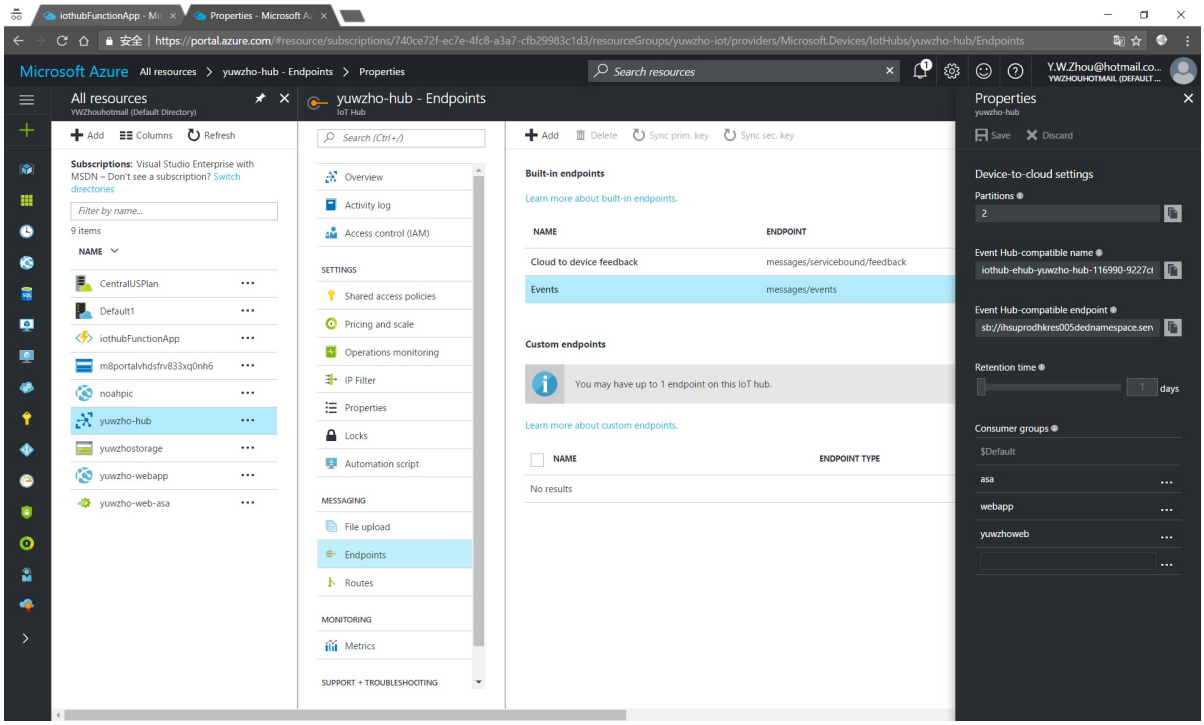
Prepare for IoT Hub connection to read messages

IoT Hub exposes a built-in Event Hub-compatible endpoint to enable applications to read IoT Hub messages. Meanwhile, applications use consumer groups to read data from IoT Hub. Before creating an Azure Function App to read data from your IoT hub, you need to:

- Get the connection string of your IoT hub endpoint.
- Create a consumer group for your IoT hub.

Get the connection string of your IoT hub endpoint

1. Open your IoT hub.
2. On the **IoT Hub** pane, click **Endpoints** under **MESSAGING**.
3. On the right pane, click **Events** under **Built-in endpoints**.
4. In the **Properties** pane, make a note of the following values:
    - Event Hub-compatible endpoint
    - Event Hub-compatible name



5. On the **IoT Hub** pane, click **Shared access policies** under **SETTINGS**.
6. Click **iothubowner**.
7. Make a note of the **Primary key** value.
8. Make up the connection string of your IoT hub endpoint as follows:

```
Endpoint=<Event Hub-compatible endpoint>;SharedAccessKeyName=iothubowner;SharedAccessKey=<Primary key>
```

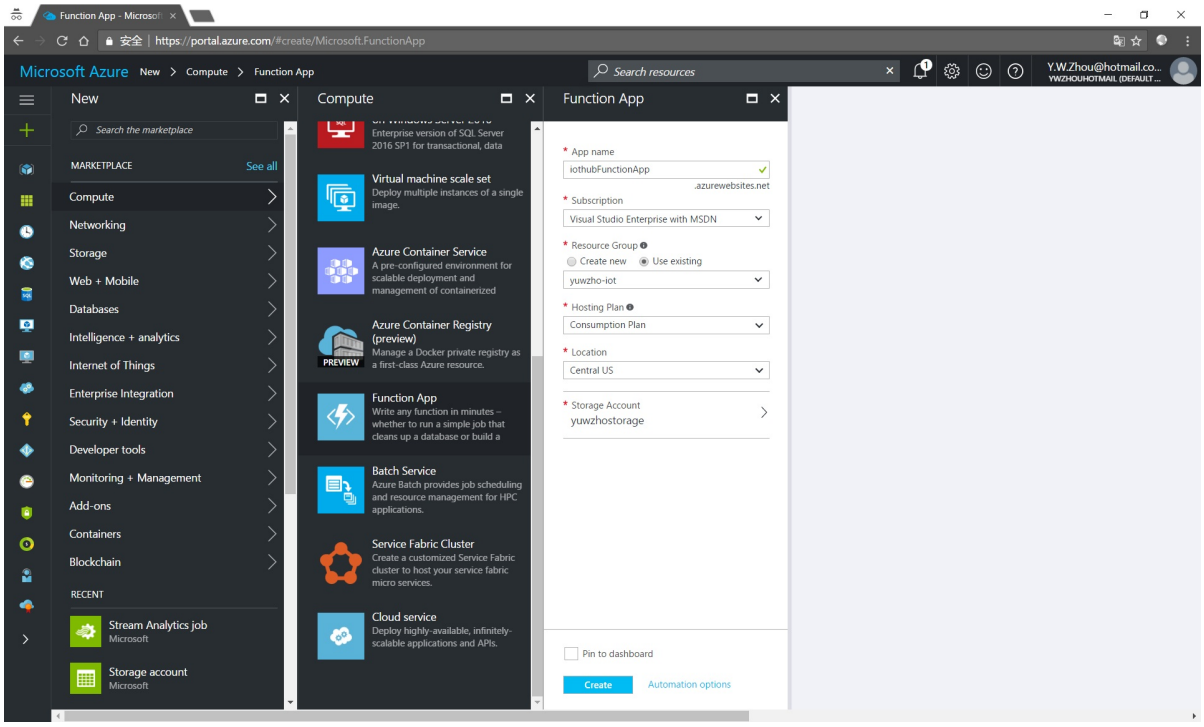
> [!Note] Replace `<Event Hub-compatible endpoint>` and `<Primary key>` with the values you noted down.

Create a consumer group for your IoT hub

1. Open your IoT hub.
2. On the **IoT Hub** pane, click **Endpoints** under **MESSAGING**.
3. On the right pane, click **Events** under **Built-in endpoints**.
4. In the **Properties** pane, enter a name under **Consumer groups** and make a note of the name.
5. Click **Save**.

Create and deploy an Azure Function App

1. In the Azure portal, click **New** > **Compute** > **Function App**.
2. Enter the necessary information for the Function App.



App name: The name of the Function App. The name must be globally unique.

Resource group: Use the same resource group that your IoT Hub uses.

Storage Account: The storage account that you created.

Pin to dashboard: Check this option for easy access to the Function App from the dashboard.

3. Click **Create**.
4. Open the Function App once it is created.
5. Create a new function in the Function App.

    i. Click **New Function**.
    ii. Select **JavaScript** for **Language**, and **Data Processing** for **Scenario**.
    iii. Click the **EventHubTrigger-JavaScript** template.
    iv. Enter the necessary information for the template.

    Name your function: The name of the function.

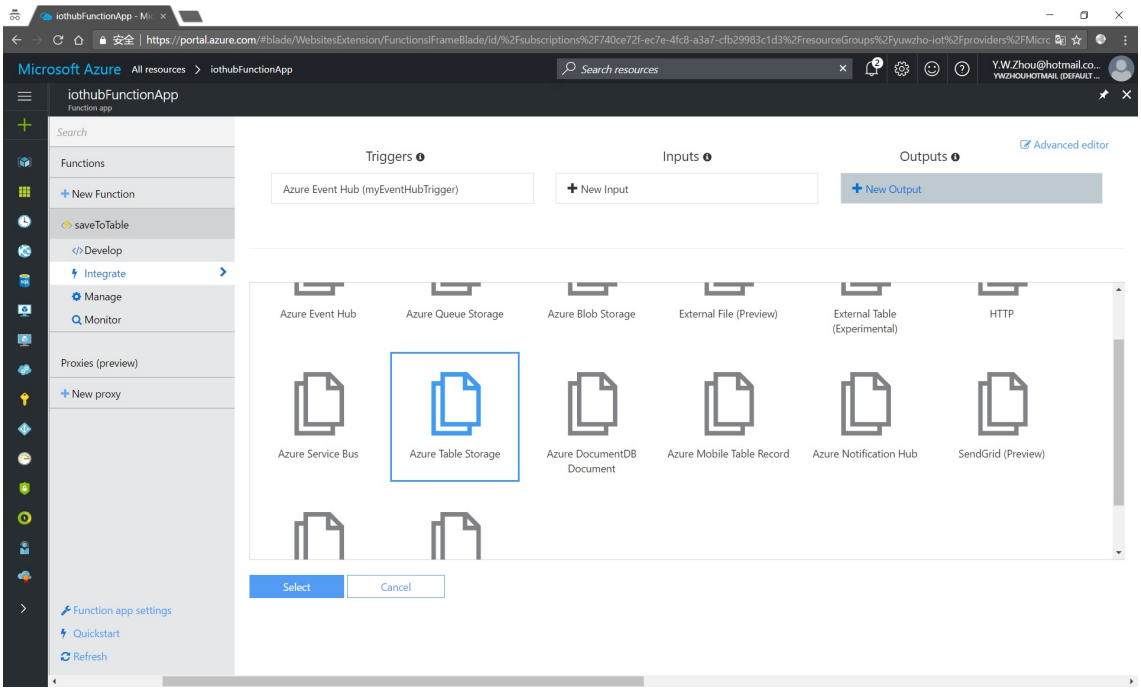
    Event Hub name: The Event Hub-compatible name you noted down.

    Event Hub connection: Click new to add the connection string of your IoT hub endpoint that you made up.

v. Click **Create**.

6. Configure an output of the function.

i. Click **Integrate** > **New Output** > **Azure Table Storage** > **Select**.



ii. Enter the necessary information.

Table parameter name: Use `outputTable` for the name, which will be used in the Azure Functions' code.

Table name: Use `deviceData` for the name.

Storage account connection: Click **new** and select or input your storage account.

iii. Click **Save**.

7. Under **Triggers**, click **Azure Event Hub (myEventHubTrigger)**.
8. Under **Event Hub consumer group**, enter the name of the consumer group that you created, and then click **Save**.
9. Click **Develop**, and then click **View files**.
10. Replace the code in `index.js` with the following, and then click **Save**.

```
'use strict';

// This function is triggered each time a message is revieved in the IoTHub.
// The message payload is persisted in an Azure Storage Table

module.exports = function (context, iotHubMessage) {
 context.log('Message received: ' + JSON.stringify(iotHubMessage));
 var date = Date.now();
 var partitionKey = Math.floor(date / (24 * 60 * 60 * 1000)) + '';
 var rowKey = date + '';
 context.bindings.outputTable = {
  "partitionKey": partitionKey,
  "rowKey": rowKey,
  "message": JSON.stringify(iotHubMessage)
 };
 context.done();
};
```

By now, you have created the Function App. It stores messages that your IoT hub receives in your Azure table storage.

> [!Note] You can use the **Run** button to test the Function App. When you click **Run**, the test message is sent to your IoT hub. The arrival of the message should trigger the Function App to start and then save the message to your Azure table storage. The **Logs** pane records the details of the process.

Verify your message in your table storage

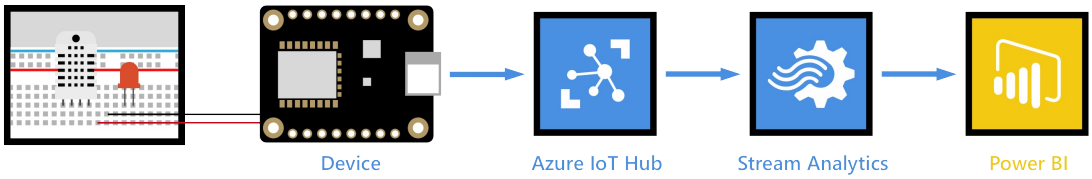
1. Run the sample application on your device to send messages to your IoT hub.
2. Download and install Microsoft Azure Storage Explorer.
3. Open Microsoft Azure Storage Explorer, click **Add an Azure Account** > **Sign in**, and then sign in to your Azure account.
4. Click your Azure subscription > **Storage Accounts** > your storage account > **Tables** > **deviceData**.

   You should see messages sent from your device to your IoT hub logged in the `deviceData` table.

Next steps

You've successfully created your Azure storage account and Azure Function App to store messages that your IoT hub receives in your Azure table storage.

Visualize real-time sensor data from Azure IoT Hub using Power BI



> [!NOTE] Before you start this tutorial, make sure you've completed Setup your device. By Setup your device, you set up your IoT device and IoT hub, and deploy a sample application to run on your device. The application sends collected sensor data to your IoT hub.

What you learn

You learn how to visualize real-time sensor data that your Azure IoT hub receives by Power BI. If you want to try visualize the data in your IoT hub with Web Apps, please see Use Azure Web Apps to visualize real-time sensor data from Azure IoT Hub.

What you do

- Get your IoT hub ready for data access by adding a consumer group.
- Create, configure and run a Stream Analytics job for data transfer from your IoT hub to your Power BI account.
- Create and publish a Power BI report to visualize the data.

What you need

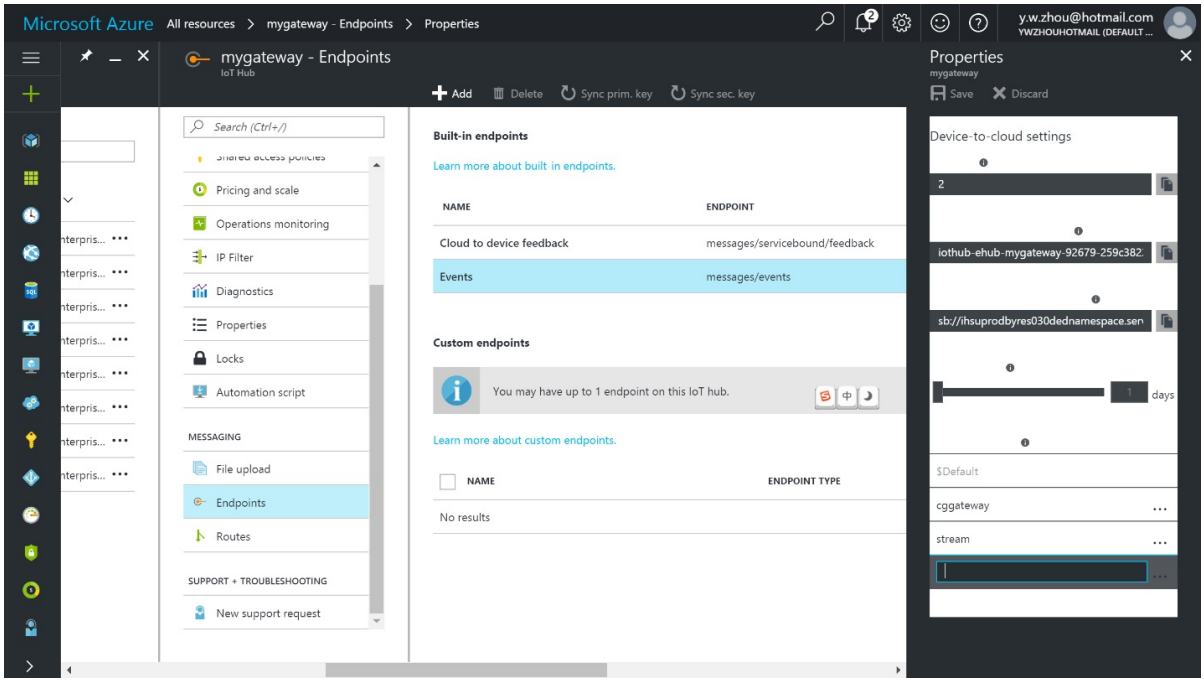
- Tutorial Setup your device completed which covers the following requirements:
  - An active Azure subscription.
  - An Azure IoT hub under your subscription.
  - A client application that sends messages to your Azure IoT hub.
- A Power BI account. (Try Power BI for free)

Add a consumer group to your IoT hub

Consumer groups are used by applications to pull data from Azure IoT Hub. In this lesson, you create a consumer group to be used by a coming Azure service to read data from your IoT hub.

To add a consumer group to your IoT hub, follow these steps:

1. In the Azure portal, open your IoT hub.
2. Click **Endpoints** on the left pane, select **Events** on the middle pane, enter a name under **Consumer groups** on the right pane, and then click **Save**.



Create, configure, and run a Stream Analytics job

Create a Stream Analytics job

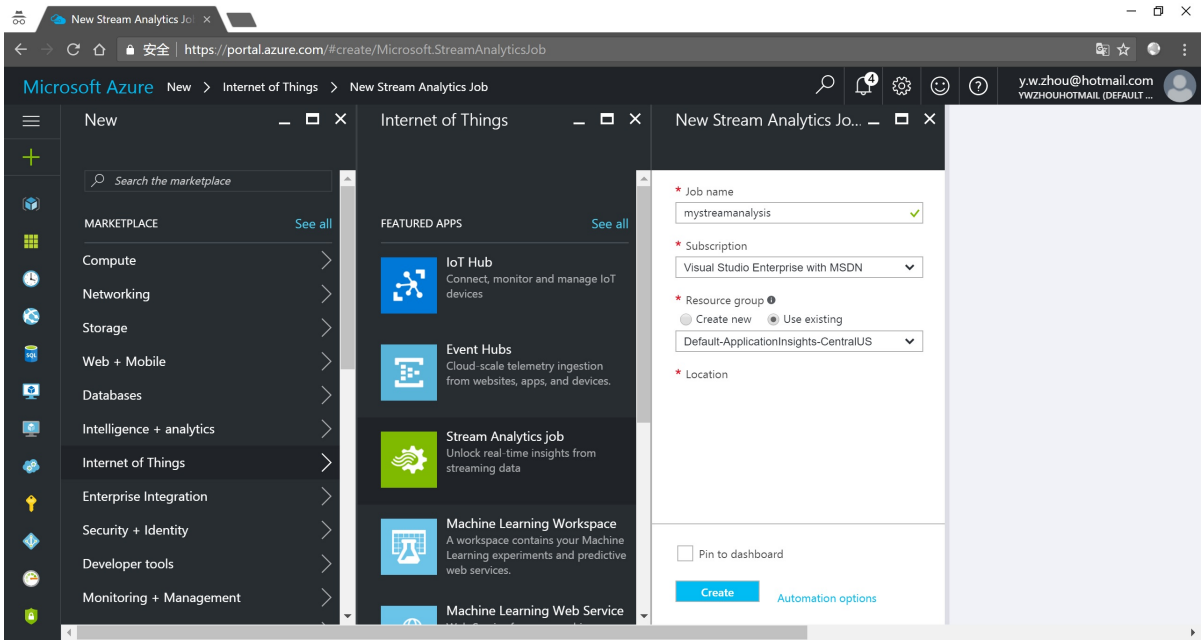
1. In the Azure portal, click New > Internet of Things > Stream Analytics job.
2. Enter the following information for the job.

   Job name: The name of the job. The name must be globally unique.

   Resource group: Use the same resource group that your IoT hub uses.

   Location: Use the same location as your resource group.

Pin to dashboard: Check this option for easy access to your IoT hub from the dashboard.



3. Click **Create**.

Add an input to the Stream Analytics job

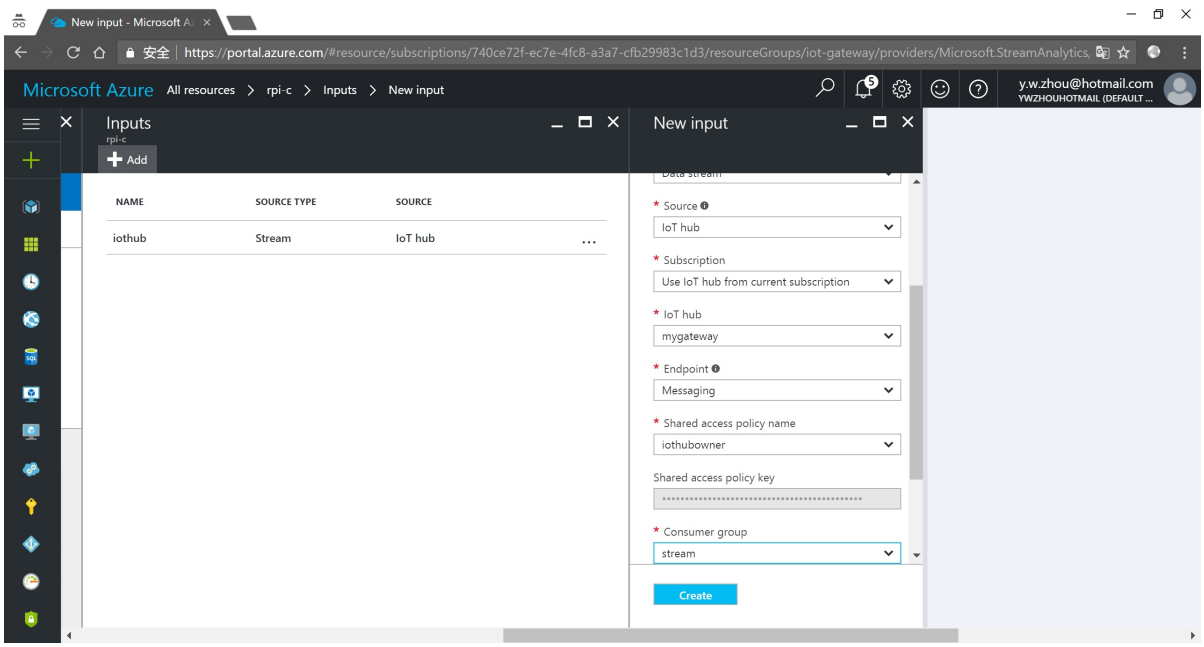
1. Open the Stream Analytics job.
2. Under **Job Topology**, click **Inputs**.
3. In the **Inputs** pane, click **Add**, and then enter the following information:

   Input alias: The unique alias for the input.

   Source: Select **IoT hub**.

   Consumer group: Select the consumer group you just created.

4. Click **Create**.



Add an output to the Stream Analytics job

1. Under **Job Topology**, click **Outputs**.
2. In the **Outputs** pane, click **Add**, and then enter the following information:

   Output alias: The unique alias for the output.

   Sink: Select **Power BI**.

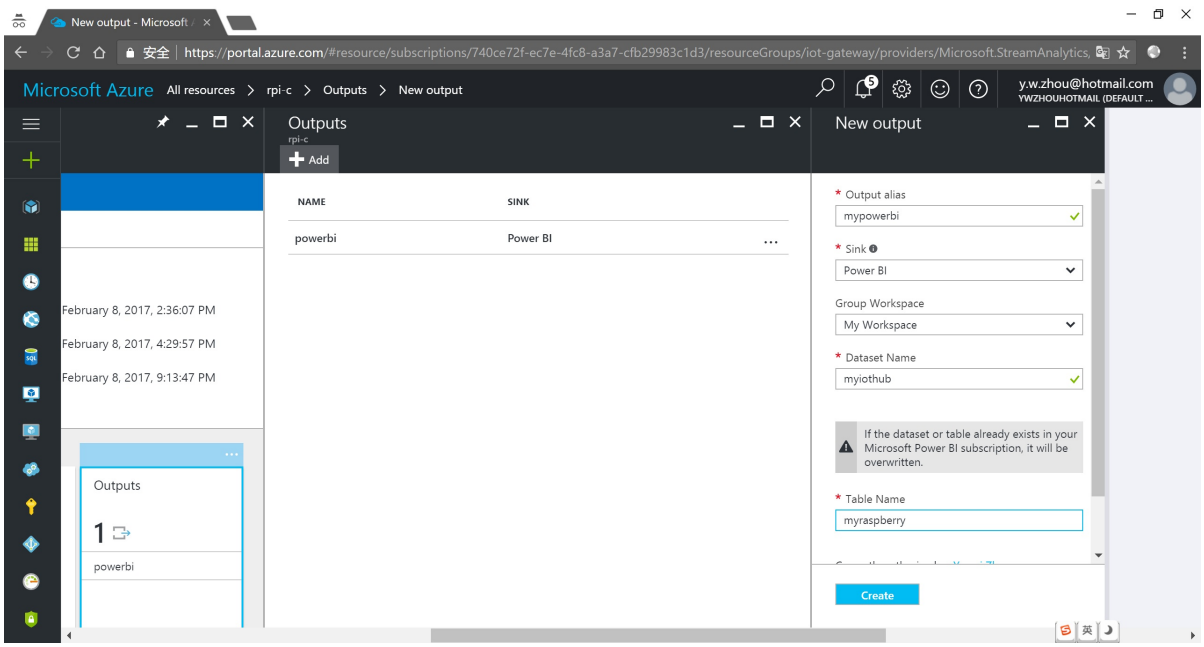
3. Click **Authorize**, and then sign into your Power BI account.
4. Once authorized, enter the following information:

   Group Workspace: Select your target group workspace.

   Dataset Name: Enter a dataset name.

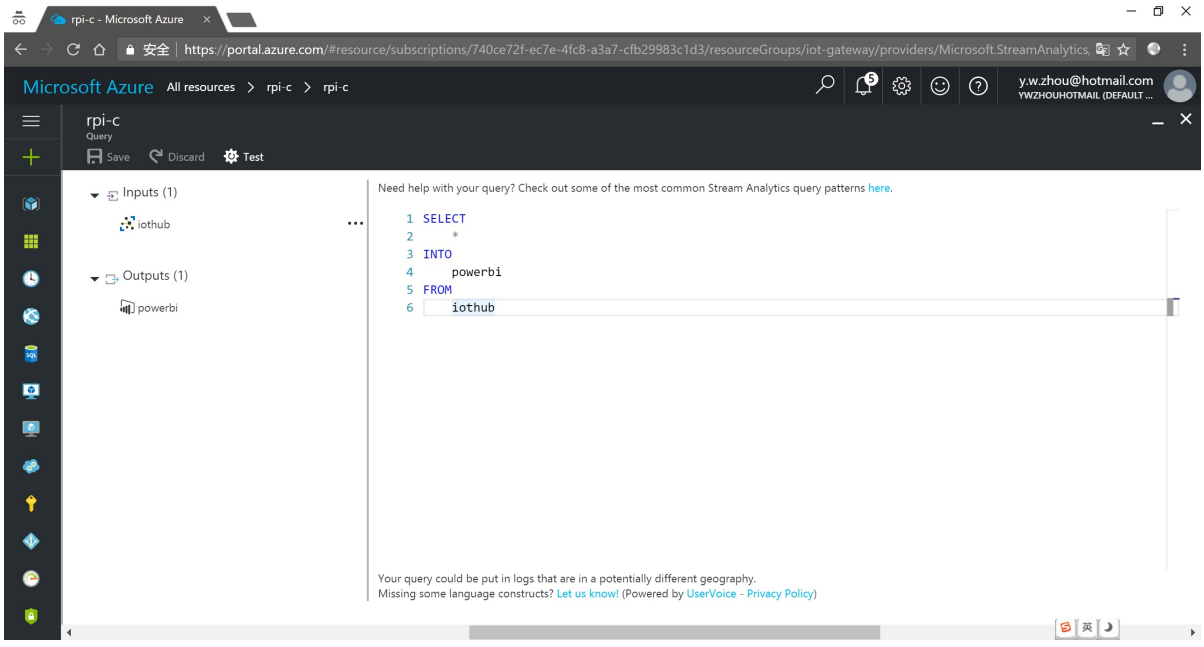
   Table Name: Enter a table name.

5. Click **Create**.



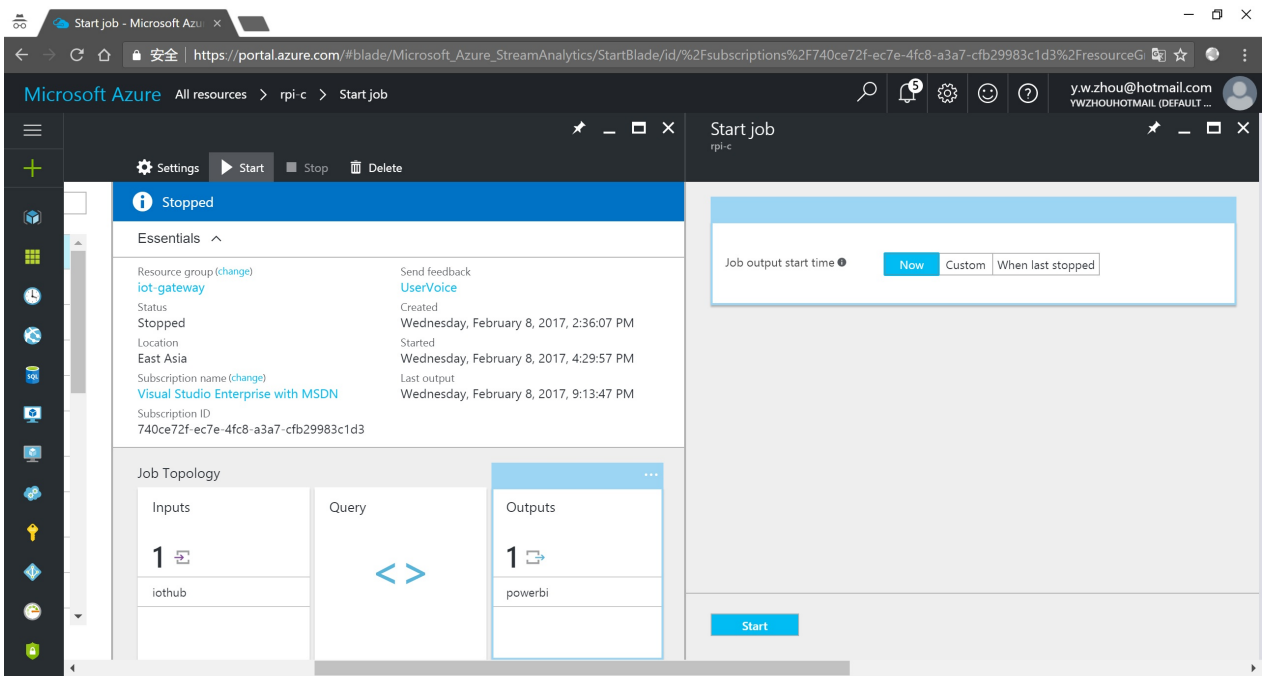
Configure the query of the Stream Analytics job

1. Under **Job Topology**, click **Query**.
2. Replace `[YourInputAlias]` with the input alias of the job.
3. Replace `[YourOutputAlias]` with the output alias of the job.
4. Click **Save**.



Run the Stream Analytics job

In the Stream Analytics job, click **Start** > **Now** > **Start**. Once the job successfully starts, the job status changes from **Stopped** to **Running**.

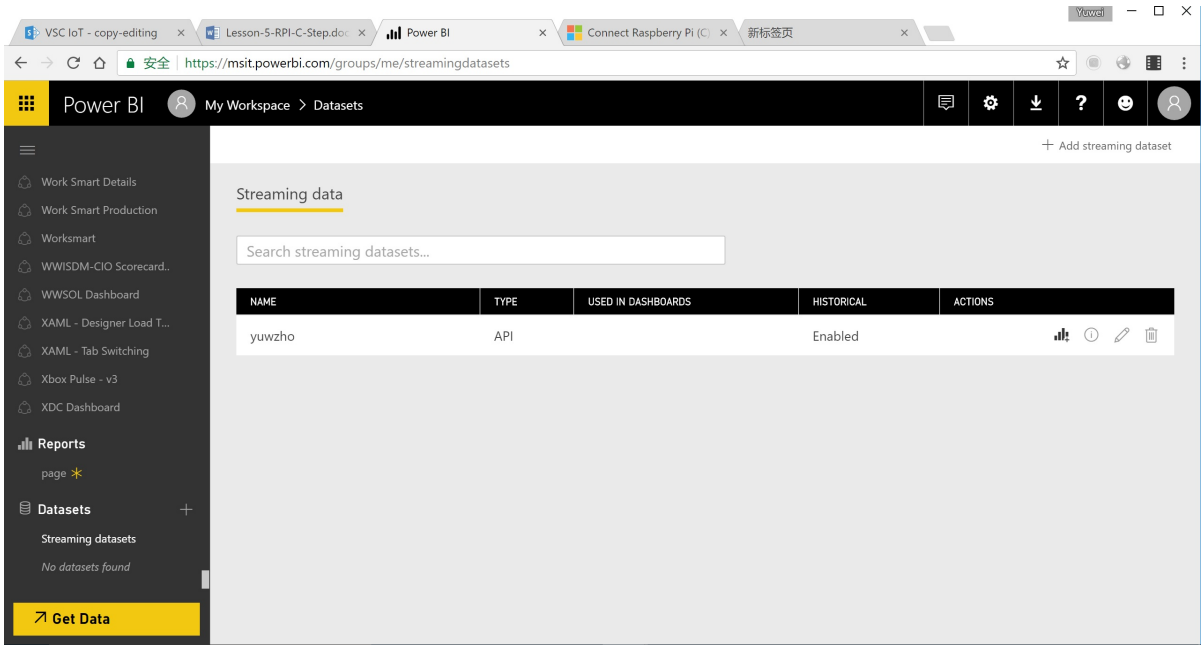


Create and publish a Power BI report to visualize the data

1. Ensure the sample application is running on your device. If not, you can refer to the tutorials under Setup your device.
2. Sign in to your Power BI account.
3. Go to the group workspace that you set when you created the output for the Stream Analytics job.
4. Click **Streaming datasets**.

   You should see the listed dataset that you specified when you created the output for the Stream Analytics job.

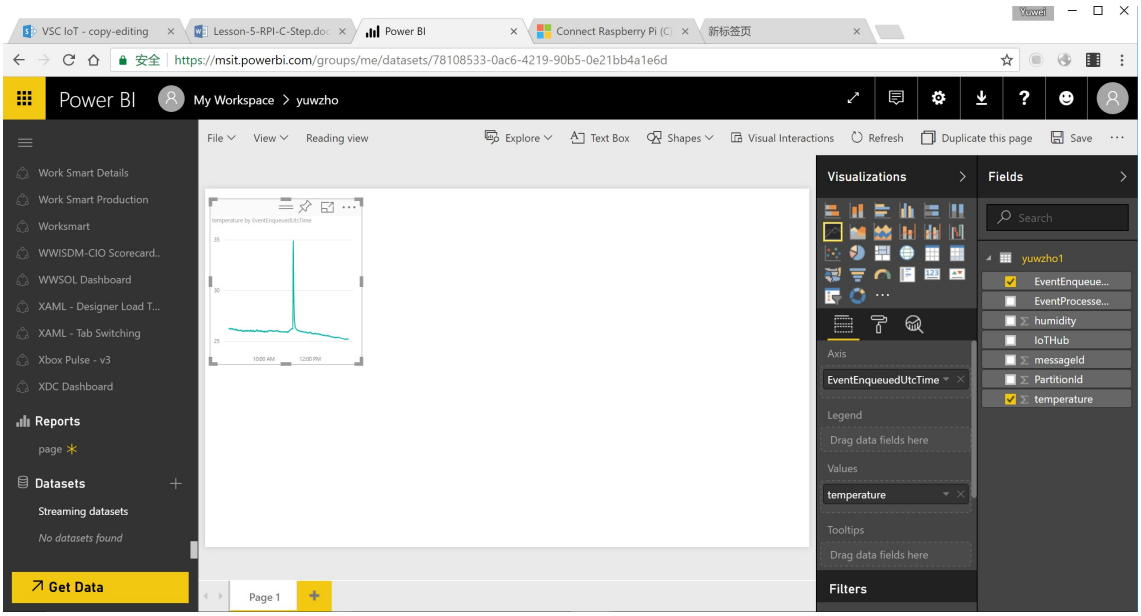
5. Under **ACTIONS**, click the first icon to create a report.



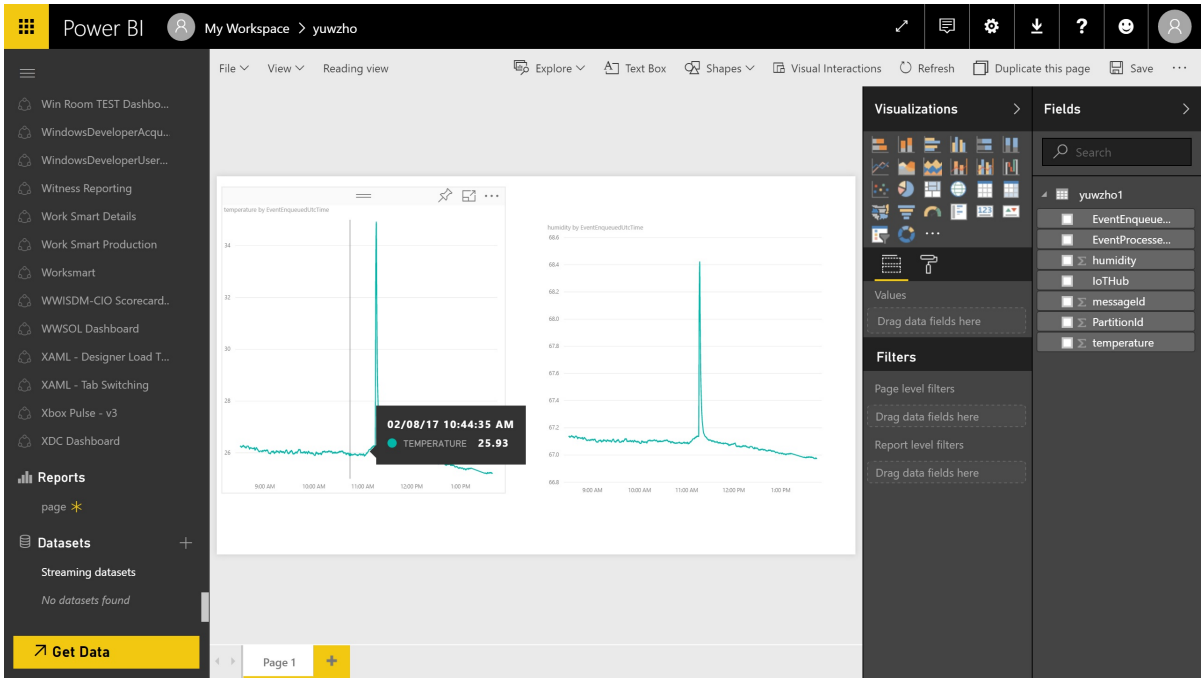
6. Create a line chart to show real-time temperature over time.

   i. On the report creation page, add a line chart.
   ii. On the **Fields** pane, expand the table that you specified when you created the output for the Stream Analytics job.
   iii. Drag **EventEnqueuedUtcTime** to **Axis** on the **Visualizations** pane.
   iv. Drag **temperature** to **Values**.

   Now a line chart is created. The x-axis of chart displays date and time in the UTC time zone. The y-axis displays temperature from the sensor.

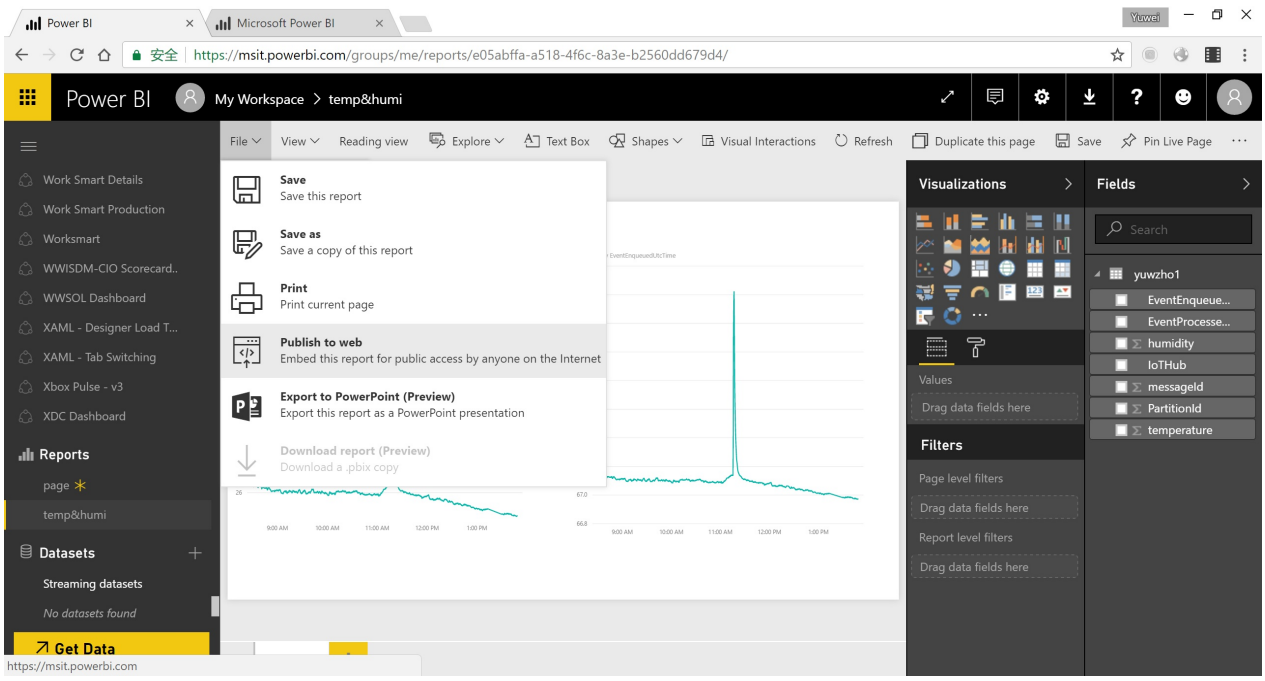


7. Create another line chart to show real-time humidity over time. To do this, follow the same steps above and place **EventEnqueuedUtcTime** on the x-axis and **humidity** on the y-axis.



8. Click **Save** to save the report.
9. Click **File** > **Publish to web**.
10. Click **Create embed code**, and then click **Publish**.

You're provided the report link that you can share with anyone for report access and a code snippet to integrate the report into your blog or website.

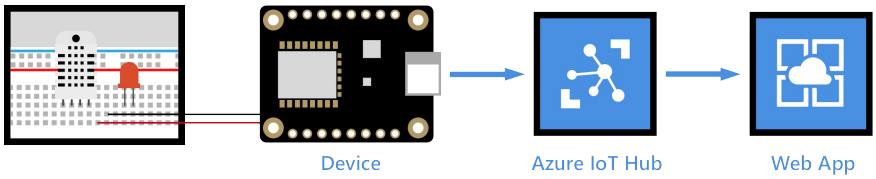


Microsoft also offers the Power BI mobile apps for viewing and interacting with your Power BI dashboards and reports on your mobile device.

Next steps

You've successfully used Power BI to visualize real-time sensor data from your Azure IoT hub. There is an alternate way to visualize data from Azure IoT Hub. See Use Azure Web Apps to visualize real-time sensor data from Azure IoT Hub.

Visualize real-time sensor data from Azure IoT Hub using Azure Web Apps



> [!NOTE] Before you start this tutorial, make sure you've completed Setup your device. By Setup your device, you set up your IoT device and IoT hub, and deploy a sample application to run on your device. The application sends collected sensor data to your IoT hub.

What you learn

In this lesson, you learn how to visualize real-time sensor data that your Azure IoT hub receives by running a web application that is hosted on an Azure web app. If you want to try visualize the data in your IoT hub with Power BI, please see Use Power BI to visualize real-time sensor data from Azure IoT Hub.

What you do

- Create an Azure web app in the Azure Portal.
- Get your IoT hub ready for data access by adding a consumer group.
- Configure the web app to read sensor data from your IoT hub.
- Upload a web application to be hosted by the web app.
- Open the web app to see real-time temperature and humidity data from your IoT hub.

What you need

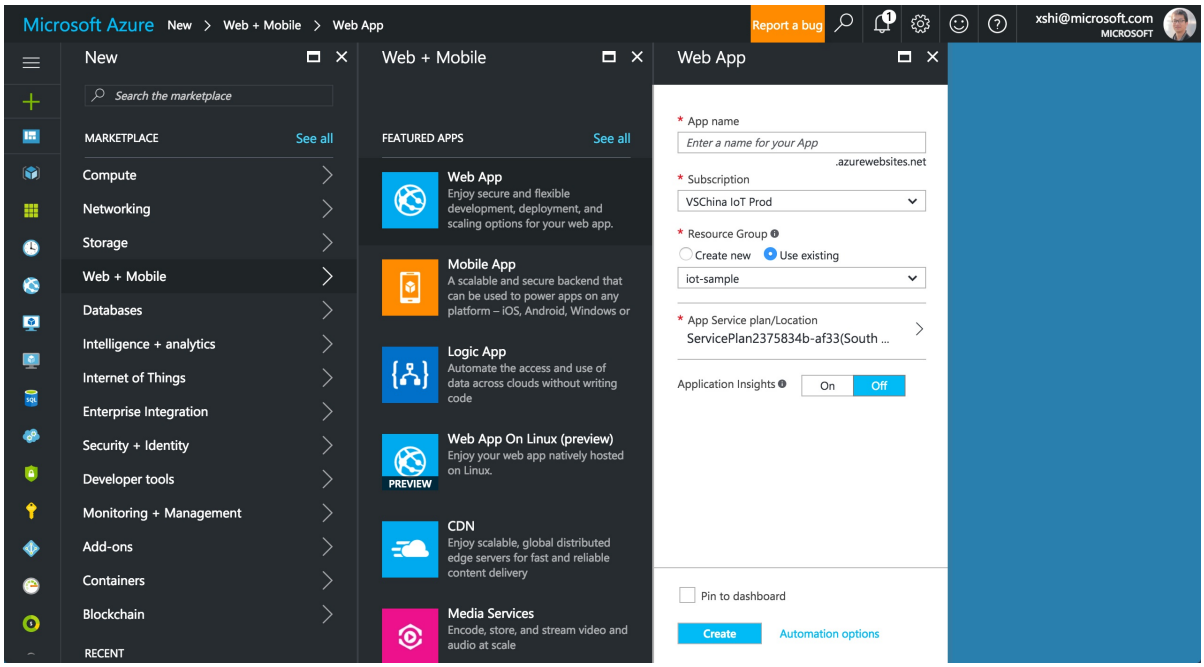
- Tutorial Setup your device completed which covers the following requirements:
  - An active Azure subscription.
  - An Azure IoT hub under your subscription.

    - A client application that sends messages to your Azure IoT hub.
- Git. (Download Git).

Create an Azure web app

1. In the Azure portal, click **New** > **Web + Mobile** > **Web App**.
2. Enter a unique job name, verify the subscription, specify a resource group and a location, select **Pin to dashboard**, and then click **Create**.

   We recommend you select the same location where your resource group is located. This assists with processing speed and reduced costs for data transfer.

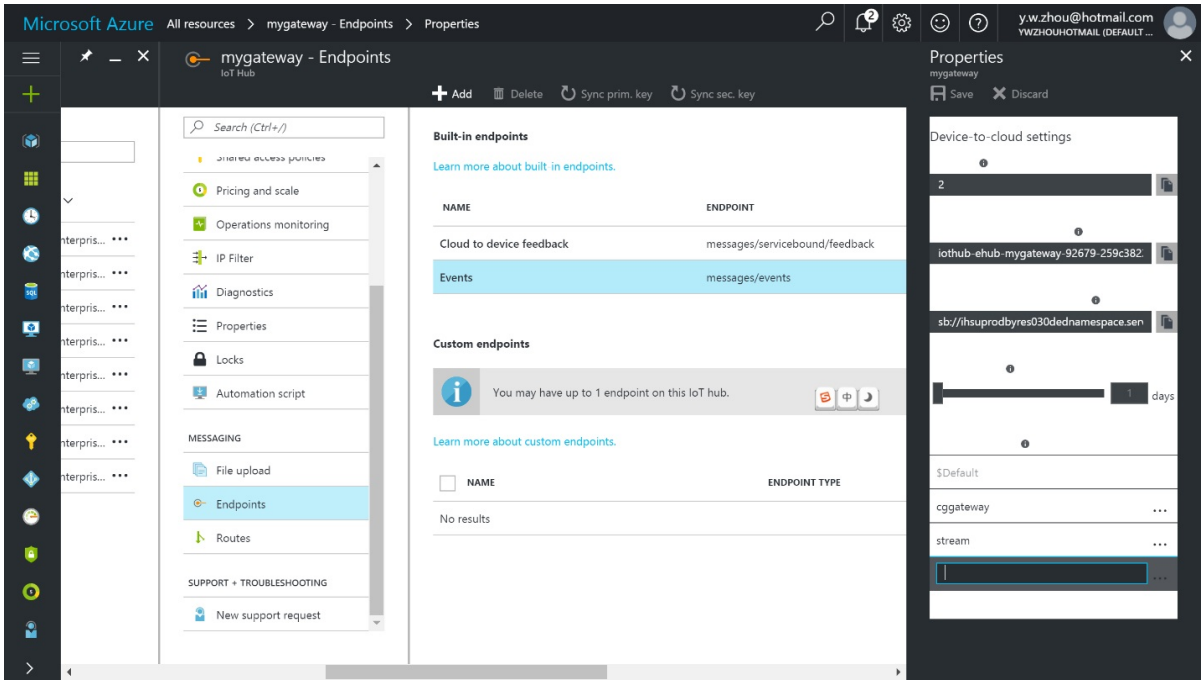


Add a consumer group to your IoT hub

Consumer groups are used by applications to pull data from Azure IoT Hub. In this lesson, you create a consumer group to be used by a coming Azure service to read data from your IoT hub.

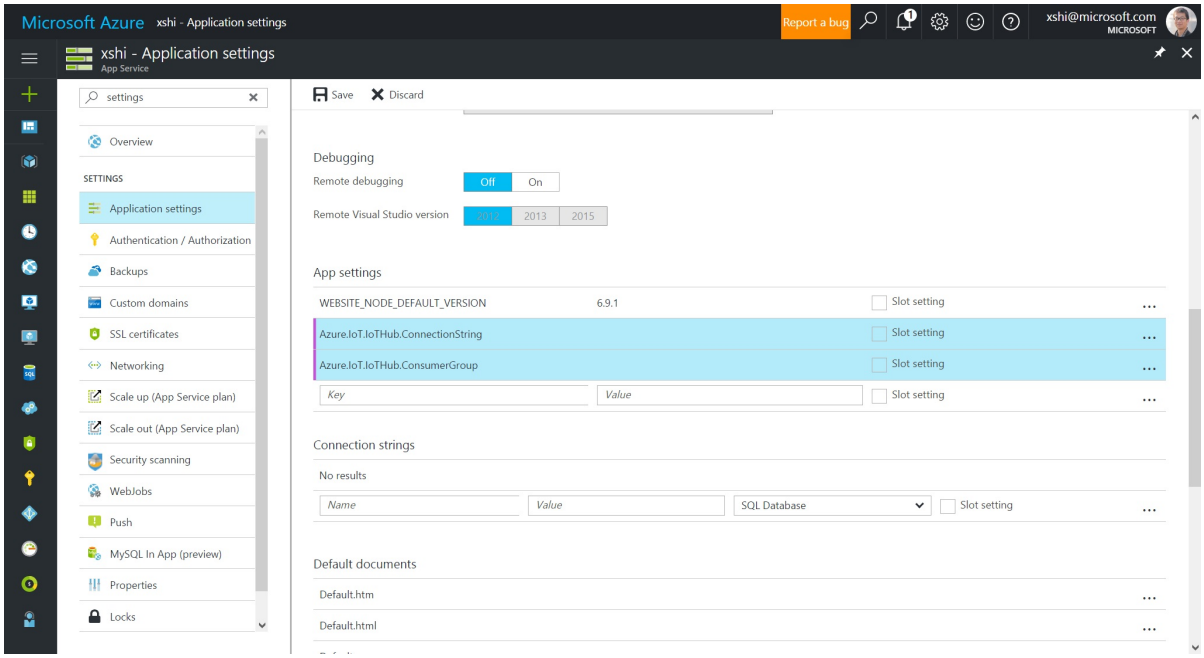
To add a consumer group to your IoT hub, follow these steps:

1. In the Azure portal, open your IoT hub.
2. Click **Endpoints** on the left pane, select **Events** on the middle pane, enter a name under **Consumer groups** on the right pane, and then click **Save**.

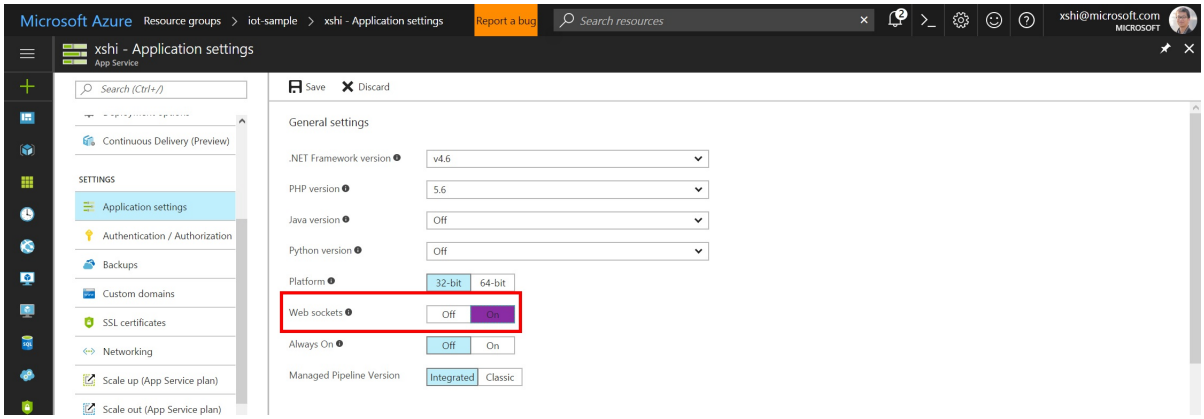


Configure the web app to read data from your IoT hub

1. Open the Web app you've just provisioned.
2. Click **Application settings**, and then add the following key/value pairs under **App settings**: see the table at the end of the steps.



3. In **Application settings**, toggle the Web sockets option under General settings.

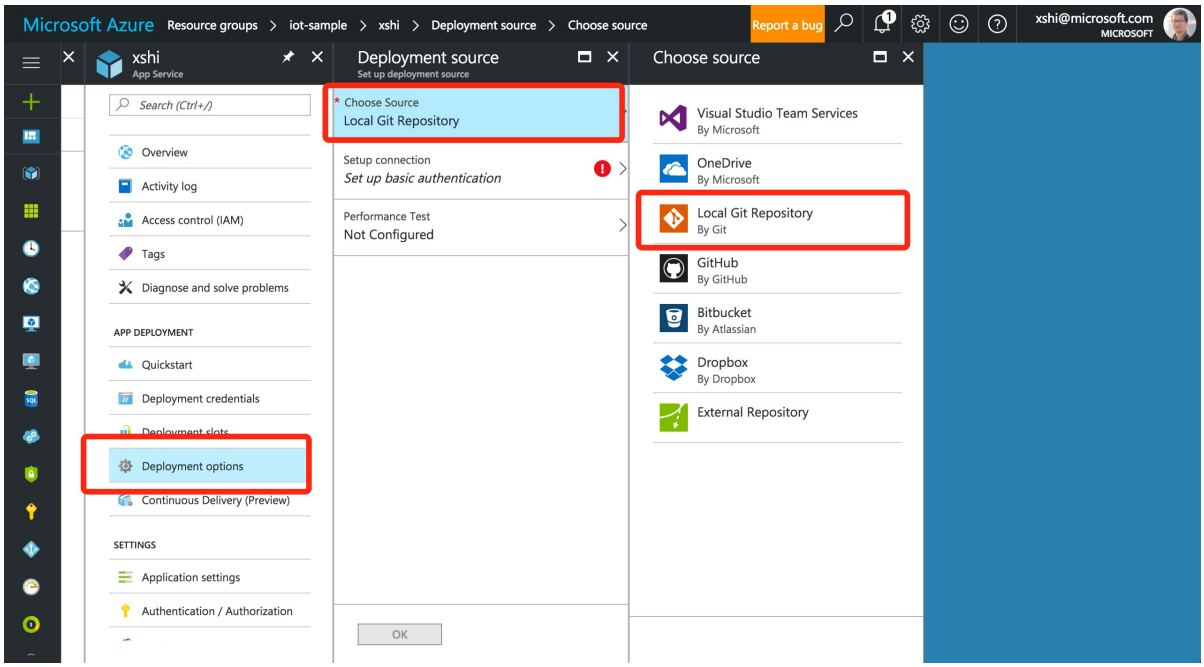


Key	Value
Azure.IoT.IoTHub.ConnectionString	Obtained from iothub-explorer
Azure.IoT.IoTHub.DeviceId	Obtained from iothub-explorer
Azure.IoT.IoTHub.ConsumerGroup	The name of the consumer group that you add to your IoT hub

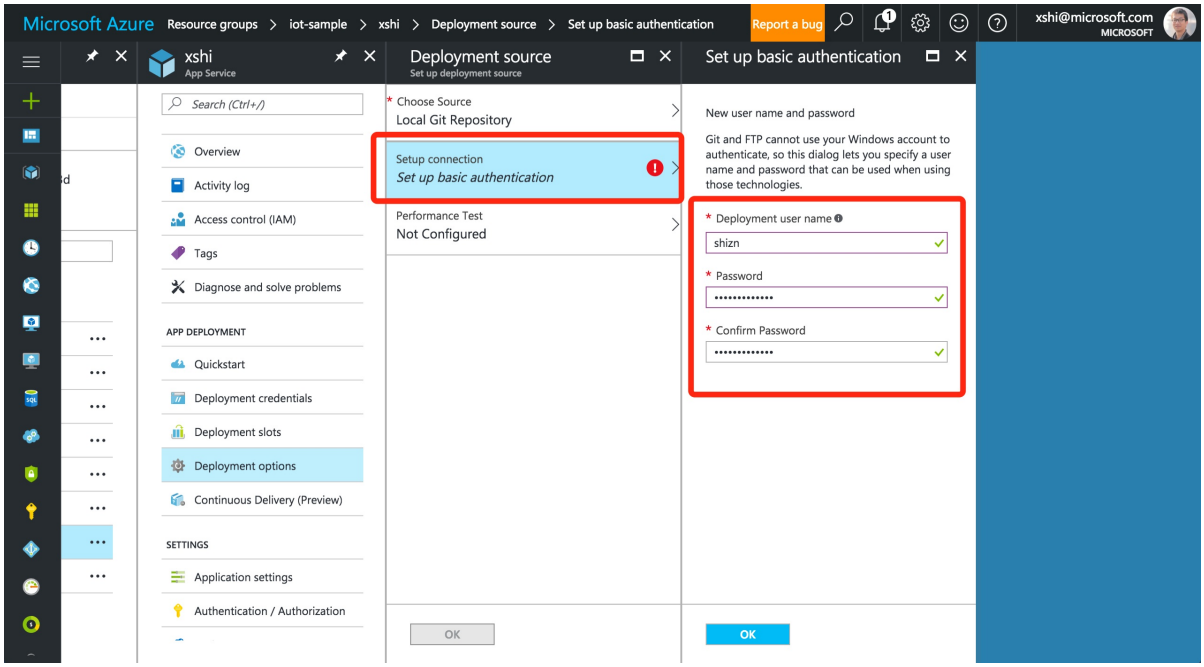
Upload a web application to be hosted by the web app

We made available a web application on GitHub which displays real-time sensor data from your IoT hub. All you need to do is to configure the web app to work with a Git repository, download the web application from GitHub and upload it to Azure for the web app to host.

1. In the web app, click **Deployment Options** > **Choose Source** > **Local Git Repository**.

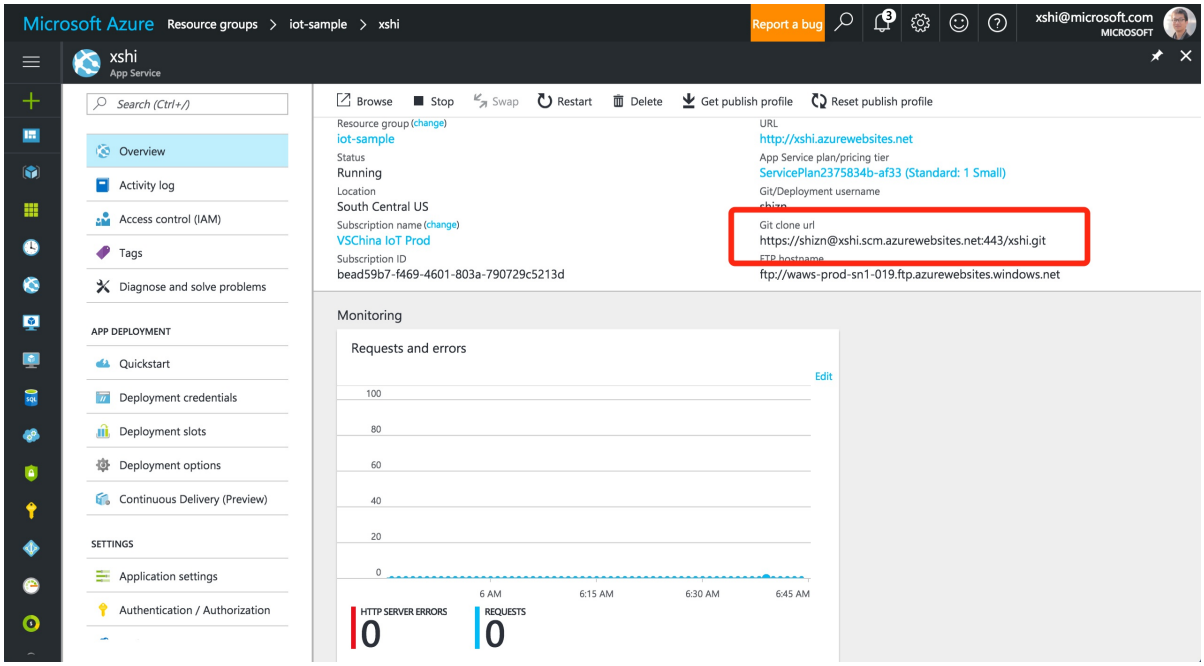


2. Click **Setup connection**, create a user name and password that will be used to connect to the Git repository in Azure, and then click **OK**.



3. Click **OK** to finish the configuration.

4. Click **Overview** and make a note of the value of **Git clone url**.



5. Open a command or terminal window on your local computer.

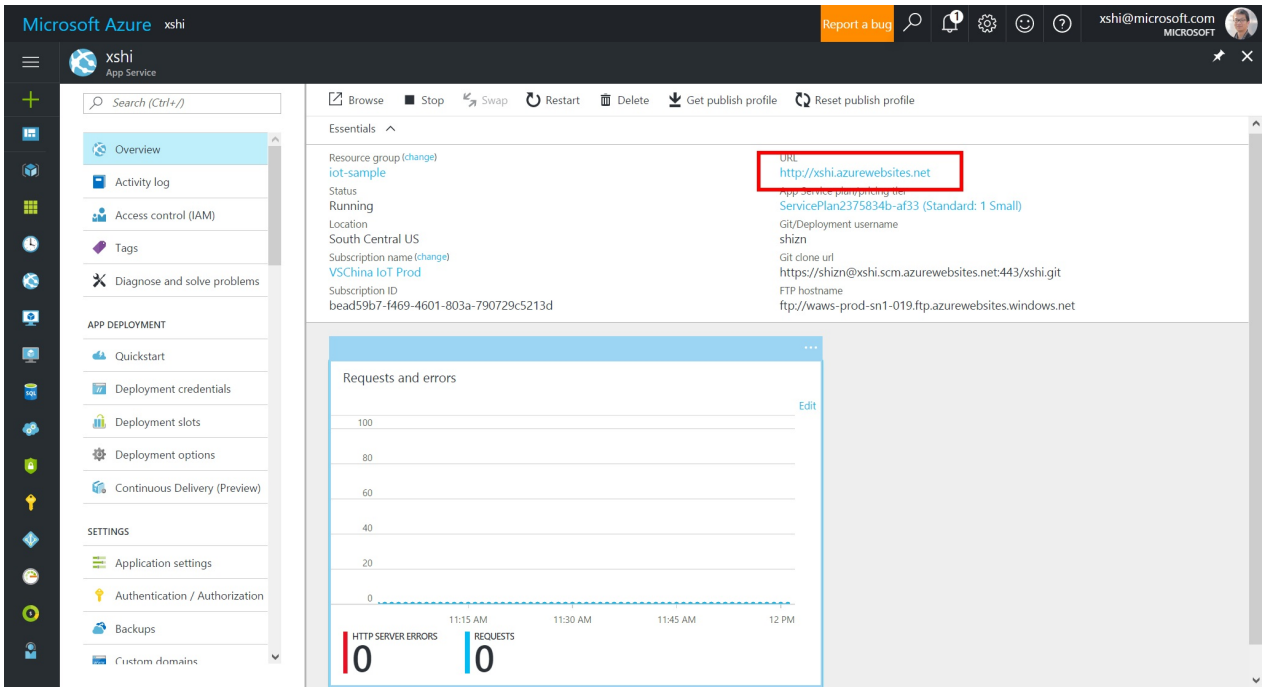
6. Download the web application from GitHub and upload it Azure for the web app to host. To do this, run the following commands:

```
git clone https://github.com/Azure-Samples/web-apps-node-iot-hub-data-visualization.git
cd web-apps-node-iot-hub-data-visualization
git remote add webapp <Git clone URL>
git push webapp master:master
```

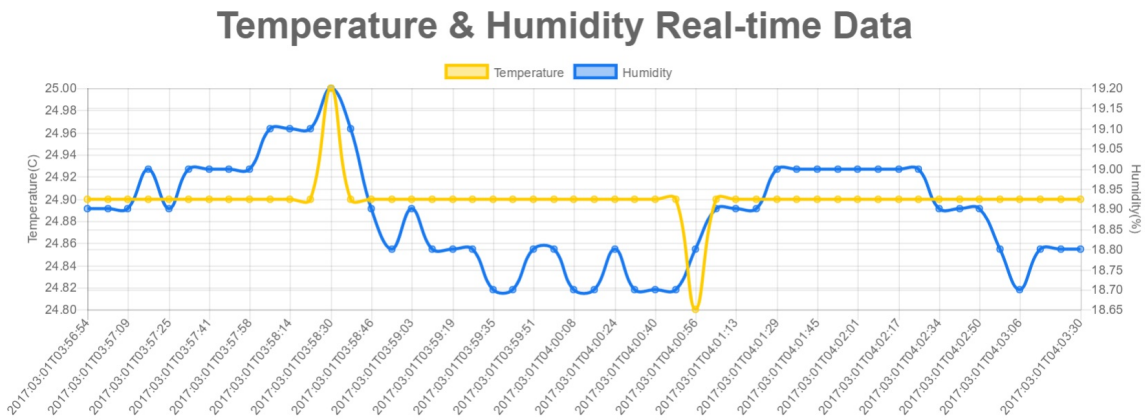
> [!Note] \ is the URL of the Git repository found on the **Overview** page of the web app.

Open the web app to see real-time temperature and humidity data from your IoT hub

On the **Overview** page of your web app, click the URL to open the web app.



You should see the real-time temperature and humidity data from your IoT hub.



Next steps

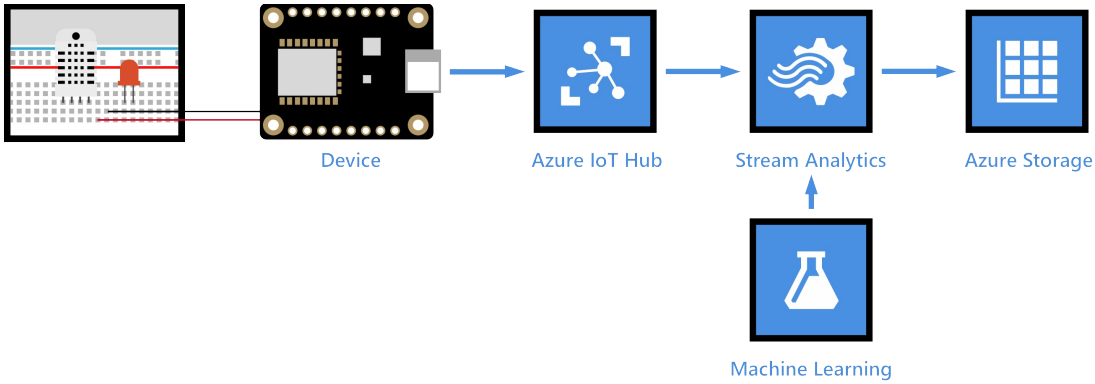
You've successfully used an Azure web app to visualize real-time sensor data from your Azure IoT hub.

There is an alternate way to visualize data from Azure IoT Hub. See Use Power BI to visualize real-time sensor data from Azure IoT Hub.

Next steps

You've successfully used Power BI to visualize real-time sensor data from your Azure IoT hub. There is an alternate way to visualize data from Azure IoT Hub.

Weather forecast using the sensor data from your IoT hub in Azure Machine Learning



> [!NOTE] Before you start this tutorial, make sure you've completed Setup your device. By Setup your device, you set up your IoT device and IoT hub, and deploy a sample application to run on your device. The application sends collected sensor data to your IoT hub.

Machine learning is a technique of data science that helps computers learn from existing data to forecast future behaviors, outcomes, and trends. Azure Machine Learning is a cloud predictive analytics service that makes it possible to quickly create and deploy predictive models as analytics solutions.

What you learn

You learn how to use Azure Machine Learning to do weather forecast (chance of rain) using the temperature and humidity data from your Azure IoT hub. The chance of rain is the output of a prepared weather prediction model. The model is built upon historic data to forecast chance of rain based on temperature and humidity.

What you do

- Deploy the weather prediction model as a web service.
- Get your IoT hub ready for data access by adding a consumer group.
- Create a Stream Analytics job and configure the job to:
  - Read temperature and humidity data from your IoT hub.
  - Call the web service to get the rain chance.

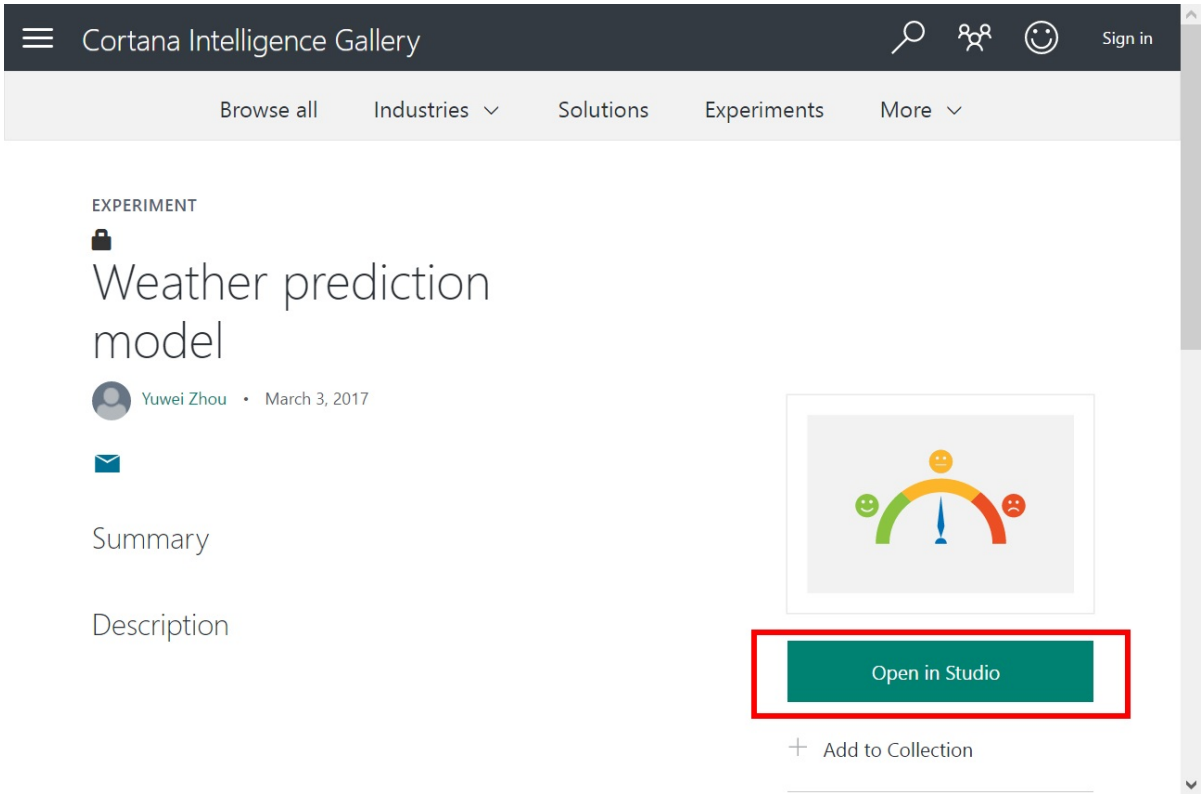
    - Save the result to an Azure blob storage.
- Use Microsoft Azure Storage Explorer to view the weather forecast.

What you need

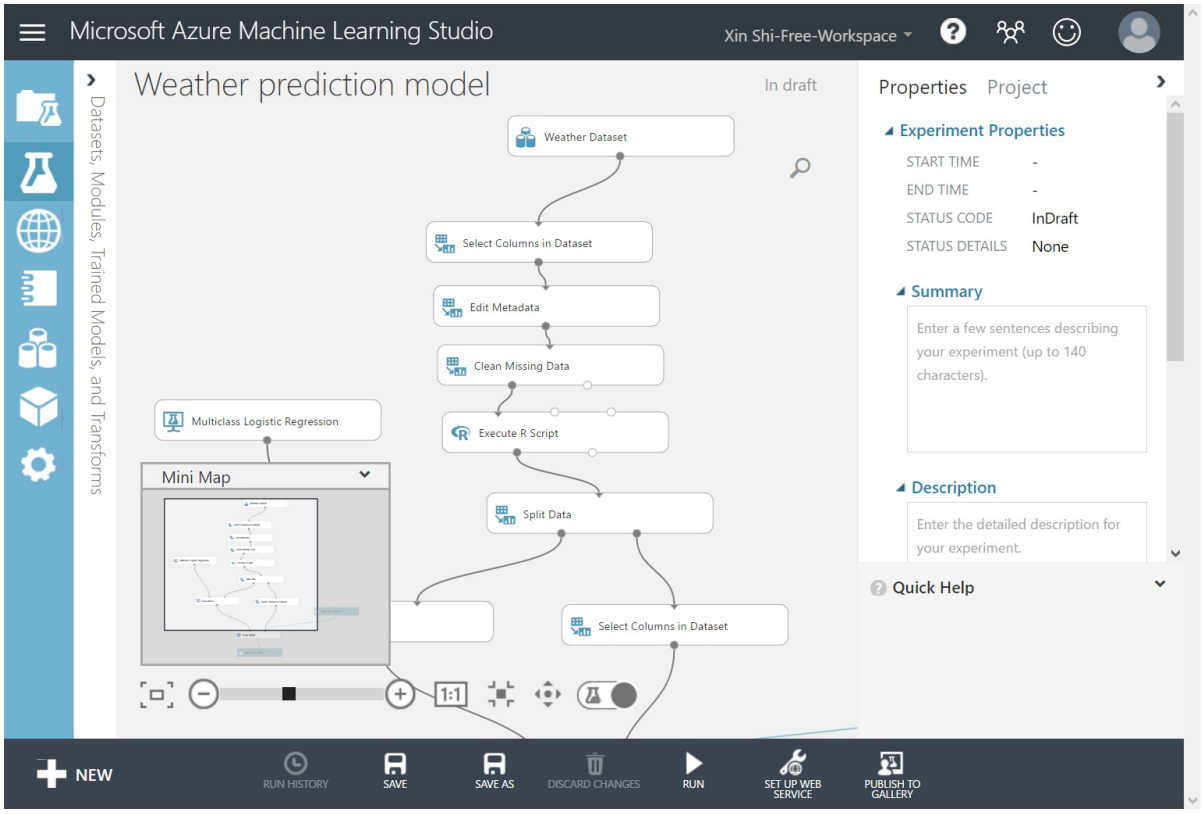
- Tutorial Setup your device completed which covers the following requirements:
    - An active Azure subscription.
    - An Azure IoT hub under your subscription.
    - A client application that sends messages to your Azure IoT hub.
- An Azure Machine Learning Studio account. (Try Machine Learning Studio for free).

Deploy the weather prediction model as a web service

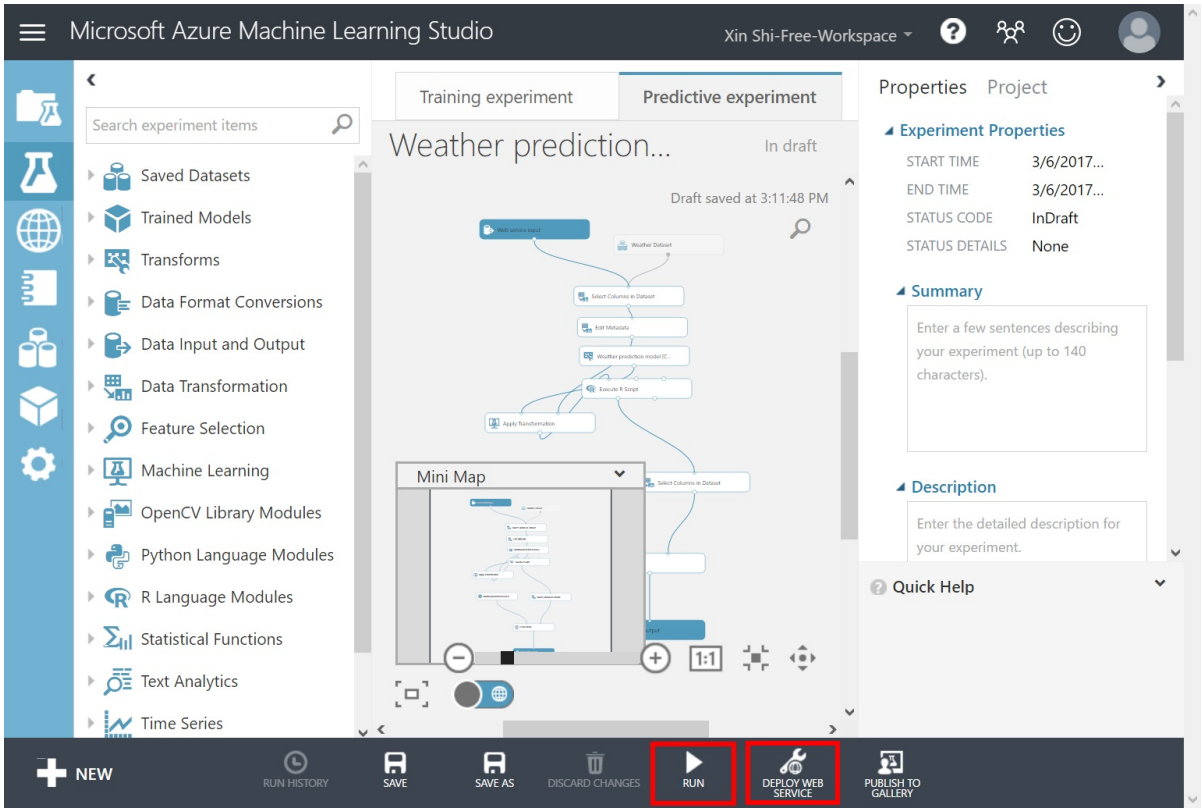
1. Go to the weather prediction model page.
2. Click **Open in Studio** in Microsoft Azure Machine Leaning Studio.



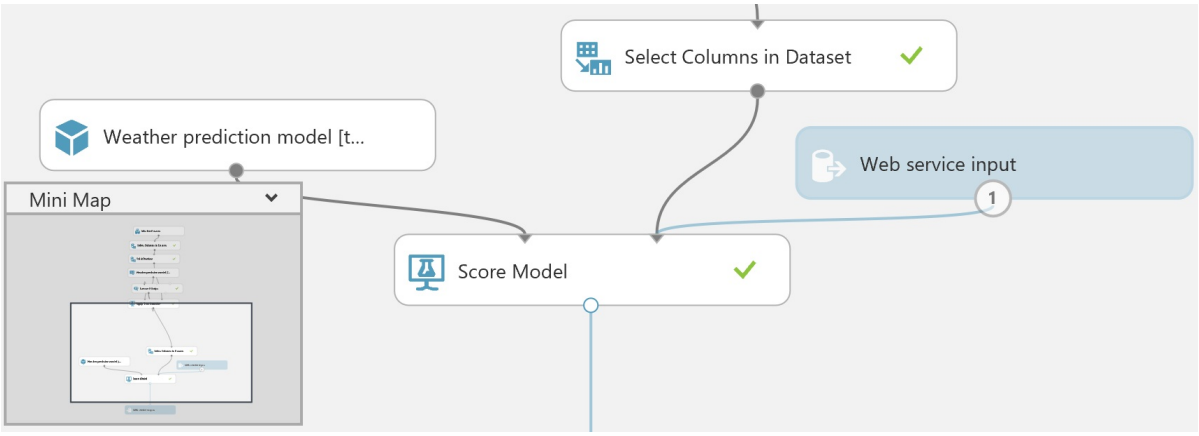
3. Click **Run** to validate the steps in the model. This step might take 2 minutes to complete.



4. Click **SET UP WEB SERVICE** > **Predictive Web Service**.

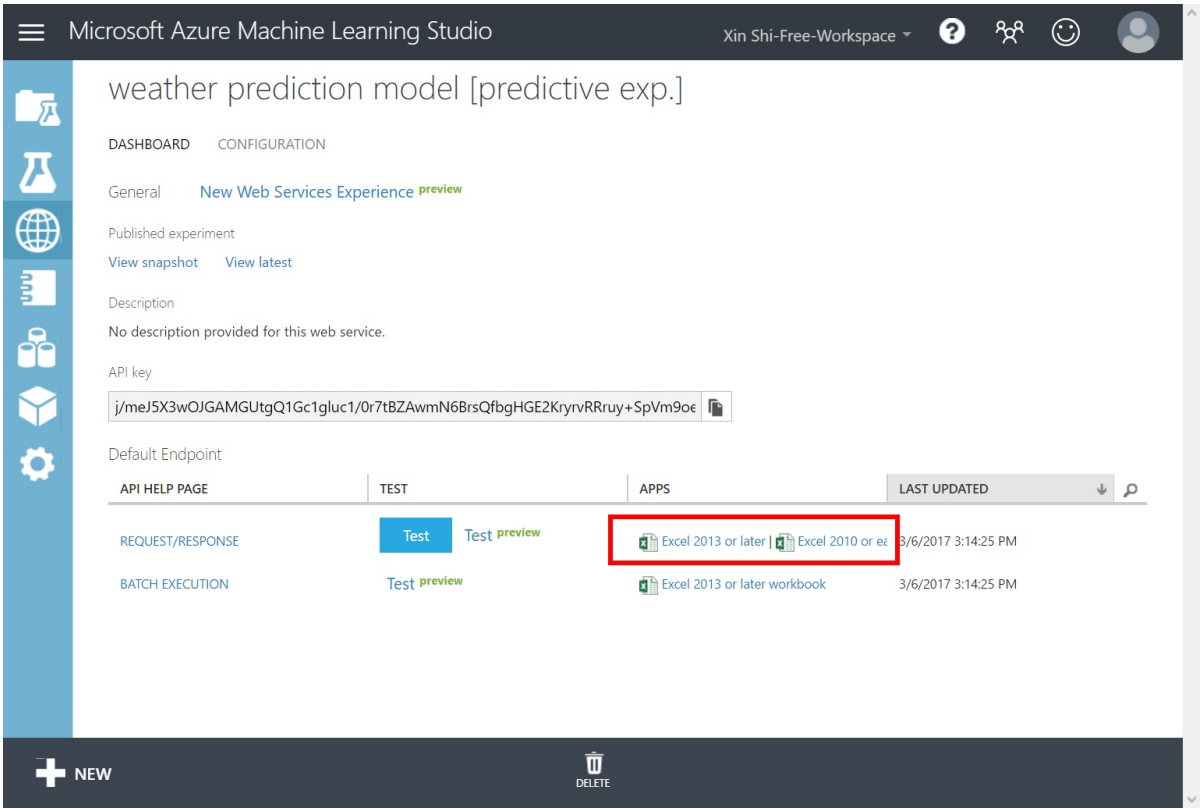


5. In the diagram, drag the **Web service input** module somewhere near the **Score Model** module.
6. Connect the **Web service input** module to the **Score Model** module.



7. Click **RUN** to validate the steps in the model.
8. Click **DEPLOY WEB SERVICE** to deploy the model as a web service.
9. On the dashboard of the model, download the **Excel 2010 or earlier workbook** for **REQUEST/RESPONSE**.

> [!Note] Ensure that you download the **Excel 2010 or earlier workbook** even if you are running a later version of Excel on your computer.



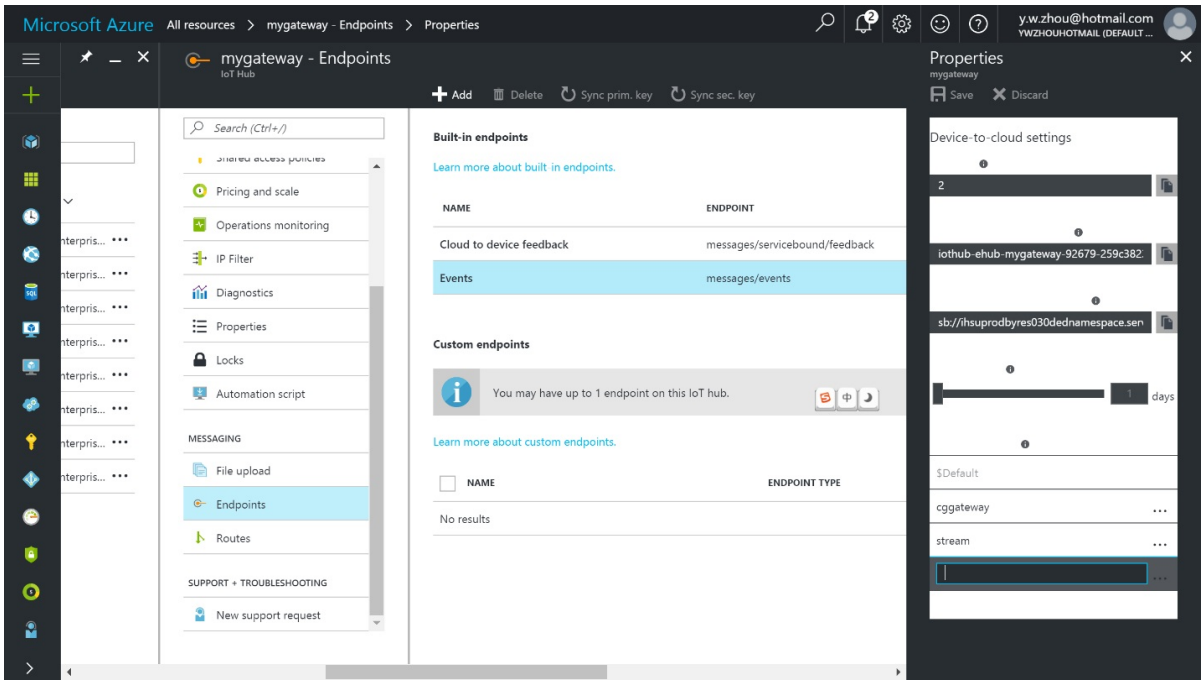
10. Open the Excel workbook, make a note of the **WEB SERVICE URL** and **ACCESS KEY**.

Add a consumer group to your IoT hub

Consumer groups are used by applications to pull data from Azure IoT Hub. In this lesson, you create a consumer group to be used by a coming Azure service to read data from your IoT hub.

To add a consumer group to your IoT hub, follow these steps:

1. In the Azure portal, open your IoT hub.
2. Click **Endpoints** on the left pane, select **Events** on the middle pane, enter a name under **Consumer groups** on the right pane, and then click **Save**.



Create, configure, and run a Stream Analytics job

Create a Stream Analytics job

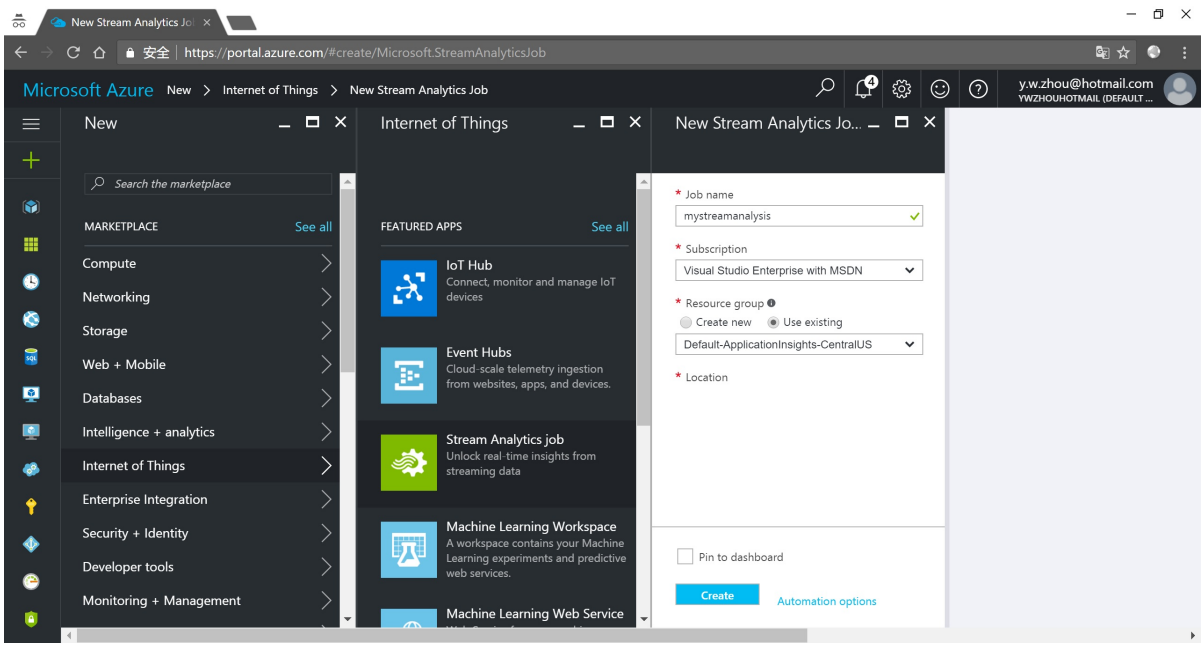
1. In the Azure portal, click **New** > **Internet of Things** > **Stream Analytics job**.
2. Enter the following information for the job.

   Job name: The name of the job. The name must be globally unique.

   Resource group: Use the same resource group that your IoT hub uses.

   Location: Use the same location as your resource group.

   Pin to dashboard: Check this option for easy access to your IoT hub from the dashboard.



3. Click **Create**.

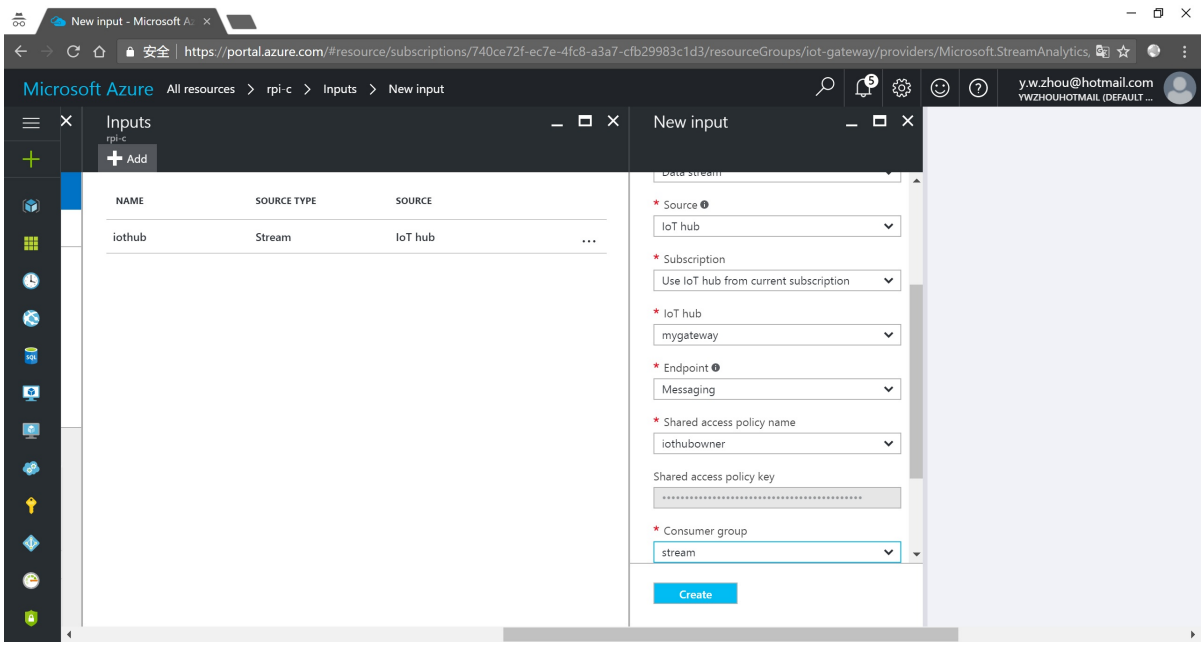
Add an input to the Stream Analytics job

1. Open the Stream Analytics job.
2. Under **Job Topology**, click **Inputs**.
3. In the **Inputs** pane, click **Add**, and then enter the following information:

   Input alias: The unique alias for the input.

   Source: Select **IoT hub**.

   Consumer group: Select the consumer group you created.



4. Click **Create**.

Add an output to the Stream Analytics job

1. Under **Job Topology**, click **Outputs**.
2. In the **Outputs** pane, click **Add**, and then enter the following information:

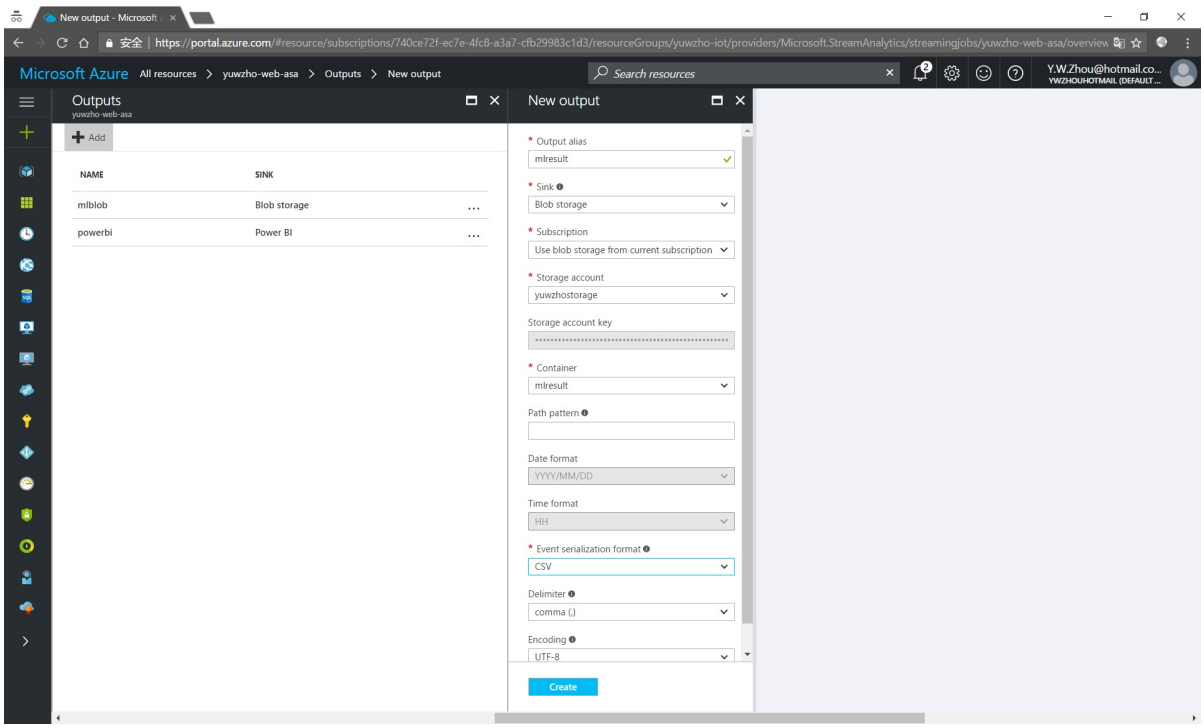
   Output alias: The unique alias for the output.

   Sink: Select **Blob Storage**.

   Storage account: The storage account for your blob storage. You can create a storage account or use an existing one.

   Container: The container where the blob is saved. You can create a container or use an existing one.

   Event serialization format: Select **CSV**.



3. Click **Create**.

Add a function to the Stream Analytics job to call the web service you deployed

1. Under **Job Topology**, click **Functions** > **Add**.
2. Enter the following information:

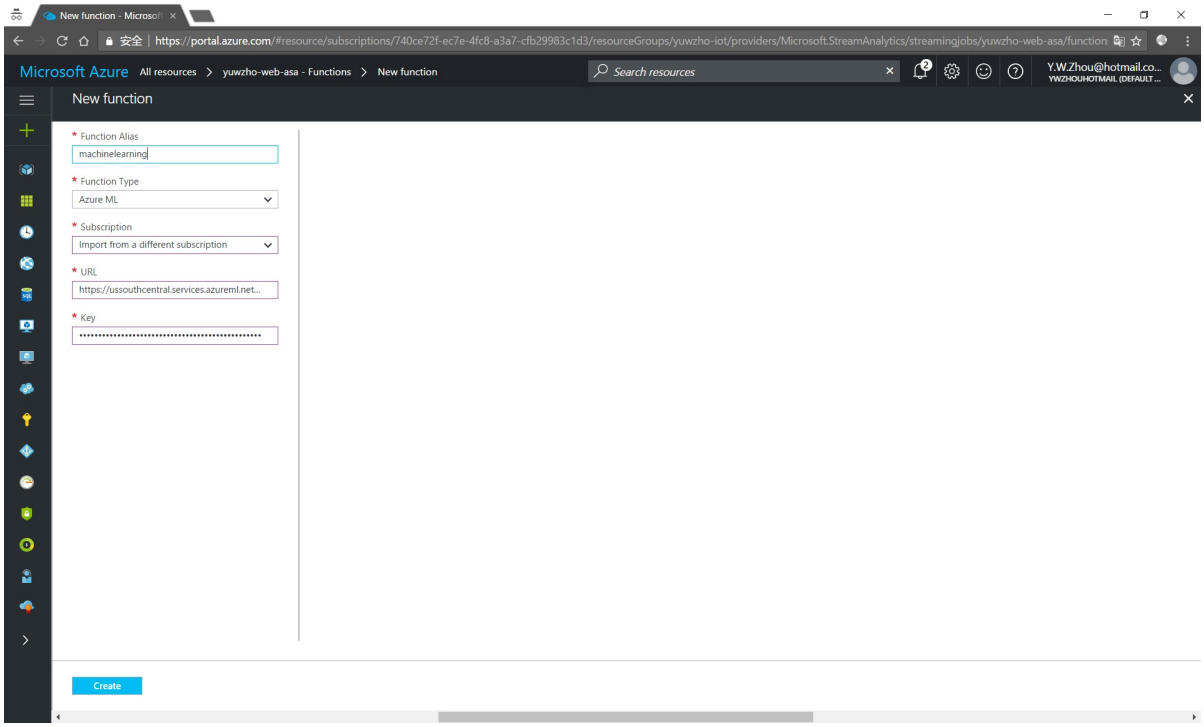
   Function Alias: Enter `machinelearning` .

   Function Type: Select **Azure ML**.

Import option: Select **Import from a different subscription**.

URL: Enter the WEB SERVICE URL that you noted down from the Excel workbook.

Key: Enter the ACCESS KEY that you noted down from the Excel workbook.



3. Click **Create**.

Configure the query of the Stream Analytics job

1. Under **Job Topology**, click **Query**.
2. Replace the existing code with the following code:

```
WITH machinelearning AS (
   SELECT EventEnqueuedUtcTime, temperature, humidity, machinelearning(temperature
, humidity) as result from [YourInputAlias]
)
Select System.Timestamp time, CAST (result.[temperature] AS FLOAT) AS temperature,
CAST (result.[humidity] AS FLOAT) AS humidity, CAST (result.[Scored Probabilities]
AS FLOAT ) AS 'probabalities of rain'
Into [YourOutputAlias]
From machinelearning
```

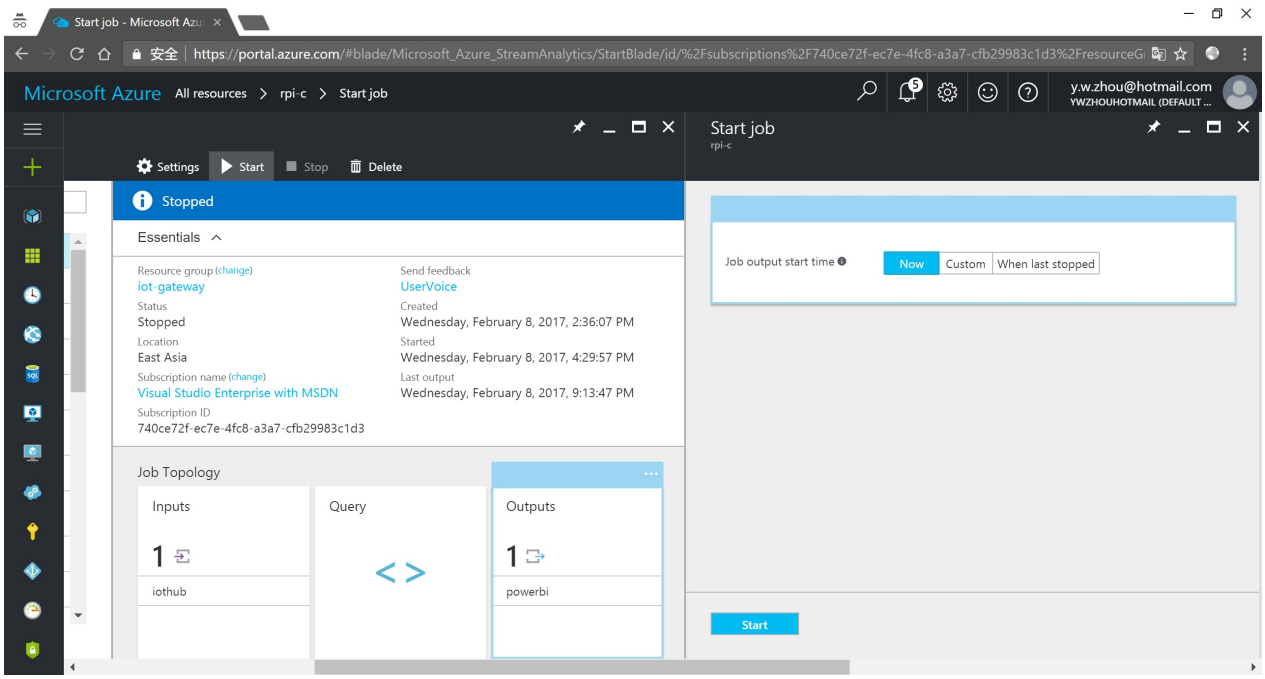
Replace `[YourInputAlias]` with the input alias of the job.

Replace `[YourOutputAlias]` with the output alias of the job.

3. Click **Save**.

Run the Stream Analytics job

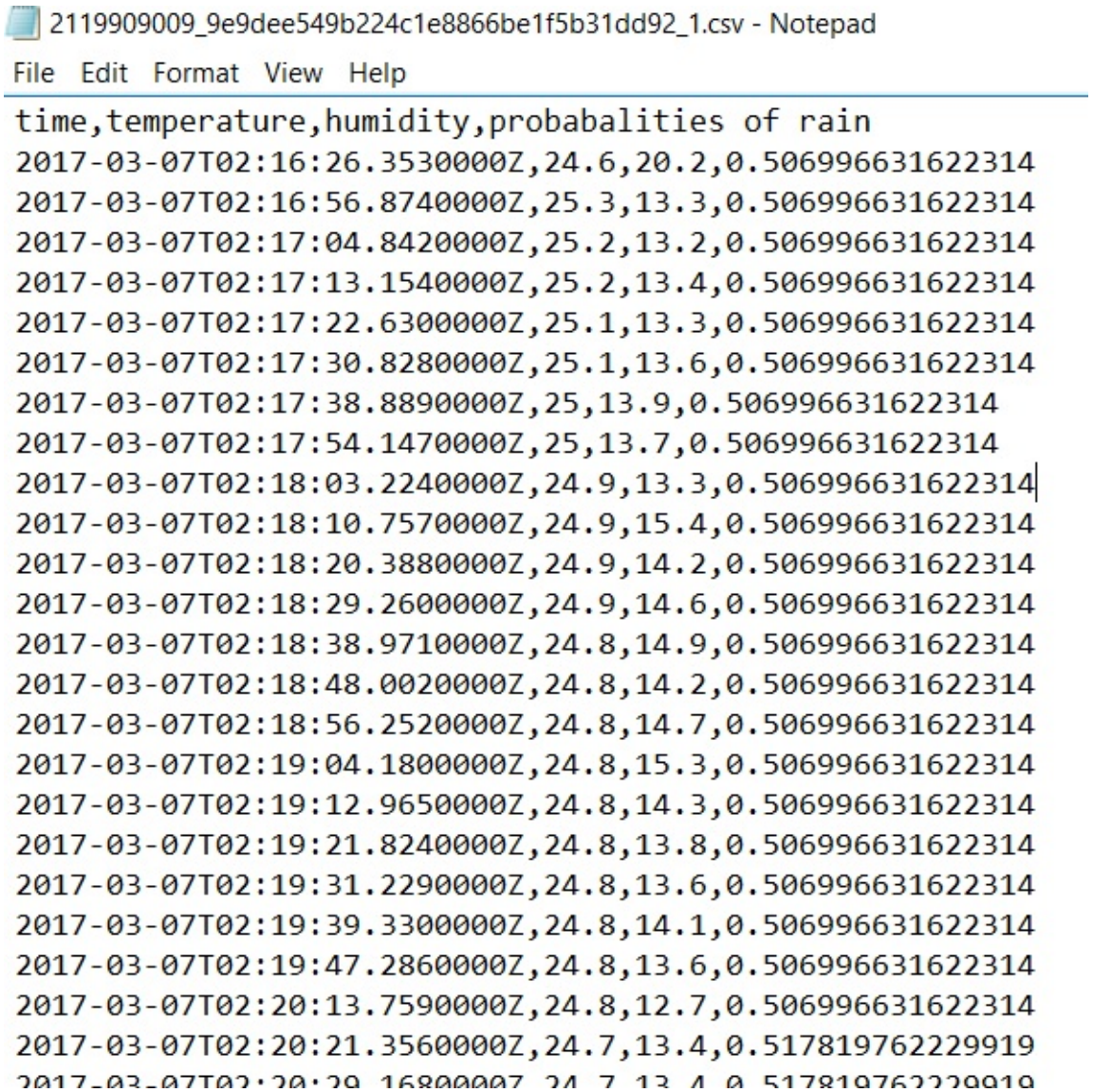
In the Stream Analytics job, click **Start** > **Now** > **Start**. Once the job successfully starts, the job status changes from **Stopped** to **Running**.



Use Microsoft Azure Storage Explorer to view the weather forecast

Run the client application to start collecting and sending temperature and humidity data to your IoT hub. For each message that your IoT hub receives, the Stream Analytics job calls the weather forecast web service to produce the chance of rain. The result is then saved to your Azure blob storage. Azure Storage Explorer is a tool that you can use to view the result.

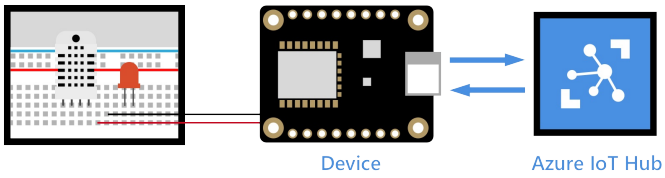
1. Download and install Microsoft Azure Storage Explorer.
2. Open Azure Storage Explorer.
3. Sign in to your Azure account.
4. Select your subscription.
5. Click your subscription > **Storage Accounts** > your storage account > **Blob Containers** > your container.
6. Open a .csv file to see the result. The last column records the chance of rain.



Summary

You've successfully used Azure Machine Learning to produce the chance of rain based on the temperature and humidity data that your IoT hub receives.

Use iothub-explorer for Azure IoT Hub device management



> [!NOTE] Before you start this tutorial, make sure you've completed Setup your device. By Setup your device, you set up your IoT device and IoT hub, and deploy a sample application to run on your device. The application sends collected sensor data to your IoT hub.

iothub-explorer is a CLI tool that you run on a host computer to manage device identities in your IoT hub registry. It comes with management options that you can use to perform various tasks.

Management option	Task
Direct methods	Make a device act such as starting or stopping sending messages or rebooting the device.
Twin desired properties	Put a device into certain states, such as setting an LED to green or setting the telemetry send interval to 30 minutes.
Twin reported properties	Get the reported state of a device. For example, the device reports the LED is blinking now.
Twin tags	Store device-specific metadata in the cloud. For example, the deployment location of a vending machine.
Cloud-to-device messages	Send notifications to a device. For example, "It is very likely to rain today. Don't forget to bring an umbrella."
Device twin queries	Query all device twins to retrieve those with arbitrary conditions, such as identifying the devices that are available for use.

For more detailed explanation on the differences and guidance on using these options, see Device-to-cloud communication guidance and Cloud-to-device communication guidance.

> [!NOTE] Device twins are JSON documents that store device state information (metadata, configurations, and conditions). IoT Hub persists a device twin for each device that connects to it. For more information about device twins, see Get started with device twins.

What you learn

You learn using iothub-explorer with various management options on your development machine.

What you do

Run iothub-explorer with various management options.

What you need

- Tutorial Setup your device completed which covers the following requirements:
  - An active Azure subscription.
  - An Azure IoT hub under your subscription.
  - A client application that sends messages to your Azure IoT hub.
- iothub-explorer. (Install iothub-explorer on your development machine)

Connect to your IoT hub

Connect to your IoT hub by running the following command:

```
iothub-explorer login <your IoT hub connection string>
```

Use iothub-explorer with direct methods

Invoke the `start` method in the device app to send messages to your IoT hub by running the following command:

```
iothub-explorer device-method <your device Id> start
```

Invoke the `stop` method in the device app to stop sending messages to your IoT hub by running the following command:

```
iothub-explorer device-method <your device Id> stop
```

Use iothub-explorer with twin's desired properties

Set a desired property interval = 3000 by running the following command:

```
iothub-explorer update-twin <your device id> {\"properties\":{\"desired\":{\"interval\
":3000}}}
```

This property can be read by your device.

Use iothub-explorer with twin's reported properties

Get the reported properties of the device by running the following command:

```
iothub-explorer get-twin <your device id>
```

One of the properties is $metadata.$lastUpdated which shows the last time this device sends or receives a message.

Use iothub-explorer with twin's tags

Display the tags and properties of the device by running the following command:

```
iothub-explorer get-twin <your device id>
```

Add a field role = temperature&humidity to the device by running the following command:

```
iothub-explorer update-twin <your device id> {\"tags\":{\"role\":\"temperature&humidit
y\"}}
```

Use iothub-explorer with Cloud-to-device messages

Send a "Hello World" message to the device by running the following command:

```
iothub-explorer send <device-id> "Hello World"
```

See Use iothub-explorer to send and receive messages between your device and IoT Hub for a real scenario of using this command.

Use iothub-explorer with device twins queries

Query devices with a tag of role = 'temperature&humidity' by running the following command:

```
iothub-explorer query-twin "SELECT * FROM devices WHERE tags.role = 'temperature&humid
ity'"
```

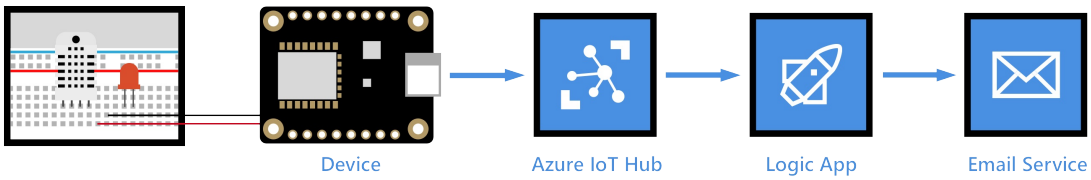
Query all devices except those with a tag of role = 'temperature&humidity' by running the following command:

```
iothub-explorer query-twin "SELECT * FROM devices WHERE tags.role != 'temperature&humi
dity'"
```

Next steps

You've learned how to use iothub-explorer with various management options.

IoT remote monitoring and notifications with Azure Logic Apps connecting your IoT hub and mailbox



> [!NOTE] Before you start this tutorial, make sure you've completed Setup your device. By Setup your device, you set up your IoT device and IoT hub, and deploy a sample application to run on your device. The application sends collected sensor data to your IoT hub.

Azure Logic Apps provides a way to automate processes as a series of steps. A logic app can connect across various services and protocols. It begins with a trigger such as 'When an account is added', and followed by a combination of actions, one like 'sending a push notification'. This feature makes Logic Apps a perfect IoT solution for IoT monitoring, such as staying alert for anomalies, among other usage scenarios.

What you learn

You learn how to create a logic app that connects your IoT hub and your mailbox for temperature monitoring and notifications. When the temperature is above 30 C, the client application marks `temperatureAlert = "true"` in the message it sends to your IoT hub. The message triggers the logic app to send you an email notification.

What you do

- Create a service bus namespace and add a queue to it.
- Add an endpoint and a routing rule to your IoT hub.
- Create, configure, and test a logic app.

What you need

- Tutorial Setup your device completed which covers the following requirements:
  - An active Azure subscription.
  - An Azure IoT hub under your subscription.
  - A client application that sends messages to your Azure IoT hub.

Create service bus namespace and add a queue to it

Create a service bus namespace

1. On the Azure portal, click **New** > **Enterprise Integration** > **Service Bus**.
2. Provide the following information:

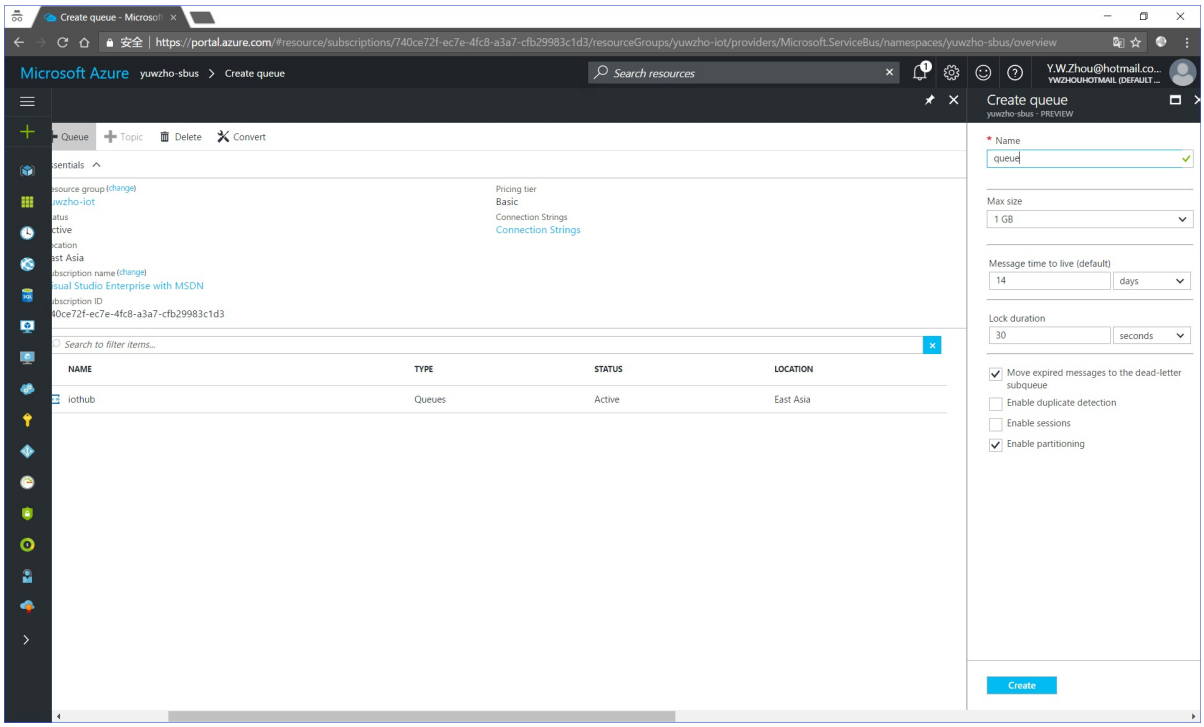
   Name: The name of the service bus.

   Pricing tier: Click **Basic** > **Select**. The Basic tier is sufficient for this tutorial.

   Resource group: Use the same resource group that your IoT hub uses.

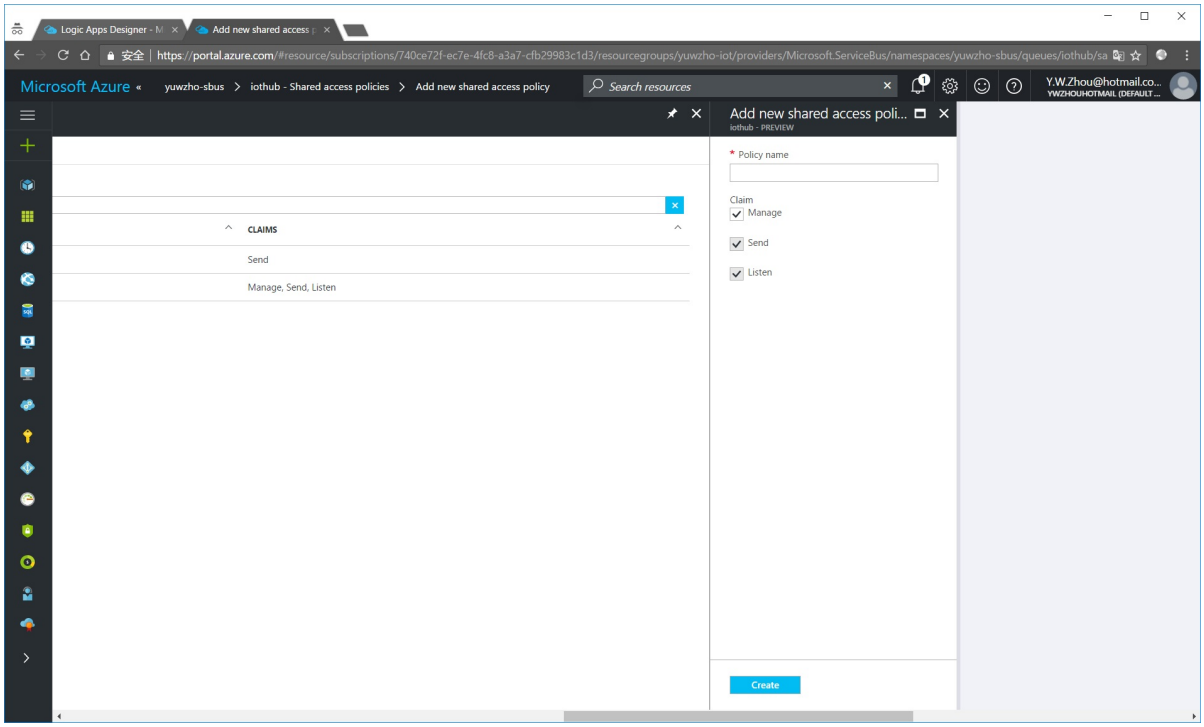
   Location: Use the same location that your IoT hub uses.

3. Click **Create**.



Add a service bus queue

1. Open the service bus namespace, and then click **+ Queue**.
2. Enter a name for the queue and then click **Create**.
3. Open the service bus queue, and then click **Shared access policies** > **+ Add**.
4. Enter a name for the policy, check **Manage**, and then click **Create**.



Add an endpoint and a routing rule to your IoT hub

Add an endpoint

1. Open your IoT hub, click Endpoints > + Add.
2. Enter the following information:

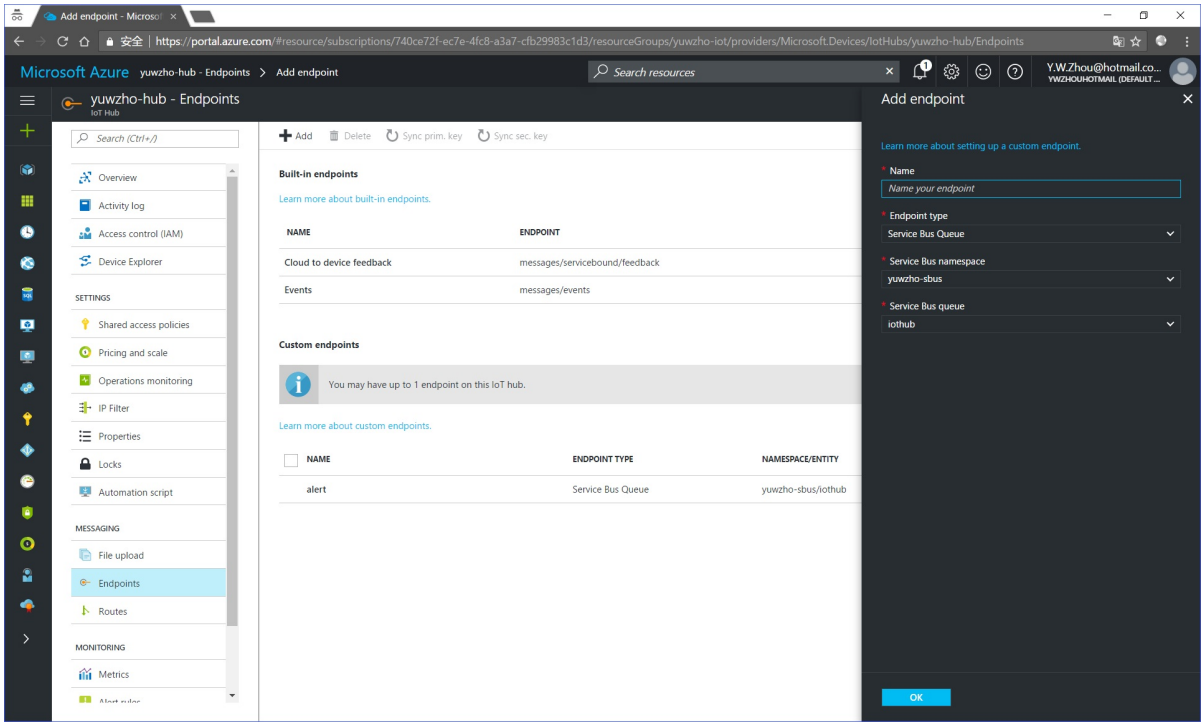
   Name: The name of the endpoint.

   Endpoint type: Select **Service Bus Queue**.

   Service Bus namespace: Select the namespace you created.

   Service Bus queue: Select the queue you created.

3. Click **OK**.



Add a routing rule

1. In your IoT hub, click **Routes** > **+ Add**.
2. Enter the following information:

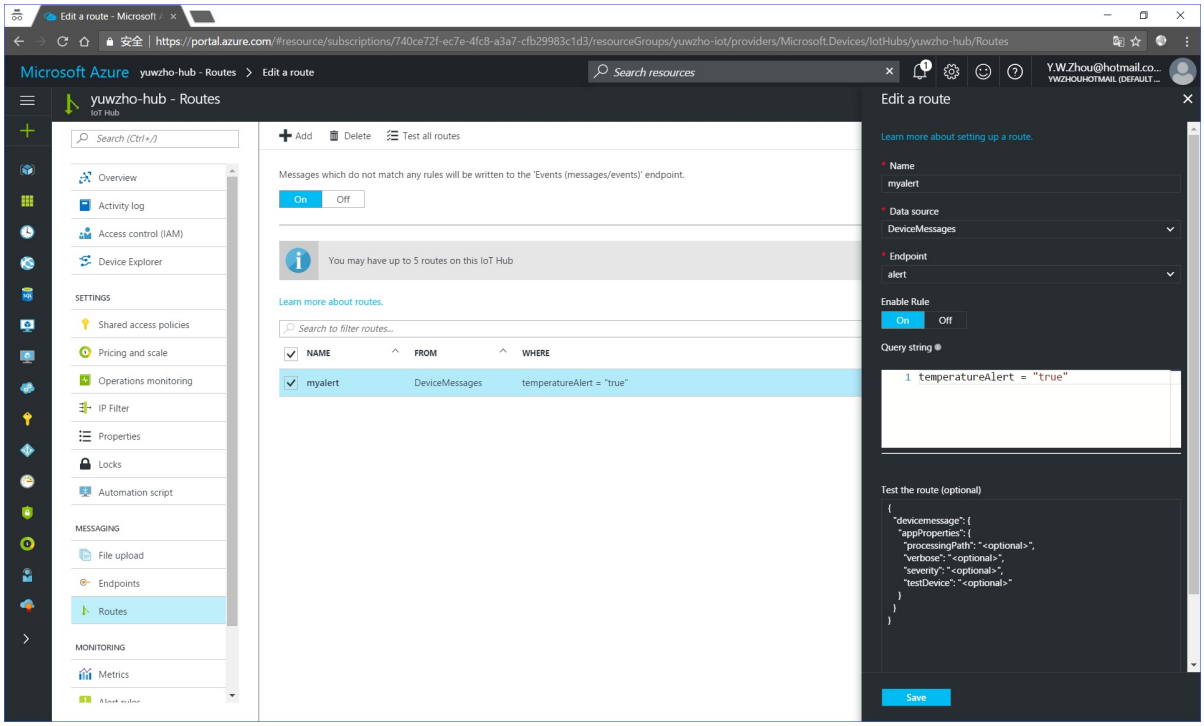
   Name: The name of the routing rule.

   Data source: Select **DeviceMessages**.

   Endpoint: Select the endpoint you created.

   Query string: Enter `temperatureAlert = "true"` .

3. Click **Save**.



Create and configure a logic app

Create a logic app

1. In the Azure portal, click **New** > **Enterprise Integration** > **Logic App**.
2. Enter the following information:

   Name: The name of the logic app.

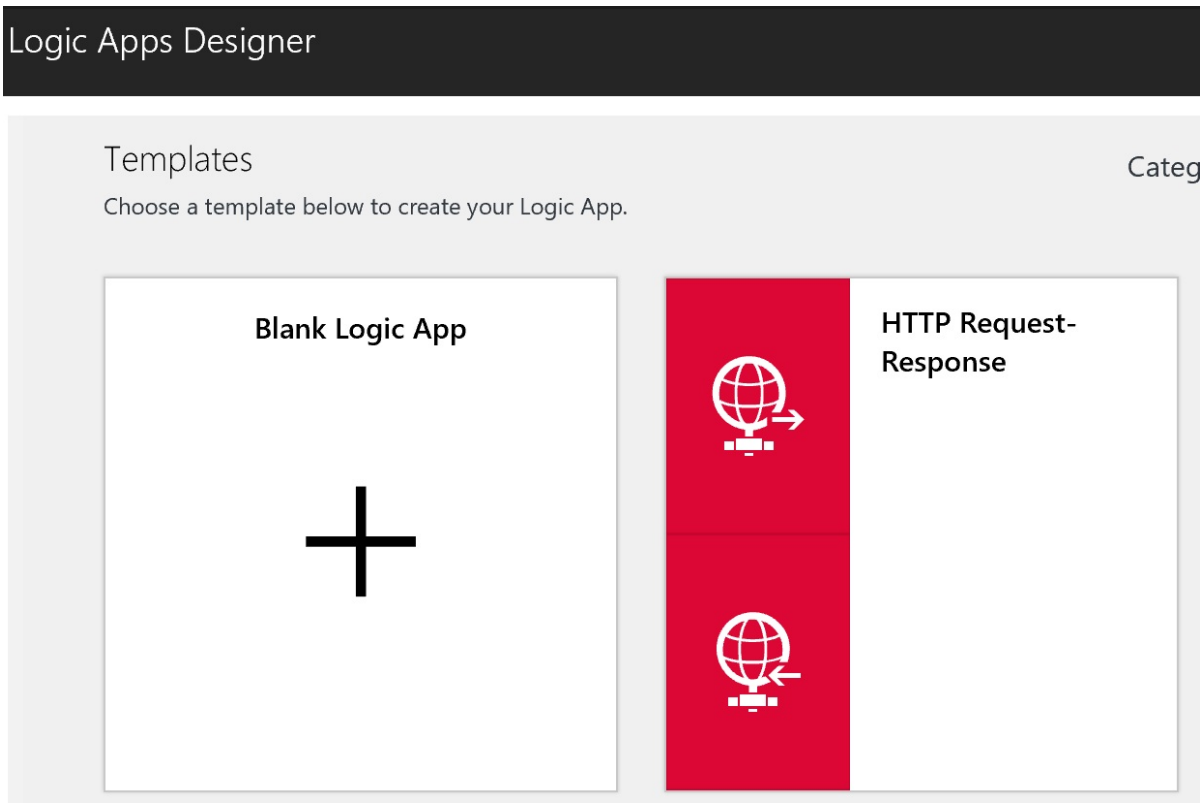
   Resource group: Use the same resource group that your IoT hub uses.

   Location: Use the same location that your IoT hub uses.

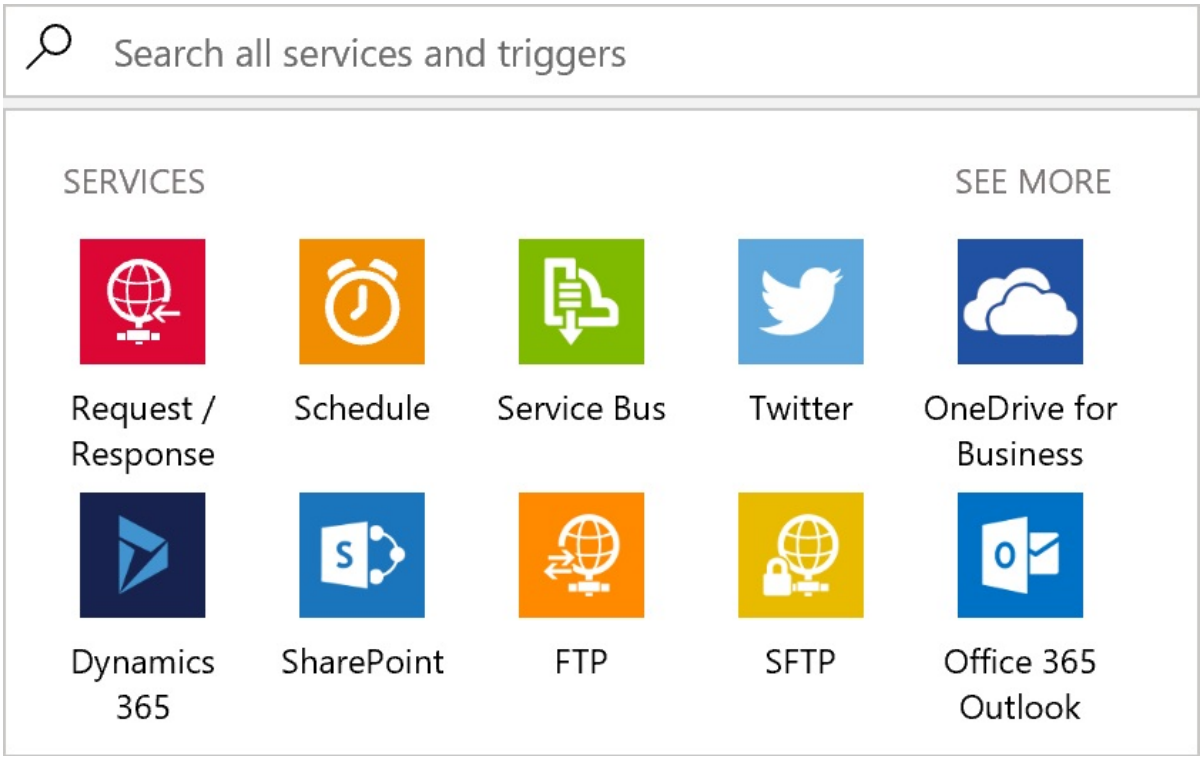
3. Click **Create**.

Configure the logic app

1. Open the logic app that opens into the Logic Apps Designer.
2. In the Logic Apps Designer, click **Blank Logic App**.



3. Click **Service Bus**.

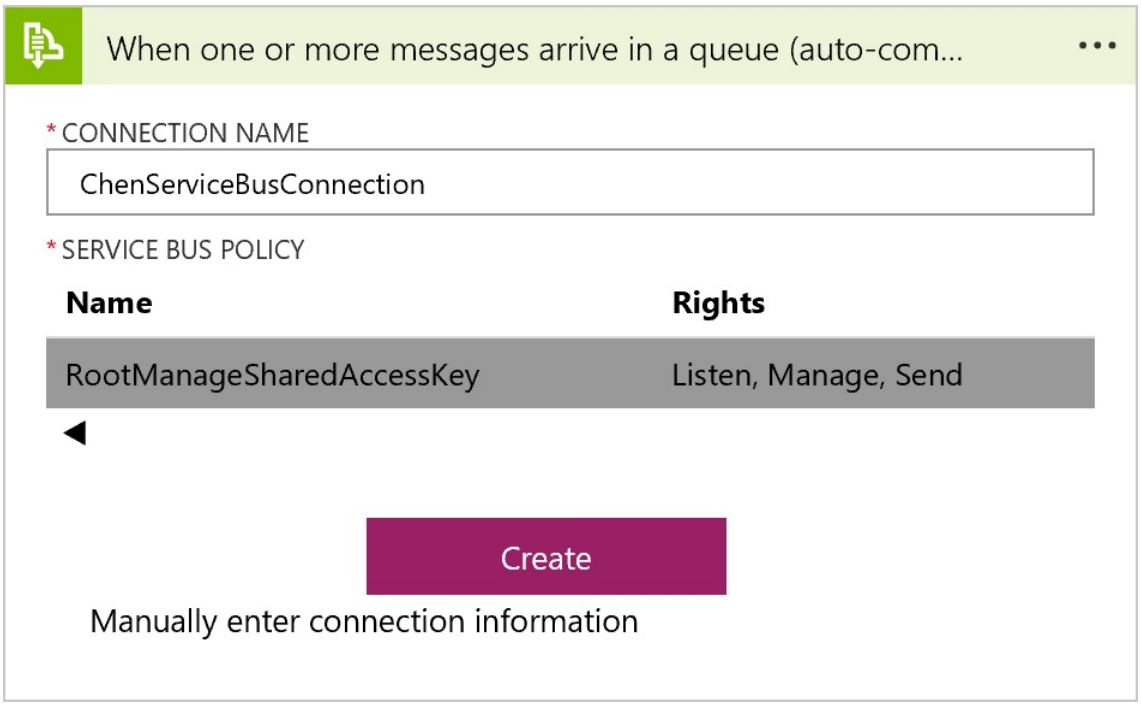


4. Click **Service Bus – When one or more messages arrive in a queue (auto-complete)**.

5. Create a service bus connection.

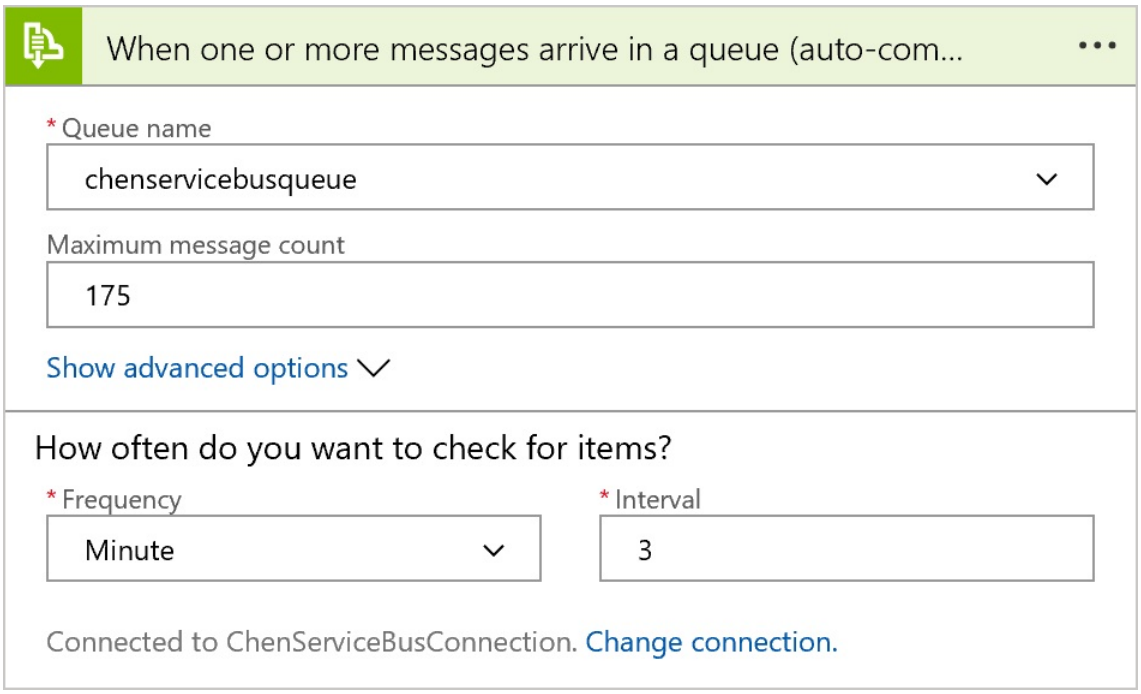
   i. Enter a connection name.

ii. Click the service bus namespace > the service bus policy > **Create**.



iii. Click **Continue** after the service bus connection is created.

iv. Select the queue that you created and enter `175` for **Maximum message count**

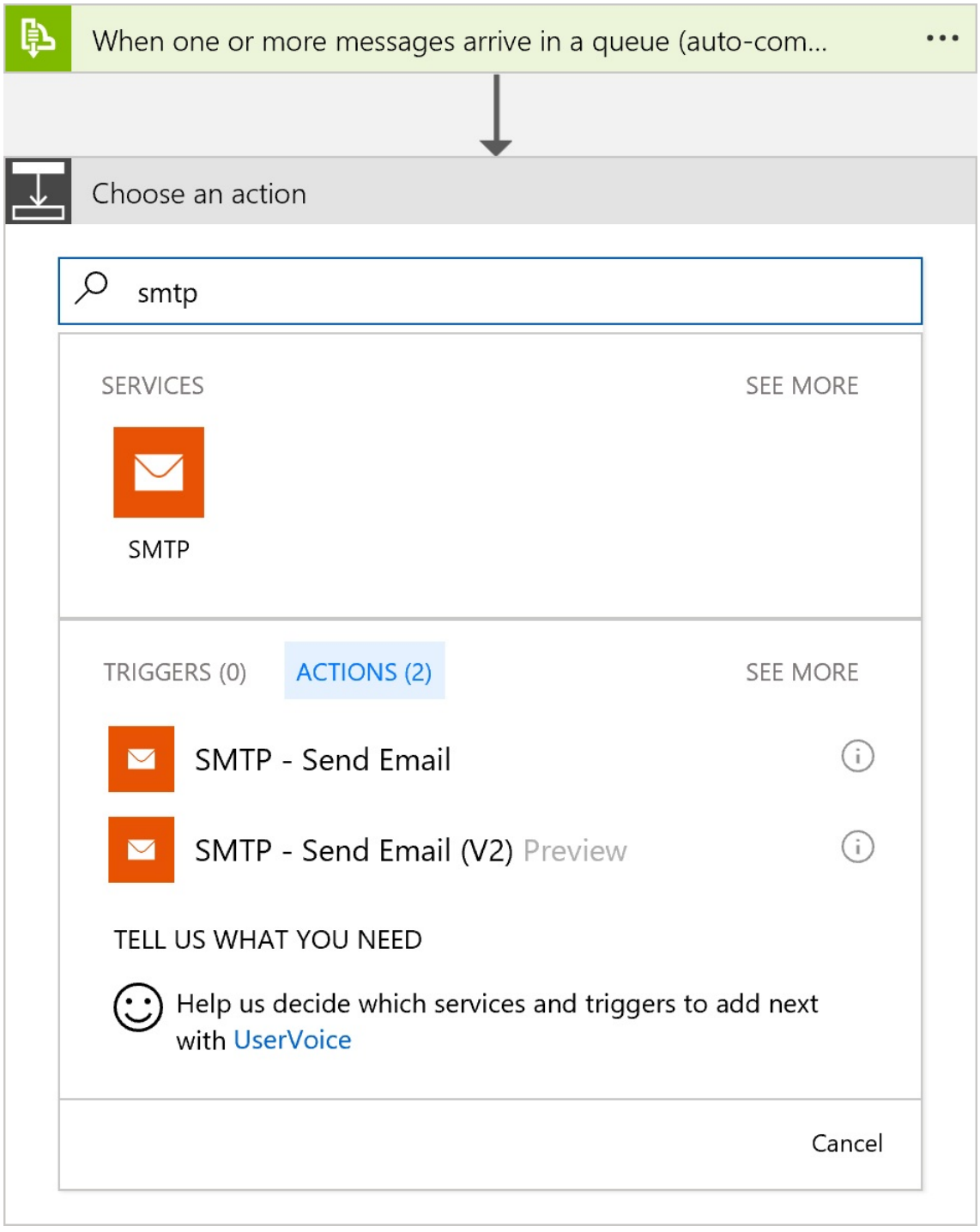


v. Click "Save" button to save the changes.

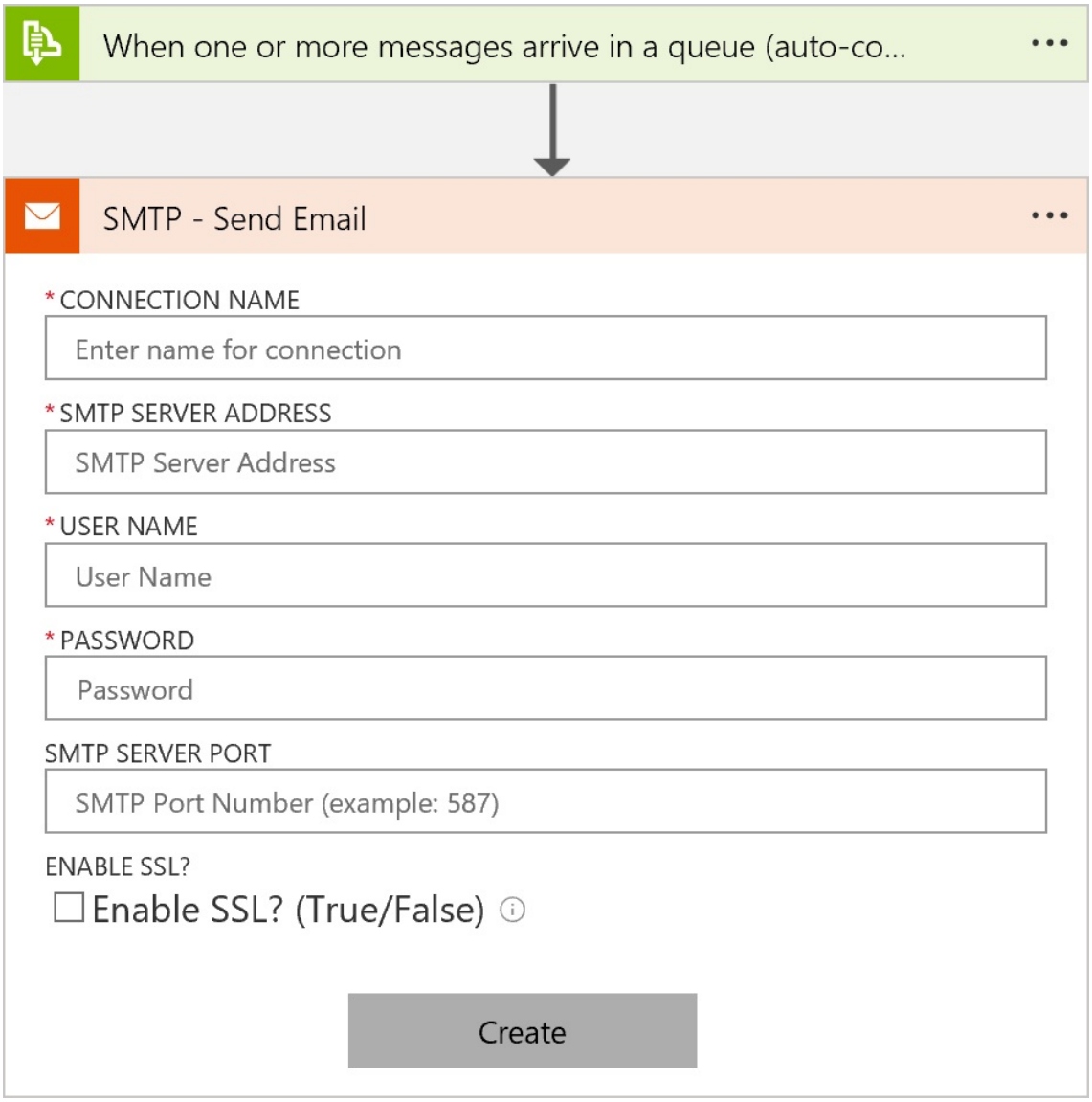
6. Create an SMTP service connection.

i. Click **New step** > **Add an action**.

ii. Type `SMTP`, click the **SMTP** service in the search result, and then click **SMTP - Send Email**.



iii. Enter the SMTP information of your mailbox, and then click **Create**.



Get the SMTP information for Hotmail/Outlook.com, Gmail, and Yahoo Mail.

iv. Enter your email address for **From** and **To**, and `High temperature detected` for **Subject** and **Body**.
v. Click **Save**.

The logic app is in working order when you save it.

Test the logic app

1. Start the client application that you deploy to your device in Connect ESP8266 to Azure IoT Hub.
2. Increase the environment temperature around the SensorTag to be above 30 C. For example, light a candle around your SensorTag.
3. You should receive an email notification sent by the logic app.

> [!NOTE] Your email service provider may need to verify the sender identity to make sure it is you who sends the email.

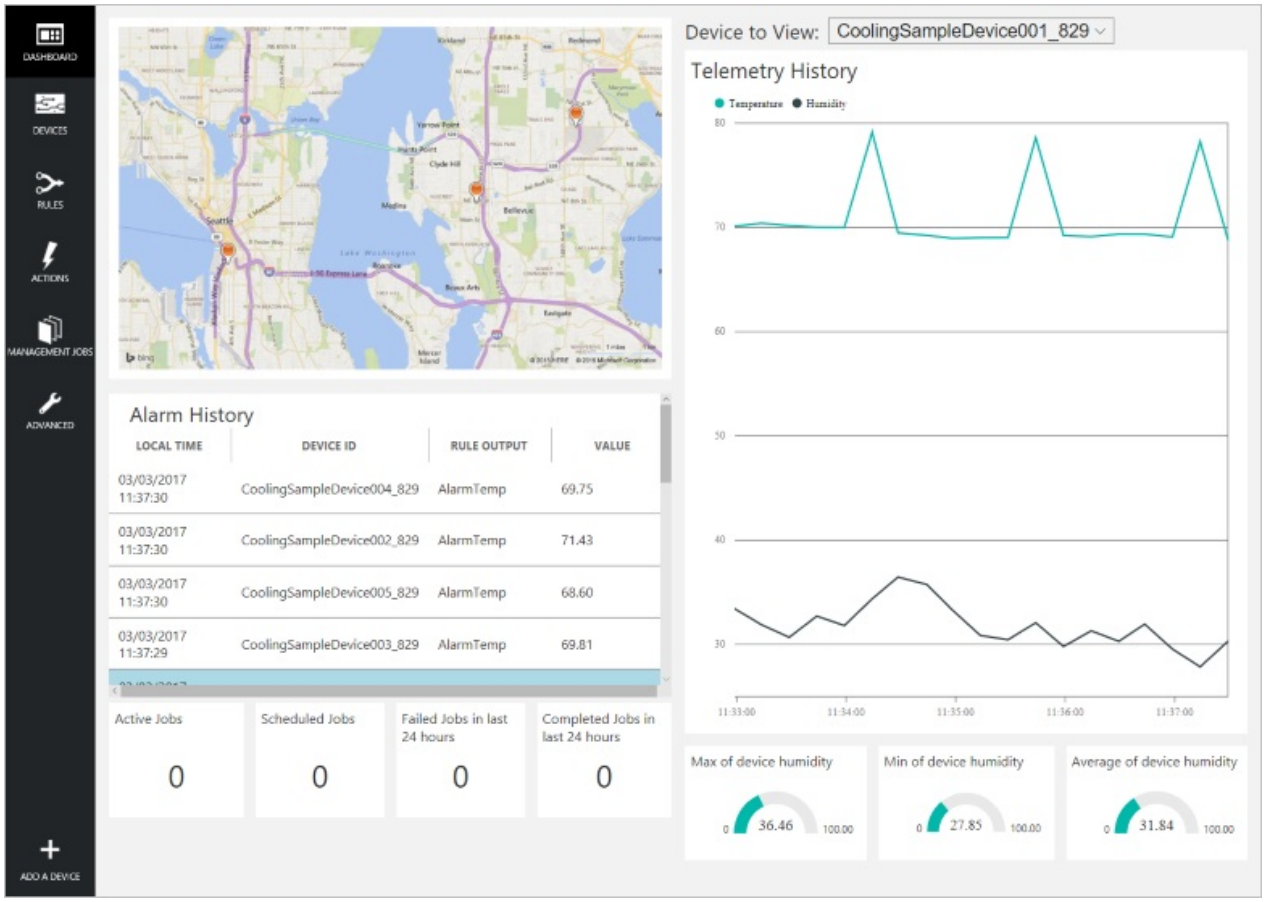
Next steps

You have successfully created a logic app that connects your IoT hub and your mailbox for temperature monitoring and notifications.

Get started with the preconfigured solutions

Azure IoT Suite preconfigured solutions combine multiple Azure IoT services to deliver end-to-end solutions that implement common IoT business scenarios. The *remote monitoring* preconfigured solution connects to and monitors your devices. You can use the solution to analyze the stream of data from your devices and to improve business outcomes by making processes respond automatically to that stream of data.

This tutorial shows you how to provision the remote monitoring preconfigured solution. It also walks you through the basic features of the preconfigured solution. You can access many of these features from the solution *dashboard* that deploys as part of the preconfigured solution:



To complete this tutorial, you need an active Azure subscription.

> [!NOTE] If you don't have an account, you can create a free trial account in just a couple of minutes. For details, see Azure Free Trial.

Provision the solution

If you haven't already provisioned the remote monitoring preconfigured solution in your account:

1. Log on to azureiotsuite.com using your Azure account credentials, and click **+** to create a solution.
2. Click **Select** on the **Remote monitoring** tile.
3. Enter a **Solution name** for your remote monitoring preconfigured solution.
4. Select the **Region** and **Subscription** you want to use to provision the solution.
5. Click **Create Solution** to begin the provisioning process. This process typically takes several minutes to run.

Wait for the provisioning process to complete

1. Click the tile for your solution with **Provisioning** status.
2. Notice the **Provisioning states** as Azure services are deployed in your Azure subscription.
3. Once provisioning completes, the status changes to **Ready**.
4. Click the tile to see the details of your solution in the right-hand pane.

> [!NOTE] If you are encountering issues deploying the pre-configured solution, review Permissions on the azureiotsuite.com site and the FAQ. If the issues persist, create a service ticket on the portal.

Are there details you'd expect to see that aren't listed for your solution? Give us feature suggestions on User Voice.

Scenario overview

When you deploy the remote monitoring preconfigured solution, it is prepopulated with resources that enable you to step through a common remote monitoring scenario. In this scenario, several devices connected to the solution are reporting unexpected temperature values. The following sections show you how to:

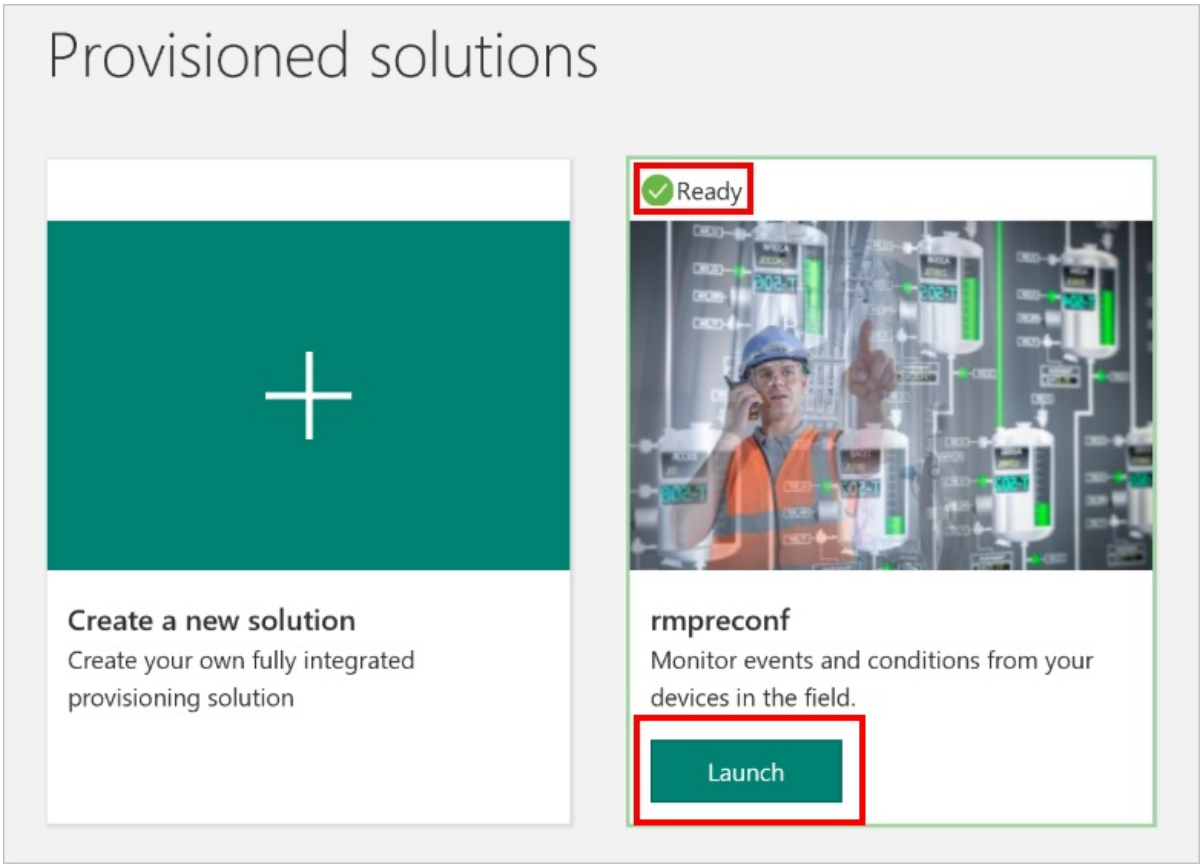
- Identify the devices sending unexpected temperature values.
- Configure these devices to send more detailed telemetry.
- Fix the problem by updating the firmware on these devices.
- Verify that your action has resolved the issue.

A key feature of this scenario is that you can perform all these actions remotely from the solution dashboard. You do not need physical access to the devices.

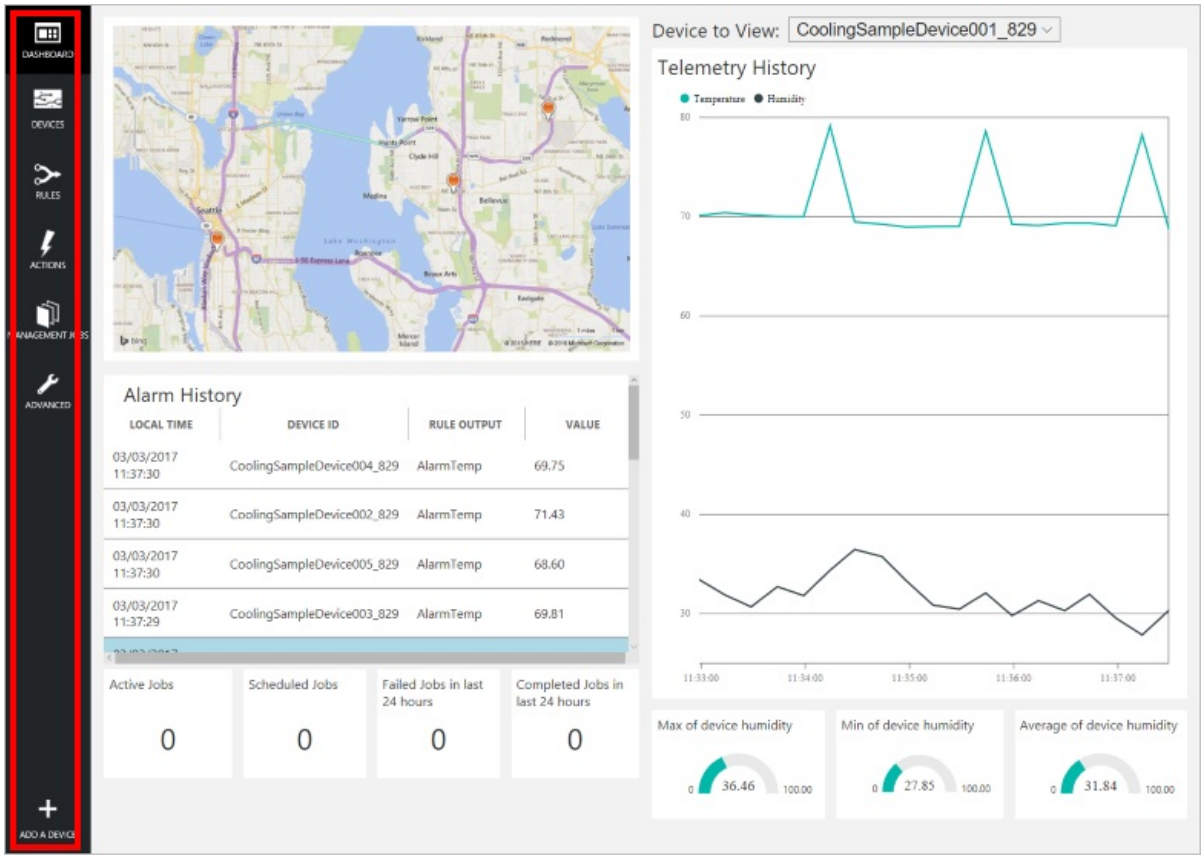
View the solution dashboard

The solution dashboard enables you to manage the deployed solution. For example, you can view telemetry, add devices, and configure rules.

1. When the provisioning is complete and the tile for your preconfigured solution indicates **Ready**, choose **Launch** to open your remote monitoring solution portal in a new tab.



2. By default, the solution portal shows the *dashboard*. You can navigate to other areas of the solution portal using the menu on the left-hand side of the page.

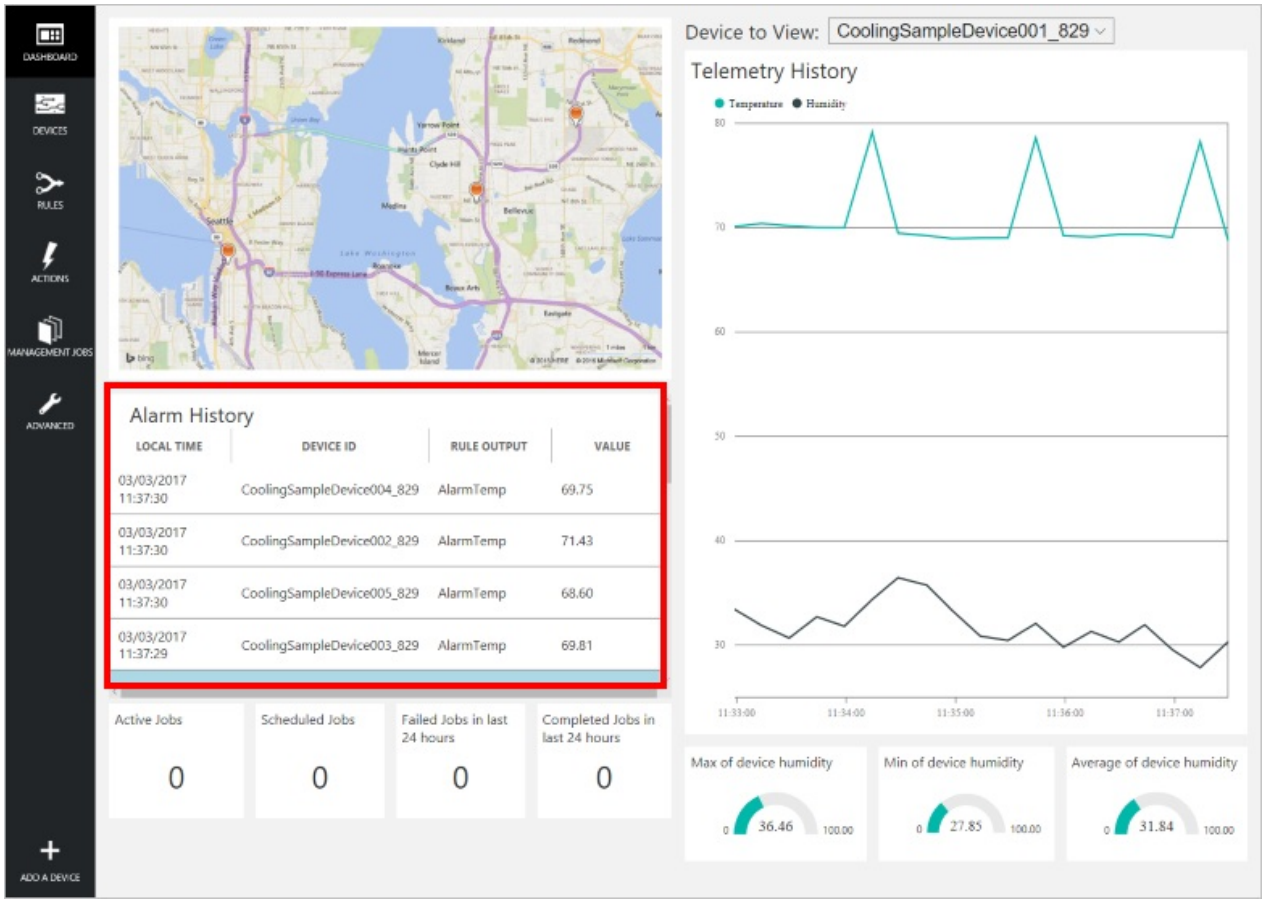


The dashboard displays the following information:

- A map that displays the location of each device connected to the solution. When you first run the solution, there are 25 simulated devices. The simulated devices are implemented as Azure WebJobs, and the solution uses the Bing Maps API to plot information on the map. See the FAQ to learn how to make the map dynamic.
- A **Telemetry History** panel that plots humidity and temperature telemetry from a selected device in near real time and displays aggregate data such as maximum, minimum, and average humidity.
- An **Alarm History** panel that shows recent alarm events when a telemetry value has exceeded a threshold. You can define your own alarms in addition to the examples created by the preconfigured solution.
- A **Jobs** panel that displays information about scheduled jobs. You can schedule your own jobs on **Management jobs** page.

View alarms

The alarm history panel shows you that five devices are reporting higher than expected telemetry values.

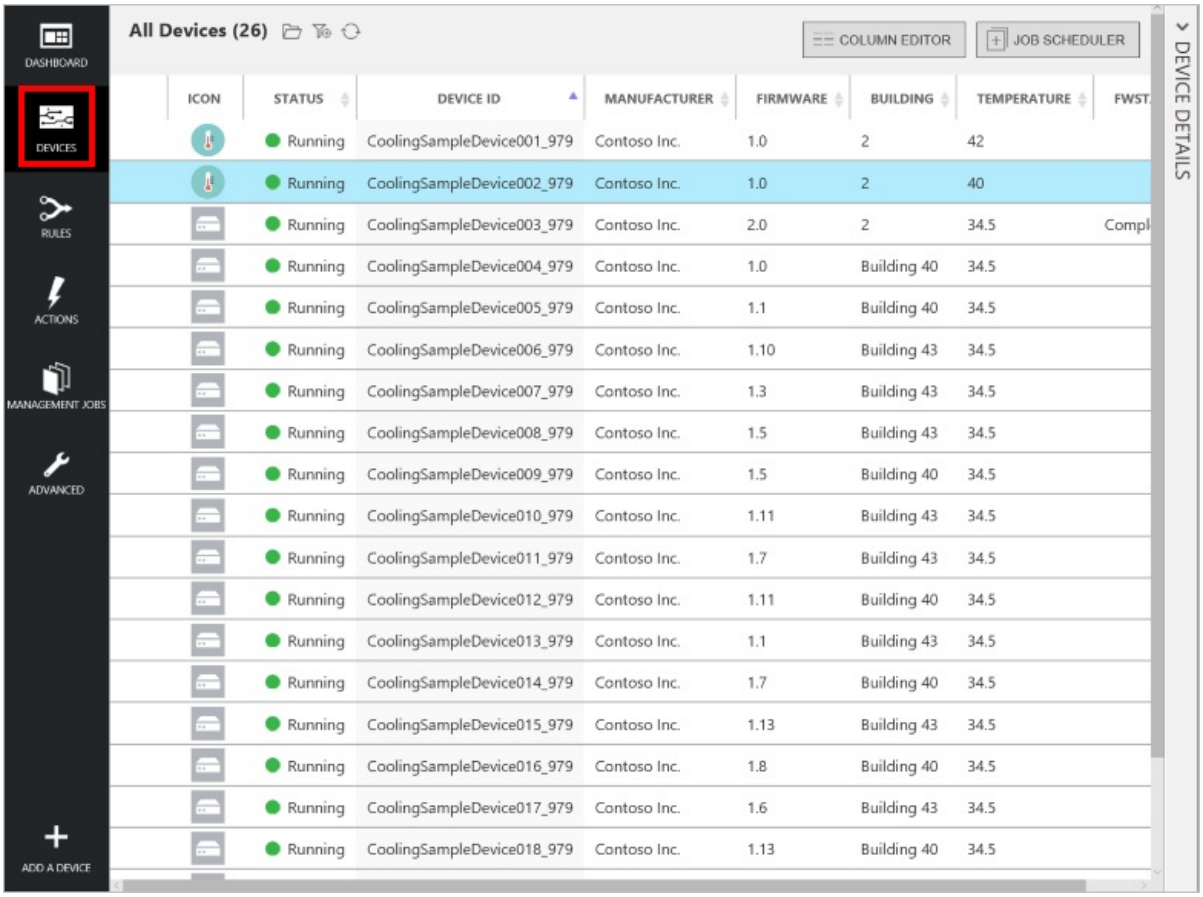


> [!NOTE] These alarms are generated by a rule that is included in the preconfigured solution. This rule generates an alert when the temperature value sent by a device exceeds 60. You can define your own rules and actions by choosing Rules and Actions in the left-hand menu.

View devices

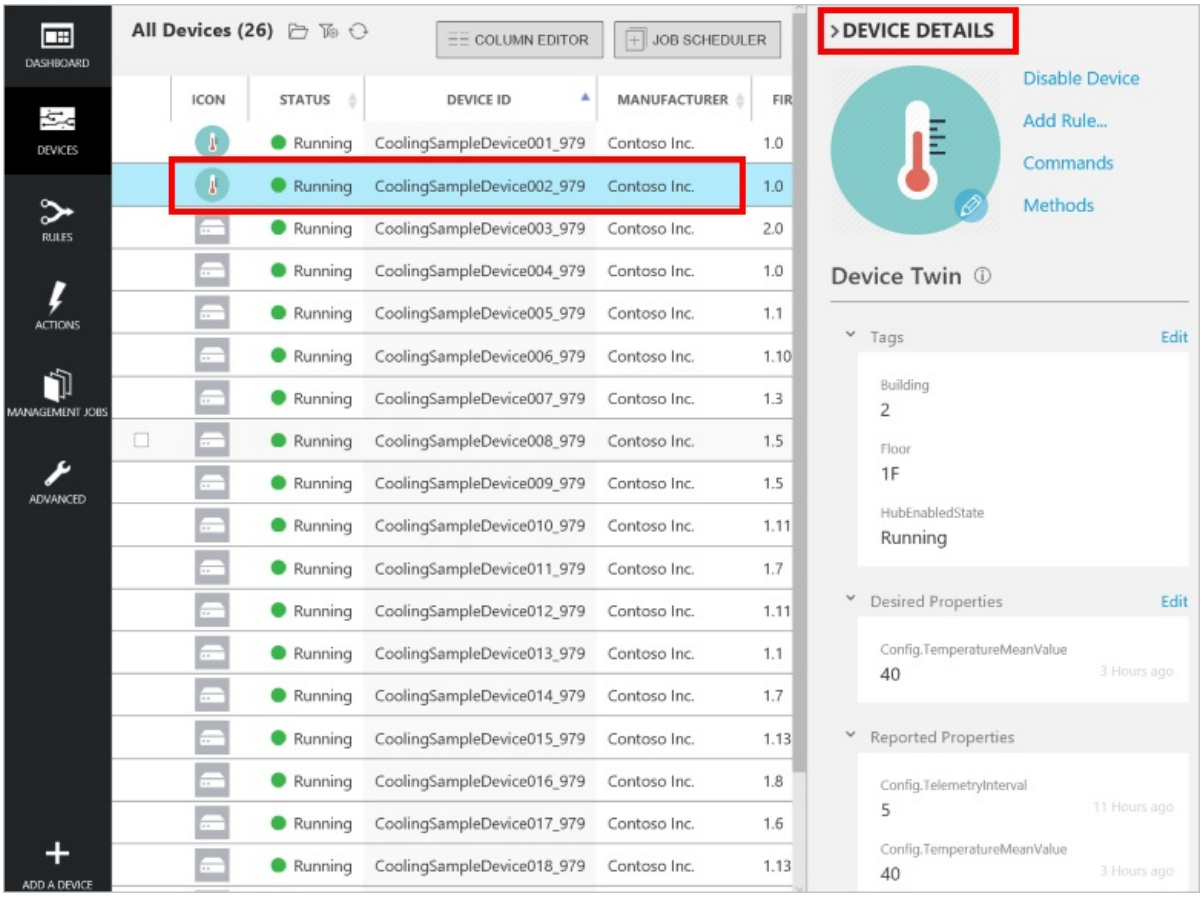
The *devices* list shows all the registered devices in the solution. From the device list you can view and edit device metadata, add or remove devices, and invoke methods on devices. You can filter and sort the list of devices in the device list. You can also customize the columns shown in the device list.

1. Choose **Devices** to show the device list for this solution.



2. The device list initially shows 25 simulated devices created by the provisioning process. You can add additional simulated and physical devices to the solution.

3. To view the details of a device, choose a device in the device list.



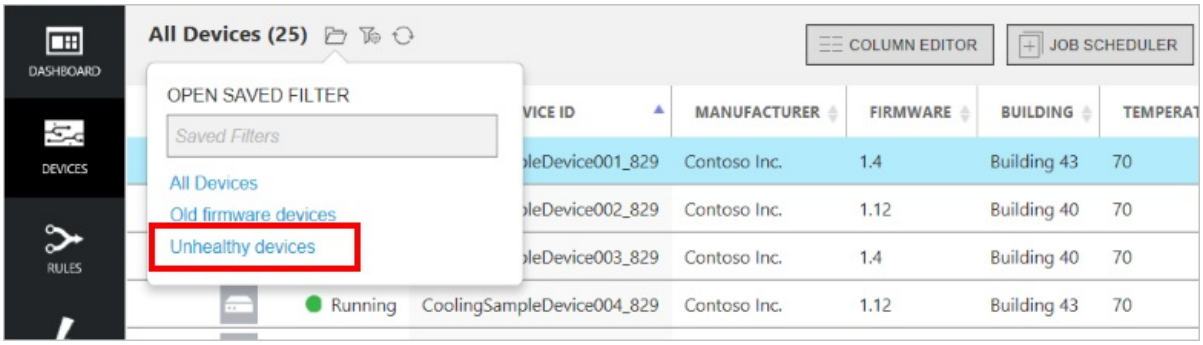
The **Device Details** panel contains six sections:

- A collection of links that enable you to customize the device icon, disable the device, add a rule, invoke a method, or send a command. For a comparison of commands (device-to-cloud messages) and methods (direct methods), see Cloud-to-device communications guidance.
- The **Device Twin - Tags** section enables you to edit tag values for the device. You can display tag values in the device list and use tag values to filter the device list.
- The **Device Twin - Desired Properties** section enables you to set property values to be sent to the device.
- The **Device Twin - Reported Properties** section shows property values sent from the device.
- The **Device Properties** section shows information from the identity registry such as the device id and authentication keys.
- The **Recent Jobs** section shows information about any jobs that have recently targeted this device.

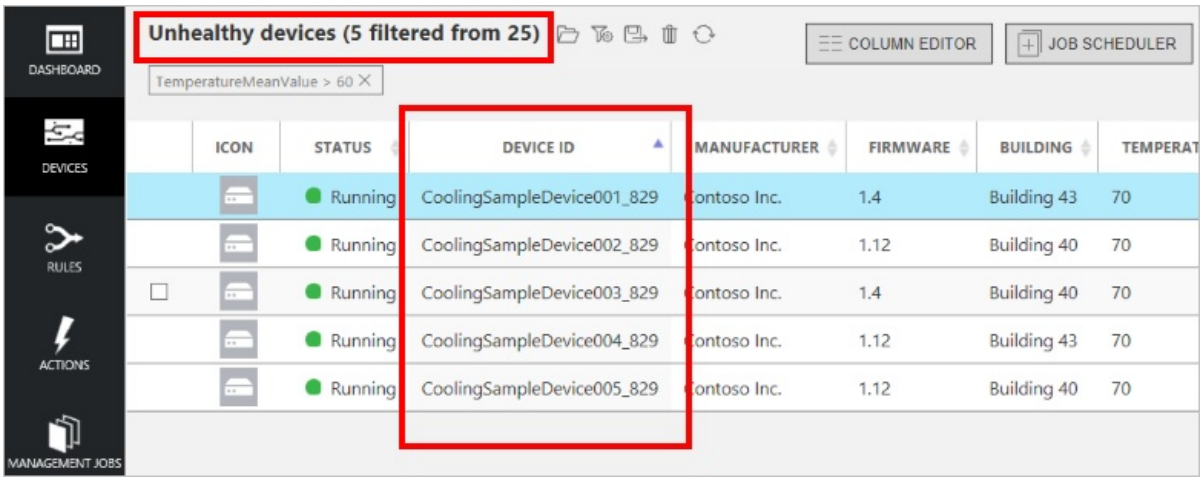
Filter the device list

You can use a filter to display only those devices that are sending unexpected temperature values. The remote monitoring preconfigured solution includes the **Unhealthy devices** filter to show devices with a mean temperature value greater than 60. You can also create your own filters.

1. Choose **Open saved filter** to display a list of available filters. Then choose **Unhealthy devices** to apply the filter:



2. The device list now shows only devices with a mean temperature value greater than 60.

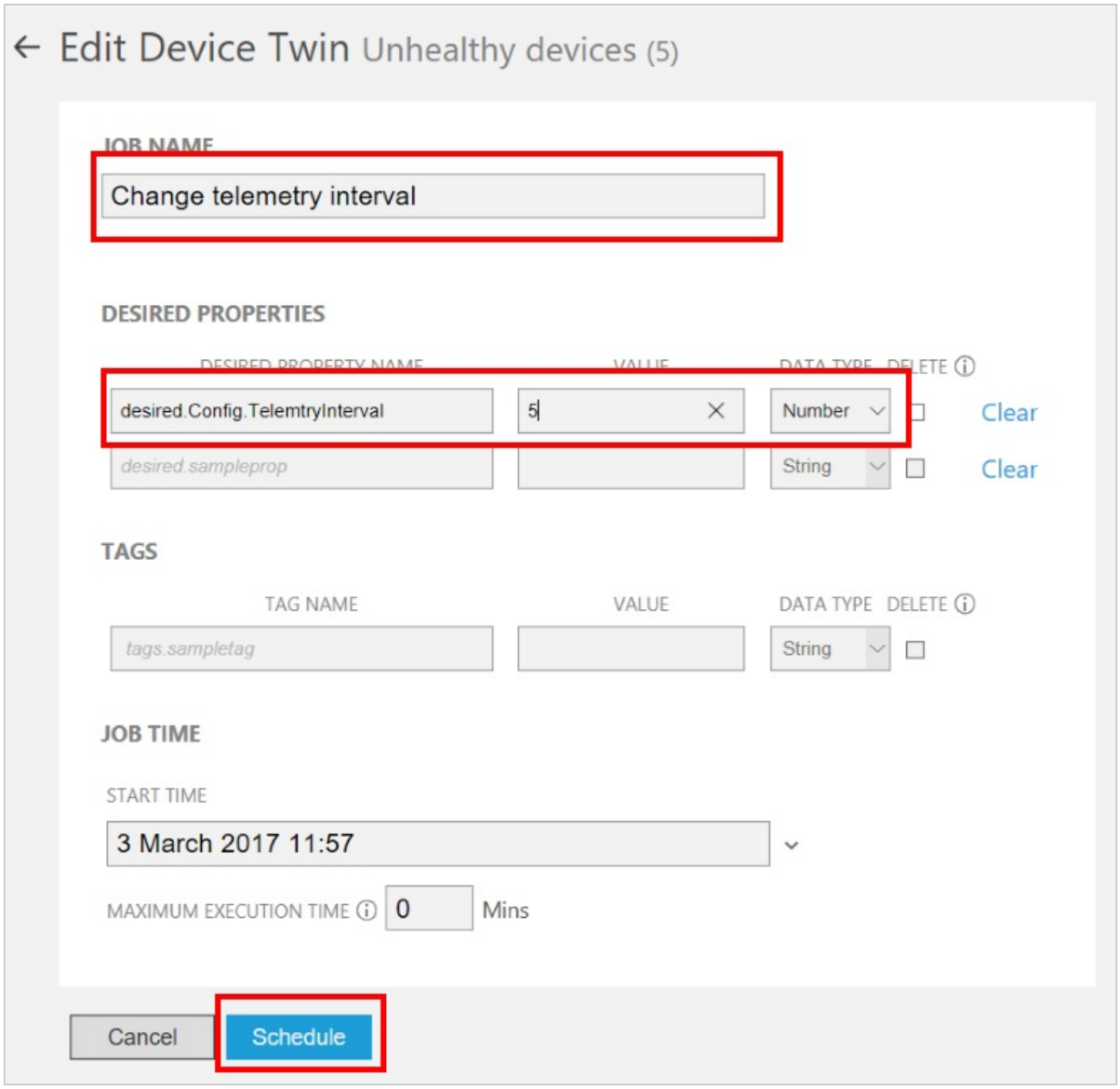


Update desired properties

You have now identified a set of devices that may need remediation. However, you decide that the data frequency of 15 seconds is not sufficient for a clear diagnosis of the issue. Changing the telemetry frequency to five seconds to provide you with more data points to better diagnose the issue. You can push this configuration change to your remote devices from the solution portal. You can make the change once, evaluate the impact, and then act on the results.

Follow these steps to run a job that changes the **TelemetryInterval** desired property for the affected devices. When the devices receive the new **TelemetryInterval** property value, they change their configuration to send telemetry every five seconds instead of every 15 seconds:

1. While you are showing the list of unhealthy devices in the device list, choose **Job Scheduler**, then **Edit Device Twin**.
2. Call the job **Change telemetry interval**.
3. Change the value of the **Desired Property** name **desired.Config.TelemetryInterval** to five seconds.
4. Choose **Schedule**.



5. You can monitor the progress of the job on the **Management Jobs** page in the portal.

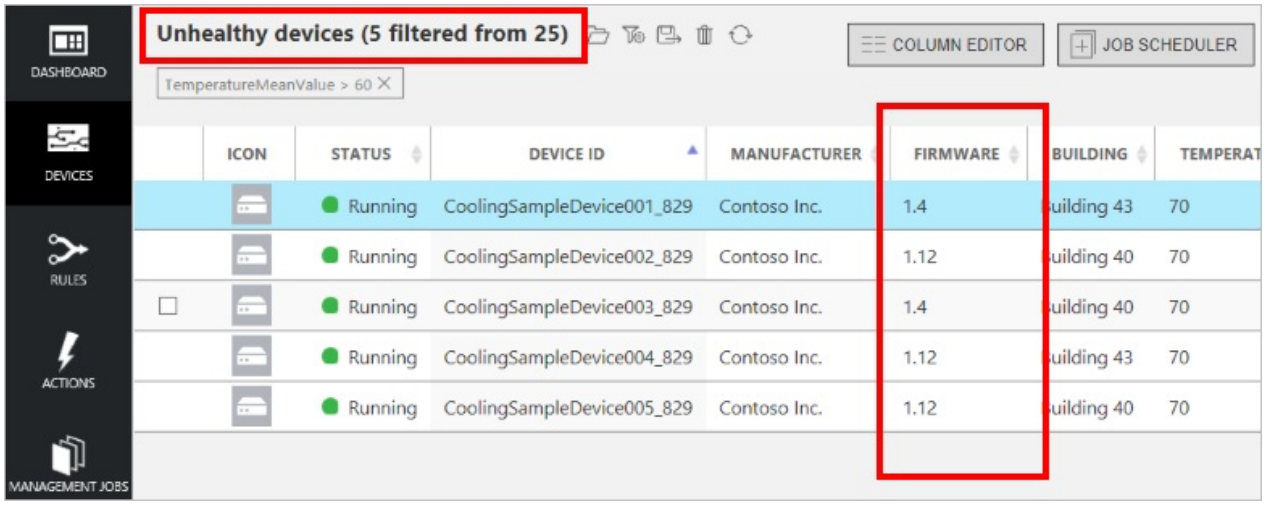
> [!NOTE] If you want to change a desired property value for an individual device, use the **Desired Properties** section in the **Device Details** panel instead of running a job.

This job sets the value of the **TelemetryInterval** desired property in the device twin for all the devices selected by the filter. The devices retrieve this value from the device twin and update their behavior. When a device retrieves and processes a desired property from a

device twin, it sets the corresponding reported value property.

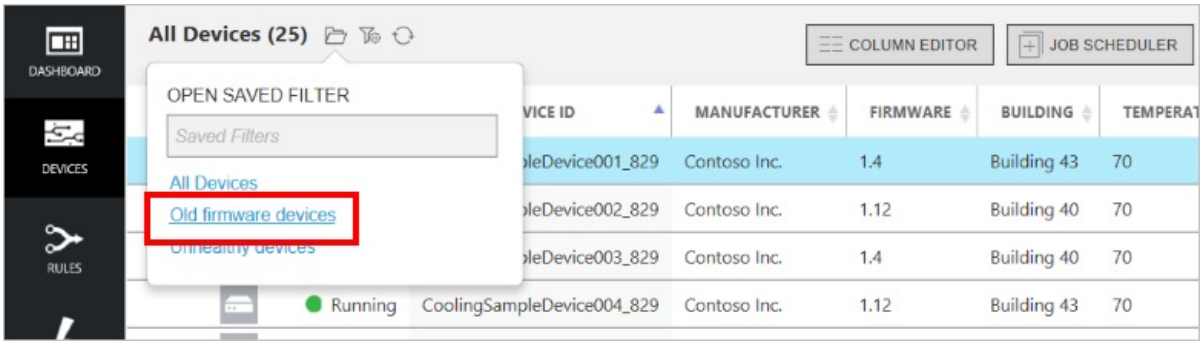
Invoke methods

While the job runs, you notice in the list of unhealthy devices that all these devices have old (less than version 1.6) firmware versions.

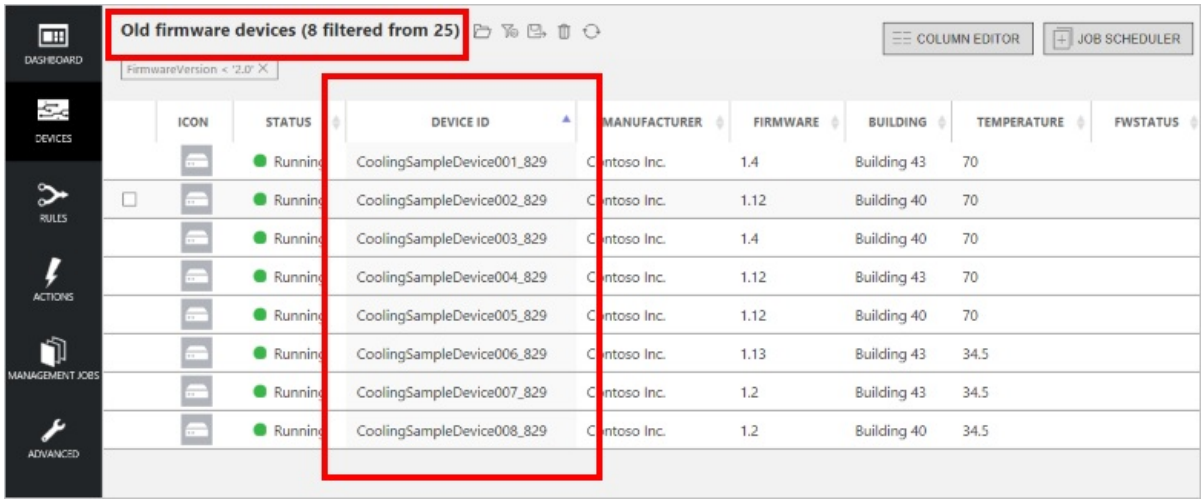


This firmware version may be the root cause of the unexpected temperature values because you know that other healthy devices were recently updated to version 2.0. You can use the built-in **Old firmware devices** filter to identify any devices with old firmware versions. From the portal, you can then remotely update all the devices still running old firmware versions:

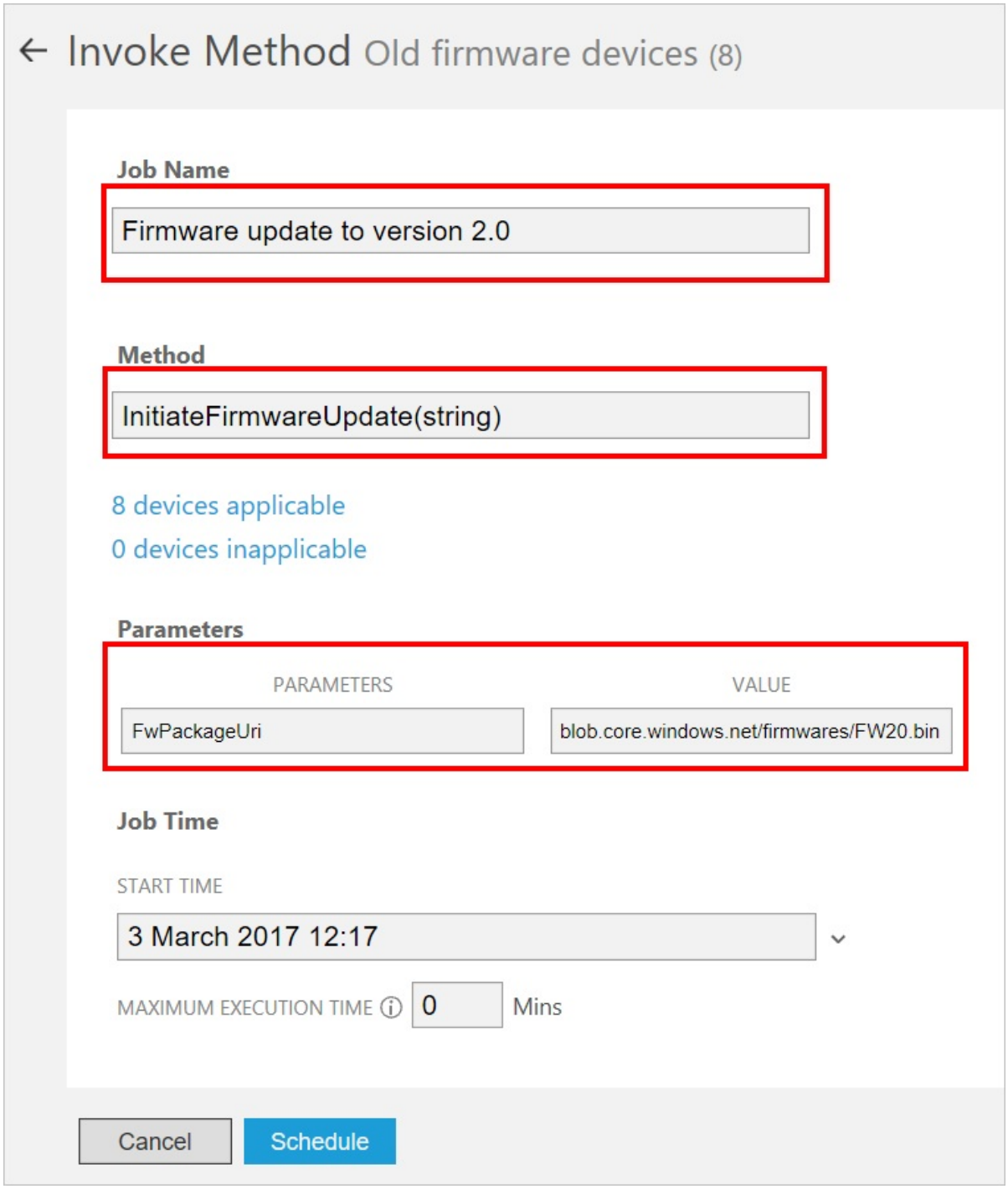
1. Choose **Open saved filter** to display a list of available filters. Then choose **Old firmware devices** to apply the filter:



2. The device list now shows only devices with old firmware versions. This list includes the five devices identified by the **Unhealthy devices** filter and three additional devices:

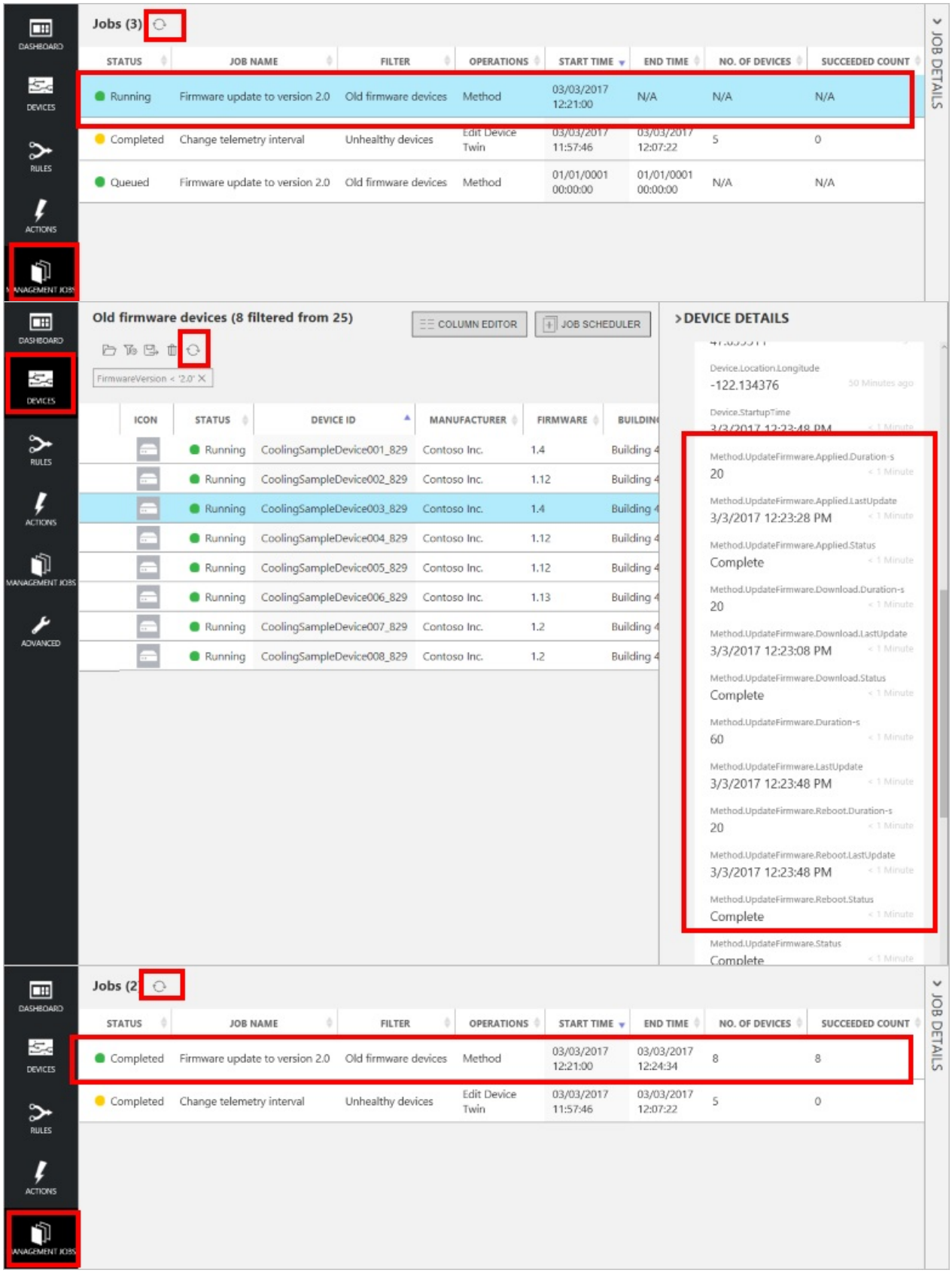


3. Choose **Job Scheduler**, then **Invoke Method**.
4. Set **Job Name** to **Firmware update to version 2.0**.
5. Choose **InitiateFirmwareUpdate** as the **Method**.
6. Set the **FwPackageUri** parameter to **https://iotrmassets.blob.core.windows.net/firmwares/FW20.bin**.
7. Choose **Schedule**. The default is for the job to run now.



> [!NOTE] If you want to invoke a method on an individual device, choose **Methods** in the **Device Details** panel instead of running a job.

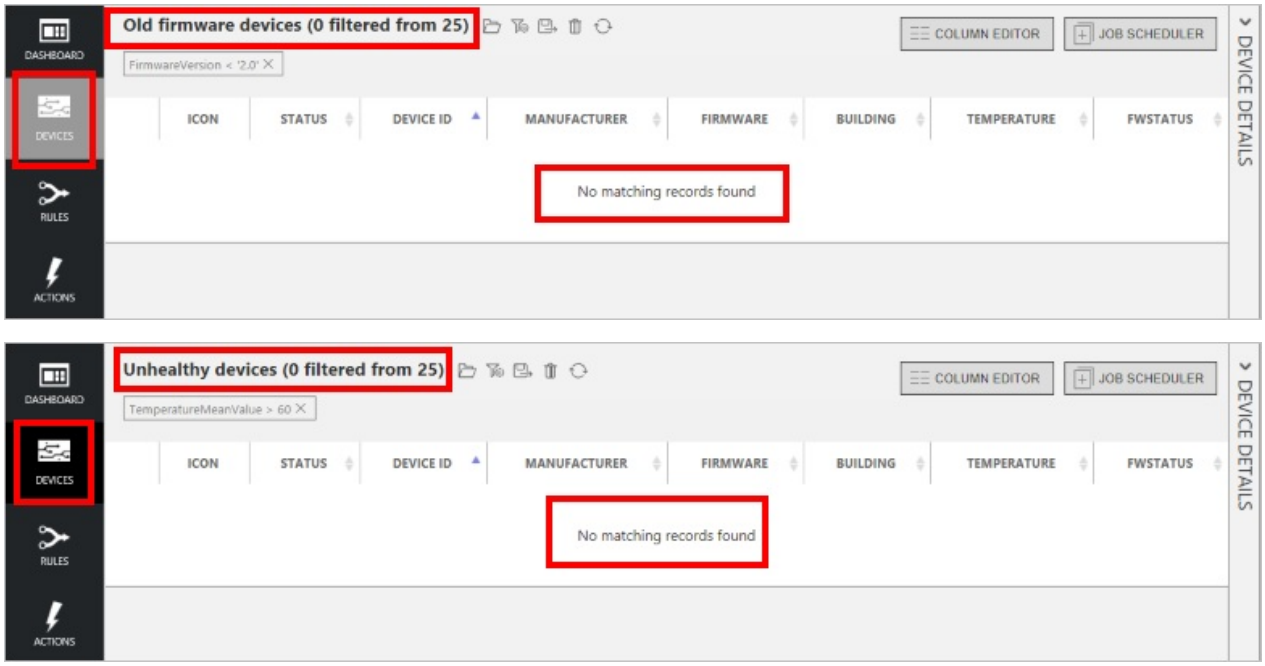
This job invokes the **InitiateFirmwareUpdate** direct method on all the devices selected by the filter. Devices respond immediately to IoT Hub and then initiate the firmware update process asynchronously. The devices provide status information about the firmware update process through reported property values, as shown in the following screenshots. Choose the **Refresh** icon to update the information in the device and job lists:



> [!NOTE] In a production environment, you can schedule jobs to run during a designated maintenance window.

Scenario review

In this scenario, you identified a potential issue with some of your remote devices using the alarm history on the dashboard and a filter. You then used the filter and a job to remotely configure the devices to provide more information to help diagnose the issue. Finally, you used a filter and a job to schedule maintenance on the affected devices. If you return to the dashboard, you can check that there are no longer any alarms coming from devices in your solution. You can use a filter to verify that the firmware is up-to-date on all the devices in your solution and that there are no more unhealthy devices:

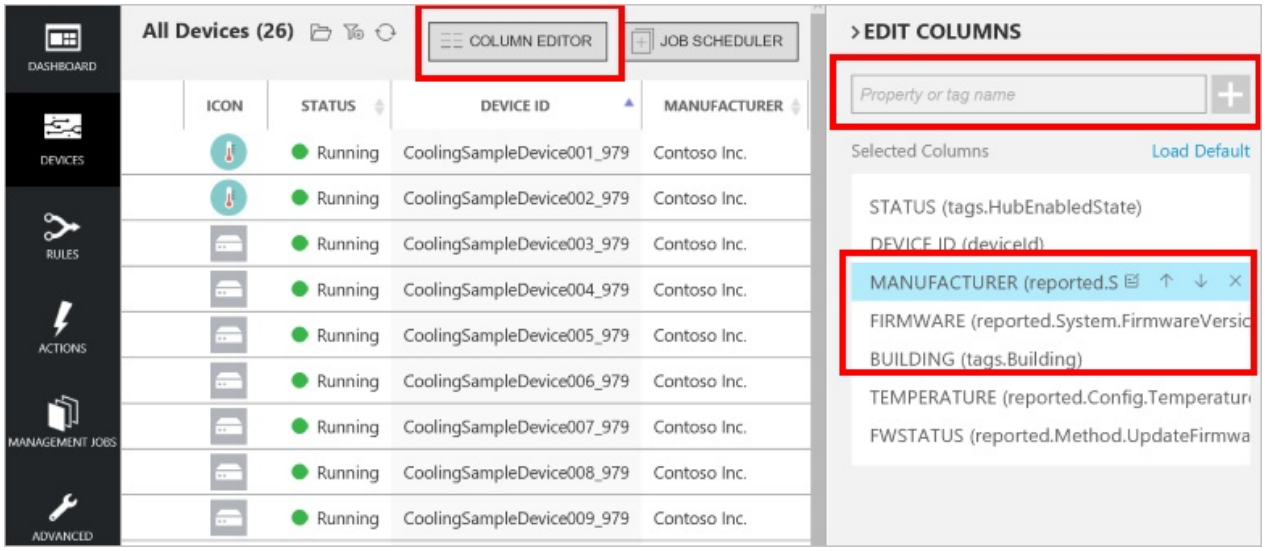


Other features

The following sections describe some additional features of the remote monitoring preconfigured solution that are not described as part of the previous scenario.

Customize columns

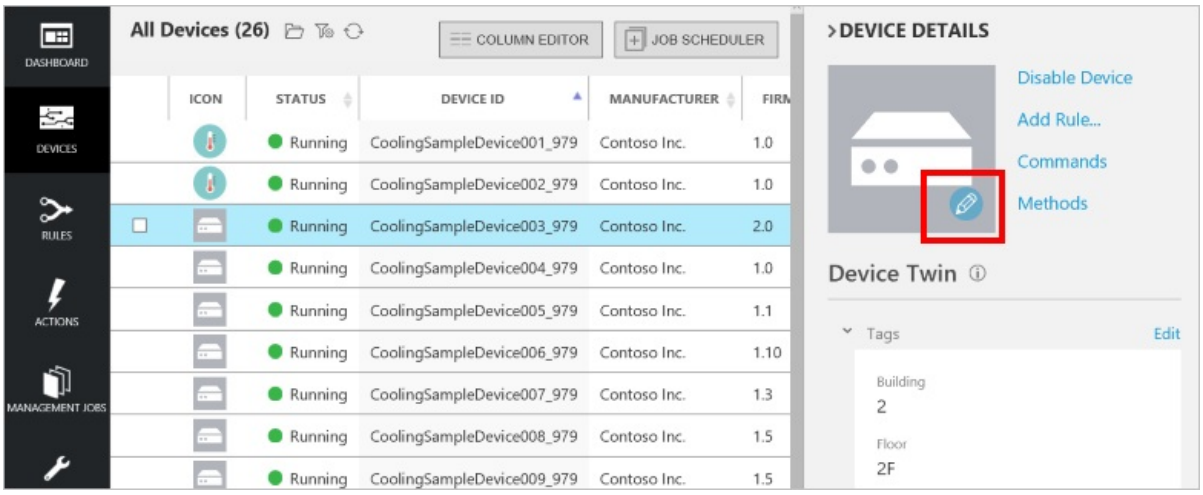
You can customize the information shown in the device list by choosing **Column editor**. You can add and remove columns that display reported property and tag values. You can also reorder and rename columns:



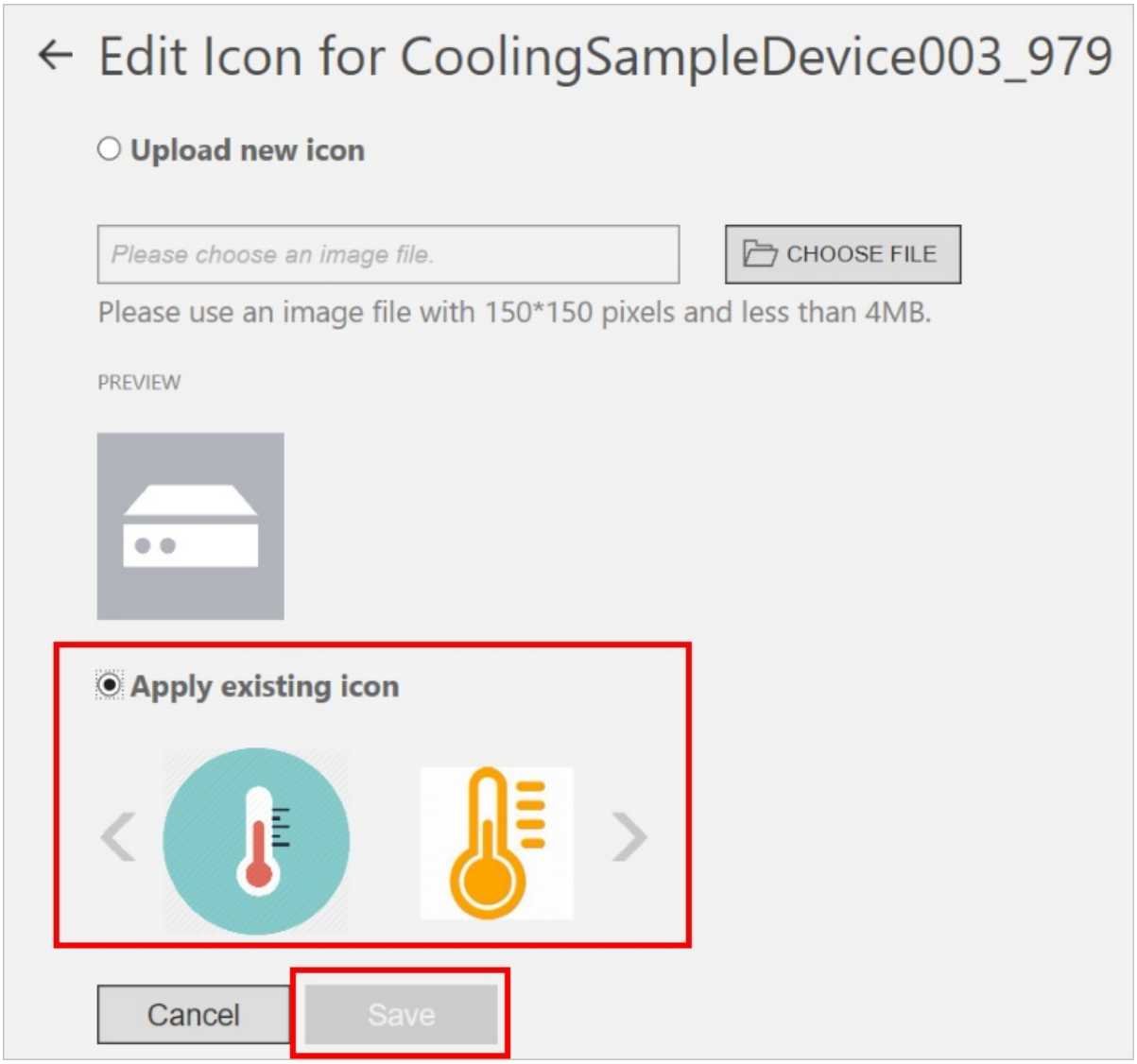
Customize the device icon

You can customize the device icon displayed in the device list from the **Device Details** panel as follows:

1. Choose the pencil icon to open the **Edit image** panel for a device:



2. Either upload a new image or use one of the existing images and then choose **Save**:



3. The image you selected now displays in the **Icon** column for the device.

> [!NOTE] The image is stored in blob storage. A tag in the device twin contains a link to the image in blob storage.

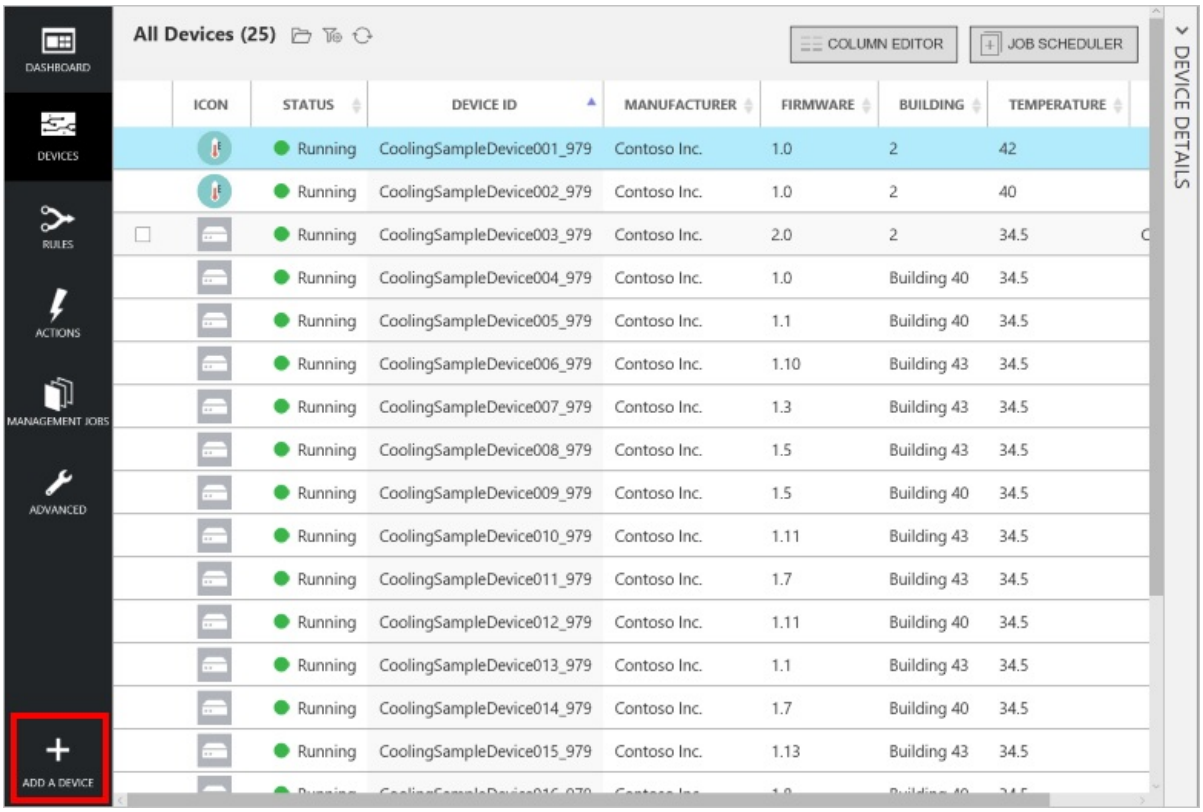
Add a device

When you deploy the preconfigured solution, you automatically provision 25 sample devices that you can see in the device list. These devices are *simulated devices* running in an Azure WebJob. Simulated devices make it easy for you to experiment with the preconfigured solution without the need to deploy real, physical devices. If you do want to connect a real device to the solution, see the Connect your device to the remote monitoring preconfigured solution tutorial.

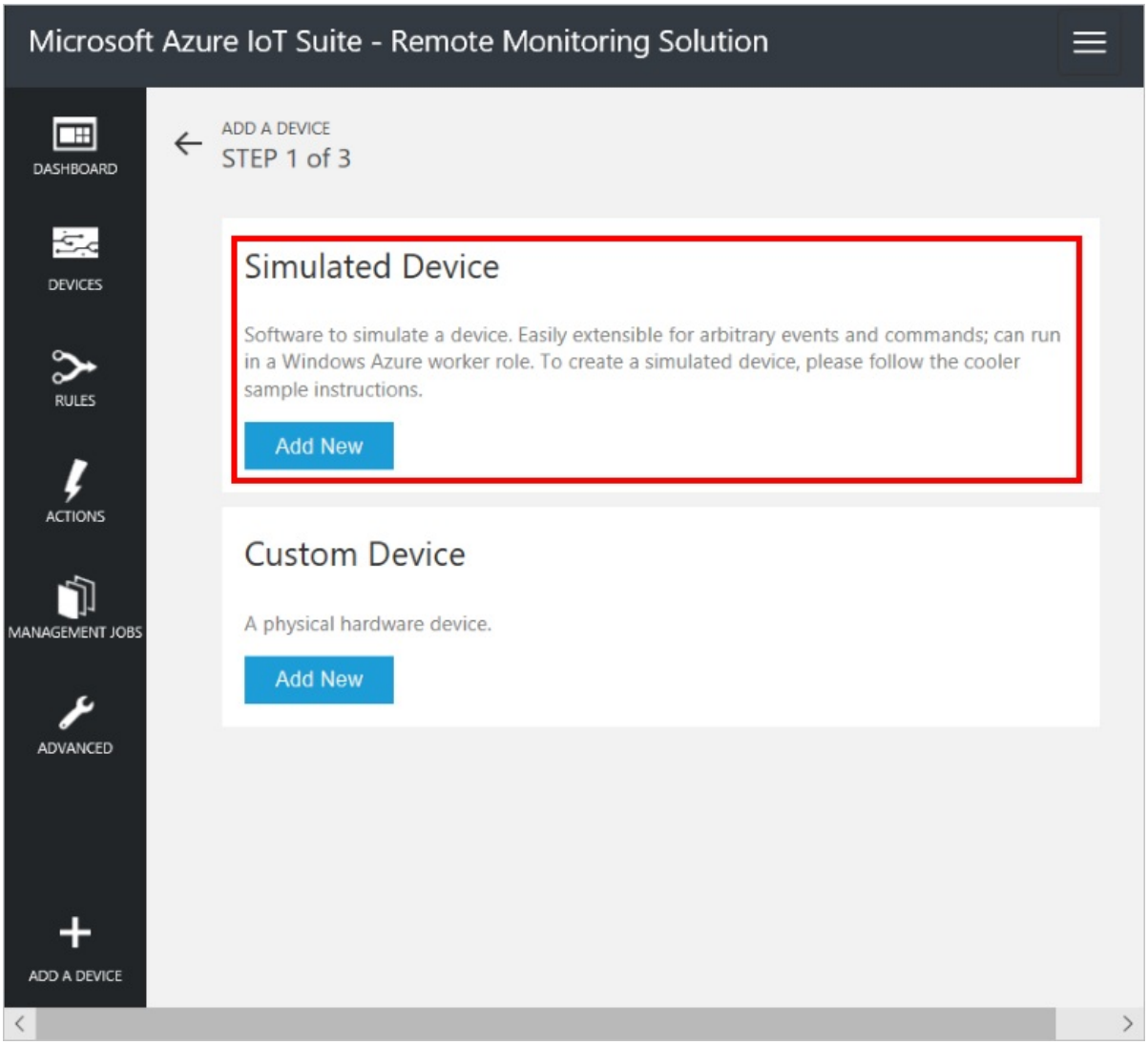
The following steps show you how to add a simulated device to the solution:

1. Navigate back to the device list.

2. To add a device, choose **+ Add A Device** in the bottom left corner.

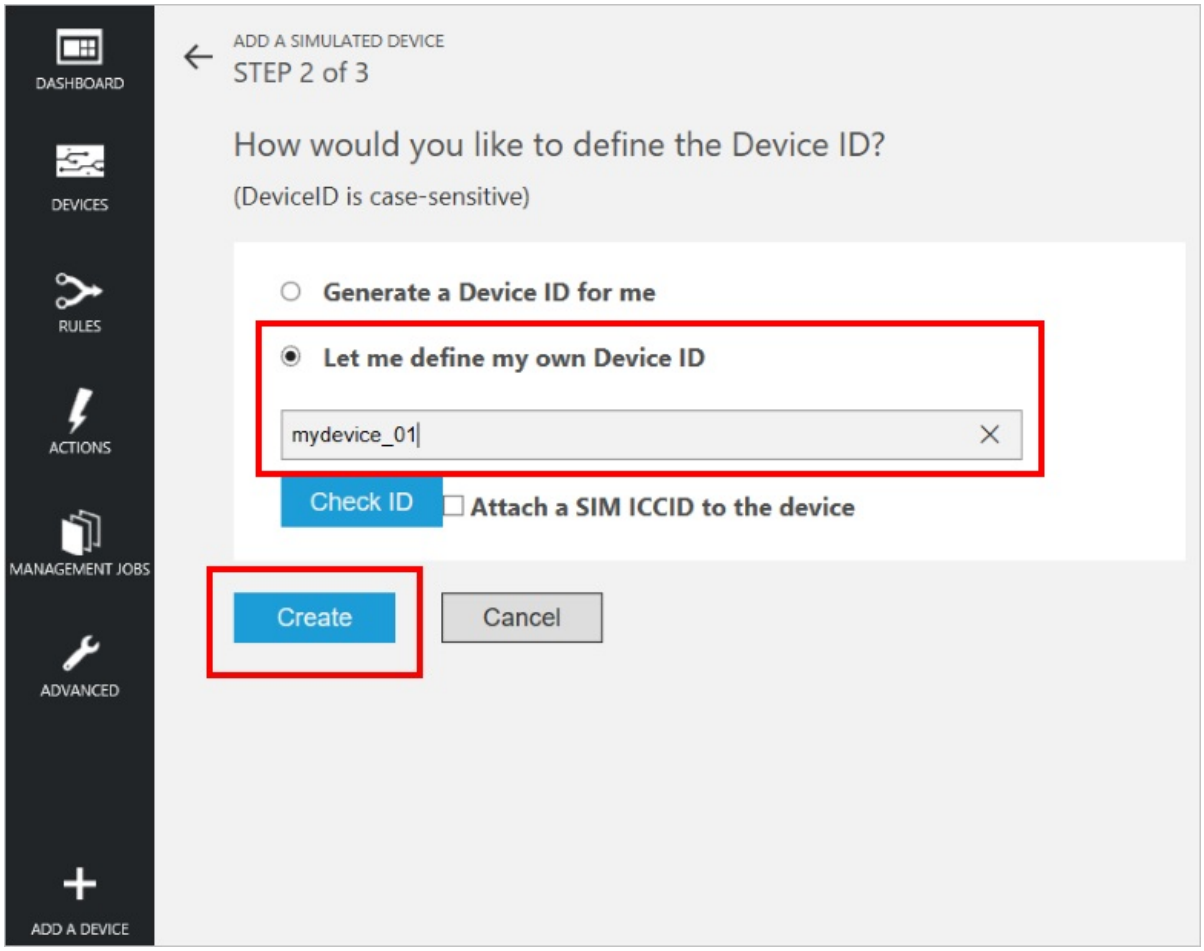


3. Choose **Add New** on the **Simulated Device** tile.



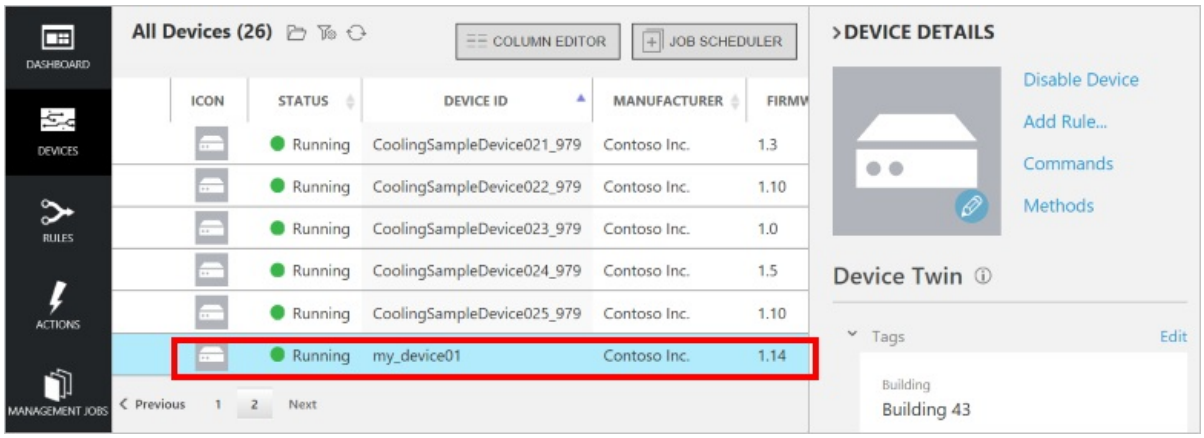
In addition to creating a new simulated device, you can also add a physical device if you choose to create a **Custom Device**. To learn more about connecting physical devices to the solution, see Connect your device to the IoT Suite remote monitoring preconfigured solution.

4. Select **Let me define my own Device ID**, and enter a unique device ID name such as **mydevice_01**.
5. Choose **Create**.

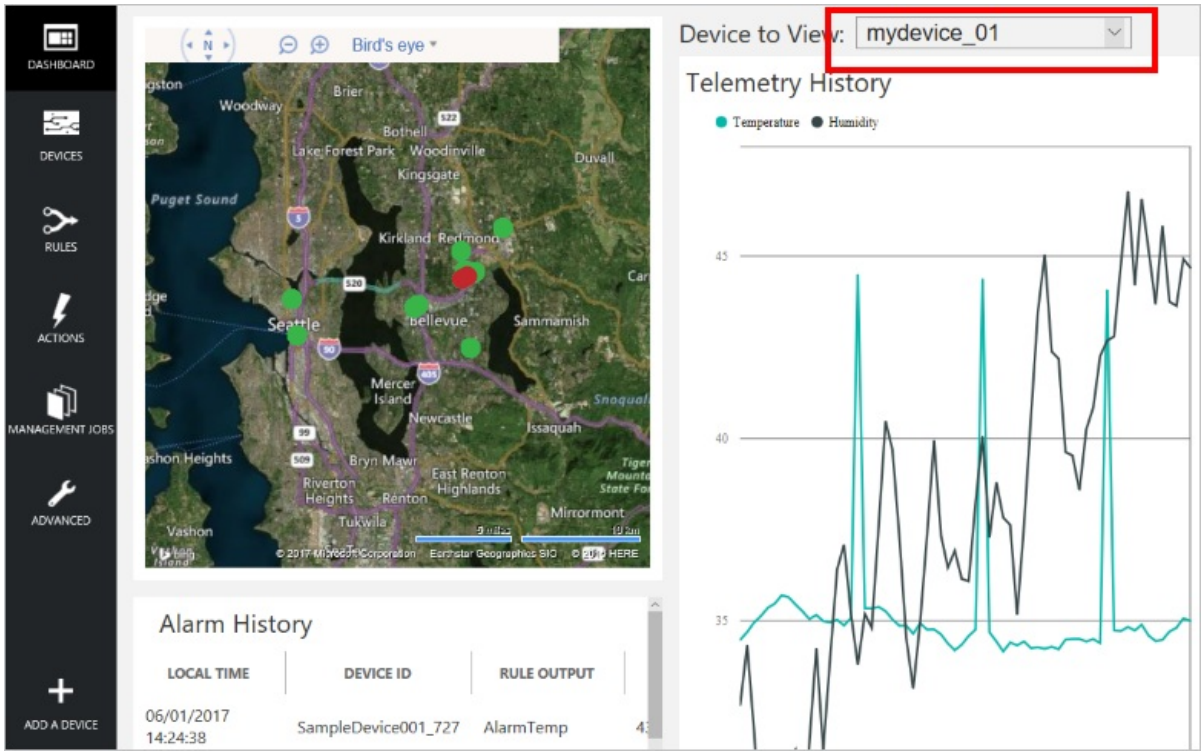


6. In step 3 of **Add a simulated device**, choose **Done** to return to the device list.

7. You can view your device **Running** in the device list.

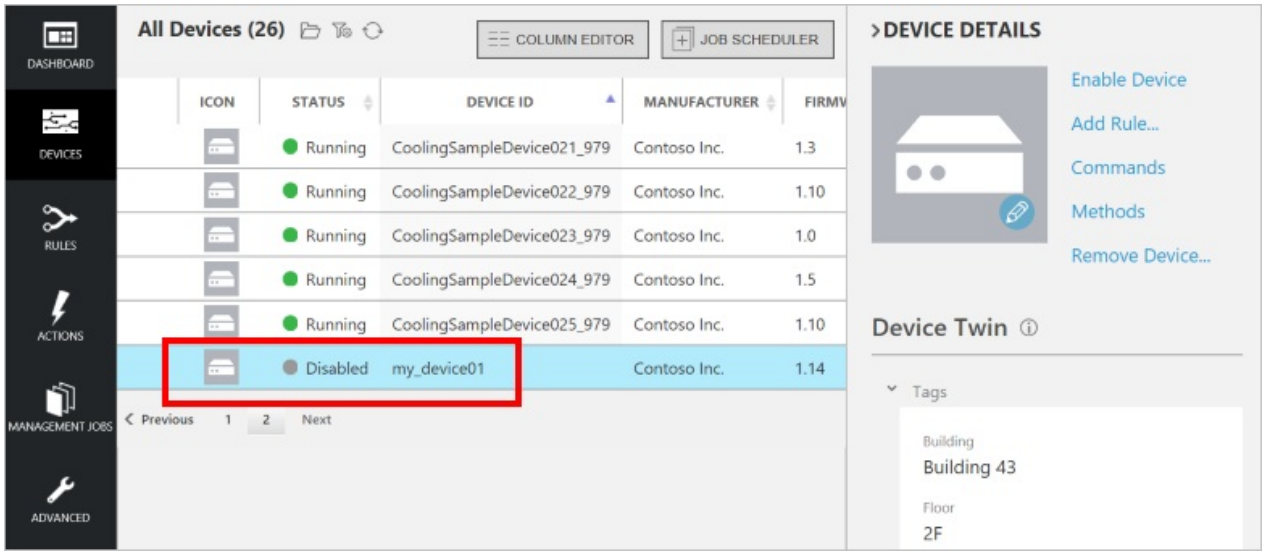


8. You can also view the simulated telemetry from your new device on the dashboard:



Disable and delete a device

You can disable a device, and after it is disabled you can remove it:

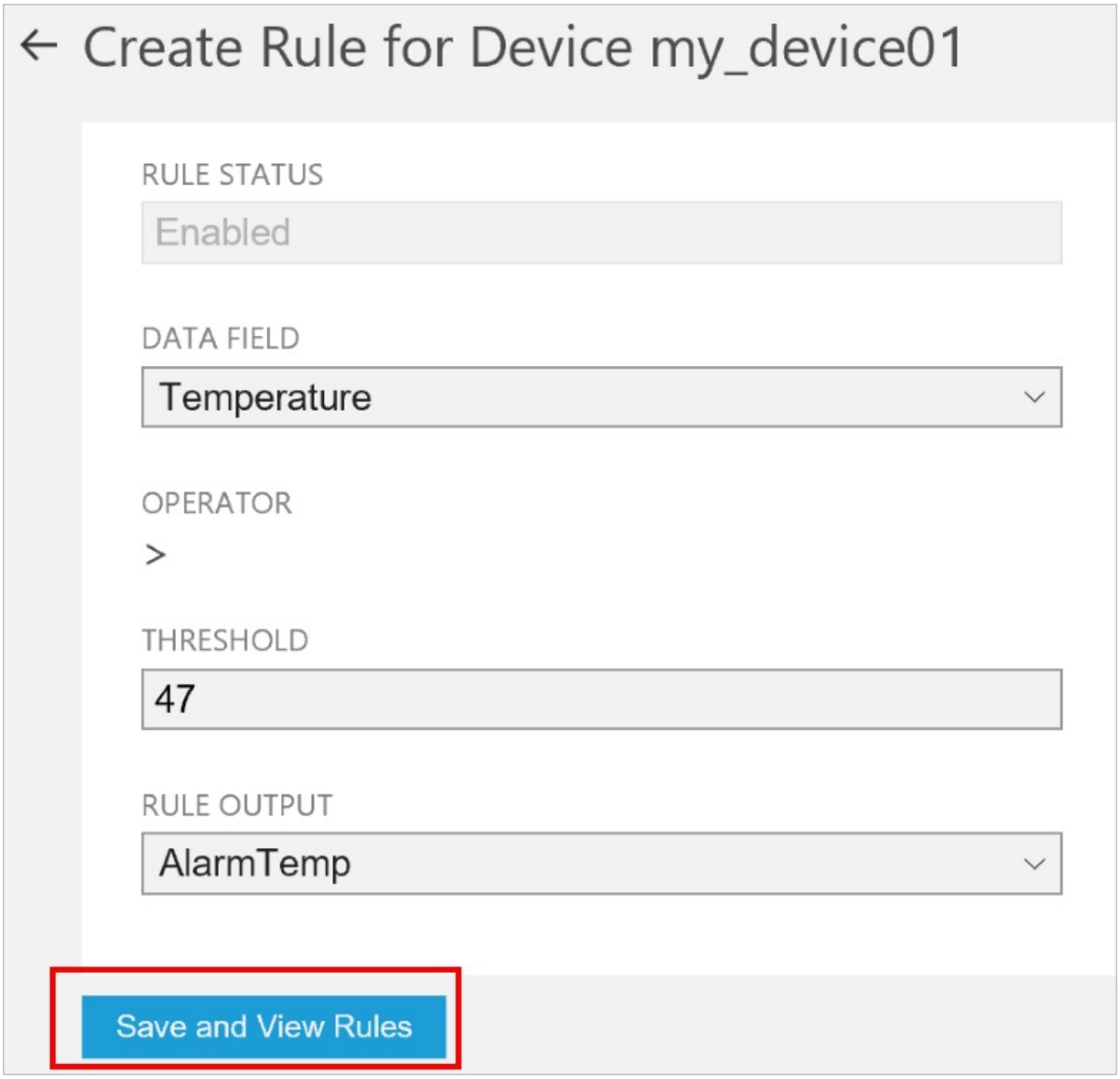


Add a rule

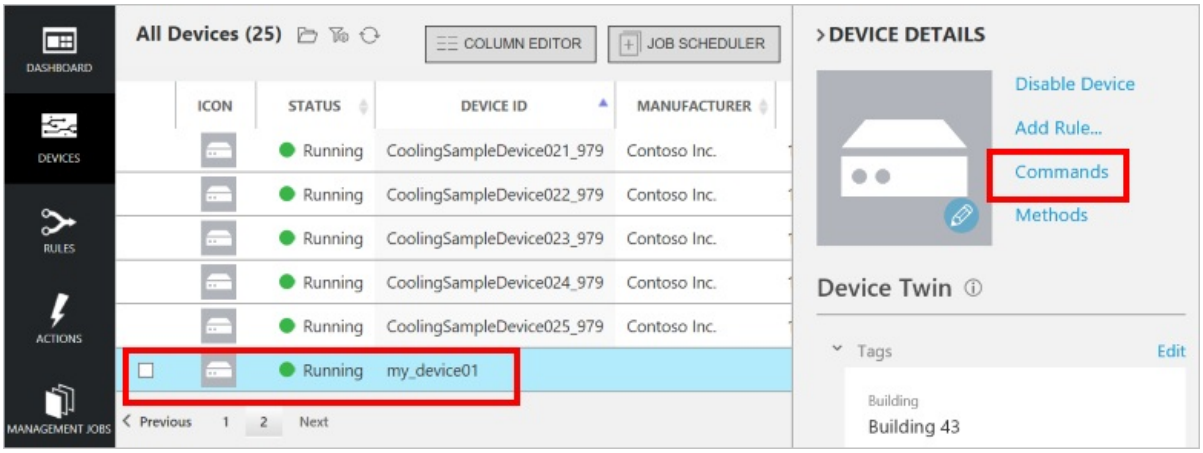
There are no rules for the new device you just added. In this section, you add a rule that triggers an alarm when the temperature reported by the new device exceeds 47 degrees. Before you start, notice that the telemetry history for the new device on the dashboard shows the device temperature never exceeds 45 degrees.

1. Navigate back to the device list.

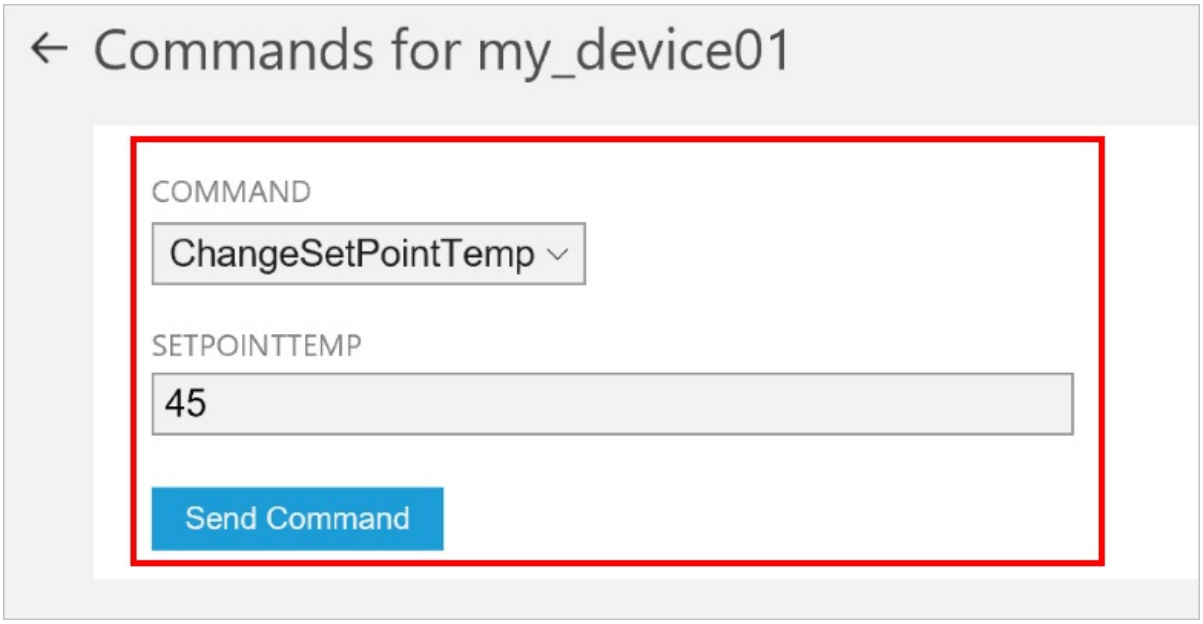
2. To add a rule for the device, select your new device in the **Devices List**, and then choose **Add rule**.
3. Create a rule that uses **Temperature** as the data field and uses **AlarmTemp** as the output when the temperature exceeds 47 degrees:



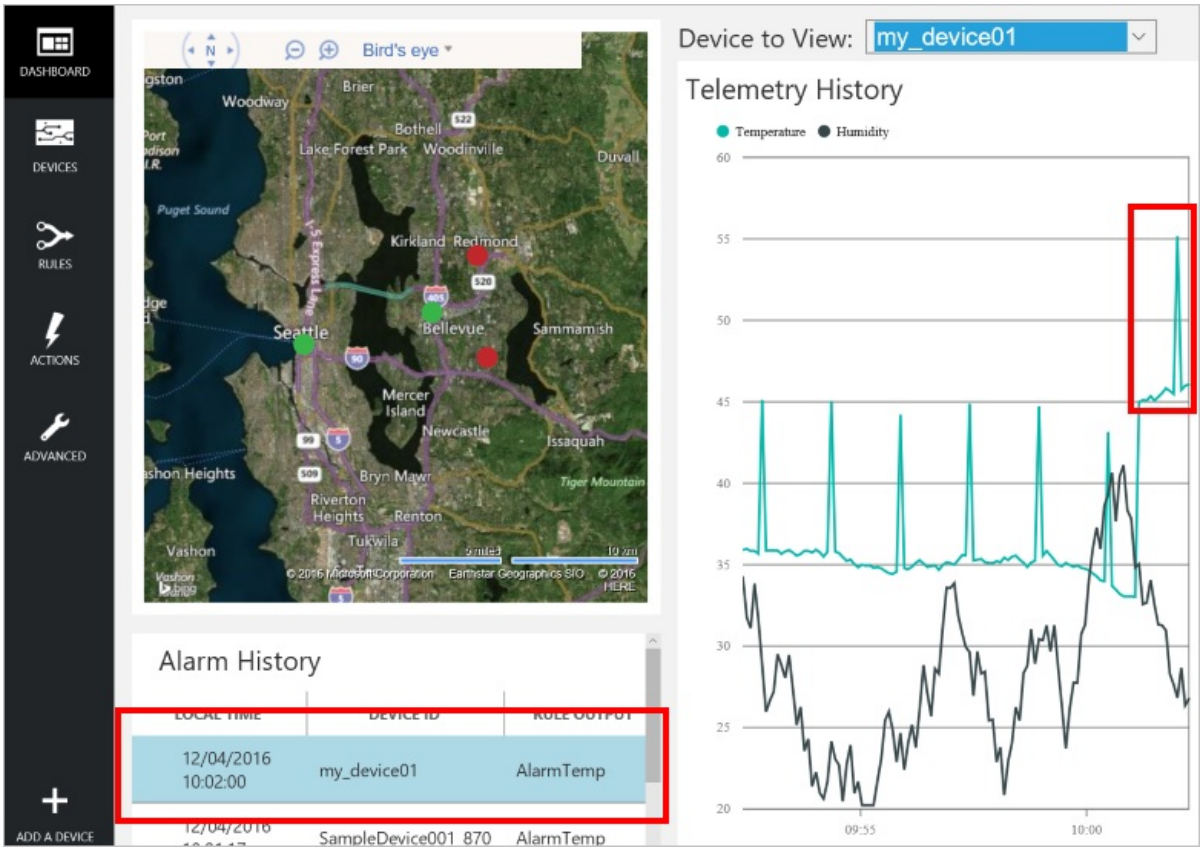
4. To save your changes, choose **Save and View Rules**.
5. Choose **Commands** in the device details pane for the new device.



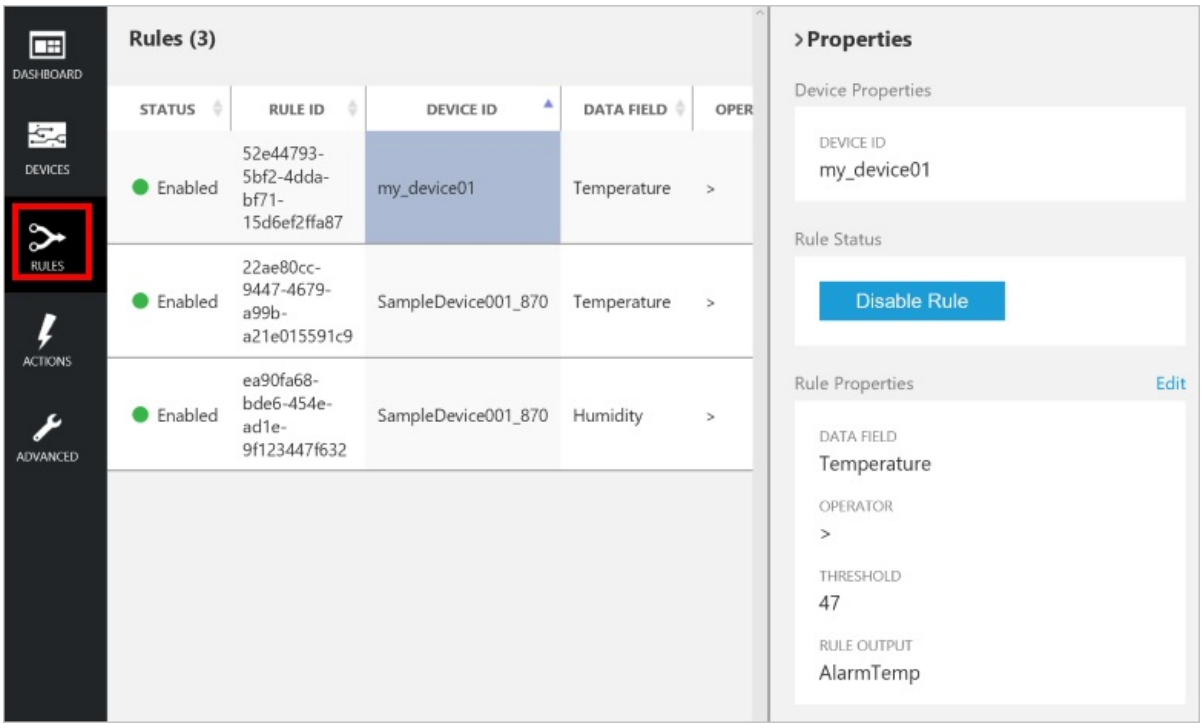
6. Select **ChangeSetPointTemp** from the command list and set **SetPointTemp** to 45. Then choose **Send Command**:



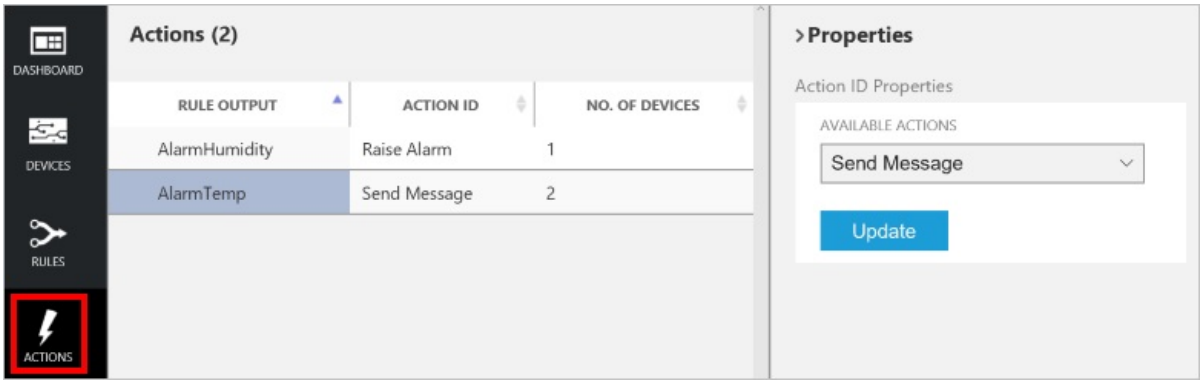
7. Navigate back to the dashboard. After a short time, you will see a new entry in the **Alarm History** pane when the temperature reported by your new device exceeds the 47-degree threshold:



8. You can review and edit all your rules on the **Rules** page of the dashboard:



9. You can review and edit all the actions that can be taken in response to a rule on the **Actions** page of the dashboard:

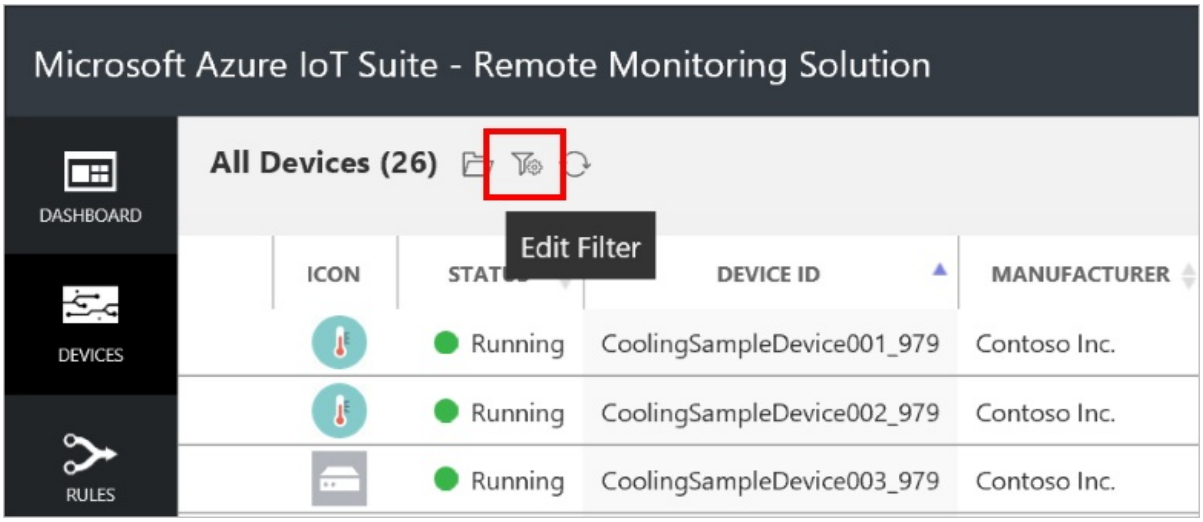


> [!NOTE] It is possible to define actions that can send an email message or SMS in response to a rule or integrate with a line-of-business system through a Logic App. For more information, see the Connect Logic App to your Azure IoT Suite Remote Monitoring preconfigured solution.

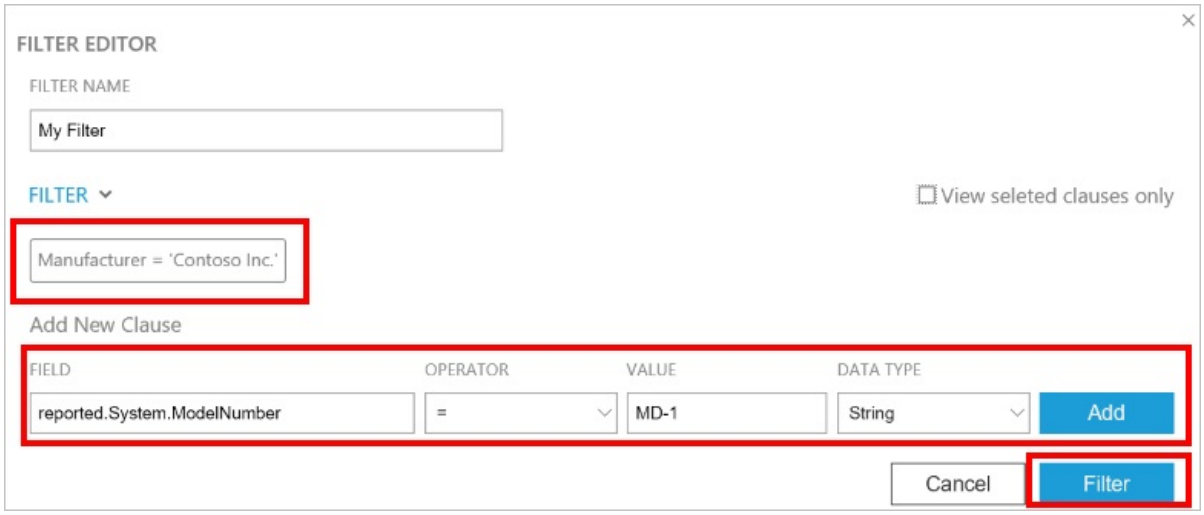
Manage filters

In the device list, you can create, save, and reload filters to display a customized list of devices connected to your hub. To create a filter:

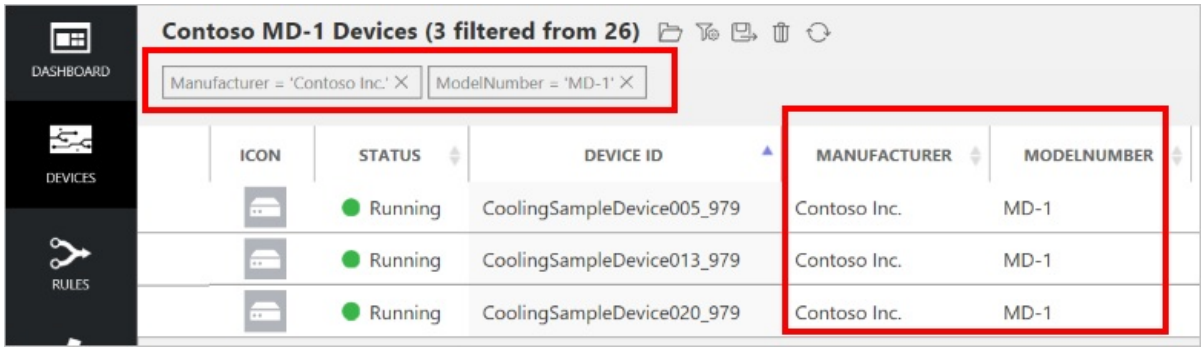
1. Choose the edit filter icon above the list of devices:



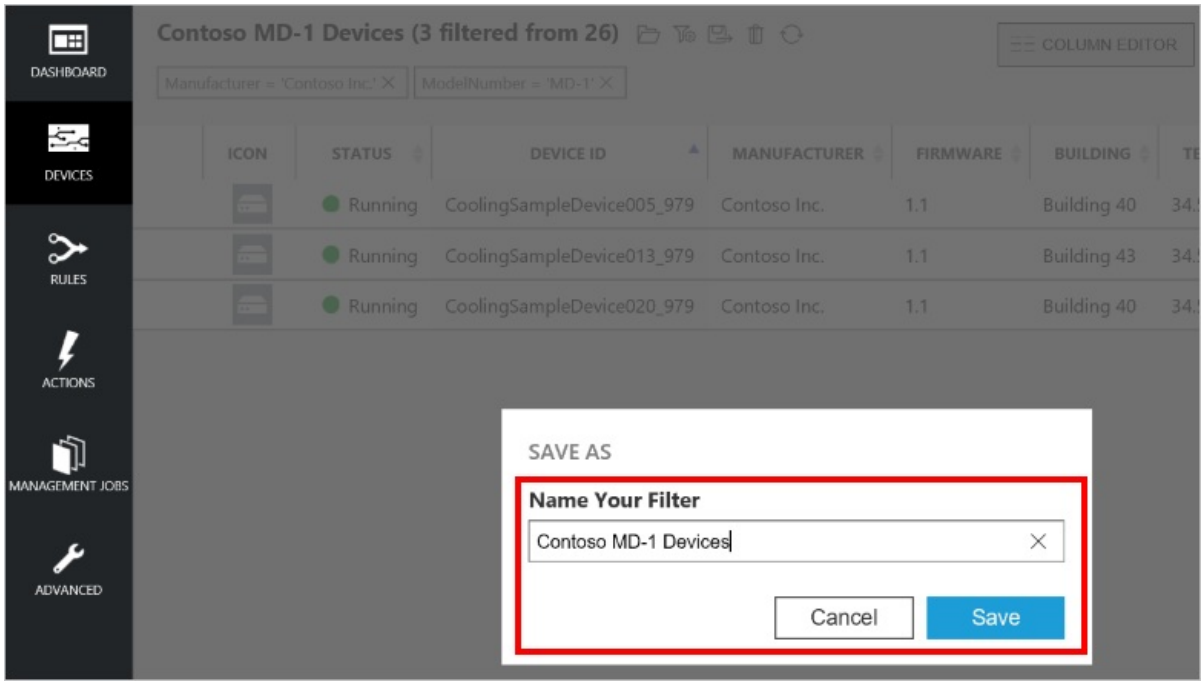
2. In the **Filter editor**, add the fields, operators, and values to filter the device list. You can add multiple clauses to refine your filter. Choose **Filter** to apply the filter:



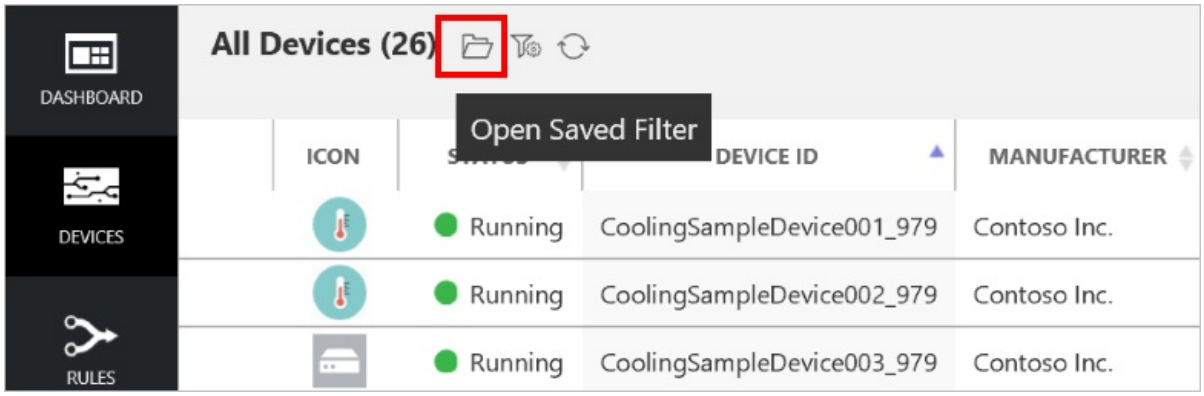
3. In this example, the list is filtered by manufacturer and model number:



4. To save your filter with a custom name, choose the **Save as** icon:



5. To reapply a filter you saved previously, choose the **Open saved filter** icon:



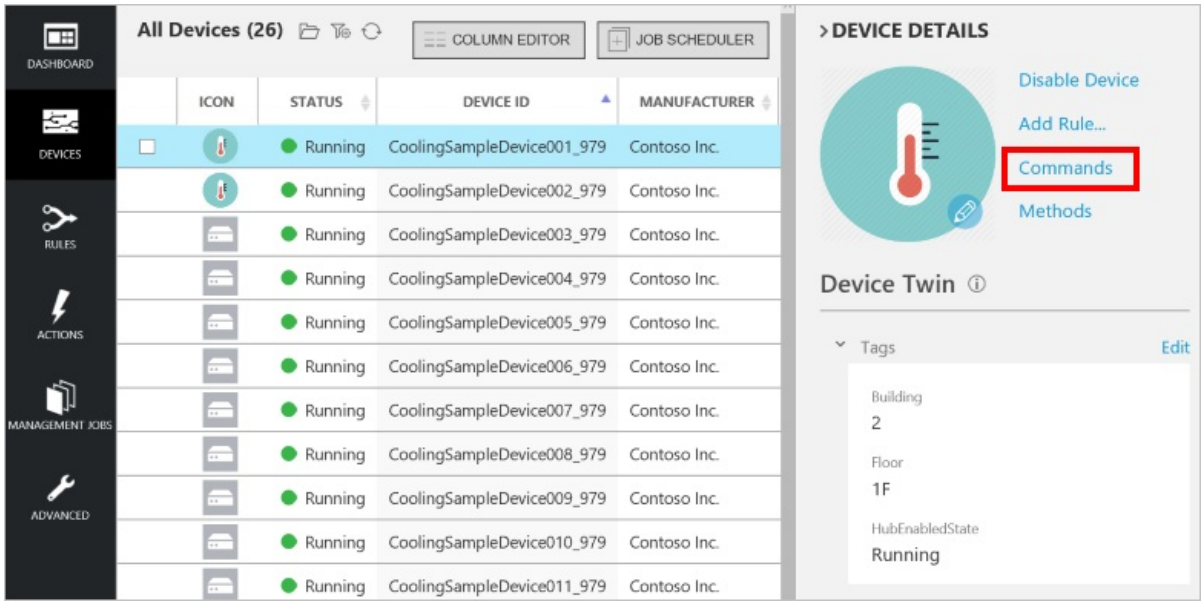
You can create filters based on device id, device state, desired properties, reported properties, and tags. You add your own custom tags to a device in the **Tags** section of the **Device Details** panel, or run a job to update tags on multiple devices.

> [!NOTE] In the **Filter editor**, you can use the **Advanced view** to edit the query text directly.

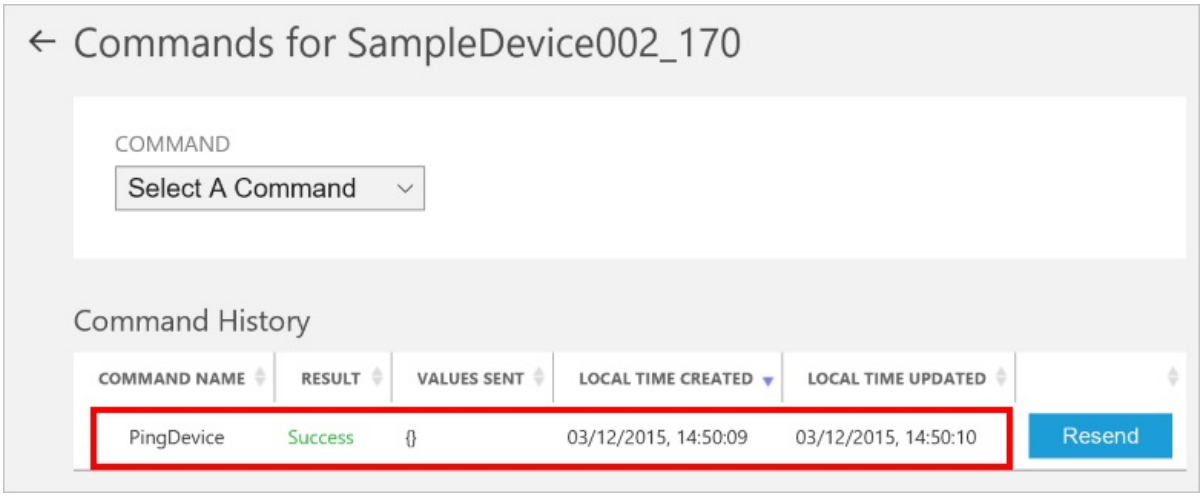
Commands

From the **Device Details** panel, you can send commands to the device. When a device first starts, it sends information about the commands it supports to the solution. For a discussion of the differences between commands and methods, see Azure IoT Hub cloud-to-device options.

1. Choose **Commands** in the **Device Details** panel for the selected device:



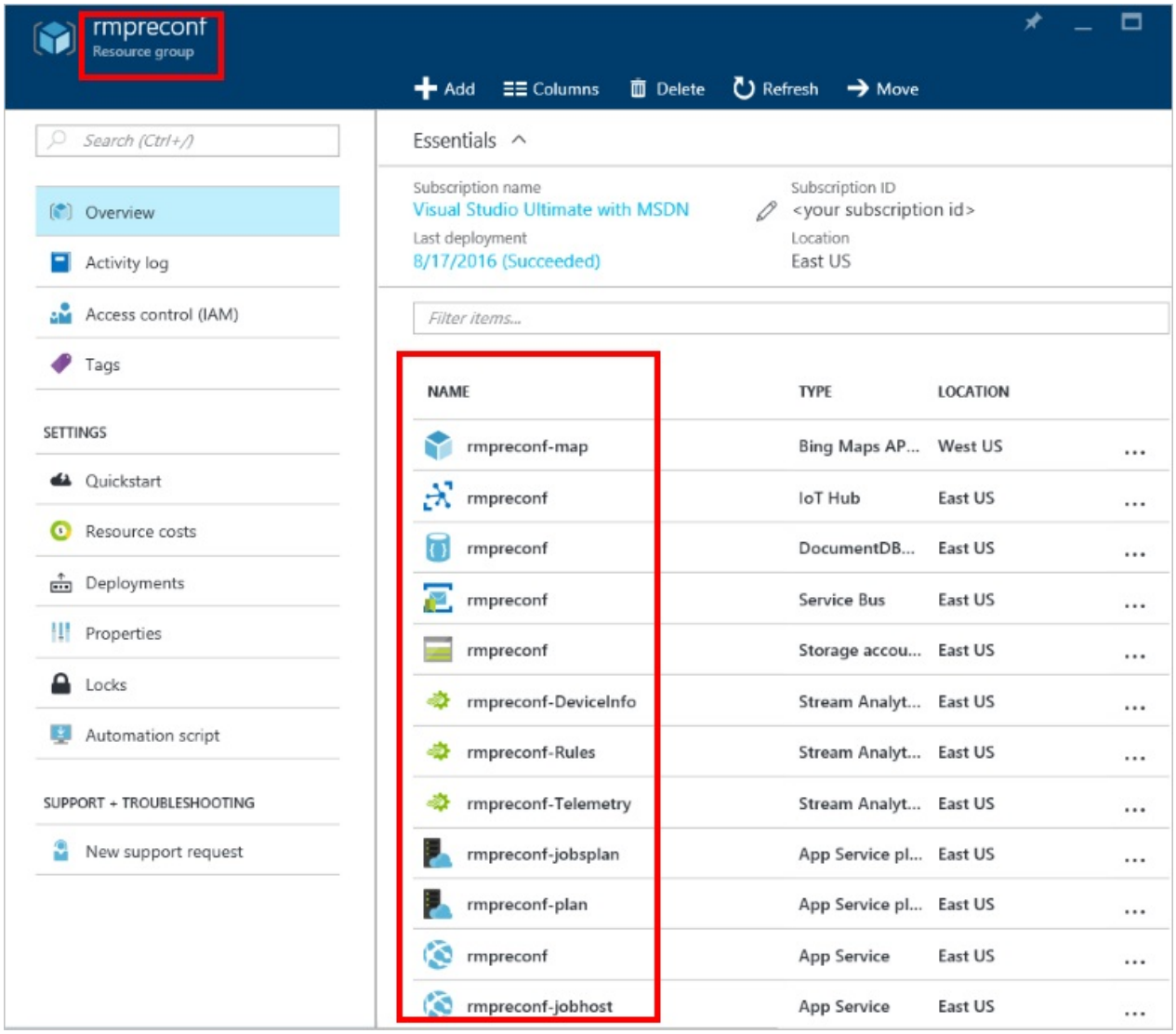
2. Select **PingDevice** from the command list.
3. Choose **Send Command**.
4. You can see the status of the command in the command history.



The solution tracks the status of each command it sends. Initially the result is **Pending**. When the device reports that it has executed the command, the result is set to **Success**.

Behind the scenes

When you deploy a preconfigured solution, the deployment process creates multiple resources in the Azure subscription you selected. You can view these resources in the Azure portal. The deployment process creates a **resource group** with a name based on the name you choose for your preconfigured solution:



You can view the settings of each resource by selecting it in the list of resources in the resource group.

You can also view the source code for the preconfigured solution. The remote monitoring preconfigured solution source code is in the azure-iot-remote-monitoring GitHub repository:

- The **DeviceAdministration** folder contains the source code for the dashboard.
- The **Simulator** folder contains the source code for the simulated device.
- The **EventProcessor** folder contains the source code for the back-end process that handles the incoming telemetry.

When you are done, you can delete the preconfigured solution from your Azure subscription on the azureiotsuite.com site. This site enables you to easily delete all the resources that were provisioned when you created the preconfigured solution.

> [!NOTE] To ensure that you delete everything related to the preconfigured solution, delete it on the azureiotsuite.com site and do not delete the resource group in the portal.

Next Steps

Now that you've deployed a working preconfigured solution, you can continue getting started with IoT Suite by reading the following articles:

- Remote monitoring preconfigured solution walkthrough
- Connect your device to the remote monitoring preconfigured solution
- Permissions on the azureiotsuite.com site