

Azure IoT Foundation

This hands on lab seeks to introduce the student to the following core Azure IoT services:

- Azure IoT Hub
- Azure Device Provisioning Service (DPS)
- Azure IoT Edge, IoT Edge Runtime & Edge Modules
- Azure Data Explorer (ADX)
- Azure Stream Analytics (ASA)

Experience will also be gained with the following technologies:

- Visual Studio Code
- Azure Virtual Machines
- Ubuntu 18
- Bash

These services are explored as they're often part of overall IoT solutions. A simplistic approach is taken with this lab to allow to reach many audiences of varying technical experience.

Ideally students taking this course have familiarity with the Azure Portal. <https://portal.azure.com>

A good way to become familiar with Azure is to use the Microsoft Learn content and learning paths as part of the Azure Fundamentals certification. You can read more at the following link: <https://docs.microsoft.com/en-us/learn/certifications/exams/az-900>

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- **Exercise 8: Cleanup**

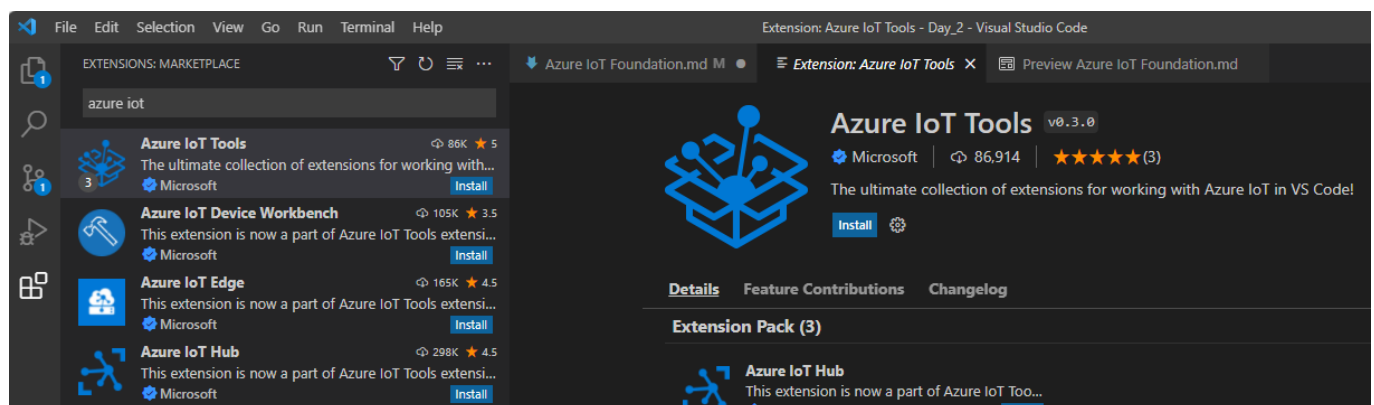
Prerequisites

Task 1: Install VS Code

[Visual Studio Code Download](#)

Task 2: Install VS Code Extensions

1. Click extensions
2. Search for **azure iot**
3. Click install for the **Azure IoT Tools** extension pack

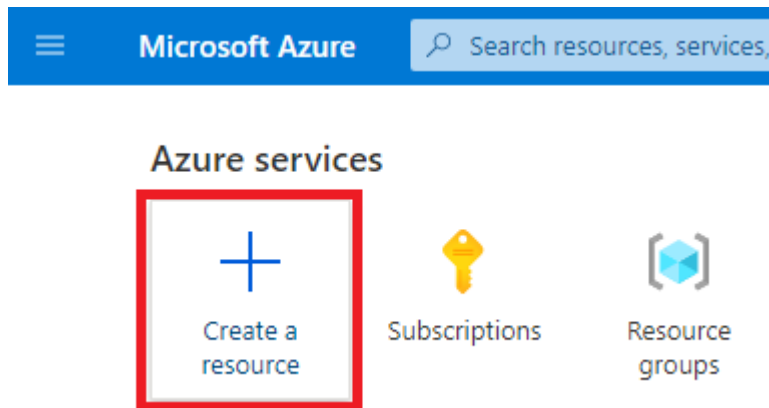


Exercise 1: IoT Hub provisioning

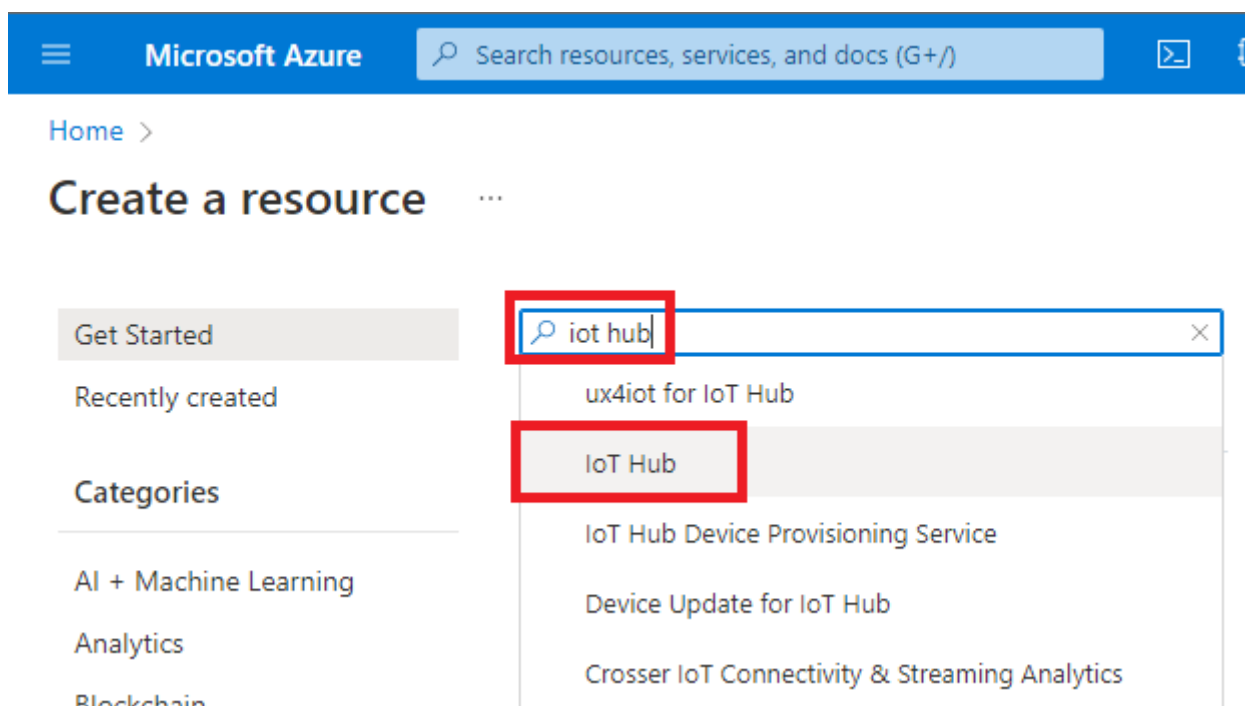
Task 1: Provision IoT Hub through the Portal

During this exercise you will use 3 different tools to create three different IoT Hubs, after this exercise we will delete two and continue the rest of the workshop with the first IoT Hub created through the Portal.

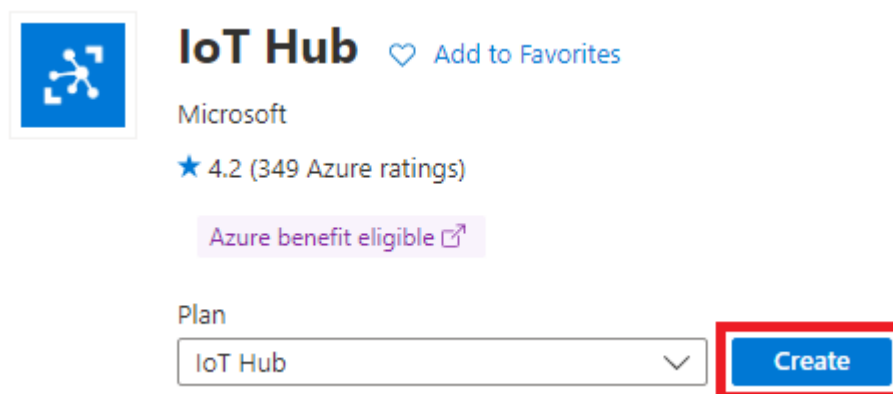
1. In your browser, navigate to the [Azure portal](#), select **+Create a resource** in the navigation pane, enter **iot hub** into the **Search the Marketplace** box.



2. Select **IoT Hub** from the results



3. Select **Create**.



4. On the **IoT Hub** blade **Basics** tab, enter the following:

- **Subscription:** Select the subscription you are using for this hands-on lab.

- **Resource group:** Click Create new underneath Resource group. Enter the name `rg-iot-academy`

The screenshot shows the Azure portal interface. At the top, there's a 'Resource group' dropdown menu with a 'Create new' link. A modal dialog is open, titled 'Create new', which explains that a resource group is a container for related resources. It has a 'Name' field with the text 'rg-iot-academy' entered, highlighted by a red box. Below the field are 'OK' and 'Cancel' buttons. In the background, the 'Instance details' section is visible, showing fields for 'IoT hub name' and 'Region'.

- **IoT Hub Name:** Enter a unique name, such as `iot-academy-johndoe-220427`. The name follows best practices for naming resources in Azure. Note:
 1. the prefix `iot-`
 2. the inclusion of a name 'johndoe' and a date `220427` (YYMMDD) this combination such as `johndoe-220427` will be known as your **suffix**. You may want to copy this to your notepad so you can copy and paste it later.

As some resources in Azure require unique names, the name and the date helps to avoid naming conflicts. More can be read concerning best practices for naming Azure resources at the following link: [Azure Naming and Tagging](#) For common resource prefixes refer to the following link: [Azure Resource Abbreviations](#)

Microsoft Azure Search resources, services, and docs (G+/)

Home > Create a resource > IoT Hub >

IoT hub

Microsoft

Basics Networking Management Tags Review + create

Create an IoT hub to help you connect, monitor, and manage billions of your IoT assets. [Learn more](#)

Project details

Choose the subscription you'll use to manage deployments and costs. Use resource groups like folders to help you organize and manage resources.

Subscription * ⓘ

Resource group * ⓘ [Create new](#)

Instance details

IoT hub name * ⓘ

Region * ⓘ

- **Region:** Select the location you are using for this hands-on lab.
- Click **Next: Networking**.
- On the **Networking** tab ensure **Public** is selected
- Click **Next: Management**.
- On the **Management** tab
 1. **Pricing and scale tier:** ensure **S1: Standard tier** is selected
 2. **Number of S1 IoT hub units:** ensure **1** is selected
 3. **Defender for IoT:** set to **On**
 4. **Assign me to the IoT Hub Data Contributor role:** select the check box
 5. **Device-to-cloud partitions:** leave the default setting of **4**
- Click **Review + create**.
- Ensure validation passes and click **Create**.

Basics Networking **Management** Tags Review + create

Each IoT hub is provisioned with a certain number of units in a specific tier. The tier and number of units determine the maximum daily quota of messages that you can send. [Learn more](#)

Scale tier and units

Pricing and scale tier * ⓘ

S1: Standard tier

[Learn how to choose the right IoT hub tier for your solution](#)

Number of S1 IoT hub units ⓘ



1

Determines how your IoT hub can scale. You can change this later if your needs increase.

Defender for IoT



On

Microsoft [Defender for IoT](#) is a separate service which adds an extra layer of threat protection for Azure IoT Hub, IoT

Role-based access control

Change the permission model to Azure role-based access control (RBAC) only, or to a combination of shared access policies and RBAC. [Learn more](#)



RBAC only



Shared access policy + RBAC

To manage the elements within an instance, a user needs access to IoT Hub data APIs. Select the suggested role below to grant yourself full access to the APIs. You can also use Access Control (IAM) to chose appropriate roles later.

[Learn more](#)



Assign me to the IoT Hub Data Contributor role ⓘ

Advanced settings

Scale

Device-to-cloud partitions ⓘ



4

Review + create

< Previous: Networking

Next: Tags >

5. After clicking create you were directed to a deployment overview page. When the deployment completes click the **Go to resource** button.

✓ Your deployment is complete



Deployment name: `iot-academy-johndoe-220427-4121...`
Subscription:
Resource group: `rg-iot-academy`

Start time: 4/12,
Correlation ID: 4

▼ Deployment details (Download)

^ Next steps

[Add and configure IoT Devices](#) Recommended

[Configure routing rules for device messaging](#) Recommended

[Go to resource](#)

Task 2: Provision IoT Hub through CLI

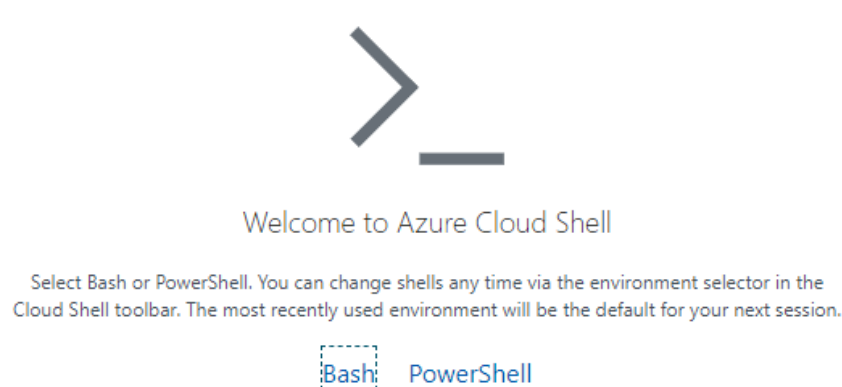
1. Open the Azure Cloud Shell with the below link

<https://shell.azure.com/>

If you've never used the Azure Cloud

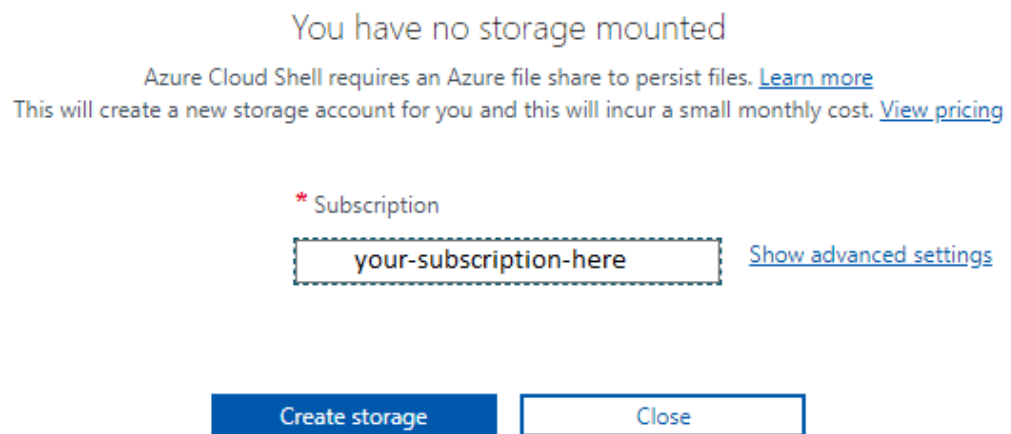
If you've never used the Azure Cloud Shell before:

1. You will be prompted to select Bash or Powershell, select **Bash**

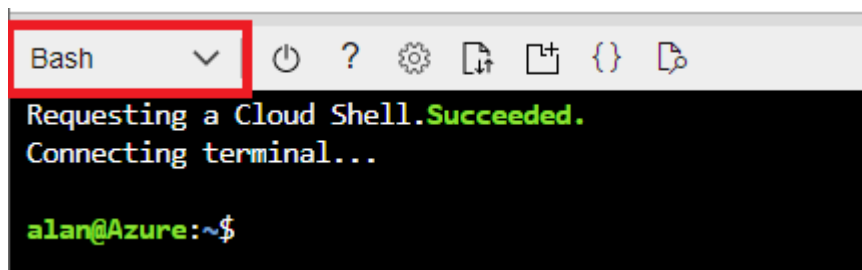


2. You will be prompted to mount a storage account, click **Create Storage** to continue. If you used Azure Cloud Shell before, you will skip this step.

- Click **Create storage**



2. If **Bash** isn't already selected switch to it

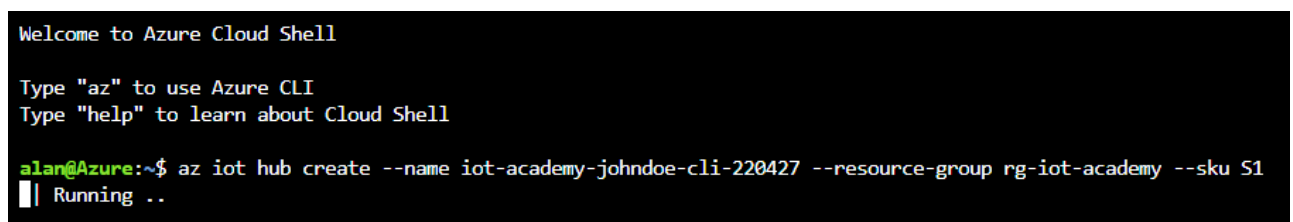


3. Once you are login run the following command to create an IoT Hub.

In the following command replace **iot-johndoe-cli-220427** with your iot hub name, replacing johndoe and the appropriate date, of the form iot-{yourname}-cli-{YYMMDD}

```
az iot hub create --name iot-academy-johndoe-cli-220427 --resource-group rg-iot-academy --sku S1
```

As the command runs you'll observe the following result.



When the command completes you'll see output as follows


```
alan@Azure:~$ az iot hub create --name iot-academy-johndoe-cli-220427
{
  "etag": "AAAADGZrwC4=",
  "id": "/subscriptions/7451d6d6-9082-46d9-9373-ccd5fcd8a1e1/resourceGroups/rg-iot-academy-johndoe-cli-220427/providers/Microsoft.IoTHub/IoTHubs/iot-academy-johndoe-cli-220427",
  "identity": {
    "principalId": null,
    "tenantId": null,
    "type": "None",
    "userAssignedIdentities": null
  },
  "location": "eastus2",
  "name": "iot-academy-johndoe-cli-220427",
  "properties": {
    "allowedFqdnList": [],
    "authorizationPolicies": null,
  }
}
```

4. In a new Edge tab, browse to the [Azure Portal](#) to verify your newly created IoT Hub.

1. From the Azure Portal home page click **All resources**, under the Navigate section.

Navigate



2. Verify you see your two created IoT Hubs in the list of resources

Home > All resources

Default Directory

Create Manage view Refresh Export to CSV Open query | Assign tags

Filter for any field... Subscription == all Resource group == all X Type == all X Lo

0 Unsecure resources

List view

<input type="checkbox"/> Name	Type	Resource group	Location
<input type="checkbox"/> cs210032001f156c351	Storage account	cloud-shell-storage-eastus2	Ea
<input type="checkbox"/> iot-academy-acadone-220427	IoT Hub	rg-iot-academy	Ea
<input type="checkbox"/> iot-academy-acadone-cli-220427	IoT Hub	rg-iot-academy	Ea

5. Delete the IoT Hub just created using the delete command.

- Go back to your Cloud Shell tab
- Run the following command to list your IoT Hubs

```
az iot hub list -o table
```

- Run the following two commands in the Cloud Shell

Again, replace johndoe and the appropriate date. You could also copy and paste the names from the previous **list** command

```
az iot hub delete --name iot-johndoe-cli-220427 --resource-group rg-  
iot-academy
```

Also, delete the IoT Hub created through the portal

```
az iot hub delete --name iot-academy-johndoe-220427 --resource-group  
rg-iot-academy
```

- Run the list command one more time to ensure your IoT Hub instances were deleted

```
az iot hub list -o table
```

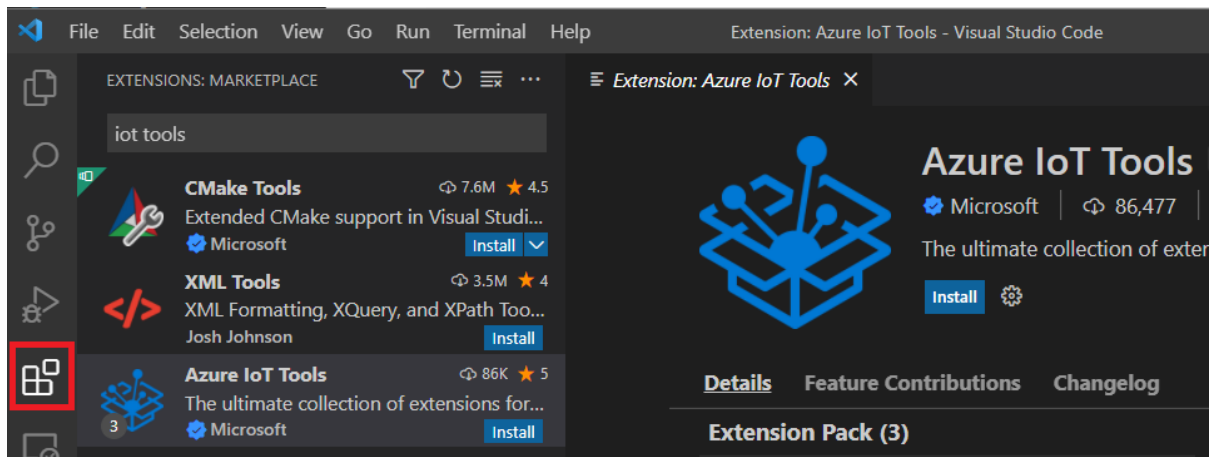
Task 3: Provision IoT Hub through VS Code

If you have not yet installed Visual Studio Code download and install from the following link:
<https://code.visualstudio.com/download>

Our third way of creating an Azure resource, IoT Hub instance, is to use Visual Studio Code.

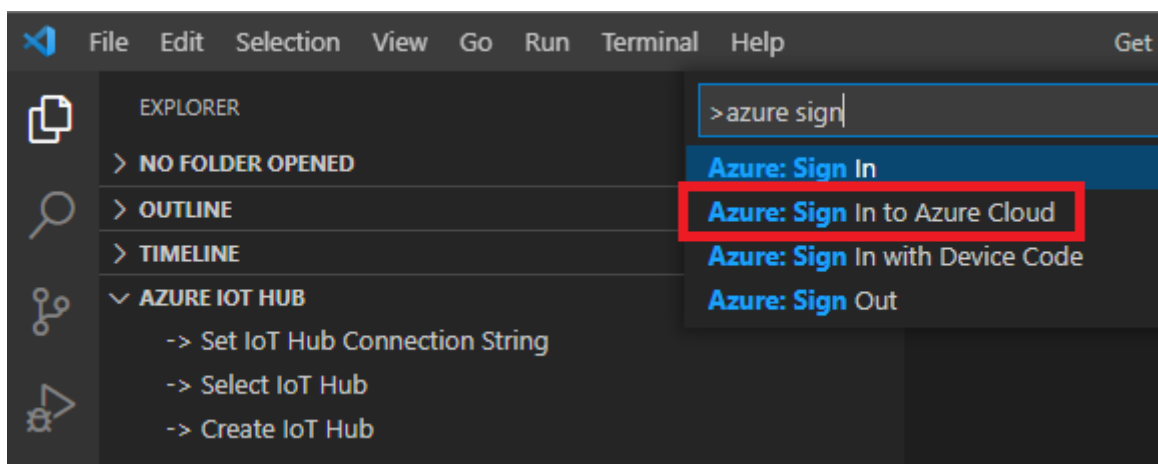
1. Install IoT Tools extension pack for VS Code in one of two ways:

- Use the following URL <https://marketplace.visualstudio.com/items?itemName=vsciot-vscode.azure-iot-tools>
- Use the extension tab (highlighted in red) in VS Code, search for **iot tools**, select **Azure IoT Tools**, click **Install**

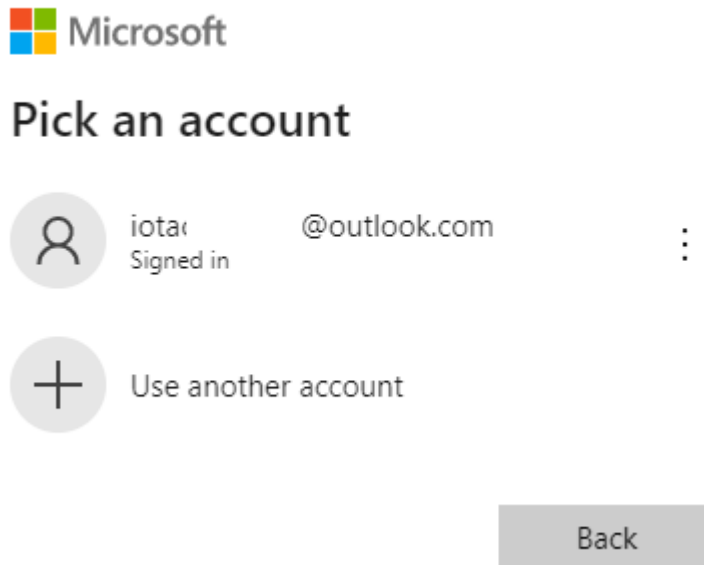


2. Sign in to your Azure account

- Click the **View** menu on the top toolbar then select **Command Palette**.
- Type 'azure sign'
- Click the **Azure: Sign in to Azure Cloud** command
- Click **Azure (Current)** (or press enter)



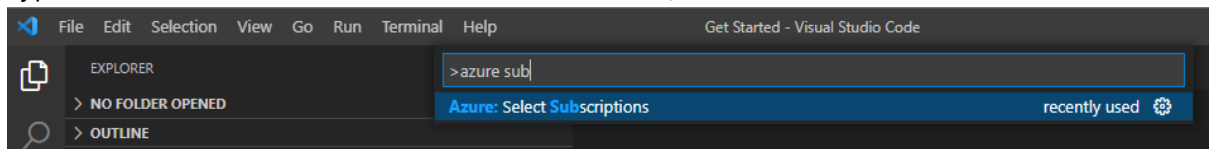
- After redirection to the browser select your account



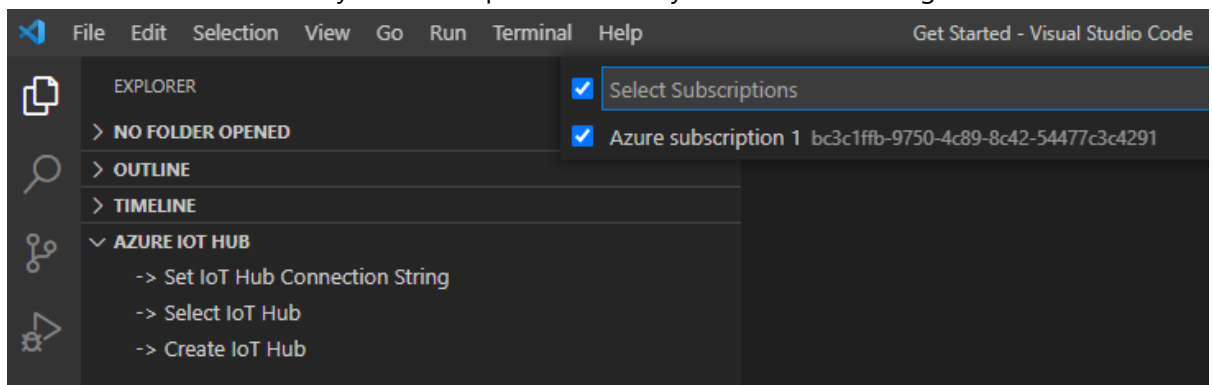
- Close the browser tab after seeing **You are signed in now and can close this page.**

3. Ensure your subscription is selected

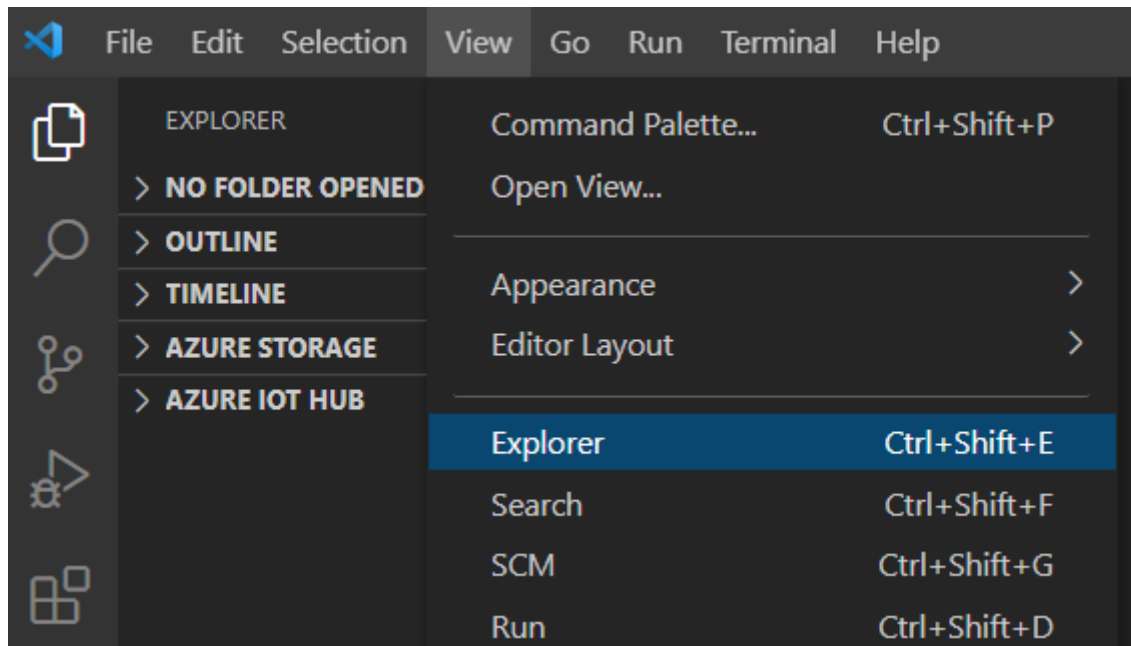
- Open the **Command Palette** (menu or shortcut)
- Type 'azure sub' and select **Azure: Select Subscriptions**



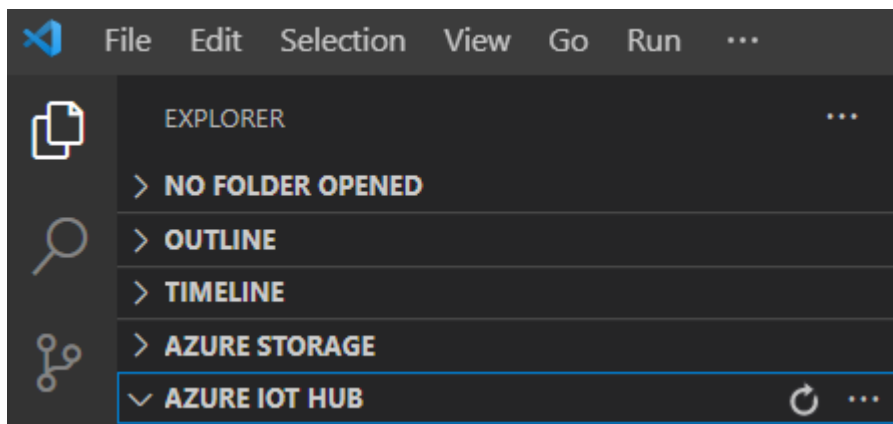
- To avoid confusion ensure your subscription is the only one selected during this hands on lab.



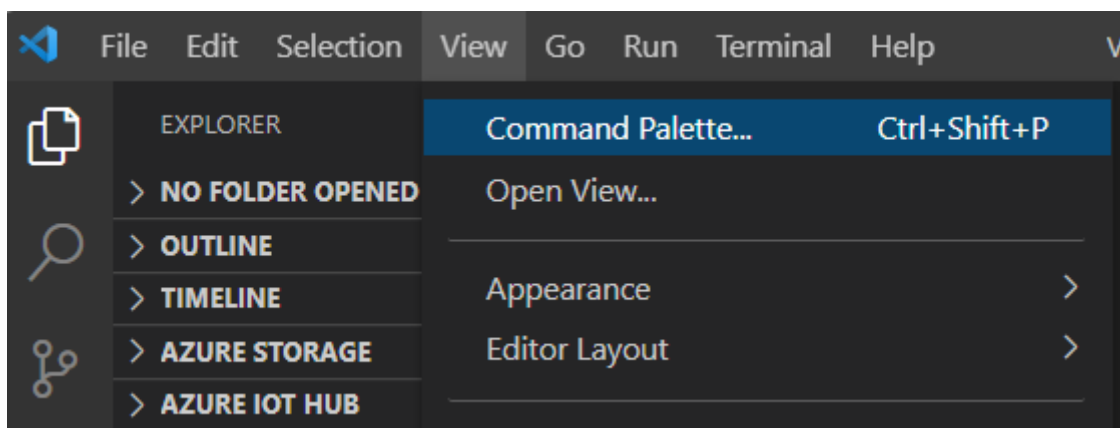
4. Click the View Menu and then Explorer



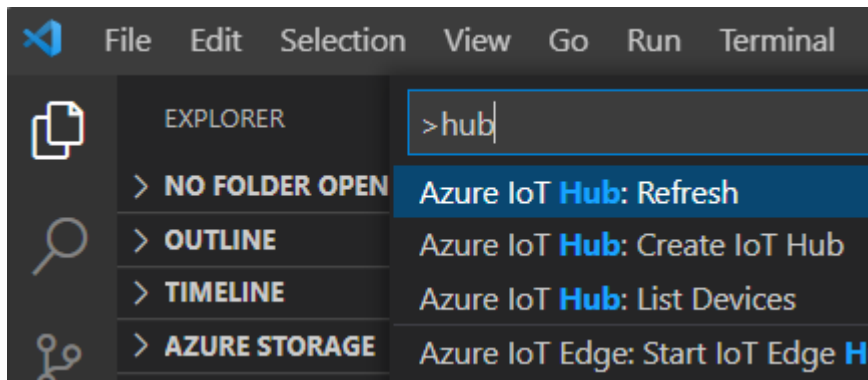
- Ensure **Azure IoT Hub** is seen in the Explorer view



- To create a new IoT Hub Go to the menu **View** on the top toolbar then select **Command Palette**.

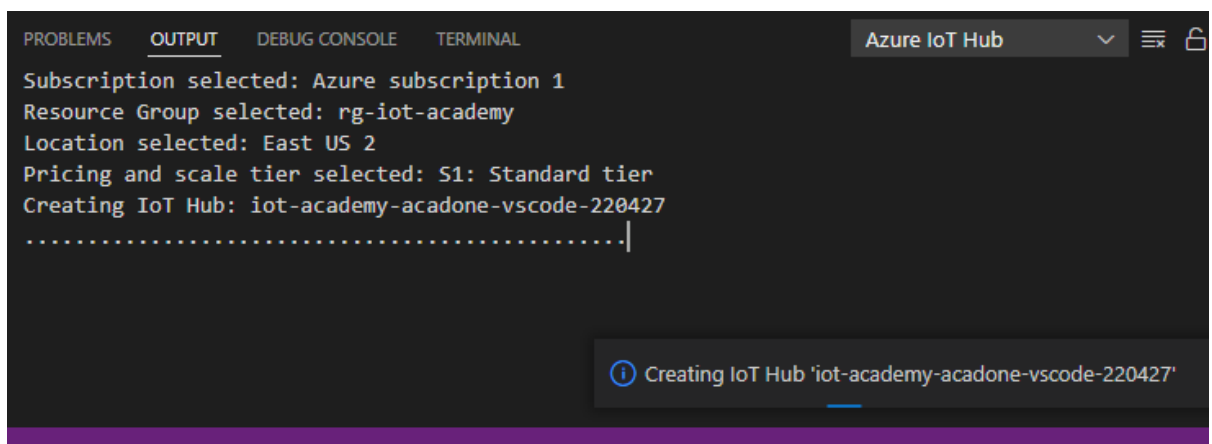


- Type **Azure IoT Hub** in the search bar, then you will see the list of commands available select **Azure IoT Hub: Create IoT Hub** and click Enter.

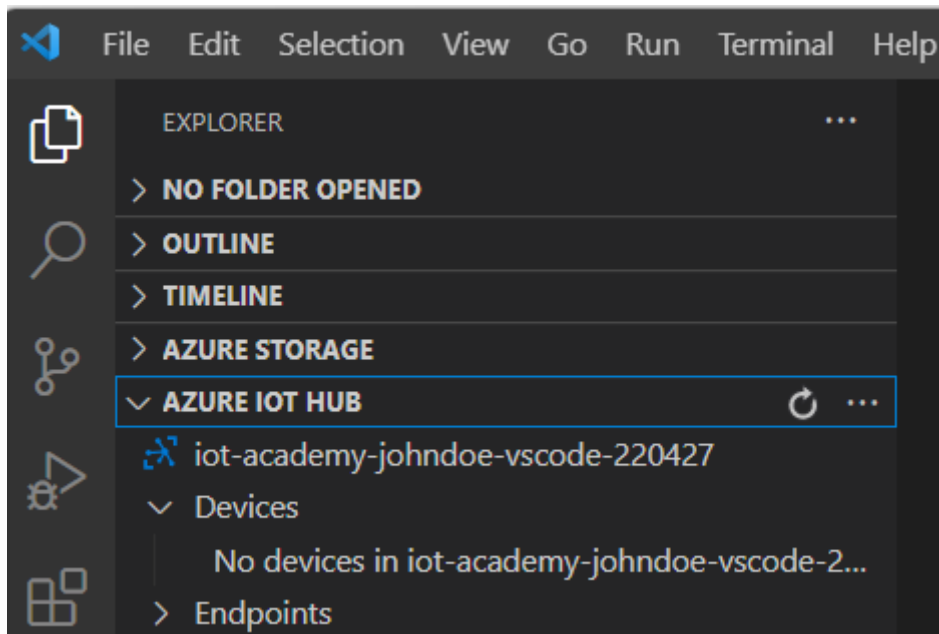


- Select the following parameters:
 - **Subscription:** Select your subscription.
 - **Resource group:** Use existing and select `rg-iot-academy`.
 - **Location:** Select the location you are using for resources in this hands-on lab.
 - **SKU:** Select **S1**.
 - **Name:** Assign a name to the IoT Hub `iot-academy-johndoe-vscode-220427` change **johndoe** and **220427** using your name and the date YYMMDD.

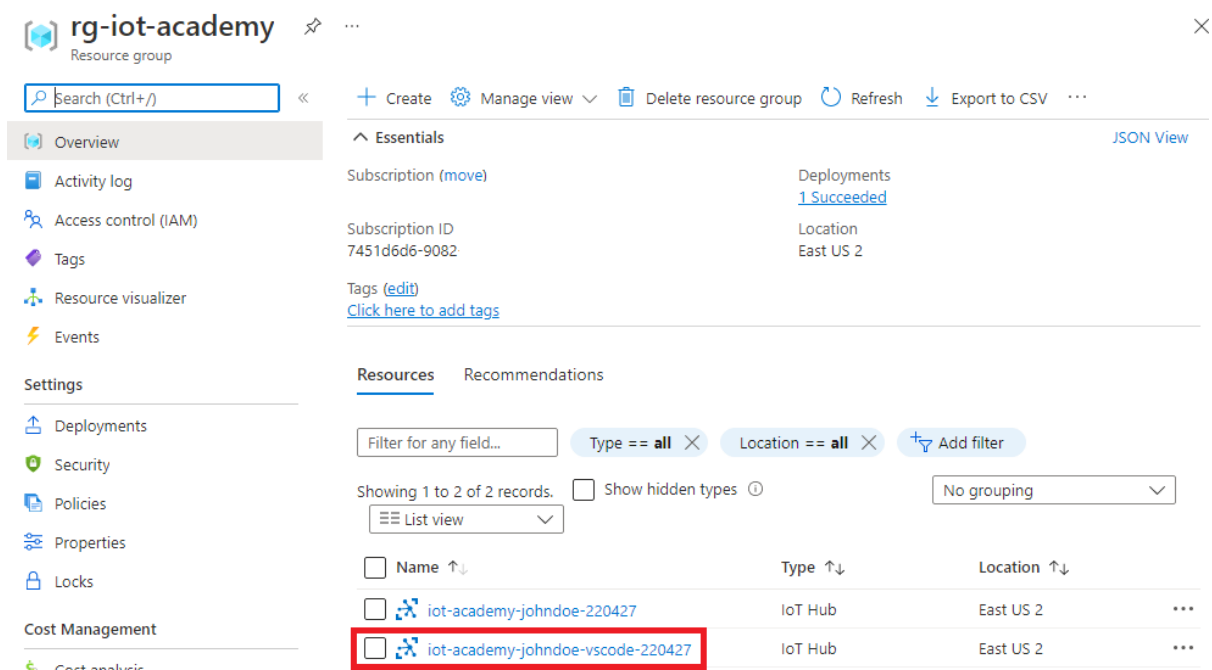
As the extension creates the IoT Hub instance you should see a status message as follows.



- After the creation process you should be able to see the new IoT Hub in VS Code and the Azure Portal.



Azure Portal Resource Group View

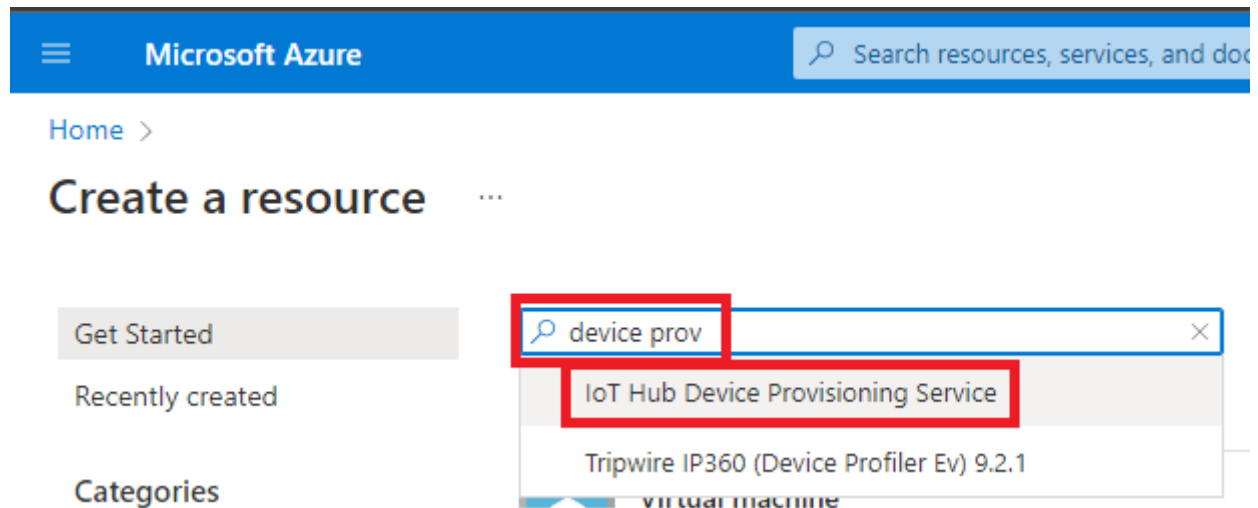


Exercise 2: Azure IoT Hub Device Provisioning Service (DPS)

Task 1: Deploy DPS

1. Create a DPS instance by:

- Go to the Azure Portal home page
- Click **Create a resource**
- Search for **device prov**
- Click **IoT Hub Device Provisioning Service**



2. Click **Create**

3. Create Details

- Enter the following details
 - Resource group: `rg-iot-academy`
 - Name: `provs-iotacad-{SUFFIX}` e.g. `provs-iotacad-johndoe220427`
 - Region: `your region`

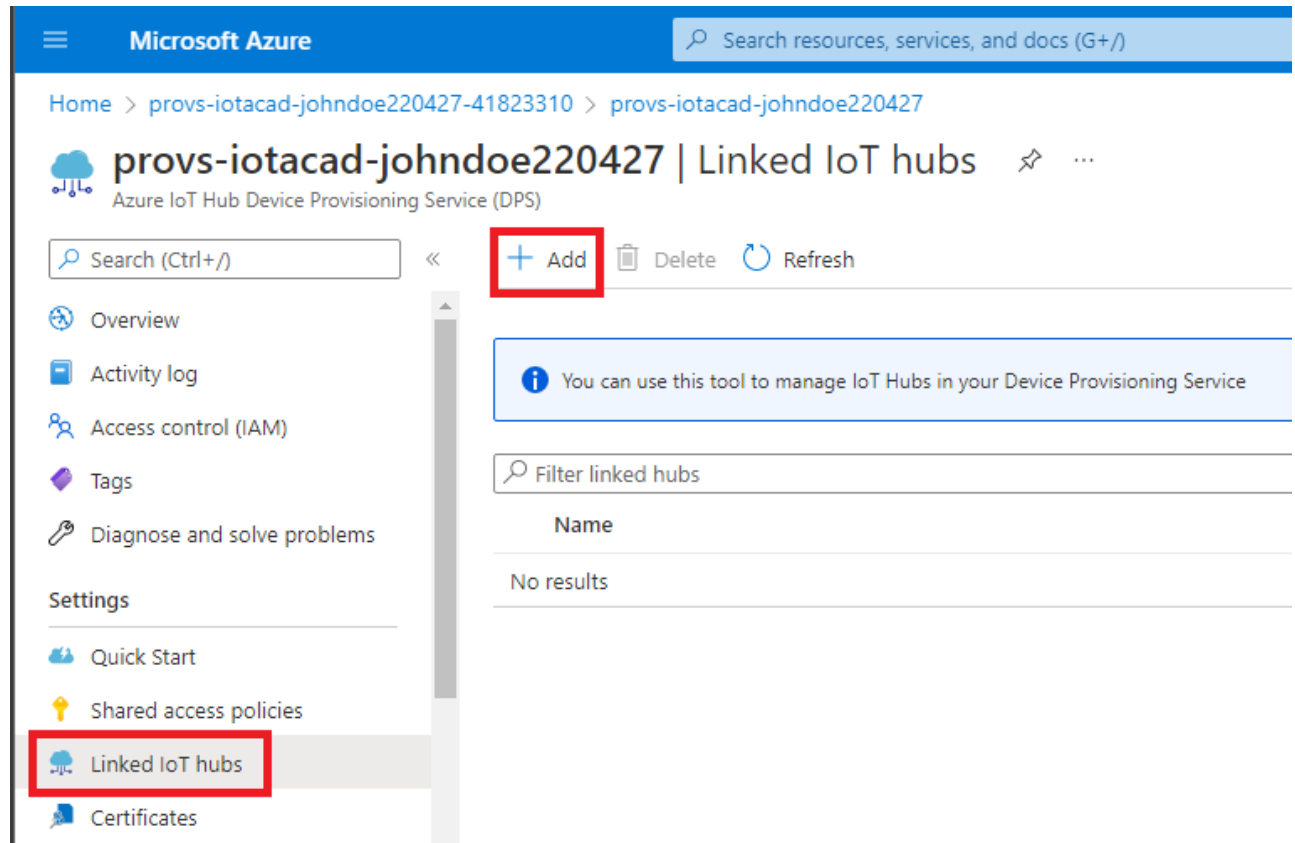
The screenshot shows the 'Azure IoT Hub device provisioning service' 'Create' page. The breadcrumb trail is 'Home > Create a resource > IoT Hub Device Provisioning Service >'. The page title is 'Azure IoT Hub device provisioning service' followed by an ellipsis. Below the title, it says 'Microsoft'. There are tabs for 'Basics', 'Networking', 'Management', 'Tags', and 'Review + create'. The 'Basics' tab is selected. The page description states: 'The Azure IoT Hub device provisioning service is a helper service for IoT Hub that enables zero-touch, just-in-time provisioning to the right IoT hub without requiring human intervention, allowing customers to provision millions of devices in a secure and scalable manner. [Learn more](#)'. Under 'Project details', it says: 'Choose the subscription you'll use to manage deployments and costs. Use resource groups like folders to help you organize and manage resources.' There are two dropdown menus: 'Subscription' (set to 'Visual Studio Enterprise Subscription') and 'Resource group' (set to 'rg-iot-academy', which is highlighted with a red box). Below these is the 'Instance details' section with two fields: 'Name' (set to 'Name this device provisioning service') and 'Region' (set to 'East US 2'). At the bottom, there are three buttons: 'Review + create' (highlighted in blue), '< Previous', and 'Next: Networking >'. There is also a 'Create new' link below the 'Resource group' dropdown.

4. Click **Review and Create**, then click **Create**


5. When the deployment completes, click **Go to resource**
6. When the Overview page loads save the **ID Scope** to notepad

Task 2: Connect IoT Hub to DPS

1. Click **Linked IoT Hubs**, then click **Add**



2. Fill in the following details, then click **Save**



Add link to IoT hub

[Learn more about linking IoT hubs.](#)

Subscription * ⓘ

Visual Studio Enterprise Subscription

IoT hub * ⓘ

iot-academy-johndoe-vscode-220427

Access Policy * ⓘ

iothubowner

Hostname

Status

Pricing Tier

Location






Save

- Click **Manage Allocation Policy**, review the options available





Home > provs-iotacad-acadone220427-42002531 > provs-iotacad-acadone220427

provs-iotacad-acadone220427 | Manage allocation

Azure IoT Hub Device Provisioning Service (DPS)

 Save Overview Activity log Access control (IAM) Tags Diagnose and solve problems

Settings

 Quick Start Shared access policies Linked IoT hubs Certificates Manage enrollments Manage allocation policy

Lowest latency: This policy assigns devices to the link with the lowest latency between device and IoT Hub.

Evenly weighted distribution: This policy evenly distributes devices across all IoT Hubs. If you have only one IoT Hub, we recommend this setting. This policy requires a desired link.

Static configuration: This policy requires a desired link and assigns devices to that link.

Select how you want to assign devices to hubs



Lowest latency



Evenly weighted distribution



Static configuration (via enrollment list only)

Task 3: Create an Individual Enrollment

1. Click **Manage enrollments**
2. Click **Add individual enrollment**

Home > provs-iotacad-acadone220427-42002531 > provs-iotacad-acadone220427


provs-iotacad-acadone220427 | Manage enrollments


Azure IoT Hub Device Provisioning Service (DPS)


<<


[+ Add enrollment group](#)


[+ Add individual enrollment](#)

 Overview


 Activity log


 Access control (IAM)


 Tags


 Diagnose and solve problems


Settings


 Quick Start

 Shared access policies

 Linked IoT hubs

 Certificates

 Manage enrollments

 You can add or remove individual device enrollments and/or

Enrollment Groups

Individual Enrollments

REGISTRATION ID

☒ `iotacademy`

3. Fill in the following details

- Mechanism: `Symmetric Key`
- Auto-generate keys: `checked`
- Registration ID: `iotacademy`
- IoT Hub Device ID: `iot-academy-edge-device`
- IoT Edge device: `True`
- Select the IoT hubs this device can be assigned to: `select your hub`
- Leave all other values at default

4. Click **Save** at the top of the page

Task 4: Gather Individual Enrollment Details

1. Click **Manage enrollments**, then click **Individual Enrollments**, then click your enrollment **iotacademy**

Microsoft Azure Search resources, services, and docs (G+)

Home > provs-iotacad-johndoe220427-41823310 > provs-iotacad-johndoe220427

provs-iotacad-johndoe220427 | Manage enrollments ⚙️ ...

Azure IoT Hub Device Provisioning Service (DPS)

Search (Ctrl+/) << + Add enrollment group + Add individual enrollment ↻ Refresh 🗑️ Delete

Overview
Activity log
Access control (IAM)
Tags
Diagnose and solve problems

Settings

Quick Start
Shared access policies
Linked IoT hubs
Certificates
Manage enrollments
Manage allocation policy

Enrollment Groups **Individual Enrollments**

Search individual enrollment by registration ID (ID has to be exact match)

REGISTRATION ID

<input checked="" type="checkbox"/> iotacademy
--

2. Take note of the following values in your notepad
 - Registration ID: **iotacademy**
 - IoT Hub Device ID: **iot-academy-edge-device**
 - Primary Key (click the copy icon shown in the image below)

Microsoft Azure Search resources, services, and docs (G+)

Home > provs-iotacad-johndoe220427-41823310 > provs-iotacad-johndoe220427 >

iotacademy ...

Enrollment Details

Save ↻ Refresh 🔑 Regenerate keys ▾

Registration Status

Status: unassigned

Assigned hub: -

Device ID: -

Last assigned: -

Authentication Type

Mechanism: Symmetric Key

Primary Key

📋

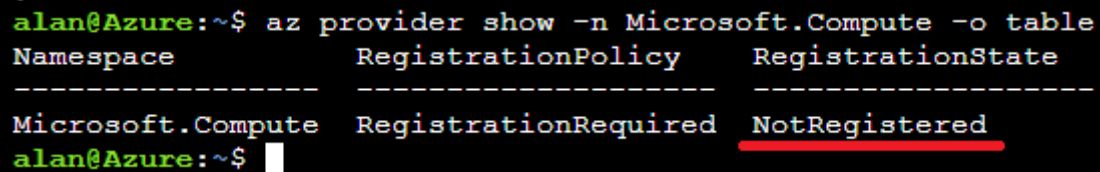
Exercise 3: Create an Ubuntu-based Azure IoT Edge Device

During this exercise you will learn how to set up an Azure IoT Edge device and connect it to IoT Hub to start streaming data.

Task 1: Ensure the Azure Resource Provider is Registered

1. Go back to your tab in Edge which has the Azure Cloud Shell, or open <https://shell.azure.com>
2. Run the following command

```
az provider show -n Microsoft.Compute -o table
```



```
alan@Azure:~$ az provider show -n Microsoft.Compute -o table
Namespace           RegistrationPolicy   RegistrationState
-----
Microsoft.Compute   RegistrationRequired NotRegistered
alan@Azure:~$
```

3. If your status is **Registered** continue to Task 2
4. If the status is **NotRegistered**, run the following command to Register the Resource Provider

```
az provider register -n 'Microsoft.Compute' --wait -o table
```

Task 2: Creating a VM to host an IoT Edge Device

In this exercise we'll set up an IoT Edge device using an Ubuntu based VM.

1. From Azure Portal select **Create resource** then from the most Popular list select **Ubuntu Server 18.04 LTS**. If you don't see it use the search box titled **Search services and marketplace** to search for **Ubuntu Server 18.04 LTS**.

Microsoft Azure Search resources, services, and docs (G+)

Home >

Create a resource

Get Started

Recently created

Categories

- AI + Machine Learning
- Analytics
- Blockchain
- Compute
- Containers
- Databases
- Developer Tools
- DevOps
- Identity

Popular Azure services

- Virtual machine [Create](#) | [Learn more](#)
- Kubernetes Service [Create](#) | [Docs](#) | [MS Learn](#)
- Azure Cosmos DB [Create](#) | [Docs](#) | [MS Learn](#)
- Function App [Create](#) | [Docs](#)
- SQL Database

See more in All services

Popular Marketplace products

- Windows Server 2019 Datacenter [Create](#) | [Learn more](#)
- Ubuntu Server 20.04 LTS [Create](#) | [Learn more](#)
- Windows 10 Pro, version 20H2 [Create](#) | [Learn more](#)
- Ubuntu Server 18.04 LTS [Create](#) | [Learn more](#)

Getting Started? Try our Quickstart center

2. Then you will need to complete the following parameters in the **Basics** tab:

Note: For the **Region** and **Size** options below. At the time of this writing there is a shortage of many VM sizes in various Azure regions for new subscriptions. This is believed to be from increased demand.

The available VM skus are based on the region, or location, you're creating a VM resource within.

For **Location** you may need to look outside of your region your other resources are in. At the time of this writing **Sweden Central** seems to have many VM skus available and was used for this demonstration.

Having your resources spread across different regions is not ideal as it can incur extra costs due to network usage. With the small scale and scope of this demo it won't have a meaningful impact on cost.

For **Size** look for a VM sku that costs < \$40 USD/month.

A good small size to make the most of your Azure credit is **B1s** which includes free hours and is also < \$8 USD/month

- **Subscription:** Select the subscription you are using for this hands-on lab.
- **Resource group:** Use existing and select your resource group, **rg-iot-academy**.
- **Virtual Machine Name:** edgedevice+SUFFIX e.g. **edgedevice-johndoe-220427**
- **Region:** Refer to **Note**
- **Availability Options:** Select **No Infrastructure redundancy required**.
- **Image:** Keep default
- **Size:** Refer to **Note**
- **Authentication Type:** Select **Password**
- **Username:** **iotacademy**

- **Password:** MSFTacademy01! (For higher security you could create your own strong password)
- **Public inbound ports:** None

3. Click the **Management** tab at the top of the pane.

The screenshot shows the 'Create a virtual machine' page in the Microsoft Azure portal, with the 'Management' tab selected and highlighted by a red box. The page header includes the Microsoft Azure logo and a search bar. The breadcrumb trail is 'Home > Create a resource >'. The main title is 'Create a virtual machine ...'. Below the title, there are tabs for 'Basics', 'Disks', 'Networking', 'Management' (highlighted), 'Advanced', 'Tags', and 'Review + create'. A sub-header reads 'Configure monitoring and management options for your VM.'.

Azure Security Center

Azure Security Center provides unified security management and advanced threat protection across hybrid [Learn more](#)

✓ Your subscription is protected by Azure Security Center basic plan.

Monitoring

Boot diagnostics ⓘ

☒ Enable with managed storage account (recommended)

☐ Enable with custom storage account

☐ Disable

Enable OS guest diagnostics ⓘ ☐

Identity

System assigned managed identity ⓘ ☐

Notice the Auto-shutdown feature. This feature is a helpful to control costs for development or infrequently used virtual machines. When the VM is shutdown you do not incur compute costs.

Auto-shutdown

Enable auto-shutdown ⓘ

☒

Shutdown time ⓘ

7:00:00 PM

Time zone ⓘ

(UTC) Coordinated Universal Time

Notification before shutdown ⓘ

☒

Email * ⓘ

Backup

Enable backup ⓘ

☐

Guest OS updates

Patch orchestration options ⓘ

Image default

Some patch orchestration options are not available for this image. [Learn more](#)

4. Click the Tags tab Add the following two tags

- environment: development
- product: iot-academy-training

Diagram showing the tags tab while creating a VM

Microsoft Azure

Search resources, services, and docs (G+)

Home > Create a resource >

Create a virtual machine

Basics

Disks

Networking

Management

Advanced

Tags

Review + create

Tags are name/value pairs that enable you to categorize resources and view consolidated billing by applying the same tag to multiple resources and resource groups. [Learn more about tags](#)

Note that if you create tags and then change resource settings on other tabs, your tags will be automatically updated.

Name ⓘ	Value ⓘ	Resource	
environment	: development	All resources	
<input type="text" value="product"/>	: <input type="text" value="iot-academy-training"/>	12 selected	
<input type="text"/>	: <input type="text"/>	12 selected	

Tags are an important aspect for management, governance, and hygiene of Azure resources. It's not uncommon to have thousands of resources in mature organizations. The tags can be used for search,

reporting, and automation tools to ease management of large deployments. You can read more at [Azure Tagging Strategy](#)

5. Last select **Review + Create** after successful validation you should be able to click **Create**
6. Once the resource is available click **Go to resource** to view the newly created Virtual Machine. You should see in the Overview section the Public IP to connect, copy the IP to your notepad.

The screenshot shows the Microsoft Azure portal interface. At the top, there's a search bar and navigation menu. Below, the breadcrumb trail indicates the path: Home > CreateVm-Canonical.UbuntuServer-18_04-lts-gen2-20220413184623 >. The main heading is 'edgedevice-johndoe-220427' with a 'Virtual machine' subtitle. A search bar is present. Below the search bar, there's a left-hand navigation pane with options like Overview, Activity log, Access control (IAM), Tags, Diagnose and solve problems, Settings, Networking, Connect, Disks, Size, and Security. The main content area shows the 'Essentials' section with various properties: Resource group (rg-iot-academy), Status (Running), Location (East US 2), Subscription (Visual Studio Enterprise Subscrip...), Subscription ID (7451d6d6-9082-46d9-9373-ccd5...), Operating system (Linux (ubuntu 18.04)), Size (Standard DS1 v2 (1 vcpu, 3.5 GiB...)), Public IP address (20.122.3.1), Virtual network/subnet (rg-iot-academy-vnet/default), DNS name (Not configured), and Tags (More (2)). The Public IP address '20.122.3.1' is highlighted with a red box.

Property	Value
Resource group	rg-iot-academy
Status	Running
Location	East US 2
Subscription	Visual Studio Enterprise Subscrip...
Subscription ID	7451d6d6-9082-46d9-9373-ccd5...
Operating system	Linux (ubuntu 18.04)
Size	Standard DS1 v2 (1 vcpu, 3.5 GiB...)
Public IP address	20.122.3.1
Virtual network/subnet	rg-iot-academy-vnet/default
DNS name	Not configured
Tags	More (2)

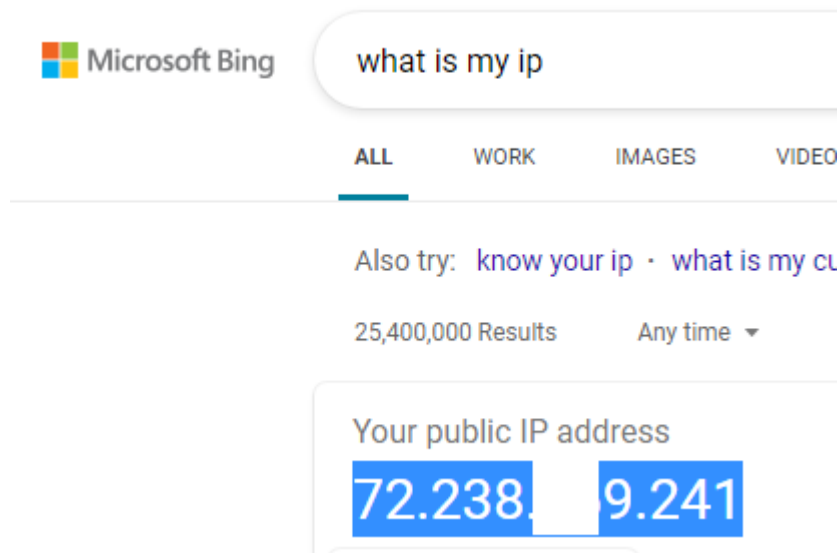
Task 3: Connecting to your Ubuntu Virtual Machine

An important aspect of building cloud infrastructure is doing it in a secure manner. As part of this exercise port 22 could be opened, for SSH, to allow quick connection to the VM. However, this could allow an attacker to attempt to breach this port. Two safer approaches could be used

- A safer approach would be to use an important feature of Azure Virtual Machines, Just-in-time (JIT) VM access. This feature allows enabling access to the VM for a specified amount of time. More information can found at [Just-in-time VM Access](#)
- Enabling SSH, port 22, access for just your IP address

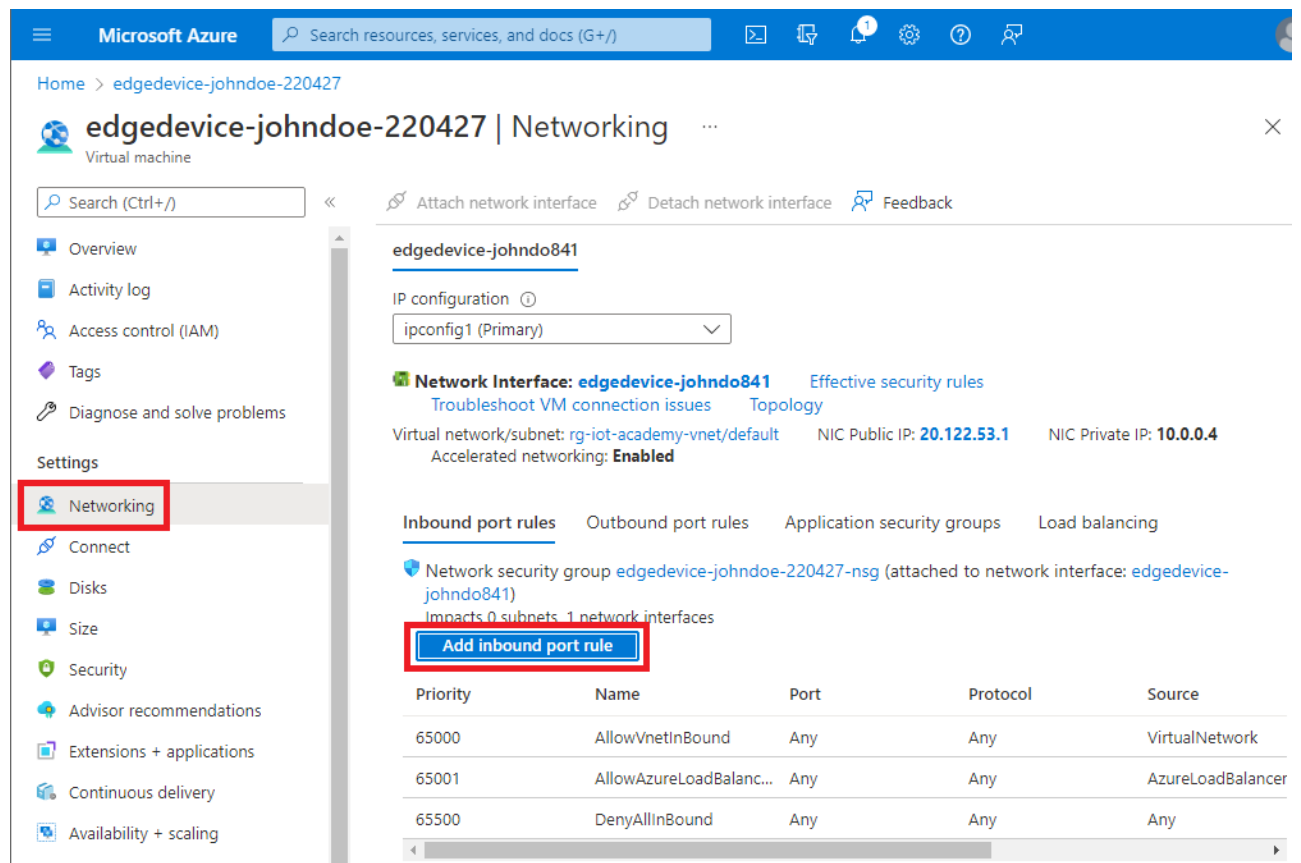
For simplicity the 2nd option will be used.

1. Go to www.bing.com in your browser and search for **what is my ip**



Copy your IP address to your notepad.


2. On your VM resource click the **Networking** tab. Click the **Add inbound port rule**



3. Set the details for the new inbound port rule, click Add.

- Source: **IP Addresses**
- Source IP addresses/CIDR ranges: **Your IP address you saved in notepad**
- Source port ranges: *****
- Service: **SSH**
- Action: **Allow**
- Priority: **100**

- Name: **Port_22**

 **Add inbound security rule** ✕
edgedevice-johndoe-220427-nsg

Source ⓘ

IP Addresses ✓

Source IP addresses/CIDR ranges * ⓘ

72.238. 9.241 ✓

Source port ranges * ⓘ

*

Destination ⓘ

Any ✓

Service ⓘ

SSH ✓

Destination port ranges ⓘ

22

Protocol

☐ Any

☒ TCP

☐ UDP

☐ ICMP

Action

☒ Allow

☐ Deny

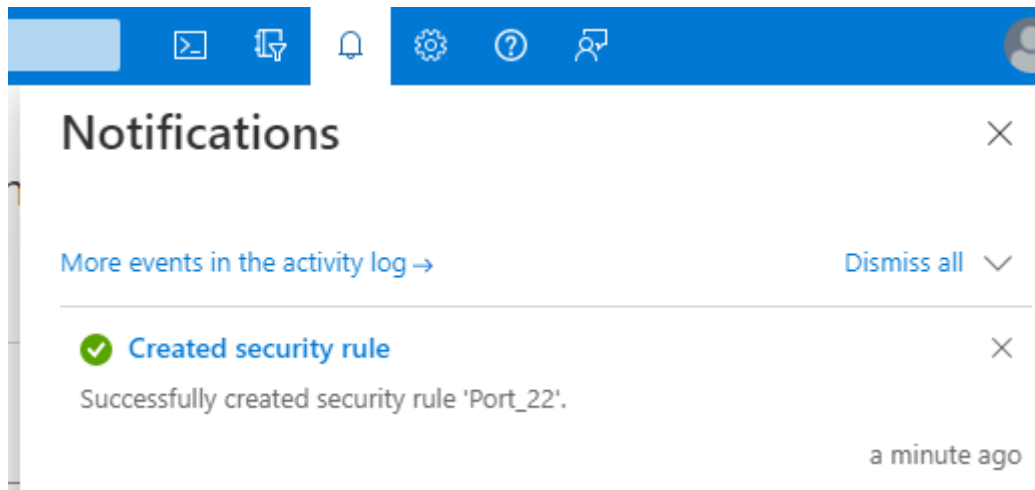
Priority * ⓘ

100

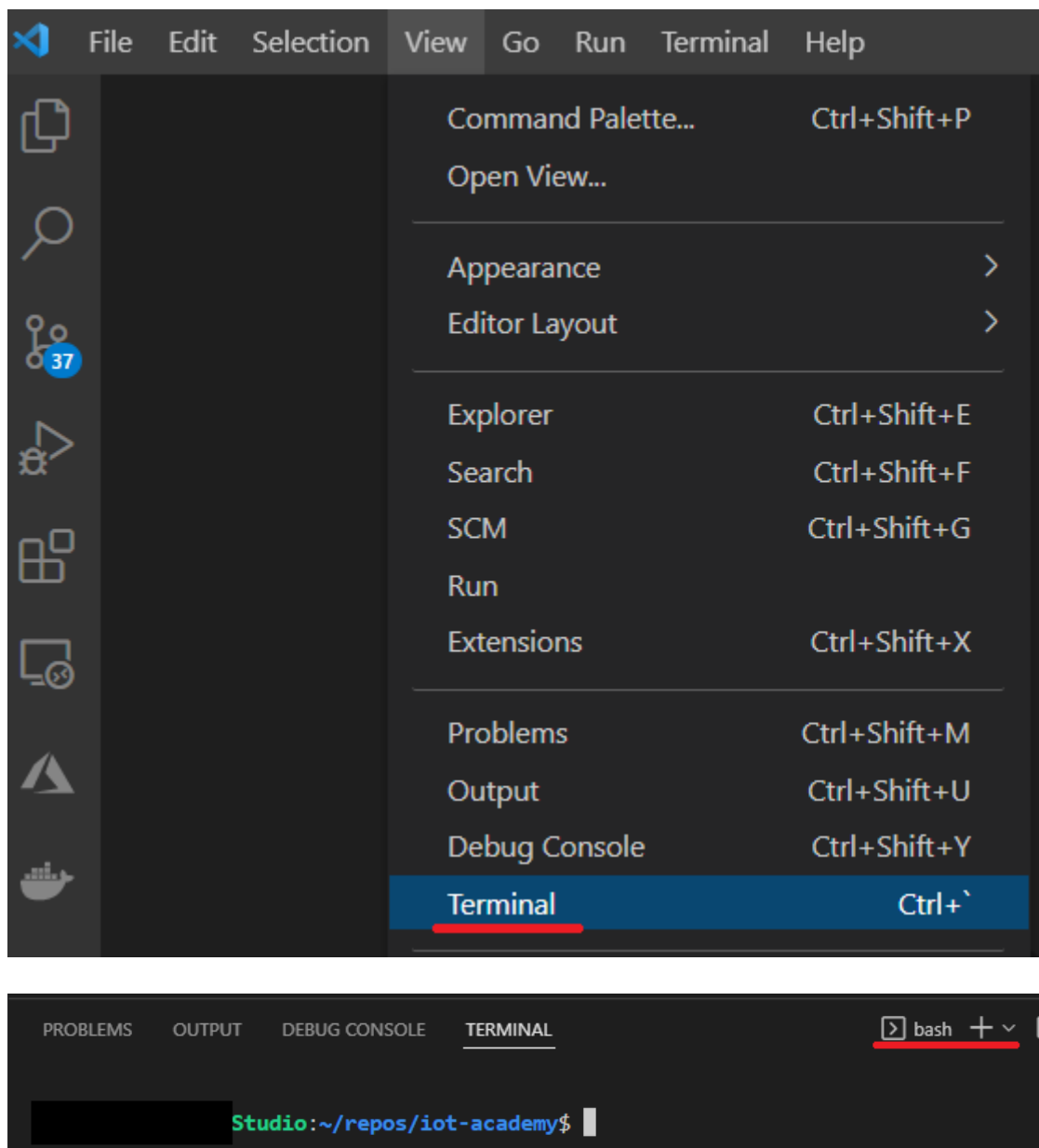
Name *

Port_22 ✓

4. Watch for the notification that the security rule created successfully



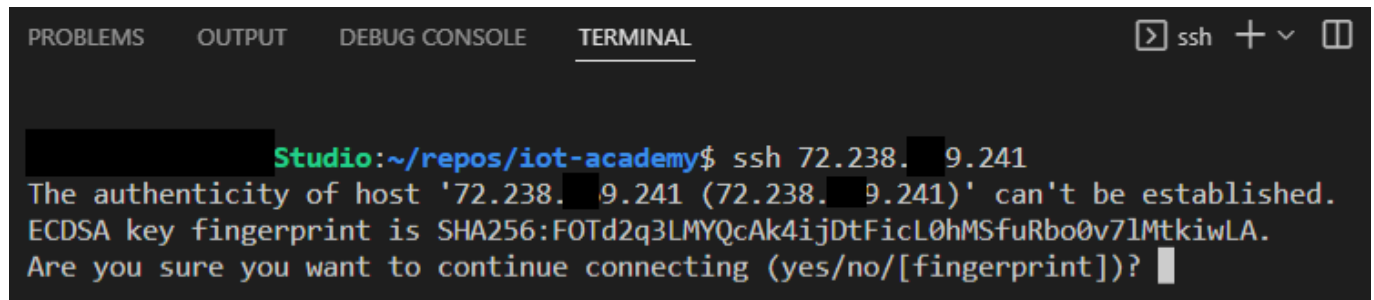
5. Switch to VS Code, use the **View** menu and click **Terminal**



If you don't see a `bash` terminal at the top, click the `+` and click `bash`

6. Enter `ssh iotacademy@{the public IP address of your VM}` and press enter. You saved the VMs public IP address earlier in your notepad. Be sure to not confuse your public IP address with the IP address of the VM. e.g. `ssh iotacademy@20.122.53.2`

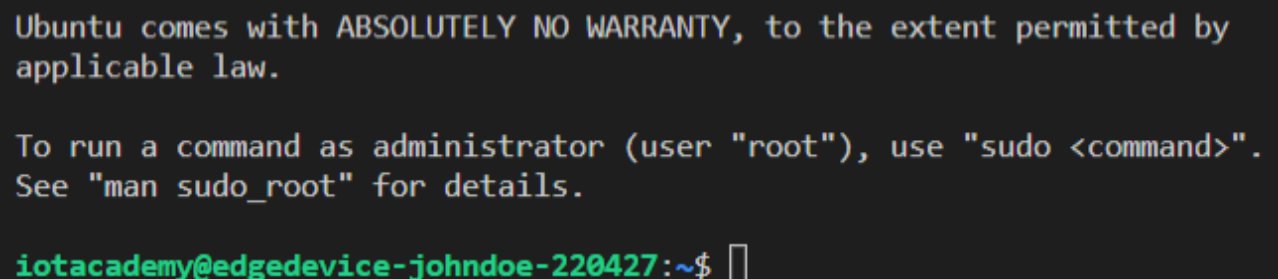
If this is your first time connecting you'll see a prompt asking `Are you sure you want to continue connecting?`. Enter `yes` and press enter.



```
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL [ssh] + - [ ]
Studio:~/repos/iot-academy$ ssh 72.238.19.241
The authenticity of host '72.238.19.241 (72.238.19.241)' can't be established.
ECDSA key fingerprint is SHA256:FOTd2q3LMYQcAk4ijDtFicL0hMSfuRbo0v7lMtkiwLA.
Are you sure you want to continue connecting (yes/no/[fingerprint])?
```

7. Enter your password you defined earlier `MSFTacademy01!` and press enter. The password can be copied to your clipboard and pasted into the terminal by:
 - left clicking on the terminal window once, to focus the window
 - right clicking on the terminal window once, this pastes the clipboard contents

After successfully connecting you'll see the following in your terminal



```
Ubuntu comes with ABSOLUTELY NO WARRANTY, to the extent permitted by
applicable law.

To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.

iotacademy@edgedevice-johndoe-220427:~$
```

Task 4: Install the Azure IoT Edge Runtime and Connect the Device

1. Now logged into the VM, Install the Edge Runtime

Install the repository configuration that matches your device operating system.

```
curl https://packages.microsoft.com/config/ubuntu/18.04/multiarch/prod.list
> ./microsoft-prod.list
```

Copy the generated list to the `sources.list.d` directory.

```
sudo cp ./microsoft-prod.list /etc/apt/sources.list.d/
```

Install the Microsoft GPG public key.

```
curl https://packages.microsoft.com/keys/microsoft.asc | gpg --dearmor >
microsoft.gpg
sudo cp ./microsoft.gpg /etc/apt/trusted.gpg.d/
```

Azure IoT Edge software packages are subject to the license terms located in each package (usr/share/doc/{package-name} or the LICENSE directory). Read the license terms prior to using a package. Your installation and use of a package constitutes your acceptance of these terms. If you do not agree with the license terms, do not use that package.

After successfully running the previous commands you'll see the following results depicted in the diagram.

```
iotacademy@edgedevice-johndoe-220427:~$ curl https://packages.microsoft.com/config/ubuntu
/18.04/multiarch/prod.list > ./microsoft-prod.list
  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left   Speed
100  101  100    101    0     0  1463      0  --:--:-- --:--:-- --:--:--  1463
iotacademy@edgedevice-johndoe-220427:~$ sudo cp ./microsoft-prod.list /etc/apt/sources.li
st.d/
iotacademy@edgedevice-johndoe-220427:~$ curl https://packages.microsoft.com/keys/microsof
t.asc | gpg --dearmor > microsoft.gpg
microsoft.gpg /etc/apt/trusted.gpg.d/  % Total    % Received % Xferd  Average Speed   Time
Time    Time    Current
                                 Dload  Upload   Total   Spent    Left   Speed
100  983  100    983    0     0 20061      0  --:--:-- --:--:-- --:--:-- 20061
iotacademy@edgedevice-johndoe-220427:~$ sudo cp ./microsoft.gpg /etc/apt/trusted.gpg.d/
```

2. Install a Container Engine

Update package lists on your device.

```
sudo apt-get update
```

Install the Moby engine.

```
sudo apt-get install moby-engine
```

3. Install the IoT Edge runtime package

```
sudo apt-get install iotedge
```

4. Edit the IoT Edge config.yaml, updating the provisioning information

- Configure the provisioning section with the information that we saved during the setup of DPS.

```
sudo nano /etc/iotedge/config.yaml
```

- Scroll down to **Manual Provisioning with an IoT Hub connection string** then comment out all the uncommented lines using the # symbol. You may have to use your arrow keys to navigate within Nano.

```
#                                     about the re-provisioning event before shutting down
#
#####

# Manual provisioning with an IoT Hub connection string (SharedAccessKey authentication)
# provisioning:
#   source: "manual"
#   device_connection_string: "<ADD DEVICE CONNECTION STRING HERE>"
#   dynamic_reprovisioning: false

# Manual provisioning with X.509 identity certificate authentication
# provisioning:
#   source: "x509"
```

- Scroll down further to locate the **DPS provisioning with symmetric key attestation** section. Uncomment the section and set the following values. Note: It's important that there are exactly two spaces for indentation used. When working with the template file the # and a space will need to be removed from each line.
 - scope_id: saved in notepad (e.g. 0ne115AEAFD)
 - registration_id: iotacademy, saved in notepad
 - symmetric_key: the primary key saved in notepad

```
# DPS provisioning with symmetric key attestation
provisioning:
  source: "dps"
  global_endpoint: "https://global.azure-devices-provisioning.net"
  scope_id: "0ne005AB0F7"
  attestation:
    method: "symmetric_key"
    registration_id: "iot-academy-edge-device"
    symmetric_key: "XJxLQ..."
  always_reprovision_on_startup: true
  dynamic_reprovisioning: false
```

After making the edits:

- press **Crtl+X** to close the file
- select **Y** to save the changes
- press enter to accept the file name

Now restart your edge daemon

```
sudo systemctl restart iotedge
```


In a few minutes you should receive a **Running** status after executing the following command.

The following command may need to be run several times if enough time has not passed since restarting the IoT Edge runtime.

Periodically re-run the command, for up to 10 minutes.

```
sudo iotedge list
```

```
iotacademy@edge device-acadone-220427:~$ sudo iotedge list
NAME          STATUS      DESCRIPTION      CONFIG
edgeAgent     running    Up 2 minutes     mcr.microsoft.com/azureiotedge-agent:1.1
iotacademy@edge device-acadone-220427:~$
```

Another command that is useful is **check** that is shown below. The **check** command:

- checks the validity of the config.yaml file
- the container engine is functional
- time is correct
- connections to DPS and IoT Hub can be established

```
sudo iotedge check
```

Note that it's normal to have some **warnings** and **errors**

```
iotacademy@edge device-acadone-220427:~$ sudo iotedge check
Configuration checks
-----
✓ config.yaml is well-formed - OK
✓ config.yaml has well-formed connection string - OK
✓ container engine is installed and functional - OK
✓ config.yaml has correct hostname - OK
✓ config.yaml has correct URIs for daemon mgmt endpoint - OK
✓ latest security daemon - OK
✓ host time is close to real time - OK
✓ container time is close to host time - OK
!! DNS server - Warning
    Container engine is not configured with DNS server setting, whi
```

Task 5: Observe the Enrollment and Device Status

1. Head back to the Azure Portal home page
2. Navigate to your DPS instance by searching for **provs** and clicking your instance.
3. Click **Manage Enrollments**
4. Click **Individual Enrollments**
5. Click **iotacademy**

Registration Status

Status: assigned

Assigned hub: `iot-academy-johndoe-vscode-220427.azure-devices.net`

Device ID: `iot-academy-edge-device`

Last assigned: Tue Apr 19 2022 00:41:57 GMT-0400 (Eastern Daylight Time)

Delete Registration

Exercise 4: Deploy an IoT Edge Module to Simulate Device Telemetry

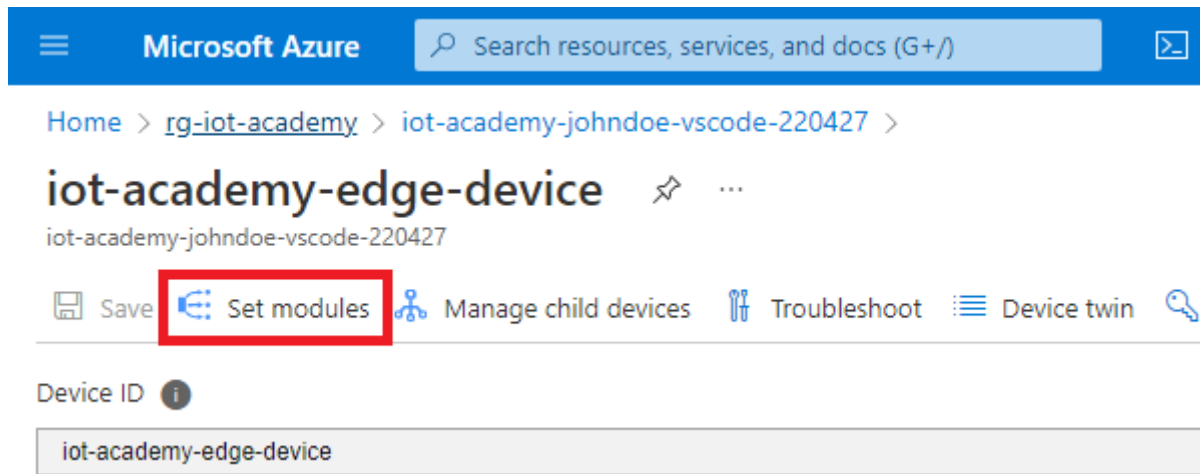
Task 1: Use the IoT Edge Module Marketplace to Provision the Simulated Temperature Sensor Module

1. In Azure Portal, navigate to your IoT Hub created in previous steps, under **Device Management** click **IoT Edge**, then click your Edge Device

The screenshot shows the Azure Portal interface for an IoT Hub. The top navigation bar includes the Microsoft Azure logo and a search bar. Below the navigation bar, the breadcrumb trail is 'Home > rg-iot-academy > iot-academy-johndoe-vscode-220427'. The main heading is 'iot-academy-johndoe-vscode-220427 | IoT Edge'. The left sidebar contains a search bar and a list of navigation options: Overview, Activity log, Access control (IAM), Tags, Diagnose and solve problems, Events, Pricing and scale, Device management, Devices, and IoT Edge. The 'IoT Edge' option is highlighted with a red box. The main content area shows the 'IoT Edge Devices' tab. It includes a 'Device name' input field with the placeholder 'enter device ID' and a 'Find devices' button. Below this are links for '+ Add IoT Edge Device', 'Refresh', and 'Delete'. A table lists the IoT Edge devices with columns for 'Device ID' and 'Runtime'. The device 'iot-academy-edge-device' is highlighted with a red box.

Device ID	Runtime
iot-academy-edge-device	417 --

2. Click **Set Modules**



Microsoft Azure

Search resources, services, and docs (G+)

Home > rg-iot-academy > iot-academy-johndoe-vscode-220427 >

iot-academy-edge-device

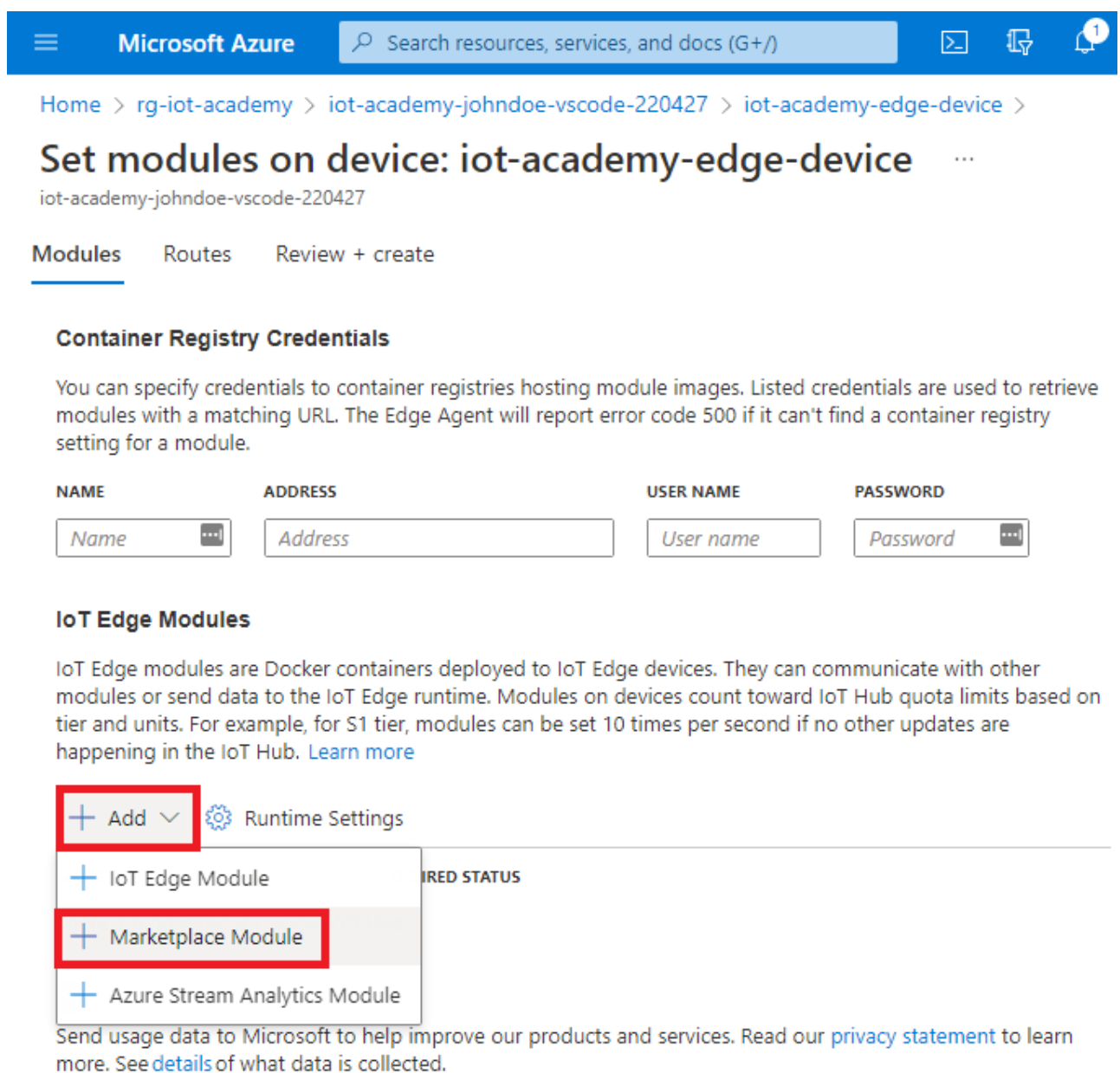
iot-academy-johndoe-vscode-220427

Save Set modules Manage child devices Troubleshoot Device twin

Device ID

iot-academy-edge-device

3. Click **Add**. Then click **Marketplace Module**



Microsoft Azure

Search resources, services, and docs (G+)

Home > rg-iot-academy > iot-academy-johndoe-vscode-220427 > iot-academy-edge-device >

Set modules on device: iot-academy-edge-device

iot-academy-johndoe-vscode-220427

Modules Routes Review + create

Container Registry Credentials

You can specify credentials to container registries hosting module images. Listed credentials are used to retrieve modules with a matching URL. The Edge Agent will report error code 500 if it can't find a container registry setting for a module.

NAME	ADDRESS	USER NAME	PASSWORD
<input type="text" value="Name"/>	<input type="text" value="Address"/>	<input type="text" value="User name"/>	<input type="password" value="Password"/>

IoT Edge Modules

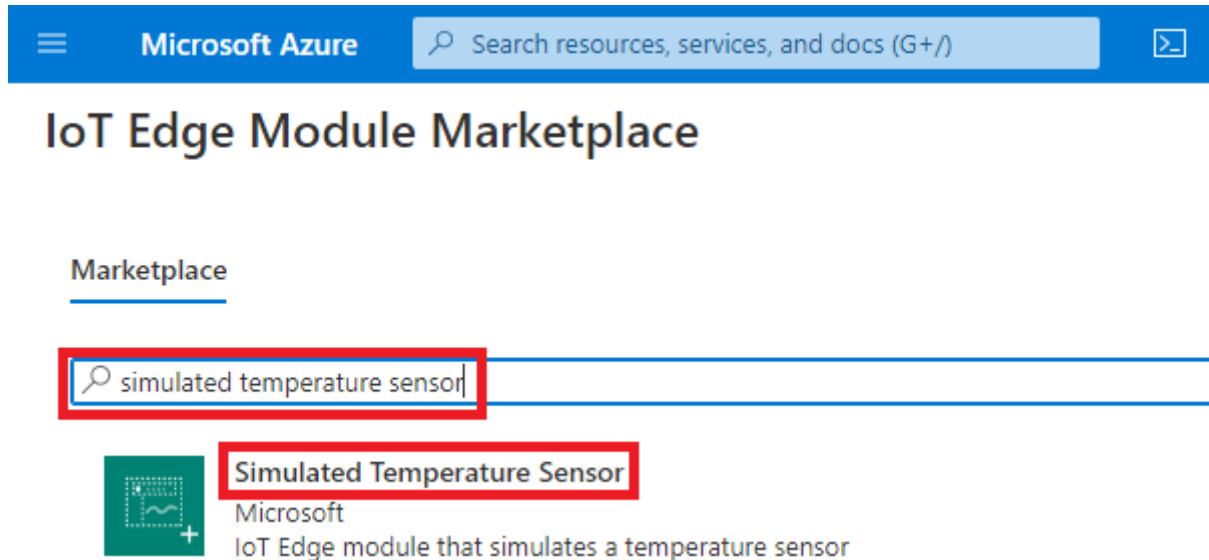
IoT Edge modules are Docker containers deployed to IoT Edge devices. They can communicate with other modules or send data to the IoT Edge runtime. Modules on devices count toward IoT Hub quota limits based on tier and units. For example, for S1 tier, modules can be set 10 times per second if no other updates are happening in the IoT Hub. [Learn more](#)

+ Add Runtime Settings

- + IoT Edge Module
- + Marketplace Module
- + Azure Stream Analytics Module

Send usage data to Microsoft to help improve our products and services. Read our [privacy statement](#) to learn more. See [details](#) of what data is collected.

4. The search box will appear, type **Simulated Temperature Sensor**, Then click the module to add it



Microsoft Azure

Search resources, services, and docs (G+)

IoT Edge Module Marketplace

Marketplace

simulated temperature sensor

Simulated Temperature Sensor
Microsoft
IoT Edge module that simulates a temperature sensor

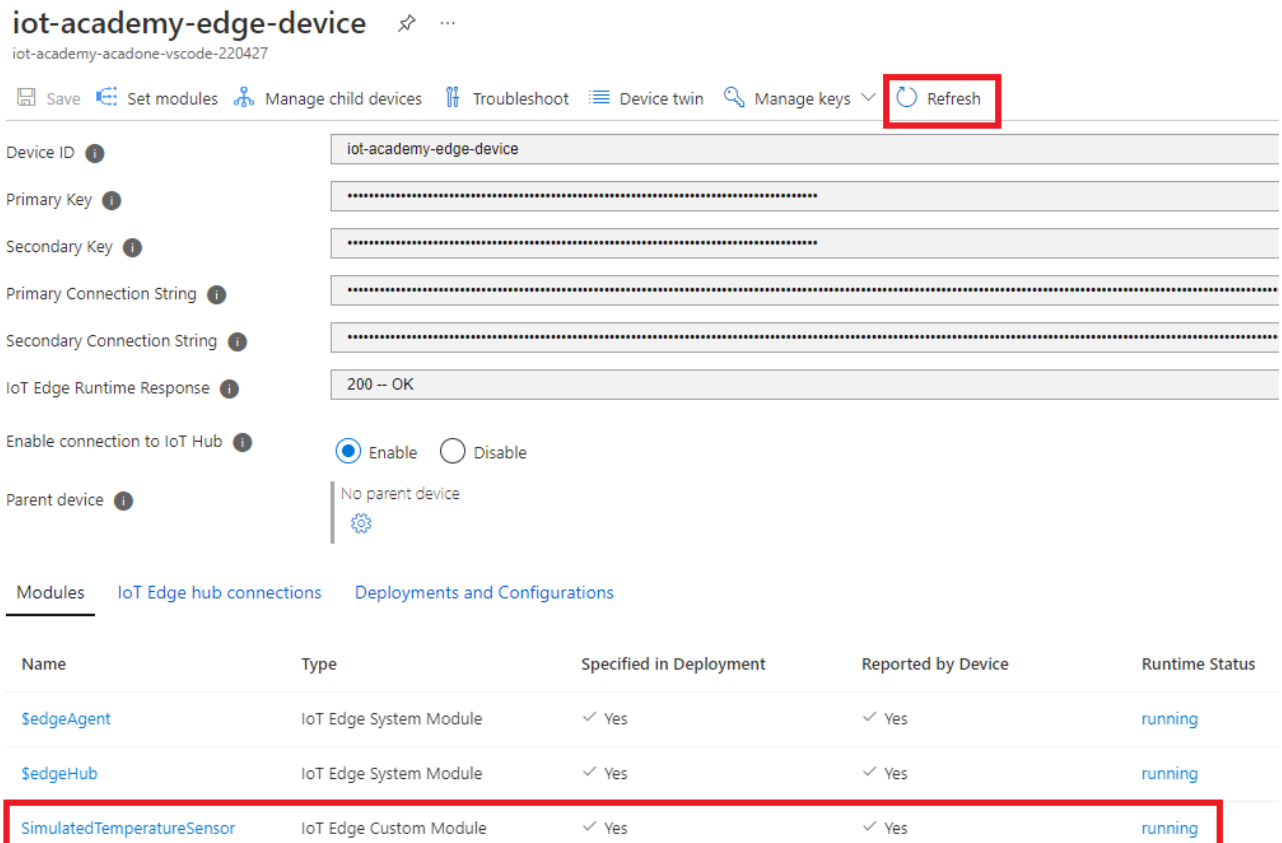
5. Review the presentation section **Routes** to learn about IoT Edge routing
6. Click **Review + create** at the bottom of the pane. Review the available settings for the Deployment
7. After validation passes click **Create** at the bottom of the pane

Task 2: Ensure the Module is Running

Review the running modules on your Edge device

It may take a few minutes for the module to deploy and come to a running state. Running modules can be verified in a few ways:

- On device details review the **Modules** section at the bottom of the pane.



iot-academy-edge-device

iot-academy-acadone-vscode-220427

Save Set modules Manage child devices Troubleshoot Device twin Manage keys Refresh

Device ID: iot-academy-edge-device

Primary Key:

Secondary Key:

Primary Connection String:

Secondary Connection String:

IoT Edge Runtime Response: 200 -- OK

Enable connection to IoT Hub: ☒ Enable ☐ Disable

Parent device: No parent device

Modules IoT Edge hub connections Deployments and Configurations

Name	Type	Specified in Deployment	Reported by Device	Runtime Status
SedgeAgent	IoT Edge System Module	✓ Yes	✓ Yes	running
SedgeHub	IoT Edge System Module	✓ Yes	✓ Yes	running
SimulatedTemperatureSensor	IoT Edge Custom Module	✓ Yes	✓ Yes	running

The **Refresh** button can also be used to get the latest status rather than refreshing the page.

- Using SSH, connect to your VM and run the `iotedge list` command as shown below

```
sudo iotedge list
```

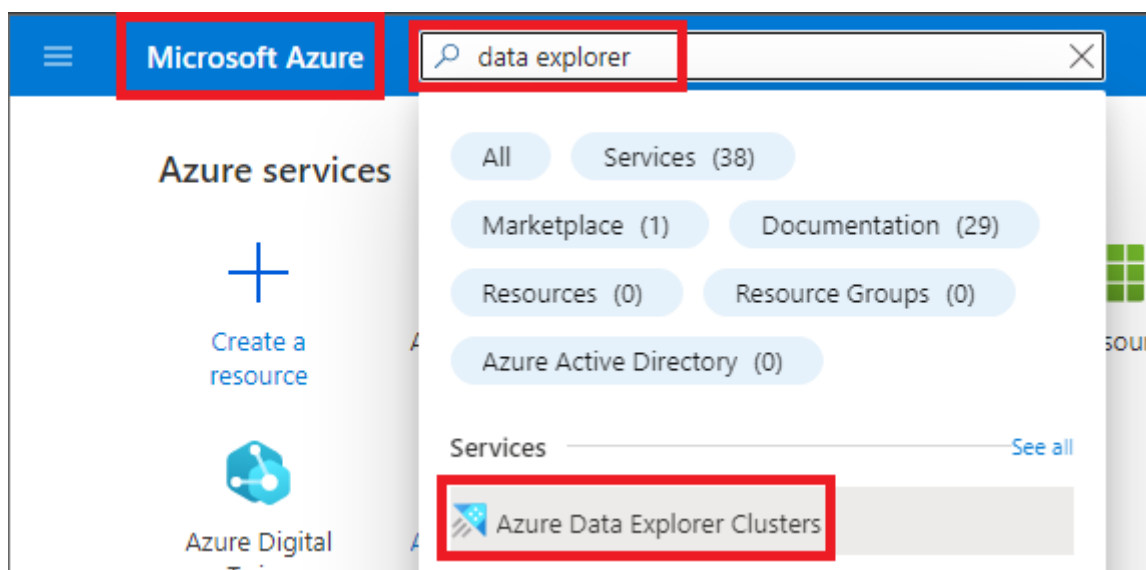
```
iotacademy@edge device-johndoe-220427:~$ sudo iotedge list
NAME                                STATUS      DESCRIPTION      CONFIG
SimulatedTemperatureSensor         running     Up 6 minutes     mcr.mic
edgeAgent                          running     Up 9 hours       mcr.mic
edgeHub                            running     Up 5 minutes     mcr.mic
iotacademy@edge device-johndoe-220427:~$
```

Exercise 5: Ingesting Telemetry Data with IoT Hub and Azure Data Explorer (ADX)

Task 1: Creating the ADX Cluster

- Find the Azure Data Explorer service to create a new cluster

- Go to the Azure Portal home page by selecting **Microsoft Azure** at the top of the window. Then click **Azure Data Explorer Clusters**



- Click **Create**
- Enter the details for the new ADX cluster then click **Review + create**
 - Details
 - Resource group: `rg-iot-academy`
 - Cluster name: `{prefix|iot|acad|johnd|220427}` e.g. `deciotacadjohnd220427`. This name must be globally unique, alphanumeric only, limited to 22 characters.
 - Region: `{Your region}` e.g. `East US 2`
 - Workload: `Dev/test`

- Compute specifications: `Dev(No SLA)_Standard_E2a_v4`
- Availability Zones: uncheck all options. Availability zones provide resiliency, most often for production systems.

Microsoft Azure

Search resources, services, and docs (G+/)

[Home](#) > [Azure Data Explorer Clusters](#) >

Create an Azure Data Explorer Cluster ...

* Basics

Scale

Configurations

Security

Network

Diagnostic settings

Tags

Review + create

PROJECT DETAILS

Select the subscription to manage deployed resources and costs. Use resource groups like folders to organize and manage all your resources.

Subscription *

Azure subscription 1

Resource group *

rg-iot-academy

Create new

CLUSTER DETAILS

Cluster name *

deciotacadone220427

Region *

East US 2

COMPUTE SPECIFICATION

Workload *

Dev/test

Size

Compute specifications *

Dev(No SLA)_Standard_E2a_v4

Select from all options

Availability zones

(none)

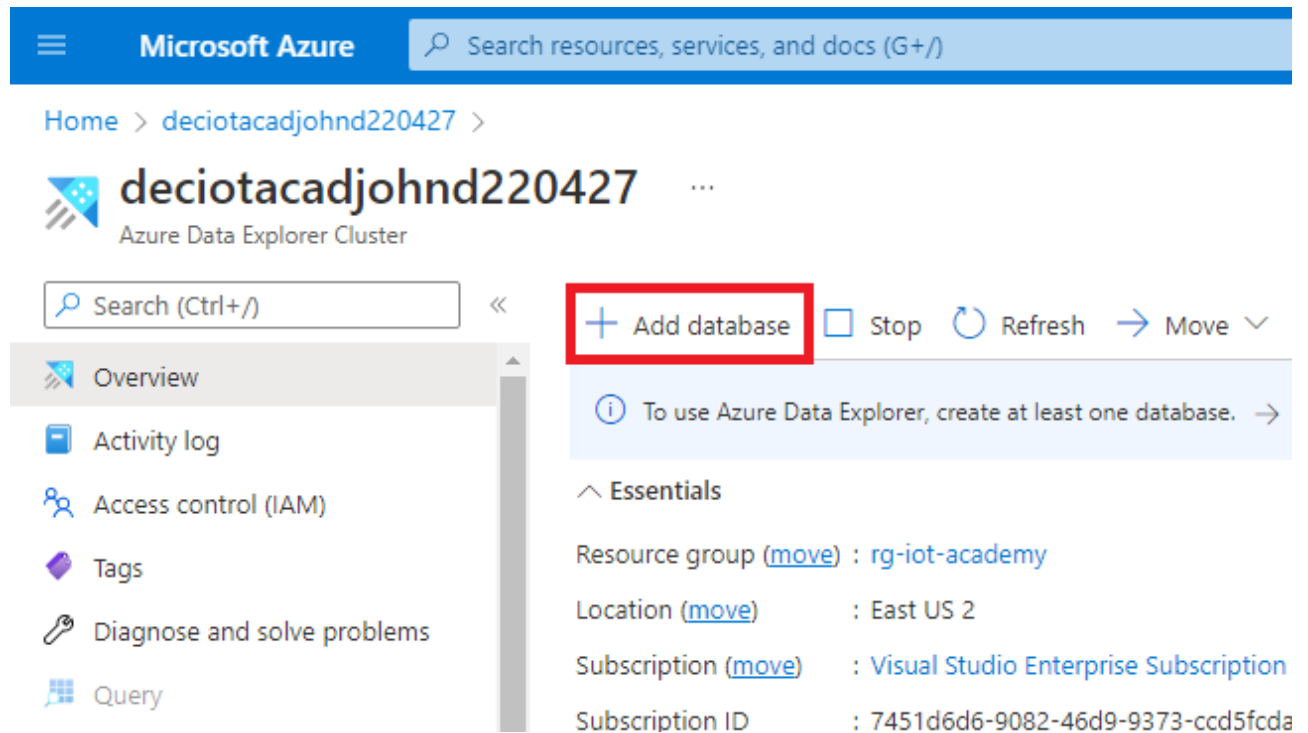
Review + create

Next : Scale >

- After validation passes click **Create**
- Wait until the cluster is created, which may take ~5-10 minutes, and click **Go to resource**

Task 2: Adding an ADX Database

1. Now on the Overview tab for your new ADX cluster click **Add database**



Microsoft Azure Search resources, services, and docs (G+)

Home > deciotacadjohnd220427 >

deciotacadjohnd220427 ...
Azure Data Explorer Cluster

Search (Ctrl+/) << **+ Add database** ☐ Stop Refresh → Move ▾

To use Azure Data Explorer, create at least one database. →

^ Essentials

Resource group ([move](#)) : rg-iot-academy

Location ([move](#)) : East US 2

Subscription ([move](#)) : Visual Studio Enterprise Subscription

Subscription ID : 7451d6d6-9082-46d9-9373-ccd5fcda

Overview

Activity log

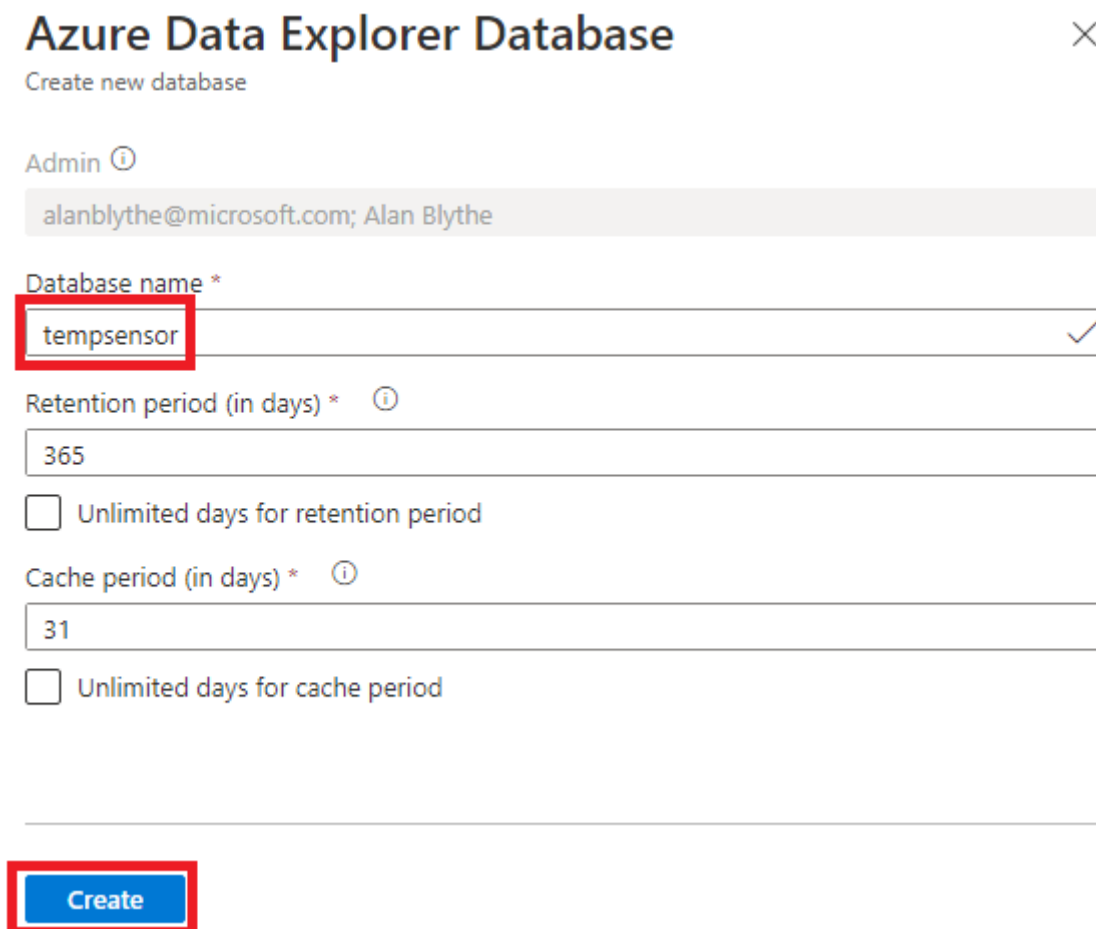
Access control (IAM)

Tags

Diagnose and solve problems

Query

2. Click **Create**



Azure Data Explorer Database

Create new database

Admin ⓘ

alanblythe@microsoft.com; Alan Blythe

Database name *

tempsensor ✓

Retention period (in days) * ⓘ

365

☐ Unlimited days for retention period

Cache period (in days) * ⓘ

31

☐ Unlimited days for cache period

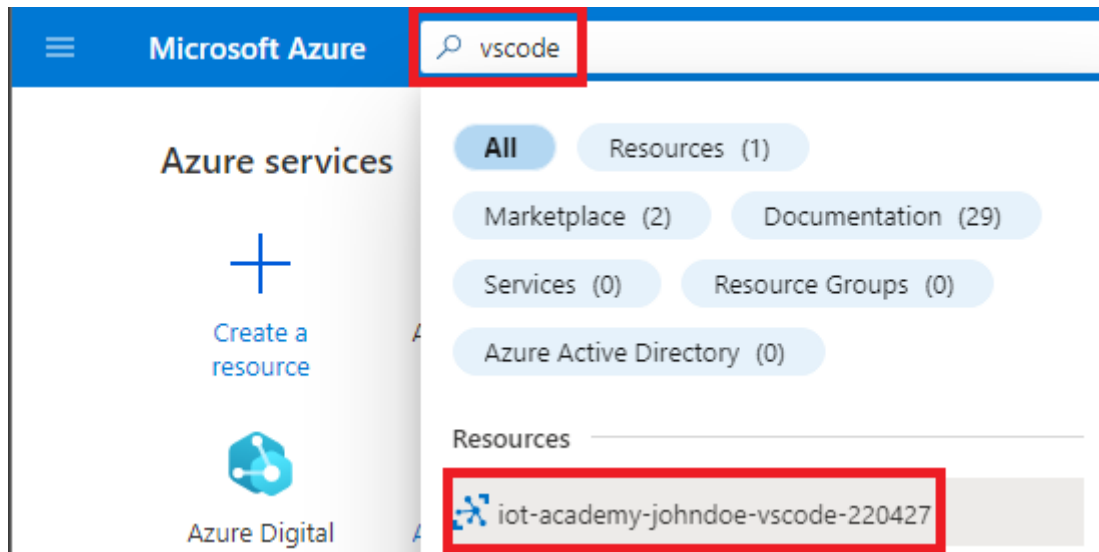
Create

- After a few moments you'll be back at the overview page.

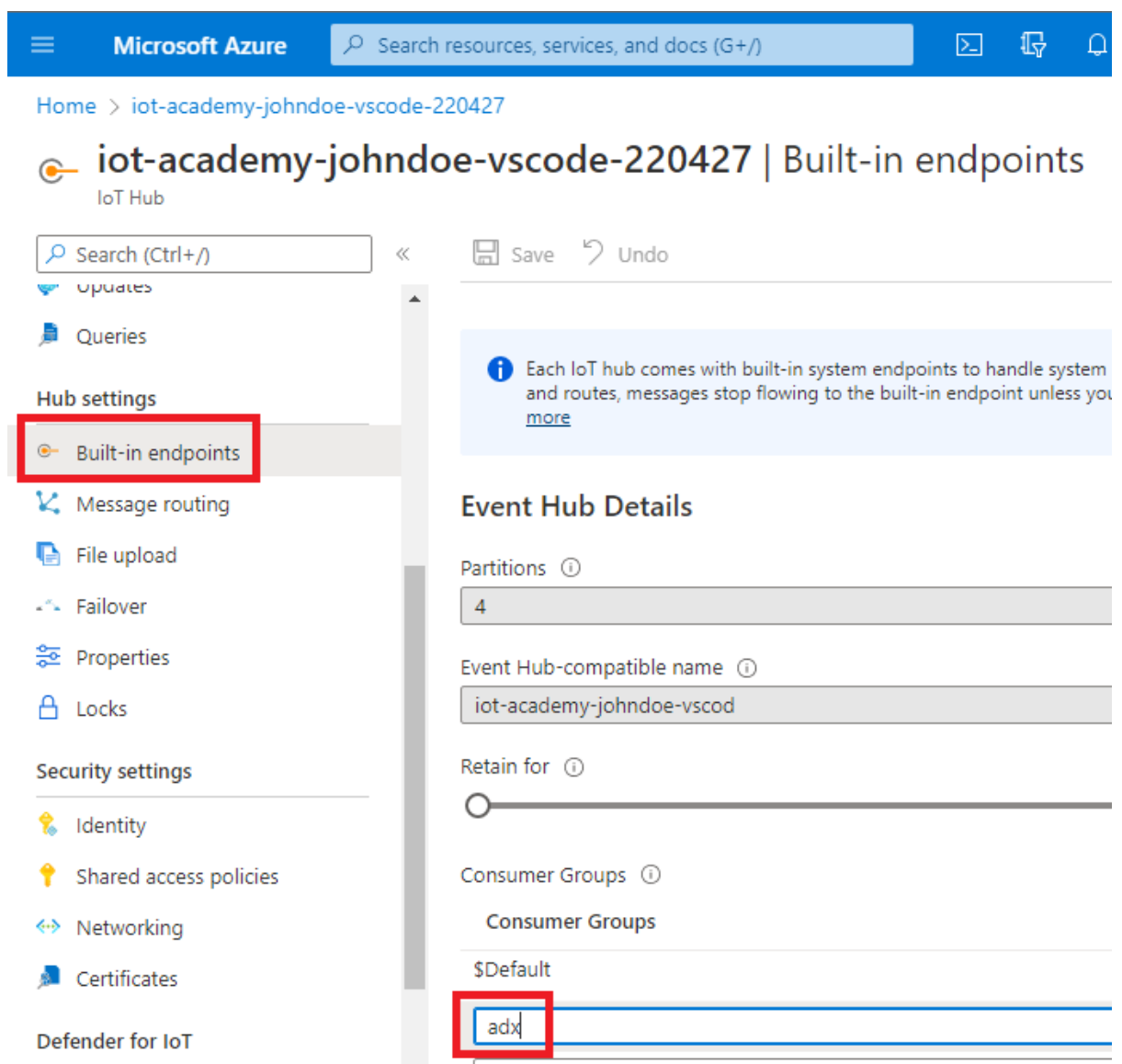
Task 3: Creating the tempsensor table

Create the tempsensor table with schema and mapping

- Use the Azure Portal search bar, type `vscode`. Your IoT Hub instance will be shown. Click your IoT Hub name to navigate to the resource.




- Click **Built-in endpoints**. Add a new consumer group under the **Consumer Groups** section. Type `adx` in the box and press tab. When you press tab your entry will be saved.

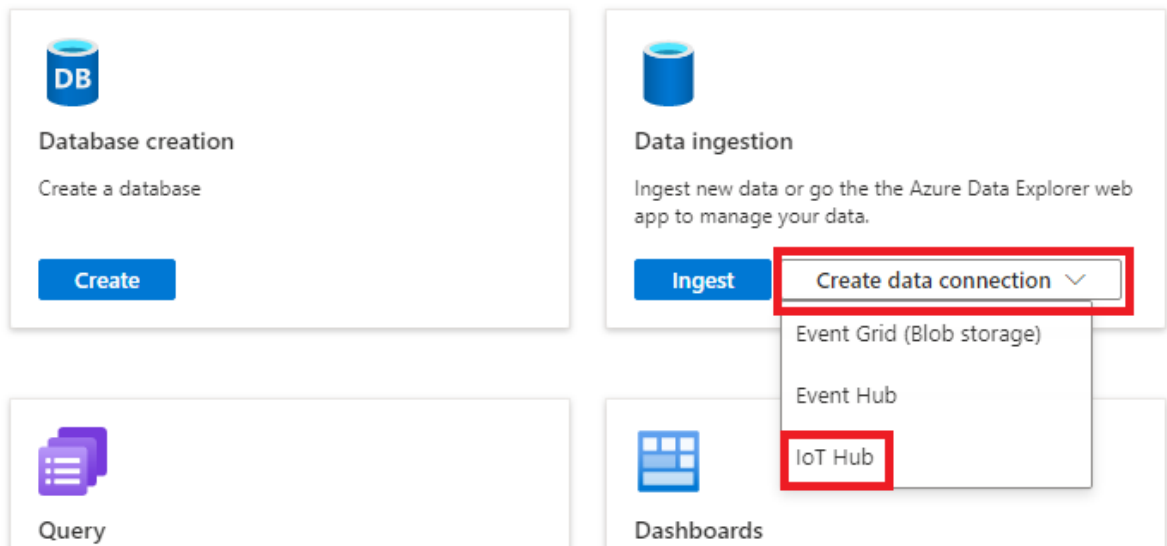


2. Create a data connection to ingest your tempsensor telemetry data

- Use the Azure Portal search bar to search for **dec**, the standard prefix for Azure Data Explorer resources. Then, click your instance to load the resource.
- Click **Create data connection** and select IoT Hub.

Get started with Azure Data Explorer

Use the Azure Data Explorer web app to manage your data easily. [Learn more](#) 



- Fill in all the fields as follows:
 - Data connection name: **tempsensor**
 - Subscription: {Your subscription}
 - IoT Hub: {Your IoT Hub that includes vscode in the name}
 - Shared Access Policy: {iothubowner}
 - Consumer Group: **adx**
 - Event system properties: Click the dropdown and select **iothub-connection-device-id**
 - Database Name: **tempsensor**
 - Table name: **tempsensor**
 - Data format: **JSON**
 - Mapping name: **tempsensorMapping**
- Click **Create**

IoT Hub



Data connection name *	<input type="text" value="tempsensor"/>
Subscription *	<input type="text" value="Visual Studio Enterprise Subscription"/>
IoT Hub *	<input type="text" value="iot-academy-johndoe-vscode-220427"/>
Shared Access Policy *	<input type="text" value="iothubowner"/>
Consumer group *	<input type="text" value="adx"/>
Event system properties	<input type="text" value="iothub-connection-device-id"/>
Database Name *	<input type="text" value="tempsensor"/>

Data routing settings

Allow routing the data to other databases (Multi database data connection) ☒ Don't allow

Target table

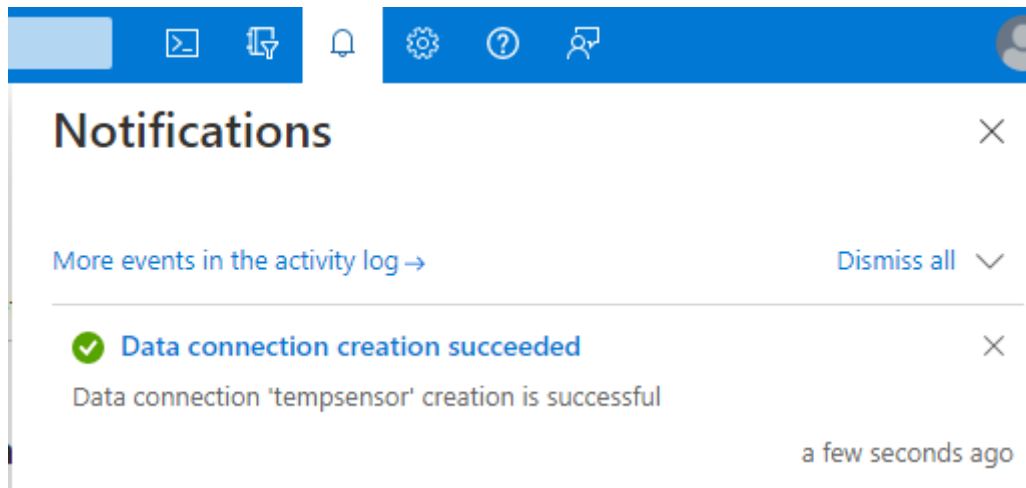
This is the default table routing setup. If you don't configure the table settings here, you'll need to configure them using Event Properties for the ingestion to succeed. The table Event Properties settings overrides the default table settings configured here. [Learn more](#)

Table name	<input type="text" value="tempsensor"/>
Data format	<input type="text" value="JSON"/>
Mapping name	<input type="text" value="tempsensorMapping"/>

This is a preview version of IoT Hub data connection. This version does not support IoT Hub manual-failover. In such cases, please recreate the data connection.

Create

- Watch for the notification for when the data connection creation is successful.



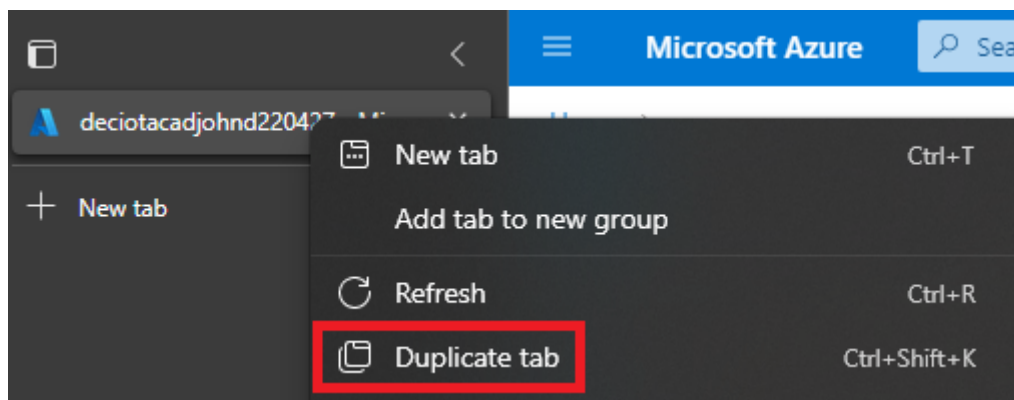
Exercise 6: Analyzing Data with Azure Data Explorer (ADX)

Task 1: Connecting ASA to IoT Hub

1. Restart the temperature sensor module to ensure fresh telemetry is flowing

The **Simulated Temperature Sensor** module sends 500 telemetry messages, once every 5 seconds. This means ~40 minutes worth of messages. As our lab takes some time to work through we'll restart the module to ensure we have plenty of data to analyze with ADX.

- Create a 2nd browser tab to have both ADX and IoT Hub open in the Azure Portal. Right click the browser tab and click **Duplicate tab**.

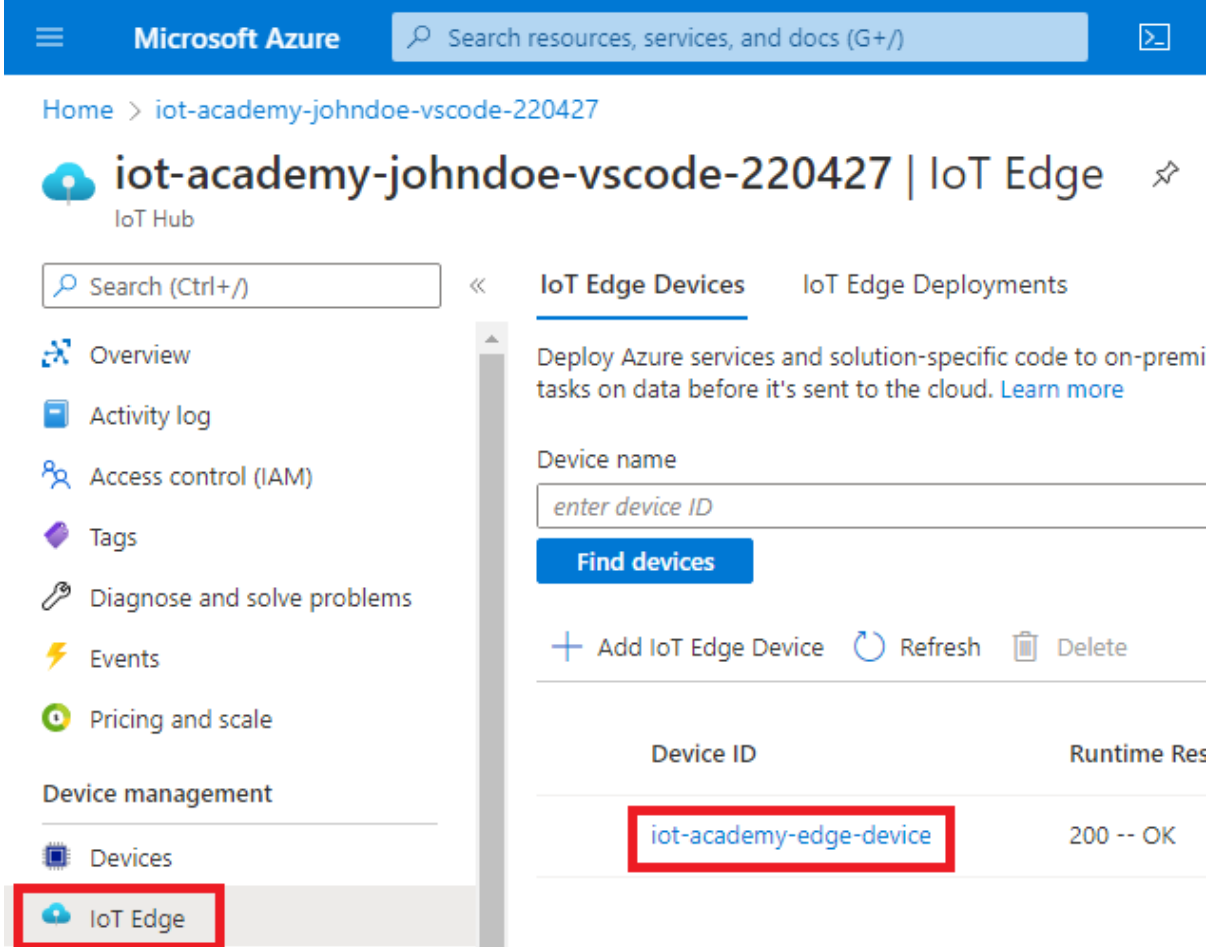


- Switch to your 2nd tab, then click Microsoft Azure at the top of window to take you to the home page.
- In your recent resources click your IoT Hub instance such as **iot-academy-johndoe-vscode-220427**

Recent resources

Name	Type
 tempsensor (deciotacadjohnd220427/tempsensor)	Azure Data Explorer Database
 deciotacadjohnd220427	Azure Data Explorer Cluster
 iot-academy-johndoe-vscode-220427	IoT Hub

- Click **IoT Edge**, then click your device **iot-academy-edge-device**



Microsoft Azure Search resources, services, and docs (G+)

Home > iot-academy-johndoe-vscode-220427

iot-academy-johndoe-vscode-220427 | IoT Edge

IoT Hub

Search (Ctrl+)

Overview
Activity log
Access control (IAM)
Tags
Diagnose and solve problems
Events
Pricing and scale

Device management

Devices
IoT Edge

IoT Edge Devices IoT Edge Deployments

Deploy Azure services and solution-specific code to on-prem tasks on data before it's sent to the cloud. [Learn more](#)

Device name

Find devices

+ Add IoT Edge Device Refresh Delete

Device ID	Runtime Res
iot-academy-edge-device	200 -- OK

- Click the **Simulated Temperature Sensor** module at the bottom of the window

Modules IoT Edge hub connections Deployments and Configurations		
Name	Type	Specified
\$edgeAgent	IoT Edge System Module	✓ Yes
\$edgeHub	IoT Edge System Module	✓ Yes
SimulatedTemperatureSensor	IoT Edge Custom Module	✓ Yes

- Click the **Troubleshoot** at the top of the window

The screenshot shows the Microsoft Azure portal interface. At the top, there's a blue header with the Microsoft Azure logo and a search bar. Below the header, the breadcrumb trail reads: Home > iot-academy-acadone-vscode-220427 > iot-academy-edge-device >. The main heading is 'IoT Edge Module Details' with a star icon and a menu icon. Below the heading, the module name 'SimulatedTemperatureSensor' is displayed. A row of buttons includes 'Module Identity Twin', 'Direct method', 'Refresh', and 'Troubleshoot'. The 'Troubleshoot' button is highlighted with a red rectangular box. Below the buttons, the 'Module Identity Name' is shown as 'iot-academy-edge-device/SimulatedTem' and the 'Primary key' is shown as a masked string of asterisks.

- Click **Restart Simulated Temperature Sensor** Notice the status that's received **Initializing simulated temperature sensor to send 500 messages, at an interval of 5 seconds**

The screenshot shows the 'Troubleshoot' page for the 'SimulatedTemperatureSensor' module. The page title is 'Troubleshoot' with a menu icon. Below the title, the module name 'SimulatedTemperatureSensor' is displayed. A row of buttons includes 'Restart SimulatedTemperatureSensor', 'Refresh', and 'Download'. The 'Restart SimulatedTemperatureSensor' button is highlighted with a red rectangular box. Below the buttons, there's a dropdown menu showing 'SimulatedTemperatureSensor' and two buttons: 'Time range: Since 15 minutes' and 'Find: Not specified'. The main content area shows the following log messages:


```

SimulatedTemperatureSensor Main() finished.
[2022-04-15 03:14:45 : Starting Module
SimulatedTemperatureSensor Main() started.
Initializing simulated temperature sensor to send 500 messages, at an interval of 5 seconds.
To change this, set the environment variable MessageCount to the number of messages that should be sent (set it to -1
[Information]: Trying to initialize module client using transport type [Amqp_Tcp_Only].
    
```

 At the bottom, it says 'Retrieved 6 line(s)'.

2. Review the data received by ADX

- Click your 1st browser tab where ADX is still loaded.
- Click **Query** and enter the following query. Also, click the >> and ensure the **tempsensor** database scope is selected.

```

tempsensor
| order by timeCreated desc
| limit 10
  
```

deciotacadjohnd220427 | Query

Search (Ctrl+/)

Overview

Activity log

Access control (IAM)

Tags

Diagnose and solve problems

Query

Open in Web UI

Filter...

deciotacadjohnd220427

tempensor

tempensor

```

1 tempensor
2 order by timeCreated desc
3 limit 10

```

Run @deciotacadjohnd220427.eas...

- Click the **Run** button. If you're used to SQL don't press F5 as it will refresh your browser.

Table 1 Stats Search Done (0.115 s)

	timeCreated	temperature	humidity
>	2022-04-15 03:19:48.0580	21.218185964...	24
>	2022-04-15 03:19:43.0330	21.403753288...	26
>	2022-04-15 03:19:38.0110	20.953964428...	24
>	2022-04-15 03:19:32.9880	20.757084664...	24
>	2022-04-15 03:19:27.9650	20.723877524...	24

Exercise 7: Processing Telemetry with Azure Stream Analytics (ASA)

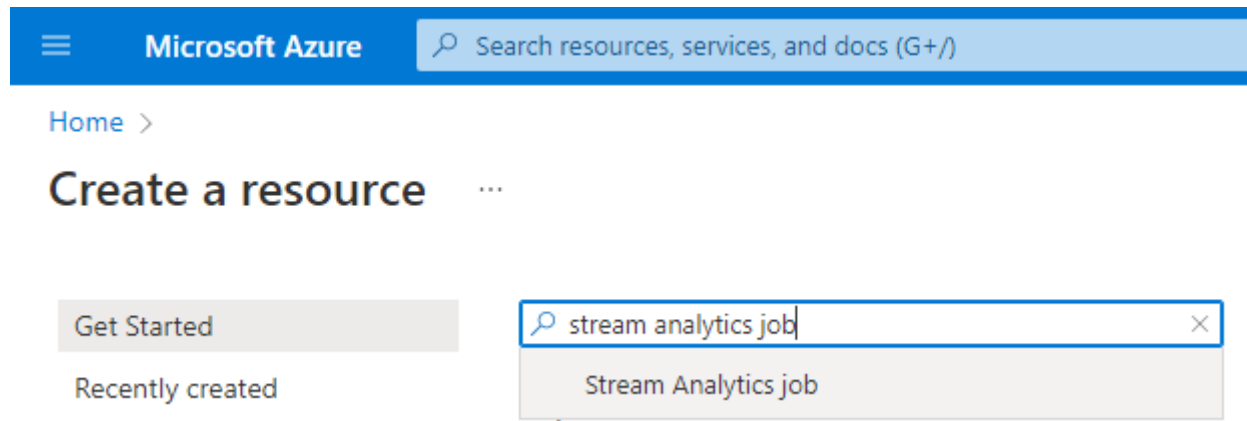
Task 1: Create a Table in ADX to Hold aggregated data

- Replace the contents of the query window with the create table statement below.
- Create a new table named `tempsensoragg` in the `tempensor` database. Reference Exercise 5 - Task 3 if help is needed.

```
.create table tempsensoragg (WindowEnd: datetime, AverageTemperature: real)
```

Task 2: Create a new ASA Job

- Go to the Azure Portal home page
- Click **Create a resource**
- Search for `stream analytics job`



4. Click **Stream Analytics job**


5. Click **Create**

6. Enter the details for the job:

- Job name: **asajob-tempagg**
- Resource group: **rg-iot-academy**
- Location: your region e.g. **East US 2**
- Hosting environment: **Cloud**
- Streaming units: **1**

[Home](#) > [Create a resource](#) > [Stream Analytics job](#) >

New Stream Analytics job ...

 This will create a new Stream Analytics job. You will be charged according to Azure Stream

Job name *

asajob-tempagg ✓

Subscription *

Visual Studio Enterprise Subscription ✓

Resource group *

rg-iot-academy ✓

[Create new](#)

Location *

East US 2 ✓

Hosting environment ⓘ

Cloud

Edge

Streaming units (1 to 192) ⓘ



3



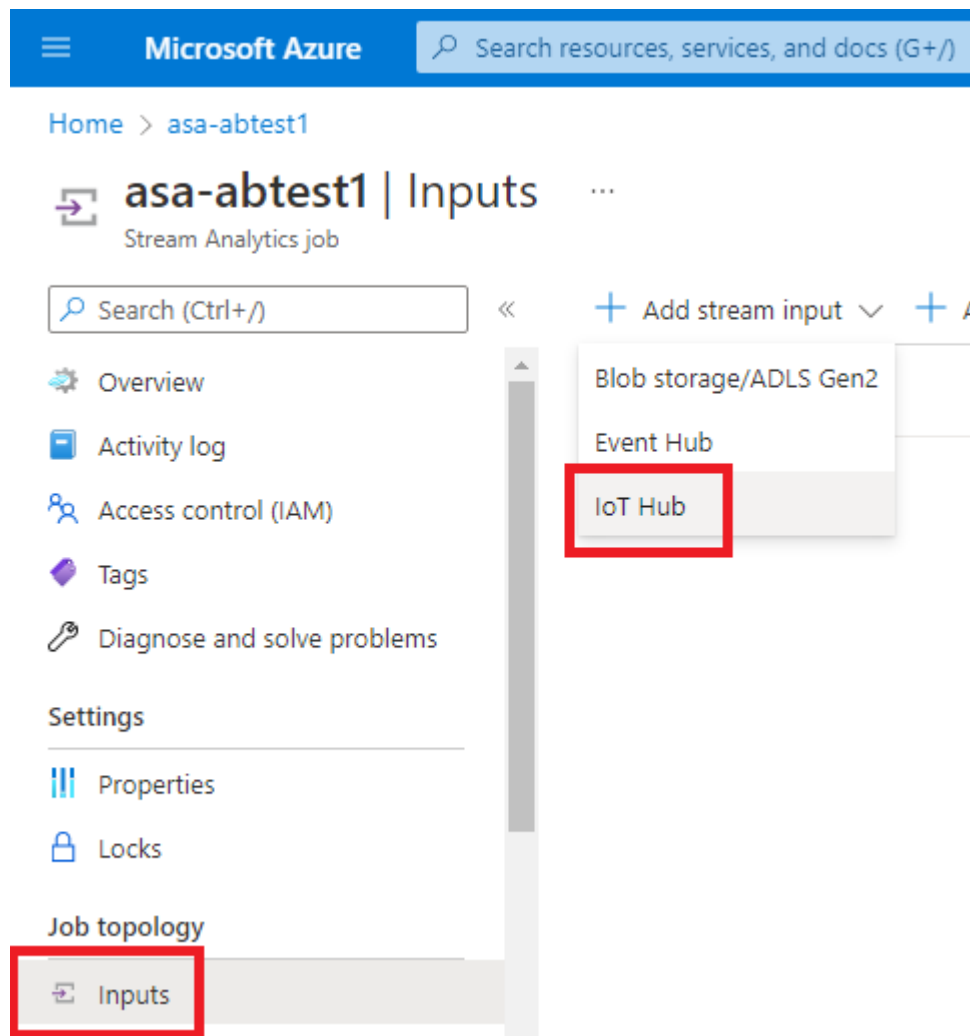
Secure all private data assets needed by this job in my Storage account. ⓘ

Create

7. When the deployment is complete click **Go to resource**

Task 3: Creating an ASA Input

- In another Edge tab navigate to your IoT Hub resource.
- Create a new consumer group named **asa**. Reference Exercise 5 - Task 4 if help is needed.
- Go back to your tab that has your ASA instance.
- Click **Inputs**, Click **Add stream input**, Click **IoT Hub**



- Enter the input details:
 - Subscription: your subscription
 - IoT Hub: your IoT Hub instance
 - Input alias: `vscodeiothub`
 - Consumer group: `asa`
 - Endpoint: `Messaging`
 - All other values: default

IoT Hub

×

New input

Input alias *

vscodeiothub

☐ Provide IoT Hub settings manually

☒ Select IoT Hub from your subscriptions

Subscription

Visual Studio Enterprise Subscription

IoT Hub * ⓘ

iot-academy-johndoe-vscode-220427

Consumer group * ⓘ

asa

Shared access policy name * ⓘ

iothubowner

Shared access policy key ⓘ

.....

Endpoint ⓘ

Messaging

Save

- Click **Save**

Task 4: Creating an ASA Output

1. Click **Outputs**
2. Click **Add**, then click **Azure Data Explorer**

The screenshot shows the Microsoft Azure portal interface. At the top, the Microsoft Azure logo and a search bar are visible. The breadcrumb navigation indicates the path: Home > Stream Analytics jobs > asajob-tempagg. The main heading is 'asajob-tempagg | Outputs', with a subheading 'Stream Analytics job'. Below this is a search bar and a '+ Add' button. The left sidebar contains a list of navigation options: Overview, Activity log, Access control (IAM), Tags, Diagnose and solve problems, Settings, Properties, Locks, Job topology, Inputs, Functions, Query, and Outputs. The 'Outputs' option is highlighted with a red box. The '+ Add' button is also highlighted with a red box, and a dropdown menu is open, showing various output sinks. 'Azure Data Explorer (Preview)' is the first option in the dropdown and is highlighted with a red box. Other options include Azure Function, Azure PostgreSQL (preview), Azure Synapse Analytics, Blob storage/ADLS Gen2, Cosmos DB, Data Lake Storage Gen1, Event Hub, Power BI, Service Bus queue, Service Bus topic, SQL Database, and Table storage. The right side of the screen shows a table with a 'Sink' column.

3. Enter the details as shown below:

- Output alias: `adx`
- Cluster: your cluster created earlier
- Database: your database created earlier
- Table: `tempsensoragg`

Azure Data Explorer (Preview) ×

New output

Output alias *

adx

- ☐ Provide Azure Data Explorer settings manually
- ☒ Select Azure Data Explorer from your subscriptions

Subscription

Visual Studio Enterprise Subscription

Cluster *

deciotacadjohnd220427

Database *

deciotacadjohnd220427/tempsensor

Authentication mode

Create system assigned managed identity

The Monitor and Ingestor role will be granted to the Managed Identity for this Stream Analytics job when you click Save. If grant fails follow the manual grant steps [here](#).

Table *

tempsensoragg

Save

4. Click **Save**

Task 5: Writing an ASA Query

1. Click **Query**
2. Copy and paste the query below into the query window

```
SELECT System.Timestamp() AS WindowEnd, avg(ambient.temperature)
AverageTemperature
INTO adx
FROM vscodeiothub
GROUP BY TumblingWindow(Duration(minute, 1))
```

3. Click **Save query**

Home > Stream Analytics jobs > asajob-tempagg

<> asajob-tempagg | Query

Stream Analytics job

Search (Ctrl+/) << Query language docs Open in Visual Studio Share feedback

Overview

Activity log

Access control (IAM)

Tags

Diagnose and solve problems

Settings

Properties

Locks

Job topology

Inputs

Functions

Query

Inputs (1)

vscodeiothub

Outputs (1)

adx

Test query Save query Discard changes

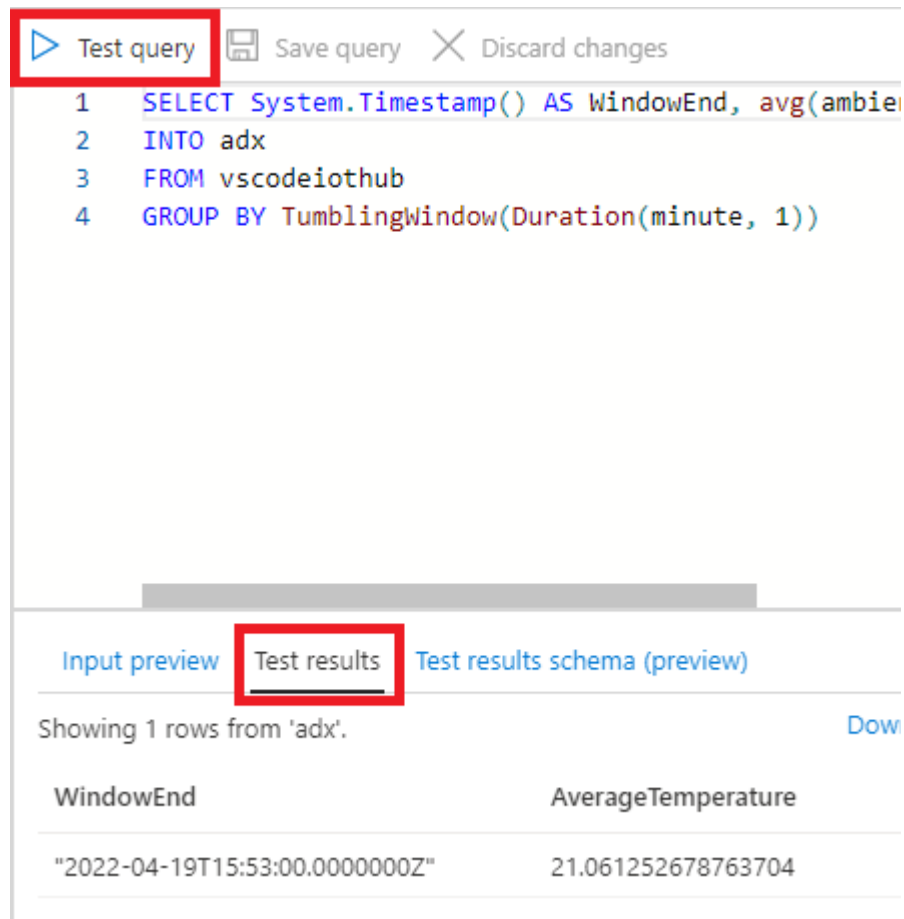
```
1 SELECT System.Timestamp() AS WindowEnd, avg(am
2 INTO adx
3 FROM vscodeiothub
4 GROUP BY TumblingWindow(Duration(minute, 1))
```

Input preview Test results Test results schema (preview)

This input has not been created. Upload a sample file to preview data as

Table {} Raw Upload sample input Download

4. In another Edge tab navigate to your IoT Hub Instance
5. Reset the **SimulatedTemperatureSensor** module as described in Exercise 6 Task 1 to ensure telemetry being sent
6. Now back to your asa job, in the other open Edge tab
7. Click **Test Query**
8. Review the results in the output under the **Test Results** tab



The screenshot shows the Azure Stream Analytics query editor. At the top, there is a toolbar with a 'Test query' button (highlighted with a red box), a 'Save query' button, and a 'Discard changes' button. Below the toolbar, the SQL query is displayed:

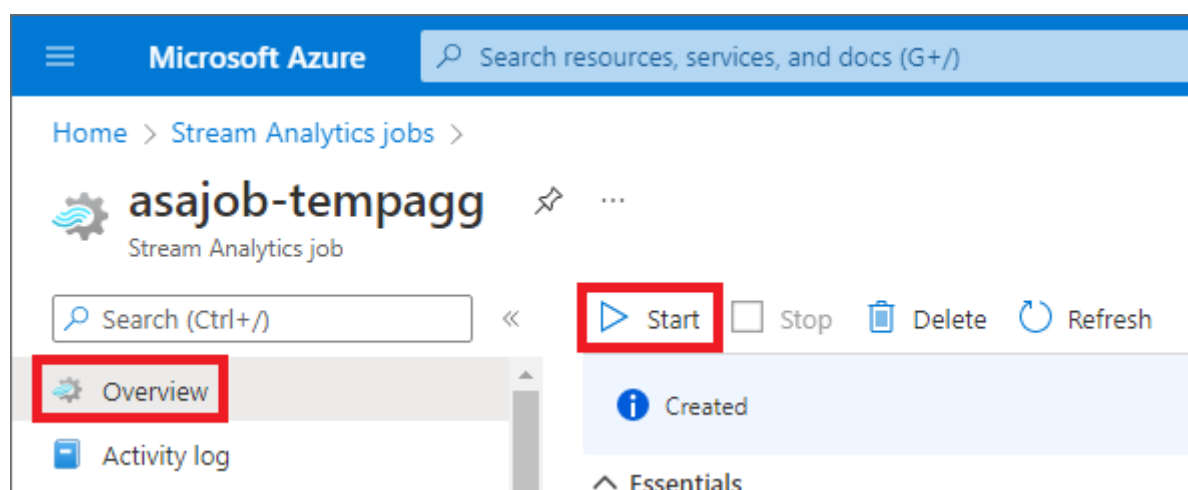
```
1 SELECT System.Timestamp() AS WindowEnd, avg(ambie
2 INTO adx
3 FROM vscodeiothub
4 GROUP BY TumblingWindow(Duration(minute, 1))
```

Below the query, there is a tabbed interface with three tabs: 'Input preview', 'Test results' (highlighted with a red box), and 'Test results schema (preview)'. The 'Test results' tab is active, showing a table with one row of data. The table has two columns: 'WindowEnd' and 'AverageTemperature'.

WindowEnd	AverageTemperature
"2022-04-19T15:53:00.0000000Z"	21.061252678763704

Task 6: Start the ASA Job

1. Go to the **Overview** tab
2. Click **Start**



The screenshot shows the Microsoft Azure portal interface. At the top, there is a search bar and a navigation menu. The main content area displays the 'asajob-tempagg' Stream Analytics job. The 'Overview' tab is selected (highlighted with a red box). In the top right corner of the job details, there is a 'Start' button (highlighted with a red box), a 'Stop' button, a 'Delete' button, and a 'Refresh' button. Below the 'Start' button, there is a 'Created' status indicator. The 'Essentials' section is visible at the bottom.

3. Click **Start** once more

Start job

asajob-tempagg

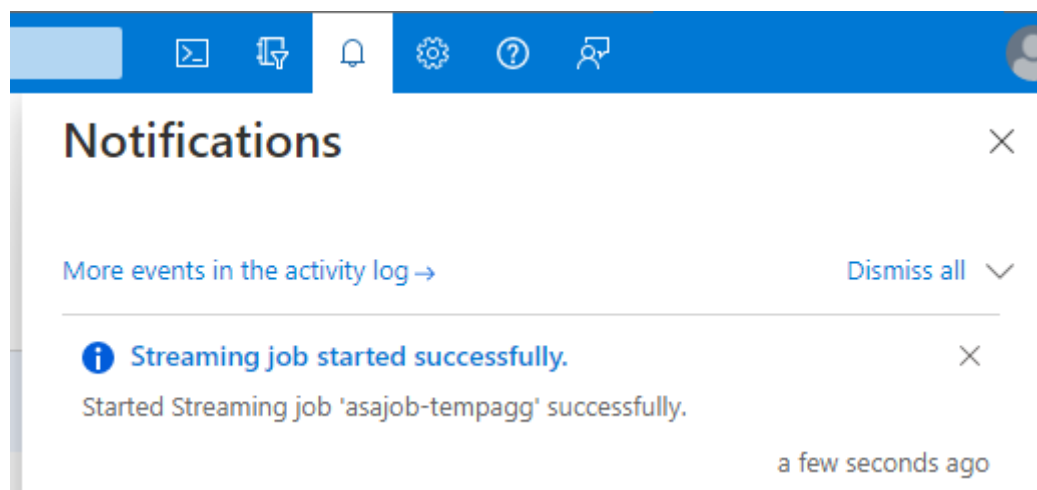
Streaming units ⓘ
1

Environment ⓘ
Standard

Job output start time ⓘ
Now Custom

Start

4. Watch the notification to ensure that the ASA job starts successfully.



Task 7: Review Collected Aggregated in ADX

1. Navigate to your ADX resource in another Edge tab
2. Click **Query**
3. Enter the query below

```
tempsensoragg  
| take 10  
| order by WindowEnd desc
```

4. Click **Run**
5. Continue clicking **Run** occasionally for 10 - 15 minutes until you see your data appear in the results as shown

» ▶ Run ⌂ Recall

Scope: @deciotacadjohnd220427.eastus2/tempsensor

```
1 tempsensoragg
2 | take 10
3 | order by WindowEnd desc
4
```

Table 1

Stats

Search

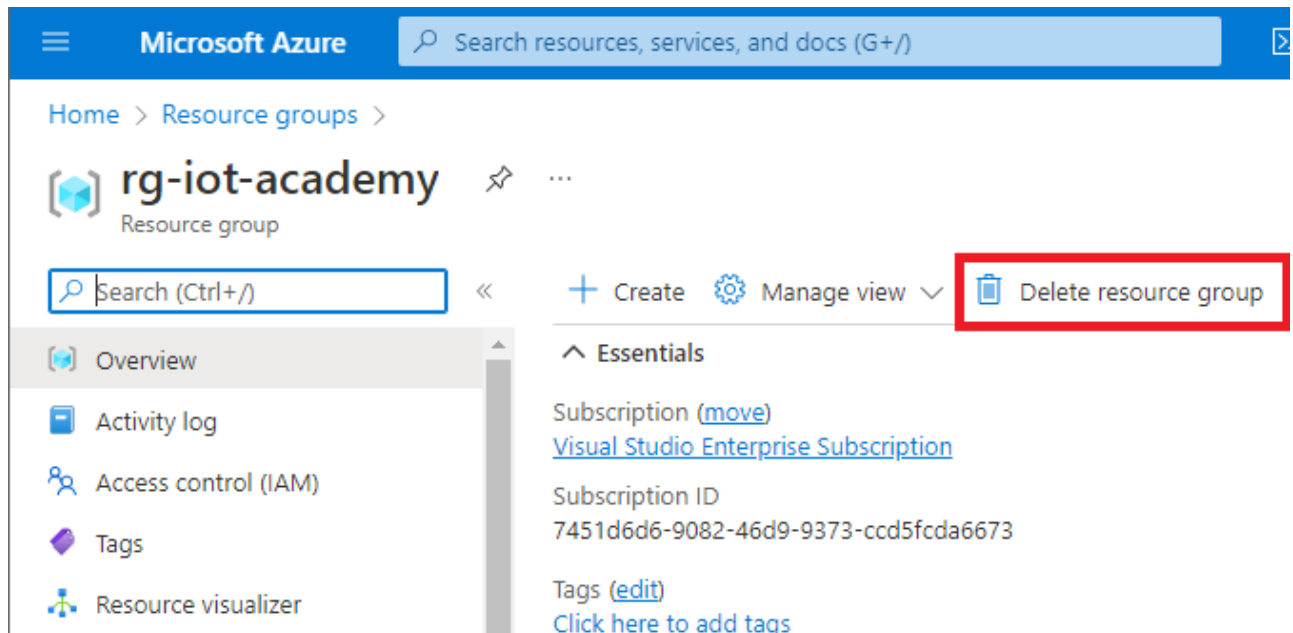
Done (0.0)

WindowEnd	AverageTemperature
> 2022-04-19 16:11:00.0000	20.970335464483906
> 2022-04-19 16:10:00.0000	20.986772362291862
> 2022-04-19 16:09:00.0000	20.88382356519213
> 2022-04-19 16:08:00.0000	21.055750912391776

Exercise 8: Cleanup

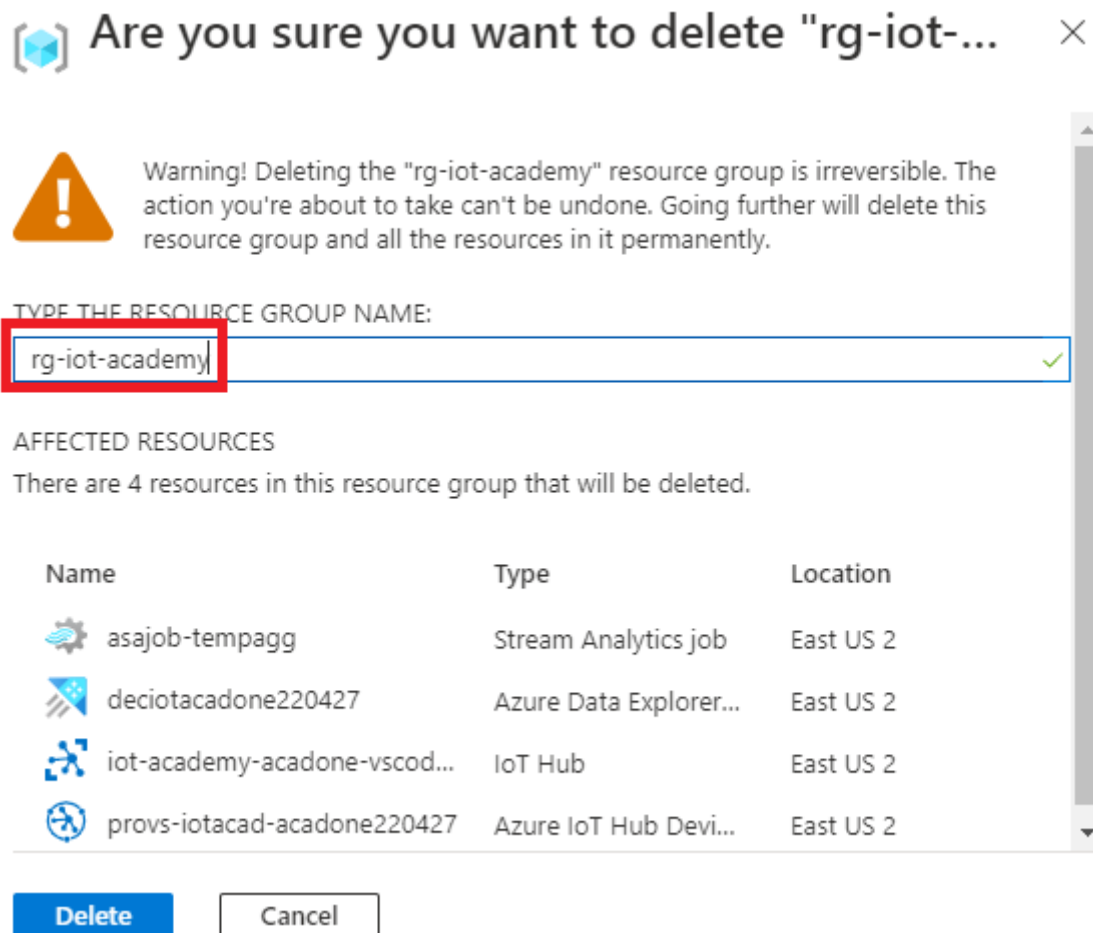
It's important to not leave your Azure resources provisioned until the next Azure IoT Academy session as there may not be enough Azure credit for the next sessions.

1. Navigate to the Azure Portal home page
2. Click **Resource groups**
3. Click **rg-iot-academy**
4. Click **Delete resource group**



The screenshot shows the Microsoft Azure portal interface. At the top, there's a search bar and navigation links. The main heading is 'rg-iot-academy' with a sub-label 'Resource group'. Below this, there's a search input field and a list of actions: 'Create', 'Manage view', and 'Delete resource group'. The 'Delete resource group' button is highlighted with a red rectangular box. On the left, there's a sidebar with navigation options: Overview, Activity log, Access control (IAM), Tags, and Resource visualizer. On the right, under 'Essentials', there's information about the subscription, including the Subscription ID (7451d6d6-9082-46d9-9373-ccd5fcd6673) and a link to add tags.

5. Type the type the name of your resource group and click **Delete**



The screenshot shows the 'Are you sure you want to delete "rg-iot-..."' confirmation dialog in the Azure portal. A warning icon and text state: 'Warning! Deleting the "rg-iot-academy" resource group is irreversible. The action you're about to take can't be undone. Going further will delete this resource group and all the resources in it permanently.' Below this, there's a text input field labeled 'TYPE THE RESOURCE GROUP NAME:' with 'rg-iot-academy' entered and a green checkmark. A table titled 'AFFECTED RESOURCES' lists 4 resources that will be deleted:

Name	Type	Location
asajob-tempagg	Stream Analytics job	East US 2
deciotacadone220427	Azure Data Explorer...	East US 2
iot-academy-acadone-vscode...	IoT Hub	East US 2
provs-iotacad-acadone220427	Azure IoT Hub Devi...	East US 2

At the bottom, there are 'Delete' and 'Cancel' buttons.