

Introduction



Mohammad Fazail Bangash
Research Associate,
GIKI

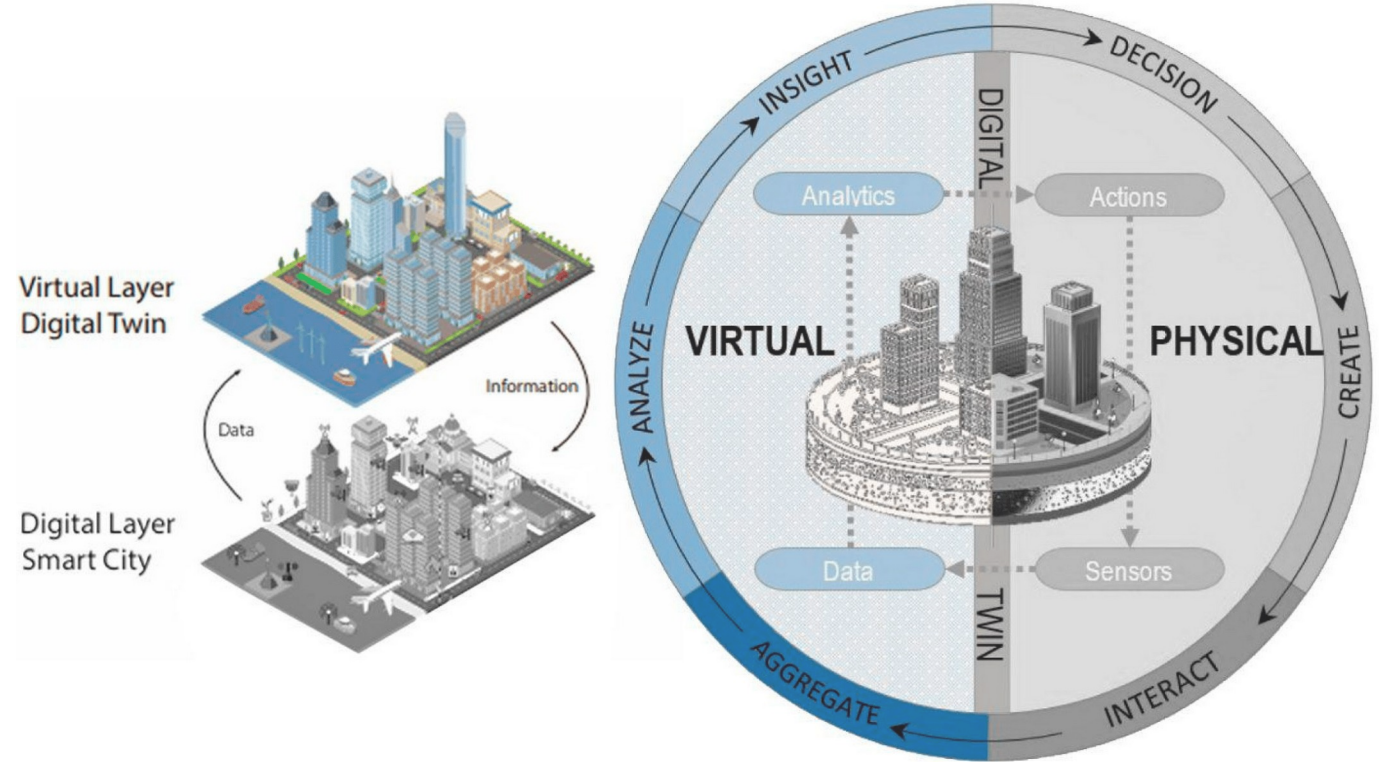
BSc. Mechanical Engineering, UET Peshawar

MS Mechanical Engineering (System Control and AI), GIKI

Research Area: Condition Monitoring, Fault Diagnosis, Digital Twin, Additive Manufacturing (Metal)

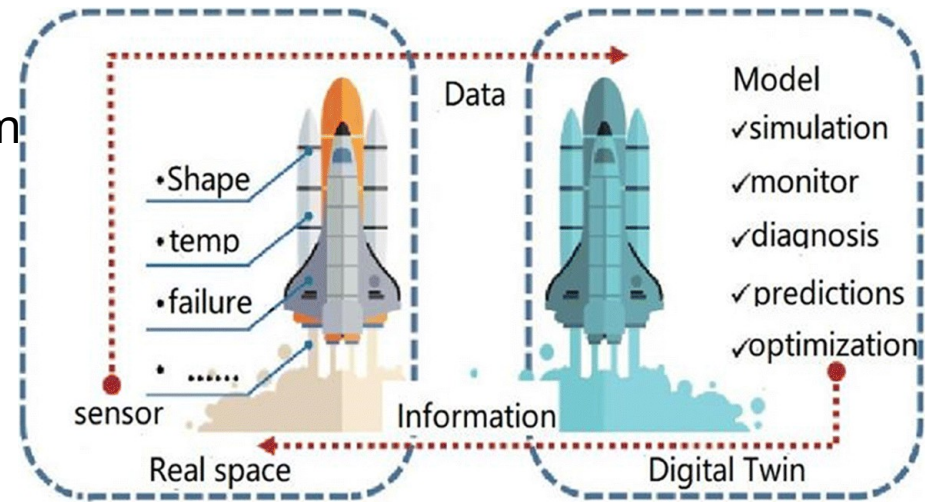
Session Outline

- Digital Twin Technology
- Use cases of Digital twin Technology
- Tools for Digital Twinning
- Digital Twin Pipeline
- MS Azure for Digital Twin
- Hands on Demonstration of Azure Digital

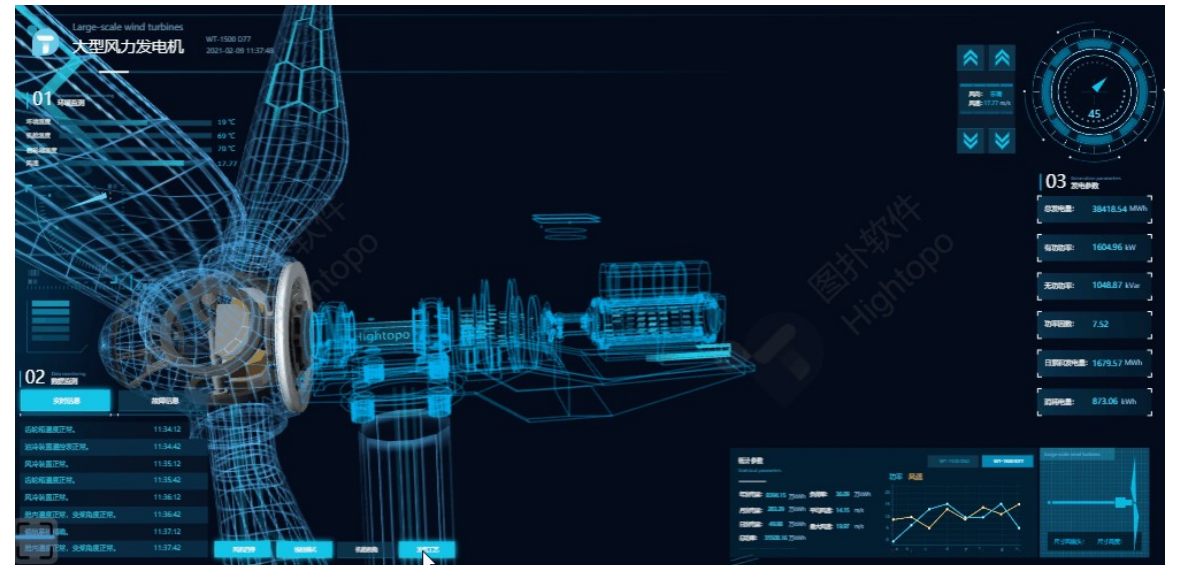
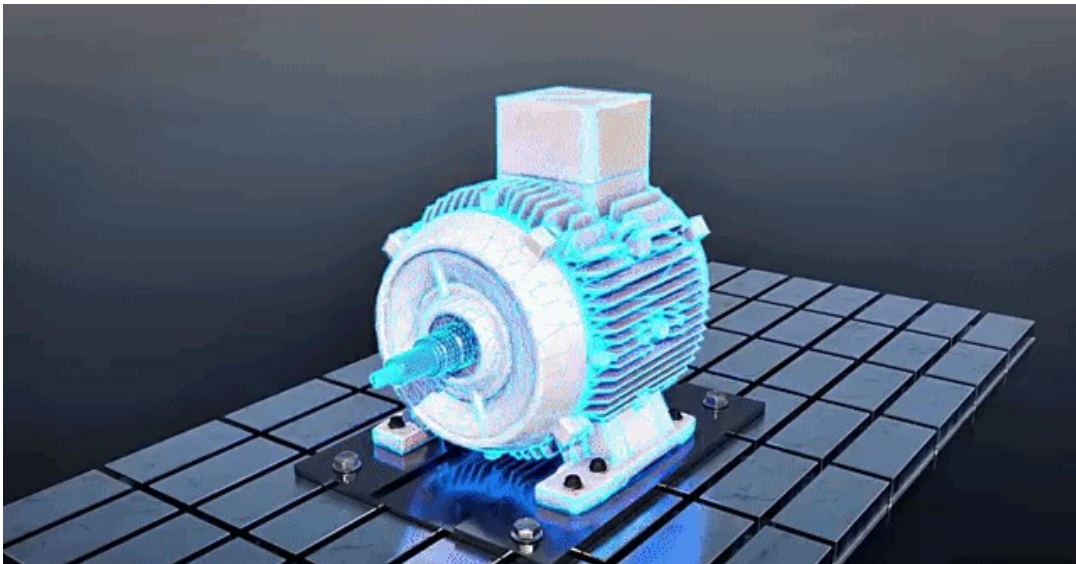


Digital Twin Technology

- Think of it as a virtual replica of a physical object, process, or system
- Concept introduced by Dr. Michael Grieves in 2002
- NASA used an early form of digital twins to monitor spacecraft performance
- What if your car could tell you when it's about to fail?



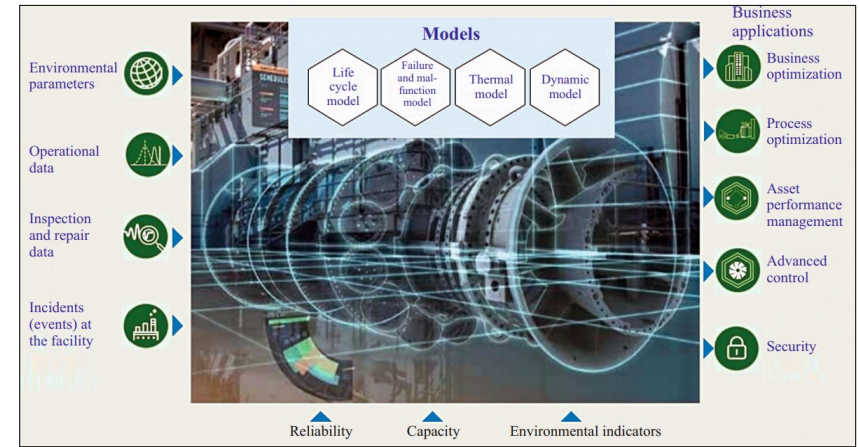
Nasa's Apollo Digital Twin



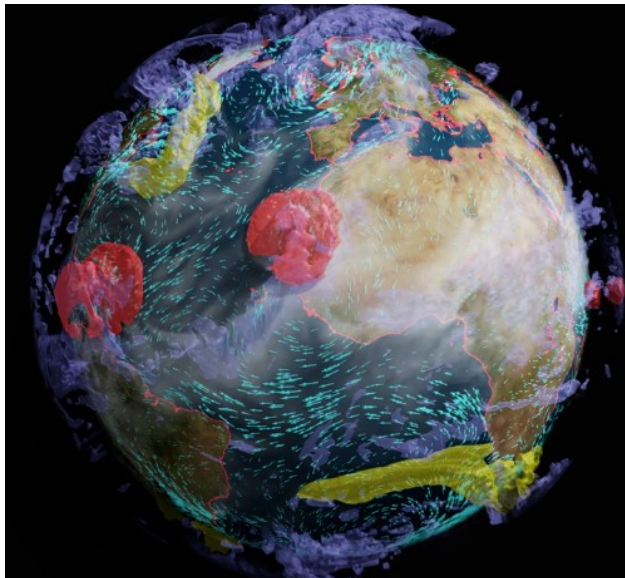
Use Cases of Digital Twin



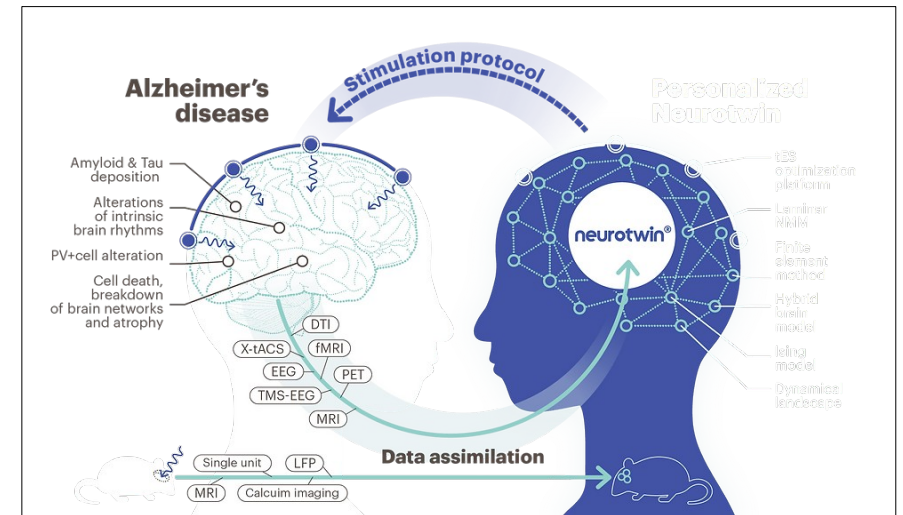
Siemens DT for in Factories



General Electric DT for Gas Turbines



Twin Earth by Nvidia



Alzheimer diagnosis by Neuro Twin

Tools for Digital Twinning



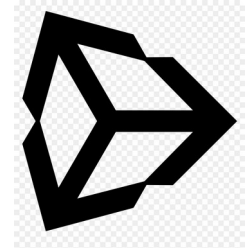
Microsoft Azure Digital Twin



Nvidia Omniverse



Ansys Twin Builder



Unity 3D



Siemens Mindsphere



Unreal Engine



PTC thingworks



Rhino

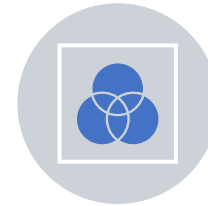
Core Terms We'll Use Today



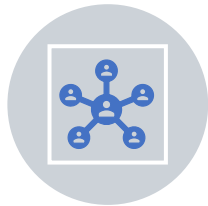
DTDL model: Defines schema (properties, components, relationships)



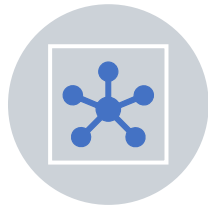
Digital twin: Instance of a model (e.g., room-1, sensor-1)



Relationship: Edge connecting twins (e.g., room-1 contains sensor-1)



Twin graph: Connected set of twins + relationships

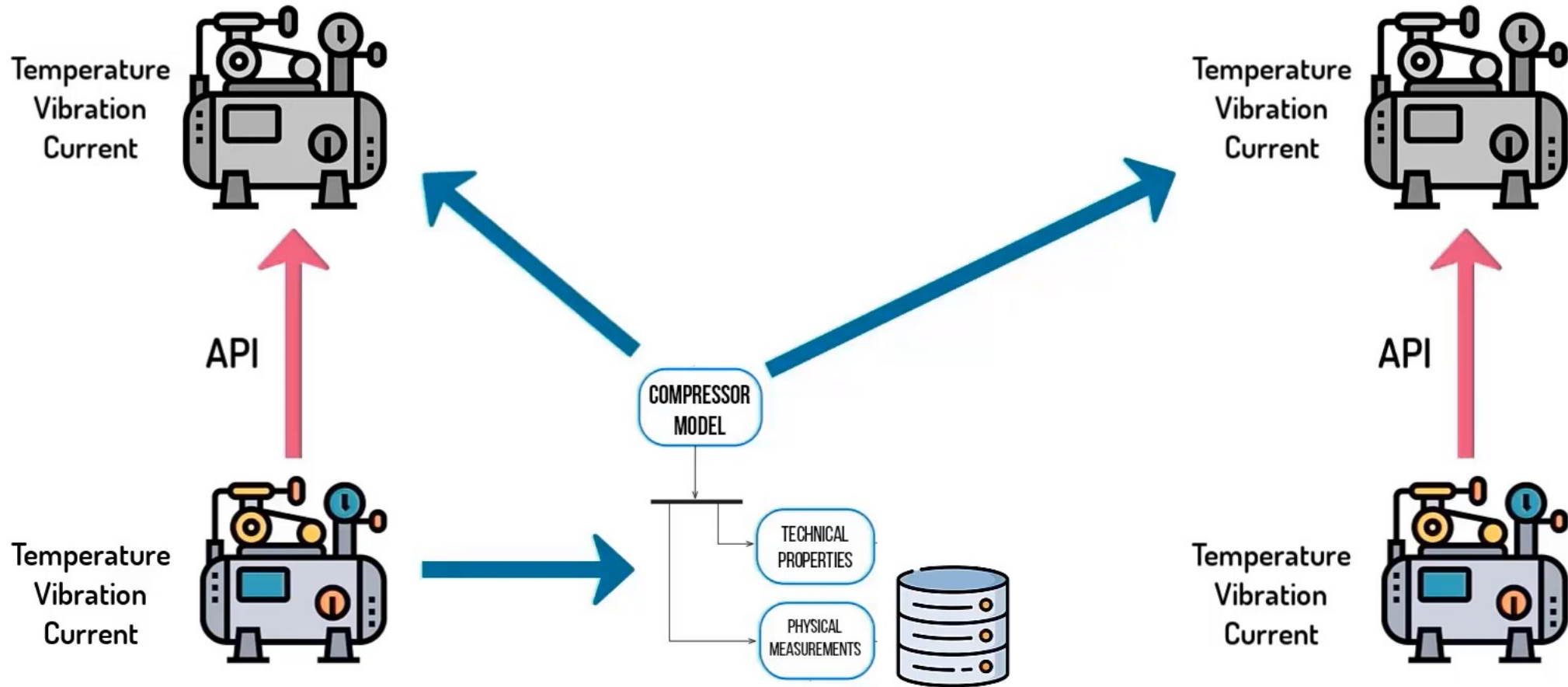


Event route / Endpoint: Rules + target to send ADT events out



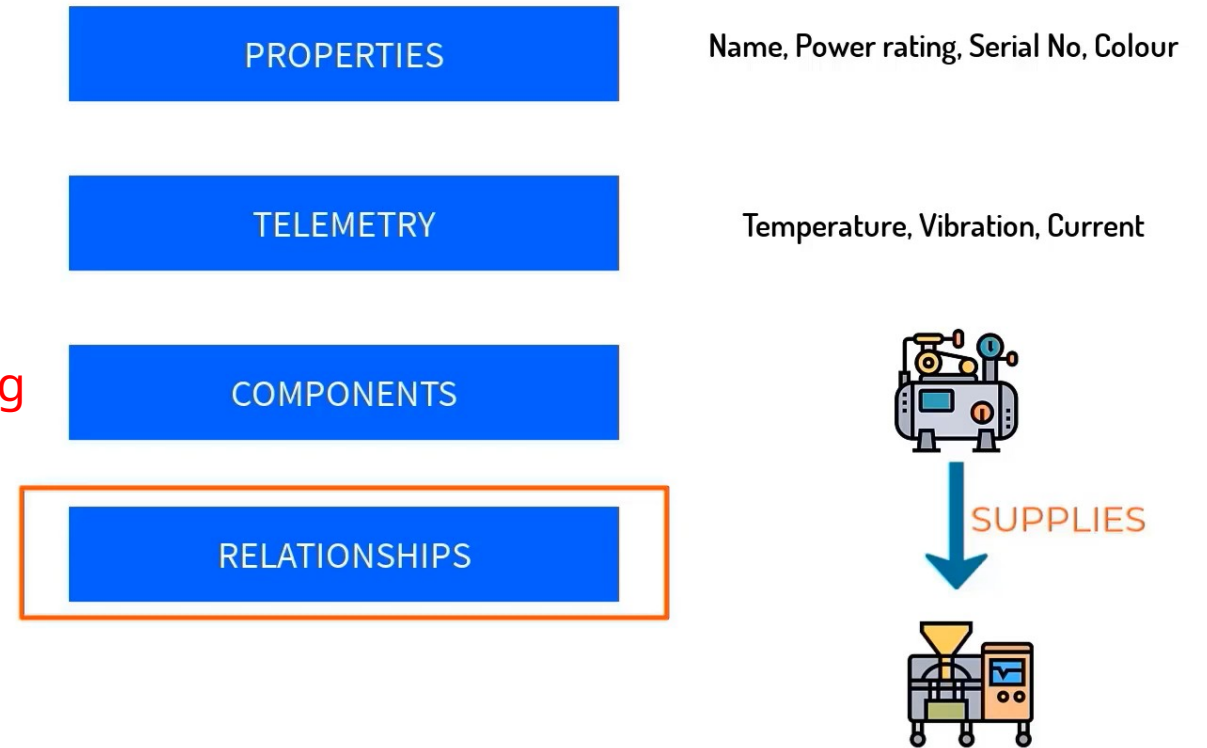
ADT Explorer: Portal-hosted UI to view graph, run queries

How a Digital Twin Works?



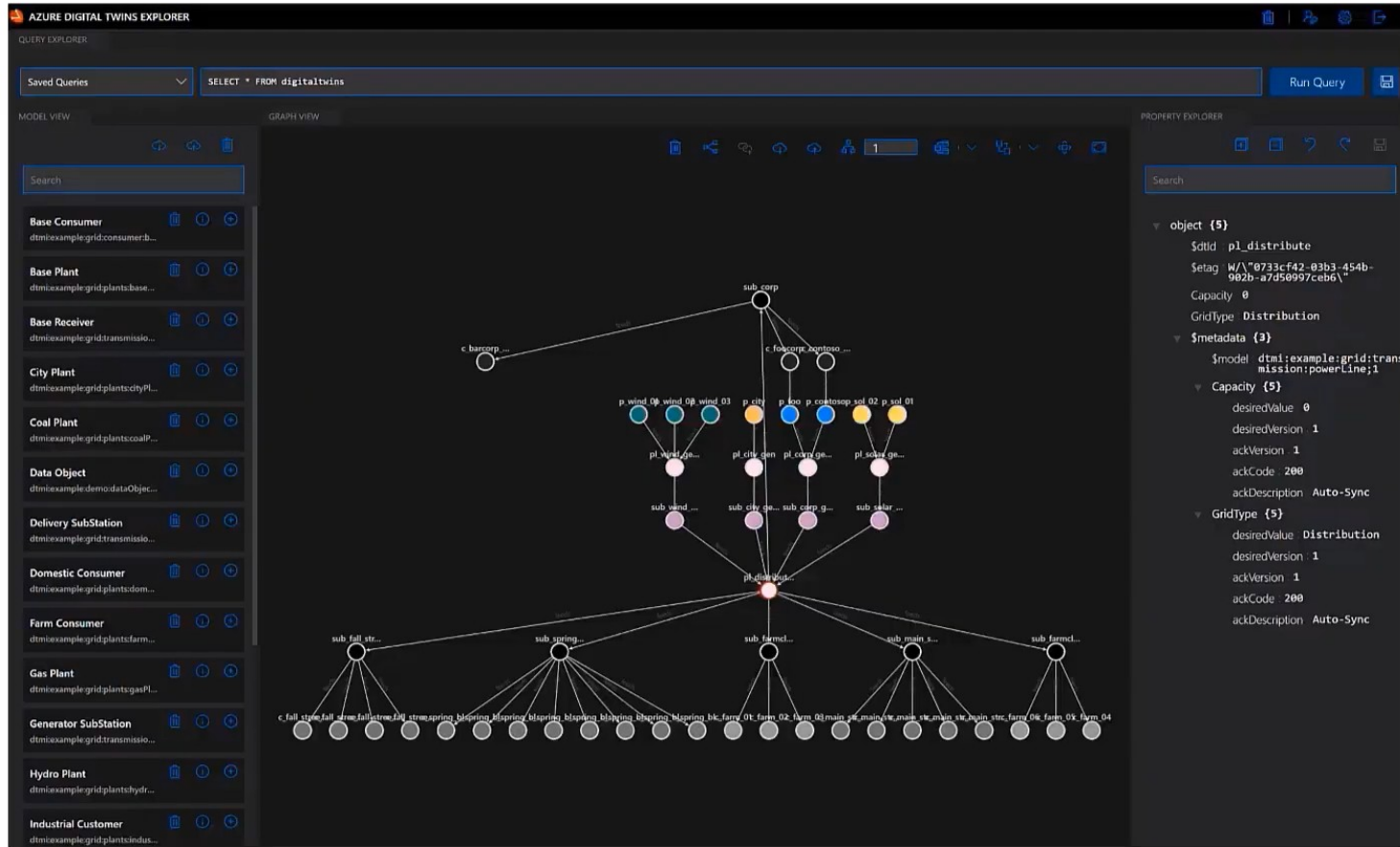
Digital Twins Definition Language (DTDL)

- DTDL = blueprint
- Digital Twin = house built from that blueprint
- Sensors = utilities and gadgets in the house sending data
- Azure = platform keeping track of all houses and their data



JSON-LD 

DTDL: Azure Digital Twins Graph



INTERFACE

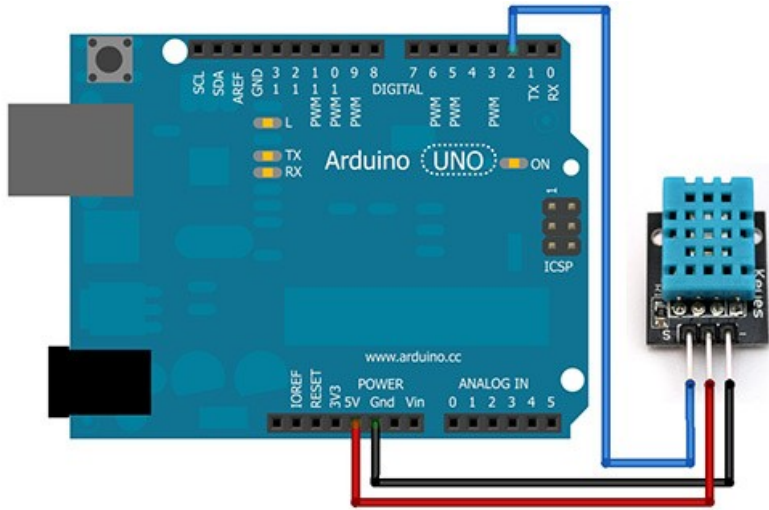
PROPERTIES

TELEMETRY

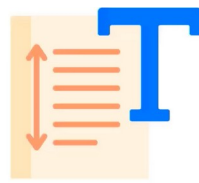
COMPONENTS

RELATIONSHIPS

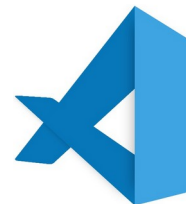
Digital twin Model for Demo Factory Using DTDL



```
File Edit Selection View Go Run Terminal Help
demofactorymodel.json X
C: > Models > demofactorymodel.json > ...
1
2
3 {
4   "@id": "dtmi:demo:Factory;1",
5   "@type": "Interface",
6   "@context": "dtmi:dtdl:context;2",
7   "displayName": "Factory Interface Model",
8   "contents": [
9     {
10      "name": "Temperature",
11      "@type": "Property",
12      "schema": "double"
13     },
14     {
15      "name": "Humidity",
16      "@type": "Property",
17      "schema": "double"
18     }
19   ]
20 }
```



.json



Visual Studio

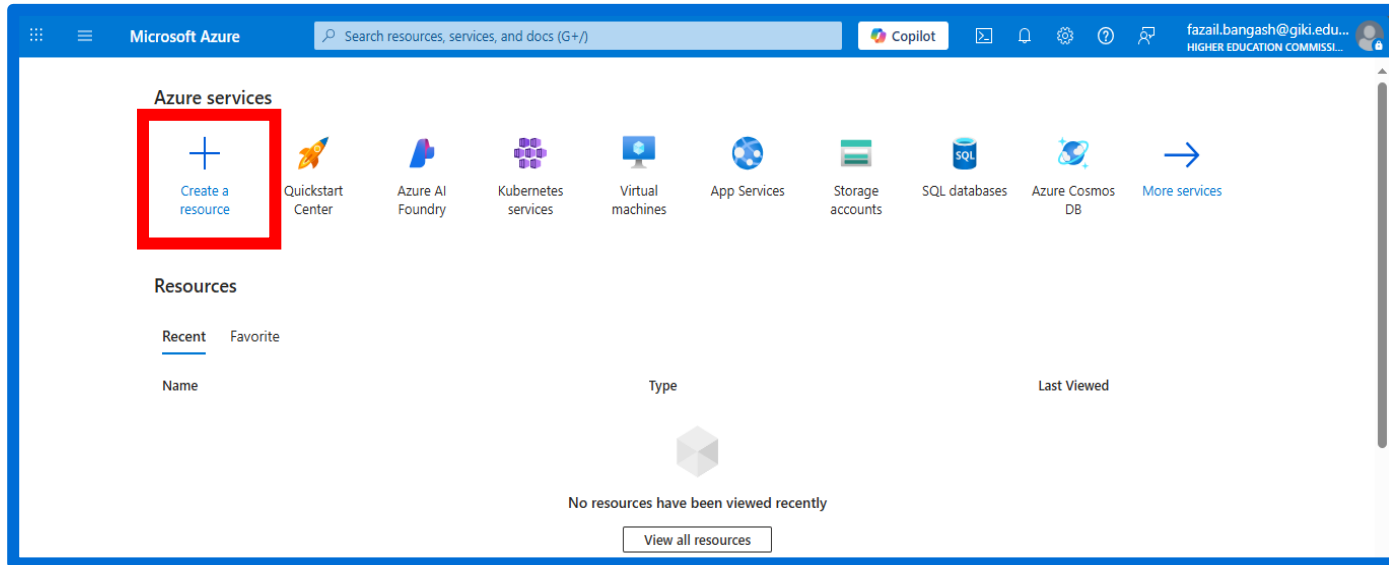


Azure Digital Twins

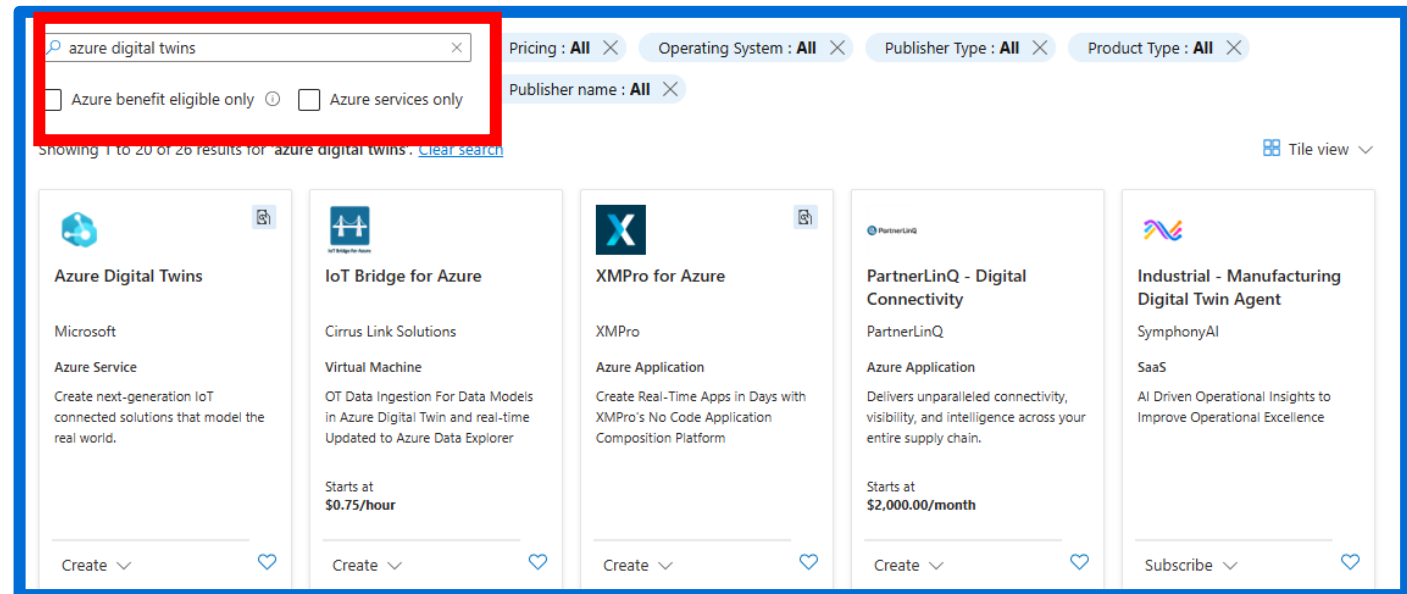


Azure IoT Hub

Digital twin Model for Demo Factory Using DTDL



- Resource is Anything you create or use in Azure
- Think of it as a “tool” or “service” in the cloud



Azure Digital Twins [Add to Favorites](#)

Microsoft | Azure Service

★ 3.5 (11 ratings)

Azure benefit eligible

Subscription: Azure for Students

Plan: Azure Digital Twins

Create



➤ **Configure:**

- Subscription: Azure for students
- Resource group: DT_workshop
- Location: South Asia
- Instance name: adtdemoinstance



Home > Create a resource > Marketplace > Azure Digital Twins >

Create Resource

Azure Digital Twins

Project details

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

Subscription * Azure for Students

Resource group * (New) DT_workshop

Instance Details

Resource name * adtdemoinstance

Region * Southeast Asia

Grant access to resource

To manage the elements within an instance, a user needs access to Azure Digital Twins data plane APIs. Select the suggested role below to grant yourself full access to the data plane APIs. You can also use Access Control (IAM) to choose appropriate roles later. [Learn more](#)

Assign Azure Digital Twins Data Owner Role

Review + create < Previous Next: Networking >

The screenshot shows the Azure portal interface for a deployment named 'adtdemoinstance'. The status 'Deployment is in progress' is highlighted with a red box. The deployment details show it was created on 9/13/2025 at 4:25:23 PM. The resource is of type 'Azure Digital Twins' and is currently in a 'Created' state. The interface includes navigation options like 'Delete', 'Cancel', 'Redeploy', 'Download', and 'Refresh'.

- Instance is A specific copy of a resource that you can use.
- Your own deployed copy of Azure Digital Twins that you can configure, use, and connect to your devices.

- Resource = the recipe
- Instance = the cake you baked using that recipe

The screenshot shows the same Azure portal interface, but the deployment 'adtdemoinstance' is now complete. The status 'Your deployment is complete' is highlighted with a red box. The deployment details show it was completed on 9/13/2025 at 4:25:34 PM. The resource is of type 'Azure Digital Twins' and is currently in a 'Created' state. The interface includes navigation options like 'Delete', 'Cancel', 'Redeploy', 'Download', and 'Refresh'. A 'Go to resource' button is visible at the bottom.

Home > adtdemoinstance

adtdemoinstance | Access control (IAM) ☆ ...

Azure Digital Twins

Search

Overview
Activity log
Access control (IAM)
Tags
Diagnose and solve problems
Resource visualizer
Settings
Connect outputs

+ Add ▾ Download role assignments Edit columns Refresh Delete Feedback

Check access Role assignments Roles Deny assignments Classic administrators

My access
View my level of access to this resource.
[View my access](#)

Check access
Review the level of access a user, group, service principal, or managed identity has to this resource. [Learn more](#)

[Check access](#)



- Access control to manage who can do what in your Azure resources
- permission to read data, edit a digital twin, or manage your IoT Hub.

adtdemoinstance | Access control (IAM) ☆ ...

Azure Digital Twins

Search

Overview
Activity log
Access control (IAM)

+ Add ▾ Download role assignments Edit columns Refresh Delete Feedback

Add role assignment
Check access Role assignments Roles Deny assignments Classic administrators

My access

- Your Azure Digital Twins instance, IoT Hub, and Function App are resources in the cloud
- You don't want just anyone to change models, read sensitive sensor data, or delete twins

Add role assignment

[Role](#) [Members](#) [Conditions](#) [Review + assign](#)

A role definition is a collection of permissions. You can use the built-in roles or you can create your own custom roles. [Learn more](#)

[Job function roles](#) [Privileged administrator roles](#)

Grant access to Azure resources based on job function, such as the ability to create virtual machines.

× Type : All Category : All

Name ↑↓	Description ↑↓
Azure Digital Twins Data Owner	Full access role for Digital Twins data-plane



Add role assignment

[Role](#) [Members](#) [Conditions](#) [Review + assign](#)

Selected role Azure Digital Twins Data Owner

Assign access to User, group, or service principal Managed identity

Members **+ Select members**

Name	Object ID	Type
No members selected		

Description Optional

[Review + assign](#) [Previous](#) [Next](#)

Select members

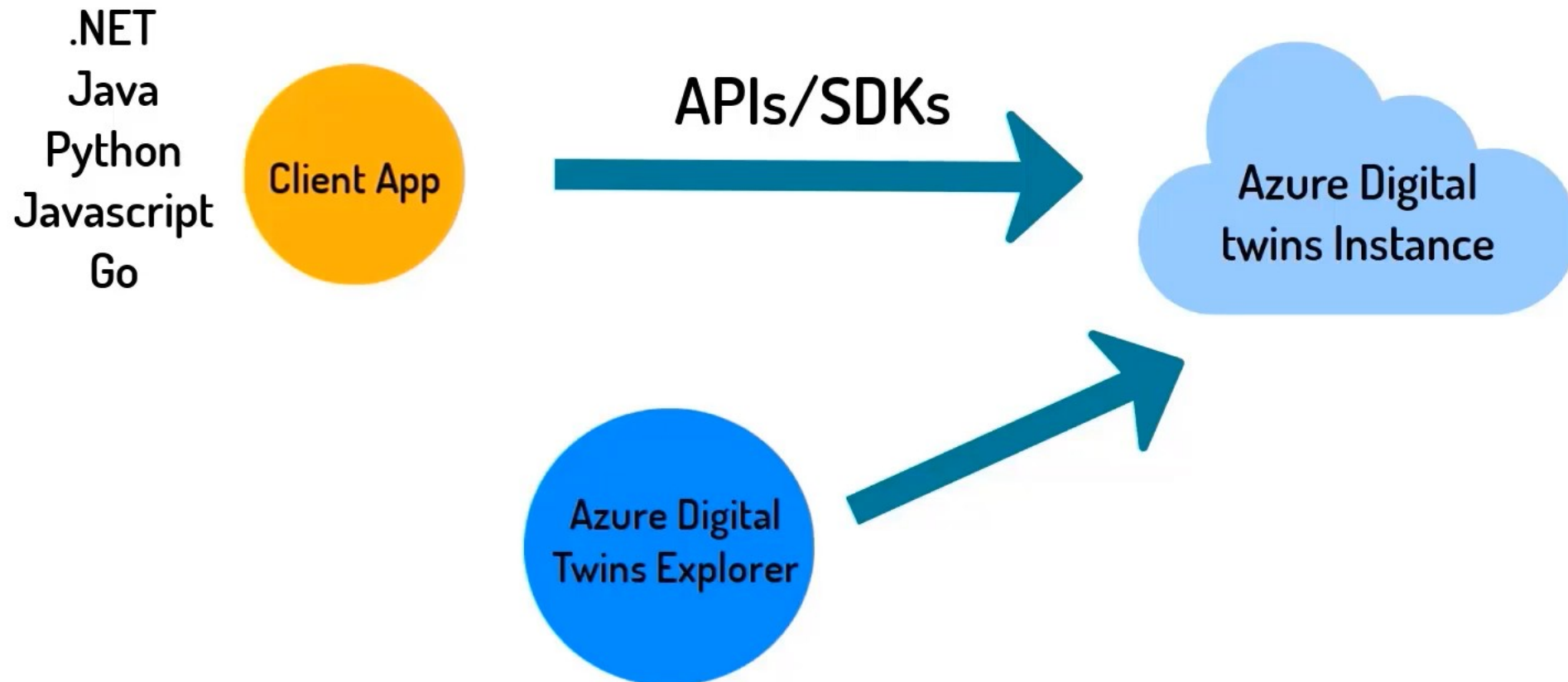
- Darakhshan Fazail 19100203@lums.edu.pk
- FAZAIL ZAHOOR SP17-BCS-011@vhrstudent.comsats.edu.pk
- Fazail Ahmad 17110153@lums.edu.pk
- FAZAIL AHMAD BADAR 04432213028@perm.onmicrosoft.com
- Fazail Bangash Research Associate FME fazzail.bangash@giki.edu.pk

Selected members:

- Fazail Bangash Research Associate FME fazzail.bangash@giki.edu.pk

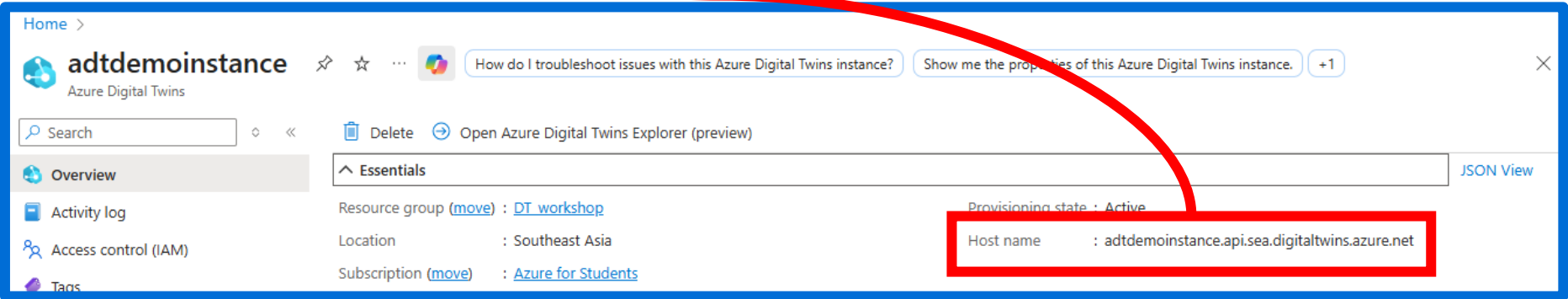
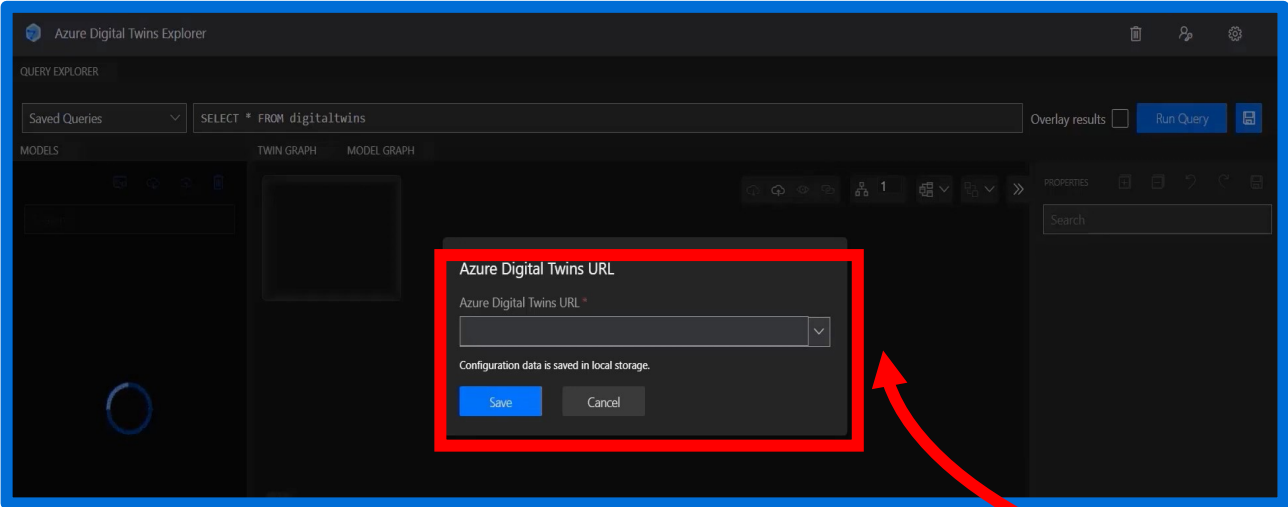
[Select](#) [Close](#)

Connecting to Azure Digital Twins Instance

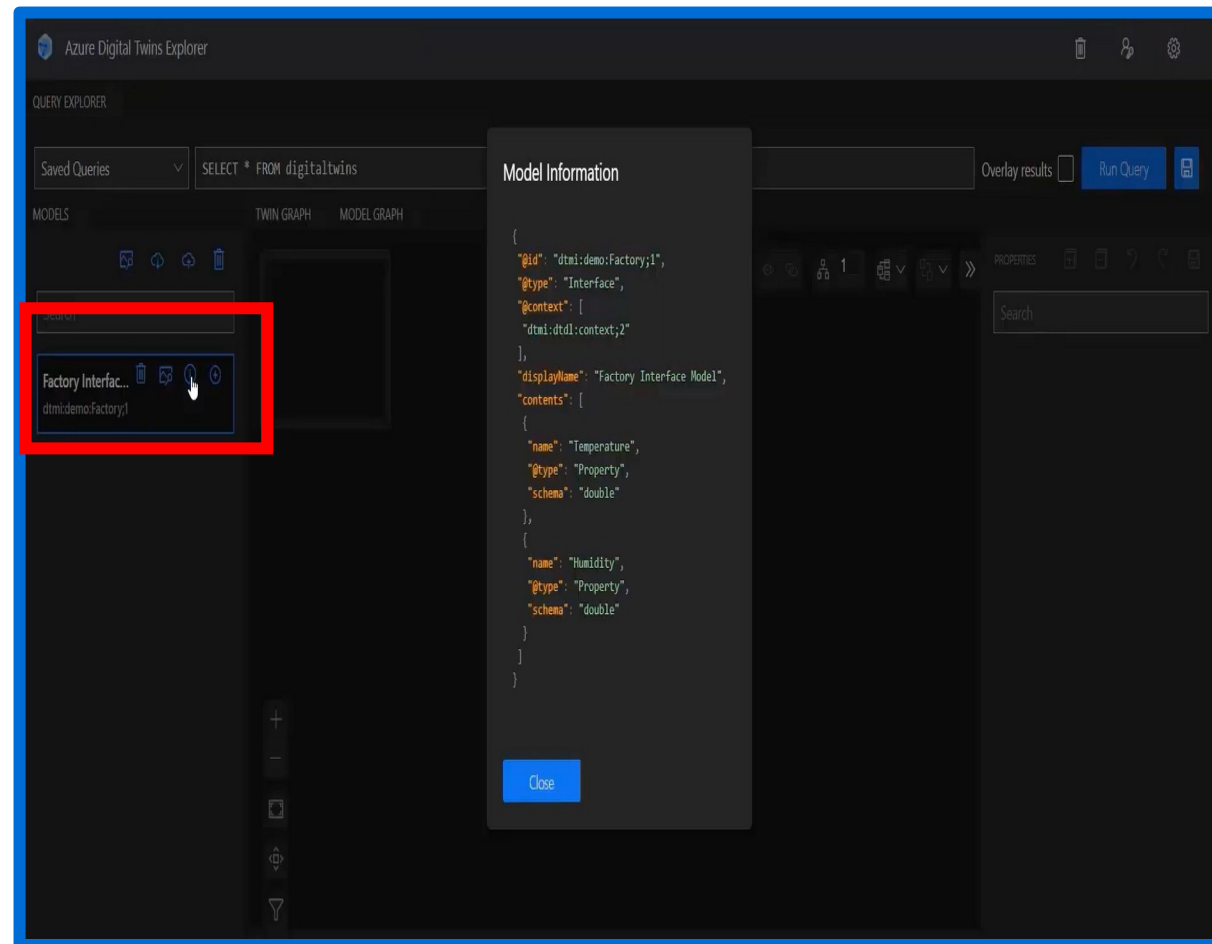
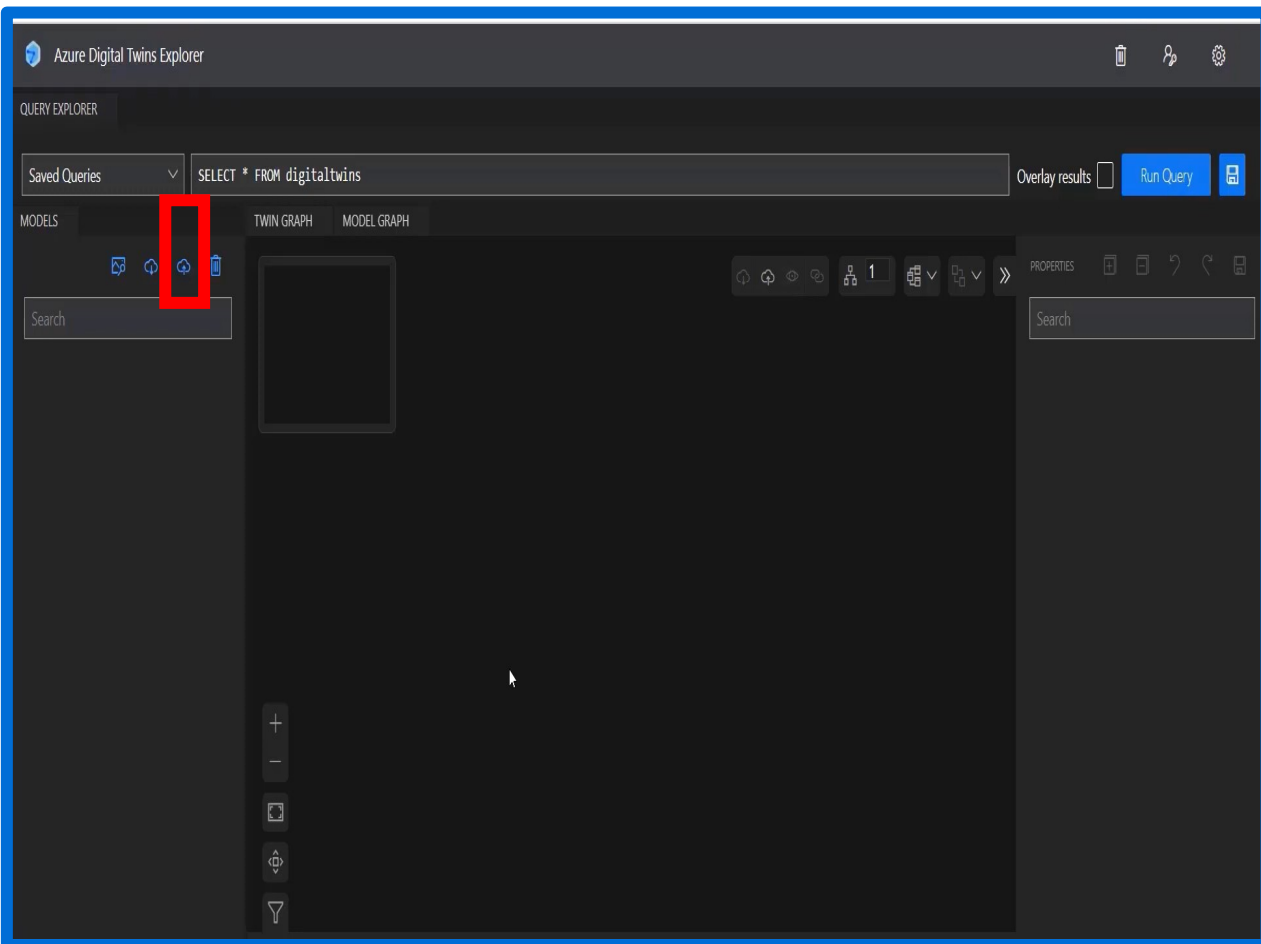


Using Azure Digital Twins Explorer

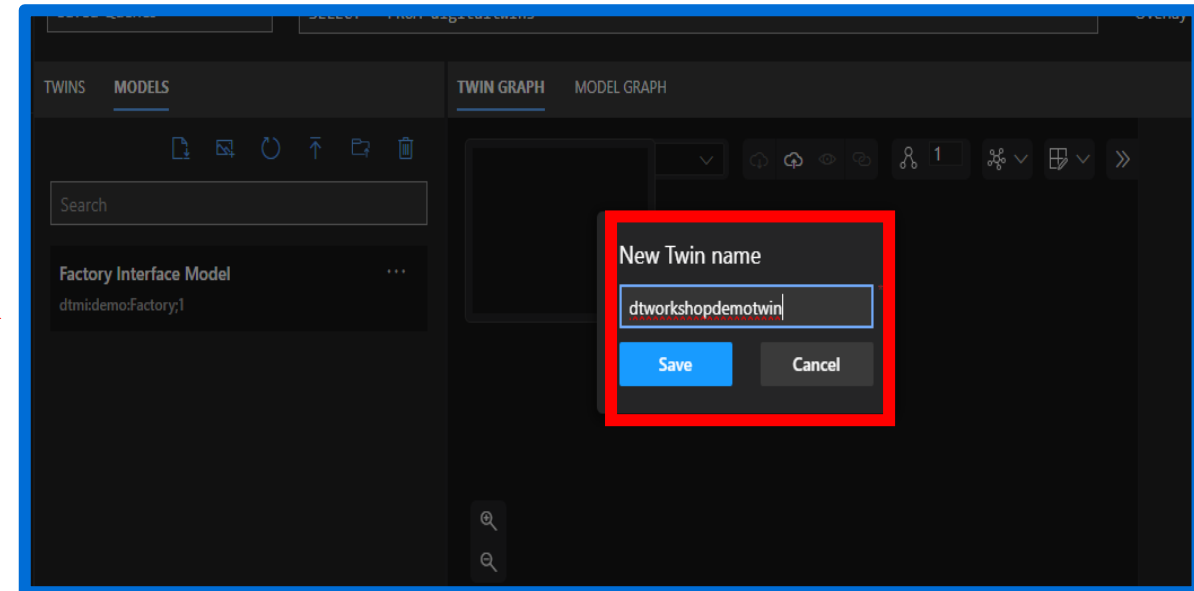
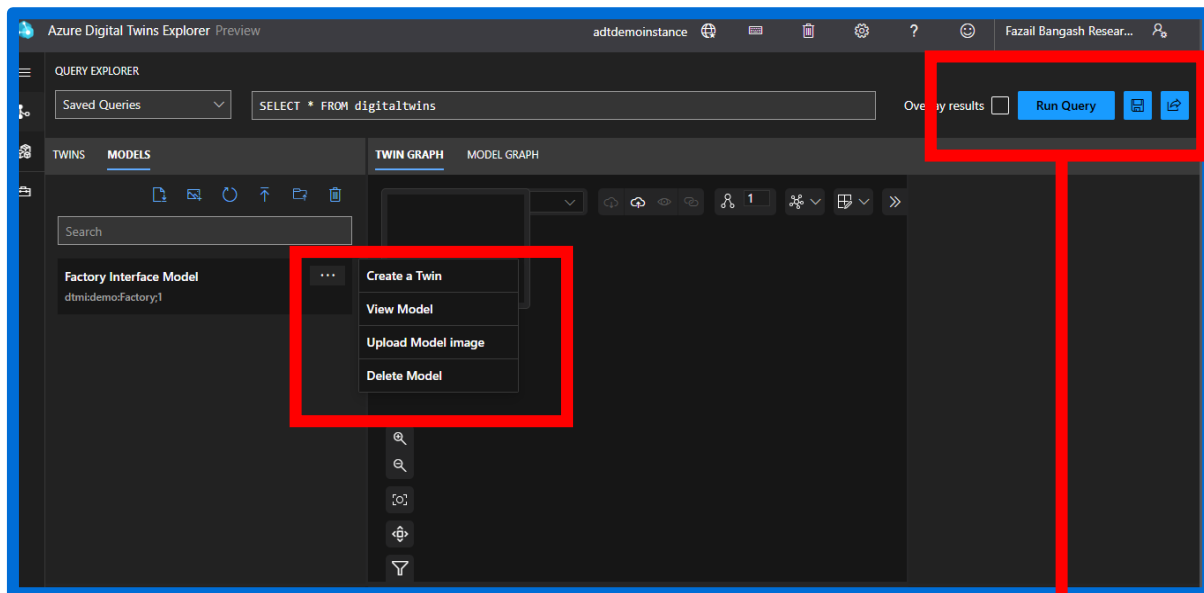
ADT host link



Uploading the model to Azure DT App

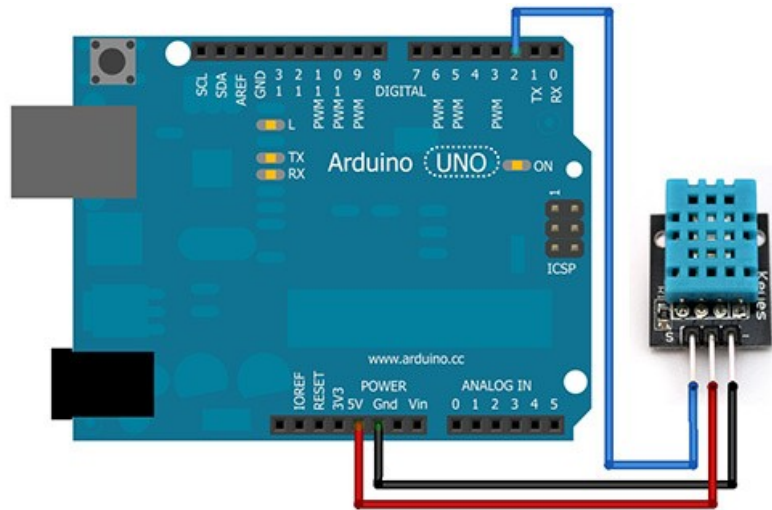


Creating Demo Twin in ADT

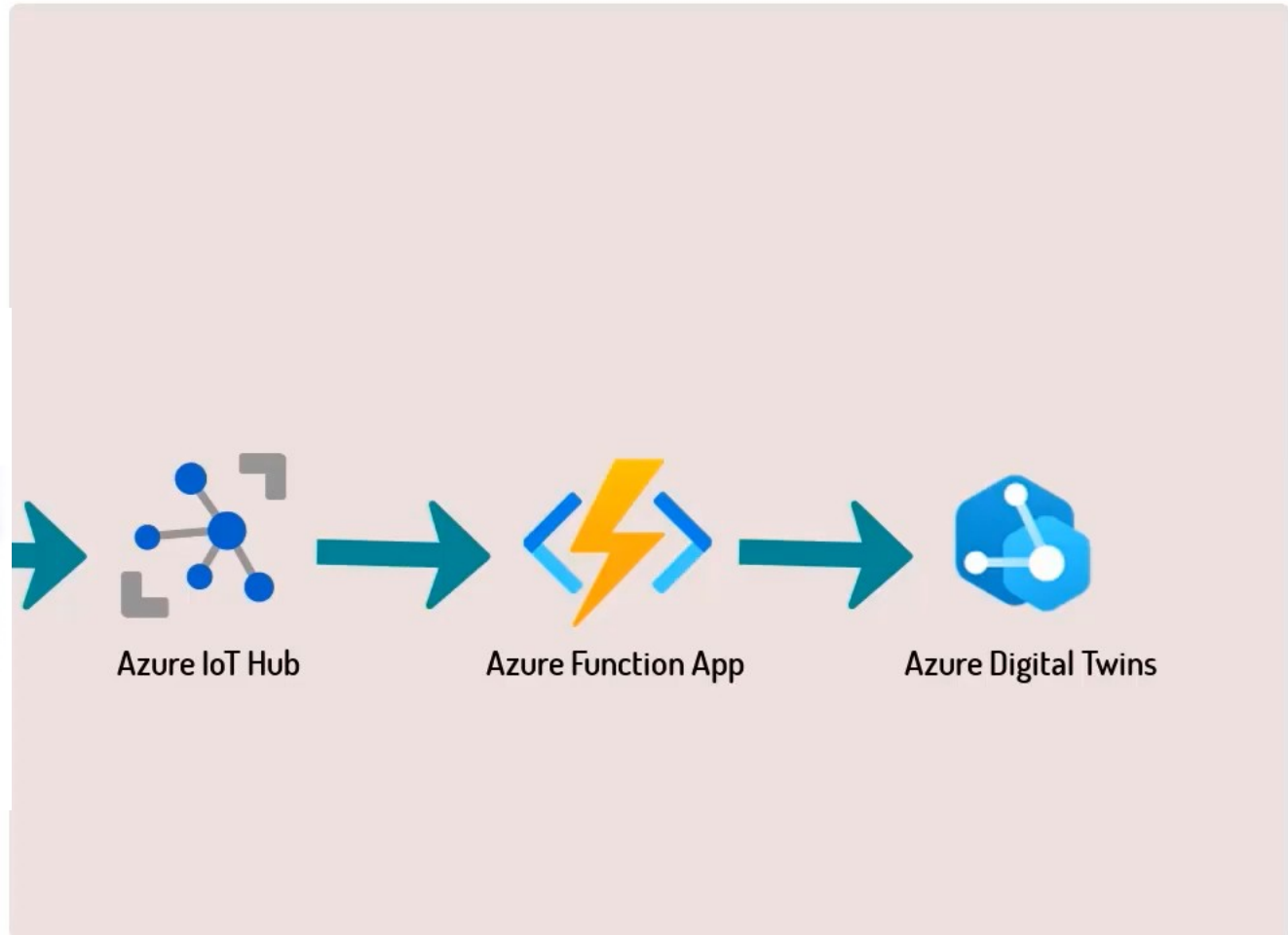


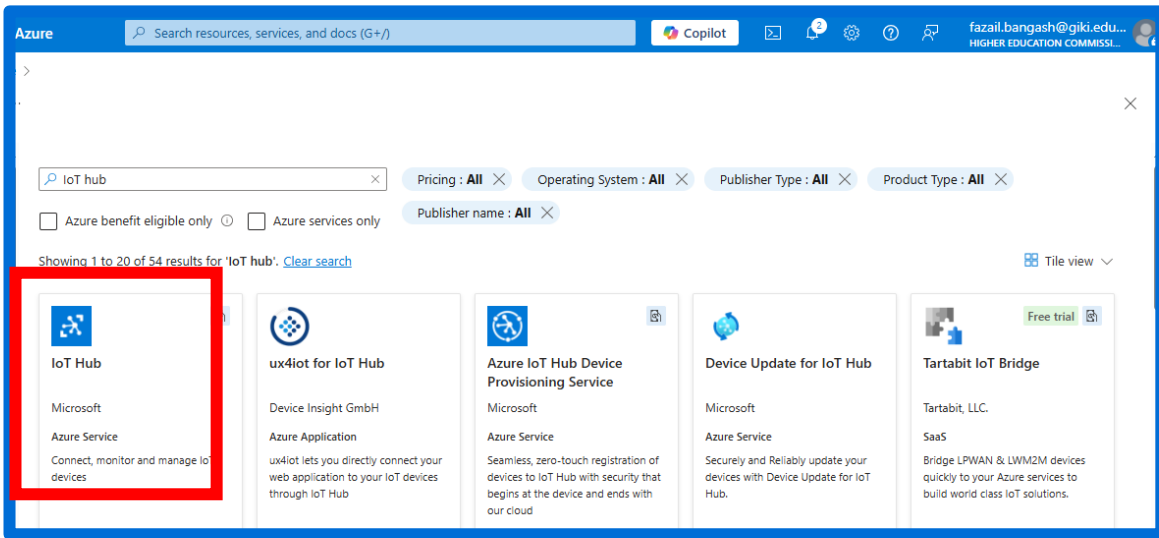
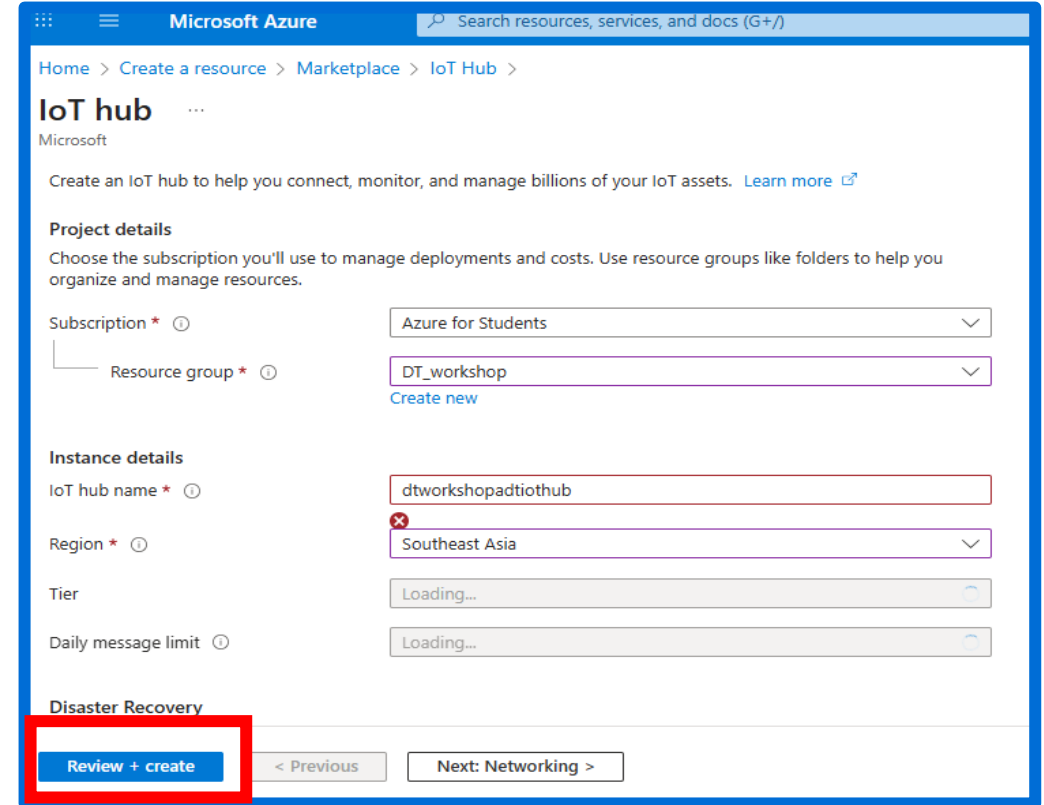
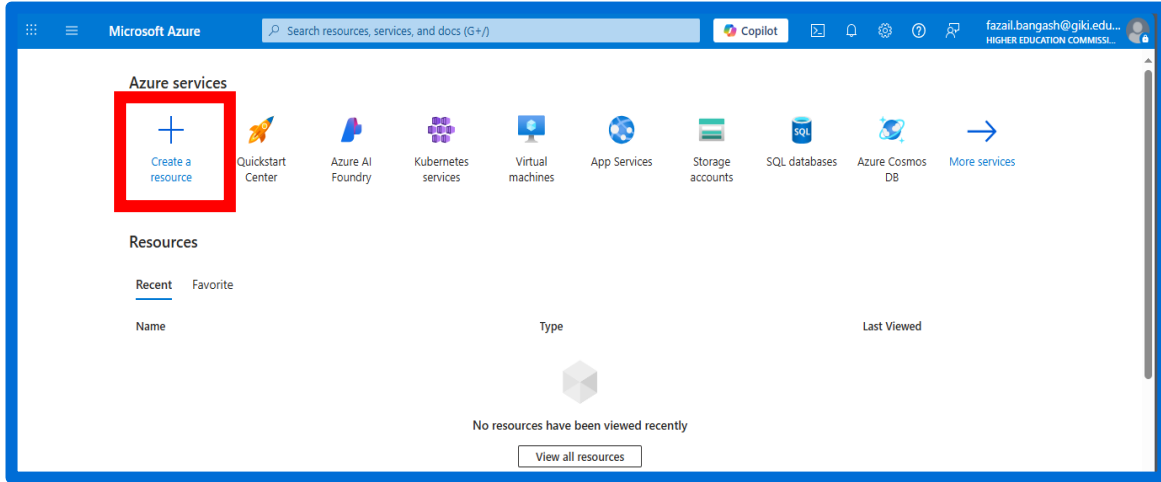
- A request to get specific data from a system or database.
- Asking Azure Digital Twins: "Show all scenarios where humidity > 60."

Creating IoT Hub for updating Digital twin



Azure Cloud





- IoT Hub receives data and acts as a gateway before sending it to Azure Digital Twins via Azure Functions

Creating a Device

Microsoft Azure | dtworkshophiothub | Devices

View, create, delete, and update devices in your IoT Hub. [Learn more](#)

+ Add Device | Edit columns | Refresh | Assign tags

enter device ID | Types: All | + Add filter

Device ID	Type
There are no devices to display.	

Navigation menu items: Activity log, Access control (IAM), Tags, Diagnose and solve problems, Events, Resource visualizer, Device management (highlighted), IoT Edge, Configurations + Deployments, Updates, Queries.



Microsoft Azure | dtworkshophiothub | Devices

Create a device

Find Certified for Azure IoT devices in the Device Catalog

Device ID *

IoT Edge Device

Authentication type: Symmetric key | X.509 Self-Signed | X.509 CA Signed

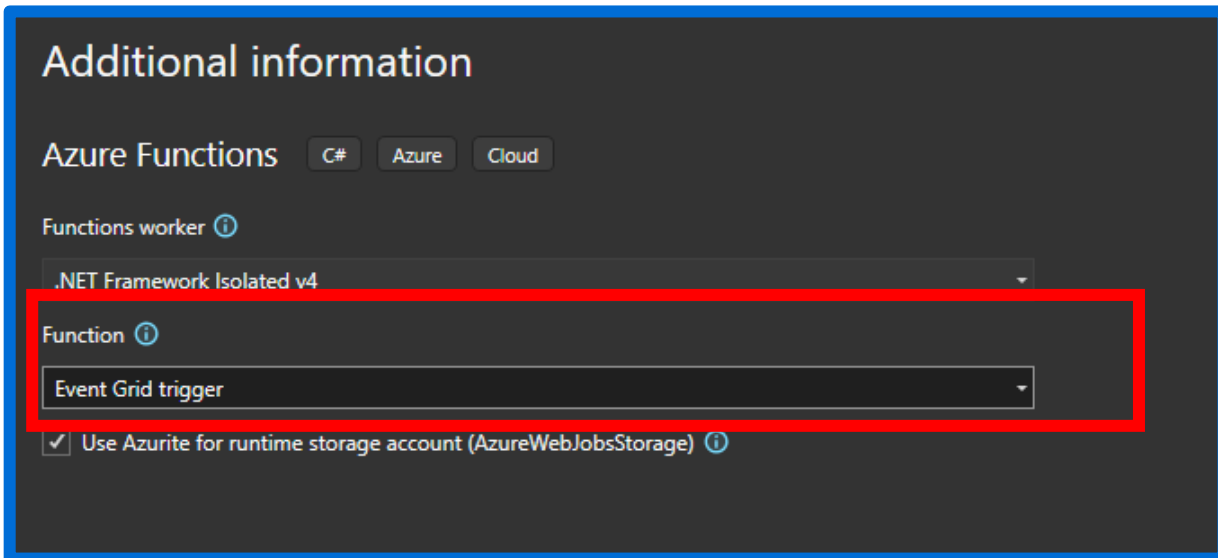
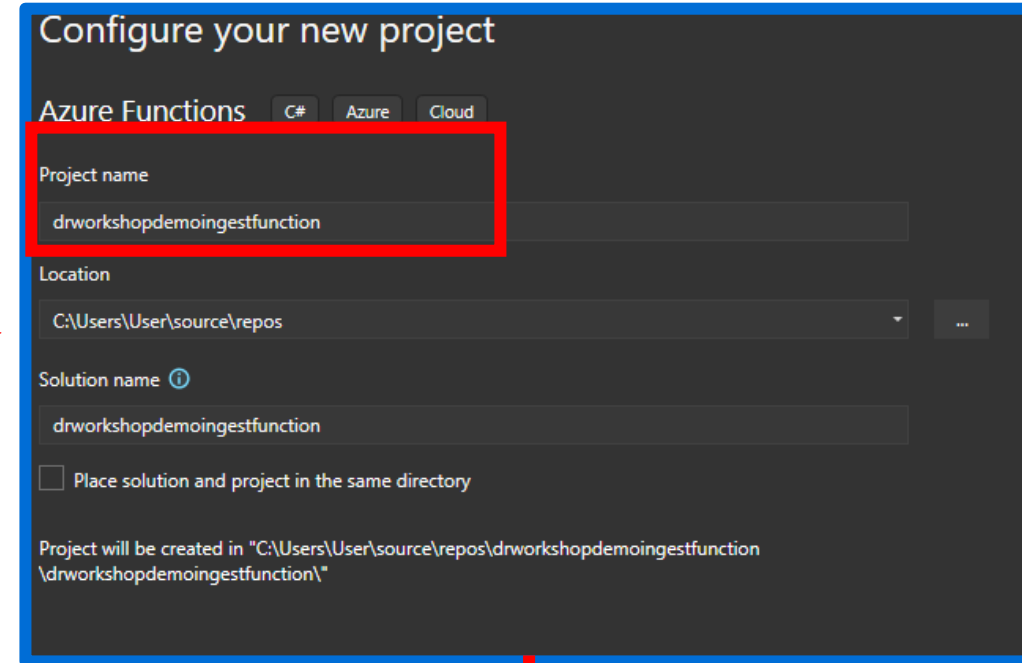
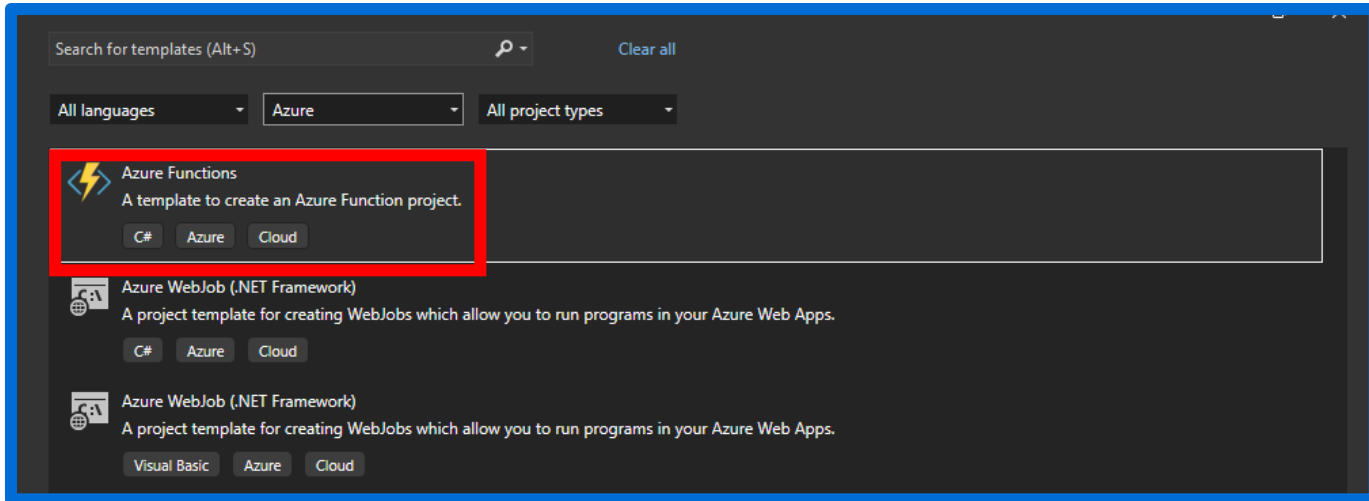
Auto-generate keys:

Connect this device to an IoT hub: Enable | Disable

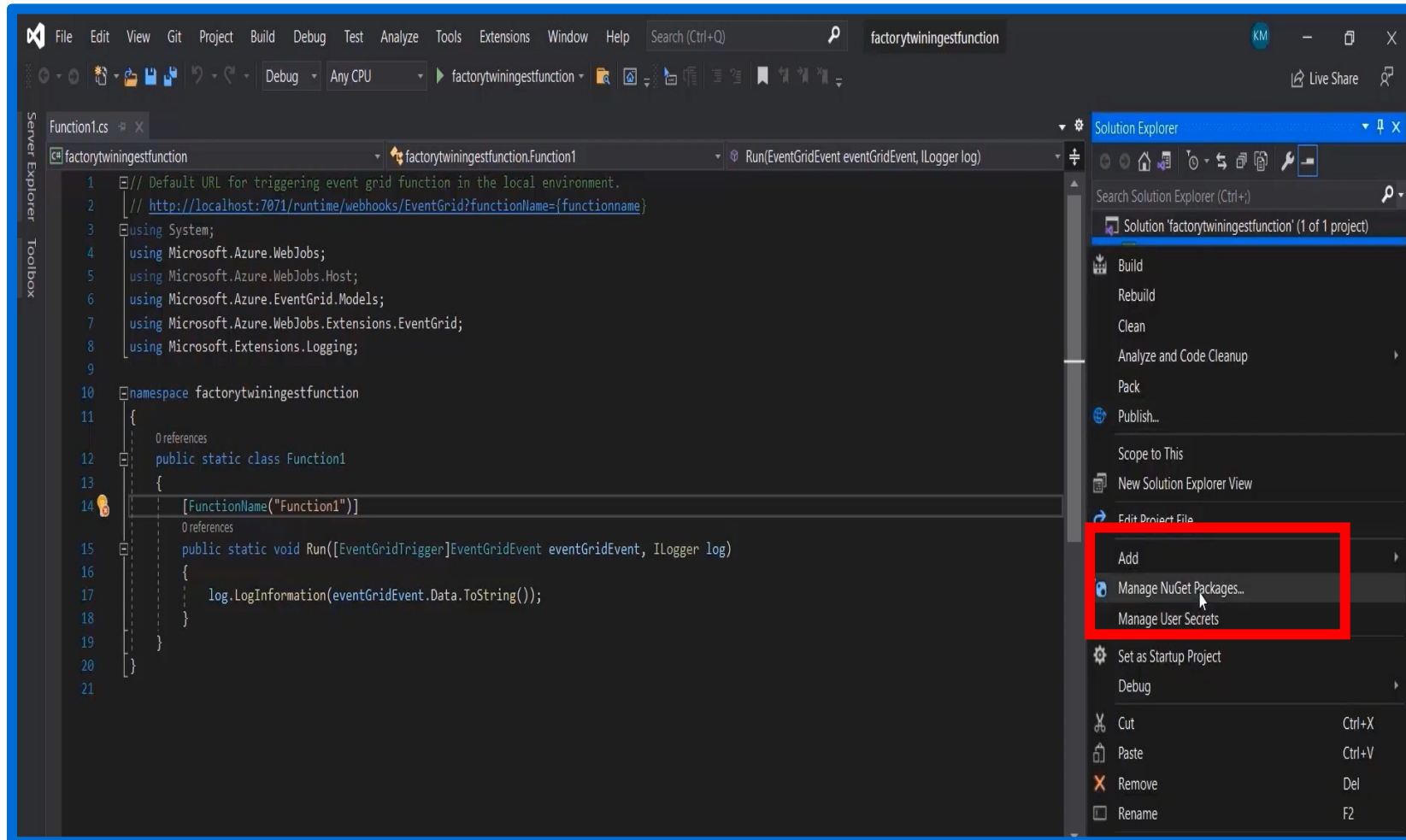
Parent device: No parent device | Set a parent device

Save

Developing Azure Function App for Ingesting data into Azure Digital Twin



Now Function to Interact with ADT, setting up ADT SDK



Azure.DigitalTwins.co

e

Azure.identity

System.net

Azure.core




File Edit View Git Project Build Debug Test Tools Extensions Window Help Search drw

Debug Any CPU drworkshopdemoingestfunction

NuGet: drwor...gestfunction Function1.cs What's New?

Browse Installed Updates 5 NuGet Package Manager

azure.digital Include prerelease

	Azure.DigitalTwins.Core by azure-sdk, Microsoft, 1.66M downloads 1.6.0 SDK for the Azure Digital Twins service
	Microsoft.Azure.DigitalTwins.Parser by johndo-ms, Microsoft, Microsoft, 3.12.7 Digital Twins Definition Language model parser This package version is deprecated.
	EvoHtmlToPdf_Azure_Client by evopdf, 1.02M downloads 12.0.0 EVO HTML to PDF Client Library for Azure can be easily integrated in any Azure application for .NET to create PDF documents from HTML pages and strings.




File Edit View Git Project Build Debug Test Tools Extensions Window Help Search drw

Debug Any CPU drworkshopdemoingestfunction

NuGet: drwor...gestfunction Function1.cs What's New?

Browse Installed Updates 5 NuGet Package Manager



azure.identity Include prerelease

	Azure.Identity by azure-sdk, Microsoft, 1.11B downloads 1.16.0 Provides APIs for authenticating to Microsoft Entra ID
	Microsoft.Identity.Client by AzureAD, Microsoft, 1.78B downloads 4.77.0 This package contains the binaries of the Microsoft Authentication Library for .NET (MSAL.NET).
	Microsoft.Identity.Client.Extensions.Msal by AzureAD, Microsoft, 1.01B downloads 4.77.0 This package contains the public client (desktop) caching to Microsoft Authentication Library for .NET (MSAL.NET).

NuGet: drwor...gestfunction Function1.cs What's New?

Browse Installed Updates 5 NuGet Package Manager



system.net.http Include prerelease

	System.Net.Http by aspnet, dotnetframework, Microsoft, 2.9B downloads 2.3.0 Provides a programming interface for modern HTTP applications, including HTTP client components that allow applications to consume web services over HTTP and HTTPS.
	System.Net.Http.Json by dotnetframework, Microsoft, 170M downloads 1.0.0 Provides a programming interface for modern HTTP applications, including HTTP client components that allow applications to consume web services over HTTP and HTTPS.

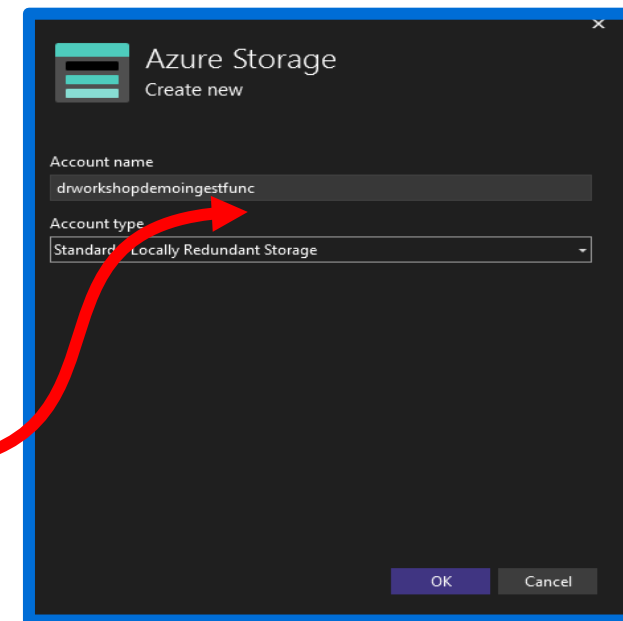
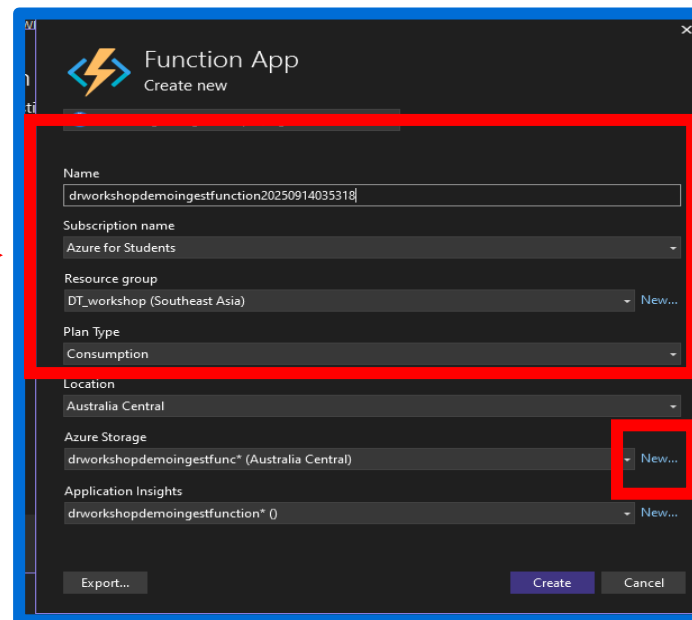
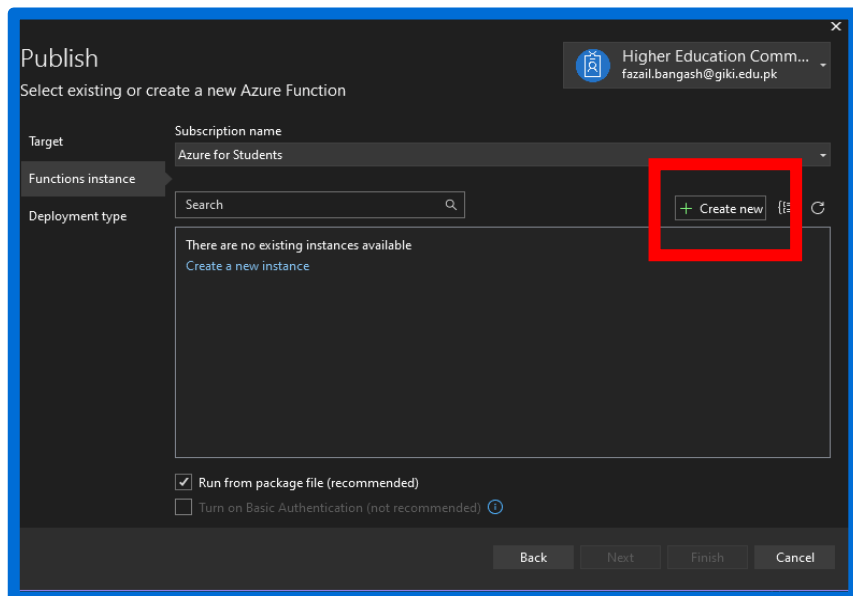
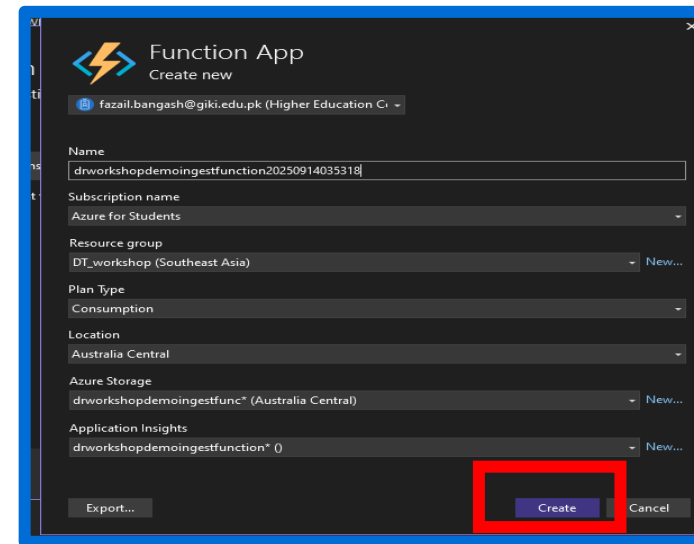
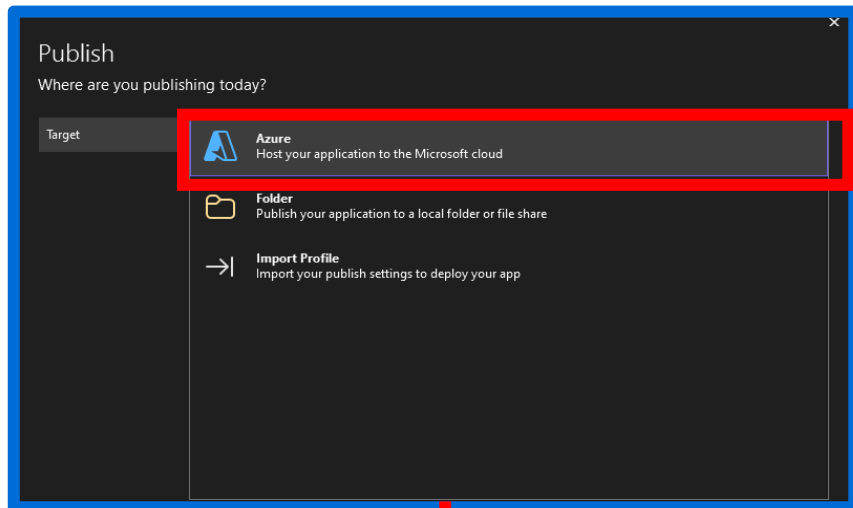
NuGet: drwor...gestfunction Function1.cs What's New?

Browse Installed Updates 5 NuGet Package Manager

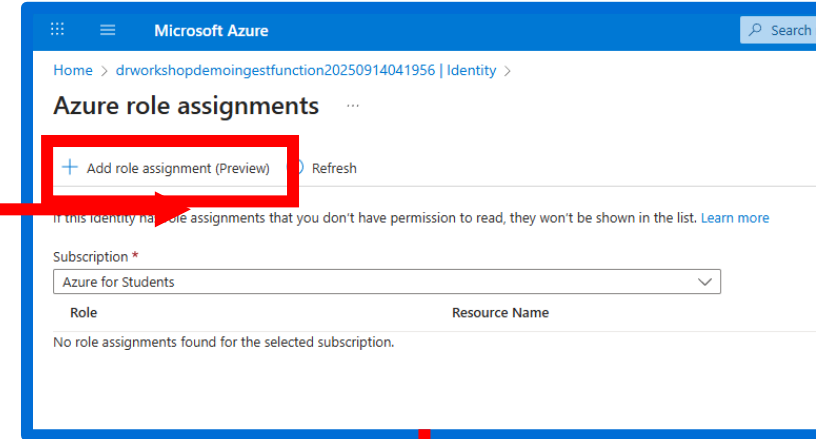
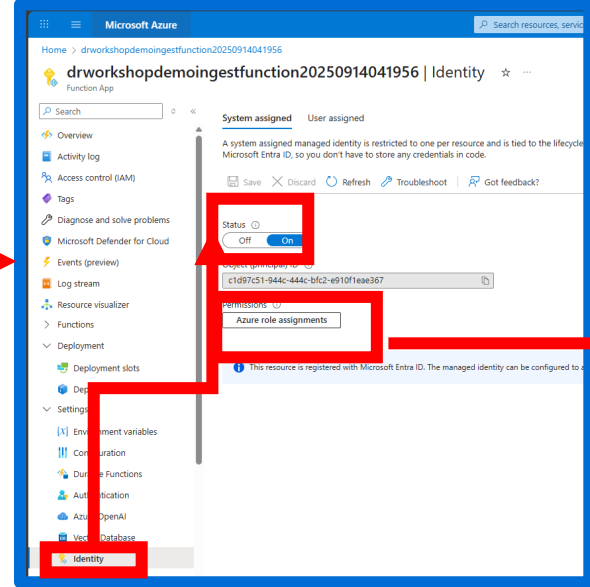
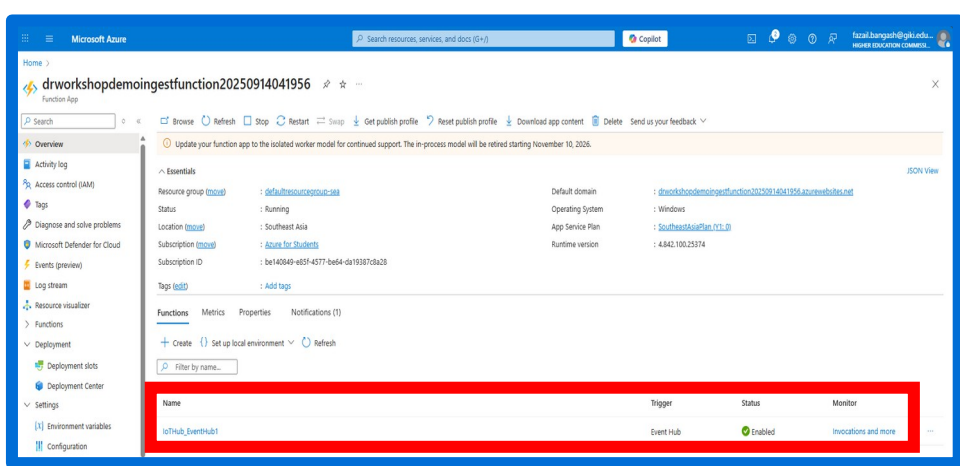
azure.core Include prerelease

	Azure.Core by azure-sdk, Microsoft, 2.47B downloads 1.48.0 This is the implementation of the Azure Client Pipeline
	Azure.Core.Amqp by azure-sdk, Microsoft, 226M downloads 1.3.1 This library contains AMQP model types used by Azure libraries.

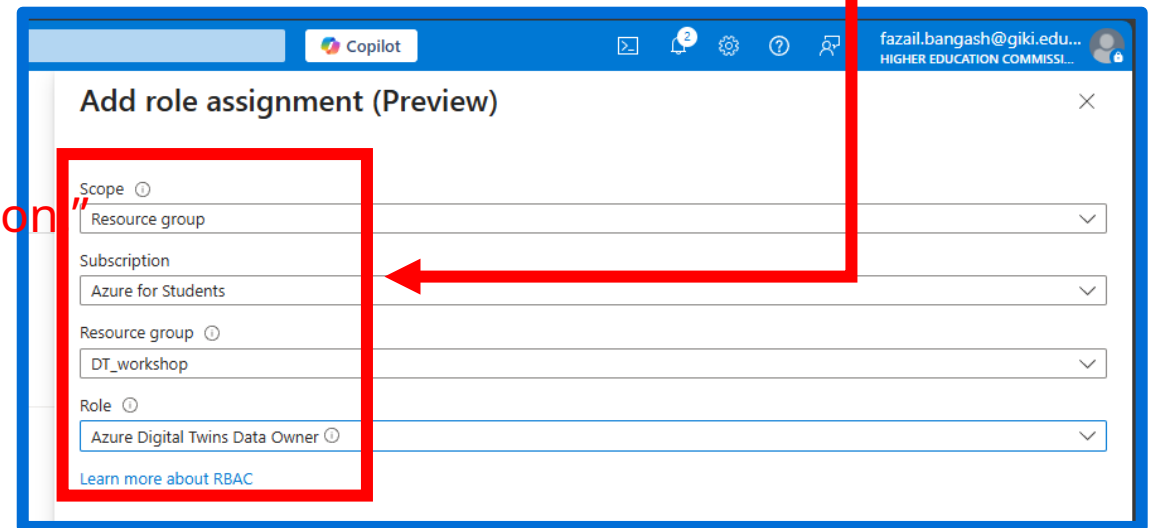
Publishing the Functions app to Azure



Connecting Azure IoT Hub to Function App



- It tells Azure: "Whenever a device sends telemetry, trigger this function"



Setting up Environmental Variable

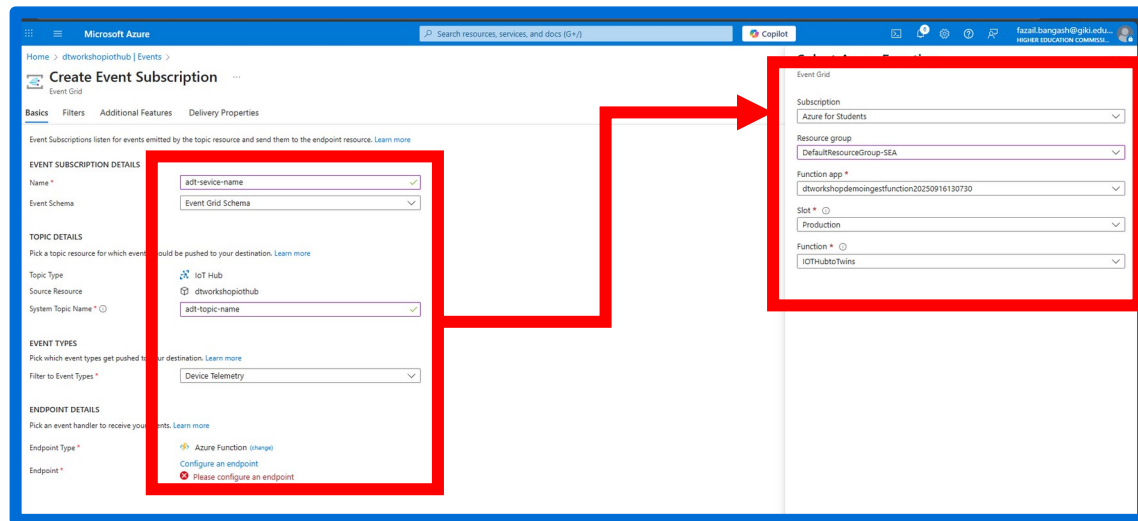
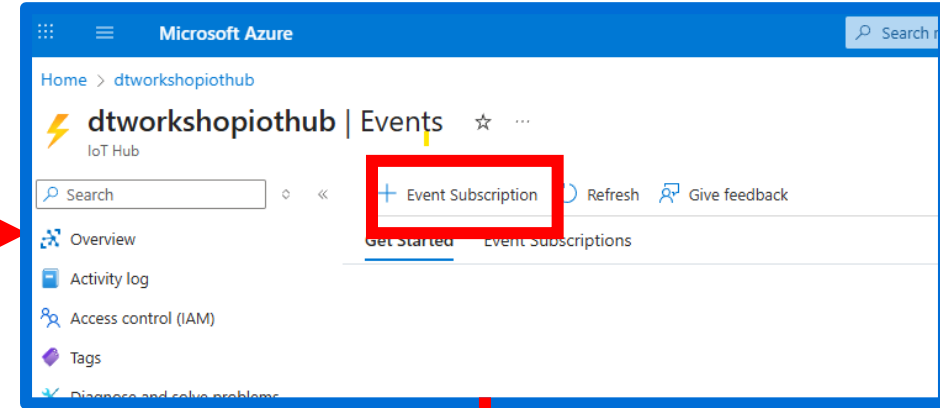
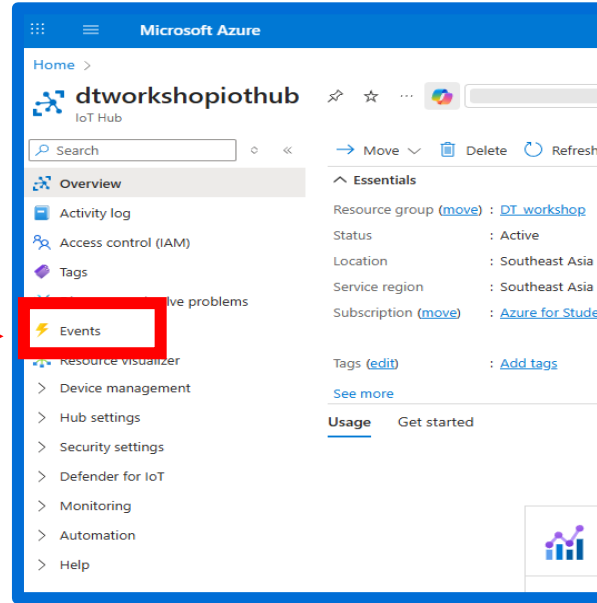
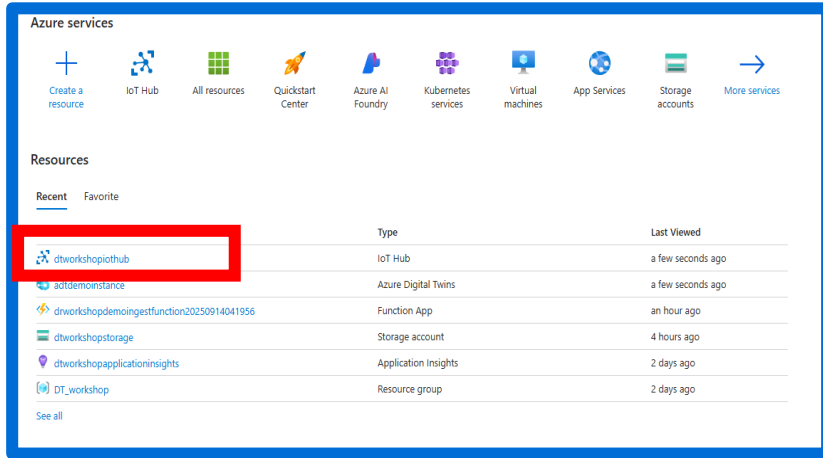
- Copy the host name from Dtinsatnce and paste here

The process involves the following steps:

- View the function app overview to identify the default domain: `drworkshopdemoingestfunction20250914041956.azurewebsites.net`.
- Navigate to the Configuration page of the function app.
- Click on the Configuration tab to view application settings.
- Click the 'Add' button in the 'App settings' table to create a new environment variable.
- Enter the name 'ADT_SERVICE_URL' and the value 'https://drworkshopdemoingestfunction20250914041956.azurewebsites.net'.
- Click 'Apply' to save the settings.
- Return to the Configuration page and click on the 'Environment variables' link to manage the newly added variable.

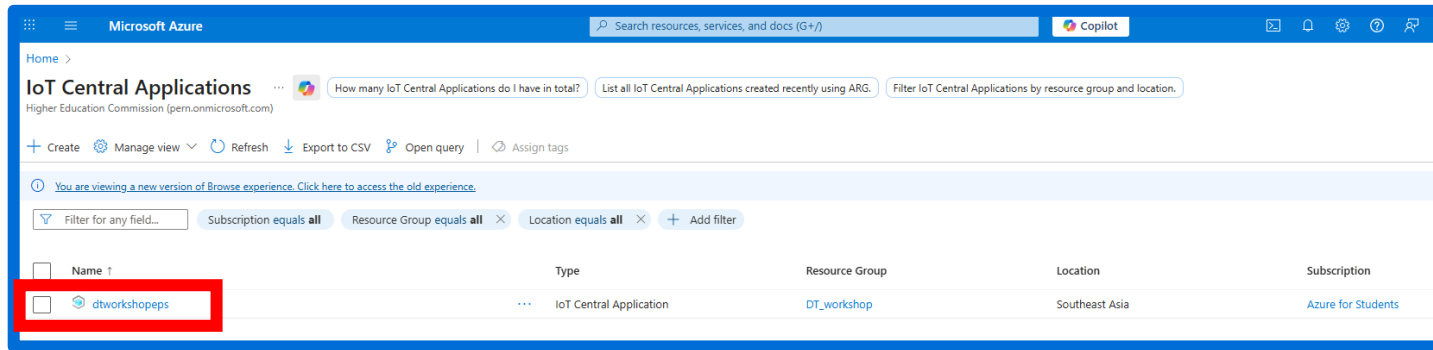
- We need to setup an EV to make "url" of our DTinsatnce accessible to our function app

Setting IoT Hub to Send Messages to App

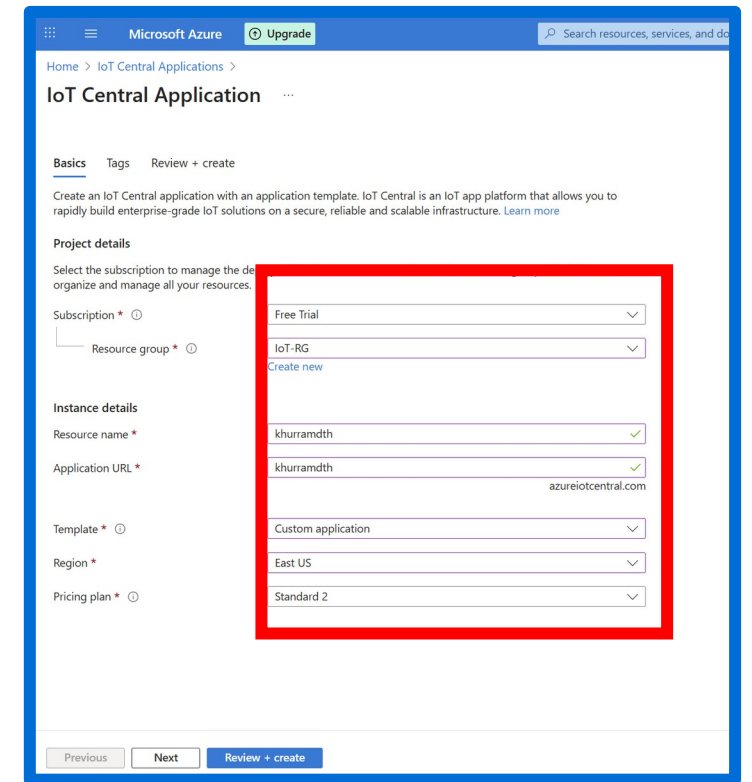
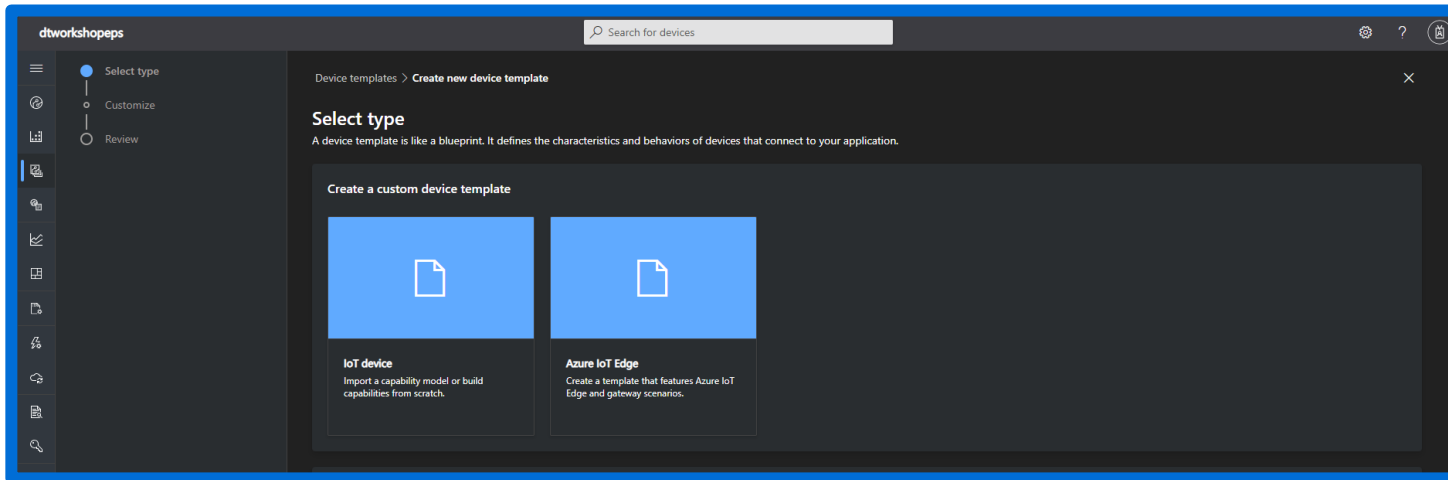


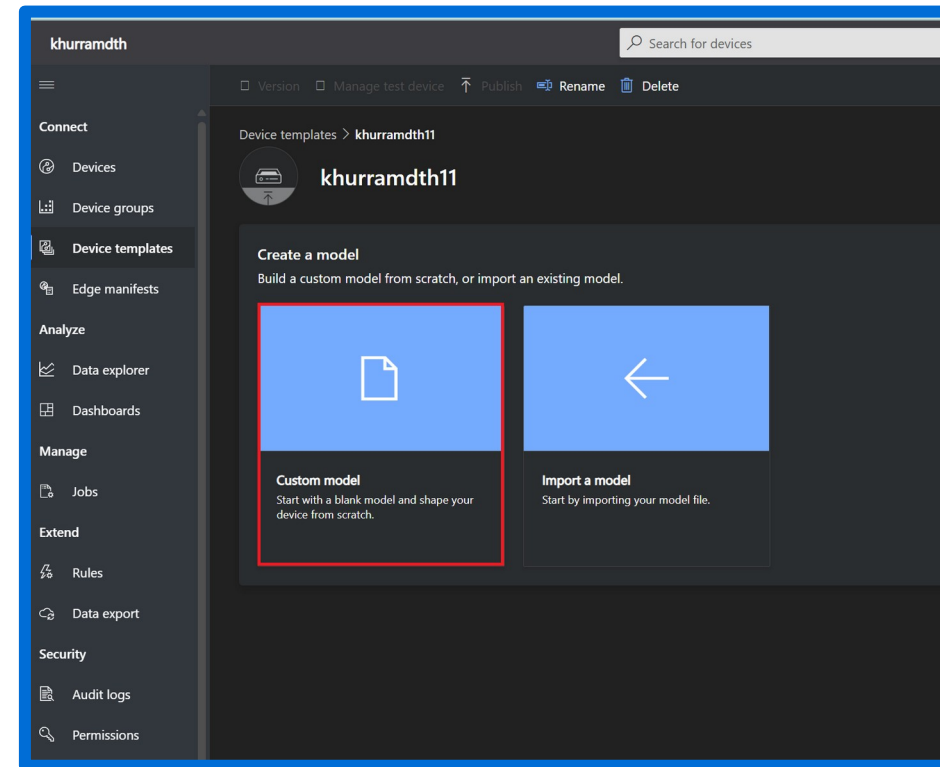
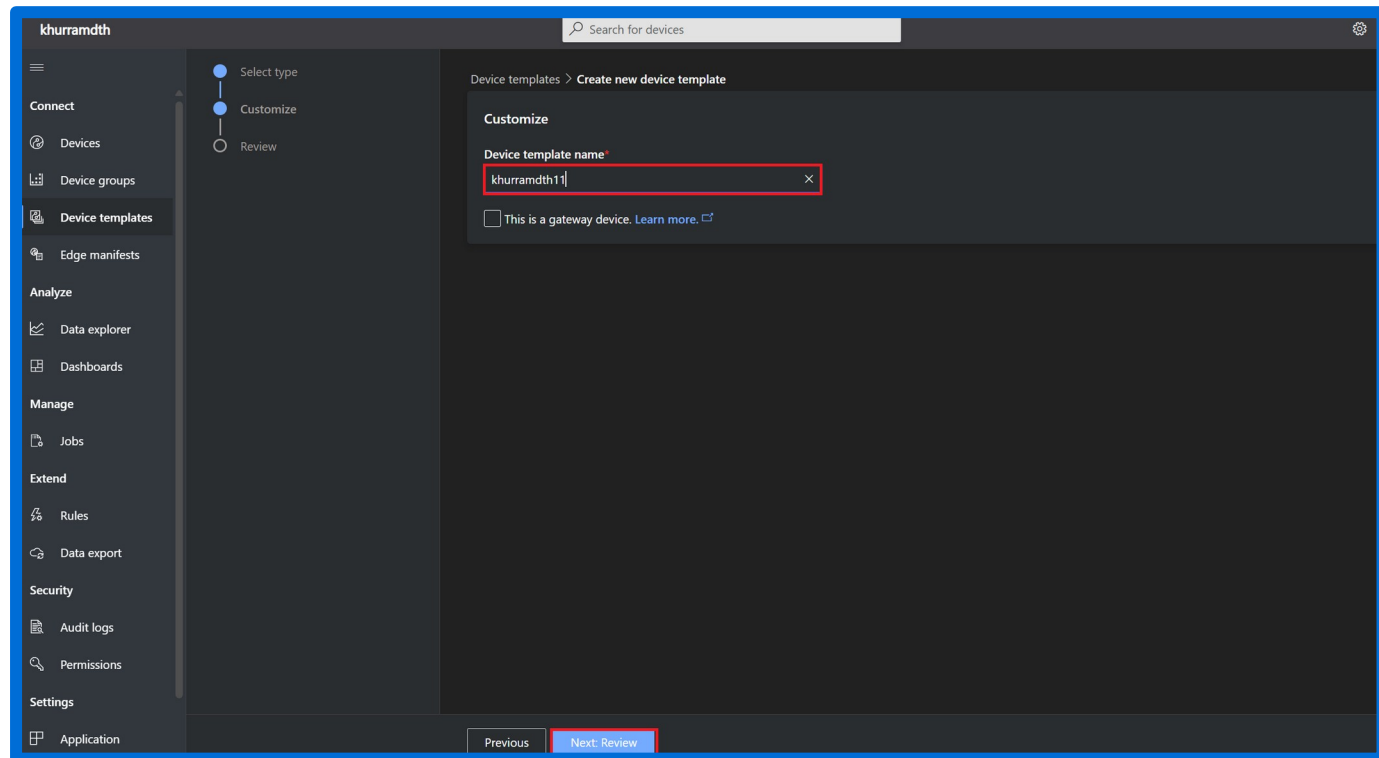
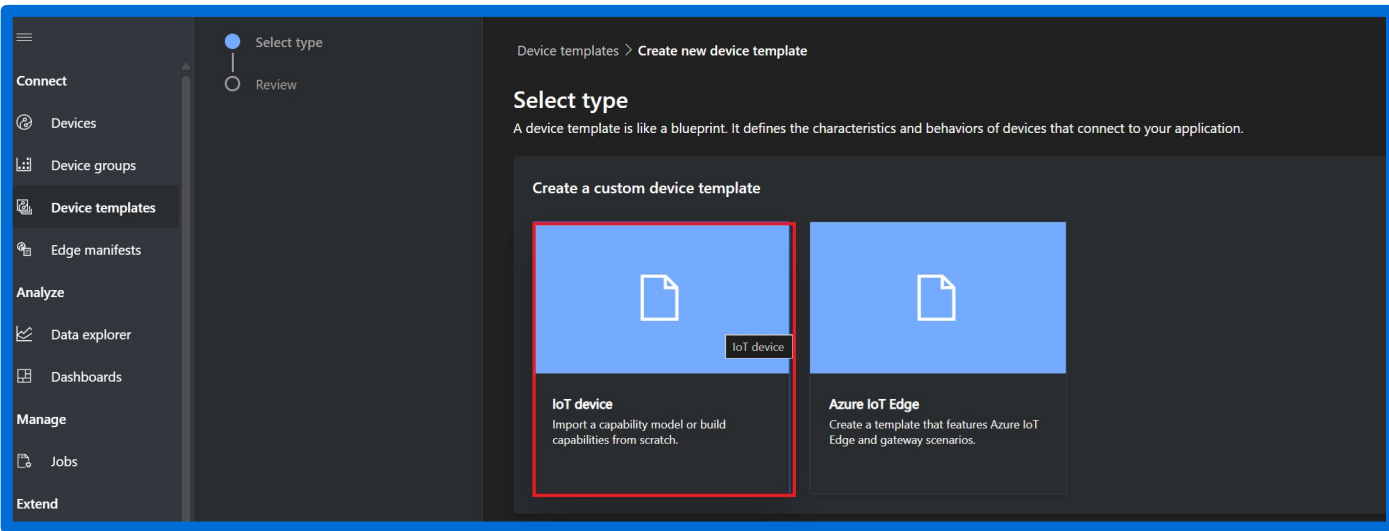
- To connect function app to iotHub, we need to setup coming device messages as Events

IoT Central App



- Live data setting





khurramdth11

Search for devices

Version Manage test device Publish Rename Delete

Device templates > khurramdth11 > Model > khurramdth11

khurramdth11
Application updated: Never Interfaces published: Never

Model

khurramdth11

Raw data

Views

khurramdth11 Root Draft

Add capabilities specific to this device model. [Learn more](#)

Save + Add capability Edit identity Export Delete ... Edit DTDL

Display name	Name *	Capability type *	Semantic type		
Temperature	Temperature	Telemetry	Temperature	X	∨
Humidity	Humidity	Telemetry	Humidity	X	∨

+ Add capability



khurramdth11

Version Manage test device Publish Rename Delete

Device templates > khurramdth11 > Model > khurramdth11

khurramdth11
Application updated: Never Interfaces published: Never

Model

khurramdth11

Raw data

Views

khurramdth11 Root Draft

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Temperature	Temperature	Telemetry	Temperature	X	∨
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+ Add capability



Publish Rename Delete

ews > New

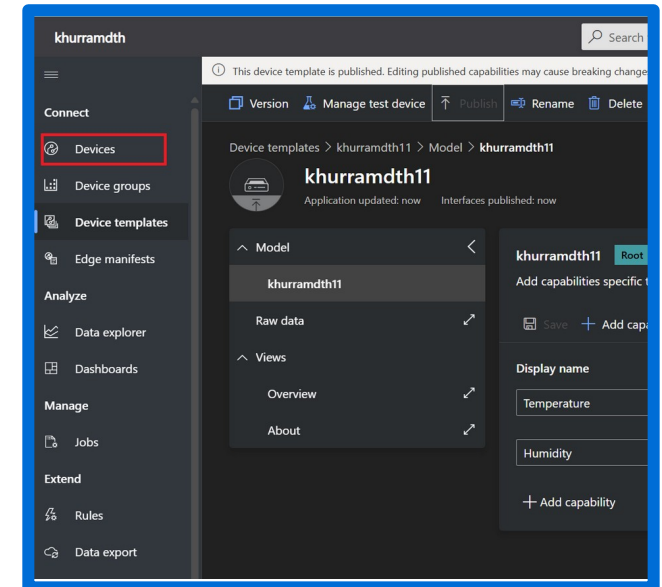
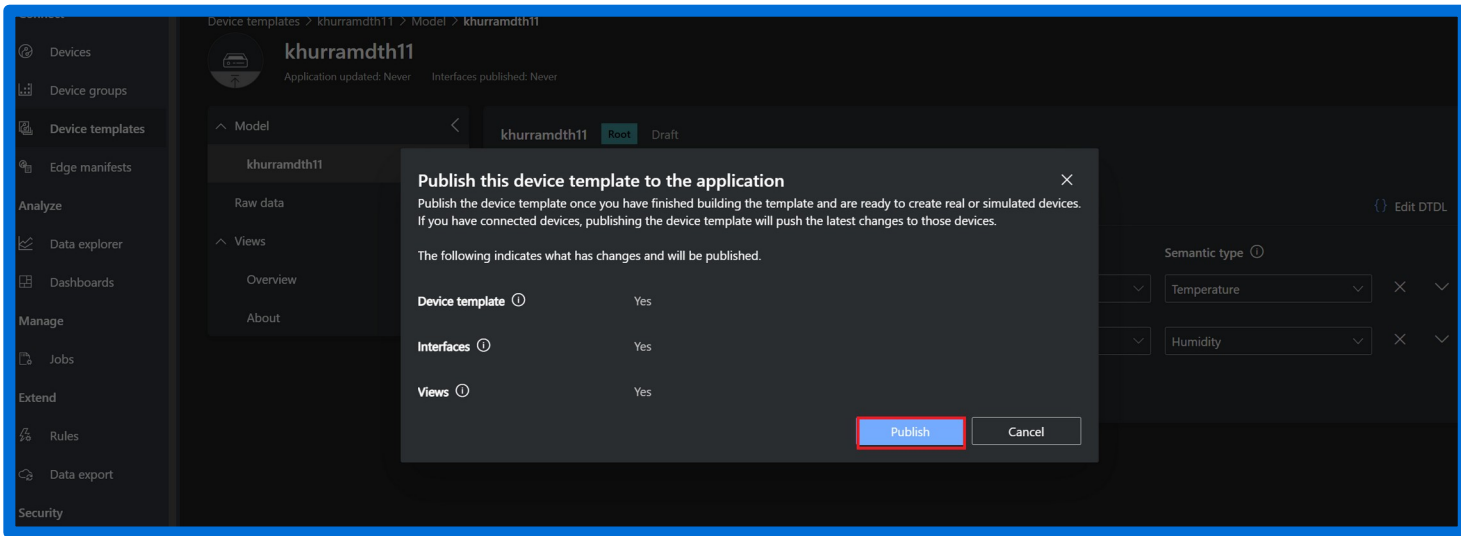
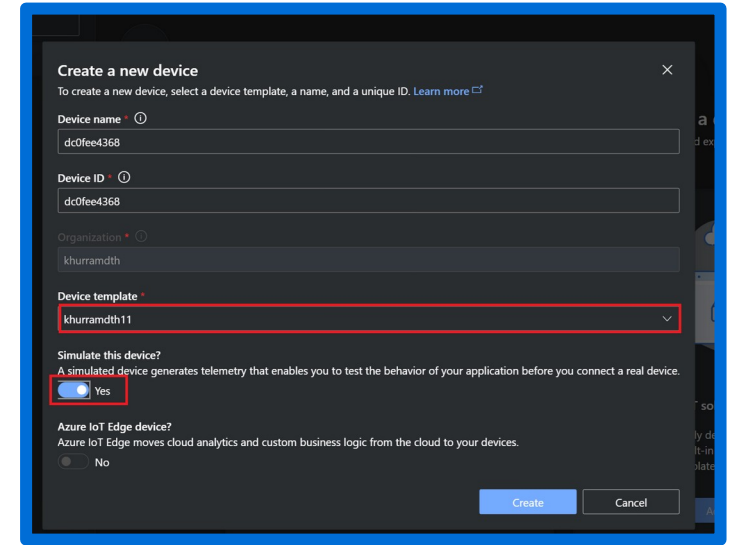
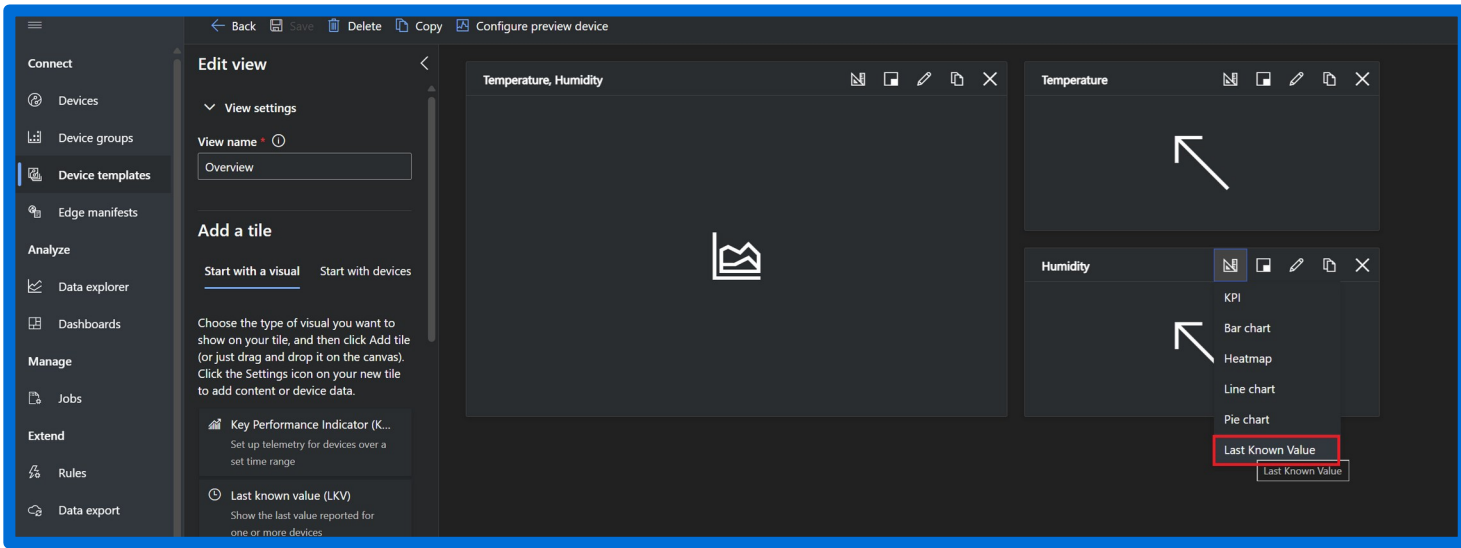
Interfaces published: Never

Select to add a new view

Editing device and cloud data
Use this view to create a form to edit and view properties defined in your capability model and solution model

Visualizing the device
Use this view to create a rich dashboard of the capability model using an array of charts, gauges and metrics tiles

Generate default views
Generate default device views to quickly begin displaying device information within an intuitive dashboard experience



Devices

Filter templates

All devices

Device explorer helps you see all your devices. Detailed information like device raw data helps you troubleshoot. [Learn more](#)

Device name	Device ID	Device template	Organization
dc0fee4368	dc0fee4368	khurramdth11	khurramdth

Device ID

- dc0fee4368

Device template ID

- dtmit:bnont50:119pmkgk

Properties



dc0fee4368

Connected | Last data received: 9/16/2025, 9:54:14 PM | SIMULATED | Organization: khurramdth

About **Overview** Raw data Mapped aliases Files

Temperature, Humidity

Temperature Humidity

58.61

Average, Past 12 hours

46.79

Average, Past 12 hours

08:25 PM 16/09/2025 09:56 PM 16/09/2025