CAPSTONE PROJECT

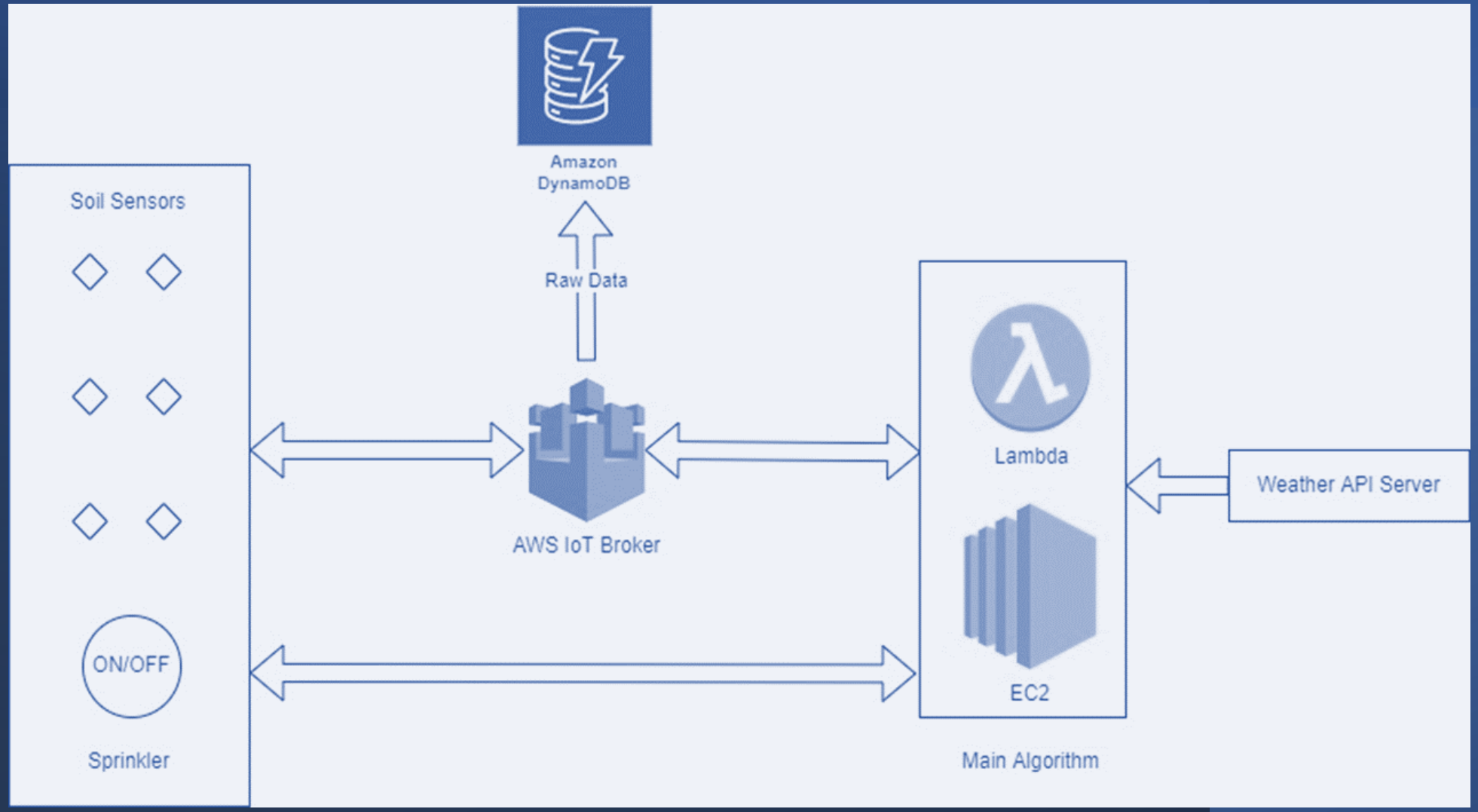
AGRI-TECH-FARM WATER MANAGEMENT

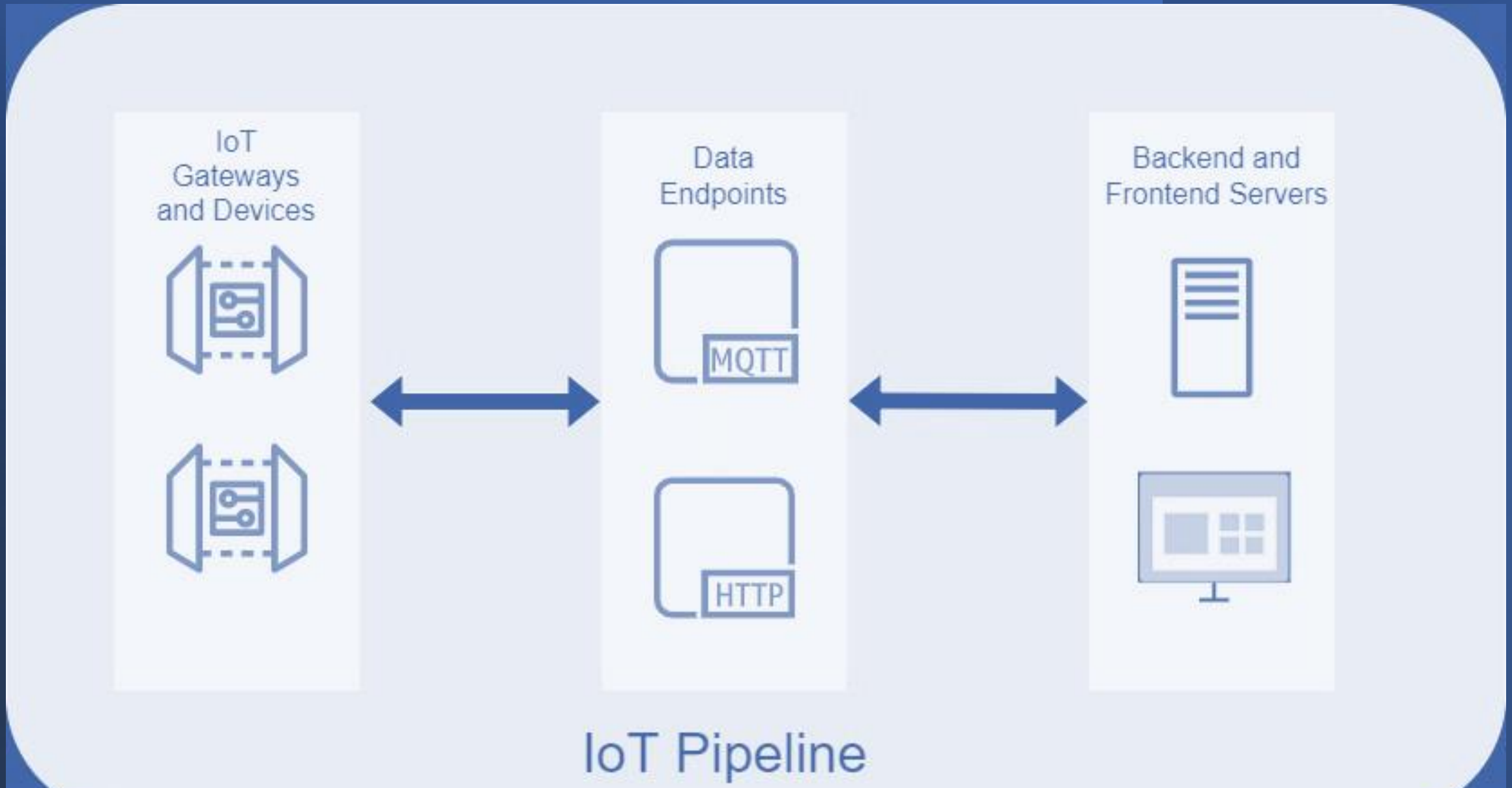
IIT Madras ACSE – August'21 Batch

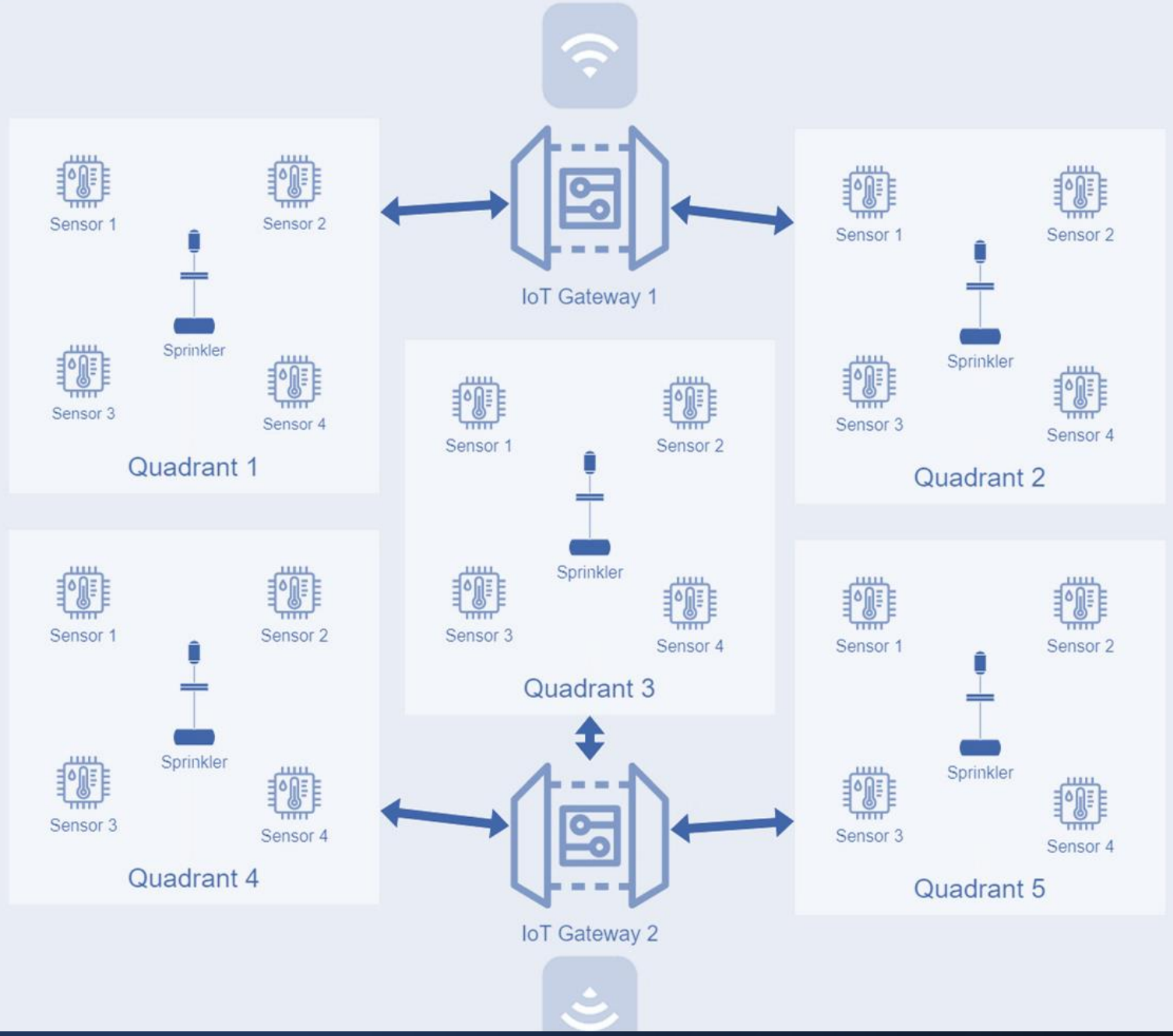
IOT Capstone Micro Group - 4

- Priyesh Rathore (Group Lead)
- Arup Ray
- Sudhakar Deekollu
- Abdullah Sholapur

High Level Architecture

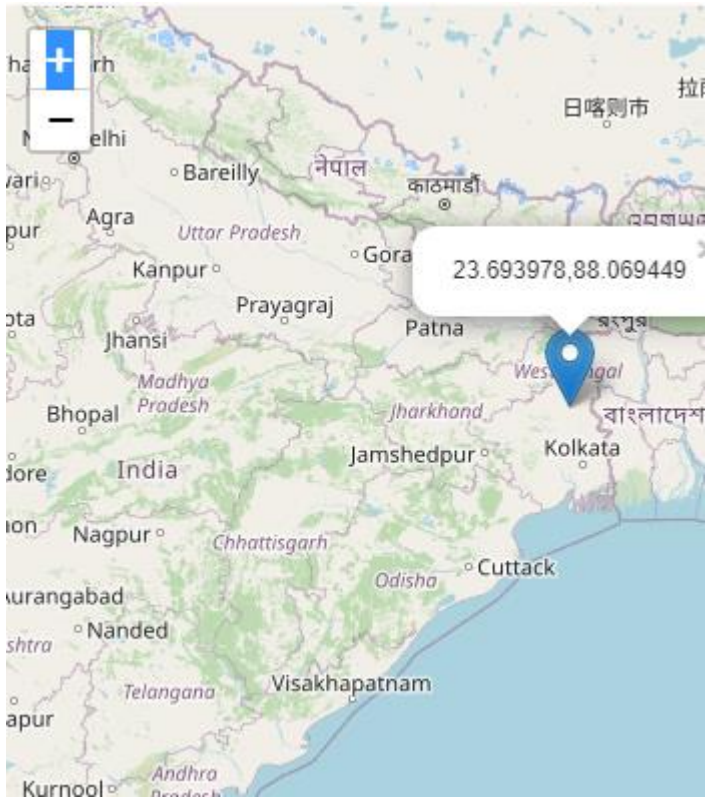



IoT
Gateways
and Devices
Data
Endpoints
MQTT
HTTP
Backend and
Frontend Servers
IoT Pipeline



- Farm is divided into 5 Quadrants.
- Each Quadrant has 4 soil moisture sensors and one sprinkler.
- When at least 2 moisture sensors go below/above the threshold of pre-set values for soil moisture, sprinkler will turn ON/OFF.
- If it is raining in the quadrant (via openweatherAPI), sprinklers won't turn ON.
- All messaging achieved through AWS IoT Core and the decision making logic working on EC2.

Location of Agricultural Land



Sprinkler to Sprinkler Distance ~ 350 Mt
Sprinkler to Sensor Distance ~ 55 Mt

Location of Sprinklers

Latitude & Longitude of Sprinklers & Sensors

			Sensor5C											Sensor2C					
			23.696863	88.067579										23.696863	88.072179				
Sensor5B			Sprinkler 5			Sensor5D						Sensor2B			Sprinkler 2				Sensor2D	
23.696363	88.067079		23.696363	88.067579		23.696363	88.068079					23.696363	88.071679		23.696363	88.072179			23.696363	88.07268
			Sensor5A												Sensor2A					
			23.695863	88.067579											23.695863	88.072179				
									Sensor1C											
									23.694563	88.069879										
						Sensor1B			Sprinkler 1			Sensor1D								
						23.694063	88.069379		23.694063	88.069879		23.694063	88.070379							
									Sensor1A											
									23.693563	88.069879										
			Sensor4C											Sensor3C						
			23.692263	88.067579										23.692263	88.072179					
Sensor4B			Sprinkler 4			Sensor4D						Sensor3B			Sprinkler 3				Sensor3D	
23.691763	88.067079		23.691763	88.067579		23.691763	88.068079					23.691763	88.071679		23.691763	88.072179			23.691763	88.07268
			Sensor4A												Sensor3A					
			23.691263	88.067579											23.691263	88.072179				

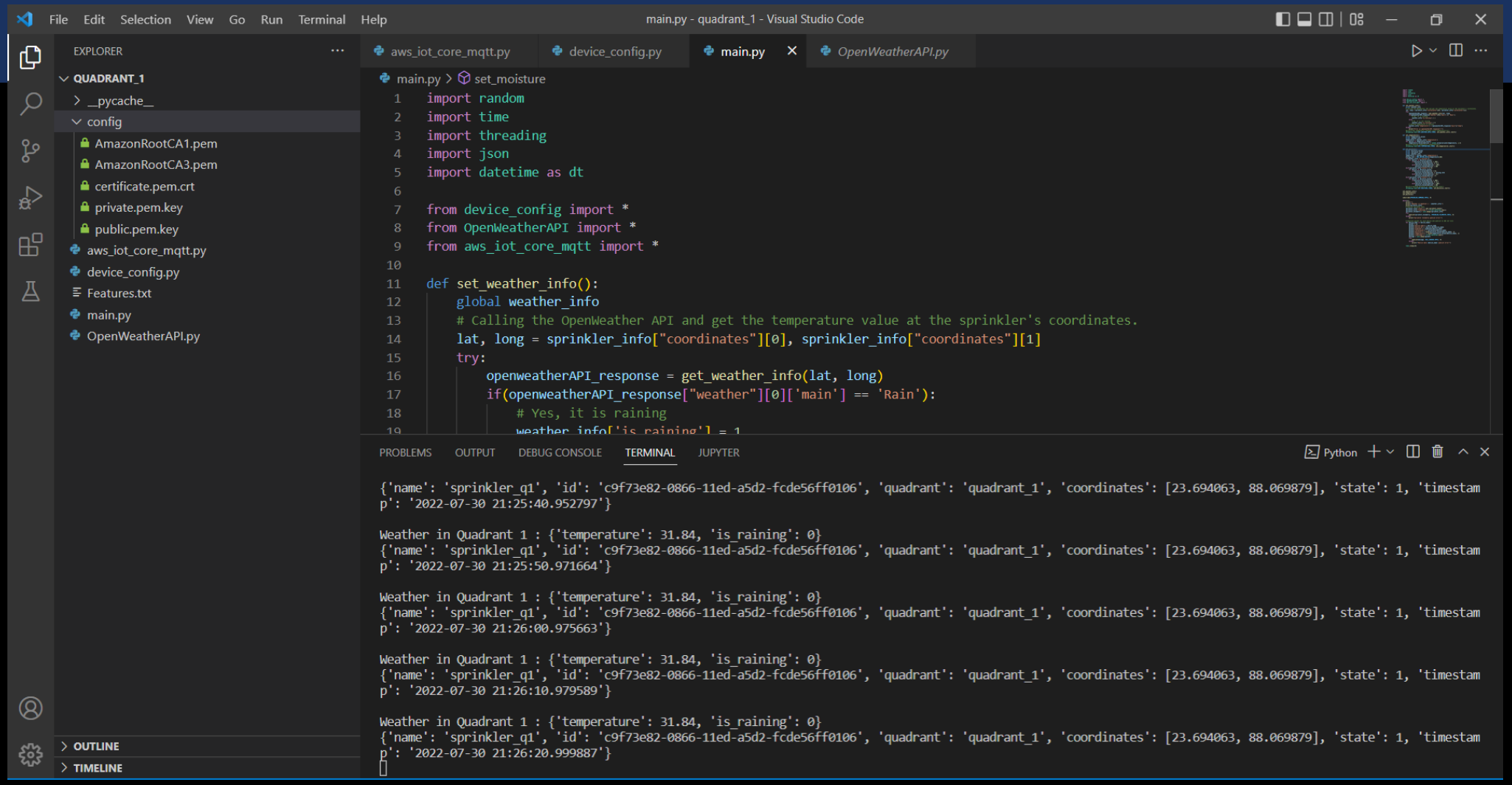
Major Components

- **Simulators:**
  - Soil sensors and Sprinkler (actuator) simulators.
  - Soil sensors simulators send simulated moisture values which depend on rain, sprinkler state and quadrant temperature.
  - Group of 4 soil sensors and 1 sprinkler for each quadrant is registered as an IoT thing in AWS IoT Core.
  - Usage of OpenweatherAPI for rain and temperature parameters.
  - Connected to AWS IoT Core MQTT for pub/sub. Publishes soil sensors data and sprinkler telemetry periodically.
  - Subscribed to sprinkler topics for ON/OFF actuation.
- **Backend & Frontend Components:**
  - DynamoDB for storing all the static device information (name, type, id, coordinates)
  - AWS IoT Core for receiving and sending MQTT data.
  - EC2 as main decision-making and data ingestion component.
  - EC2 is registered as a thing in IoT Core for Pub/Sub. Subscribes to all topics for sensor and sprinkler telemetry and publishes sprinkler ON/OFF commands to appropriate topics.
  - InfluxDB for application data (hosted at the EC2) as well as visualization Dashboards.
  - Open Weather API integrated in backend (EC2) for weather monitoring purposes.
  - Web GUI based device provisioning application.

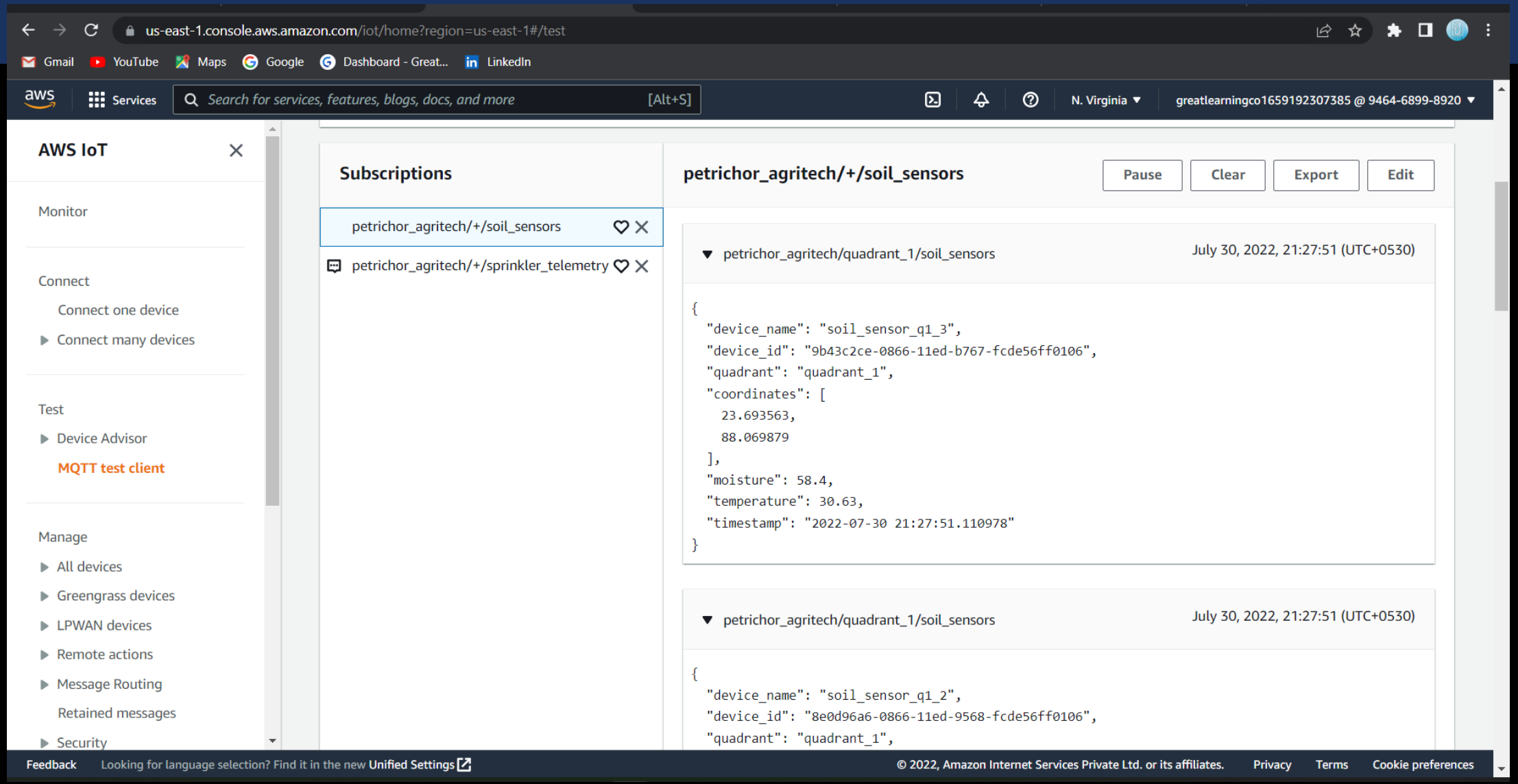
MQTT TOPIC(S) STRUCTURE

TOPIC NAME	TOPIC STRUCTURE	TOPIC EXAMPLE
SOIL SENSOR TOPIC	<company name>/<quadrant>/soil_sensors	"petrichor_agritech/quadrant_1/soil_sensors“
SPRINKLER_TELEMETRY_TOPIC	<company name>/<quadrant>/sprinkler_telemetry	"petrichor_agritech/quadrant_1/sprinkler_telemetry"
SPRINKLER_COMMAND_TOPIC	<company name>/<quadrant>/sprinkler_command	"petrichor_agritech/quadrant_1/sprinkler_command"

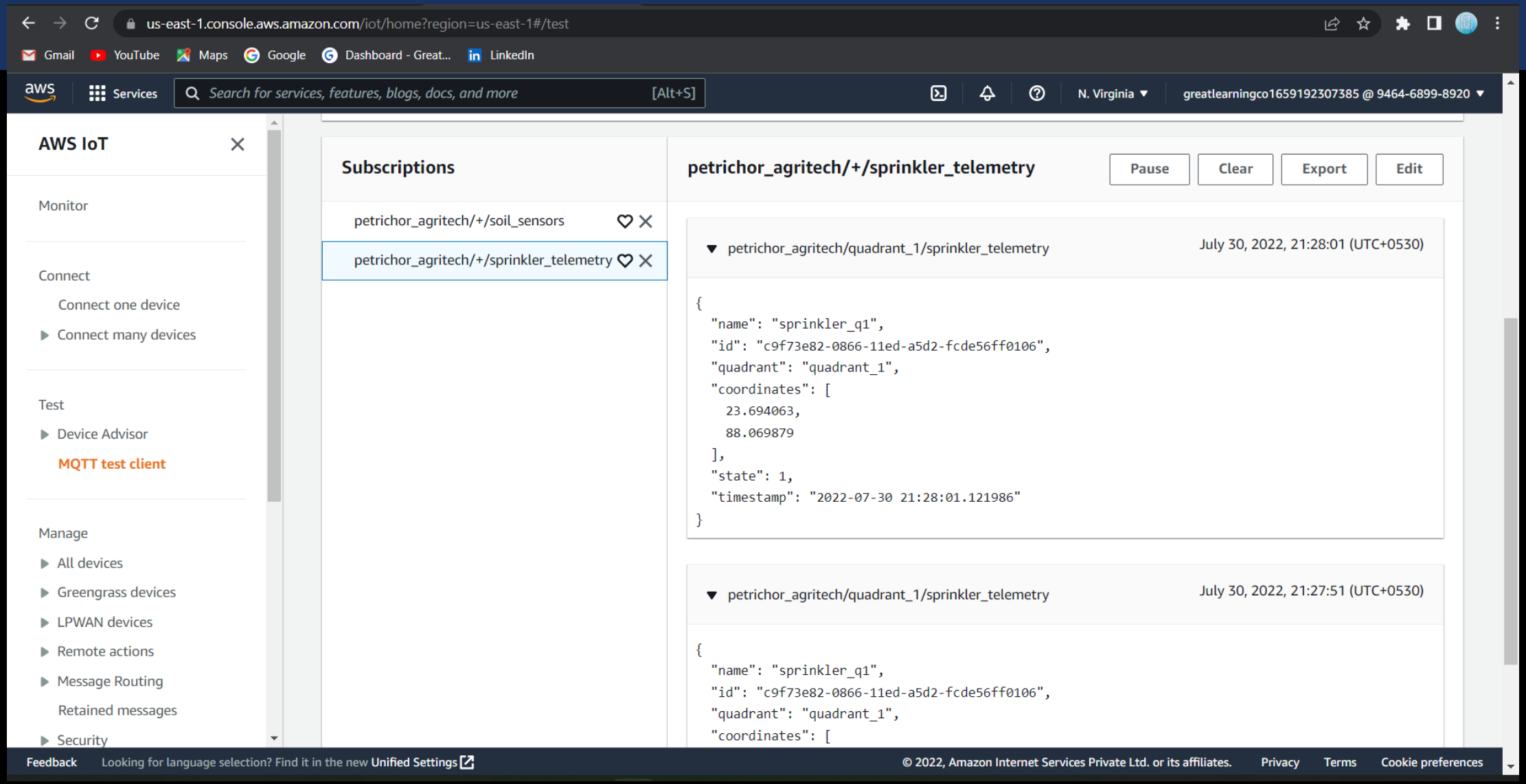
SIMULATOR RUNNING



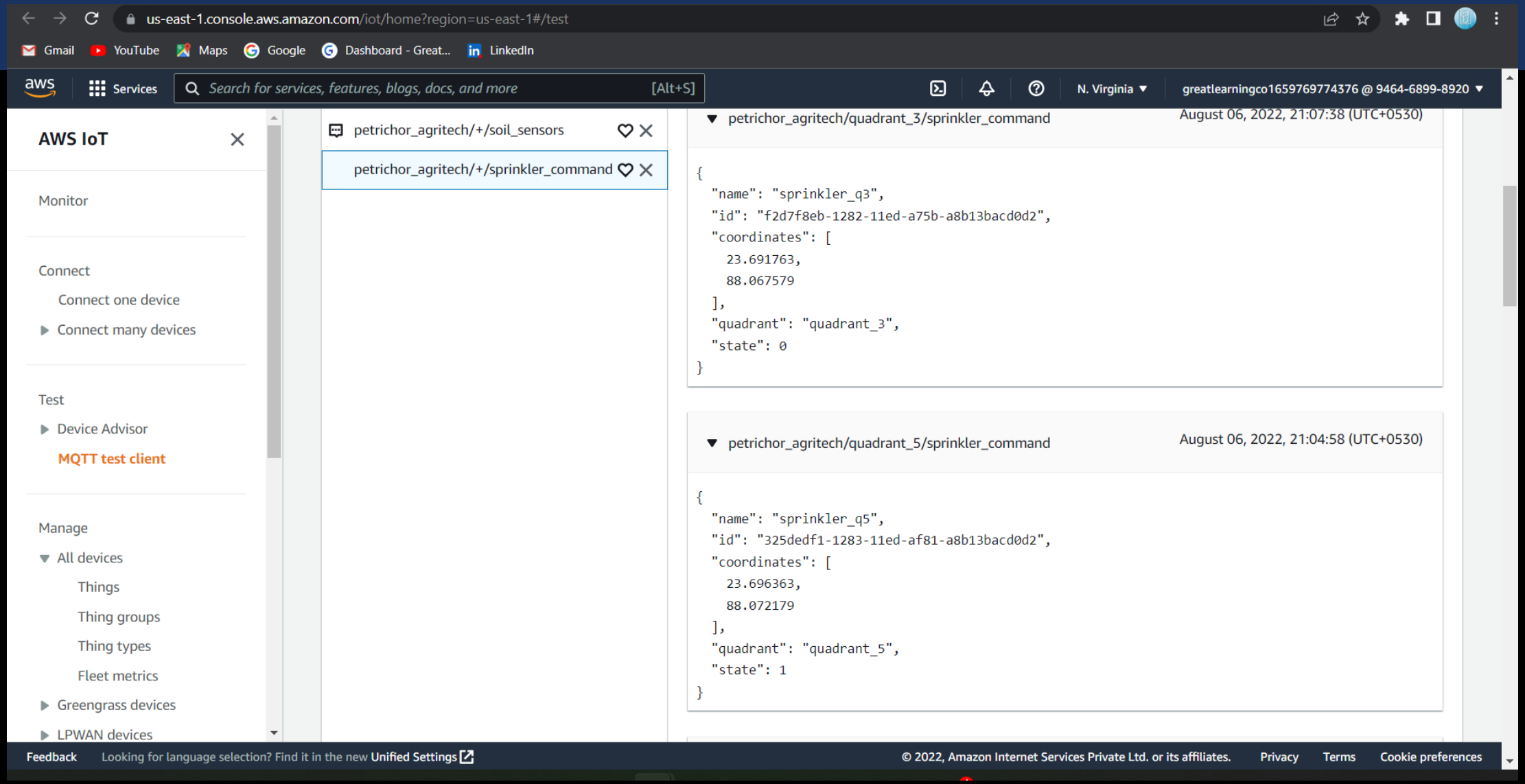
AWS IOT CORE RECEIVING MQTT DATA



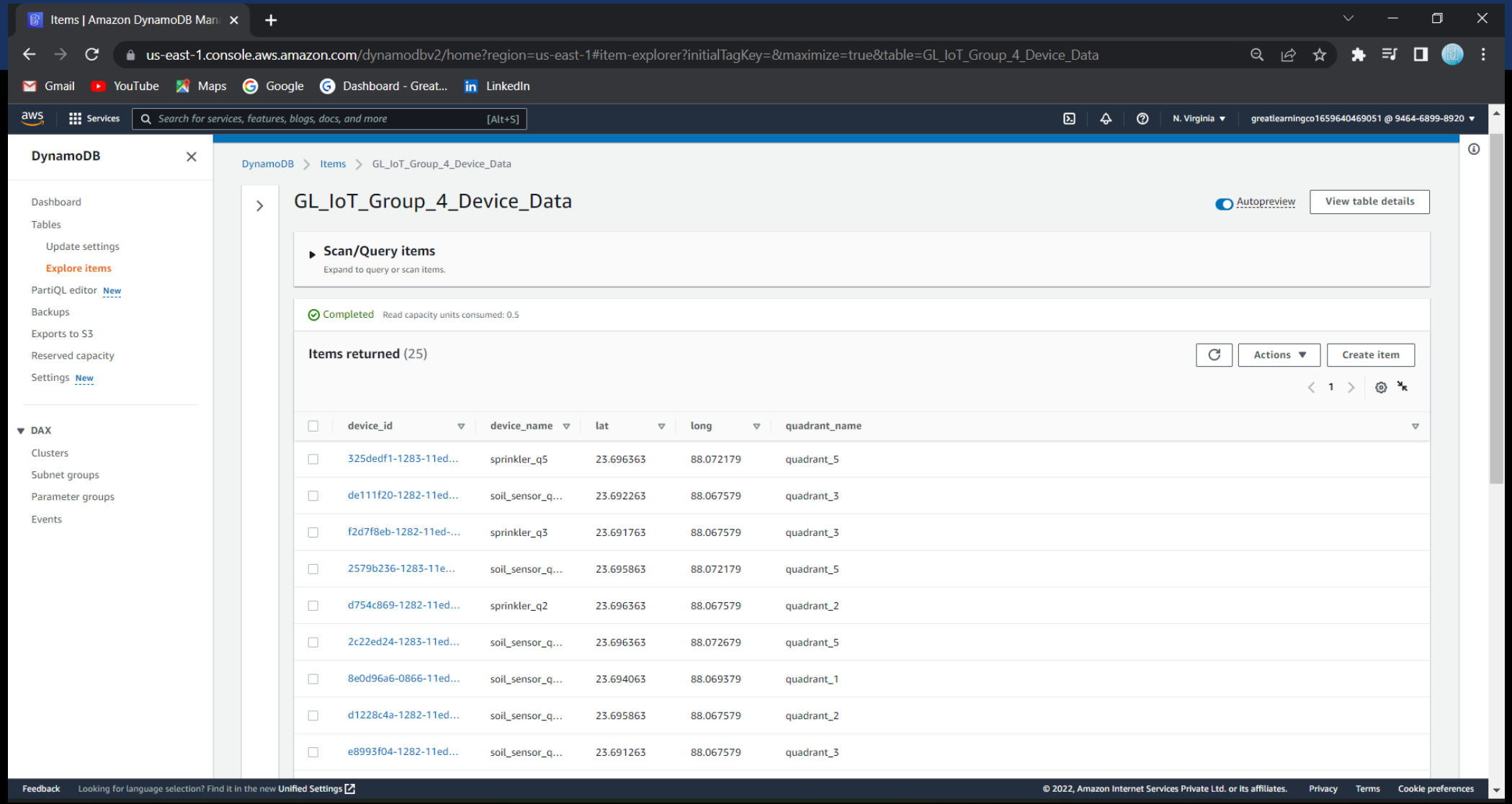
AWS IOT CORE RECEIVING MQTT DATA



AWS IOT CORE RECEIVING MQTT DATA



AWS DYNAMODB : STATIC DEVICE INFORMATION



BACKEND (EC2) RUNNING

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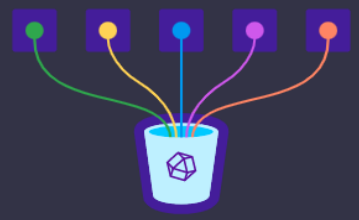
INFLUXDB HOME PAGE

Not secure | 54.196.189.22:8086/orgs/a2fc136bc3162ec2

Gmail YouTube Maps Google Dashboard - Great... LinkedIn

Getting Started

1

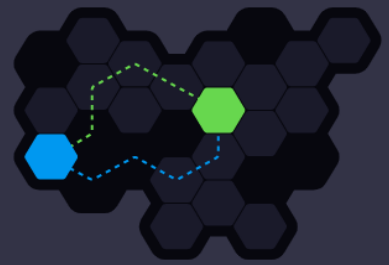


LOAD YOUR DATA

2

BUILD A DASHBOARD

3



SET UP ALERTING

Some Handy Guides and Tutorials

- Get Started with Flux
- Explore Metrics
- Build a Dashboard

Account LOGOUT

Recent Dashboards

Filter dashboards...

- Quadrant - 1 : Weather
- Quadrant 1 : Graphs
- Quadrant - 1 : Real Time
- Name this Dashboard

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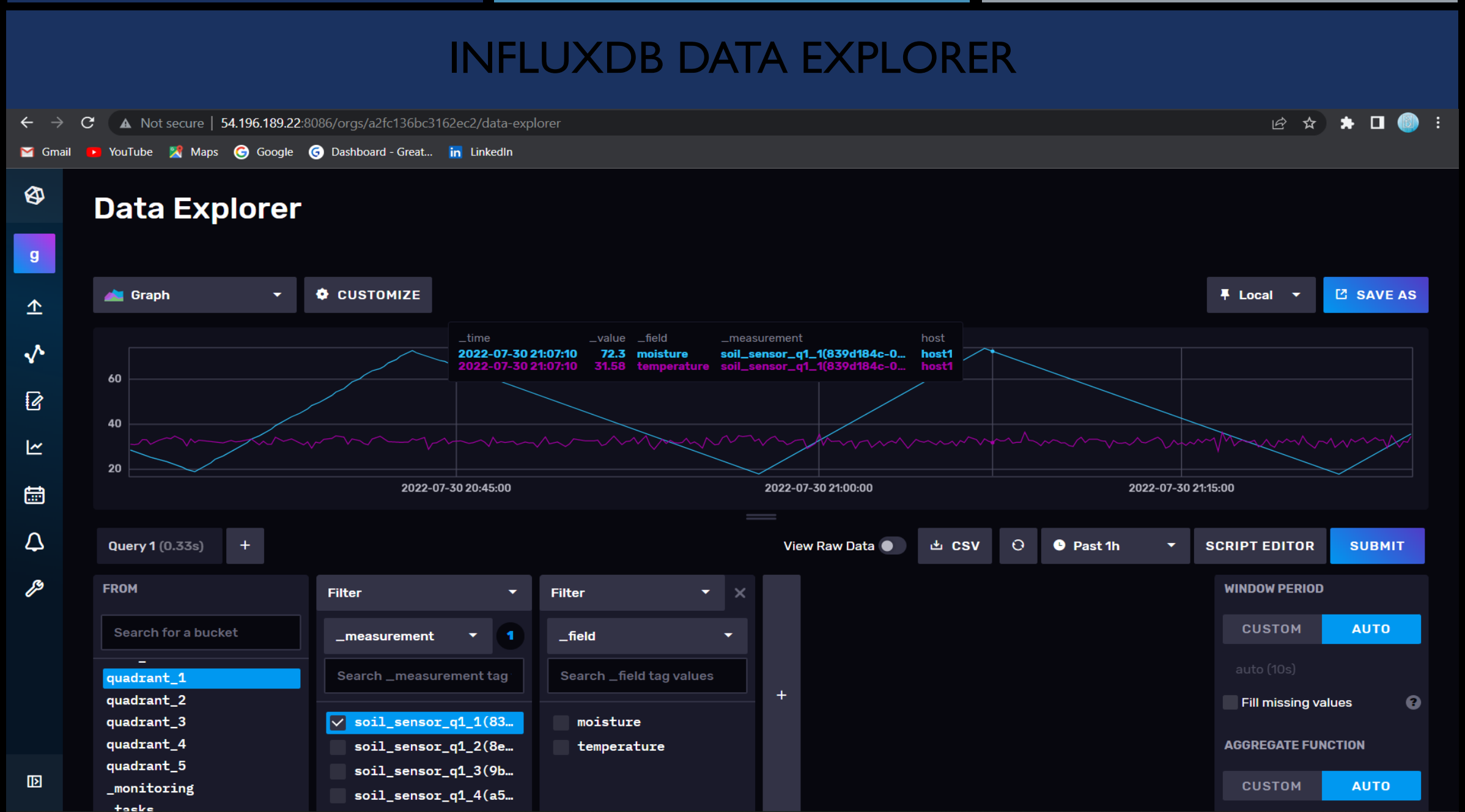
Frontend: a2bd1f3

INFLUXDB DATA EXPLORER



DASHBOARDS

Dashboards

Filter dashboards...

Sort by Name (A → Z)

+ CREATE DASHBOARD

Quadrant - 1 : Real Time
No description
Last modified 9 hours ago
q1 real_time

Quadrant - 2 : Real Time
No description
Last modified 9 hours ago
real_time q2

Quadrant - 3 : Real Time
No description
Last modified 4 hours ago
real_time q3

Quadrant - 4 : Real Time
No description
Last modified 9 hours ago
real_time q4

Quadrant - 5 : Real Time
No description
Last modified 9 hours ago
real_time q5

Quadrant 1 : Graphs
No description
Last modified 43 minutes ago
q1 graphs

Quadrant 1 : Weather
No description
Last modified 7 minutes ago
q1 weather

Quadrant 2 : Graphs
No description
Last modified 9 hours ago
q2 graphs

Quadrant 2 : Weather
No description
Last modified 6 minutes ago
q2 weather

Quadrant 3 : Graphs
No description
Last modified 9 hours ago
q3 graphs

Quadrant 3 : Weather
No description
Last modified 6 minutes ago
q3 weather

Quadrant 4 : Graphs
No description
Last modified 7 minutes ago
q4 graphs

Quadrant 4 : Weather
No description
Last modified 5 minutes ago
q4 weather

Quadrant 5 : Graphs
No description
Last modified 6 minutes ago
q5 graphs

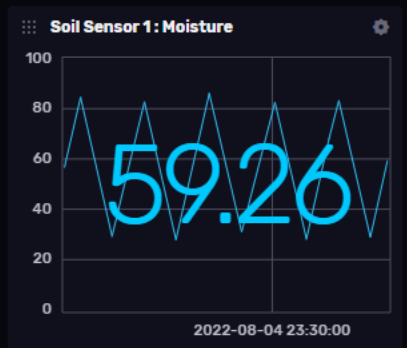
Quadrant 5 : Weather
No description
Last modified 5 minutes ago
q5 weather

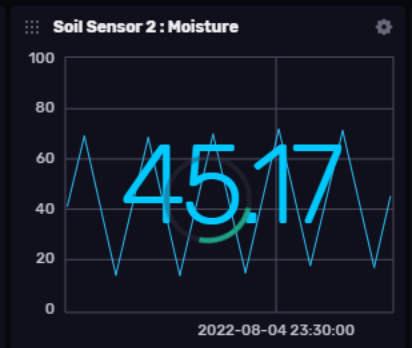
DASHBOARDS

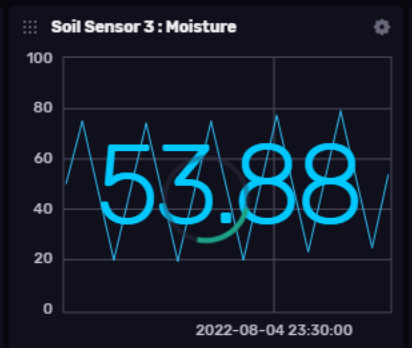
Quadrant - 1 : Real Time

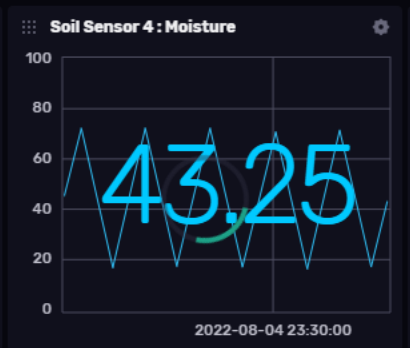
ADD CELL | ADD NOTE | Show Variables | Enable Annotations | ... | REFRESHING EVERY 10S | Local | Past 1h

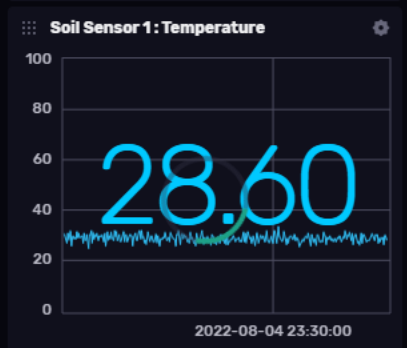
This dashboard doesn't have any cells with defined variables. Learn How

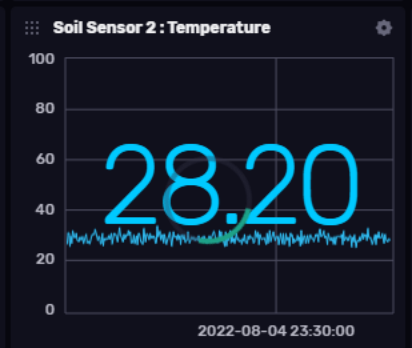


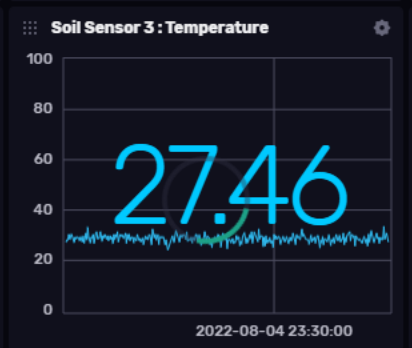


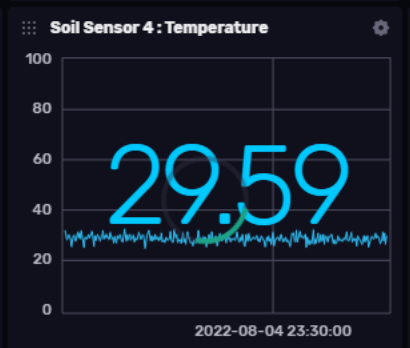


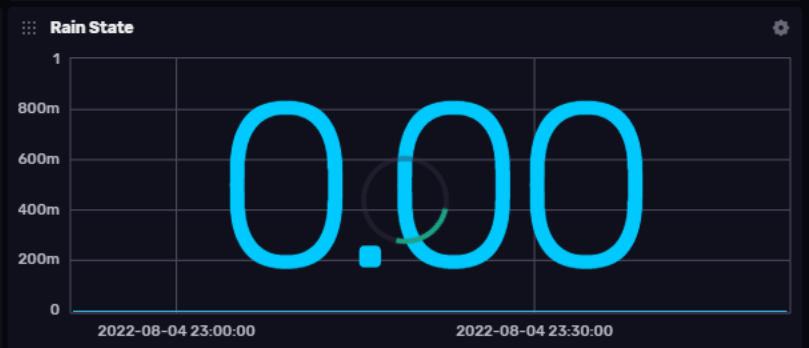










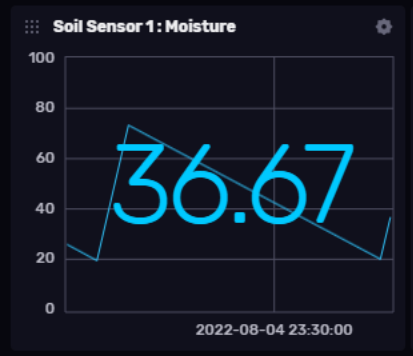


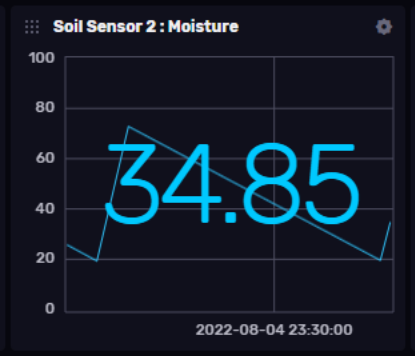
DASHBOARDS

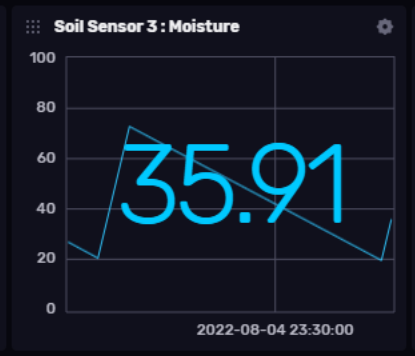
Quadrant - 2 : Real Time

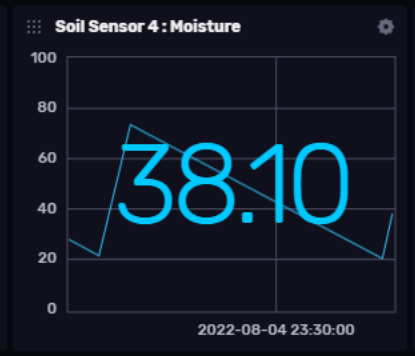
ADD CELL | ADD NOTE | Show Variables | Enable Annotations | ENABLE AUTO REFRESH | Local | Past 1h

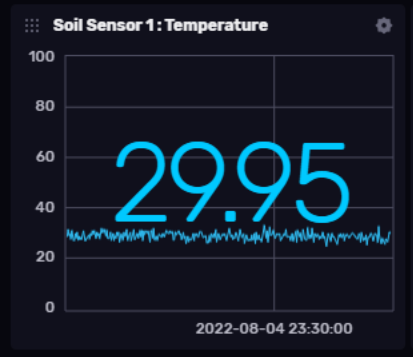
This dashboard doesn't have any cells with defined variables. Learn How

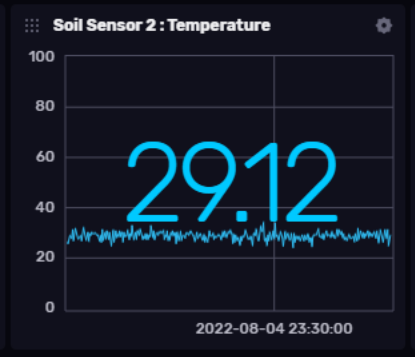


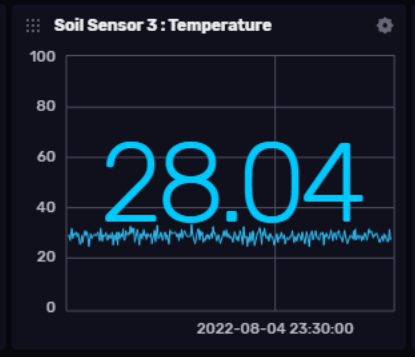


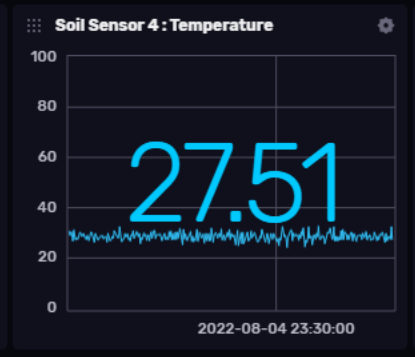












DASHBOARDS


This dashboard doesn't have any cells with defined variables. Learn How
Sensor 2
Sensor 3
_time _value _field _measurement host
2022-08-04 23:17:50 70.22 moisture soil_sensor_q1_3(9b43c2ce-0... host1
2022-08-04 23:17:50 29.45 temperature soil_sensor_q1_3(9b43c2ce-0... host1
Sensor 4
Sprinkler
Rain State

DASHBOARDS

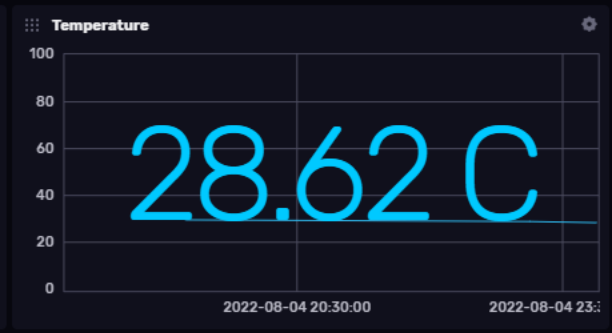

Quadrant 2 : Graphs
ADD CELL
ADD NOTE
Show Variables
Enable Annotations
ENABLE AUTO REFRESH
Local
Past 3h
This dashboard doesn't have any cells with defined variables. Learn How
Sensor 3
Sensor 4
Sprinkler
Rain State

DASHBOARDS

Quadrant 1 : Weather

ADD CELL | ADD NOTE | Show Variables | Enable Annotations | ••• | REFRESHING EVERY 10S | Local | Past 6h

This dashboard doesn't have any cells with defined variables. Learn How



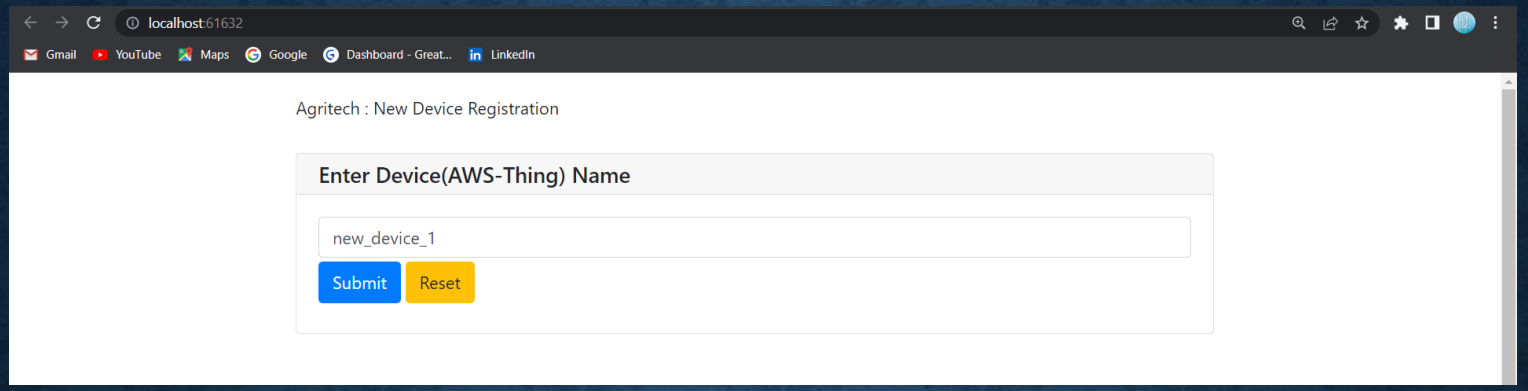
SCALABILITY

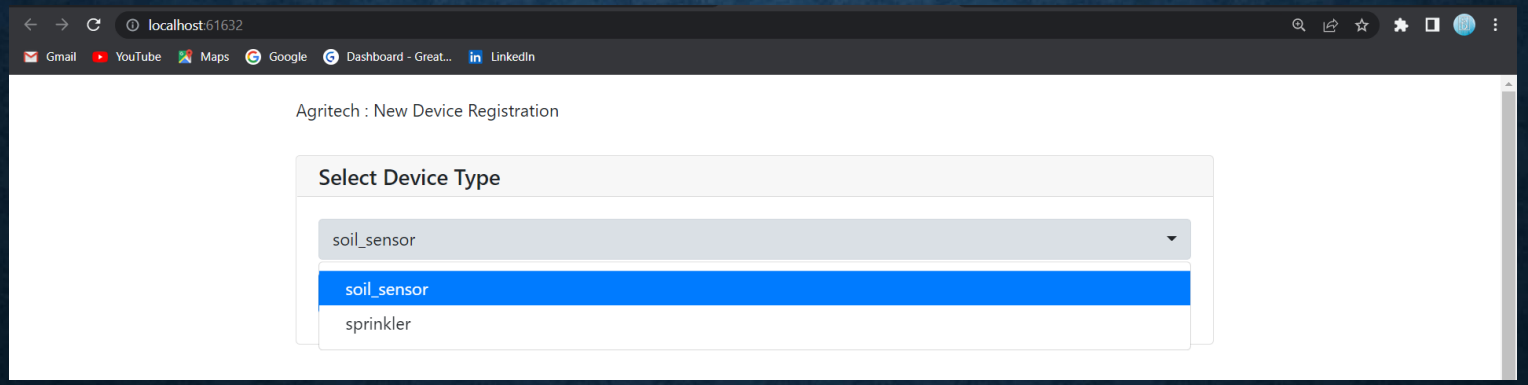
- The backend application is completely dynamic i.e. it doesn't require any hard-coding in terms of device information.
- When the backend application starts running it subscribes the MQTT topics using wildcards. So even if there is data on new topics it will still receive the data.
- Then as soon as it gets the device packets, it starts keeping and updating a real-time buffer for all the devices (soil sensors and sprinklers), maintaining real-time information for those devices.
- If it receives a MQTT message for a device that is not present in its buffer then it adds the device to the buffer, creates appropriate measurements (storage) in the InfluxDB and according to its quadrant it will start acting on its readings.
- So adding devices will be a task for the field only and the backend will automatically adjust the data ingestion and control logic as long as the MQTT topics are appropriate.
- The control logic periodically iterates over each quadrant checking all the soil sensors measurements and actuates the sprinklers if needed.

DEVICE PROVISIONING APPLICATION

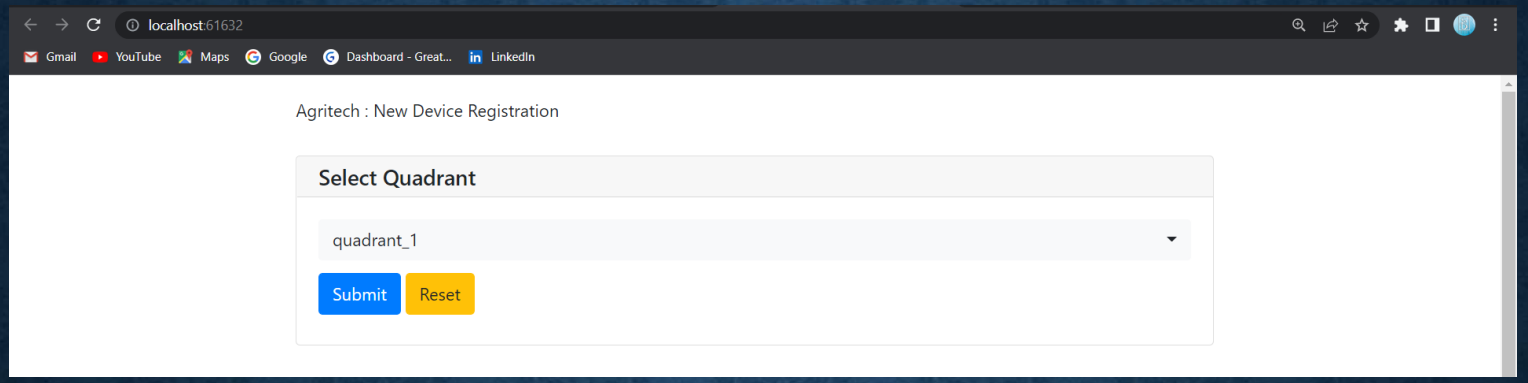
- This App is a web based GUI which takes parameters : Device Name, Device Type, Quadrant, Latitude, Longitude.
- It then generates a uuid (Unique ID) for that device.
- Then it registers it on AWS IoT Core as a thing and generates its certificates.
- It saves the certificates in a folder in the same directory.
- It also creates a DynamoDB entry for that created device.

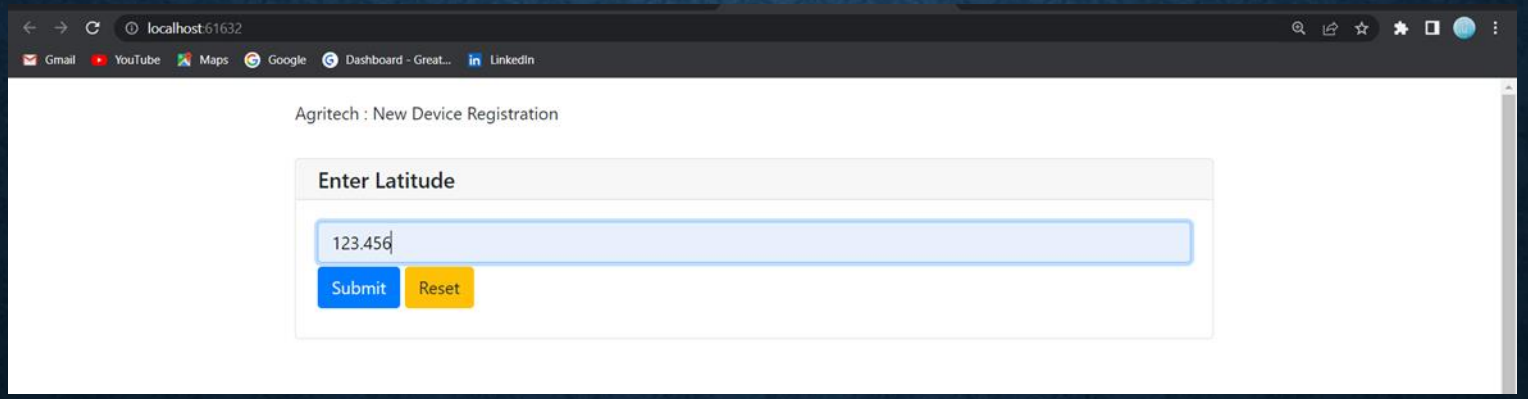
DEVICE PROVISIONING APPLICATION



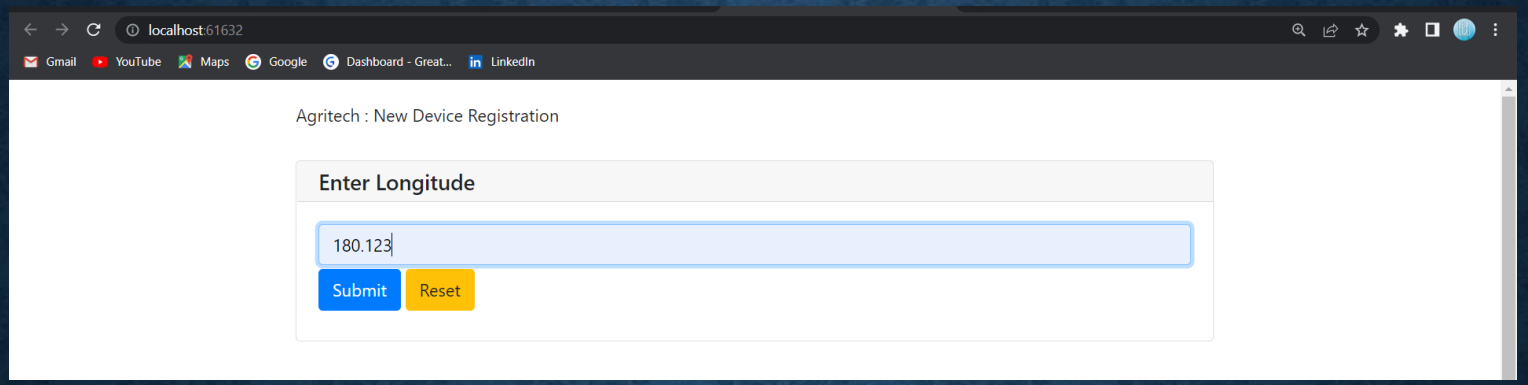


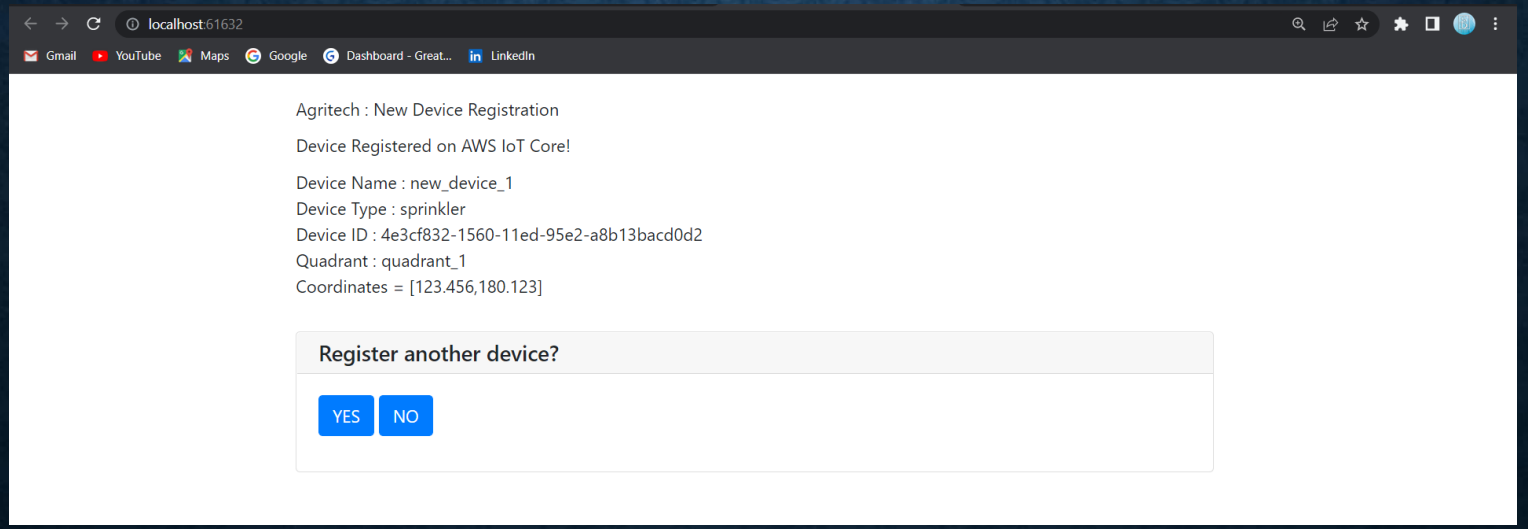
DEVICE PROVISIONING APPLICATION





DEVICE PROVISIONING APPLICATION

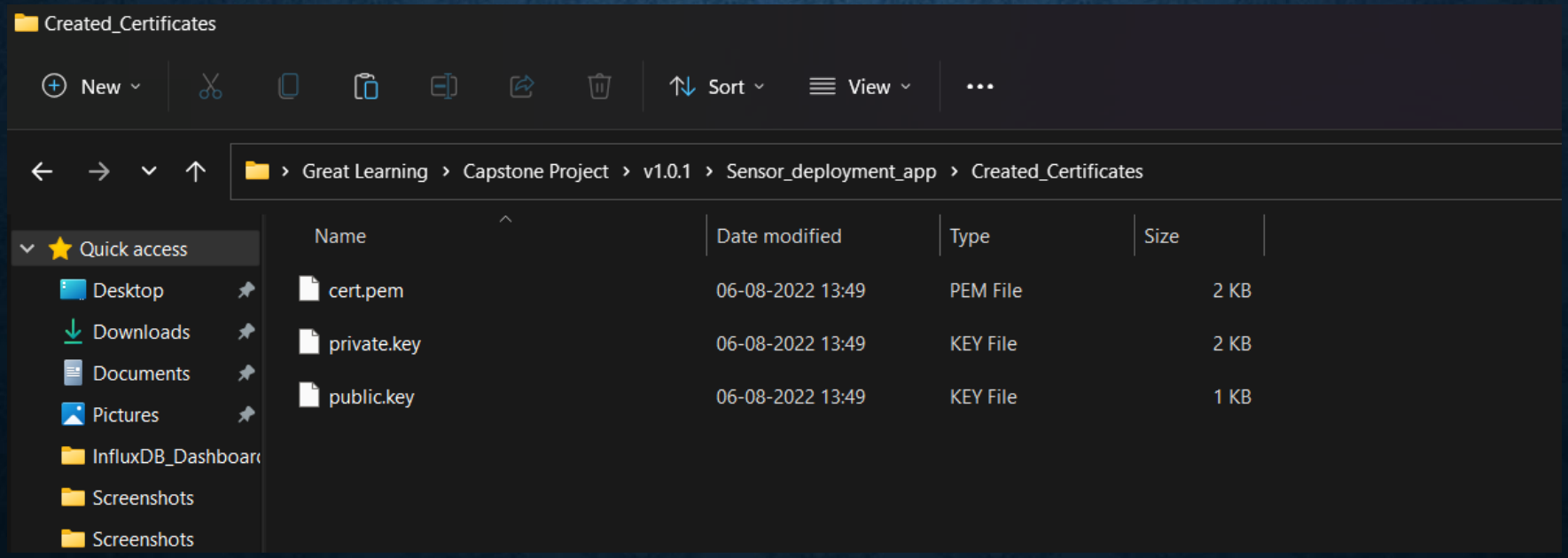




DEVICE PROVISIONING APPLICATION

- After this a new device is created on AWS IoT Core as a Thing with proper policy attached. Certificates are saved as shown below.
- A new item is inserted into the DynamoDB table.

(See code for more details.)



AREAS OF FUTURE IMPROVEMENT

- We are currently storing "cold" data into DynamoDB. This design can be improved because we can store it in S3 buckets which are better for cold-storage since we are using InfluxDB to store our real-time data.
- Process metrics can be studied and fed as inputs to improve the software architecture which is a continuous process.

THANK YOU