Hochschule für Technik
und Wirtschaft Berlin

University of Applied Sciences

Project Studies

[Semester 1: Pro-ITD]

Project Report

on

Evaluation of Cloud Computing based on IoT Platforms

By: Anusree Preetha Ranjith & Sharanya Adiga
To: Prof.Dr.Alexander Huhn
Date: 27th March, 2023

Table of contents:

1) Abstract

1.1 Background

IoT is a network of different devices that are connected to the internet, which interoperate with each other in order to exclude human involvement in regular operations. The IoT can also measure and analyze the parameters of their own state, the environment, or other devices, to provide information for system users. As the IoT is becoming something of a nebulous concept, more devices and software are being used and added. In view of this, our study presents a comparison of the IoT cloud platform vendors, Microsoft Azure, Amazon Web Services (AWS), and Google Cloud, from users' perspectives.

Although there are many different types of IoT platform vendors, the problem is how to compare them according to the users' needs. This is because the system users may differ in their purpose, capacity, or financial capability.

1.2 Project Scope & Objectives

Finding the best fit: Organizations can identify the IoT platform that best meets their unique requirements by evaluating the various IoT platforms. By doing this, they may be able to avoid investing in a platform that might not satisfy their needs.

Cost Effectiveness and Flexibility : Organizations can find affordable solutions that offer the required functionality by comparing various IoT platforms. Long-term cost reductions may be achieved as a result of this. Also , each IoT platform has unique capabilities and constraints. Organizations can choose which platform is the most adaptable and easily customizable to fulfill their needs by evaluating several platforms.

Improved security: IoT platforms need to have strong security features to guard against online threats. Organizations can pick the platform with the most robust security measures and the ability to offer the best protection against security breaches by evaluating various platforms.

1.3 Method

We have performed an analysis where we compare all three Cloud Computing IoT Platforms with a simple experiment using Node-Red as the interface. Here , we receive the weather data from **dwdweather** and it is sent to the cloud services of the three platforms where the data is stored and alerts are sent.

2) Introduction

2.1 AWS (Amazon Web Services)

The cloud computing platform offered by Amazon is called AWS (Amazon Web Services). It provides a vast selection of tools and services for computing, storage, databases, analytics, machine learning, IoT, security, and other areas. With Amazon, users can rapidly and simply create scalable and adaptable IT infrastructure in the cloud without requiring a large upfront investment or commitment over an extended period of time.

Businesses and organizations of all sizes and sectors frequently utilize AWS to host their applications and services in the cloud, enhance scalability and dependability, and cut expenses.

2.2 Google IoT

Google IoT is a cloud-based platform that gives organizations access to their IoT devices' data and allows them to connect, manage, and analyze it. It offers a collection of resources to assist businesses in designing and implementing secure IoT solutions.

Device registration, telemetry data intake, real-time data processing and secure communication are just a few of the features offered by Google IoT. Organizations using Google IoT may monitor device performance and health, automate workflows based on data-driven insights, and gather and analyze data from their IoT devices in real-time.

2.3 Azure IoT

Microsoft provides the cloud computing platform and service known as Azure. It offers a variety of cloud-based services, including those for networking, analytics, computing, and storage. Businesses may create, deploy, and manage apps and services using Azure across a global network of data centers that Microsoft manages.

Azure provides a range of services, including virtual machines, app services, data services, networking services, and security services. Moreover, it offers resources and services for DevOps, IoT, and the internet of things (IoT).

3) Analysis

3.1 AWS (Amazon Web Services)

To evaluate which cloud computing platform is the best we thought of studying each in detail. Study involves sending weather data to the cloud and analyzing the results. **Figure 1** represents the architecture of the study using AWS; where we get weather data using dwd weather (German Meteorological Service) and then it is sent to the AWS cloud which is then processed and finally alerts are sent.

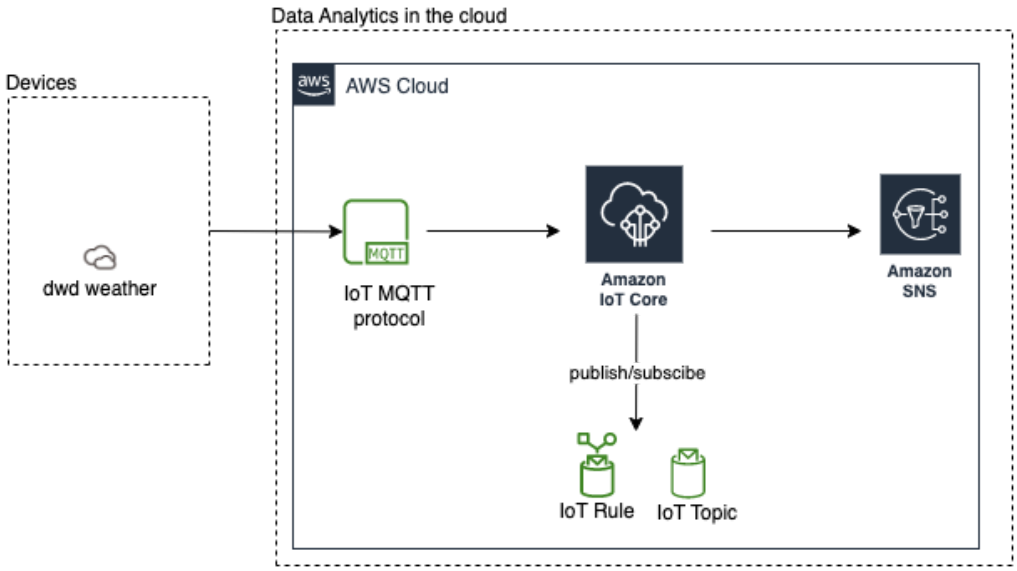

Figure 1. AWS IoT Architecture

The above system is implemented using Node-RED which is shown in **Figure 2** where we are getting weather data from dwd weather node where it uses MOSMIX station (03772 for London) number to get the data for a particular city. Next it is connected to Node-RED test node where connection to Amazon Iot Core is done using IoT MQTT protocol then after the connection we are able to publish and subscribe to the respective topics ; Later one of the amazon services called as SNS(Simple notification Service) is

used to send the mail alerts to the specified mail id. IoT Rule includes a set of defined rules by the user to the topics.

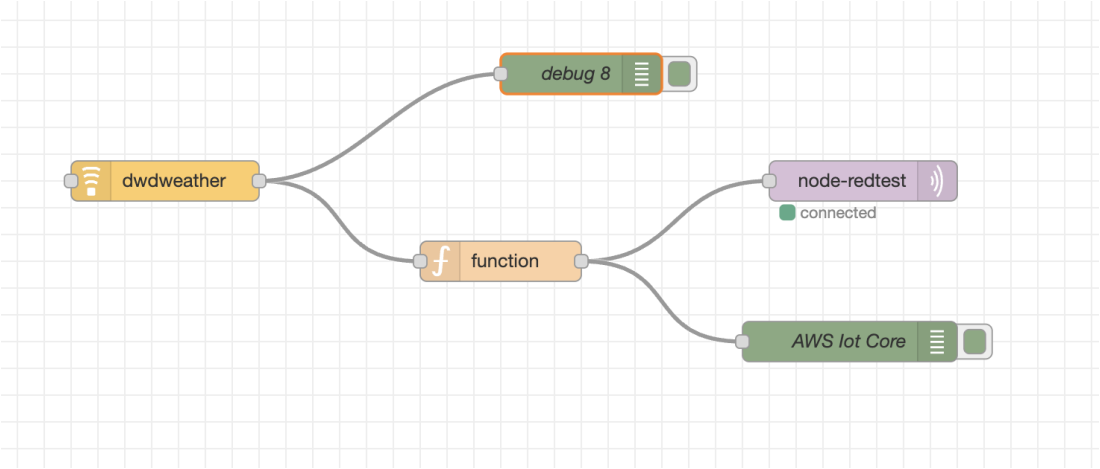

Figure 2. AWS Node-RED flow.

Below **Figure 3** reflects the telemetry of AWS. The MQTT test client is used for communication with AWS IoT Core where we have to specify the topic name which it has to publish/subscribe to . Also we can observe that weather data can be seen in the AWS IoT Core ensuring that the data is sent to the AWS cloud.

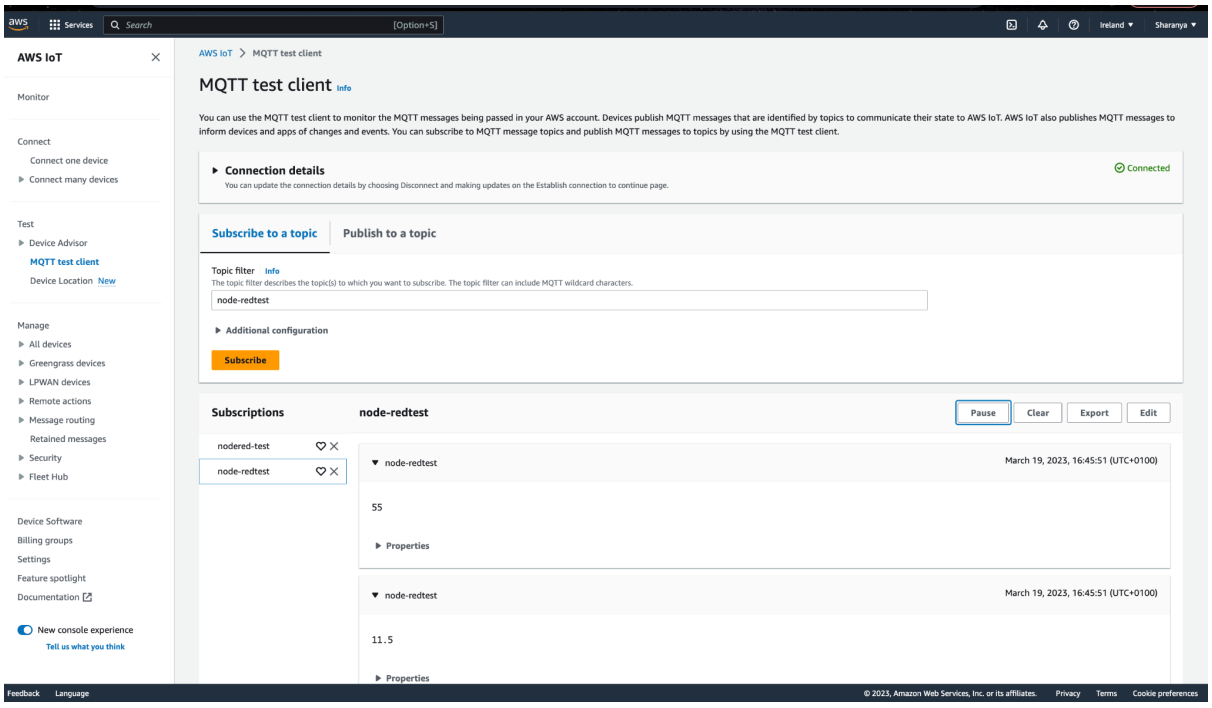

Figure 3. Telemetry

Finally the alert mails using AWS service named SNS which is signified in **Figure 4**.

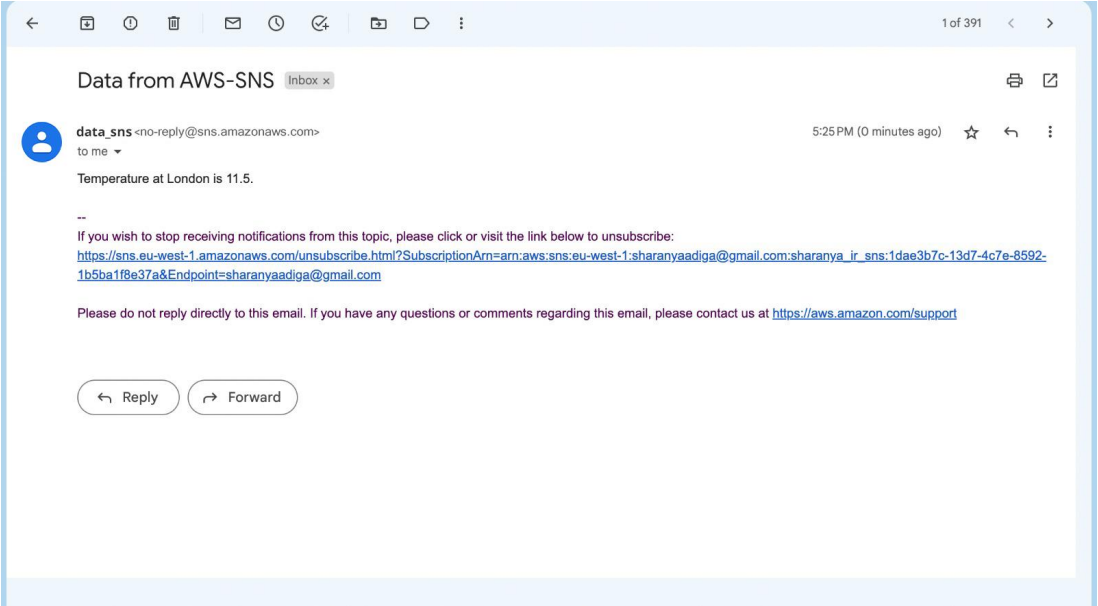

Figure 4. Mail Alert from AWS SNS

3.2 Google IoT

We have conducted an experiment where we have used dwdweather to get the daily weather data which is then received by the Google IoT Core via Node-RED. The connection to the Google IoT Core is done using Google Pub/Sub where the data is processed. Finally we send alerts using Google Cloud Function. **Figure 5** represents the basic architecture of Google IoT.

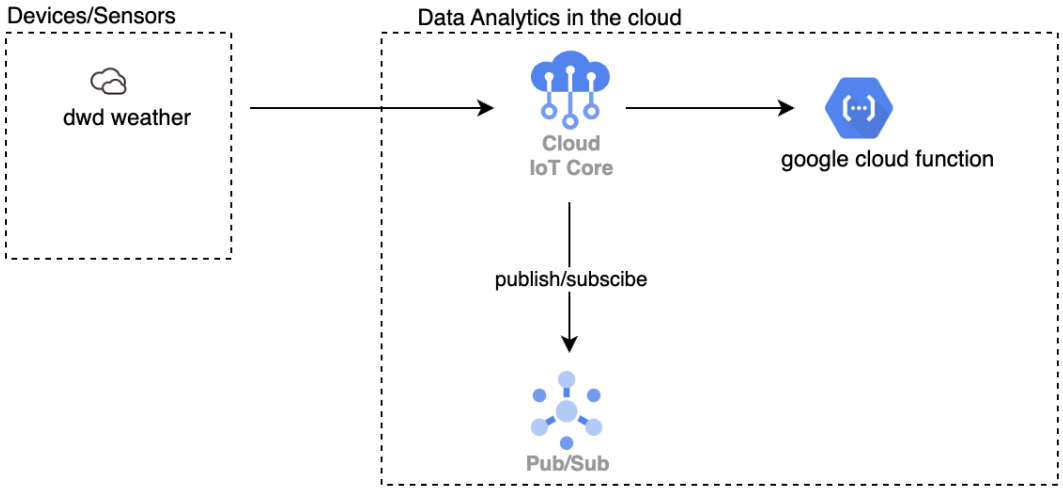

Figure 5. Google IoT Architecture

Figure 6 represents the Node-RED flow of Google IoT which we have implemented. We get the weather data from dwdweather node (using MOSMIX station 03772) and we extract only the temperature data which is sent to pubsub node which connects to Google Cloud Pub/Sub and publishes messages to a specified topic. Then the data is sent using the Iot command-send node which requires projectId, region, registerId and deviceId which we obtain from GCP.

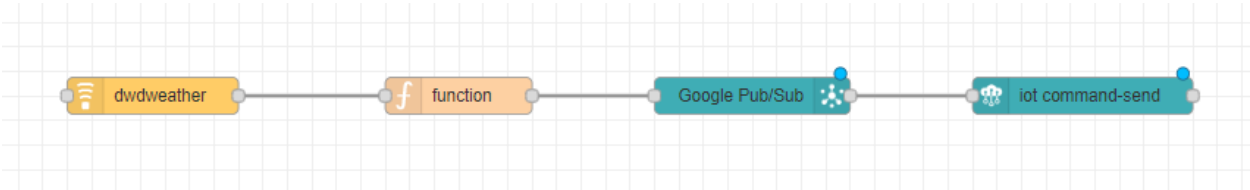

Figure 6. Google IoT Node-RED flow

Figure 7 shows the telemetry of the analysis where we can see the incoming temperature data to the cloud.

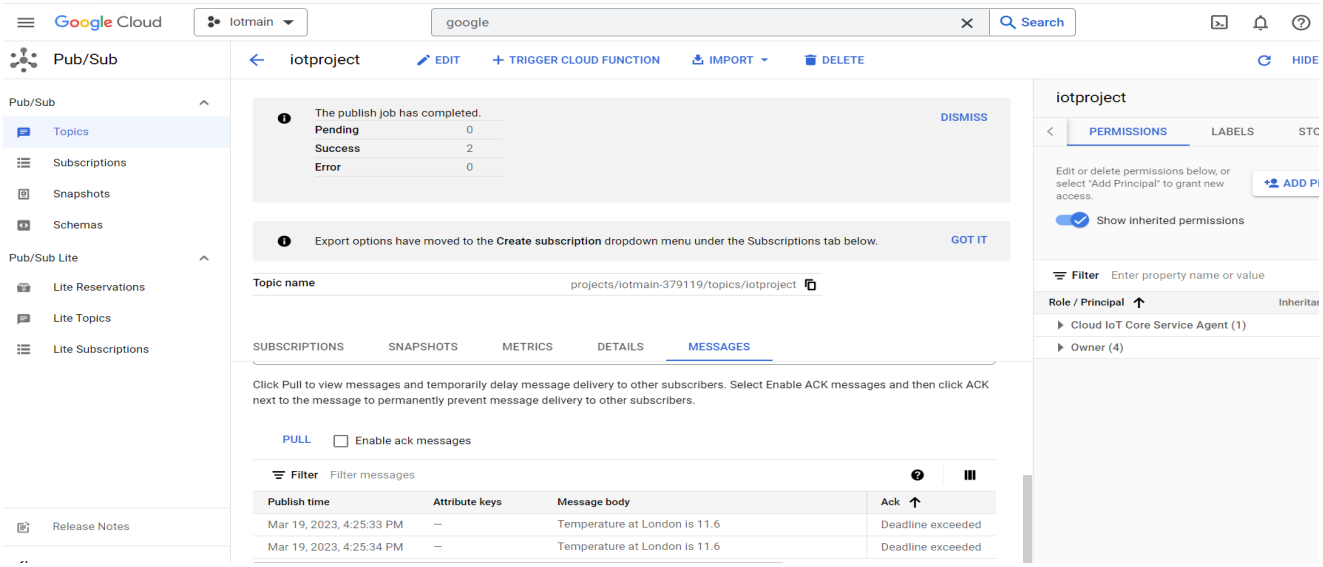

Figure 7. Telemetry

Finally we send alerts to our gmail via the Google Cloud function shown in **Figure 8**.

Figure 8. Alert mail from Google cloud function

3.3 Azure IoT

Similar research was done for Azure IoT, where we used dwdweather to obtain the daily weather data, which was then transmitted to the Azure IoT Explorer via Node-RED. Using the Azure Iot Hub connector, the data is processed and sent to the Logic App . Finally, we employ Logic App's built-in Gmail connector to send an email with the telemetry data as the body of the email to transmit notifications. The fundamental design of Google IoT is shown in **Figure 9**.

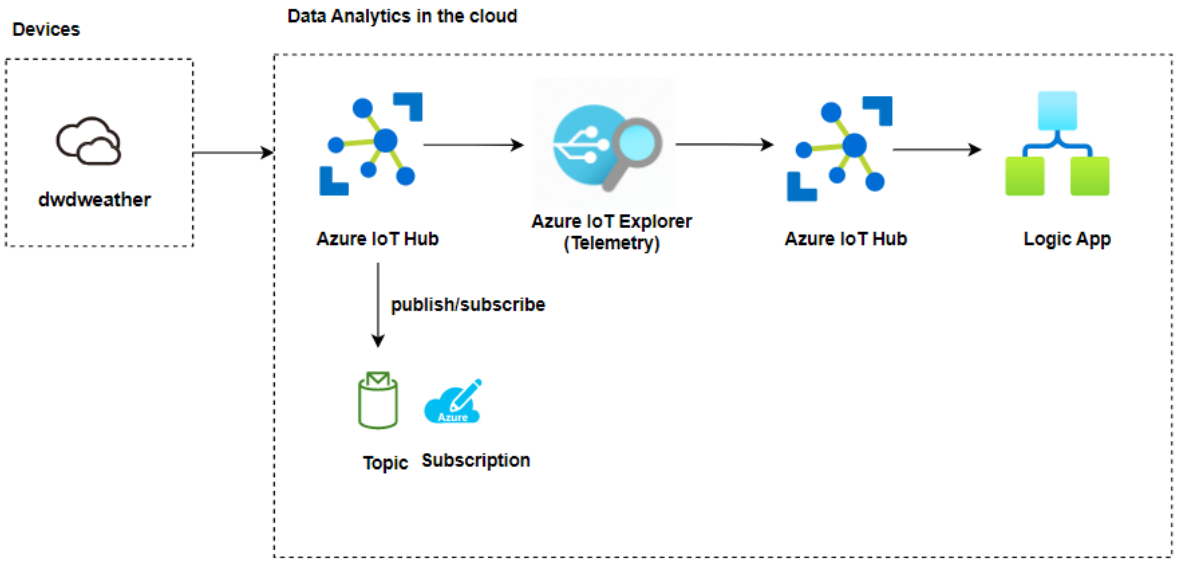

Figure 9. Azure IoT architecture

The Azure IoT Node-RED flow that we implemented is shown in **Figure 10.** We obtain the weather data from the dwdweather node and just the temperature information is extracted and delivered to the Azure Iot Hub node. This node allows you to send messages to your Azure IoT Hub and contains the protocol and hostname. The Azure Iot Hub Registry allows you to register devices with your Azure IoT Hub and the Azure Iot Hub Receiver is a simple node for receiving device-to-cloud messages via default Azure Events Hub endpoint. It does not require a payload.

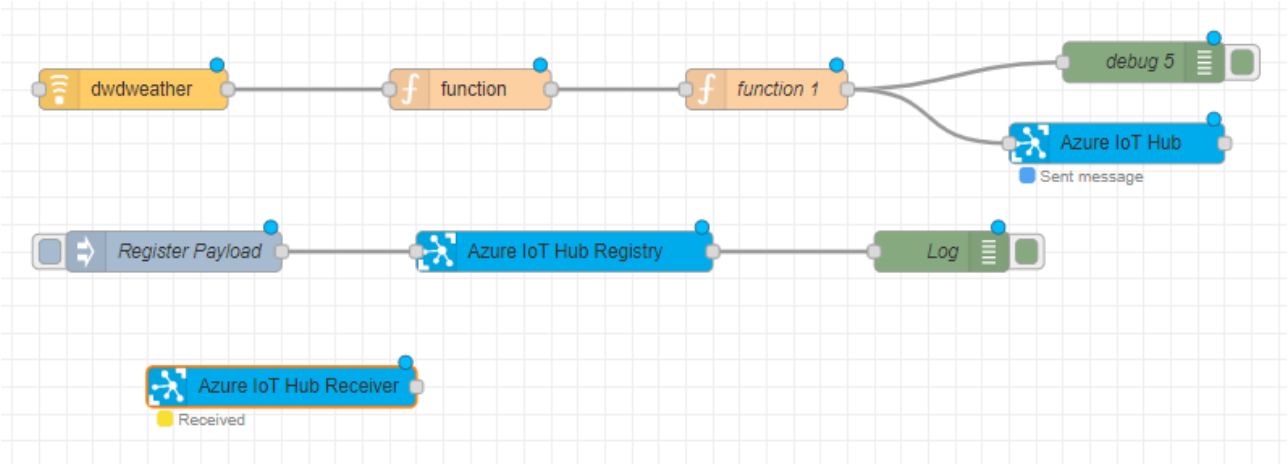

Figure 10. Azure IoT Node-RED Flow

Figure 11 displays the analysis's telemetry where the data is received by the event hub, allowing us to see the incoming temperature data to the cloud.

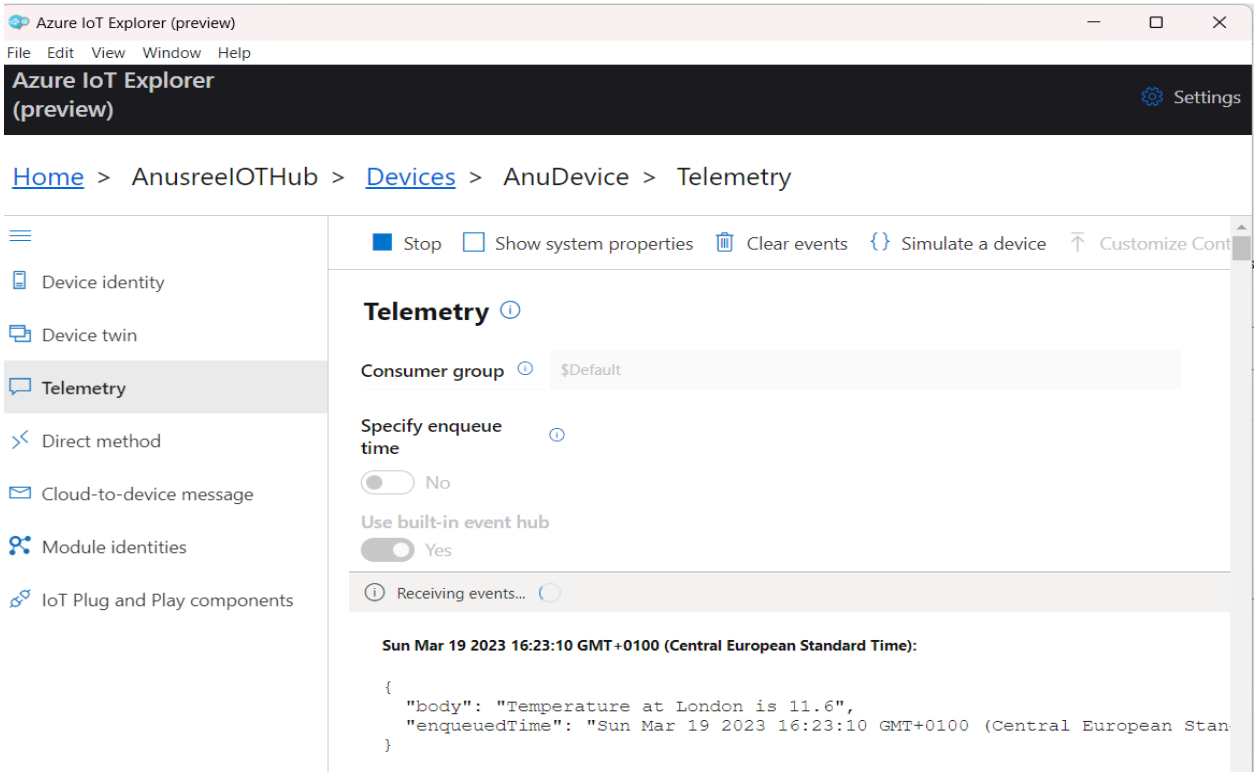

Figure 11. Azure IoT Explorer (Telemetry)

Lastly, we use Azure Logic App depicted in **Figure 12** to send alerts to our gmail account.

Figure 12. Email alert from Azure Logic App

4) Results

Categories	AWS	AZURE	GOOGLE IOT
Computing (For Establishing Connection)	AWS IoT Core	Azure Iot Hub	Google IoT Core
Telemetry	MQTT Test Client	Azure Iot Explorer	Google Pub/Sub
Alerts	SNS	Logic App	Cloud Function

4.1 Computing

Device connectivity: Azure IoT Hub supports a number of protocols, including MQTT, AMQP, and HTTP, which allows for device connectivity. Moreover, it facilitates communication between devices and the cloud. Several protocols, including MQTT, HTTP, and WebSockets, are supported by the AWS IoT Core. Moreover, it facilitates communication between devices and the cloud. Finally, Google IoT Core supports a variety of protocols, including HTTP and MQTT. Moreover, it facilitates communication between devices and the cloud.

Device Management: Azure IoT Hub offers device management capabilities as device twin, device registry, and direct device methods. Device management tools like device shadows, and device registries are offered by AWS IoT Core. Finally, the Google IoT Core offers device administration tools like device registry, configuration management.

Data processing services like stream processing and real-time analytics are offered by Azure IoT Hub. Data processing tools like rule engines, and real-time analytics are offered by AWS IoT Core. In addition, Google IoT Core offers data processing tools like real-time analytics, dataflow pipelines, and Pub/Sub communications.

Pricing for all three services are based on number of messages and data usage.

4.2 Telemetry

Features and Capabilities : Users can publish and subscribe to MQTT topics, send and receive messages, and test IoT devices using the web-based AWS MQTT Test Client. Managing and monitoring IoT devices, sending and receiving messages, and checking device information are all made possible by the desktop application Azure IoT Explorer. The last cloud-based messaging service is Google Pub/Sub,

which enables users to post and subscribe to topics as well as process messages utilizing multiple subscribers.

Ease of Use : Users can easily test their IoT devices and data streams thanks to the simplicity of the AWS MQTT Test Client. The management and monitoring of IoT devices is made easier by the user-friendly interface offered by the Azure IoT Explorer. For Google Pub/Sub , it is easy to set up and provides a simple interface for publishing and subscribing to topics.

Integration : Amazon MQTT Test Client interfaces with other AWS services including AWS IoT Core. The Azure IoT Explorer integrates seamlessly with other Azure services such as Azure IoT Hub and lastly, the Google Pub/Sub interfaces with other Google Cloud services including Google Cloud Function.

Pricing for AWS MQTT Test Client and Azure IoT Explorer is free while Google Pub/Sub offers free for a limited number of messages per month and additional usage is charged based on number of messages and data processed.

4.1 Alerts

Features and Capabilities : Users of AWS SNS can deliver alerts and messages to emails, SMS, push notifications for mobile devices Here only email function is used. AWS SNS also provides support for email filtering, so it is helpful to filter out unwanted emails.
Azure Logic App is a cloud-based solution that enables users to automate workflows and integrate apps and data across many platforms and services It provides connectors for multiple email services such as Office 365 Outlook and Gmail, Google Cloud Function is a serverless computing tool that enables users to build and run applications in response to events and triggers and can be used to send emails through email services such as Gmail.

Scalability : AWS SNS is very scalable and capable of handling massive amounts of notifications and messages.For Azure Logic App, it is very scalable and capable of handling massive amounts of data and workflows. Finally, the Google Cloud Function can manage massive amounts of events and triggers and is extremely scalable.

5. Conclusion and Future Work

In conclusion, AWS IoT, Azure IoT, and Google IoT are all cloud-based platforms that enable the deployment, management, and monitoring of IoT devices and data streams.

Overall, the best platform for your IoT needs will depend on your specific requirements, such as scalability, security, integration, and ease of use. It is important to evaluate each platform based on your specific use case to determine which one is the best fit for your organization.

Future work

AWS IoT, Azure IoT, and Google IoT are all evolving platforms that are continuously adding new features and capabilities to meet the evolving needs of IoT applications. Here are some of the future work for these platforms:

1. All three platforms are expected to expand their edge computing capabilities to enable data processing and analytics to be performed closer to the edge devices. This will help reduce latency and bandwidth requirements and improve overall system performance.

2. Machine learning is becoming increasingly important for IoT applications, and all three platforms are expected to expand their machine learning capabilities to enable predictive maintenance, anomaly detection, and other intelligent IoT applications.

6. Acknowledgement

Without the constant support of our supervisor, Professor.Dr.Alexander Huhn, this project and the research that went into it would not have been feasible. From our initial interaction with the various cloud platforms to the final draft of this dissertation, his zeal, knowledge, and meticulous attention to detail have been an inspiration and kept our work on track. This report corresponds with the Project Studies module of the Degree Programme of the “Professional IT Business and Digitalization” and therefore is intended to shed light on the various phases we went through in order to achieve the desired results.

References

[1]. Aina'u Shehu Muhammed; Derya Ucuz "Comparison of the IoT Platform Vendors, Microsoft Azure, Amazon Web Services, and Google Cloud, from Users' Perspectives 978-1-7281-6939-2/20/$31.00 ©2020 IEEE.

[2] https://flows.nodered.org/node/node-red-contrib-azure-iot-hub

[3] https://flows.nodered.org/node/node-red-contrib-aws

[4] https://docs.aws.amazon.com/iot/latest/developerguide/iot-gs.html

[5]https://docs.aws.amazon.com/sns/latest/dg/sns-getting-started.html

[6] https://cloud.google.com/pubsub/docs/publish-receive-messages-console

[7] https://flows.nodered.org/node/node-red-contrib-google-cloud