Ben-Gurion University
of the Negev

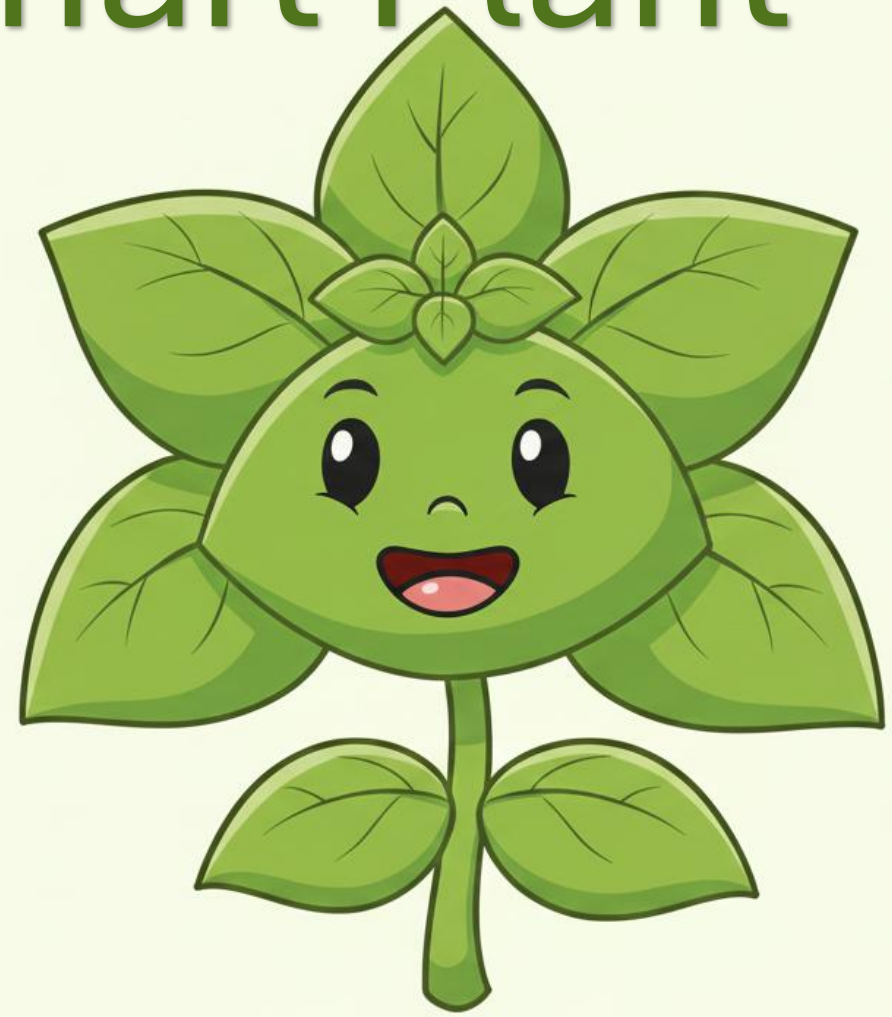
Course: Internet of Things

Lecturer: Guy Tel-Zur
Presentors: Tal Adoni, Omri Aviram

Subject: Smart Irrigation system

My Smart Plant

My Smart Plant



The Story – Thailand & the Basil Plant

Literature Review

Environmental Research 222 (2023) 115313

Contents lists available at ScienceDirect

Environmental Research

journal homepage: www.elsevier.com/locate/envres

Comparative analysis of IoT-based controlled environment and uncontrolled environment plant growth monitoring system for hydroponic indoor vertical farm ☆

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[b] Zonal Head- IT Academics, Ajeenkya D Y Patil University, Pune, Maharashtra, (iNurture Education Solution, Bangalore), India

Automated vs Manual

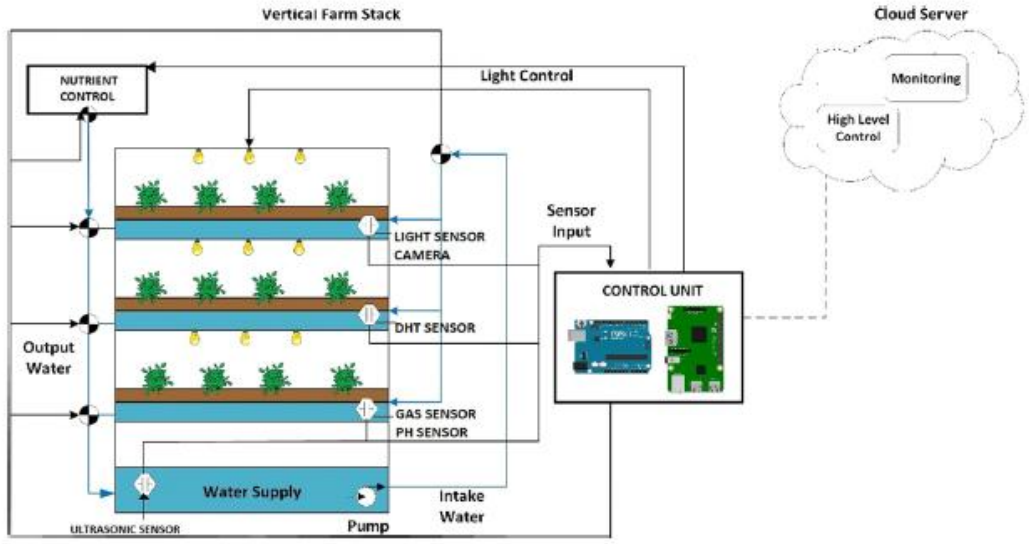


Fig. 2. An automated vertical hydroponic farming setup.

- Active components – Arduino Mega and Raspberry Pi
- Contain Cameras, Flow sensors, Gas Sensors and Water-level sensors

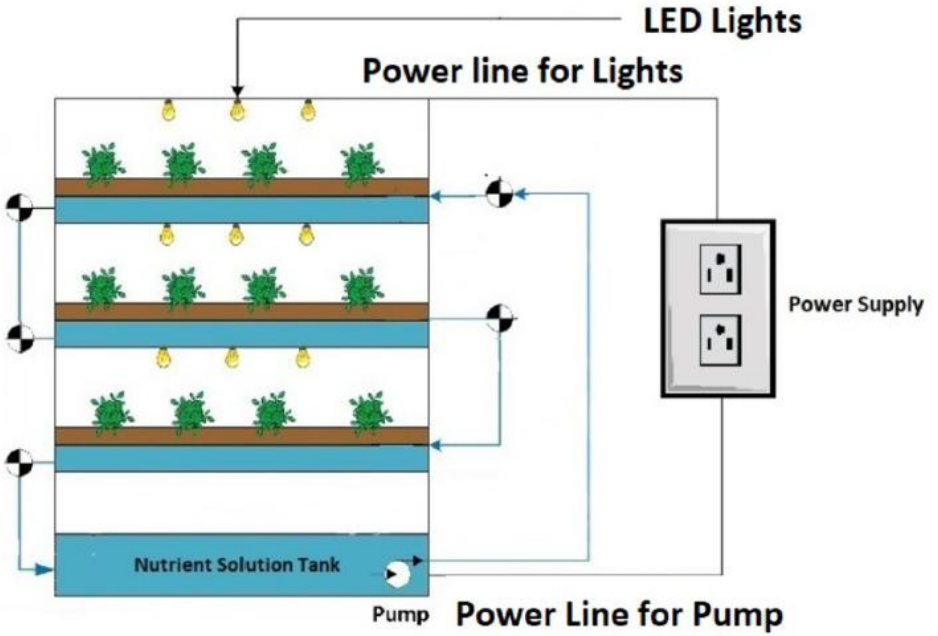
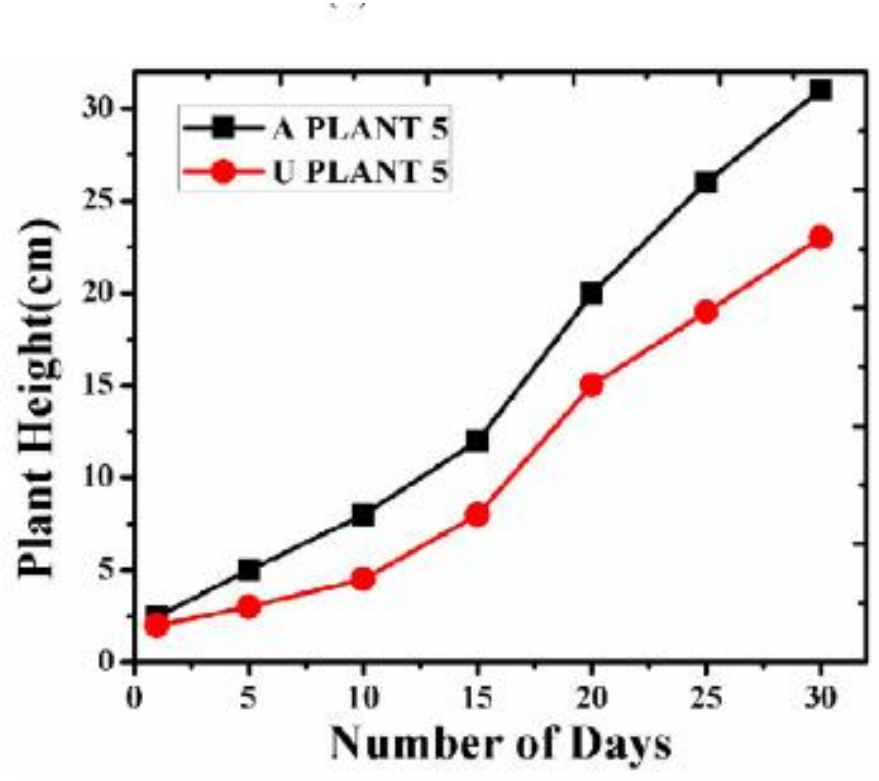


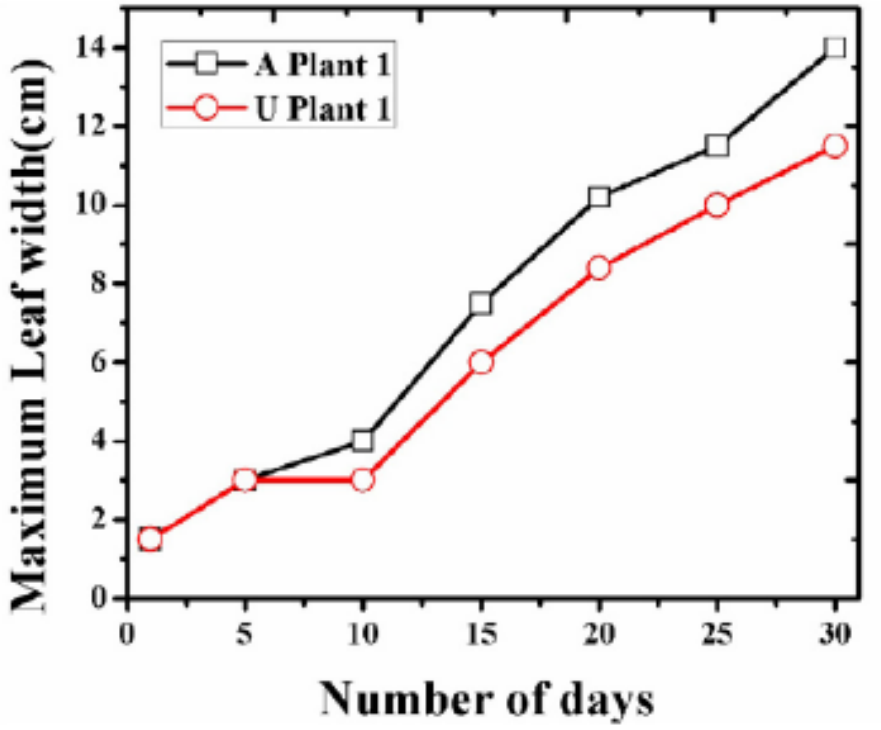
Fig. 1. An unautomated vertical hydroponic farming setup.

- Passive components for monitoring the data
- Done by the Grower

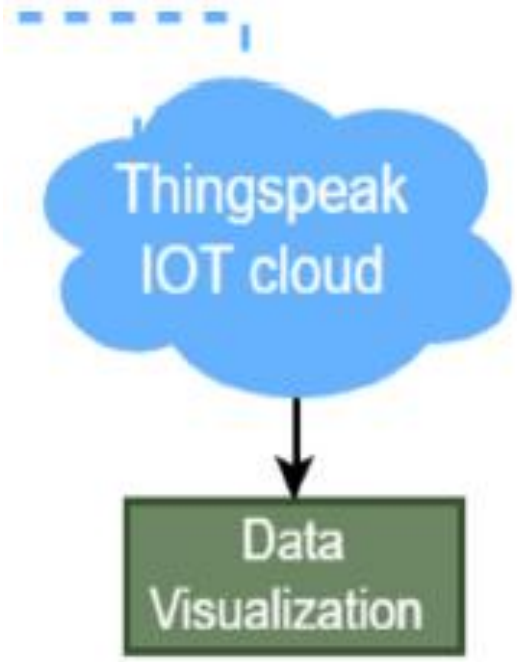
Automated vs Manual

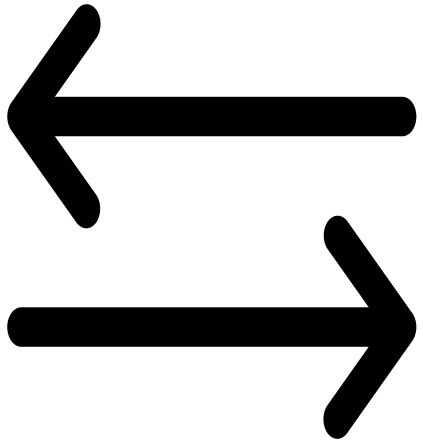


(e) Plant 5



(a) Plant 1


Thingspeak
IOT cloud
Data
Visualization




QuestDB


Grafana


aws

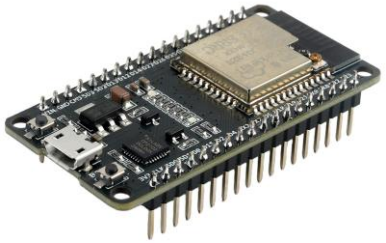
System Components

DHT22 – Temperature and humidity sensor

Capacitive Soil Moisture Sensor v2.0

LED

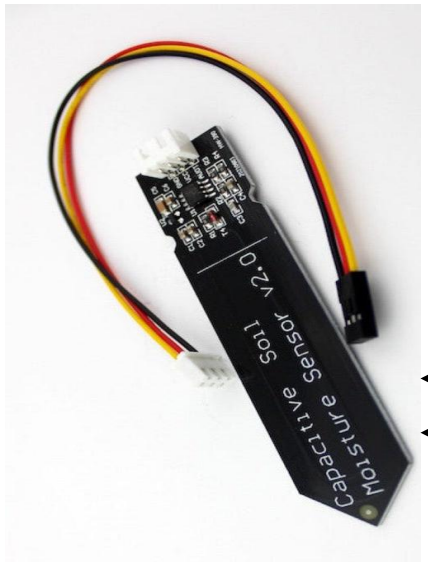
Breadboard

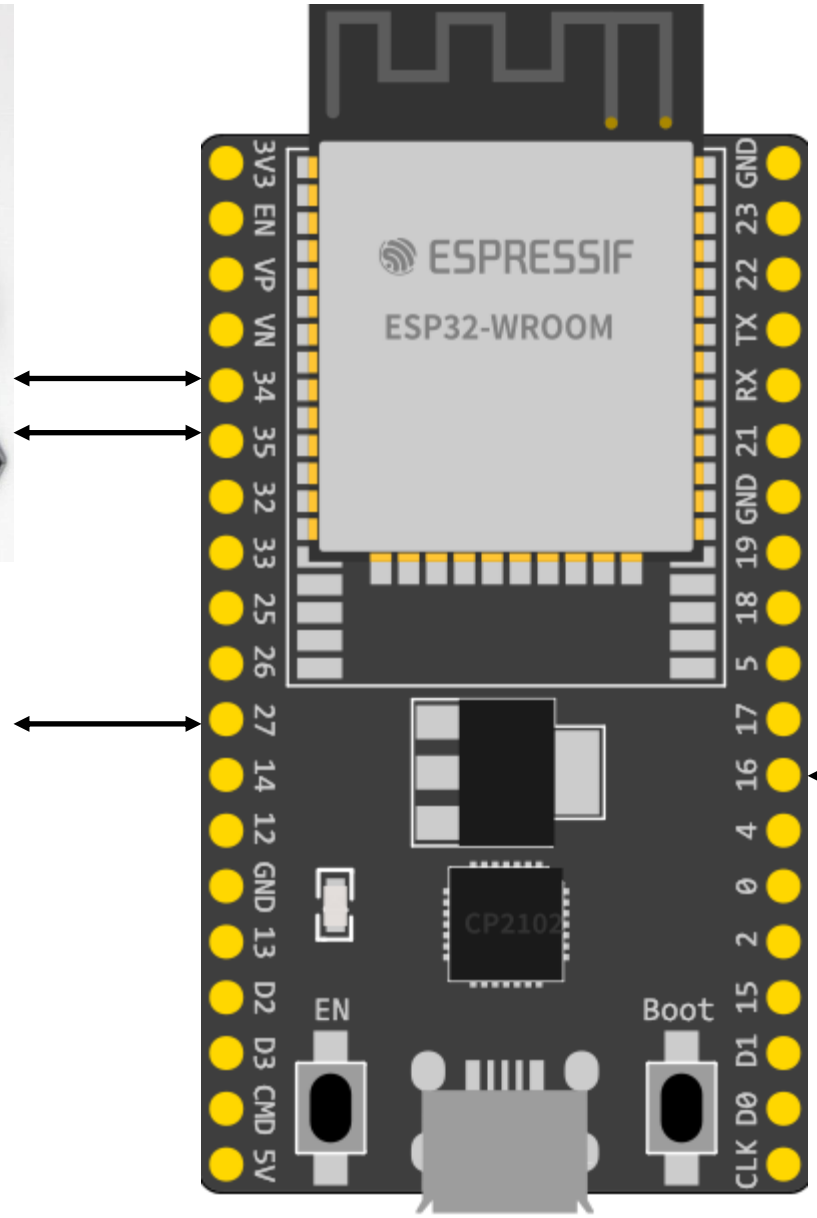


ESP32 – Microcontroller

Hardware Connections & Local Control

- Capacitive soil moisture sensors connected to ESP32 ADC pins (Ports 34, 35) – 500 averaged samples
- Local temperature and humidity sensing using a DHT22 sensor (GPIO 17)
- LED used as a local status indicator, designed to operate independently of internet connectivity (GPIO 16)





Network Connectivity & Cloud Ingestion

Wi-Fi connection from ESP32 to local network.

Secure MQTT communication over TLS.

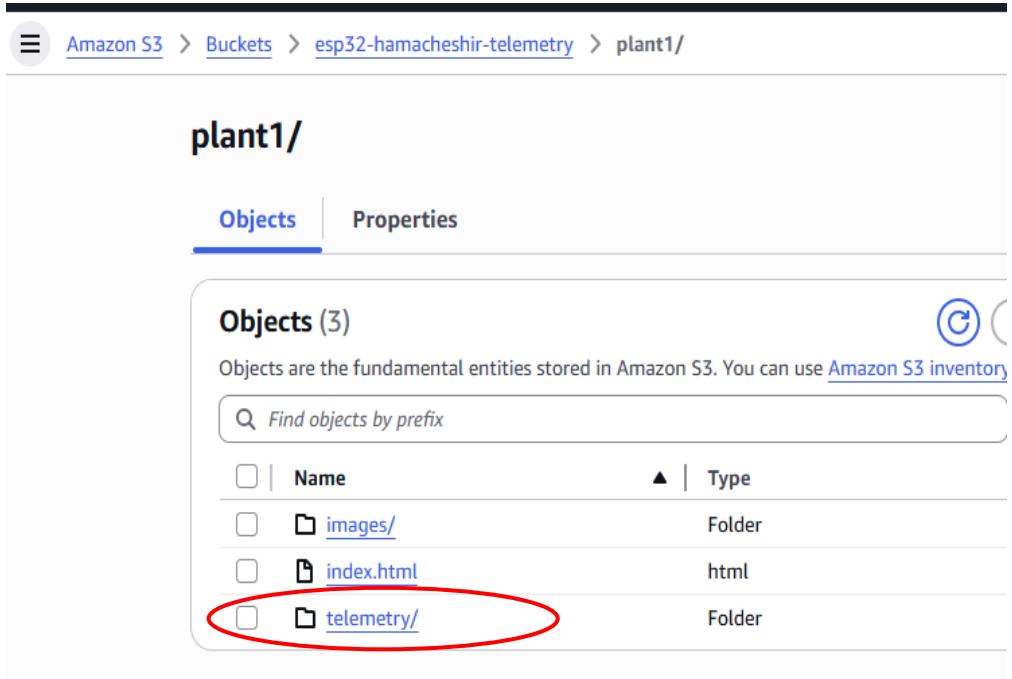
Device authentication using X.509 certificates.

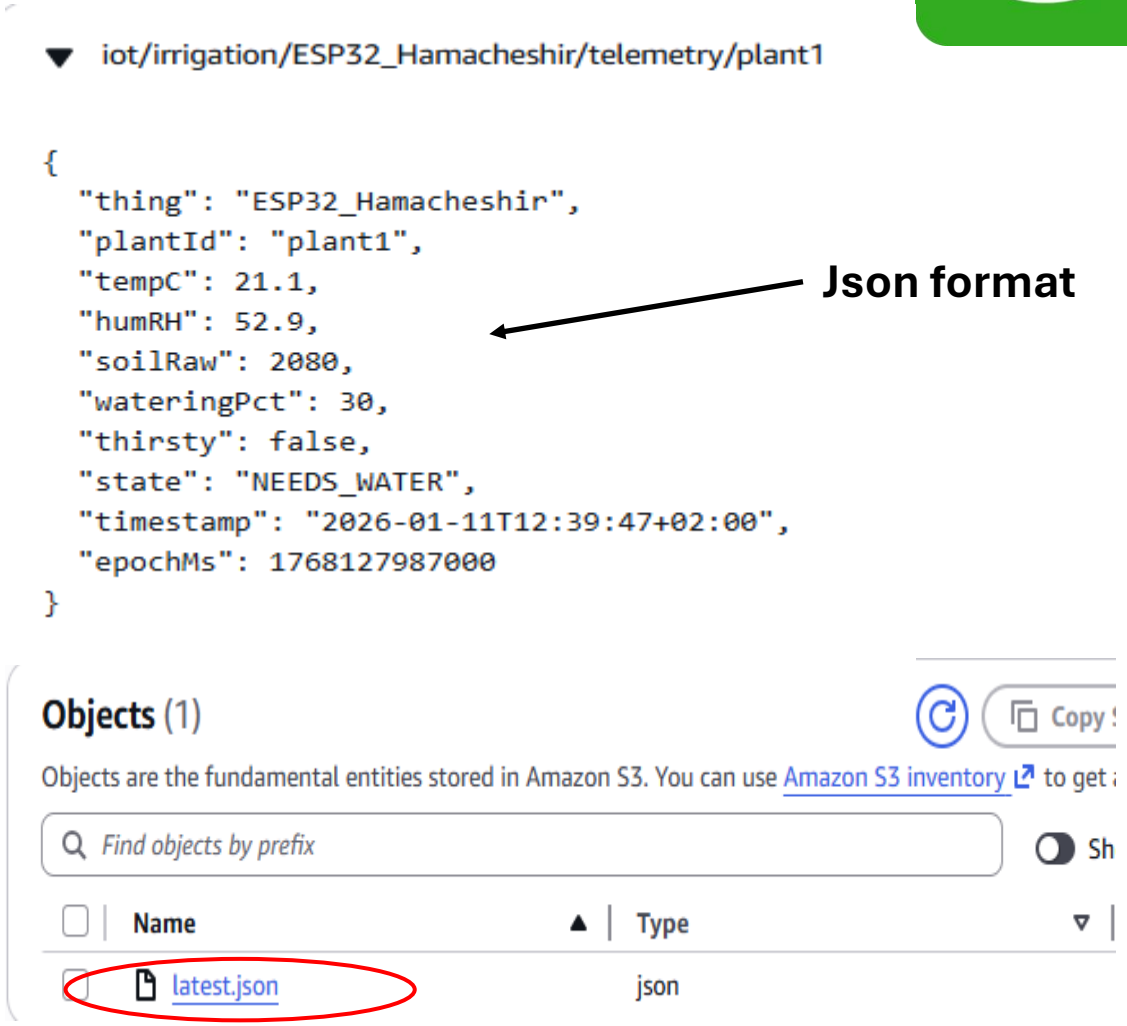
Data ingestion via AWS IoT Core.

IoT Rules engine for routing incoming telemetry.

Data Storage – Amazon S3

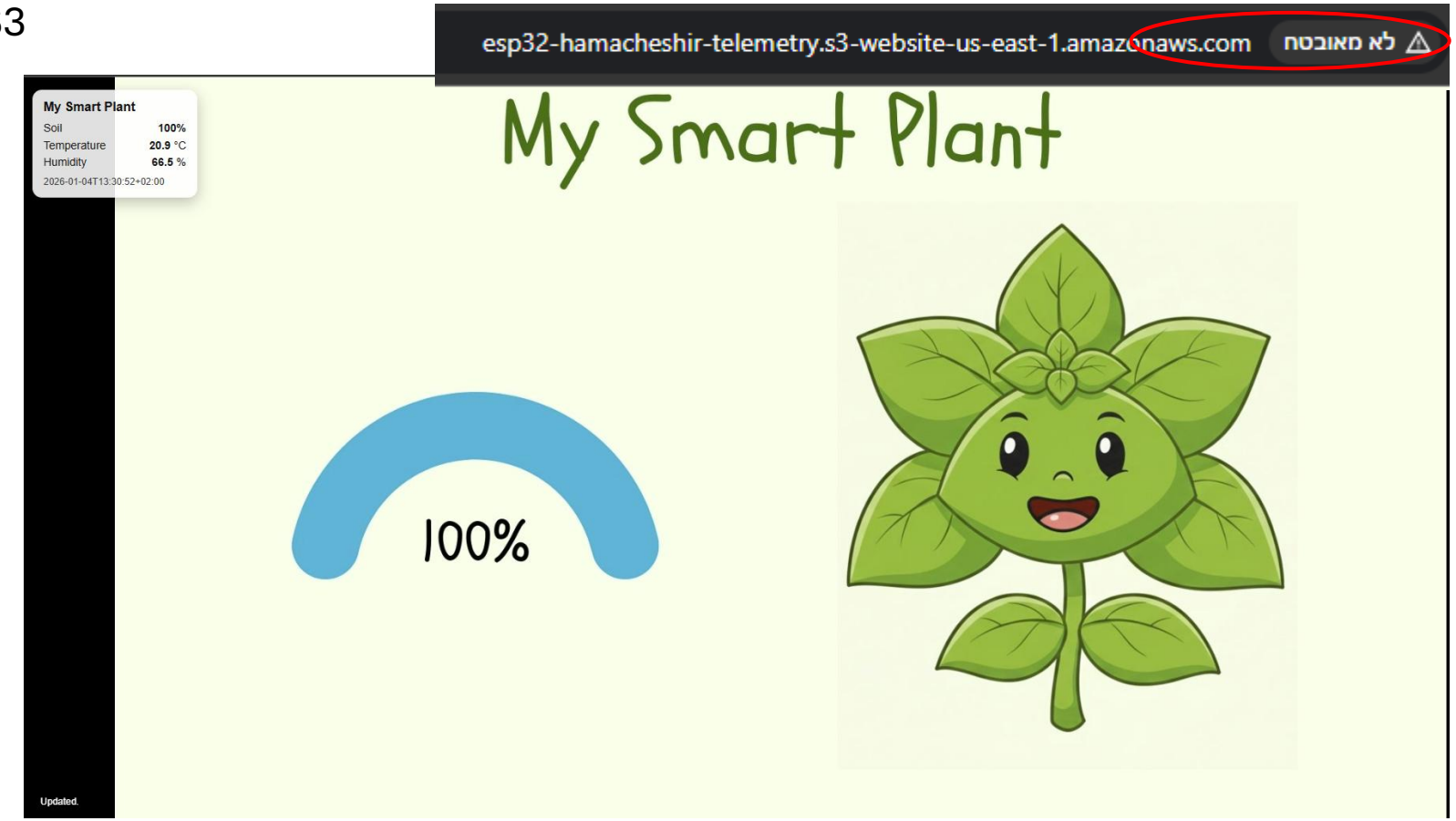
- Sensor data stored as JSON files in Amazon S3
- Each plant has its own telemetry folder
- Inside the telemetry folder latest.json holds the most recent measurement
- S3 used as a simple, scalable, and low-cost data store





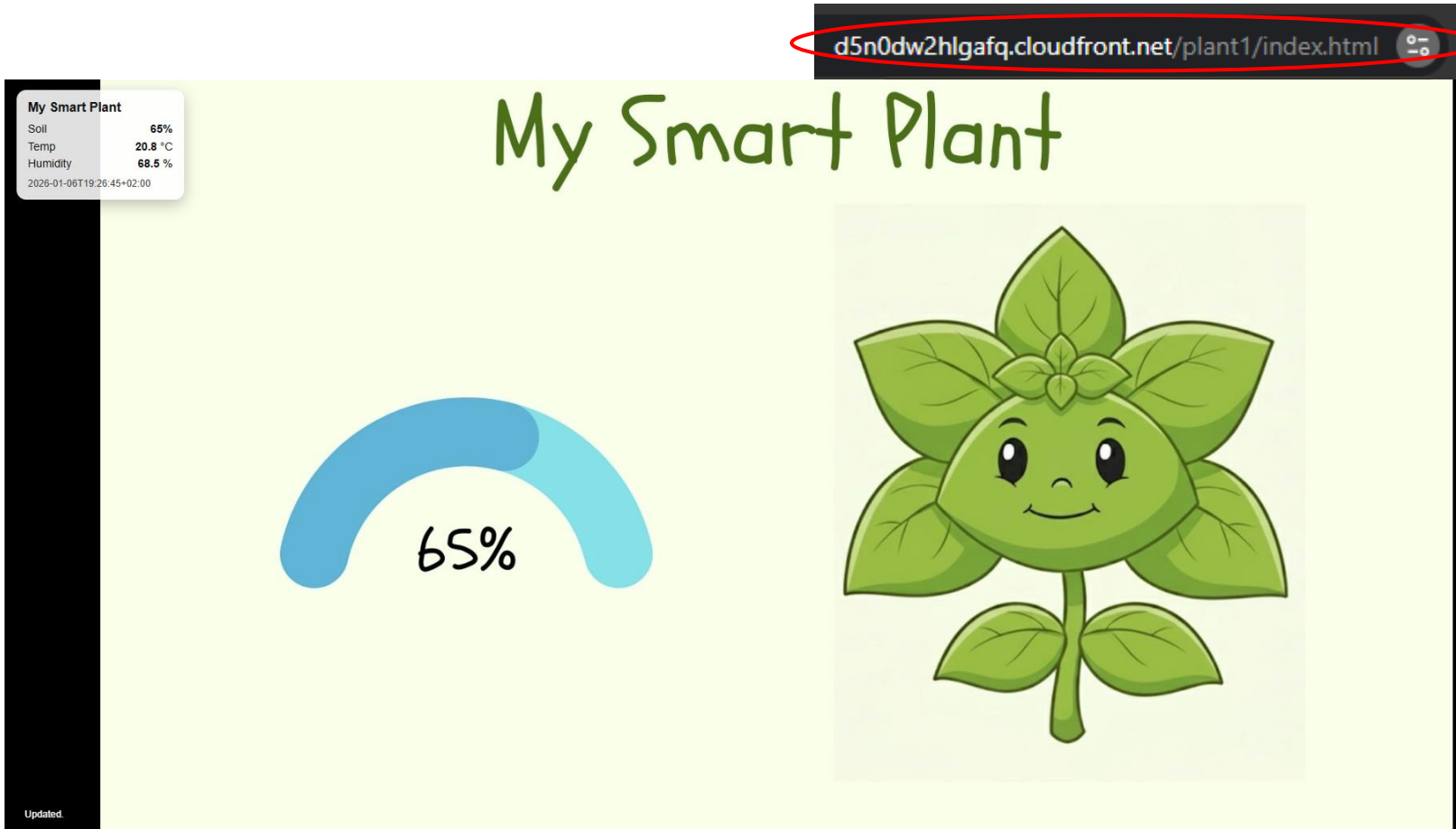
Initial Prototype – Single Plant

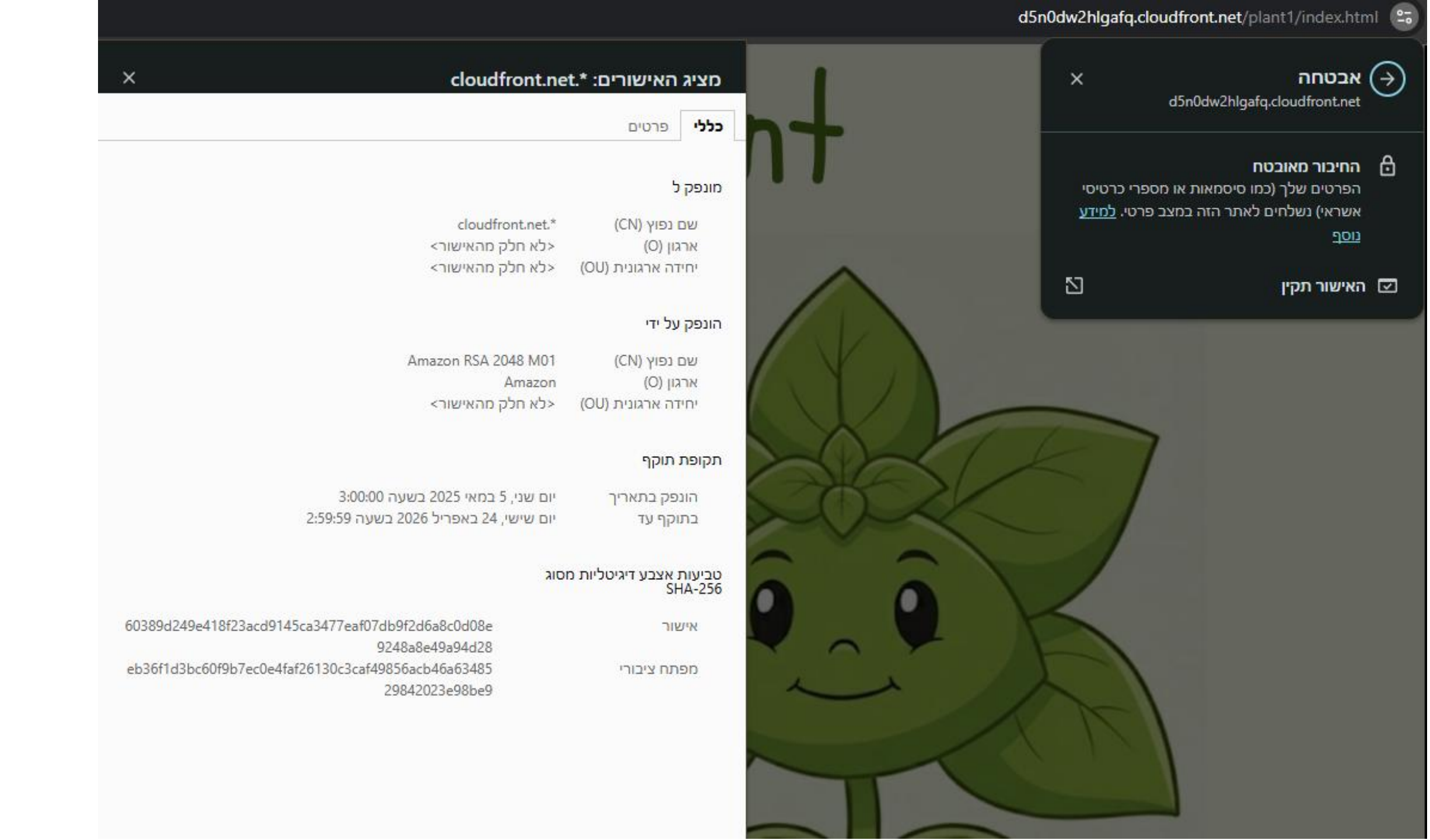
- One plant monitored
- Data stored in S3
- Static website hosted directly from S3
- Public, non-secure access



Secure Visualization – CloudFront

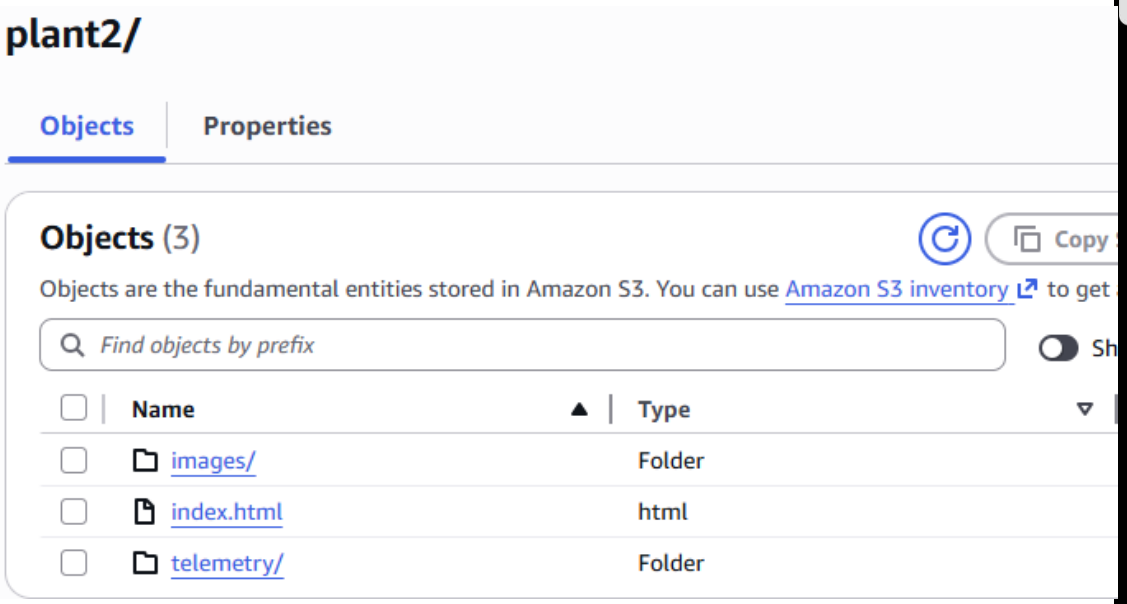
- CloudFront used as a secure content delivery layer
- HTTPS enabled with Amazon certificate
- Controlled access to S3
- Improved performance and security

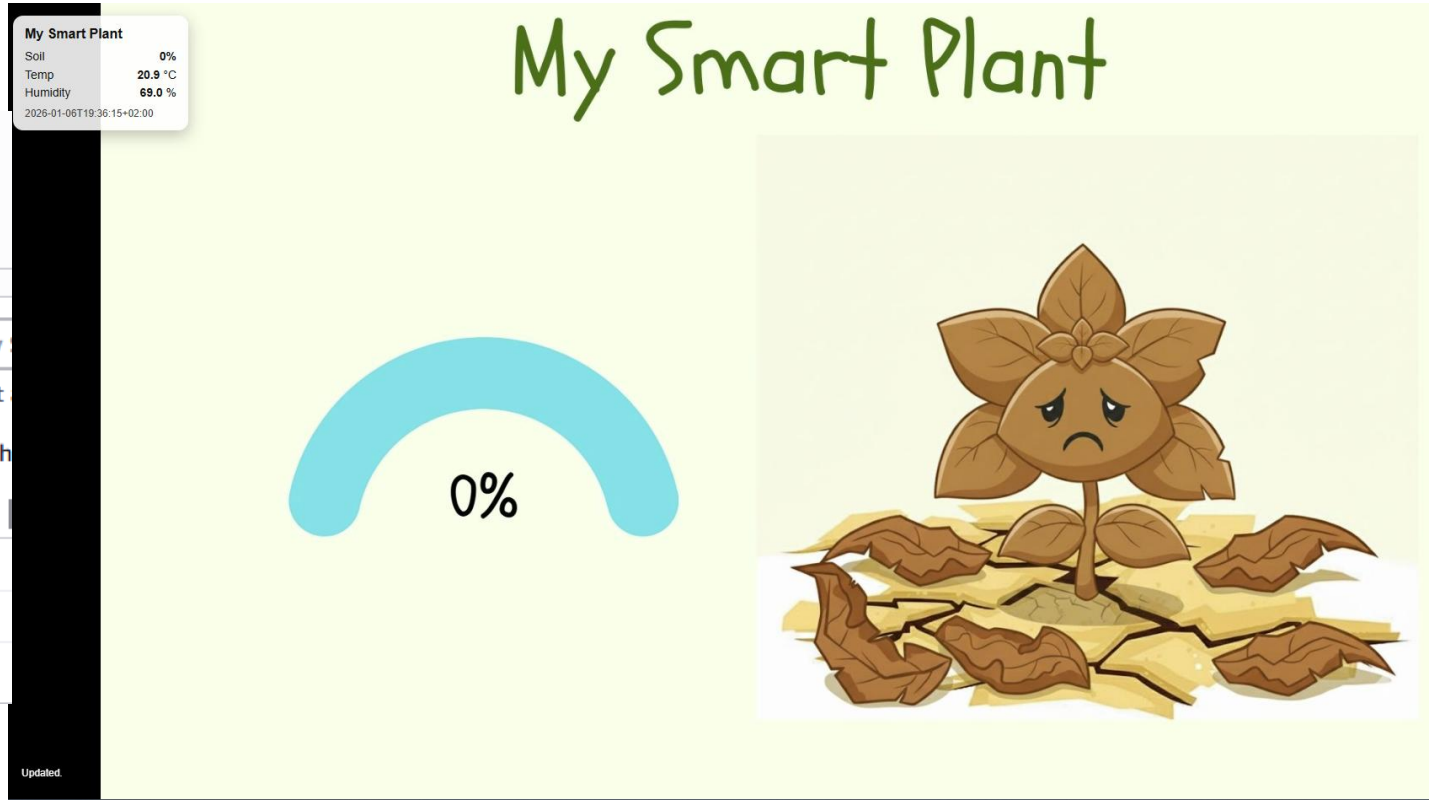



d5n0dw2hlgafq.cloudfront.net/plant1/index.html
אבטחה
d5n0dw2hlgafq.cloudfront.net
החיבור מאובטח
הפרטים שלך (כמו סיסמאות או מספרי כרטיסי אשראי) נשלחים לאתר הזה במצב פרטי. למידע נוסף
האישור תקין
מציג האישורים: *.cloudfront.net
כללי
פרטים
מונפק ל
שם נפוץ (CN) *.cloudfront.net
ארגון (O) <לא חלק מהאישור>
יחידה ארגונית (OU) <לא חלק מהאישור>
הונפק על ידי
שם נפוץ (CN) Amazon RSA 2048 M01
ארגון (O) Amazon
יחידה ארגונית (OU) <לא חלק מהאישור>
תקופת תוקף
הונפק בתאריך יום שני, 5 במאי 2025 בשעה 3:00:00
בתוקף עד יום שישי, 24 באפריל 2026 בשעה 2:59:59
טביעות אצבע דיגיטליות מסוג SHA-256
אישור 60389d249e418f23acd9145ca3477eaf07db9f2d6a8c0d08e9248a8e49a94d28
מפתח ציבורי eb36f1d3bc60f9b7ec0e4faf26130c3caf49856acb46a63485e29842023e98be9

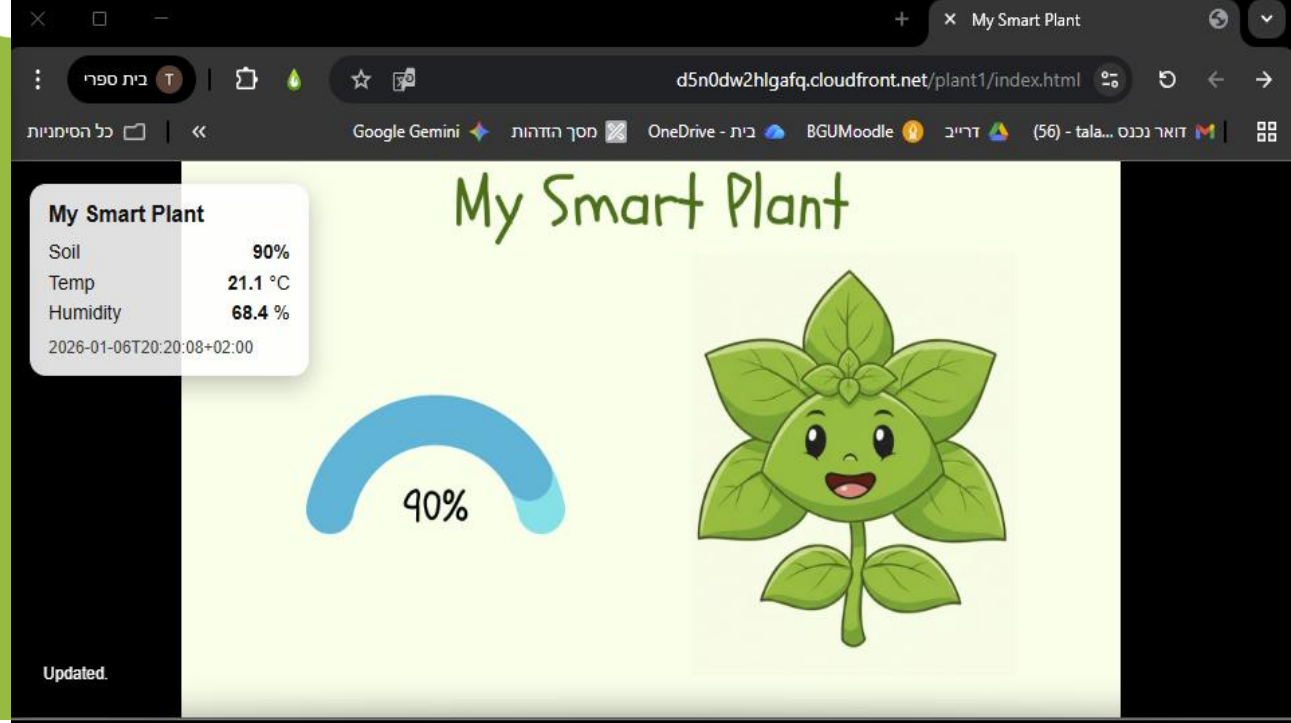
Scalability – Multiple Plants

- Additional soil moisture sensors added
- Each plant has its own data pipeline
- Separate secure website per plant
- QR code for easy accesss

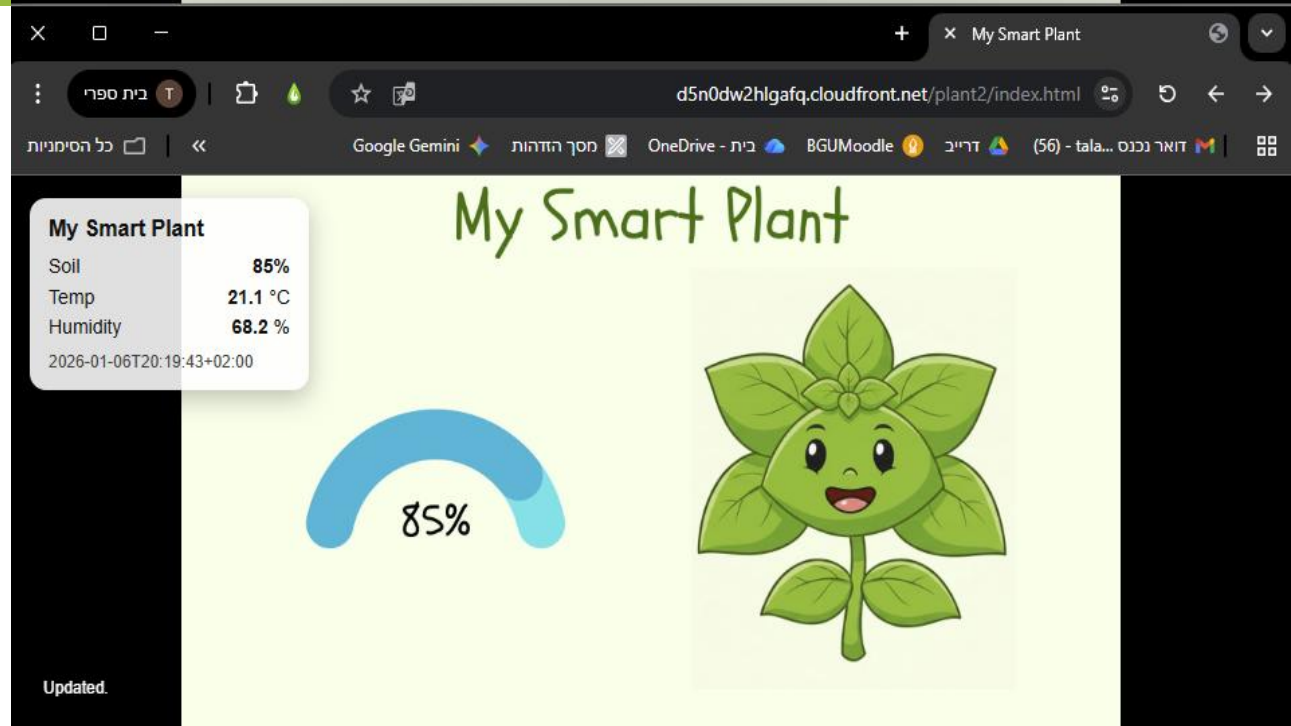




Plant 1



plant 2



All Plants Data

d5n0dw2hlgafq.cloudfront.net/dashboard/all_plants_data.html

All Plants Data

Plant 1

Temperature	21.1 °C
Humidity	68.2 %
Soil Moisture	90%
Status	OK

Last Cloud Update: 20:19:38

Plant 2

Temperature	21.1 °C
Humidity	68.2 %
Soil Moisture	85%
Status	OK

Last Cloud Update: 20:19:43

[All Plants Data Link]

My Smart Plant

d5n0dw2hlgafq.cloudfront.net/plant1/index.html

My Smart Plant

Soil	90%
Temp	21.1 °C
Humidity	68.4 %

2026-01-06T20:20:08+02:00

Updated.

My Smart Plant

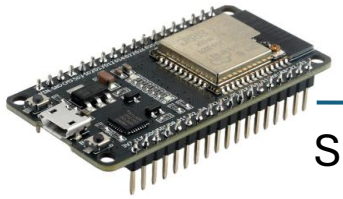
d5n0dw2hlgafq.cloudfront.net/plant2/index.html

My Smart Plant

Soil	85%
Temp	21.1 °C
Humidity	68.2 %

2026-01-06T20:19:43+02:00

Updated.



Sensor data acquisition & network access

WiFi

MQTT over TLS

AWS IoT Core

IoT Rule: Store telemetry data

S3

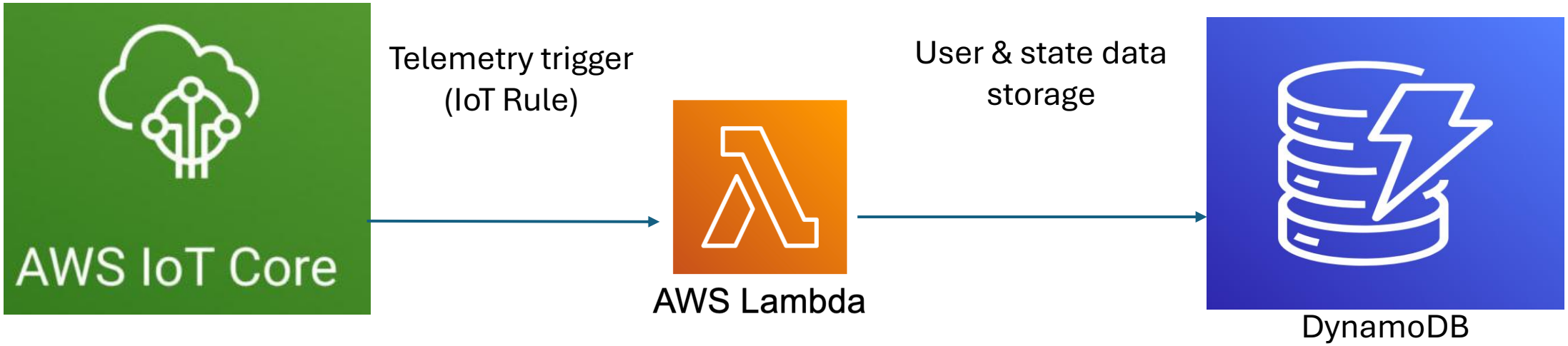
GPIO

Static data distribution

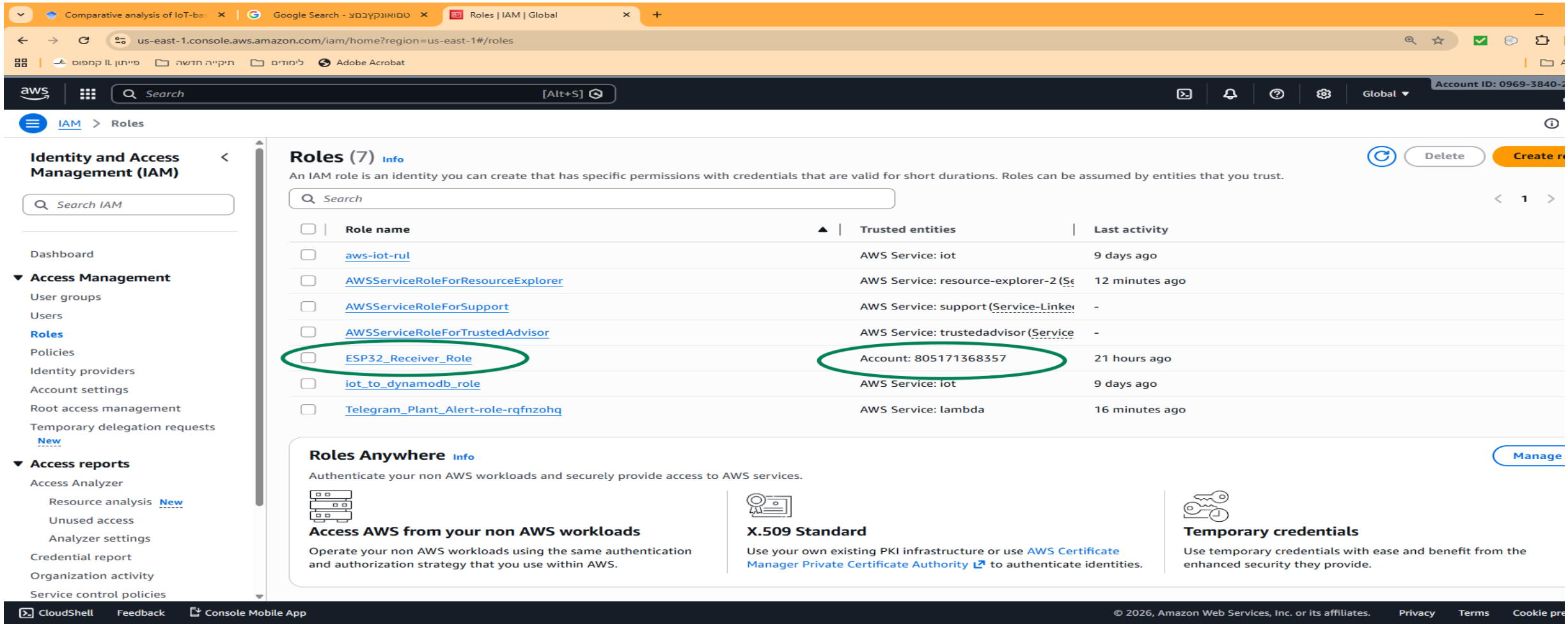
Amazon CloudFront

https://

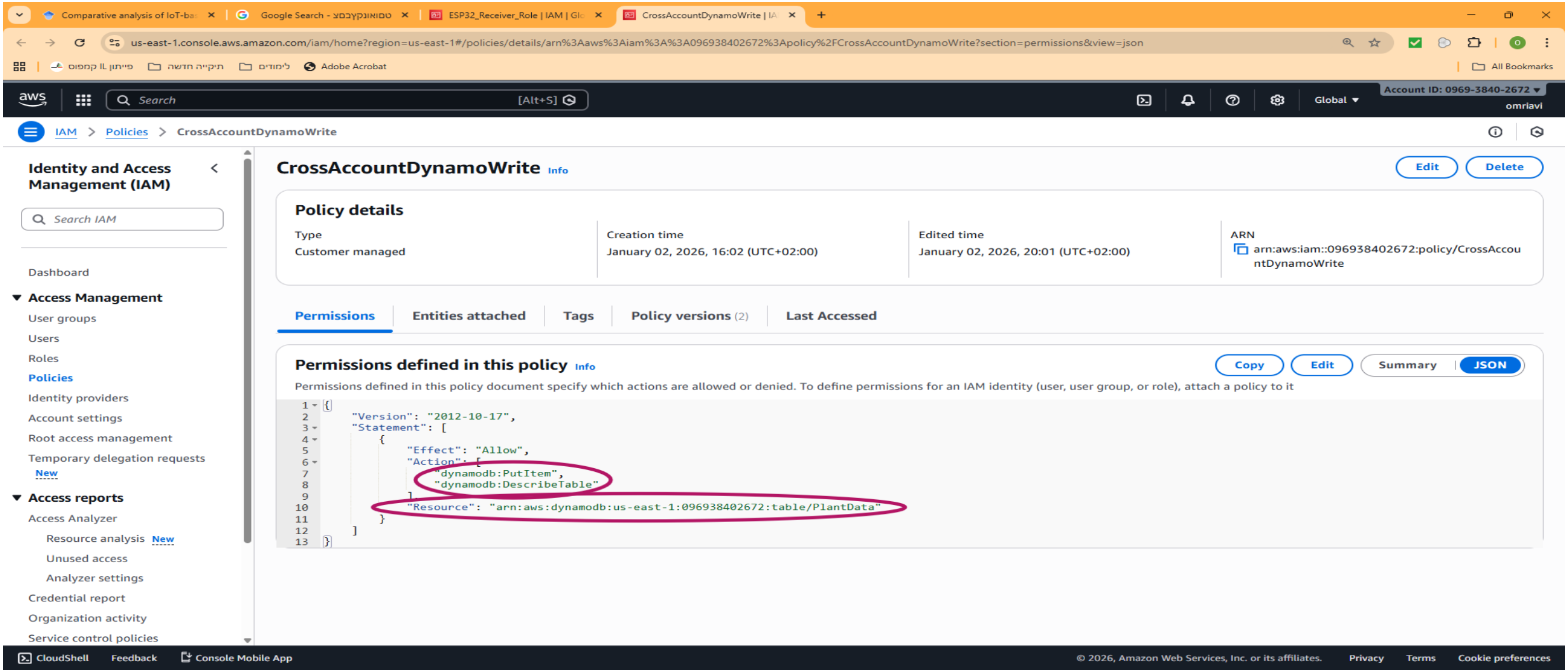
Cross-Account IAM Role



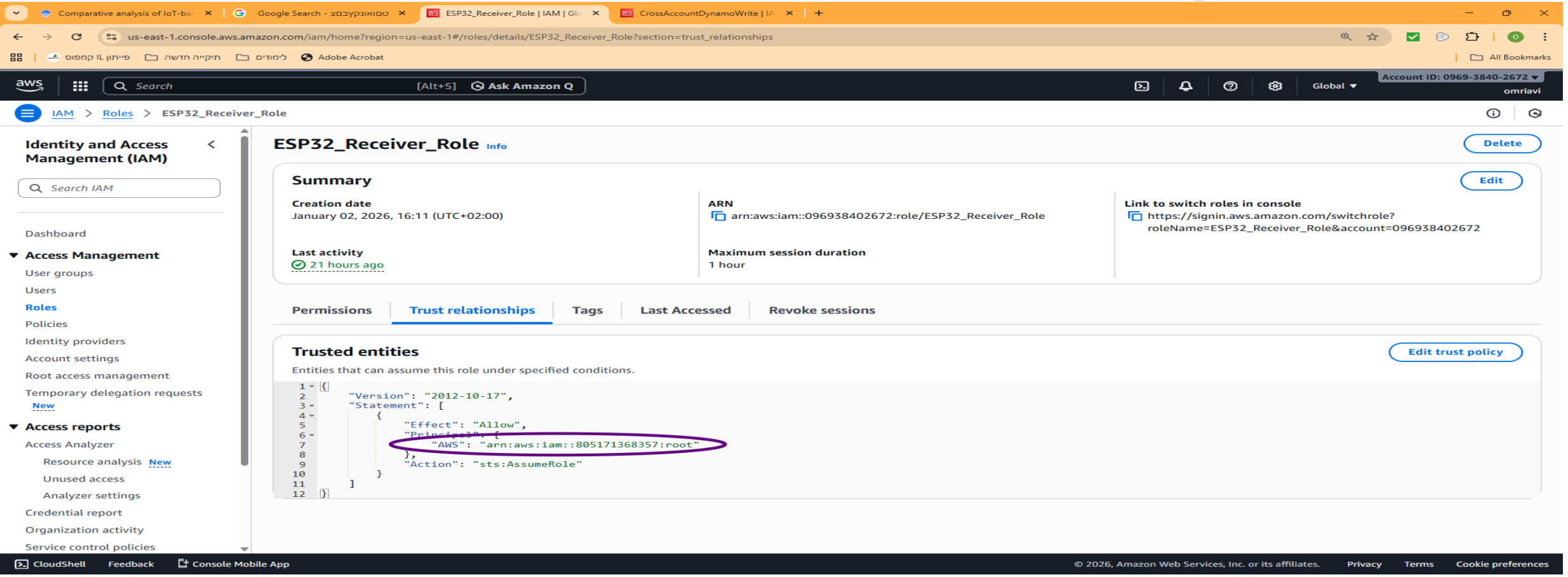
1.Role


Comparative analysis of IoT-ba
Google Search - טסואונקעבסצ
Roles | IAM | Global
us-east-1.console.aws.amazon.com/iam/home?region=us-east-1#/roles
Adobe Acrobat
aws
Search
[Alt+S]
Global
Account ID: 0969-3840-2
IAM > Roles
Identity and Access Management (IAM)
Search IAM
Dashboard
Access Management
User groups
Users
Roles
Policies
Identity providers
Account settings
Root access management
Temporary delegation requests
New
Access reports
Access Analyzer
Resource analysis New
Unused access
Analyzer settings
Credential report
Organization activity
Service control policies
Roles (7) Info
An IAM role is an identity you can create that has specific permissions with credentials that are valid for short durations. Roles can be assumed by entities that you trust.
Delete
Search
1
Role name
Trusted entities
Last activity
aws-iot-rul
AWS Service: iot
9 days ago
AWSServiceRoleForResourceExplorer
AWS Service: resource-explorer-2 (Se
12 minutes ago
AWSServiceRoleForSupport
AWS Service: support (Service-Linke
-
AWSServiceRoleForTrustedAdvisor
AWS Service: trustedadvisor (Service
-
ESP32_Receiver_Role
Account: 805171368357
21 hours ago
iot_to_dynamodb_role
AWS Service: iot
9 days ago
Telegram_Plant_Alert-role-rqfnzohq
AWS Service: lambda
16 minutes ago
Roles Anywhere Info
Manage
Authenticate your non AWS workloads and securely provide access to AWS services.
Access AWS from your non AWS workloads
Operate your non AWS workloads using the same authentication and authorization strategy that you use within AWS.
X.509 Standard
Use your own existing PKI infrastructure or use AWS Certificate Manager Private Certificate Authority to authenticate identities.
Temporary credentials
Use temporary credentials with ease and benefit from the enhanced security they provide.
CloudShell
Feedback
Console Mobile App
© 2026, Amazon Web Services, Inc. or its affiliates.
Privacy
Terms

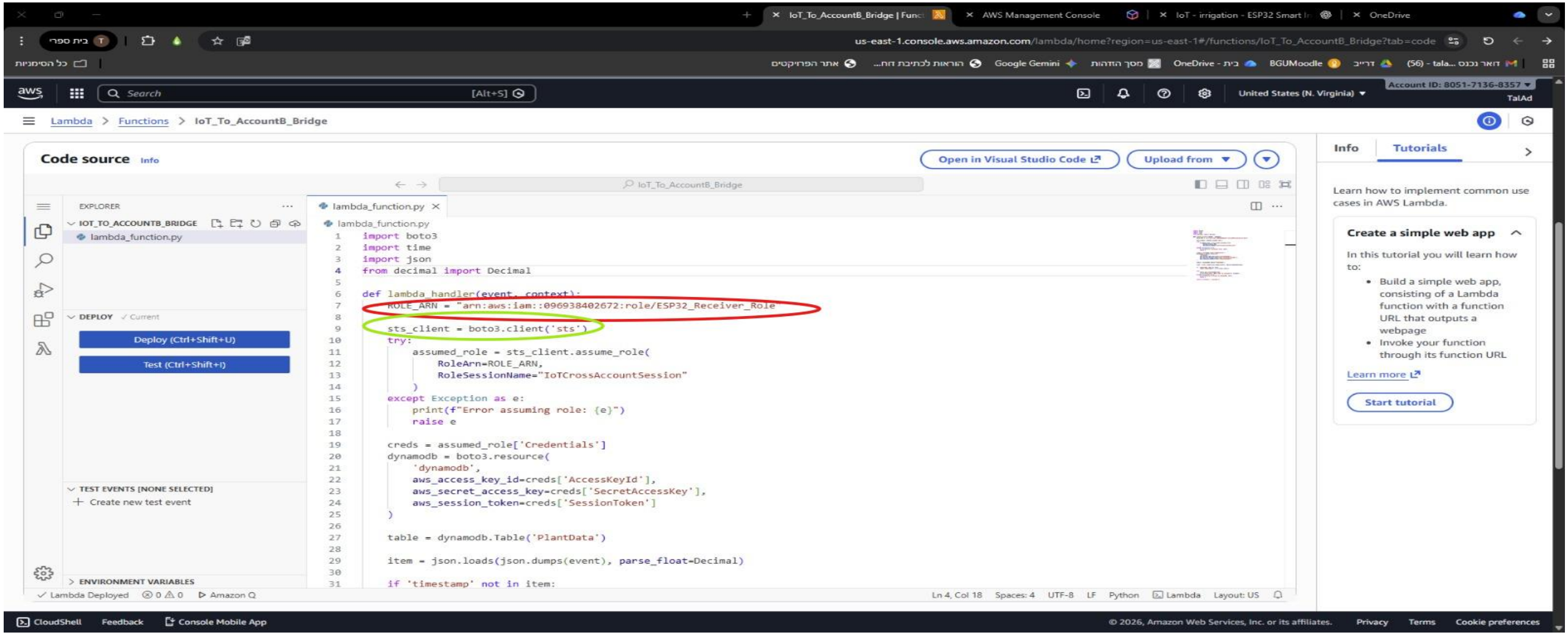
2.Permissions Policy

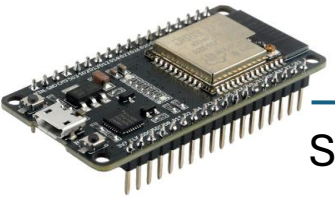


3.Trust Relationship



4.Cross-Account Data Flow via AWS Lambda





Sensor data acquisition & network access

WiFi

MQTT over TLS

AWS IoT Core

Telemetry trigger (IoT Rule)

AWS Lambda

User & state data storage

DynamoDB

IoT Rule: Store telemetry data

S3

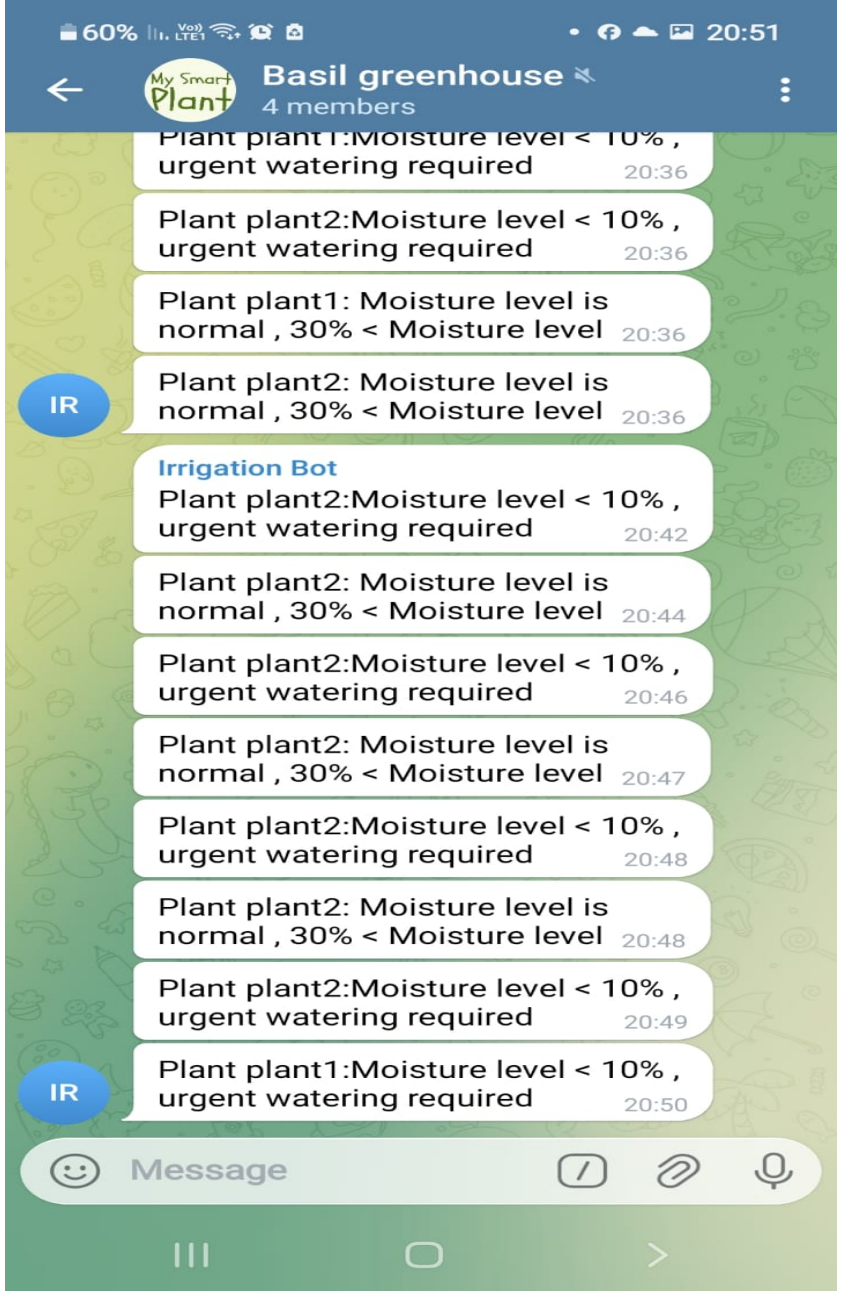
GPIO

Static data distribution

Amazon CloudFront

https://

Alert ! ! !



DynamoDB

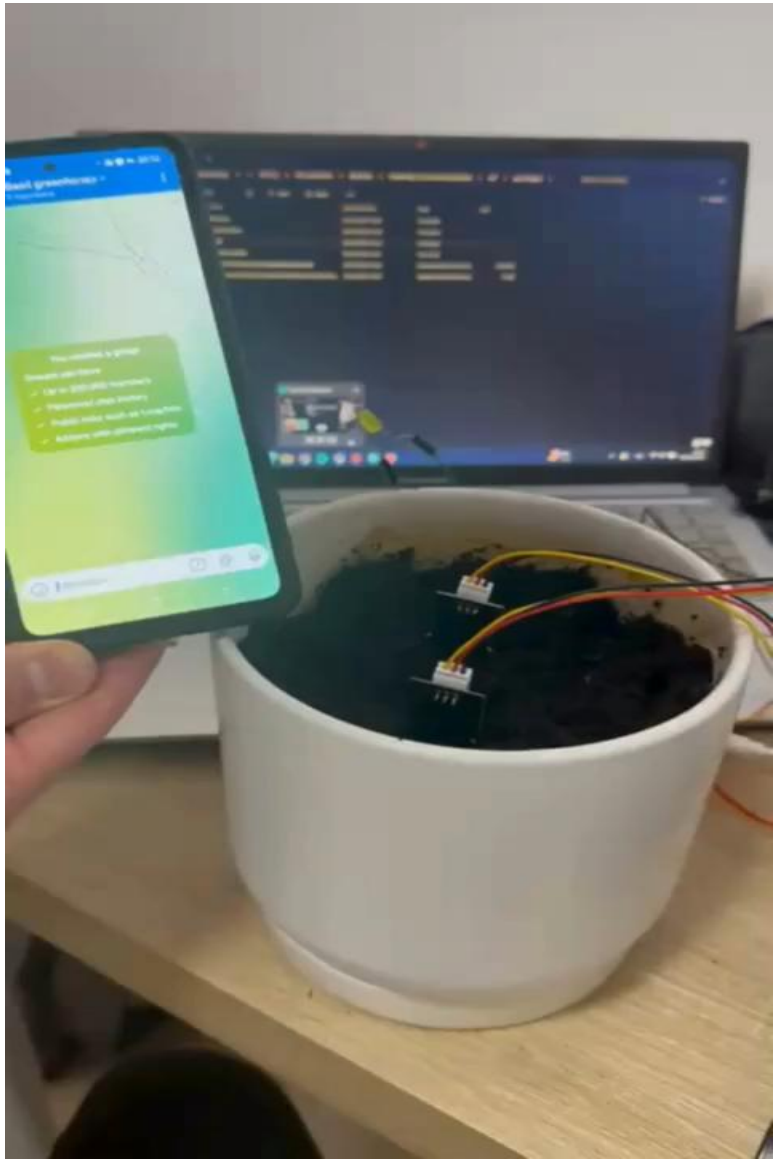
Condition-based trigger

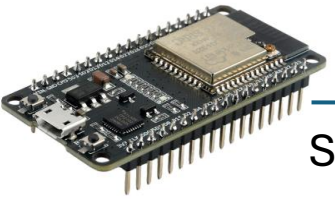
AWS Lambda

Alert delivery (Telegram Bot)

User alert & interaction

Demonstration Video





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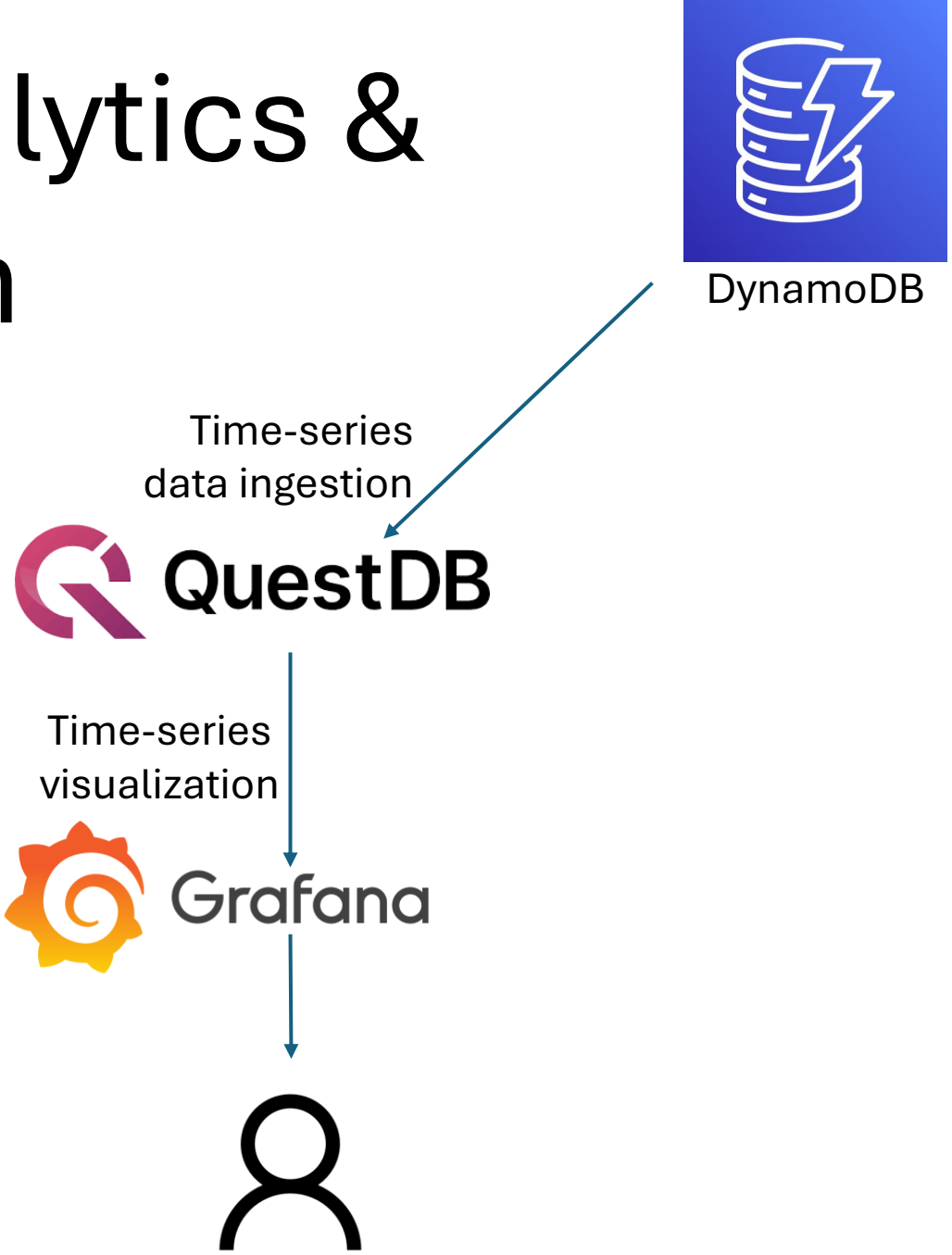
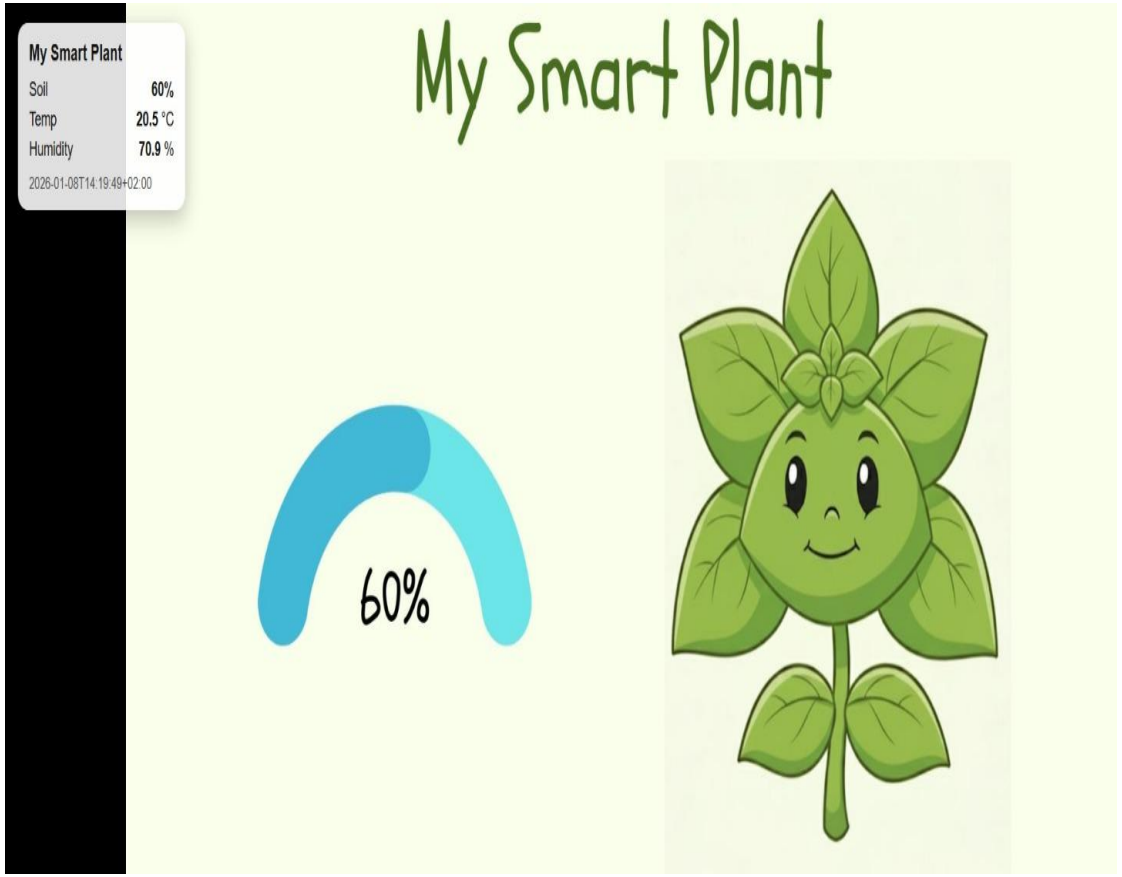
https://

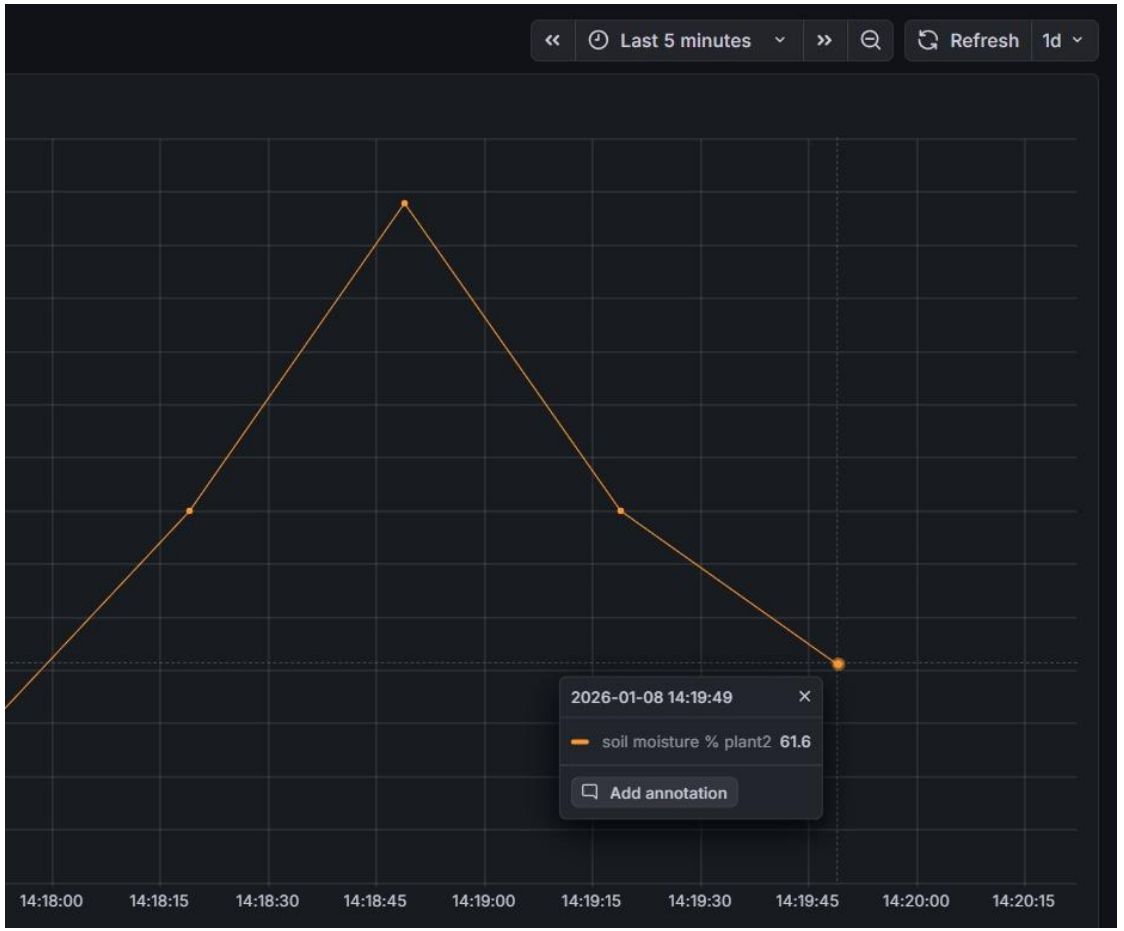
User alert & interaction

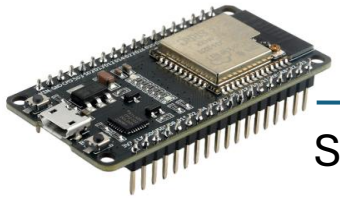
Real-Time Data Analytics & Visualization



RT visualization VS. Website







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S3

Condition-based trigger

Time-series data ingestion

QuestDB

AWS Lambda

Static data distribution

Amazon CloudFront

Time-series visualization

Alert delivery (Telegram Bot)

GPIO

Grafana

https://

User alert & interaction

Challenges

1. **Limited GPIO / ADC Resources**
   Solution: Use additional ESP32 controllers that operate in parallel and publish data using separate identities and topics.

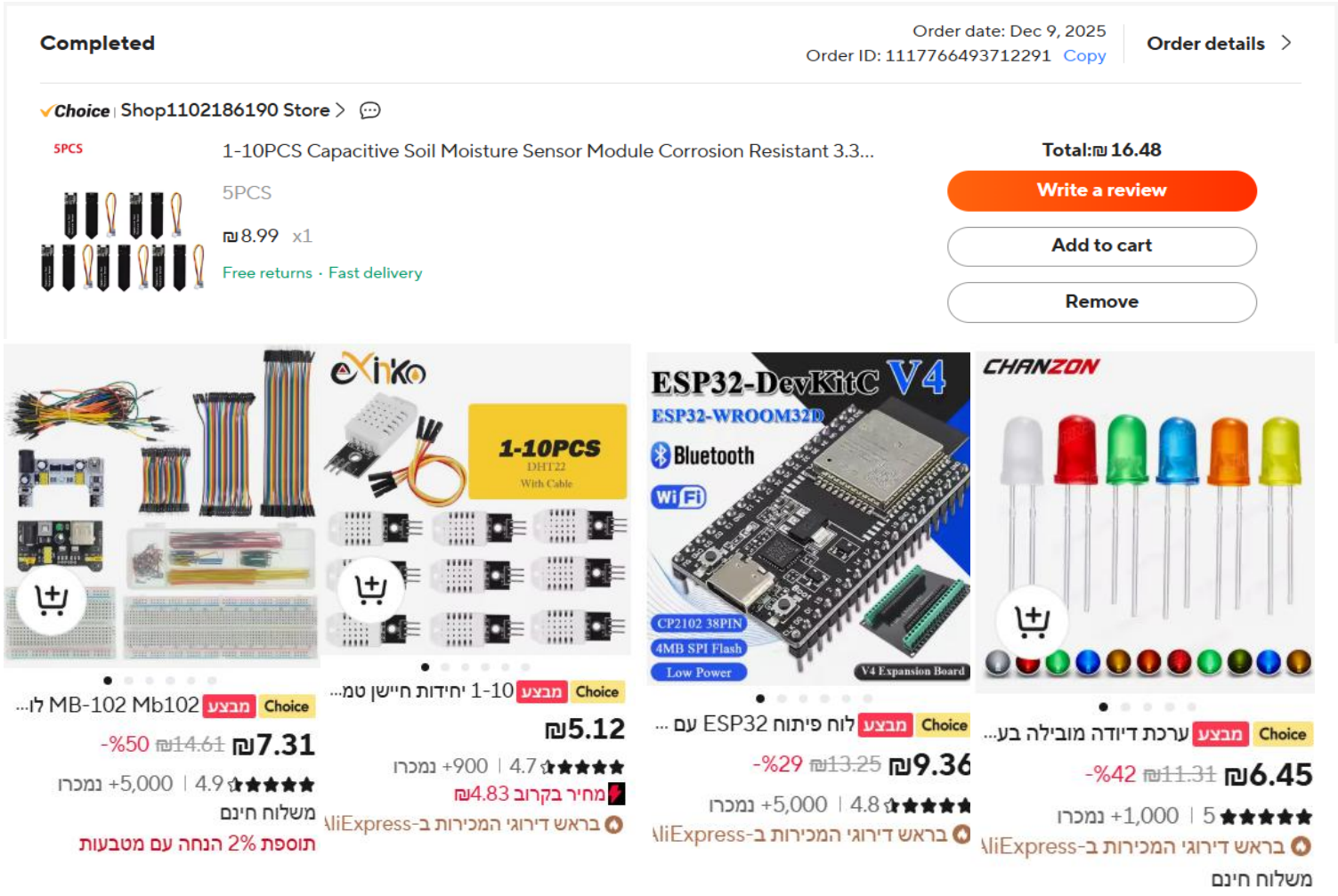
2. **Unstable Wiring and Sensor Disconnections**
   Solution: Use more reliable physical connections such as wider prototyping boards or dedicated PCBs with fixed wiring.
   Plant1 Plant2 All_plants_data

3. **Intermittent WiFi / Cloud Connectivity**
   Solution: Provide local status indication and implement retry mechanisms with temporary local data buffering.

4. **Noisy Analog Soil Moisture Measurements**
   Solution: Apply high-sample averaging and per-sensor calibration to improve measurement stability and accuracy.

Project Cost – Components

- ESP32 DevKit V4– 16.48 ILS
- DHT22 – 5.12 ILS
- Jumpers – 7.31 ILS
- 5Capacitive soil moisture sensor – 16.48 ILS
- **Components total (USD) - $14.53**



Project Cost – AWS

Approximate usage for 10 days use (Jan):

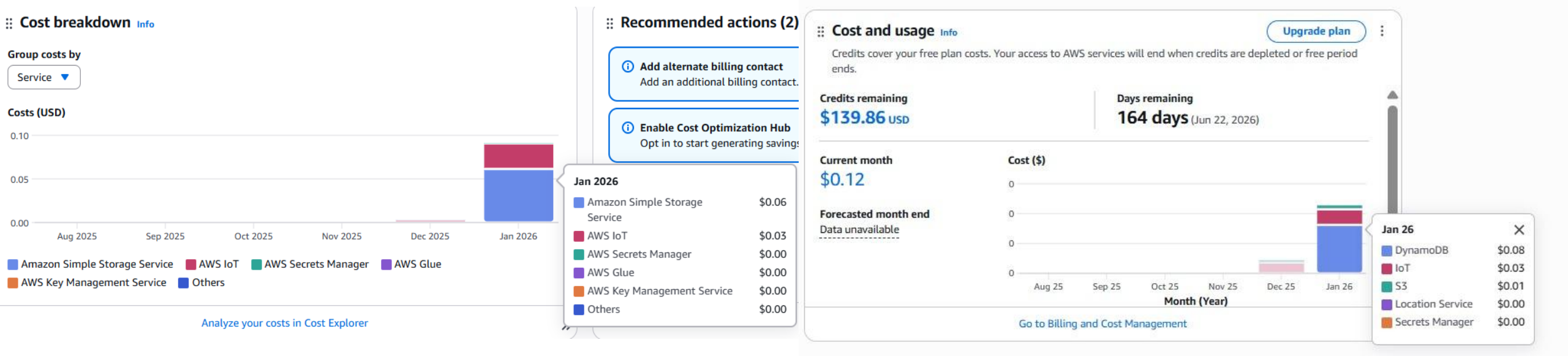
- Amazon Simple Storage Service (S3) – $0.06
- AWS IoT – $0.03

User 2:

- AWS IoT - $0.03
- DynamoDB – $0.08

Approximate usage per month:

- Amazon Simple Storage Service (S3) – $0.18
- AWS IoT –$0.18
- DynamoDB - $0.24



Project Cost – Total Cost (2 plants)

- Components - $14.53
- AWS Services (per month) – $0.6
- **Total - $15.13**

* 3.15 ILS = 1 USD (11/01/2026)

My Smart Plant

Summary

- Designed and implemented an IoT-based smart irrigation monitoring system using ESP32
- Enabled local decision making with offline indication and cloud-based monitoring
- Implemented secure data ingestion, visualization, user notification and data analysis using AWS IoT, S3, CloudFront AWS Lambda, DynamoDB, Grafana, QuestDB and Telegram
- Demonstrated system scalability by supporting multiple plants with independent data pipelines
- Combined low hardware cost with minimal cloud expenses, suitable for home and small-scale use

References

1. Kaur, G., Upadhyaya, P., & Chawla, P. (2023). Comparative analysis of IoT-based controlled environment and uncontrolled environment plant growth monitoring system for hydroponic indoor vertical farm. *Environmental Research*, *222*, Article 115313. https://doi.org/10.1016/j.envres.2023.115313
2. https://he.aliexpress.com
3. https://www.google.com/finance/

My Smart Plant

Thank You For Listening

My Smart Plant

Q&A