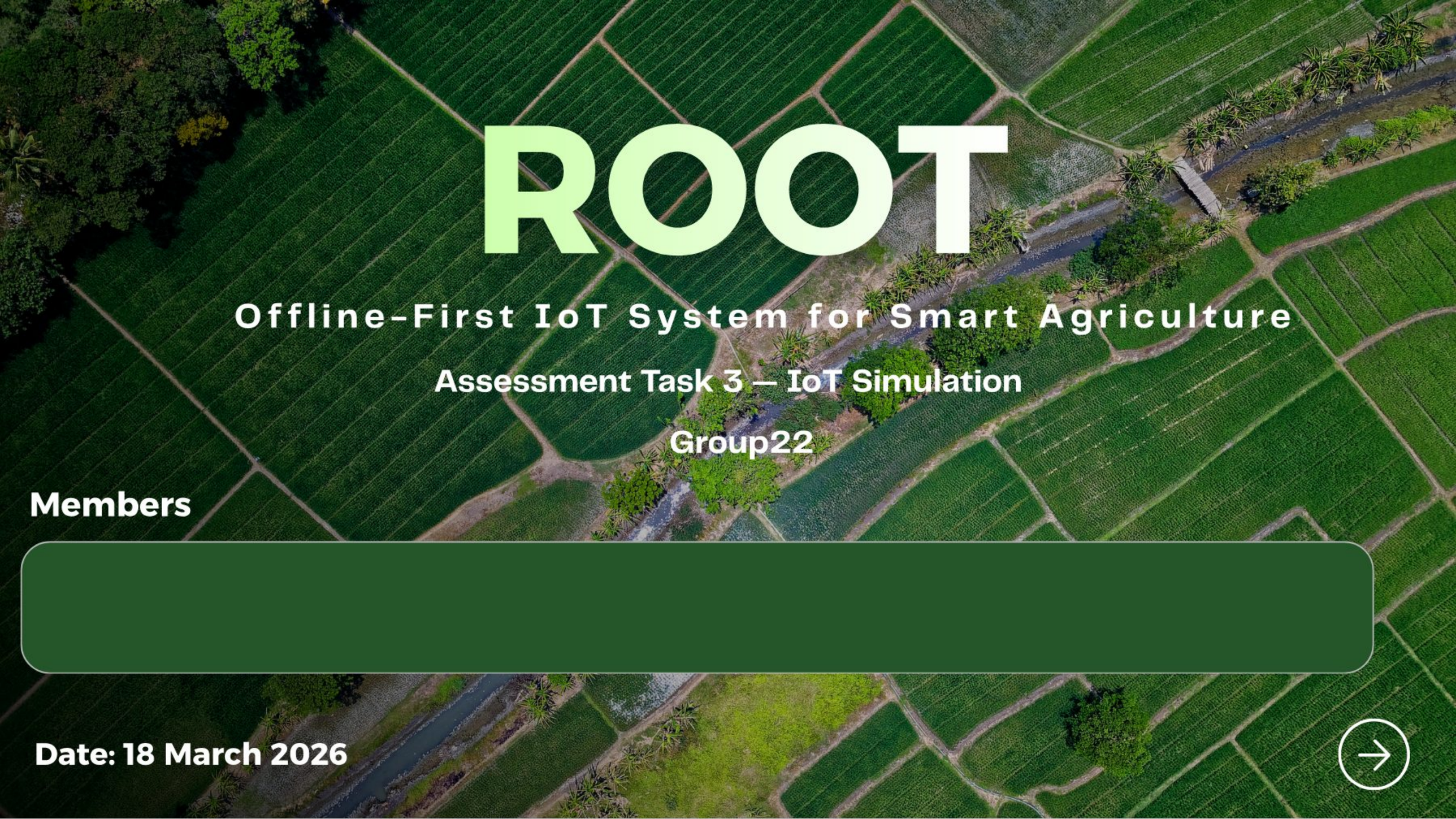


ROOT

Offline-First IoT System for Smart Agriculture

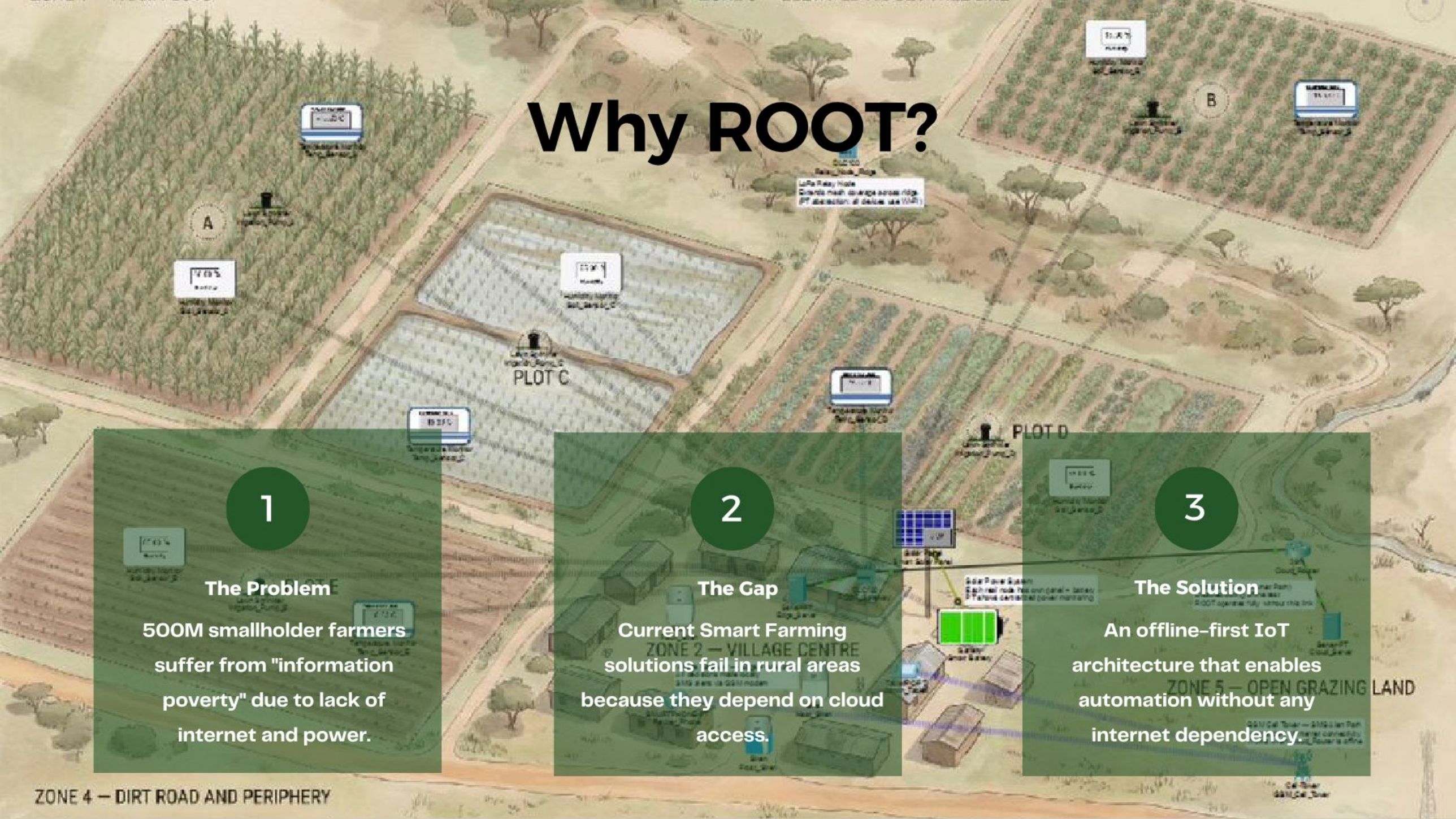
Assessment Task 3 — IoT Simulation

Group22

Members

Date: 18 March 2026

Why ROOT?



1

The Problem

500M smallholder farmers suffer from "information poverty" due to lack of internet and power.

2

The Gap

Current Smart Farming solutions fail in rural areas because they depend on cloud access.

3

The Solution

An offline-first IoT architecture that enables automation without any internet dependency.

SDG Alignment & Societal Impact

SDG 2 (Zero Hunger)

Improving crop yields by providing data-driven insights to farmers who were previously excluded from technology.

SDG 9 (Innovation & Infrastructure)

Introducing a decentralized IoT architecture designed specifically for low-infrastructure environments.

SDG 12 (Responsible Consumption)

Maximizing resource efficiency by ensuring that water and fertilizers are only used when data confirms the need.



Stakeholders & KPIs

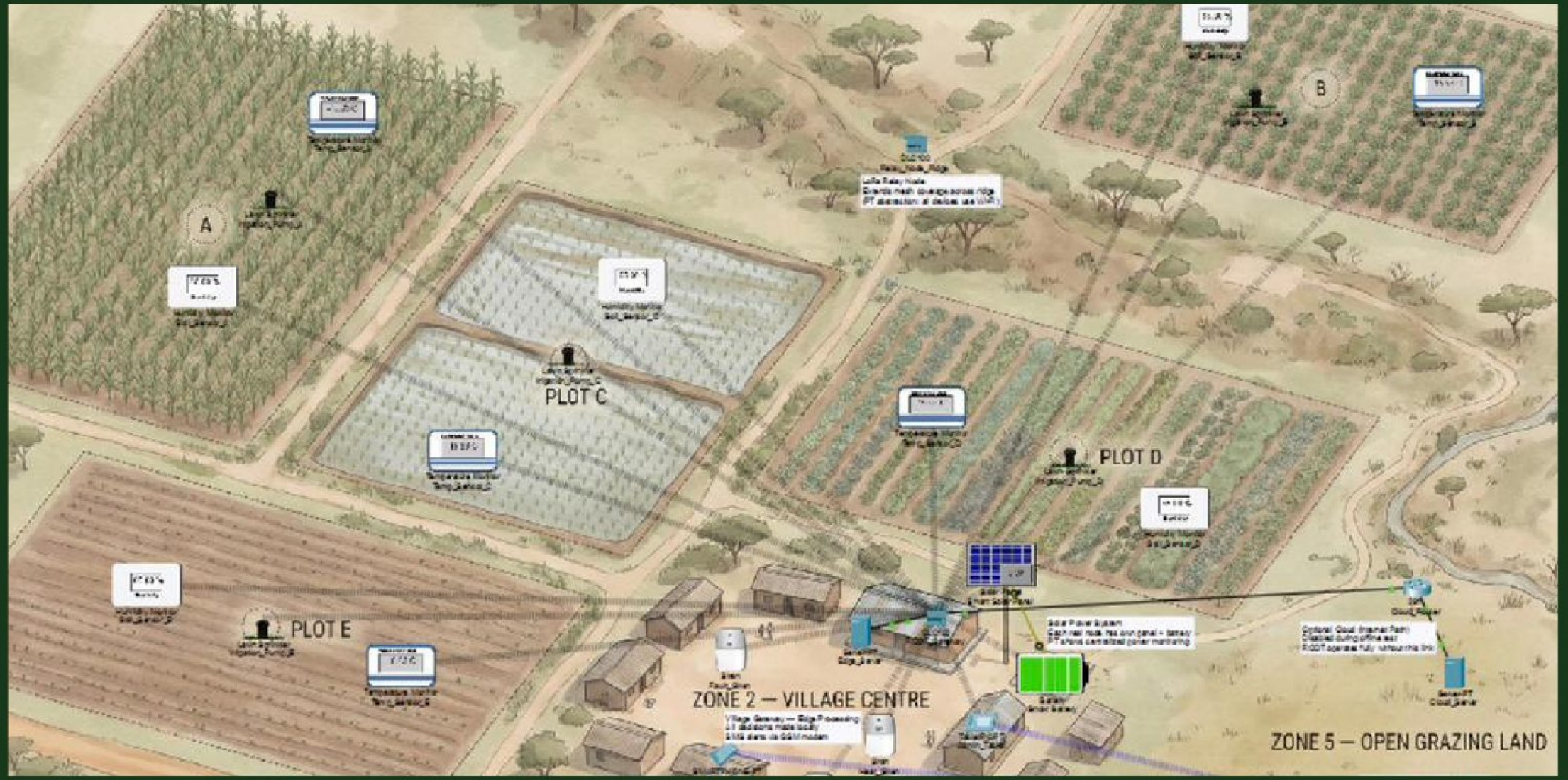
01 **Farmers**
Receive real-time SMS alerts for irrigation and weather warnings.

02 **Cooperative Admins**
Monitor the system via a local dashboard for resource management.

03 **Extension Officers**
Access aggregated data to provide better agricultural advice.

KPI	HOW Simulation Proves It
False Positive Reduction	Sensor fault test: 1 bad sensor → no irrigation, fault alert instead.
Offline Resilience	Cloud router disabled → all automation and local logic still work.
Precision Irrigation	All 5 sensors in a plot must agree (Match All) before pumps activate.

System Architecture Overview



System Architecture Overview

01

Network Topology

A comprehensive simulation involving 28 interconnected devices, representing a real-world agricultural deployment.

02

Infrastructure Layout

The design covers 5 distinct farm plots, each equipped with its own dedicated sensors and actuators.

03

Centralized Processing

A Village Centre hub acts as the brain of the system, hosting the Gateway and Edge Server for local data management.

04

Connectivity Layer

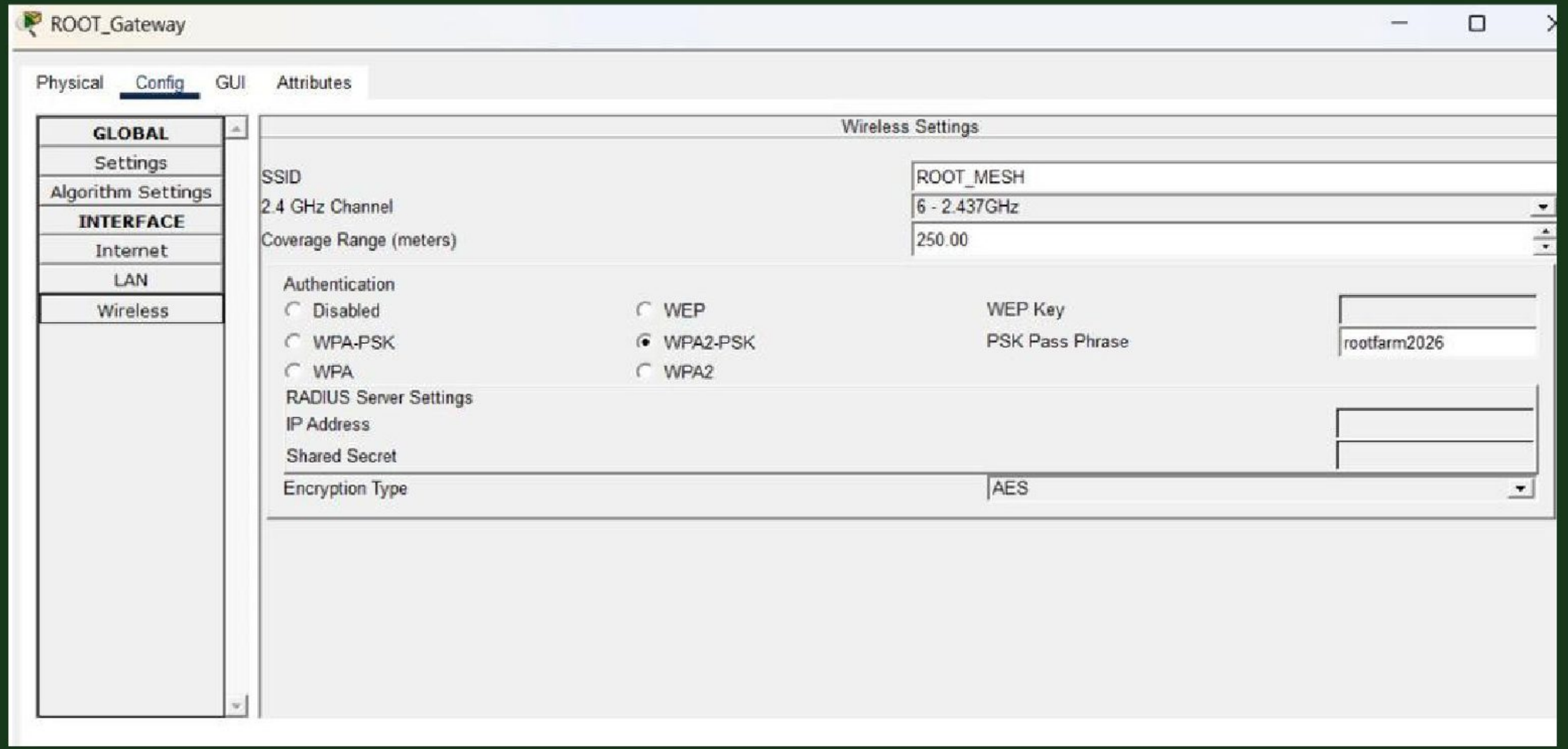
Integrated GSM infrastructure ensures that critical alerts reach the farmers' mobile devices via a simulated cellular path.



Real → PT Mapping

Real System Component	Packet Tracer Representation
LoRa peer-to-peer mesh network	Simulated using Wi-Fi to represent wireless communication between nodes
ESP32 with soil moisture sensor	Represented by Humidity Monitor to simulate environmental data sensing
SIM800L GSM module for alerts	Simulated through Cell Tower and Smartphone for message delivery
Solar-powered system with battery	Smart Solar Panel and Battery used to mimic energy supply

Device Configuration Summary





Device Configuration Summary

Edge Processing

All system intelligence is localized within the village server to eliminate latency and dependency on external internet.

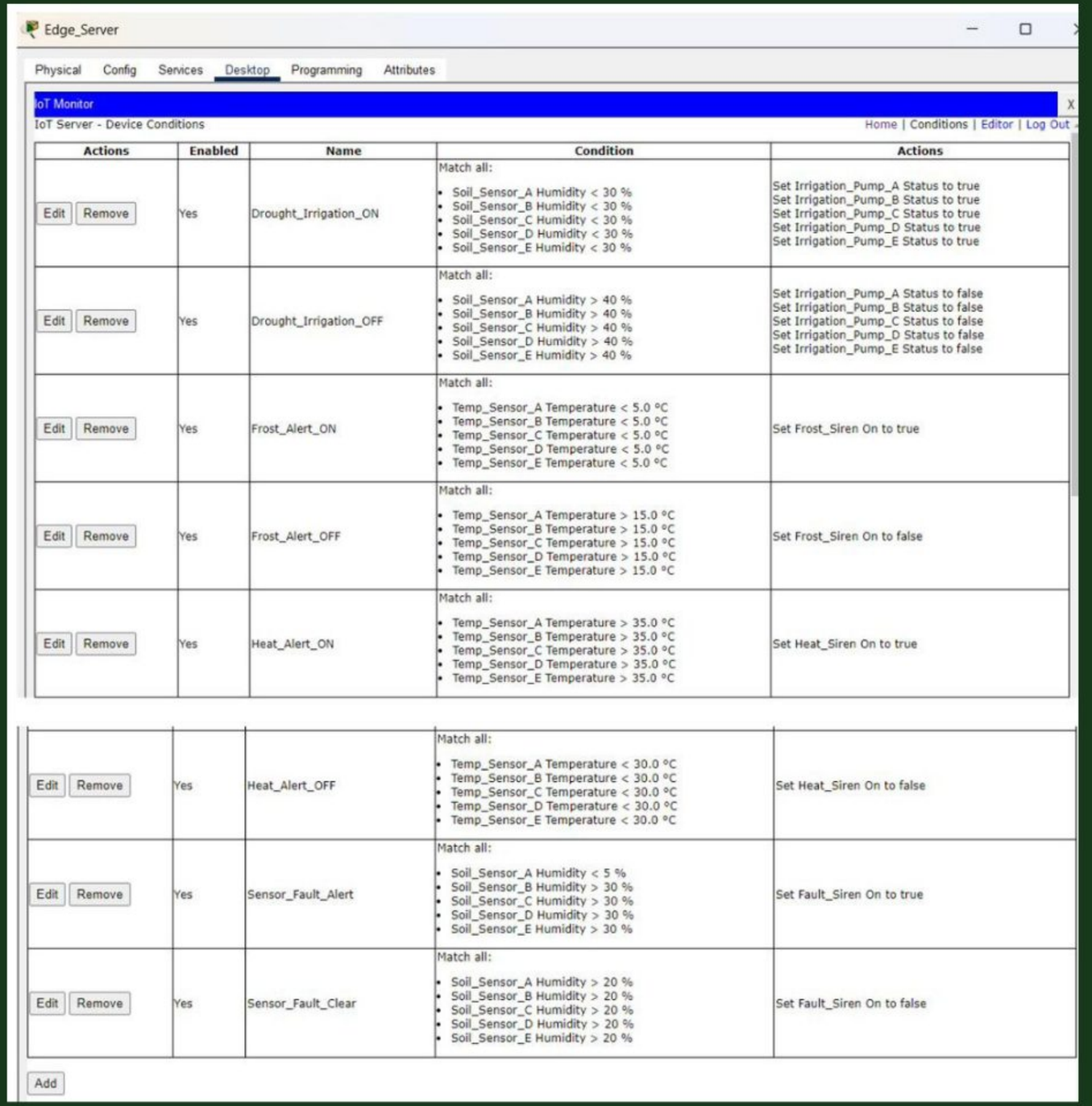
Operational Cycle

A logical flow that begins with continuous environmental sensing, followed by edge-based data processing, and concluding with automated field actuation.

System Autonomy

The design ensures that critical decision-making scripts remain operational even during total network isolation.

Automation Logic Overview



Actions	Enabled	Name	Condition	Actions
Edit Remove	Yes	Drought_Irrigation_ON	Match all: • Soil_Sensor_A Humidity < 30 % • Soil_Sensor_B Humidity < 30 % • Soil_Sensor_C Humidity < 30 % • Soil_Sensor_D Humidity < 30 % • Soil_Sensor_E Humidity < 30 %	Set Irrigation_Pump_A Status to true Set Irrigation_Pump_B Status to true Set Irrigation_Pump_C Status to true Set Irrigation_Pump_D Status to true Set Irrigation_Pump_E Status to true
Edit Remove	Yes	Drought_Irrigation_OFF	Match all: • Soil_Sensor_A Humidity > 40 % • Soil_Sensor_B Humidity > 40 % • Soil_Sensor_C Humidity > 40 % • Soil_Sensor_D Humidity > 40 % • Soil_Sensor_E Humidity > 40 %	Set Irrigation_Pump_A Status to false Set Irrigation_Pump_B Status to false Set Irrigation_Pump_C Status to false Set Irrigation_Pump_D Status to false Set Irrigation_Pump_E Status to false
Edit Remove	Yes	Frost_Alert_ON	Match all: • Temp_Sensor_A Temperature < 5.0 °C • Temp_Sensor_B Temperature < 5.0 °C • Temp_Sensor_C Temperature < 5.0 °C • Temp_Sensor_D Temperature < 5.0 °C • Temp_Sensor_E Temperature < 5.0 °C	Set Frost_Siren On to true
Edit Remove	Yes	Frost_Alert_OFF	Match all: • Temp_Sensor_A Temperature > 15.0 °C • Temp_Sensor_B Temperature > 15.0 °C • Temp_Sensor_C Temperature > 15.0 °C • Temp_Sensor_D Temperature > 15.0 °C • Temp_Sensor_E Temperature > 15.0 °C	Set Frost_Siren On to false
Edit Remove	Yes	Heat_Alert_ON	Match all: • Temp_Sensor_A Temperature > 35.0 °C • Temp_Sensor_B Temperature > 35.0 °C • Temp_Sensor_C Temperature > 35.0 °C • Temp_Sensor_D Temperature > 35.0 °C • Temp_Sensor_E Temperature > 35.0 °C	Set Heat_Siren On to true
Edit Remove	Yes	Heat_Alert_OFF	Match all: • Temp_Sensor_A Temperature < 30.0 °C • Temp_Sensor_B Temperature < 30.0 °C • Temp_Sensor_C Temperature < 30.0 °C • Temp_Sensor_D Temperature < 30.0 °C • Temp_Sensor_E Temperature < 30.0 °C	Set Heat_Siren On to false
Edit Remove	Yes	Sensor_Fault_Alert	Match all: • Soil_Sensor_A Humidity < 5 % • Soil_Sensor_B Humidity > 30 % • Soil_Sensor_C Humidity > 30 % • Soil_Sensor_D Humidity > 30 % • Soil_Sensor_E Humidity > 30 %	Set Fault_Siren On to true
Edit Remove	Yes	Sensor_Fault_Clear	Match all: • Soil_Sensor_A Humidity > 20 % • Soil_Sensor_B Humidity > 20 % • Soil_Sensor_C Humidity > 20 % • Soil_Sensor_D Humidity > 20 % • Soil_Sensor_E Humidity > 20 %	Set Fault_Siren On to false

Add

Automation Logic Overview

Scenario	Trigger	Actuator
Drought	All soil sensors < 30%	Irrigation pumps ON
Frost	Temperature < 5°C	Frost siren ON
Heat Stress	Temperature > 35°C	Heat siren ON
Sensor Fault	1 sensor abnormal vs others	Fault alert ON

All rules use “Match All” to ensure accurate decisions based on multiple sensors (collective corroboration).

Challenges & PT Limitations

Challenges & Justified Design Decisions"

Challenge	Solution
No LoRa support in PT	Wi-Fi used to simulate wireless communication; relay node represented visually
No API for Photo Sensor	Solar panel output used as light intensity proxy
SMS not supported	Cell Tower + Smartphone simulate GSM alert system
No time-based logic	Instant triggers used; time-based logic explained in Assignment 2

Test Results Summary

All 7 Tests Passed

Test	Result
Drought Detection	Pass ✅
Frost Alert	Pass ✅
Heat Stress Alert	Pass ✅
Sensor Fault Detection	Pass ✅
Manual Actuator Control	Pass ✅
Offline Resilience	Pass ✅
Data Communication	Pass ✅

Conclusion

The ROOT IoT simulation demonstrates a smart agriculture system that integrates sensors, actuators, and automation to monitor environmental conditions and control irrigation and alerts effectively.

Key features such as drought detection, frost alerts, heat stress monitoring, manual control, and data communication were successfully demonstrated.

Although some limitations exist in Packet Tracer, the core IoT workflow was fully implemented, proving the system is practical and feasible for real-world deployment.


THANK YOU FOR
LISTENING!