CySecAgri

Team 17 Faculty Panel Presentation
December 4th, 2022

Meet the Team

David Wolfe	CybE	- IoT Sensors & Basestation
Tom Ruminski	CprE	- IoT Sensors & Basestation
Rian Lamarque	CybE	- AWS Infrastructure
Eli Hanson	CybE	- AWS Infrastructure
Joe Hunter	CprE	- Frontend Development
Syed Al-hussain	SE	- Frontend Development

Professor Govindarasu - Advisor/Client

Problem Statement

- Primary Problem:
  - Farmers need to manually test, record, and chart Internet of Things (IoT) sensor data
  - IoT Farming is inaccessible
  - No method of detection for malicious activity
- Gap in the Market:
  - KaaIoT
    - Closed Source
    - No detection
  - Opensensing
    - Open Source
    - Unintuitive and complex

Figure 1. *Manually checked soil sensor.*

Project Context

- **Intended for small and large farm owners**
- **Implement a secure IoT platform to enable data collection and analysis**

Problem:	Solution:
Time consuming data collection	Sync to Cloud
Lack of anomaly detection	AI powered analysis
No real time data access	Mobile App with real time readings

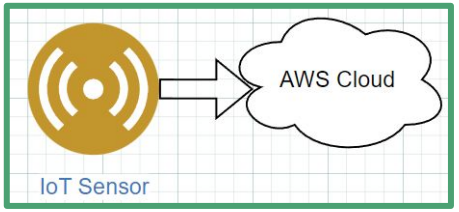


Figure 2. *Sensor to Cloud Syncing*

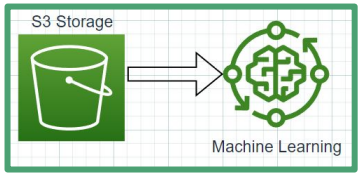


Figure 3. *Anomaly Detection*

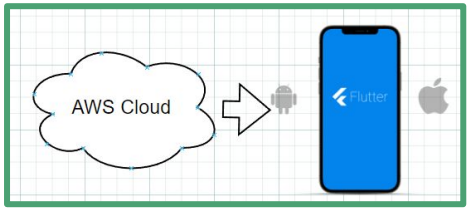


Figure 4. *Real Time Data Access*

Solution Overview

System Diagram

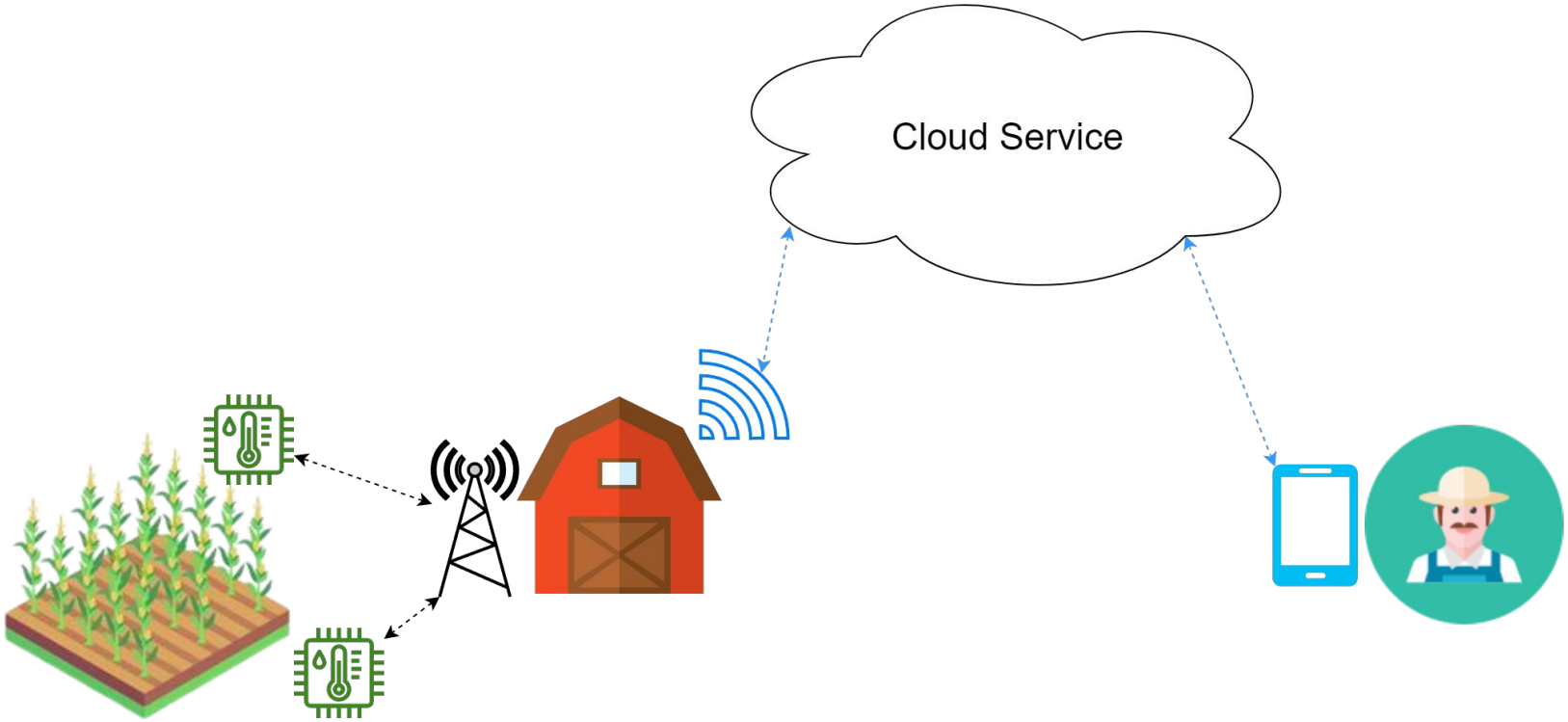


Figure 5. *System Overview I.*

System Diagram

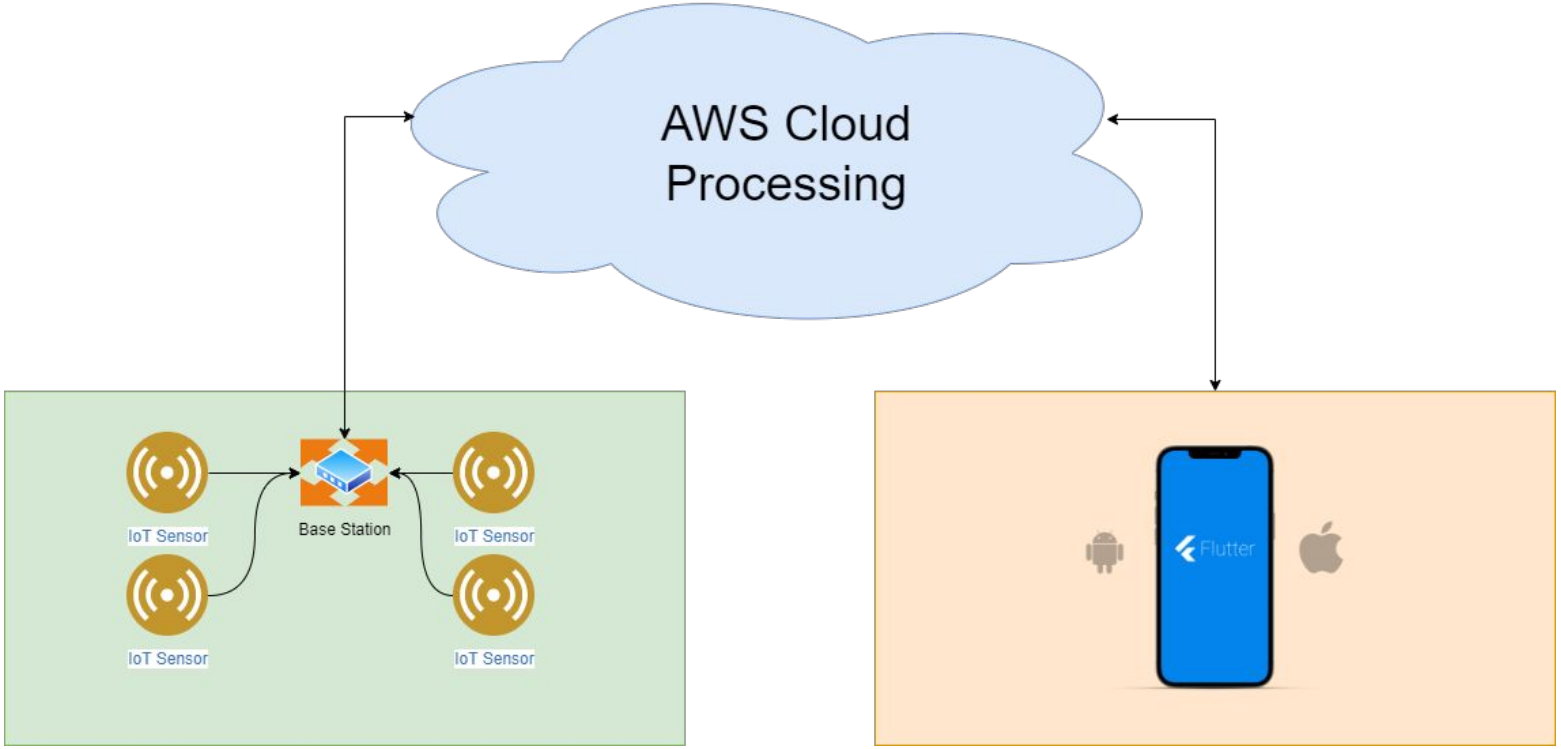


Figure 6. *System Overview II.*

User & Project Analysis

Intended Users & Uses

1. Large Scale Farmers
2. Gardeners (Smaller family farms)
3. System Administrators
4. Co-Ops
5. Owners of only house plants (Students)
6. People learning to take care of plants

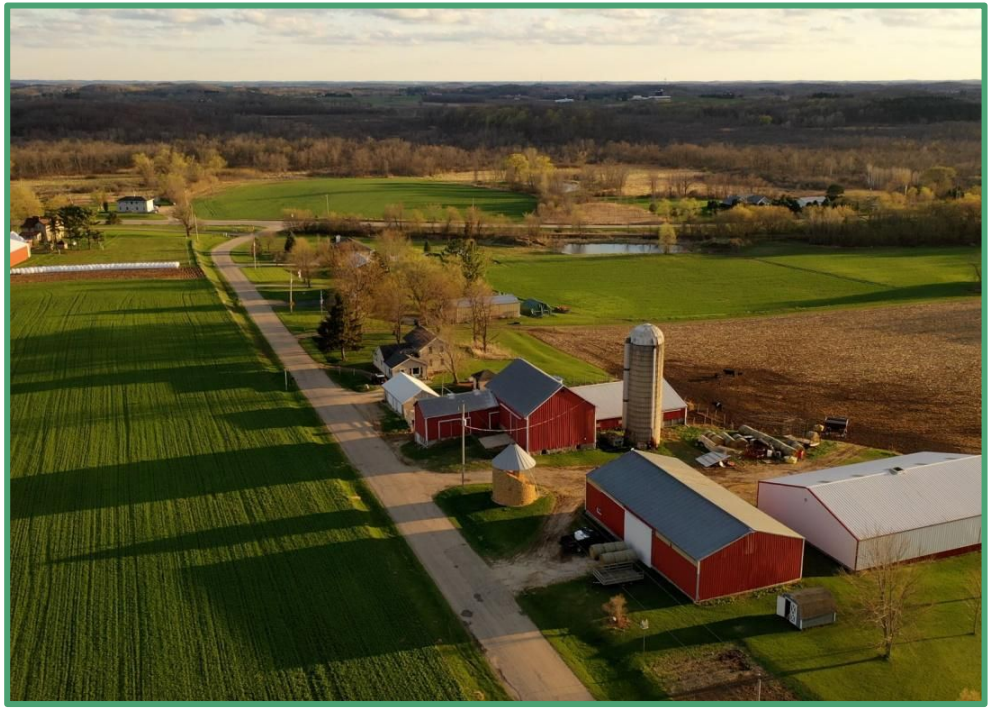


Figure 7. Large Scale Farm

How These Users Will Benefit

- **Improve crop yields with realtime data for large scale farmers**
- **Notifications supplied to users if plants need attention**

Figure 8. User watering plants

Functional & Non-Functional Requirements

- **IoT Sensors & Basestation**
  - **Functional:** Medium-long range wireless transmitter (LoRa)
  - **Non-Functional:** Secure and consistent data collection and distribution
- **AWS cloud**
  - **Functional:** Data transfer using MQTT for IoT and SQS for application
  - **Non-Functional:** Data can be stored and accessible from any location and time
- **Flutter application**
  - **Functional:** Data visualization and representation of sensor data
  - **Non-Functional:** Data will be quickly accessible and up to date
- **Security Requirements**
  - Users will only be able to access their accounts data
  - Data will be encrypted end-to-end in transit

Additional Requirements & Constraints

- **Physical**
  - Durability
  - Sensor footprint
  - Sensors are visible in the field
- **Resource**
  - Battery life should last from planting to harvest
- **Environment**
  - Batteries don't leak into soil
  - Materials don't change soil nutrient levels
- **UI**
  - System performs identically regardless of location
  - Operates on multiple operating systems
  - Users can not view other users data

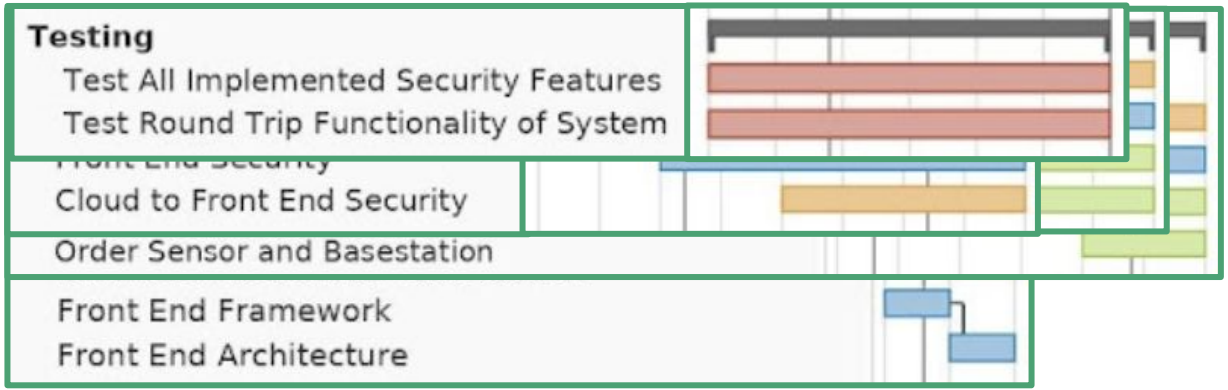
Figure 9. Example existing sensor

Project Plan

Project Management Plan

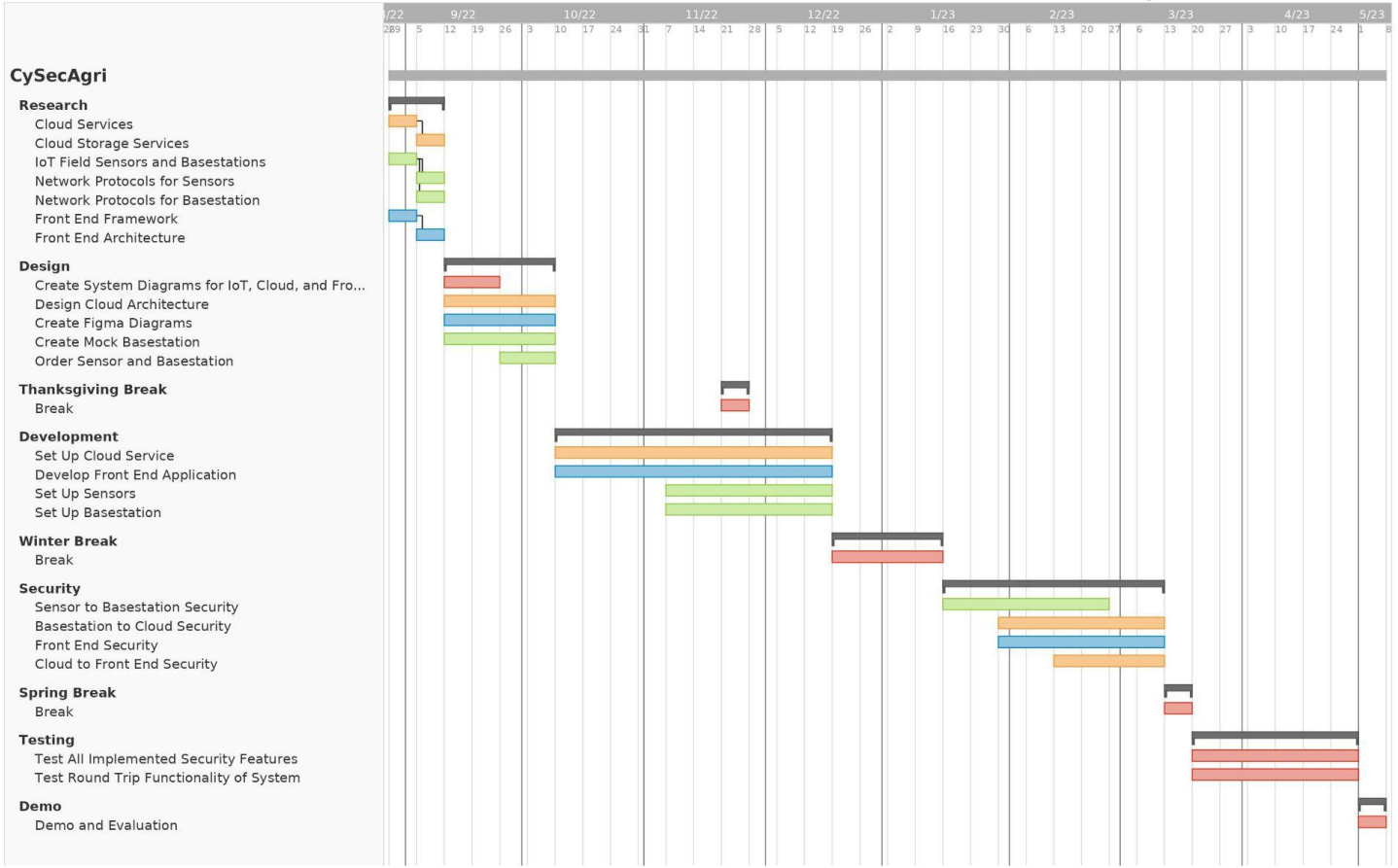
- **Research**
  - **Week 1 - Week 2**
- **Design**
  - **Week 3 - Week 6**
- **Development**
  - **Week 7 - Week 16**
- **Security**
  - **Week 21 - Week 28**
- **Testing**
  - **Week 30 - Week 36**

Figure 10. *Gantt Chart Milestones*



Gantt Chart

Figure 11. *Gantt Chart*



Complexity - IoT

Basestation and sensor security

- **Security Focused Deployment**
  - **Asymmetric cryptography**
  - **Full disk encryption**
  - **Ingress & Egress filtering**

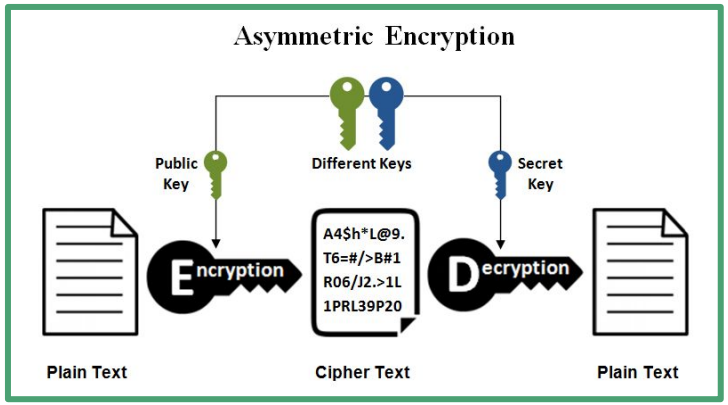


Figure 12. *Encryption of Data in Transit*

Complexity - Cloud

Data storage design

- **One user may access data from multiple sensors so an efficient storage solution is required**

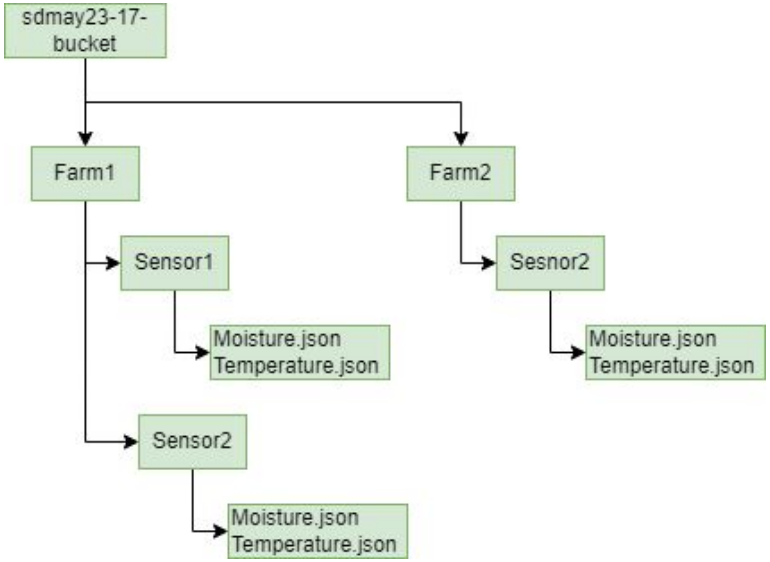


Figure 13. *File Structure*

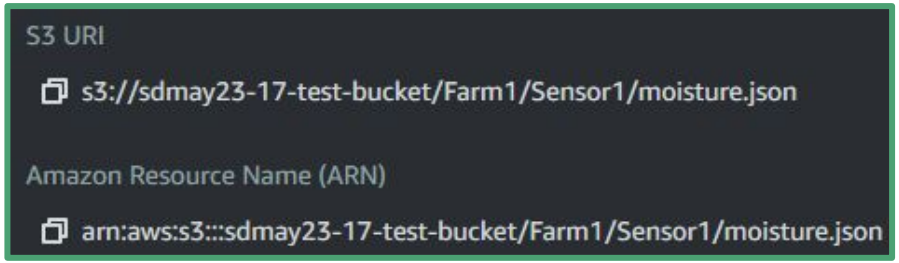


Figure 14. *AWS Console View*

Current Implementation

IoT Sensors & Basestation

- Sensor-to-Basestation Protocols
  - PHY - LoRa RF
  - Data Link - LoRaWAN
  - Application Layer - OTAA
  - Topology - Star
- Basestation-to-Cloud Protocols
  - PHY - WiFi
  - Net/Transport - TCP/IP
  - Application - MQTT

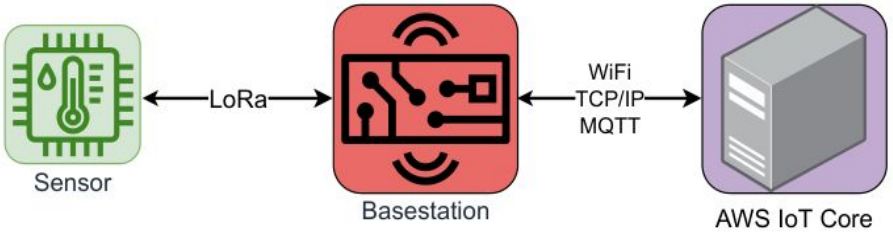


Figure 15. *IoT Device Communication Diagram.*

- Sensors (2)
  - Soil Temp. and Moisture
  - SenseCAP S2104
- Basestation (1)
  - LoRaWAN Concentrator Chip + RaspberryPi

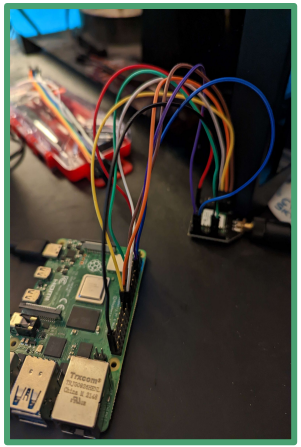


Figure 16. *Basestation.*

AWS Infrastructure

- IoT Core collects from mock base station
- Message Lambda parses hex data
- S3 receives decimal data from lambda for storage
- Frontend App queries S3 for data

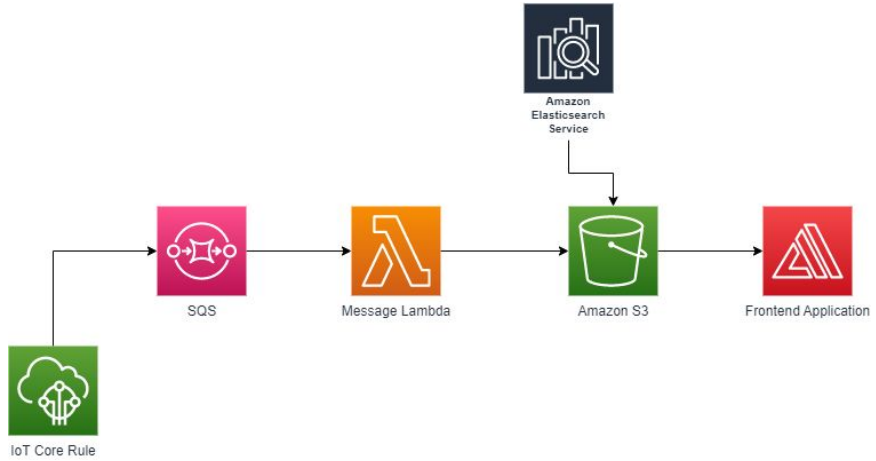


Figure 18. *AWS Diagram Design*

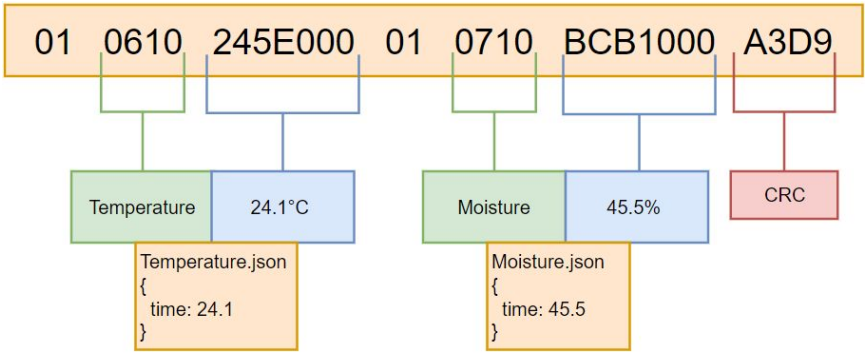


Figure 17. *Hex Data to Decimal*

Front End Development

- Use RESTful API to get sensor data
- Scroll view to see sensor data
- Graph view to see sensor data and trends overtime

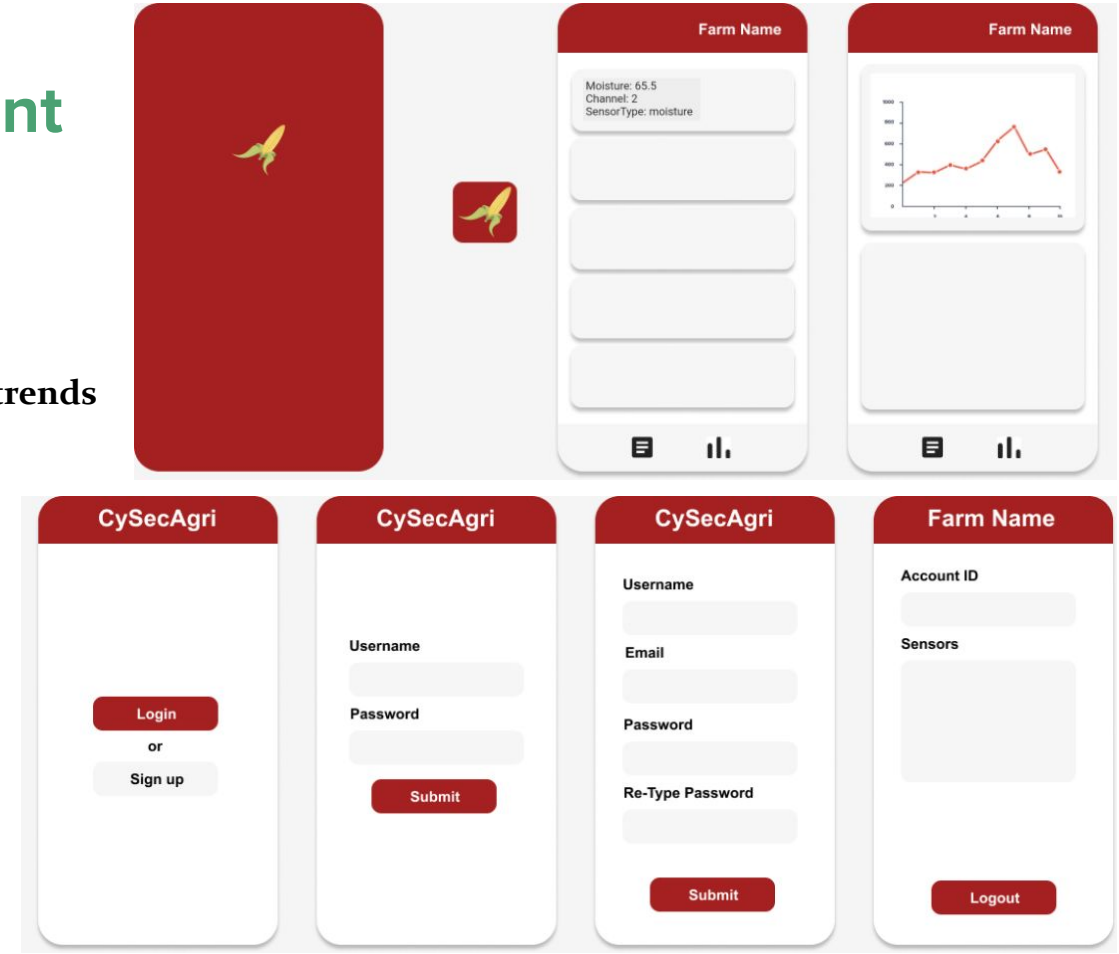


Figure 19. *Flutter figma designs*

Testing Plan

- **Flutter app**
  - **Unit Testing**
  - **Integration Testing**
- **CI/CD Pipeline**
  - **Terraform for AWS infrastructure**
- **Manual Testing with sensors and raspberry pi basestation**
- **Offensive Security Testing**
  - **API Testing**
  - **Assumed Breach**
    - **Enumerate Privilege Escalation Vectors**
  - **Application Testing**
    - **Reverse engineering**

Figure 20. *Testing.*

Conclusion

- **Currently:**
  - **Working prototype**
  - **Simulated IoT data**
  - **Prototype AWS architecture**
  - **Application proof of concept**
- **Next Semester:**
  - **Finalize basestation and inner AWS workings**
  - **Continue app development**
  - **Implement security**
  - **Security testing**

Figure 21. *Happy Consumers.*

Questions + Feedback