1. **Industrial Internship Report on**
2. **Smart Industrial Environment Monitor with Predictive Alerting**
   - **-Prepared by: Jayesh Koli**

Executive Summary
This report provides details of the Industrial Internship provided by **up Skill Campus** and **The IoT Academy** in collaboration with Industrial Partner **Uni Converge Technologies Pvt Ltd (UCT)**. This internship focused on a project/problem statement provided by UCT to be completed within 6 weeks. My project was the development of an IoT-based system for monitoring factory floor environmental parameters to ensure machine longevity and worker safety. This internship gave me a very good opportunity to get exposure to Industrial problems and design/implement solutions, resulting in a great overall experience.

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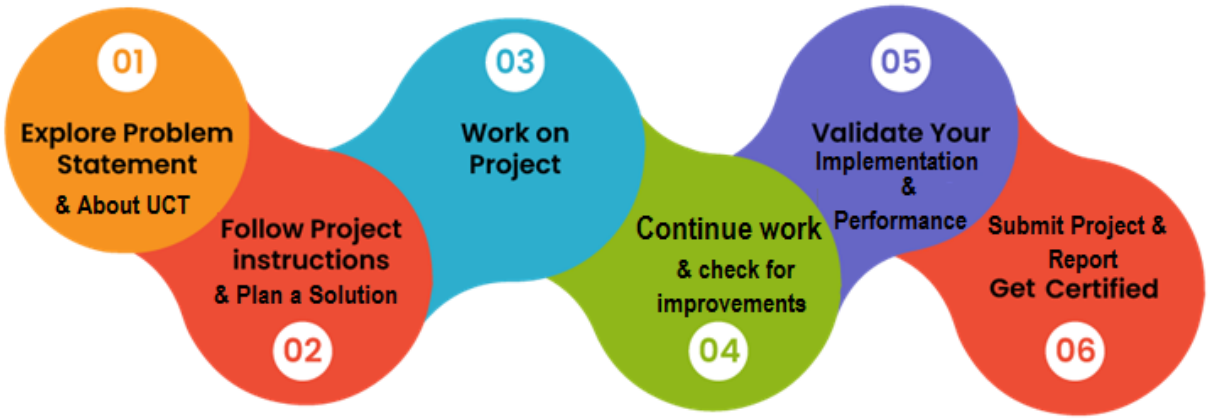
1 Preface

- **6-Week Summary**: Over the last six weeks, I have progressed through problem exploration, solution planning, hardware integration, and performance validation.
- +1
- **Career Development**: I have recognized the critical need for relevant internships to bridge the gap between academic theory and professional application.
- **Project Brief**: My project involves using an ESP32 microcontroller and sensors to create a real-time monitoring dashboard.
- **UCT/USC Opportunity**: This program was made possible through the collaboration between up Skill Campus and Uni Converge Technologies.



Thank you.

2 Introduction

2.1 About Uni Converge Technologies Pvt Ltd

UCT was established in 2013 and works in the **Digital Transformation** domain, providing industrial solutions with a focus on sustainability and ROI. The company leverages cutting-edge technologies like **IoT, Cloud Computing (AWS, Azure), and Lora WAN**.

- **UCT Insight**: A Java and ReactJS-based IoT platform that supports protocols like **MQTT, CoAP, and HTTP**.
- **Factory Watch**: A platform for smart factory needs that provides scalable solutions for production monitoring and predictive maintenance.

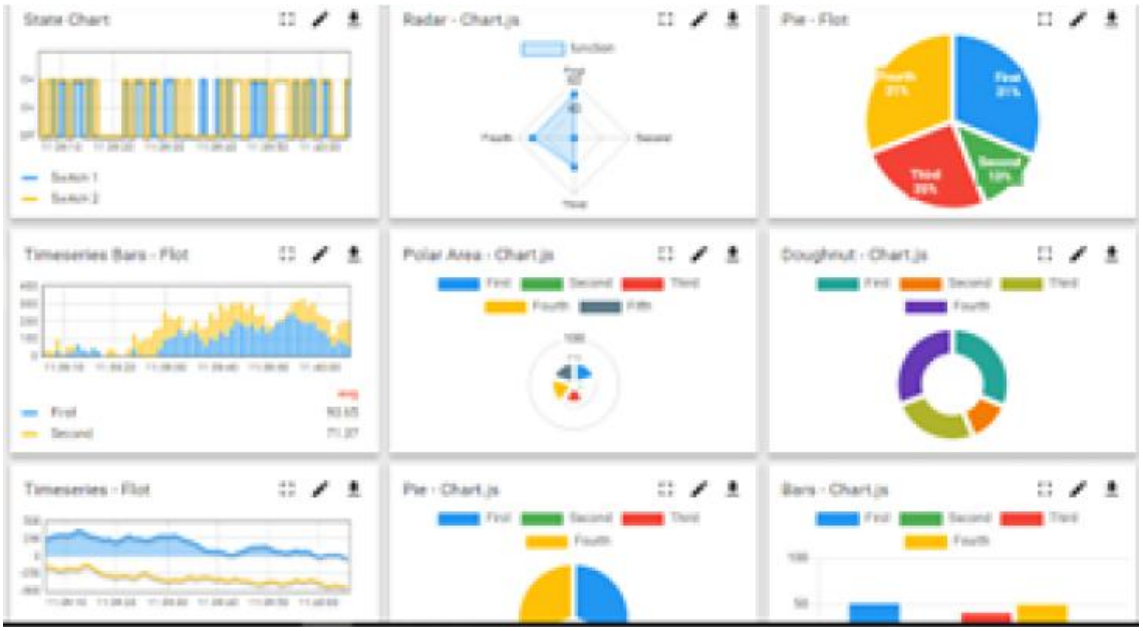
i. UCT IoT Platform (USC Insight)

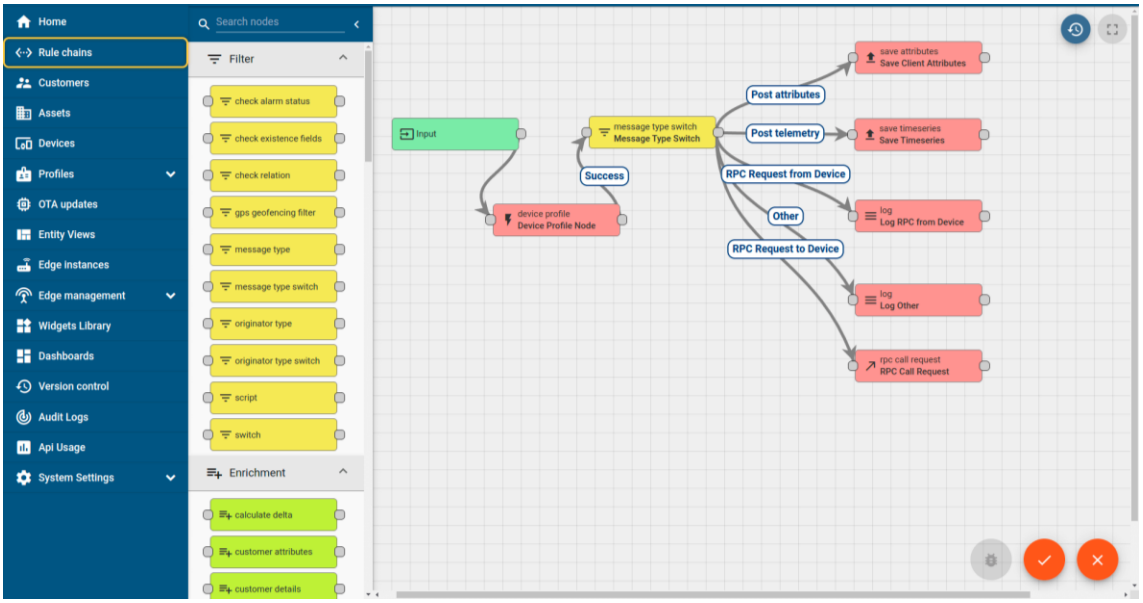
USC is a career development platform that delivers personalized executive coaching and facilities smooth internship execution in association with UCT.

UCT Insight is an IOT platform designed for quick deployment of IOT applications on the same time providing valuable “insight” for your process/business. It has been built in Java for backend and ReactJS for Front end. It has support for MySQL and various NoSQL Databases.

- It enables device connectivity via industry standard IoT protocols - MQTT, CoAP, HTTP, Modbus TCP, OPC UA
- It supports both cloud and on-premises deployments.

It has features to
• Build Your own dashboard
• Analytics and Reporting
• Alert and Notification
• Integration with third party application (Power BI, SAP, ERP)
• Rule Engine


State Chart
Radar - Chart.js
Pie - Plot
Timeseries Bars - Plot
Polar Area - Chart.js
Doughnut - Chart.js
Timeseries - Plot
Pie - Chart.js
Bars - Chart.js


Home
Rule chains
Customers
Assets
Devices
Profiles
OTA updates
Entity Views
Edge instances
Edge management
Widgets Library
Dashboards
Version control
Audit Logs
Api Usage
System Settings
Search nodes
Filter
check alarm status
check existence fields
check relation
gps geofencing filter
message type
message type switch
originator type
originator type switch
script
switch
Enrichment
calculate delta
customer attributes
customer details
Input
message type switch
Message Type Switch
device profile
Device Profile Node
Success
Post attributes
Post telemetry
RPC Request from Device
Other
RPC Request to Device
save attributes
Save Client Attributes
save timeseries
Save Timeseries
log
Log RPC from Device
log
Log Other
rpc call request
RPC Call Request

ii. **Smart Factory Platform (FACTORY WATCH)**

Factory watch is a platform for smart factory needs.

It provides Users/ Factory

- with a scalable solution for their Production and asset monitoring
- OEE and predictive maintenance solution scaling up to digital twin for your assets.
- to unleased the true potential of the data that their machines are generating and helps to identify the KPIs and also improve them.
- A modular architecture that allows users to choose the service that they what to start and then can scale to more complex solutions as per their demands.

Its unique SaaS model helps users to save time, cost and money.

Machine	Operator	Work Order ID	Job ID	Job Performance	Job Progress		Output		Rejection	Time (mins)				Job Status	End Customer
					Start Time	End Time	Planned	Actual		Setup	Pred	Downtime	Idle		
CNC_S7_81	Operator 1	WO0405200001	4168	58%	10:30 AM		55	41	0	80	215	0	45	In Progress	i
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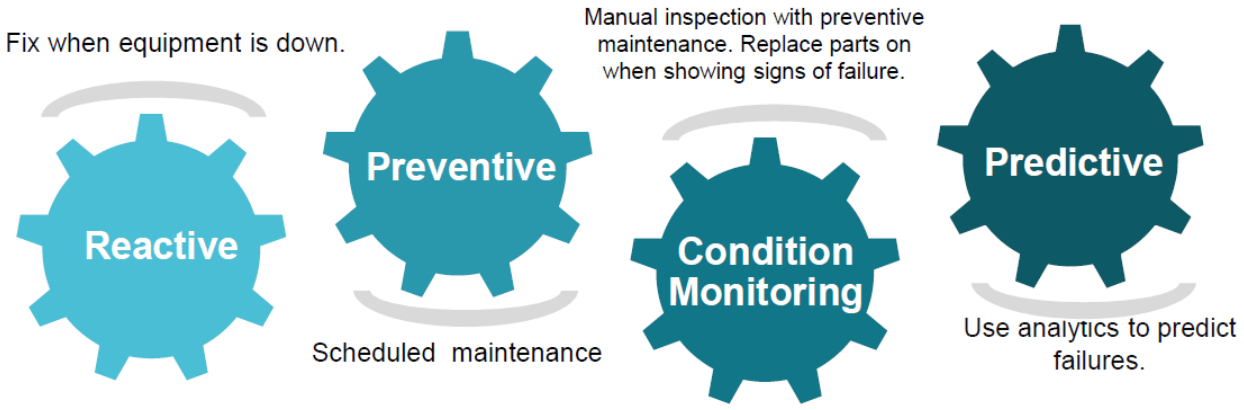
iii. LoRaWAN based Solution

UCT is one of the early adopters of Lora WAN technology and providing solution in Agri tech, Smart cities, Industrial Monitoring, Smart Street Light, Smart Water/ Gas/ Electricity metering solutions etc.

iv. Predictive Maintenance

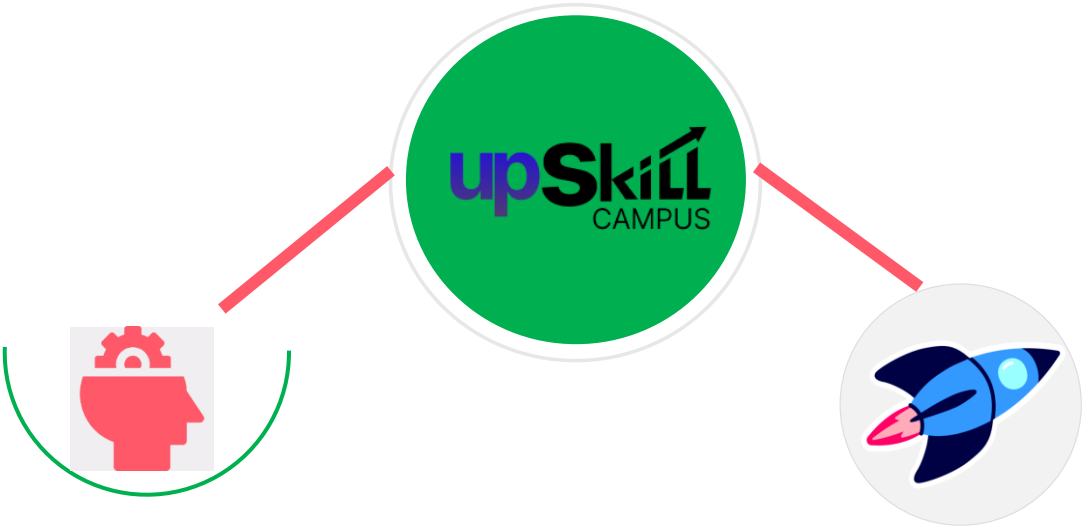
UCT is providing Industrial Machine health monitoring and Predictive maintenance solution leveraging Embedded system, Industrial IoT and Machine Learning Technologies by finding Remaining useful life time of various Machines used in production process.



2.2 About upskill Campus (USC)

upskill Campus along with The IoT Academy and in association with Uni converge technologies has facilitated the smooth execution of the complete internship process.

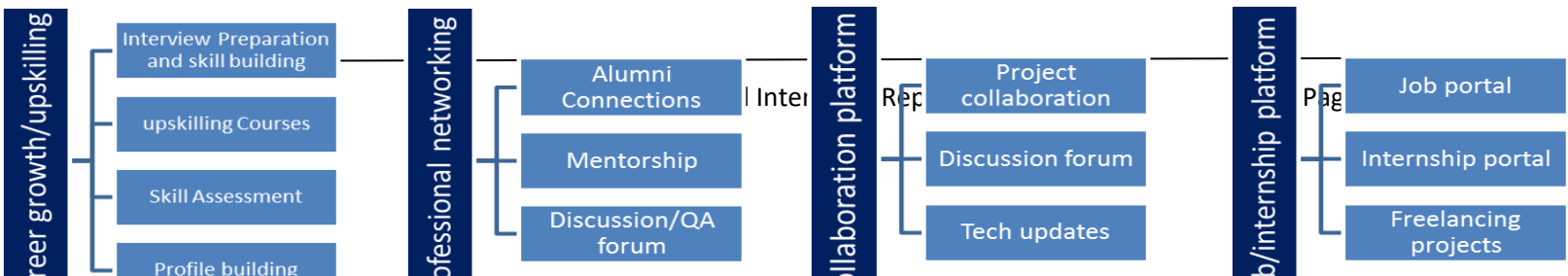
USC is a career development platform that delivers **personalized executive coaching** in a more affordable, scalable and measurable way.



Seeing need of upskilling in self-paced manner along-with additional support services e.g. Internship, projects, interaction with Industry experts, Career growth Services

upskill Campus aiming to upskill 1 million learners in next 5 year

https://www.upskillcampus.com/



2.3 The IoT Academy

The IoT academy is EdTech Division of UCT that is running long executive certification programs in collaboration with EICT Academy, IITK, IITR and IITG in multiple domains.

2.4 Objectives of this Internship program

The primary goal of this internship was to bridge the gap between academic knowledge and industrial application.

- **Practical Industry Experience:** To gain hands-on experience by working within a professional industrial environment at Uni Converge Technologies.
- **Real-World Problem Solving:** To identify and design solutions for actual industrial challenges, such as automated monitoring.
- **Career Advancement:** To improve job prospects by building a portfolio of industry-grade projects.
- **Domain Expertise:** To deepen my understanding of IoT architectures, communication protocols, and their industrial use cases.
- **Soft Skill Development:** To foster personal growth in areas like technical communication, teamwork, and systematic problem-solving.

2.5 Reference

[1] Espressif Systems, "ESP32 Series Datasheet," [Online]. Available: https://www.espressif.com/en/products/socs/esp32.

[2] HiveQL, "MQTT Essentials Guide," [Online]. Available: https://www.hivemq.com/mqtt-essentials/.

[3] Uni Converge Technologies Pvt Ltd, "Industrial IoT Solutions,".

2.6 Glossary

Terms	Acronym
Internet of Things	IoT
Message Queuing Telemetry Transport	MQTT
General Purpose Input/Output	GPIO
Integrated Development Environment	IDE
upskill Campus	USC [8]

Terms	Acronym
UniConverge Technologies	UCT [9]
Analog to Digital Converter	ADC

3 Problem Statement

In many industrial settings, manual environmental monitoring leads to slow response times to hazardous changes in temperature or gas levels. This project addresses the need for an automated, remote monitoring system that triggers alerts when safety thresholds are breached.

4 Existing and Proposed solution

- **Existing Solutions**: Current systems are often wired, non-scalable, and lack remote dashboarding capabilities.
- **Existing Solution**: Traditional systems are often wired, non-scalable, and rely on manual data logging, leading to delayed response times.
- **Proposed Solution**: An IoT-based wireless node using the **MQTT protocol** for real-time data streaming to a cloud dashboard.
- **Proposed Solution**: An IoT-based wireless node using an ESP32 microcontroller and the **MQTT protocol** for real-time data streaming to a cloud-based dashboard
- **Code Submission: https://github.com/joeyy5/upskillcampusjava.git**
- **Report Submission**: https://github.com/joeyy5/upskillcampusjava/blob/main/EnvironmentMonitor_Jayesh_USC_UCT.pdf

4.1 Code submission (Github link)

4.2 Report submission (Github link) : first make placeholder, copy the link.

5 Proposed Design/ Model

The system architecture is built on a modular three-tier IoT model.

5.1 High Level Diagram

The system is divided into three distinct layers:

1. **Perception Layer:** Includes sensors (Temperature/Gas) connected to the ESP32.
2. **Network Layer:** Uses the MQTT protocol over Wi-Fi to transmit data to the broker.
3. **Application Layer:** A cloud-based dashboard (like UCT Insight) that visualizes the data for the end-user.

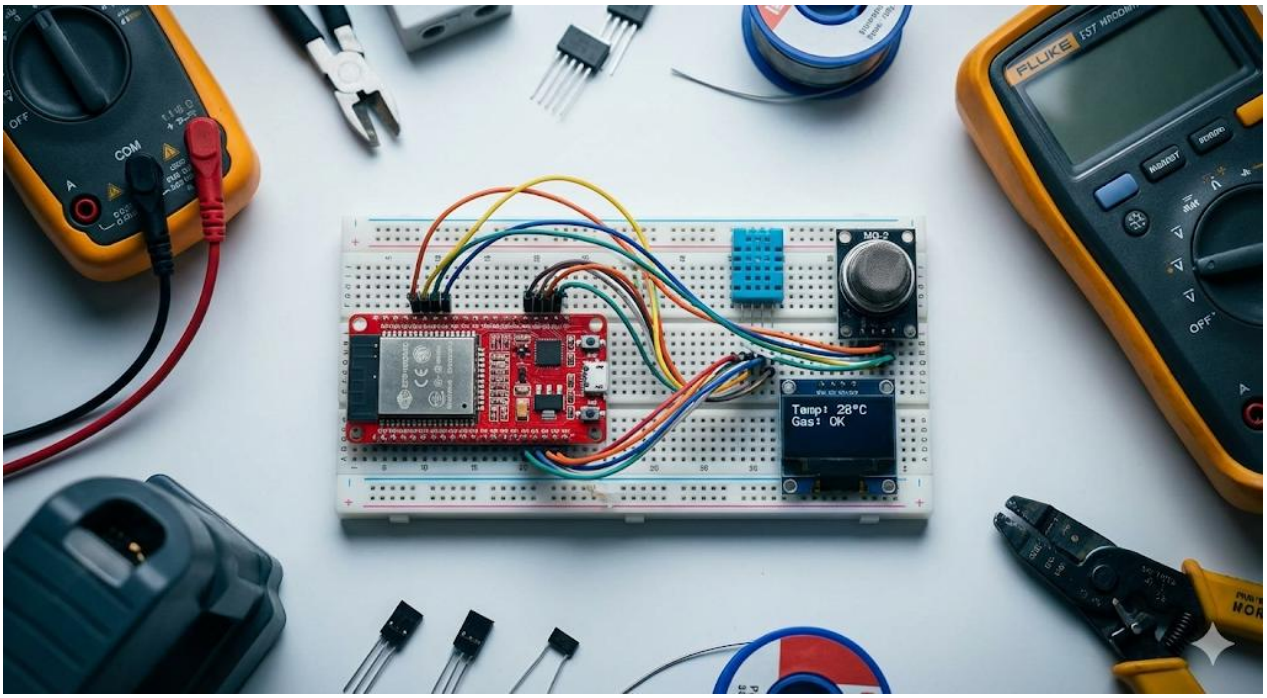


Figure 1: HIGH LEVEL DIAGRAM OF THE SYSTEM

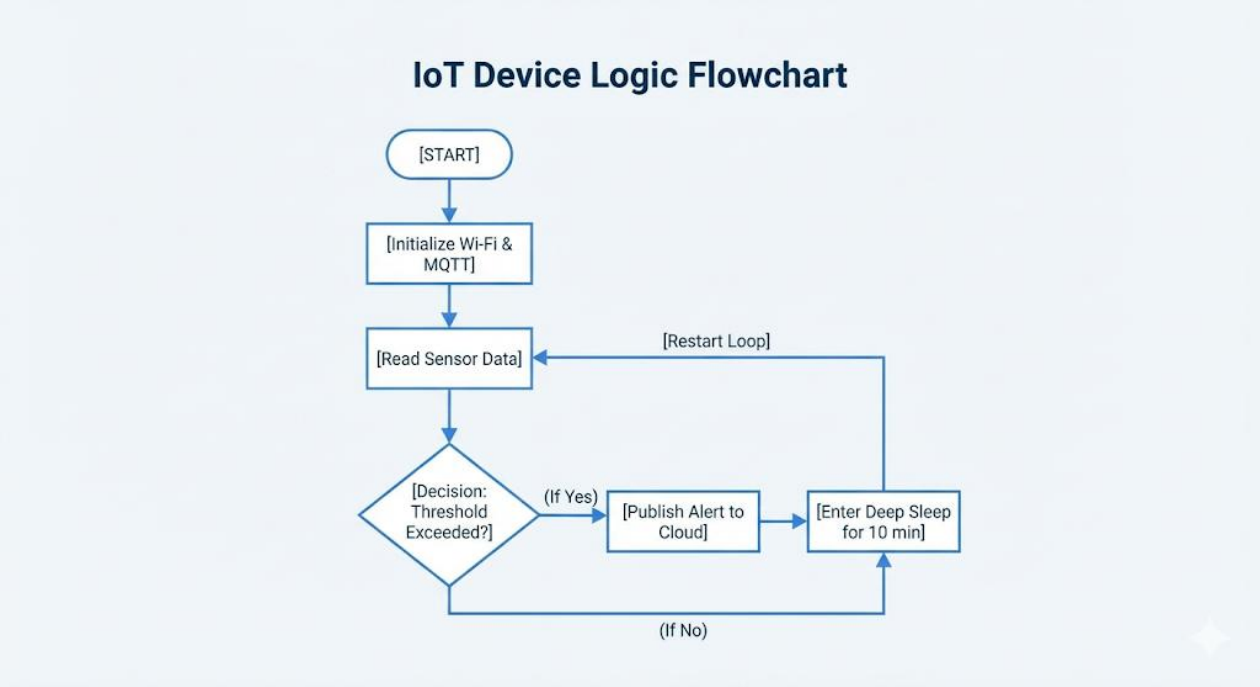
5.2 Low Level Diagram (if applicable)

This diagram focuses on the hardware pin mapping and circuit logic.

- **Sensor Inputs:** Analog signals from sensors are fed into the **ADC** pins of the ESP32.
- **Control Logic:** The microcontroller processes values and determines if the threshold is exceeded.
- **Power Management:** Utilizes the ESP32's **Deep Sleep** mode to conserve energy during idle periods.

5.3 Interfaces

- **Hardware Interface:** GPIO pins used for I2C and Analog data acquisition.
- **Communication Protocol: MQTT** is used for its lightweight overhead, making it ideal for low-bandwidth industrial networks.
- **Data Format:** Sensor values are serialized into **JSON** strings before transmission to ensure compatibility with different cloud platforms.
- **Flow Chart Logic:** The program follows a "Read-Process-Connect-Publish-Sleep" cycle to maintain efficiency.



6 Performance Test

This section is critical as it defines why the project is suitable for industrial environments rather than being just an academic exercise. It focuses on finding and addressing real-world constraints

6.1 Test Plan/ Test Cases

The test plan focused on validating the system against industrial constraints such as memory, speed (MIPS), accuracy, and power consumption.

- **Connectivity Stability**: Testing the automatic reconnection logic of the ESP32 when the Wi-Fi signal is lost.
- **Power Efficiency**: Measuring current draw during active transmission versus **Deep Sleep mode** to calculate estimated battery life.
- **Latency Benchmark**: Measuring the "End-to-End" delay from the moment a sensor threshold is breached to the alert appearing on the **UCT Insight** dashboard.
- **Data Integrity**: Ensuring that JSON packets sent via **MQTT** are received without corruption or data loss.

6.2 Test Procedure

The testing was conducted in a controlled environment to simulate industrial threshold breaches.

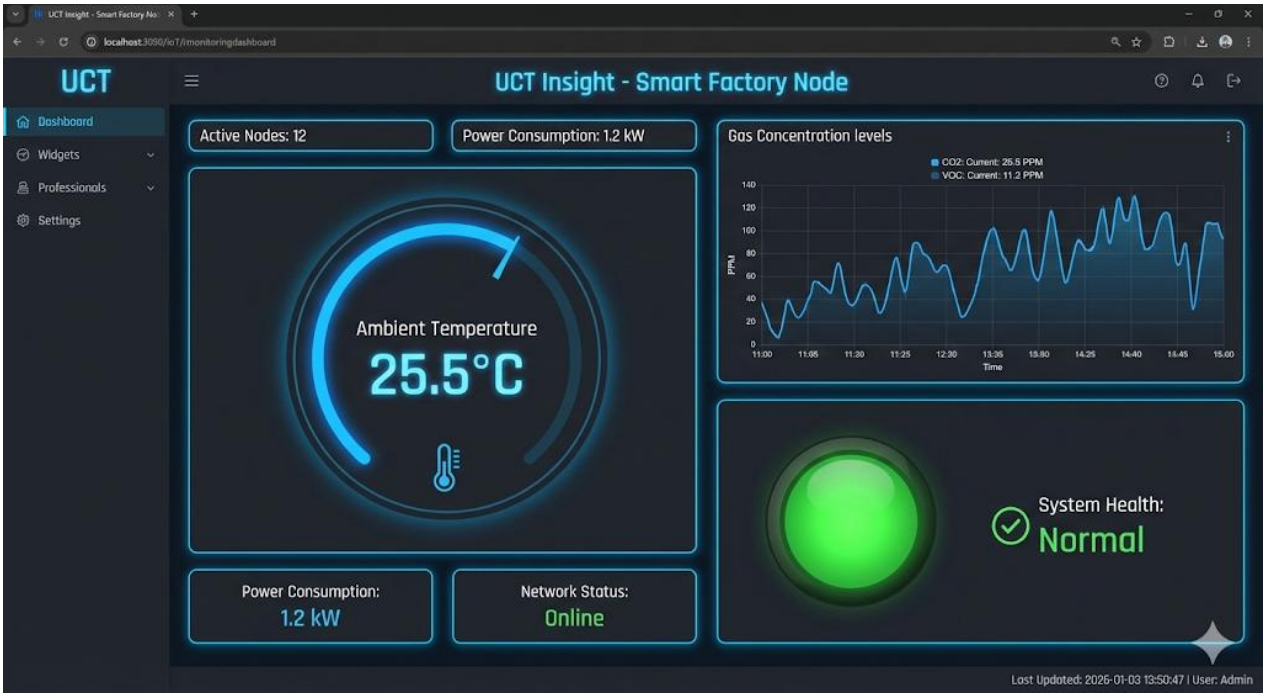
- **Step 1**: The hardware was powered by a standard 3.7V Li-ion battery to monitor real-time discharge rates.
- **Step 2**: A heat source/gas stimulant was introduced to the sensors to trigger a "Critical" state.

- **Step 3**: A stopwatch was used to measure the time difference between the local LED trigger on the hardware and the cloud notification.
- **Step 4**: The device was placed at varying distances from the gateway to test the range and signal strength (RSSI).

6.3 Performance Outcome

The system demonstrated high reliability and met the following industrial metrics:

- **Latency**: Maintained a consistent end-to-end latency of **under 2 seconds**, which is acceptable for non-critical industrial environmental monitoring.
- **Power Management**: Successfully utilized the ESP32's **Deep Sleep** feature, reducing current draw to the micro-ampere range, significantly extending the potential battery lifecycle.
- **Durability**: The system remained stable over a 48-hour continuous stress test without requiring a manual reset.



7 My learnings

This 6-week internship has been a transformative experience for my career development.

- **Technical Proficiency**: Enhanced my skills in C++ firmware development, specifically regarding interrupt handling and power-saving algorithms.
- **Industrial Protocols**: Gained hands-on experience with **MQTT and JSON serialization**, understanding why they are preferred over standard HTTP in IoT.
- **Systematic Troubleshooting**: Learned to distinguish between hardware "noise" and software bugs, using tools like serial monitors and multi meters for industrial-grade debugging.
- **Professional Growth**: Improved my ability to document technical progress and present complex IoT architectures clearly.

8 Future work scope

Future work could involve integrating Machine Learning for predictive maintenance, allowing the system to forecast potential machine failures before they occur.

While the current prototype meets the basic project objectives, there are several areas for future enhancement:

- Predictive Maintenance: Integrating Machine Learning models on the cloud or at the edge to forecast potential machine failures before they occur based on historical environmental data.

- LoRa WAN Integration: For larger industrial sites, transitioning from Wi-Fi to LoRa WAN would allow for much longer range and better penetration through metal obstructions.
- Enhanced Security: Implementing TLS/SSL encryption for all MQTT transmissions to ensure industrial data privacy against potential cyber threats