College of
ENGINEERING, COMPUTING
AND APPLIED SCIENCES

Remote Water Quality Sensor Set

Camren J. Khoury, Noah Friedman, Matthew Mugrage, Salvador Ruiz, Afif Uddin,
Yordan Zlatev, Justin Keller, Paul Kupfer, David Vaughn

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Mission

To design and deploy a modular, low-cost, and scalable early flag detection and warning system for water quality that enables continuous, real-time monitoring of critical environmental parameters in free-flowing water environments. The project integrates affordable sensors, cost-effective computing, embedded systems, and custom PCB design to generate reliable, field-deployable data that supports public health, environmental protection, and disease trend analysis, while distributing water quality information in accessible formats that account for language differences, technological access, and infrastructure limitations so communities can interpret and act on the data effectively.

Figure 1. From Left to Right: KiCAD, GitHub, AWS, SupaBase

Project Charter + Literature Review

Our project charter established the mission, scope, and phased development plan for building a low-cost water quality sensor system, outlining stages from breadboard prototyping and calibration to PCB integration, networking, durability, and documentation. The system focuses on monitoring key parameters including pH, turbidity, conductivity, temperature, and residual chlorine to support early detection of contamination events. The literature review strengthened this foundation by defining measurable early-warning thresholds, narrowing deployment to high-risk and low-visibility segments of distribution systems, and grounding parameter selection in established standards. It also analyzed current manual and industrial monitoring approaches, identifying their cost, accessibility, and continuity limitations.

Water Quality Sensor Project Literature Review
Project Director: Camren Khoury
Project Members:
Noah Friedman
Afif Uddin
Matthew Mugrage
Salvador Ruiz

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CEDC Water Quality Sensor Project – Literature Review

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Figure 2. Literature Review Title Page and Table of Contents

Data Visualization Project

Alongside physical electronic component development, the Data Visualization group has been founded to work in parallel with this project to better analyze the data found for specific trends, indicators and warnings. The goal of this group is to effectively communicate problems, readings, and visuals to the user and/or facilitator of the sensor node.

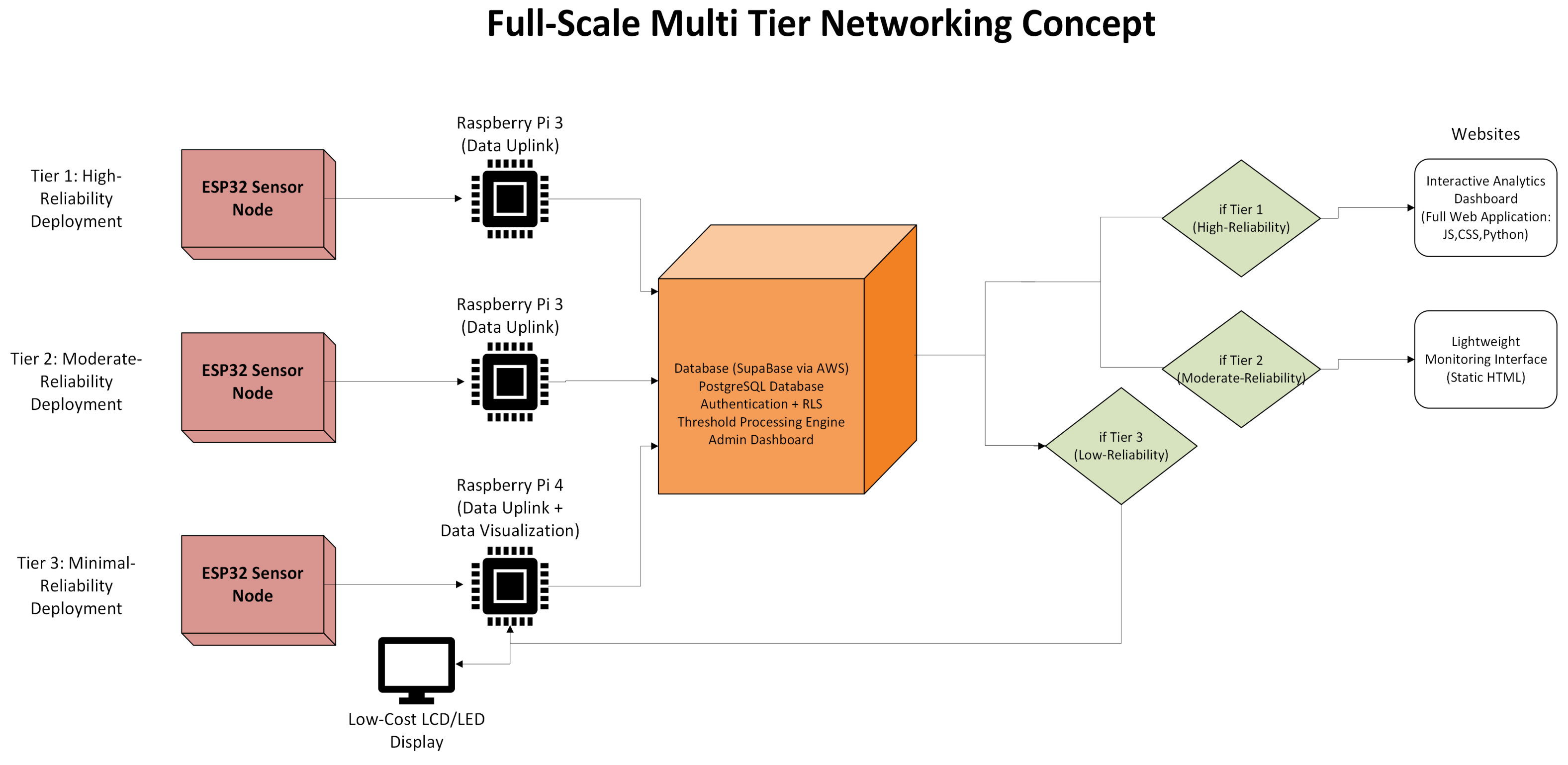
Full-Scale Multi Tier Networking Concept

Figure 3. Full-Scale Multi-Tier Networking Concept

The full-scale multi-tier networking architecture (above) illustrates how data distribution adapts to varying infrastructure conditions. Because network reliability, bandwidth availability, and local computing capacity differ across deployment environments, the system is designed to scale its method of communication accordingly. This ensures that water quality data remains accessible and actionable regardless of location. The high-reliability dashboard prototype (below) represents the most feature-complete deployment model. Built using a full web stack including HTML, CSS, JavaScript, and ReactJS, it enables interactive visualization, dynamic data rendering, and secure user access in environments with stable connectivity and sufficient computing resources.

Sensor Node 01
Live Monitoring • Clemson, SC

PH LEVEL 6.68 Good
TURBIDITY 2.86 NTU Good
TEMPERATURE 18.48 °C Fair
TDS 410.41 ppm Good
CONDUCTIVITY 566.29 µS Good

Live Trends (pH, Turb, Temp)

Dissolved Solids & Conductivity

Parameter Health Check

TDS vs Conductivity Correlation

System
Overall Quality 92.4%
Uptime 772h 5m 53s
Data Points 25
Last Sync 7:23:55 PM

Figure 4. Analytics Dashboard Prototype (Single-Node View)

PCB Development

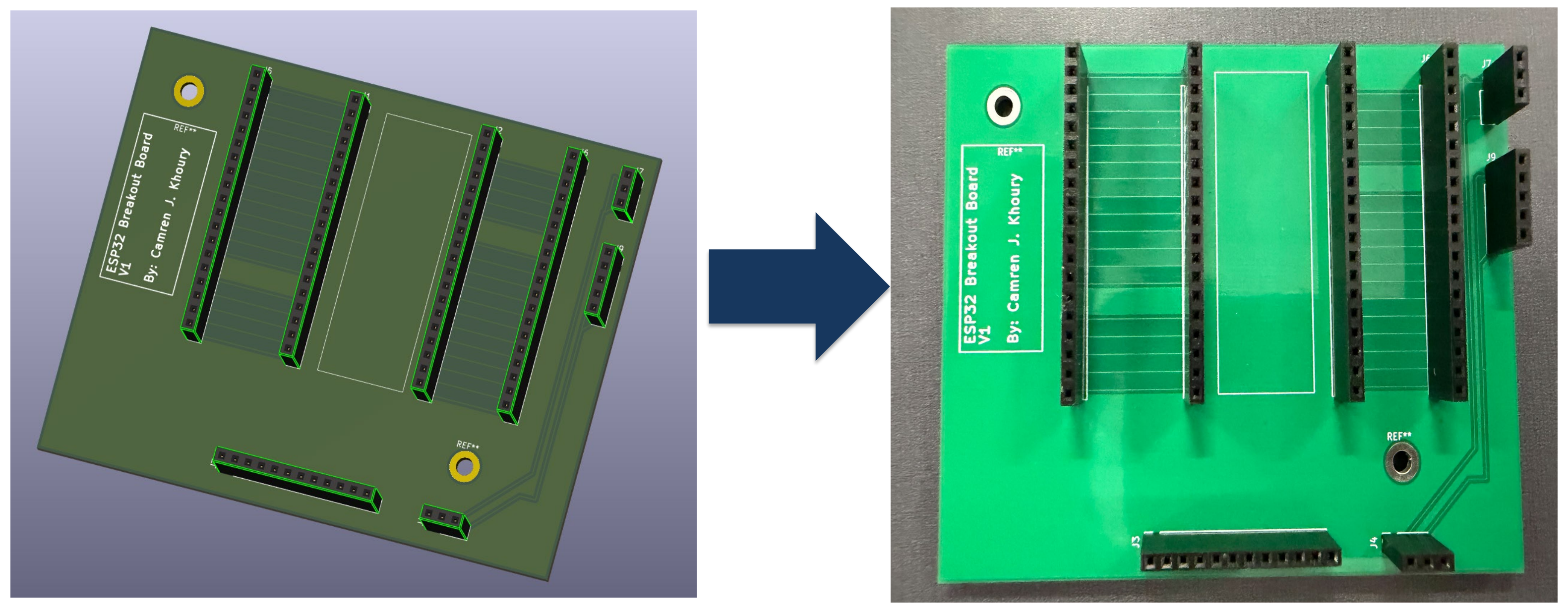

Figure 5. ESP32 Breakout Board

Due to the physical size and pin density of the ESP32 module, traditional breadboard development was impractical. To address this, a custom PCB was designed as a breakout board to route all GPIO pins to accessible female headers for structured testing and integration. The board also incorporates a common ground distribution and dedicated power input connectors to improve reliability and simplify system wiring during development and deployment. This also allowed the team to get familiar with PCB development through KiCAD and soldering.

Moving Forward

Moving forward, the team will integrate and validate each sensor independently with the ESP32 microcontroller to ensure accurate calibration and stable data acquisition. After individual verification, the sensors will be combined into a unified system and configured to operate asynchronously without signal interference or timing conflicts. Following full system validation, a finalized PCB will be developed to consolidate the design into a deployable form factor. The system will then be connected to the cloud database for real-time data transmission and visualization in preparation for the end-of-year demonstration.

Conclusion

This project has established the foundational architecture for a scalable, low-cost remote water quality monitoring system, including sensor integration, PCB development, and cloud-based data planning. While full system integration remains in progress, current results demonstrate a clear path toward reliable early-warning detection and infrastructure-adaptive data communication.

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