



# Clarity: A Smart Building Monitoring Solution

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## The Motivation and Problem

TEKTELIC Communications has IoT solutions for monitoring indoor environments. TEKTELIC's BREEZE sensor can measure **CO2 levels, light, temperature, humidity, and barometric pressure** within a room. TEKTELIC's MEMO tablet can display specific data from the BREEZE sensors as well as custom messages. These devices (along with TEKTELIC's gateways and network server) provide a way to collect and track indoor environmental data.

While there are applications for displaying sensor data, none of them can monitor a large-scale smart building system that uses TEKTELIC devices. Aside from scale, most existing solutions display connected devices using a list. This makes it challenging for users to locate (and differentiate) the IoT devices within a single room, on a specific floor, or in an entire building.

Additionally, many existing applications of this type provide few access controls. Therefore, an application that has multiple levels of user privileges as well as support for multiple organizations (tenancies) while keeping their data separate from each other is needed.

Finally, because the BREEZE sensors are mainly used for measuring indoor air quality, users should have an application that shares pertinent air quality data and suggests potential methods to adjust CO2 levels.

## Objectives

The objective of this project was to **create a web application** that could be used to **monitor a smart building system made up of TEKTELIC IoT devices**.

The application would include features such as **tracking sensor locations** on a floor plan, **displaying real-time data** (temperature, humidity, room occupancy, etc.) from one or more sensors, **historical data analysis**, and **indoor air quality evaluation**.

The air quality evaluation feature would use CO2 data from the BREEZE sensors to display information regarding indoor air quality, and would suggest various ways to adjust CO2 levels within the building if needed.

The application's interface would allow users to upload their own floor plan images and mark sensor locations on these floor plans. The application would also possess multi-tenant and multi-user capabilities. This means that different tenants would be independent of each other and users would only see data belonging to their own tenancy. The application would also have role-based access controls for different users, such as an administrator user or a standard user.

Finally, the project would utilize existing proprietary LoRaWAN sensors, a tablet to display important datasets, LoRaWAN gateways, and the TEKTELIC Network Server - all of which have been supplied by our sponsor.

## Results

### Backend Results

- Created a database
- Created APIs for accessing and updating the application's data
- Set up the application to run on an Amazon EC2 instance
- Implemented user authentication
- Implemented tenancy-based and role-based access restrictions

### Fullstack Results

- Enabled communication between the server and the application UI
- Configured the MEMO tablet to display the real time data of devices in the same room
- Integrated the TEKTELIC network server with the application's backend server to configure devices and fetch real time data packets from sensors

### Frontend Results

- Designed the overall look and layout of the website using the prototyping tool Figma
- Implemented the UI using JavaScript, HTML, CSS, and the React framework.

### Validation of Results

- Conducted exploratory testing with mock data
- Conducted white box testing of individual components
- Determined how many of the planned features were implemented

## Solution

- We have created a web application that can be accessed at <http://clarity.tektelic-dev.com>
- This web application:
  - Visualizes **real time** CO2, temperature, humidity, and room occupancy collected from specific sensors, rooms, or floors
  - Visualizes CO2, temperature, humidity, and room occupancy **over a specified period of time** for specific sensors, rooms, or floors
  - Displays **warnings if dangerous CO2 levels have been detected** by sensors
  - Allows users to **view, add, edit, or remove a sensor or floor** in their tenancy, depending on the users' access privileges
  - Supports **three different user types** (super administrator, tenancy administrator, and standard user) **with varying access privileges** to functionalities in the application
  - Allows users to **view and edit their personal information** (name, role, email, password, etc.), depending on their access privileges
  - **Summarizes sensor data** throughout the entire building by generating a line plot visualization of the average data over an interval of time specified by the user
  - Allows users to **log into and log out** of the application, and only displays data from the logged-in user's tenancy

