Scalable Air Quality Monitoring System For Smart Buildings

Case Studies

Air Quality Sensor Platform

Client Overview

A major real estate company managing commercial properties across North America.

Problem Statement

The client needed to monitor air quality in their buildings to ensure tenant safety and comply with regulations. They lacked a scalable system to deploy and manage air quality sensors across their property portfolio

Solution

Effective ventilation of indoor environments has been shown to reduce the transmission rates of COVID-19. Measurement of CO_2, in addition to temperature and humidity, was used as a means of establishing and monitoring the performance of ventilation systems.

We developed a full feature platform to deploy a fleet of IAQ (Indoor Air Quality) sensors, map them to their digital twin with their spatial context attached, ingest and normalize the telemetry data, and finally provide monitoring dashboards and actionable alerts. The operations team could then provide remedial work required to maintain the buildings within optimum conditions.

Highlights

- Deployed a fleet of IAQ sensors to measure the CO_2 levels as well as temperature and relative humidity levels inside the office spaces as an indicator of ventilation rate.
- Developed a workflow to enable plug and play onboarding of the IAQ sensors, including mapping them to their digital twin.
- Developed a Data Pipeline to ingest and normalize the telemetry data, enriched with the necessary spatial context.
- Setup monitoring dashboards, and actionable insights along with alerts.
- Deployment figures (graphical highlight) :

- 4.5 K sensors (6 sensors per floor)
- 500 gateways (1 gateway per every other floor)
- 100 locations (600 floors) in 5 countries (4 time zones)
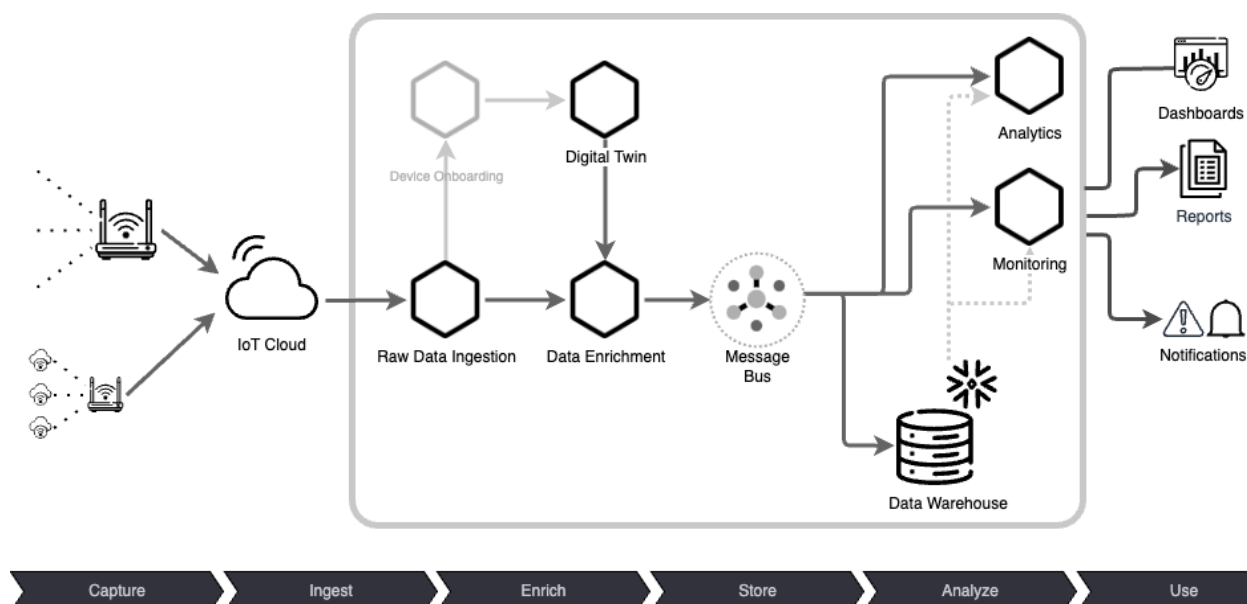
Sensor Deployment

We worked with the client to select a cost-effective solution for the sensor network. It consisted of a fleet of battery powered "all-in-one" indoor/outdoor sensors capable of measuring CO2, temperature and humidity levels, connected wirelessly over LoraWAN to on-premise gateways. The gateways in turn connected to a cloud based LoRaWAN server. The gateways selected were 4G-LTE enabled for connection to the LoRaWAN server for locations that did not have access to the corporate network for connectivity. We then set up integrations with the LoRaWAN server to ingest the sensor data (over a secure MQTTS connection) to our data pipeline.

We worked with a partner to deploy the sensors across the office locations using the workflow we developed for plug and play installation via a mobile app.

Device Management Custom Software And Mobile App

We developed a Digital Twin solution to manage the full life cycle of all sensor devices. The device manager provided management functionalities to create

deployment plans, identity provisioning, configuration, over-the-air updates, spatial context, and more. It worked as the backend service provider for the mobile app. Consolidate and simplified location data spread across multiple sources of truths.

We developed an iOS app to simplify the device installation and onboarding process for installers (third party vendor. Within the app, the installers could simply search for the right building to bring up a map of the floor, and use a placement guide presented to install the sensors to their correct spot. Then to map the sensors to their digital twin, the installers would simply scan the QR codes attached to the sensors, essentially adding spatial context to the sensors.

## Data Pipeline For Real Time Monitoring

We developed a Data Pipeline (Golang) to ingest the telemetry data from the sensors, map the sensors to their digital twins, and enrich the raw data with additional context needed for further analysis. Enriched data was persisted to ElasticSearch and Snowflake. We set up monitoring dashboards with Kibana to provide near real time snapshots of the air quality of all buildings, zoomed into floor level. Programmable alerts were set up with ElastAlert to send alerts when air quality crossed defined thresholds to Pager Duty, Slack, etc. Snowflake was used for data warehousing, as well as for ad hoc querying and advanced analytics.

Data Pipeline integration with the TTI LoRaWAN server also provided a flow to auto enroll the sensors to the device registry — generate their digital twins.

Data Pipeline services were deployed as containerized applications to Kubernetes.
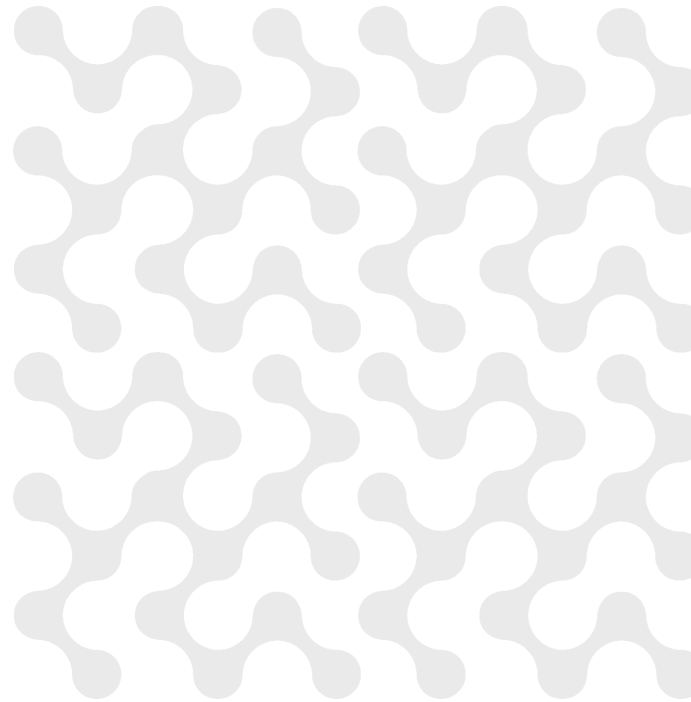
Technology

- **Languages:** GoLang, Node.js, Swift
- **Messaging/Protocol:** LoraWAN, MQTT, RabbitMQ
- **Platform:** Kubernetes, The Thing Stack (TTI), AWS Services
- **Data/Analytics:** Postgres, Redis, Event Store, Snowflake, Tableau, ElasticSearch, Kibana
- **Metrics**: Prometheus, Grafana
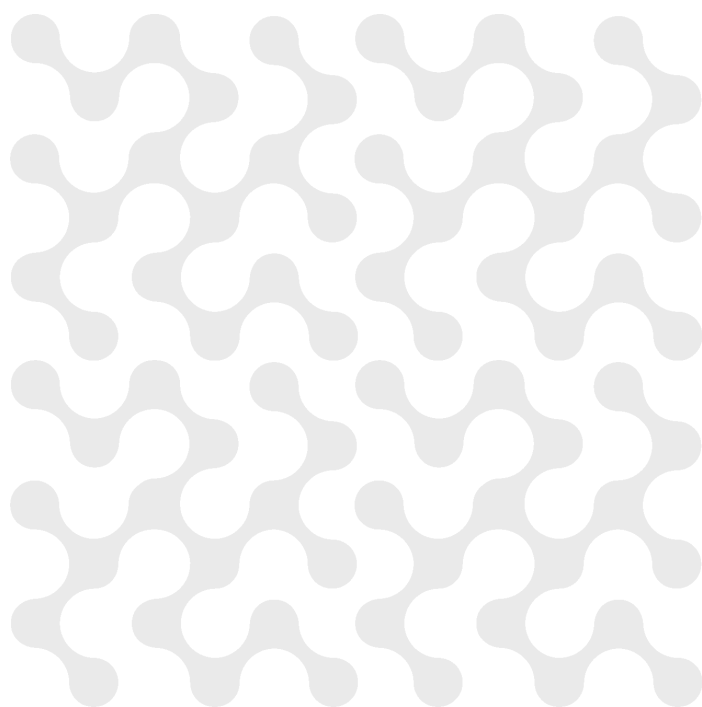
Process

1. **Discover**: We collaborated with various internal teams within the client organization to understand the nature of the office spaces across their fleet of buildings, and examined the state of existing technology infrastructure.

2. **Define**: Based on our findings, we selected a cost-effective solution for the sensor network that would and define technology stack to power the data collection

3. **Develop**: We started off with defining standard API contracts to allow development across different work streams concurrently, and iteratively developed towards an optimal solution. We put in place robust application debugging and monitoring tools that helped us ensure that we put a solid system in place.

4. **Deliver**: We delivered a robust sensor platform that allowed the client to have a holistic picture of their office spaces, as well as the ability to drill down to individual space units to gain valuable insights of the air quality.

Impact

Real-time monitoring

The Sensor Platform provided a central place for real-time monitoring of the air quality of the coworking spaces across the globe.

Valuable insights

In addition to the air quality, the sensor data also provided information on the workspace usage pattern for different regions during different times of the day and week, etc.

Improved resource allocation

Based on the predictive usage, the company could make sure the on the ground workforce is better prepared to make the spaces run smoothly.

Keep Office Spaces up and running

The tools to monitor the air quality and ability to receive actionable alerts and insights, allowed the company to keep its spaces open.