April 2024

Higher Diploma in Computer Science

Final Project

SiteVisor

Digital Twin Application for Buildings Monitoring and Asset Management

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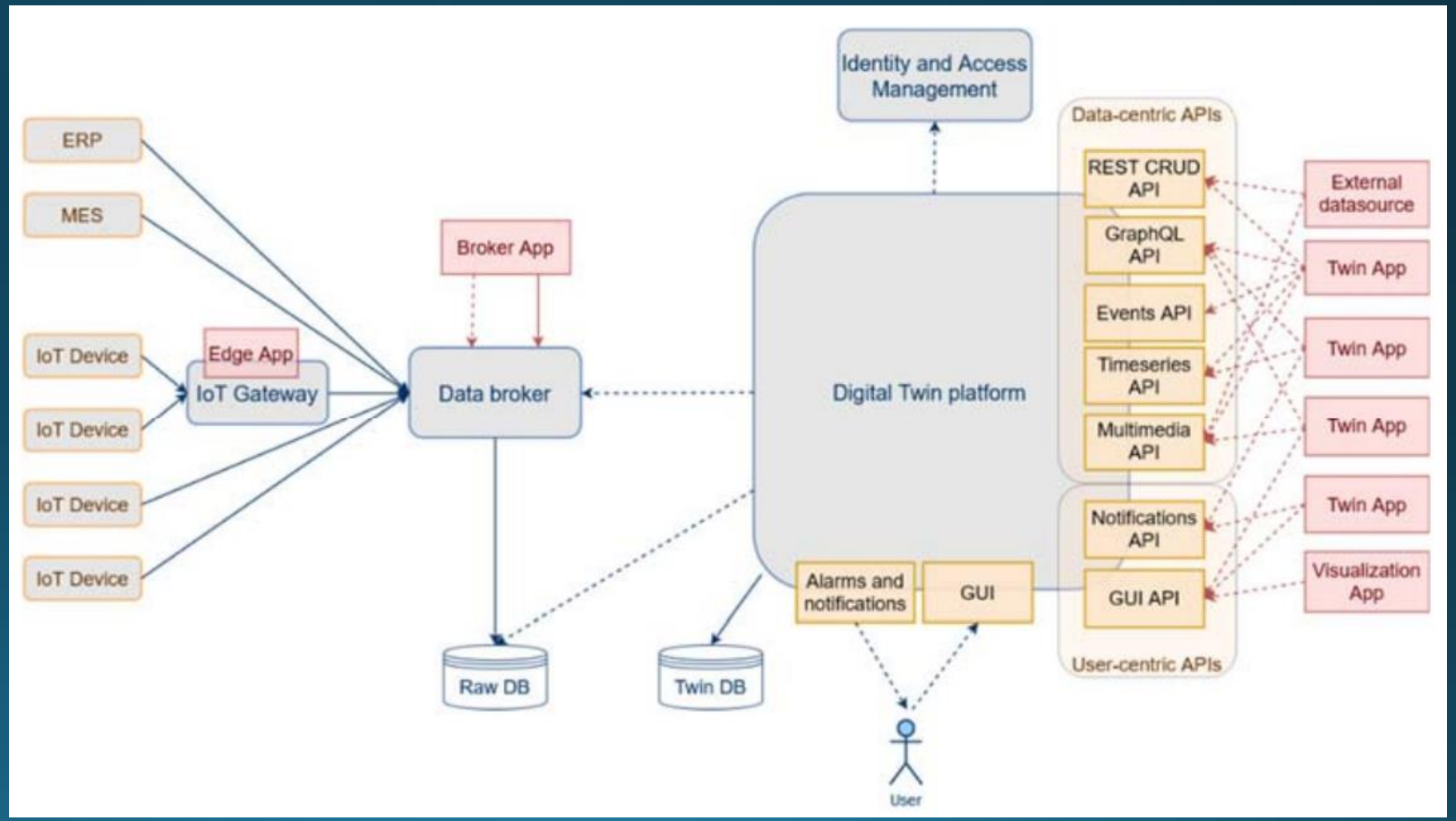
https://grzpiotrowski.github.io/sitevisor-project/

Introduction

- Background
- Problem statement: Limited insight into status and condition of a building
- Proposed solution: Approachable tool for managing a continuous feed of environmental sensor data
- Target users: facility managers, environmental engineers
- Use cases
  - Environmental monitoring of buildings
  - Managing rooms and sensors
  - Future: Managing any assets (equipment, building components)

Research & Analysis

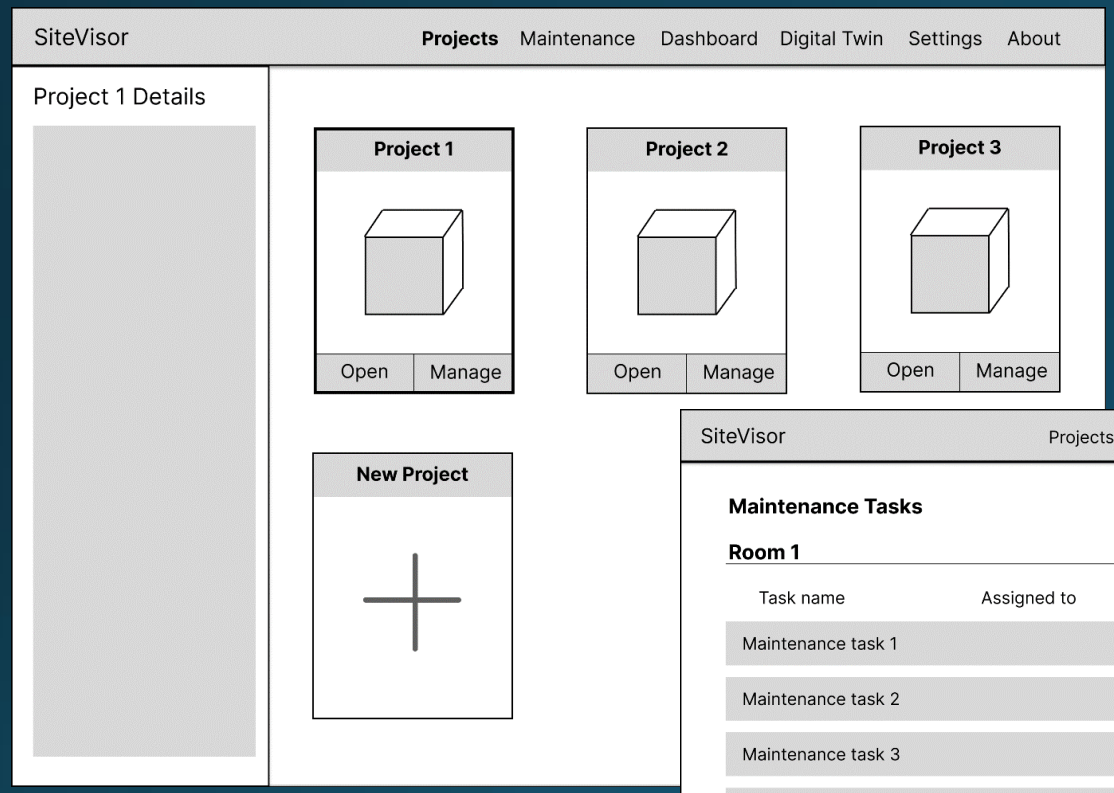
- What is a Digital Twin?
- Technologies:
  - SvelteKit
  - TypeScript
  - WebSocket
  - PostgreSQL
  - Django
  - Docker
  - Strimzi
  - Kafka
  - Kubernetes

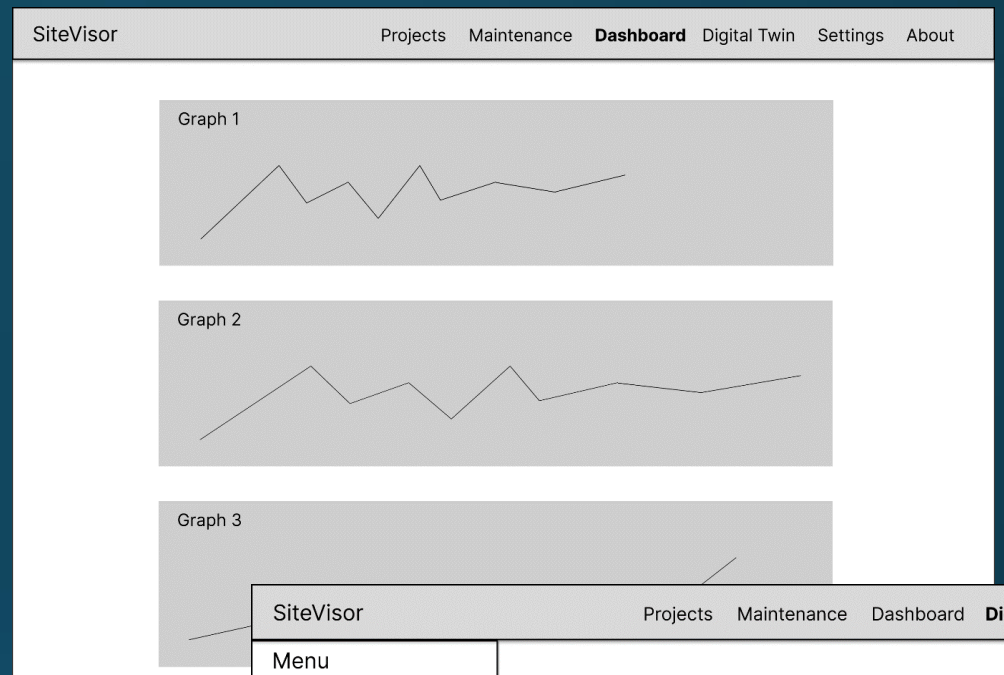


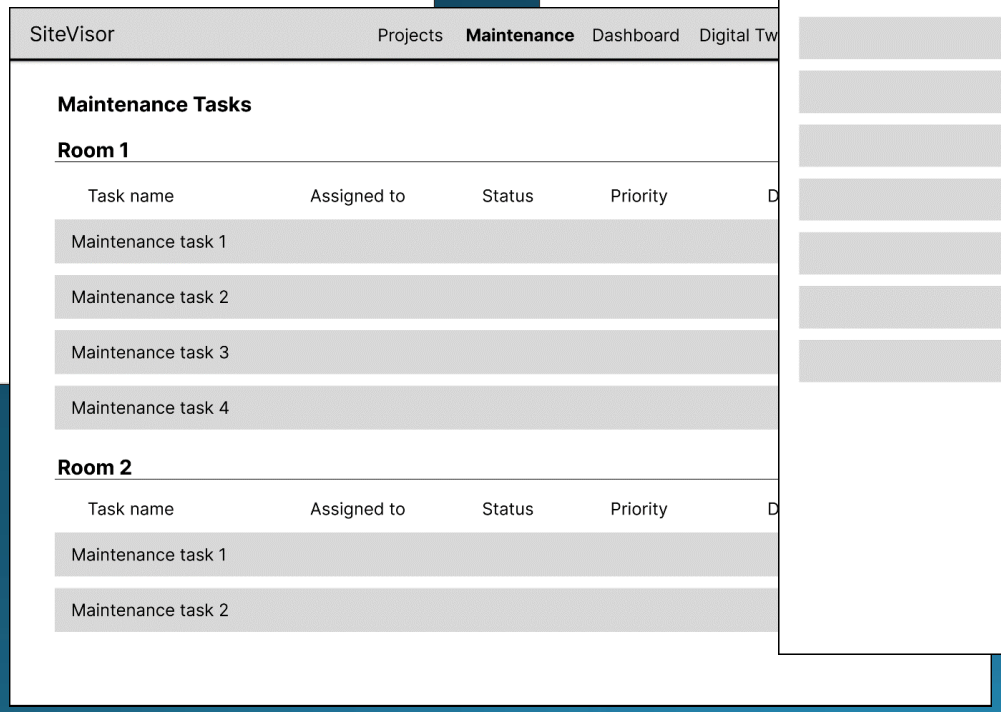
Source: Nölle, C. et al., 2022. *Digital Twin-enabled Application Architecture for the Process Industry*

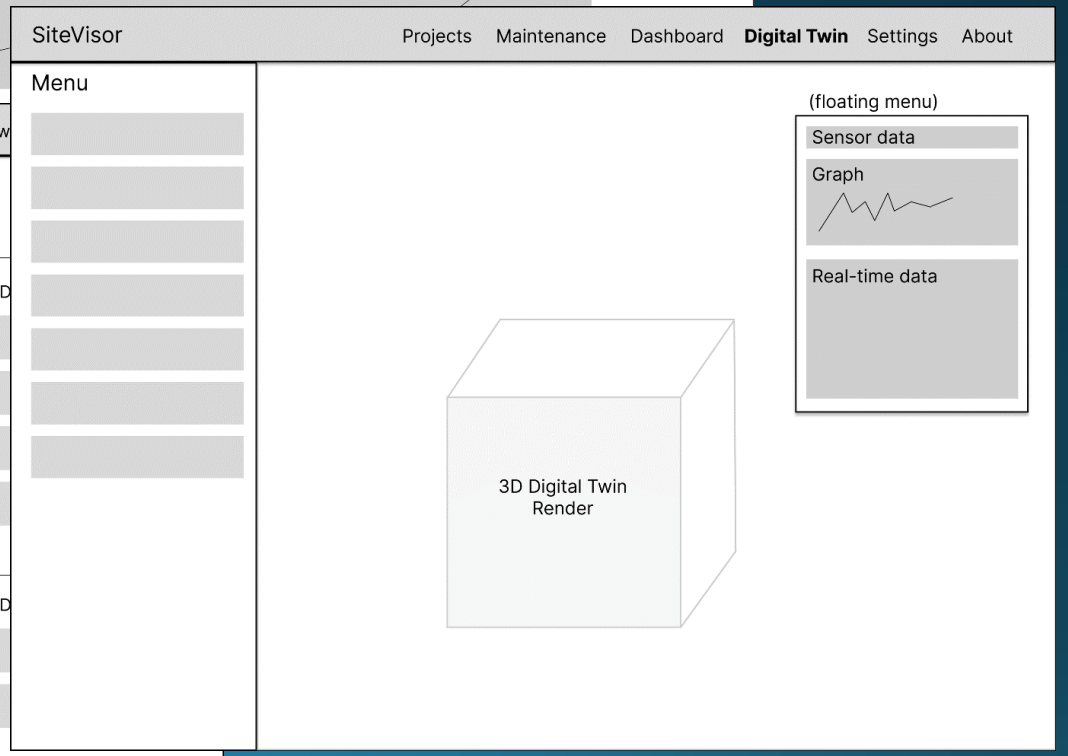
Planning

- Wireframes



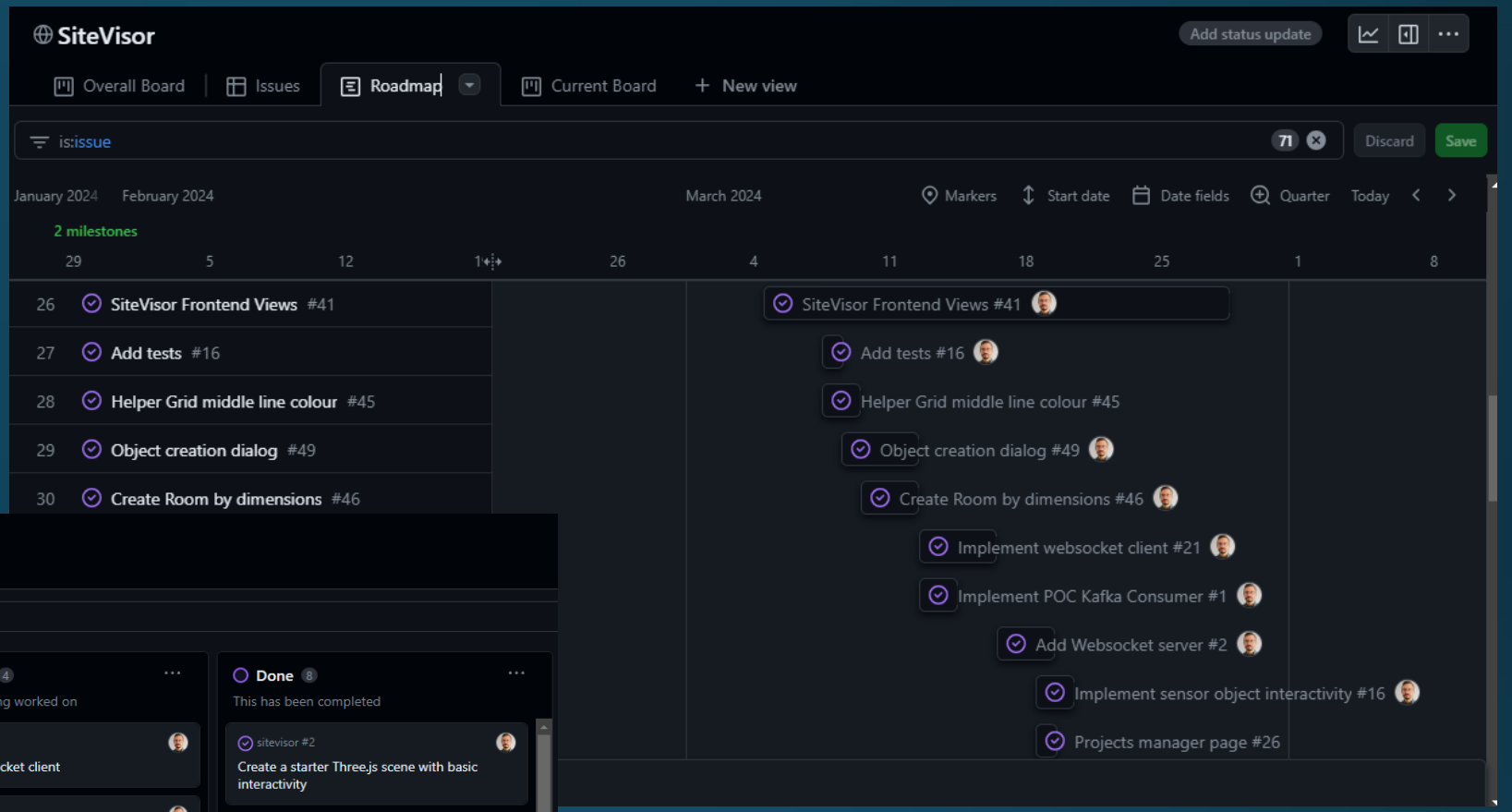


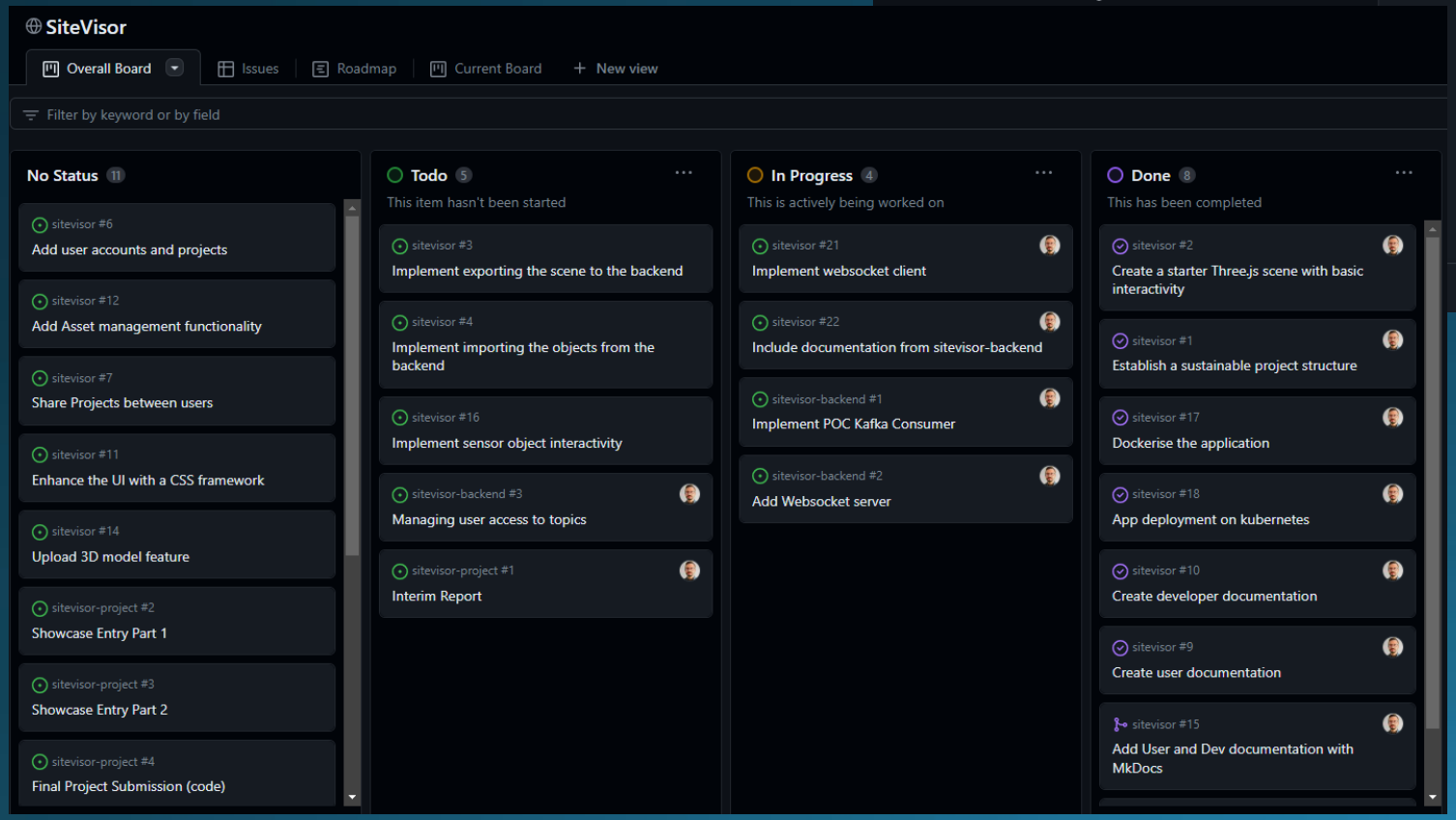




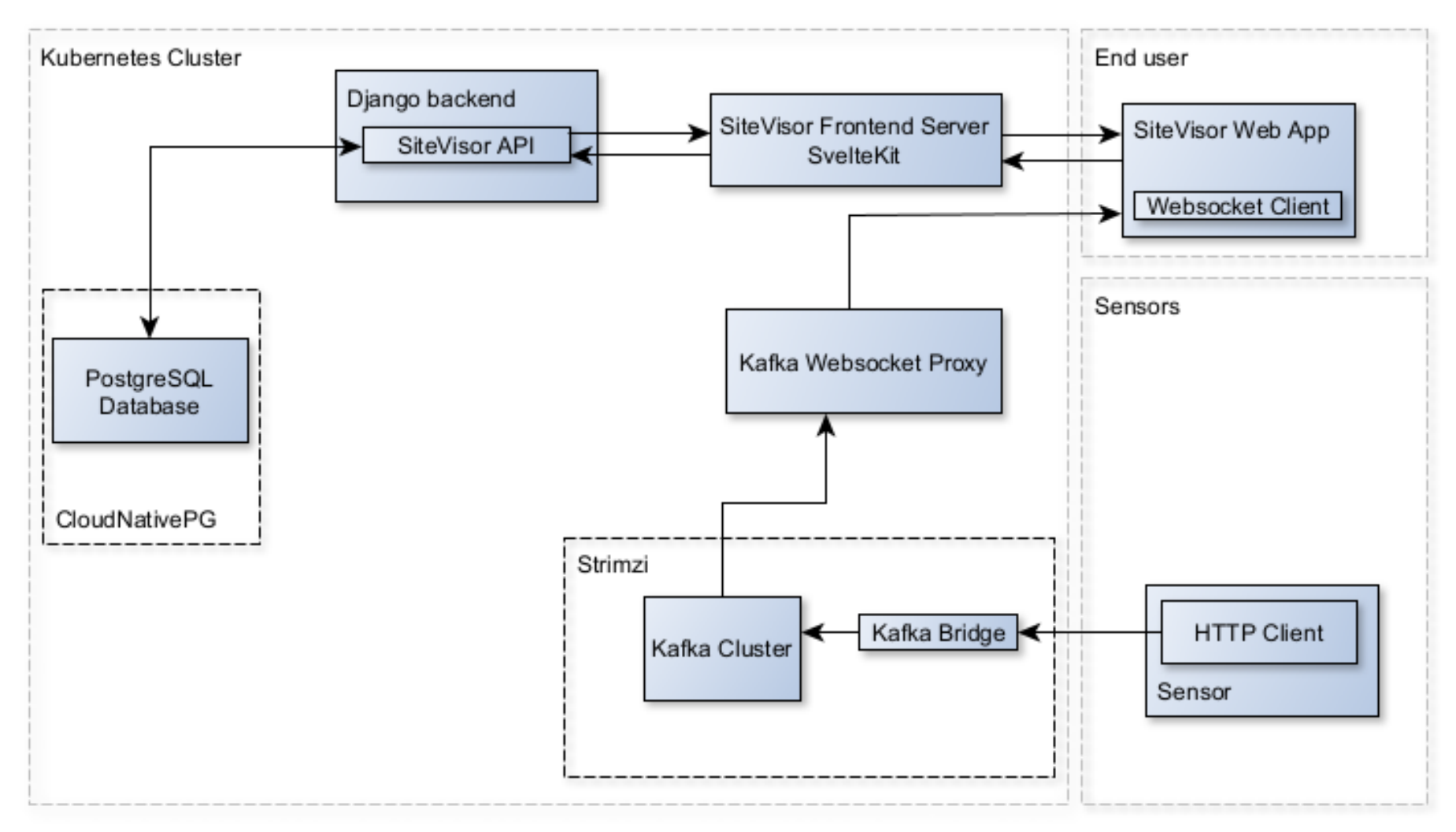
Planning

- GitHub Project

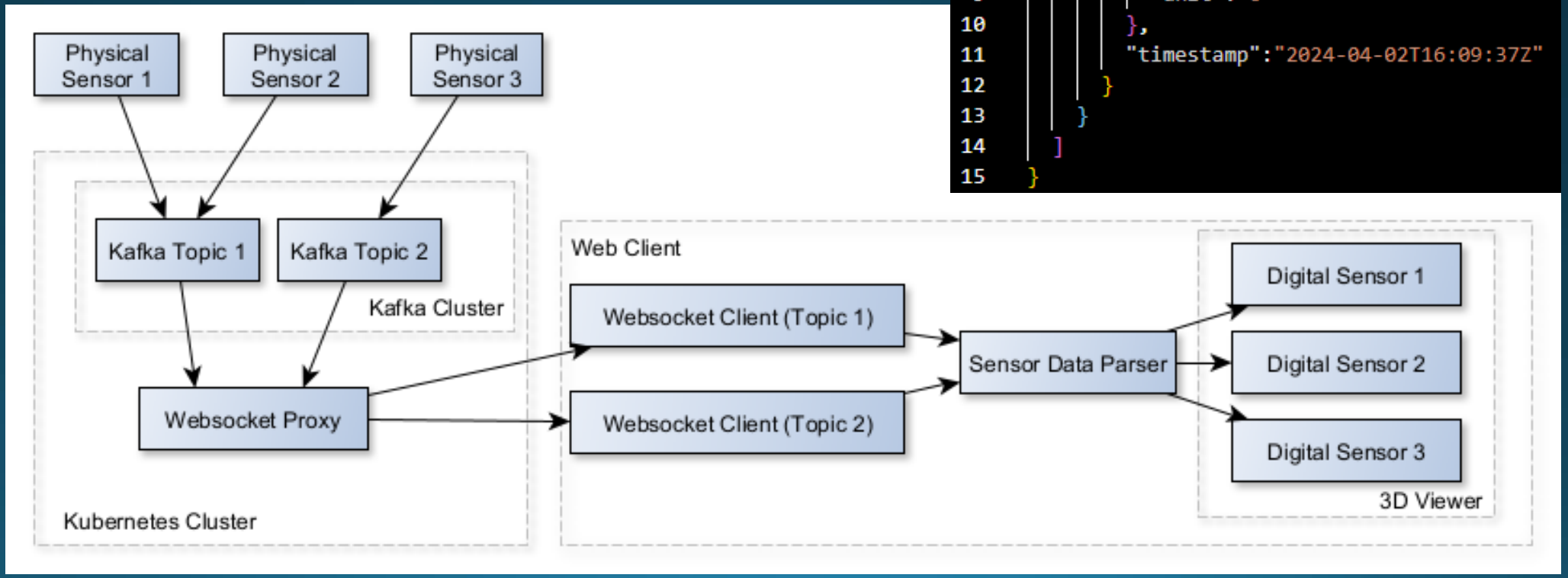




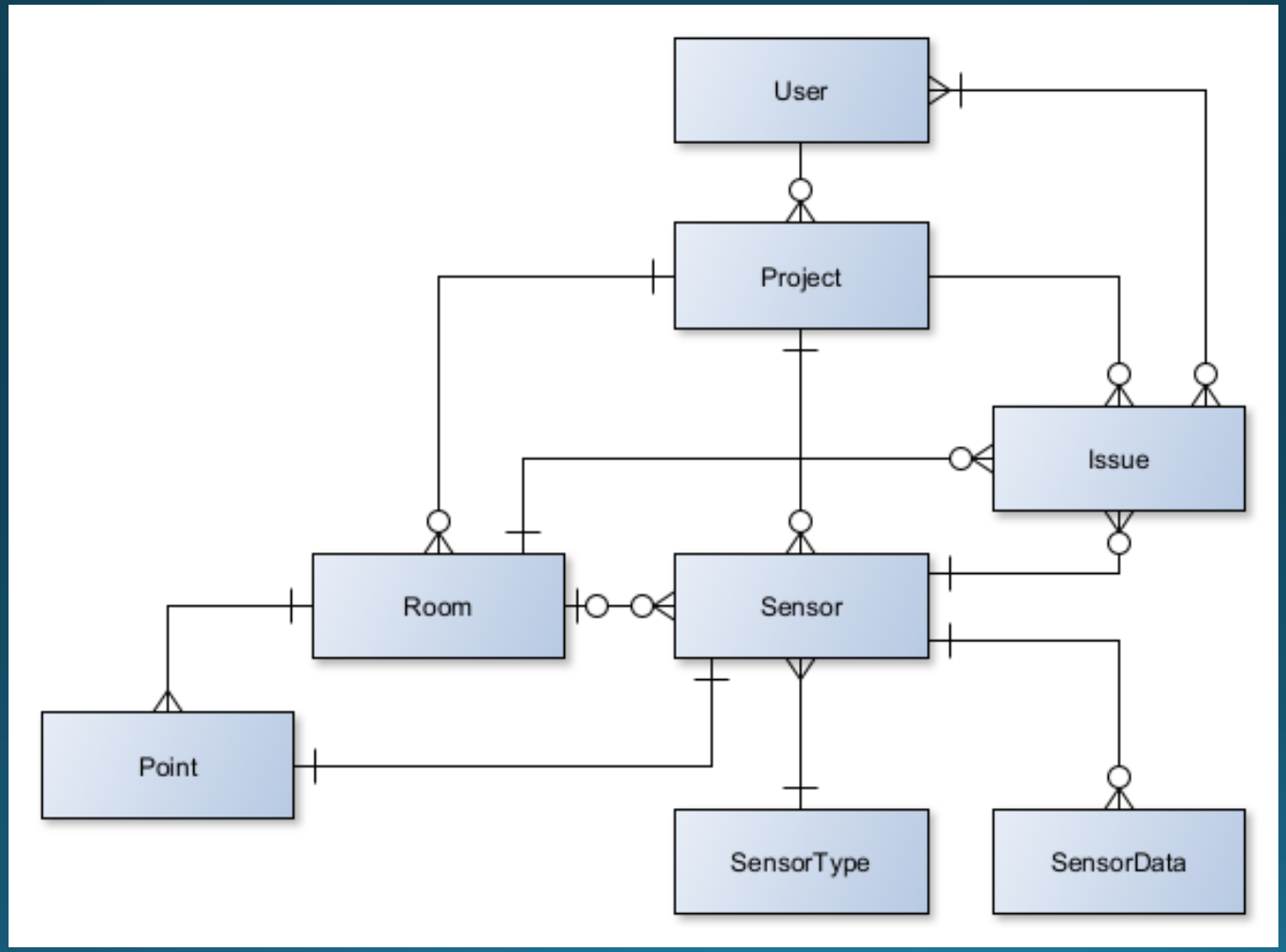
Implementation - Architecture



Implementation – Sensor Data flow



Implementation – Data model



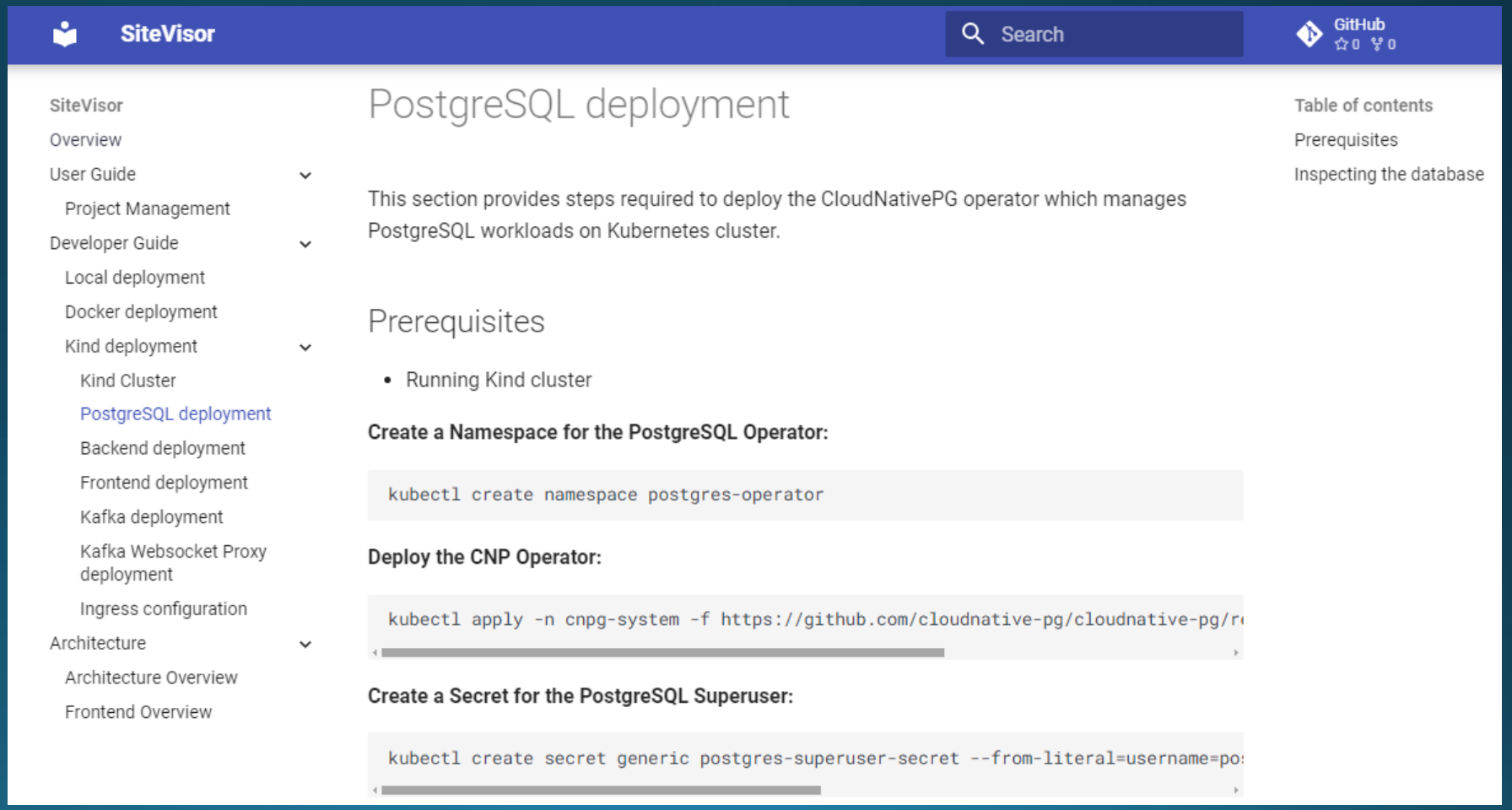
Deployment

- Kind Cluster for development
- Strimzi: Kafka in Kubernetes

- Future:
  - CI/CD Pipeline
  - Cloud deployment

Documentation

- Vital part of the project
- Describes k8s deployment



Overcoming Challenges

- Kafka – Websocket Connection
  - Not natively supported by Kafka or Strimzi.
  - Found an existing project as a fitting solution
- Websocket connection to Kubernetes
  - Wanted to use k8s Gateway API initially (WebSocket support only in experimental channel)
  - Switched to NGINX Ingress.
- Managing Websocket Clients
- Designing project architecture
- Structuring the codebase
- Database integration: MongoDB vs PostgreSQL

Use of AI

- No AI used for the report, video, project ideation or docs
- ChatGPT used in code development:
  - Way of condensing lengthy internet searching
  - Getting exposed to tech, ideas, approaches
  - Quickly prototyping
  - Getting a very rough idea for implementation to kickstart work
  - Simple copy/paste was not an option
  - Always ended up needing own research and dev

Project demonstration

Future development

- Implement Sink Connector for sensor data (WIP)
- User Roles
- Focus on Security – Manage access to Kafka
- Move WebSocket clients to Web Workers
- Upload GLTF Files
- Alerts/Notifications
- Enhanced Digital Twin and 3D Viewer features
  - Object collisions
  - Generic Asset object
  - Send signals from Digital Twin to actuators/devices
  - Room properties derived from sensor data
  - Building levels
- Frontend tests (challenging for Three.js)

Recap & Learnings

- More experience with Svelte/SvelteKit
- Expanded on my Three.js skills
- Learned Django
- Learning Kafka and Strimzi from scratch
- Kubernetes from Web App Developer's perspective
- Extensive use of Git/GitHub

Thank You