

LeafLink - Infrastructure for Sensor Management

Degree programme : BSc in Computer Science
Specialisation : Distributed Systems and IoT
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Managing metadata and time series, as well as streamlining sensor node provisioning and lifecycle management are core challenges while designing IoT systems. In response, and based on BFH's «Internet of Soils» research project, this thesis developed a custom cloud infrastructure made up of several interconnected microservices. Features include automated device provisioning, browser-based firmware flashing, runtime-generated Protobuf schemas, and LoRaWAN integration.

The Idea

In research projects relying on distributed sensor networks, such as BFH's «Internet of Soils», efficient device management and structured data handling are critical for scaling and reliability. However, existing solutions often involve manual setup, inconsistent metadata practices, and siloed storage systems. This thesis proposes a unified approach to overcome these issues by designing an infrastructure that automates sensor provisioning and ensures coherent handling of environmental data collected via LoRaWAN.

The System

To address these limitations, a microservice-based cloud infrastructure was developed, built on cloud-native principles, and hosted on a BFH-provided virtual server. A reverse proxy secures and exposes all public services via a single SSL-protected endpoint. The system connects to the TTN ecosystem via MQTT for data ingestion and a REST API for device provisioning. All services are containerized with Docker and deployed automatically through GitLab CI/CD pipelines.

The Solution

LeafLink improves usability with automation and centralized management. Devices can be provisioned and flashed directly from the browser, with TTN keys injected during the process. Metadata like sensor nodes and project links is managed through an intuitive UI and stored in a linked data triplestore, enabling extensible and semantic modeling. A built-in compiler engine retrieves firmware from GitLab, compiles it, and makes the binaries available via the frontend, streamlining deployment workflows. The result is a flexible, reusable platform for research-focused sensor infrastructures.

Future Work

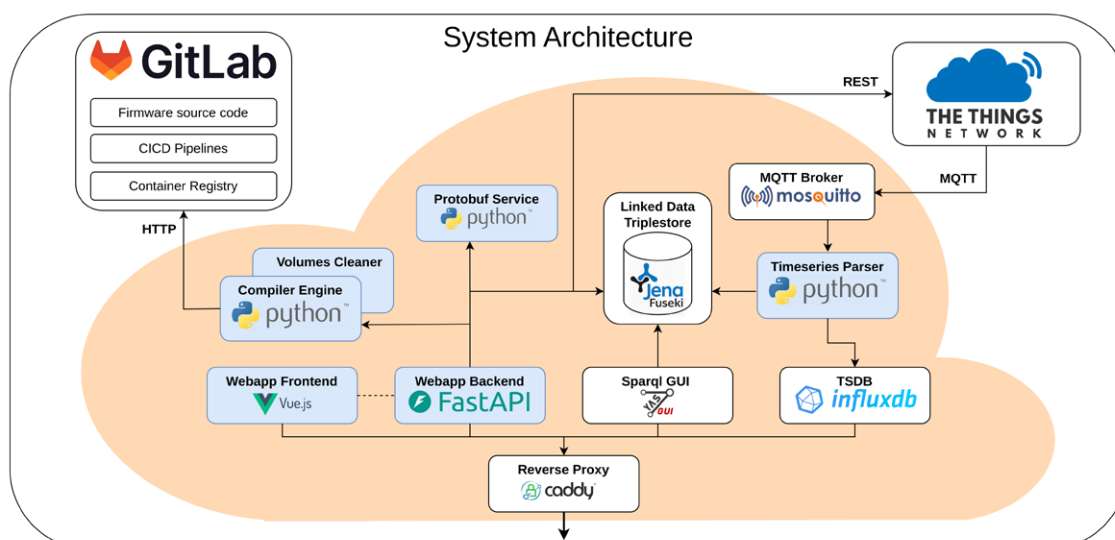
LeafLink offers a scalable foundation for automated sensor infrastructures across research and industry. Future enhancements may include over-the-air firmware updates, expanding the linked data schema with external resources, and supporting a broader range of hardware platforms for compilation and provisioning.



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Blue boxes indicate custom-built system components, while white ones represent hosted third-party tools.