

# Development of a Metadata Management System for GNSS Stations

M. Bradke and J. Kindermann

✉ markus.bradke@gfz-potsdam.de

Helmholtz Centre Potsdam - GFZ German Research Centre for Geosciences, Telegrafenberg, 14473 Potsdam, Germany  
Department 1: Geodesy

Due to evolving user demands and the need for interoperability with other systems, GNSS station metadata must be machine-readable. We propose an information system, implemented as a web application, for managing GNSS station metadata that ensures both, high usability and interoperability. *Stationeer* uses the GeodesyML standard for exchanging geodetic metadata and is designed to be easily extensible, accommodating diverse use cases. It exceeds comparable systems in key user experience metrics.

## Introduction

Global navigation satellite systems (GNSS) have become integral to various aspects of society. Since the first GNSS was made publicly available in 1995, its role has expanded significantly. While initial applications were primarily in science and geodesy, it is estimated that over the next 10 years, more than 80% of GNSS revenue will come from services enabled by GNSS devices. GNSS global revenues are expected to rise from €260B in 2023 to €580B in 2033 [1].

To accommodate these use cases, GNSS data must be FAIR (findable, accessible, interoperable, and reusable) so that automated systems can process it. Metadata is crucial for achieving these properties. An important piece of GNSS metadata is the site log, which describes the detailed configuration of a GNSS station. Site logs were introduced in the early days of GNSS as a purely human-readable file format, which does not facilitate automated processing.

A proposed standard called GeodesyML aims to address this problem, but its adoption has been limited due to the scarcity of implementations. To encourage broader adoption, a system is needed that fully supports GeodesyML while also including all the features of current systems that manage GNSS station metadata with ASCII site logs. Such a system would motivate station operators to transition their metadata to the GeodesyML format. This poster gives an introduction to "*Stationeer*" [2], the web-based GNSS station metadata management system developed at GFZ.

## System Design and Features

*Stationeer* is designed as multitier architecture to separate the logical layers of presentation, processing, and data management (Fig. 1). The whole application is containerized to ensure portability and scalability by encapsulating components in lightweight, isolated units. The backend, written in PHP8 using Laravel as framework, is separated from the NextJS/React frontend. This way we can leverage from an extensive RESTful API made available to the public. As data management tier, we are using PostgreSQL with the PostGIS extension to perform spatial queries.

The main features of the application include:

- **Extensive Network Maps:** Stations can be filtered by various parameters (Fig. 2), e.g., antenna/receiver vendors and models, countries, tectonic plates, networks. Users can bookmark and categorise a set of stations.
- **Station Log Manager:** Station logs can be generated and edited within the UI. GeodesyML and ASCII site logs are supported as input. The system includes a draft mode feature, allowing users to manipulate content before publishing it (Fig. 3).
- **Third-party Authentication:** The system uses the Helmholtz Authentication provider and GitHub OAuth for a secure user authentication.
- **Roles & Permissions:** A robust roles and permissions mechanism is in place to control access and actions to sensitive parts of the metadata.
- **Notification Centre:** An integrated notification centre helps users stay updated with real-time alerts and messages within the application.
- **Export Formats:** Metadata can be exported in GeodesyML v0.6, ASCII site logs, and JSON.
- **REST API:** All API endpoints are well documented using the OpenAPI v3.0 specification and SwaggerUI as frontend (Fig. 4).

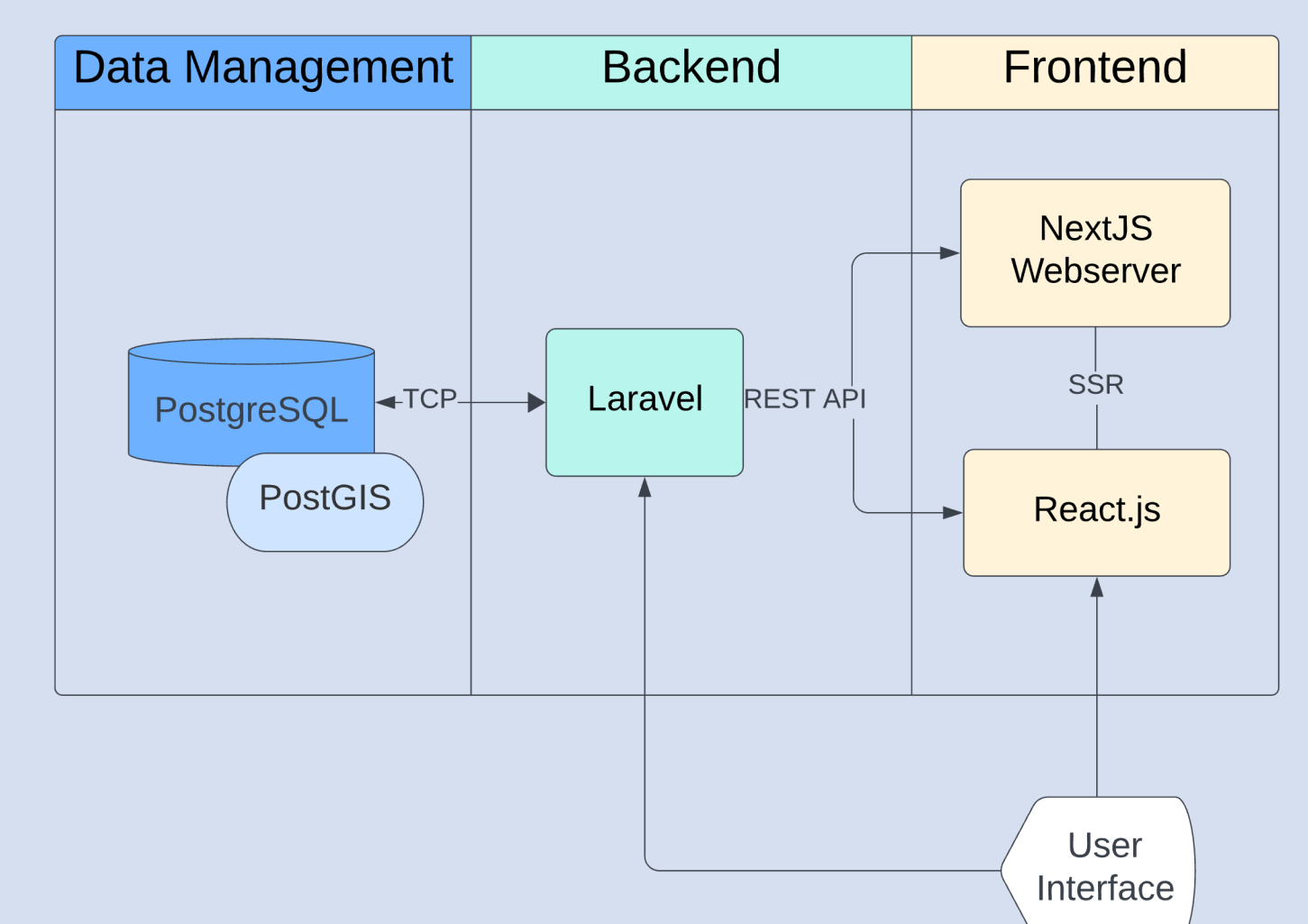


Fig. 1 Stationeer Application Architecture

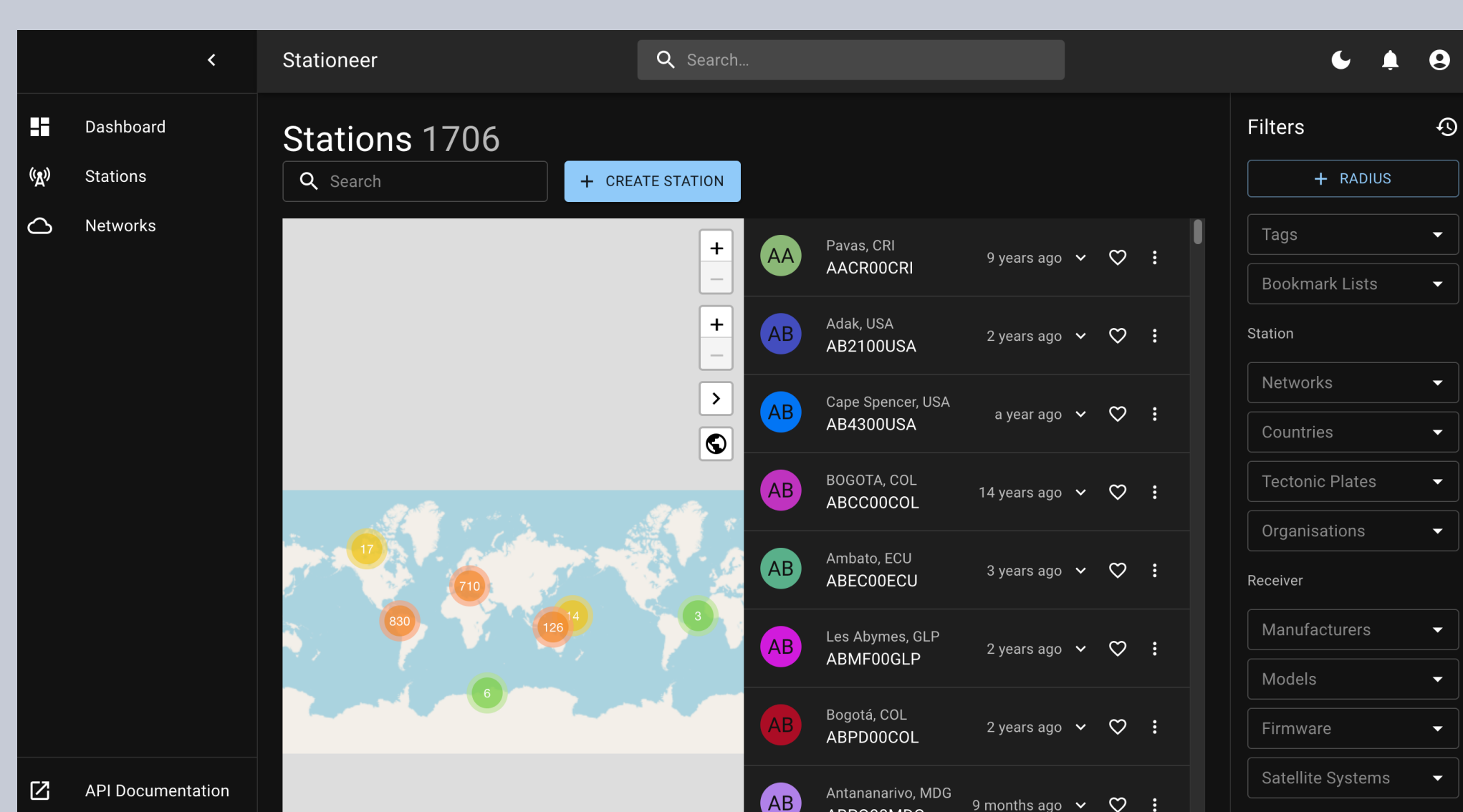


Fig. 2 Stationeer network overview with filter options

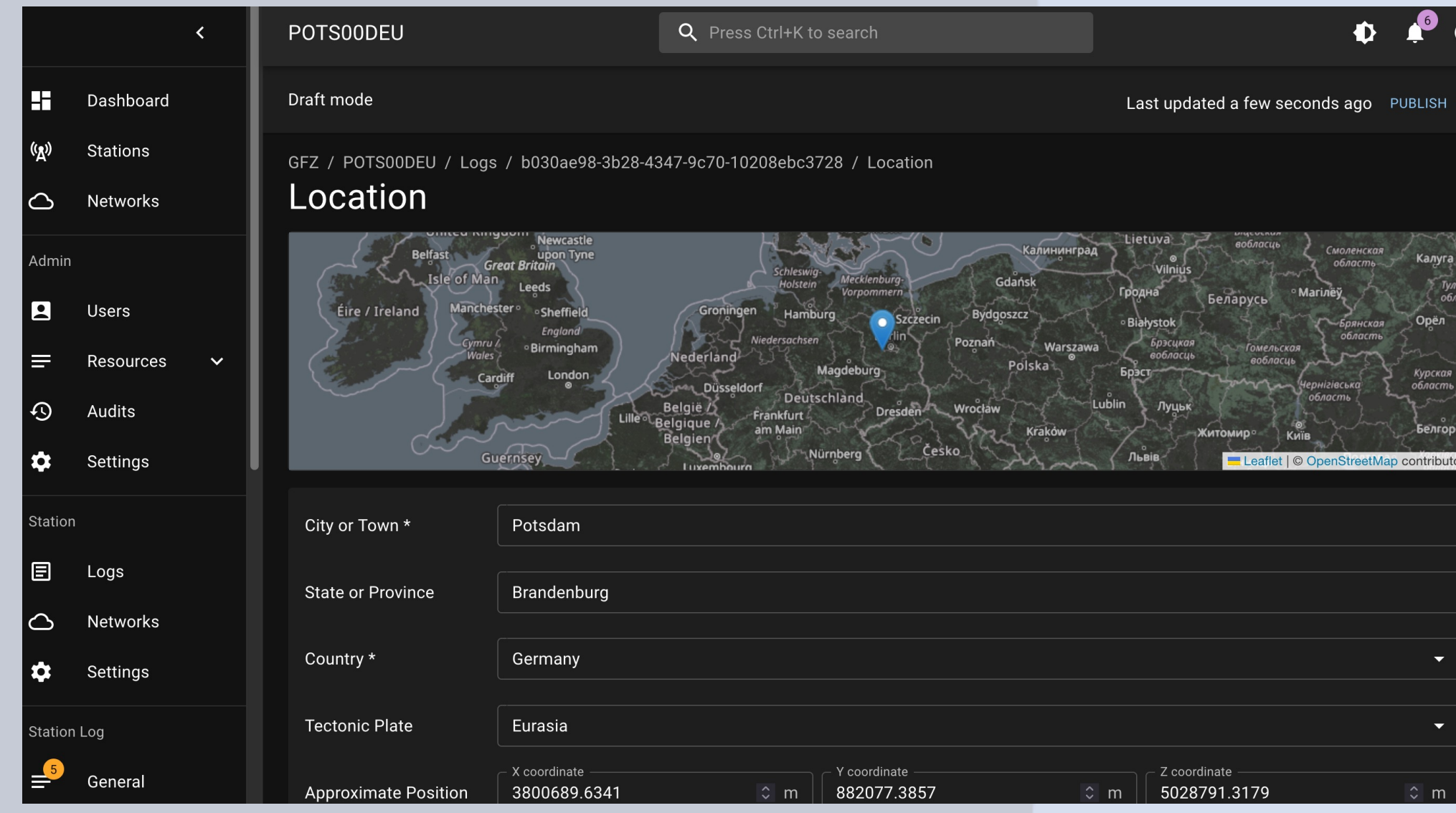


Fig. 3 Stationeer station log manager

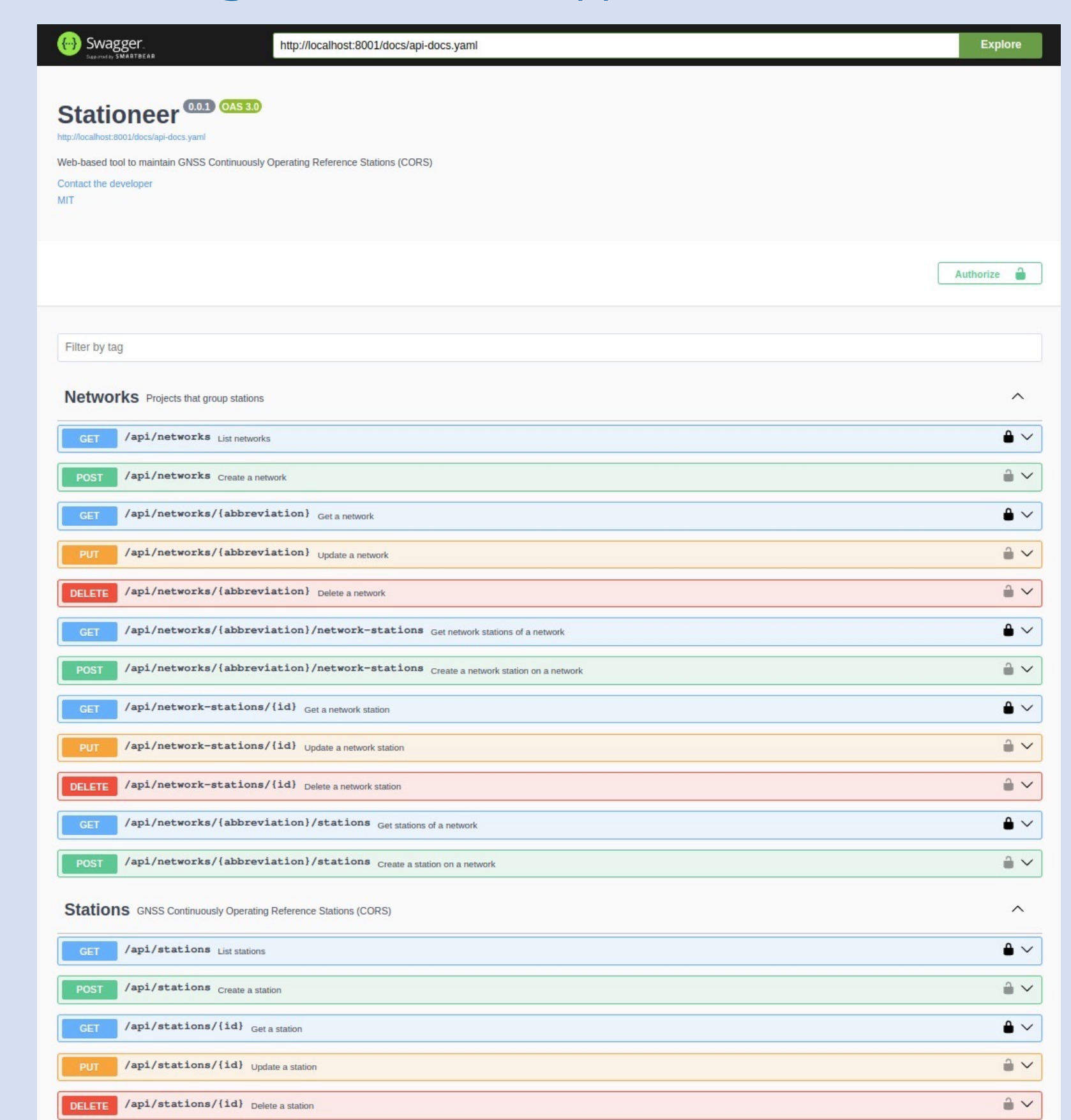


Fig. 4 Stationeer REST API documentation

## Performance

*Stationeer's* performance has been tested against similar applications in the GNSS field. It excels in terms of performance, accessibility, best practices, and Search Engine Optimization. The results have been validated using Google's Lighthouse application (Fig. 5).



Fig. 5 Lighthouse metrics for accessing a station map on the different systems

## References

- [1] European Union, „EUSPA EO and GNSS Market Report“, 2024, available at: [https://www.euspa.europa.eu/sites/default/files/euspa\\_market\\_report\\_2024.pdf](https://www.euspa.europa.eu/sites/default/files/euspa_market_report_2024.pdf)
- [2] Kindermann, J., Development of an information system for the management of GNSS station metadata using GeodesyML, Bachelor Thesis, Hochschule Neubrandenburg, 2022, available at: [https://digibib.hs-nb.de/resolve/id/dbhsnb\\_thesis\\_0000002931](https://digibib.hs-nb.de/resolve/id/dbhsnb_thesis_0000002931)
- [3] Google, Lighthouse, available at: <https://developer.chrome.com/docs/lighthouse/overview>