

Abstract

The railway industry faces big challenges with asset management. Keeping track of all the parts of a train, like wagons and equipment, is very important for safety and making the service reliable. But, traditional systems are often centralized, which can make data hard to trust and not very transparent. This can lead to problems with data integrity, where it is hard to prove the history of a part or be sure that maintenance was completed correctly. It is difficult to have a single, trusted record when many different companies (like operators and maintenance crews) need to share information.

This thesis proposes a new system to solve these problems. The goal is to create a decentralized platform for asset tracking and maintenance. This platform uses blockchain technology to make a transparent and immutable (unchangeable) record of all assets and their maintenance history.

The main contribution is a hybrid three-tier architecture. The system's core is a Solidity smart contract on the blockchain. This contract defines the data structures for trains, wagons, and equipment, and it enforces the rules for how they are linked. This creates the trusted "on-chain" ledger. The second layer is a backend API, built in Python with FastAPI. This backend works as middleware, it connects our web application to the blockchain. It also manages user authentication using a local SQLite database, this is the 'hybrid' part that keeps user data private and off-chain. The final layer is a web application, built with React, which provides a user interface for staff to manage assets and view maintenance records.

This thesis shows a complete solution, from the smart contract to the user interface. The system creates a single, trusted source for all asset data. This makes it possible to have a fully auditable and transparent maintenance history, which can improve safety, reduce costs, and build trust between different railway partners.