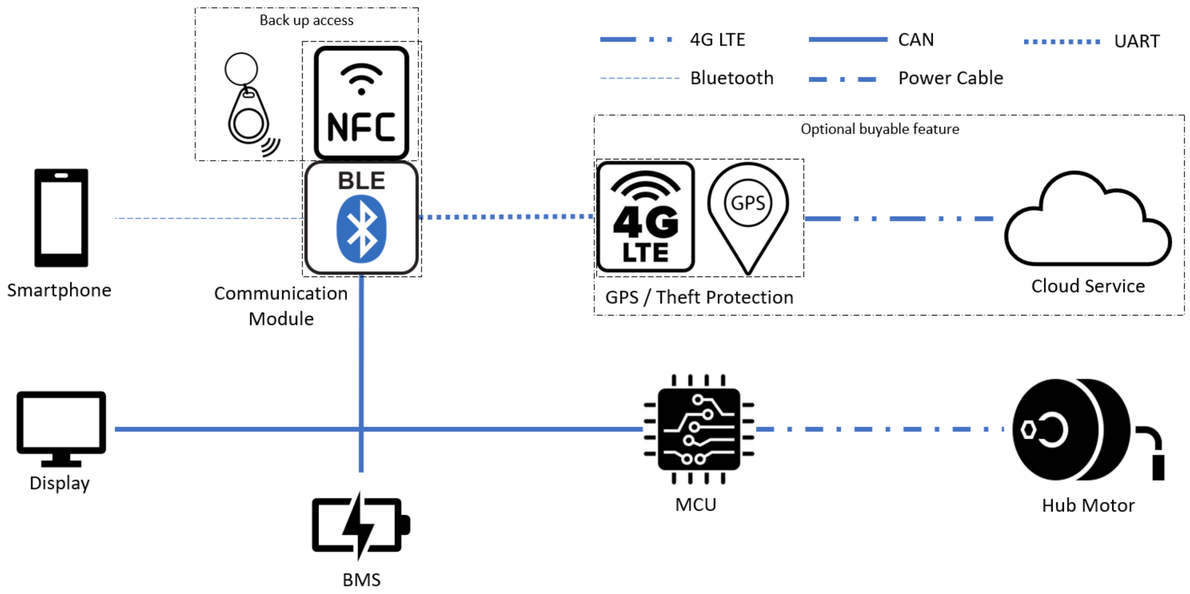
HSLU Hochschule Luzern

Technik & Architektur
Electrical Engineering

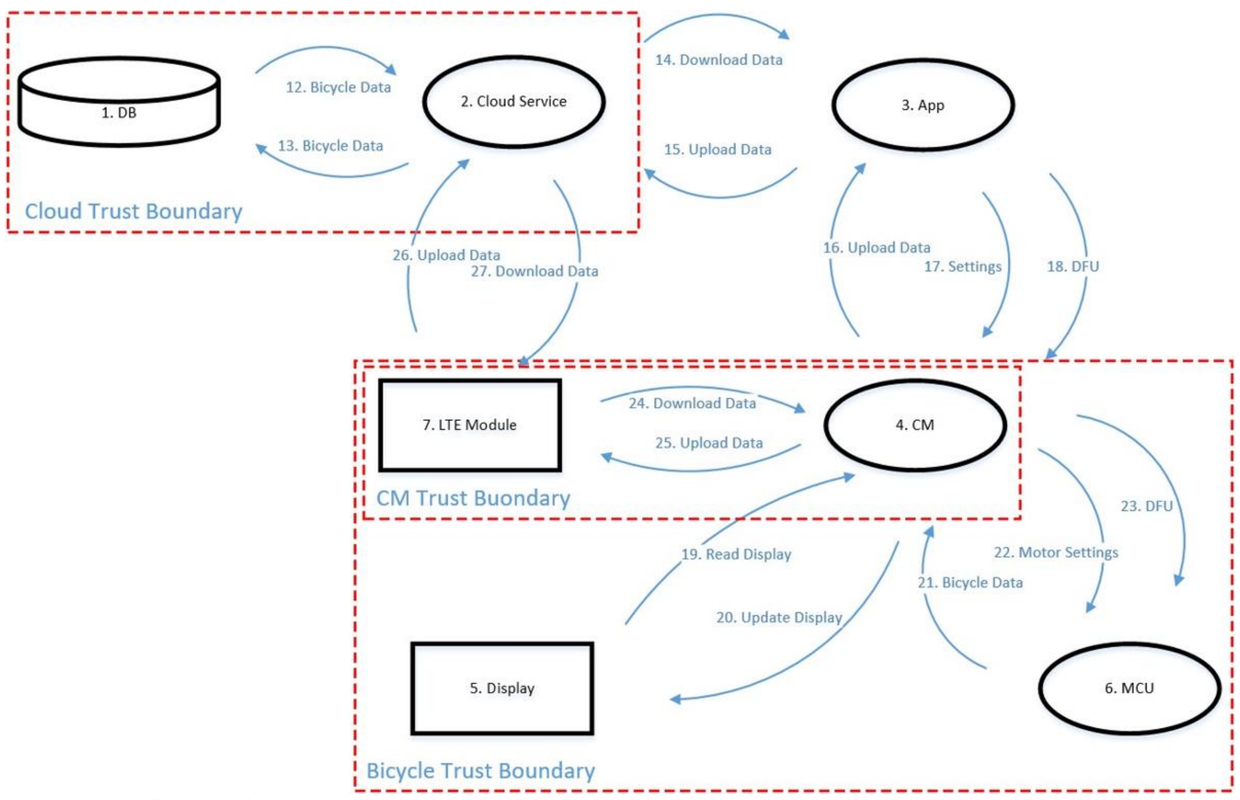
Master's Thesis Electrical Engineering

Security Architecture for Light Electric Vehicles

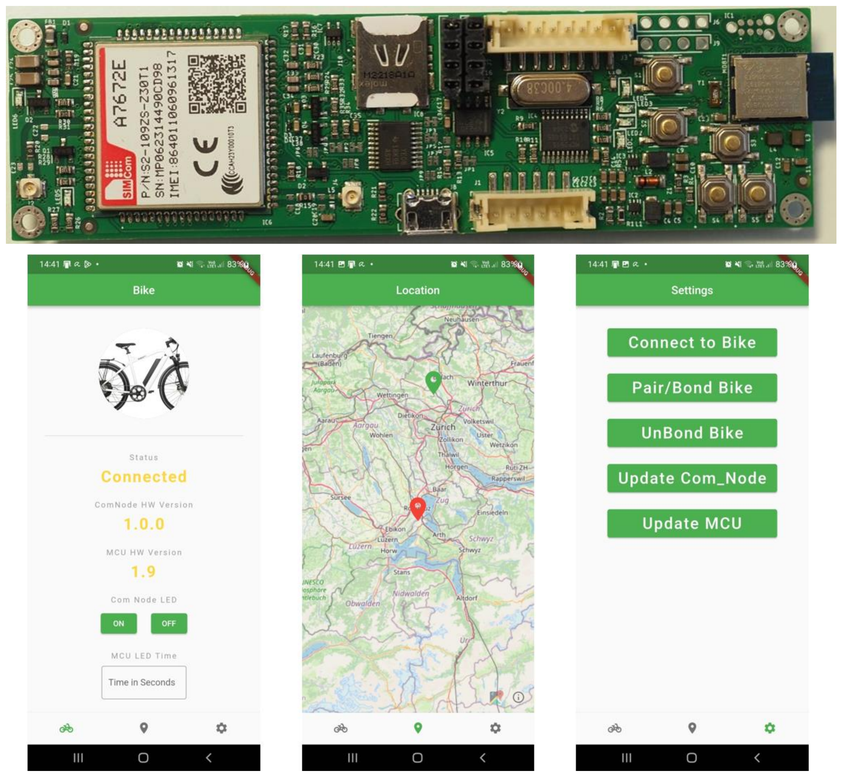
AureusDrive's Power45 e-bike



Recommended communication concept



Data flow diagram of recommended communication concept



PCB and mobile application

Type-approved light electric vehicles such as AureusDrive's Power45 e-bike must comply with multiple regulations. On the one hand, these regulations apply to the type-approval process itself. On the other hand, with further digitalization, e-bikes must comply with regulations concerning security, particularly cyber security. Many of the regulations are established, and further ones are coming soon.

Currently, AureusDrive does not have a communication module integrated into their e-bikes.

This thesis aims to elaborate a concept for a communication module that allows over-the-air device firmware updates of the different e-bike components and telemetry data, as well as the exchange of settings. Additional features are GPS tracking and a locking system of the e-bike as theft protection.

The focus lies on security, particularly cyber security, and compliance with the applicable regulations. It also includes the question of how it can be implemented into the existing e-bike system and its cost impact.

Based on a threat modeling and state-of-the-art analysis, a communication and security concept was elaborated and tested as a proof-of-concept.

The proof-of-concept includes the hardware design with a TrustZone-M-based SoC and LTE module on a so-called communication module that can be mounted on the e-bike.

Security features provided by TrustedFirmware-M, such as secure boot and secure storage, are used within the firmware realization. The BLE communication is secured based on passkey-based bonding, and further authentication methods, such as hashed-message-authentication codes, are used. Encryption methods are discussed and applied to the various involved parts.

A mobile application based on the state-of-the-art cross-platform Flutter framework is used for device firmware updates. The mobile application's user interface guides through the different adjustable settings and displays telemetry data from the e-bike. The current e-bike location can also be displayed on a map as a theft protection feature.

GPS tracking is based on the LTE network by sending the current GPS location via MQTT to the cloud services. The cloud services include an MQTT broker, a time series database, and serverless cloud computing to respond to API requests.

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AUREUS Drive

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