Smart Grid Integration of Electric Buses

Implementation of an Uni- and Bidirectional Charging Infrastructure

Enrico Lauth[1] – Andreas F. Raab[2] – Dietmar Göhlich[1] – Kai Strunz[2]
Technische Universität Berlin

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Introduction and Motivation

The substitution of bus fleets based on combustion technologies to electrically powered systems will lead to major changes in the transport sector. The increasing power and energy demand for charging processes will add another layer of complexity to existing power systems, i.e. at depots, terminal stations or bus stops (**Fig. 1**). In order to explore possible solutions for smart grid applications, the integration of an unidirectional (150 kW) and bidirectional (120 kW) charging infrastructure for the operation of an electric bus is investigated and demonstrated. Intelligent charging and discharging algorithms are tested and evaluated with regard to the provision of power system services. This is especially relevant relating to the energy transition and the fluctuating feed-in of renewable energies.

Fig. 1: Bus stop with charging station

Charging Infrastructure and Grid Connection

Compulsory and enhanced functionalities are reflected to maintain the most important processes given by directives and technical connection requirements, e.g. requisites for feeding electricity into the grid according to VDE AR-N 4105. Numerous system protection and meter devices are integral part of the developed charging infrastructure (**Fig. 2**).

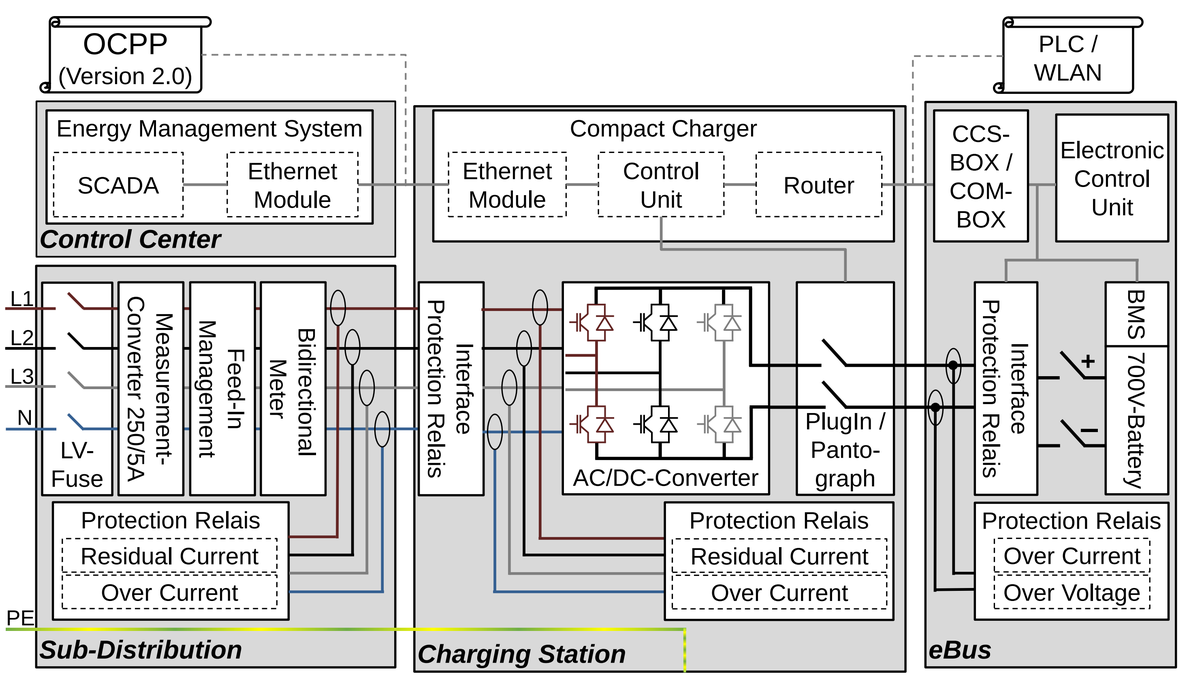

Fig. 2: Schematic circuit diagram

A bidirectional smart meter is installed to allow the use of load-dependent and time-variable charging and discharging processes. In addition, a radio-based feed-in management is used to reduce the feed-in power, if required. The charging station is equipped with an AC/DC converter. The contacting of the charging station and the electric bus is realized either by a pantograph (unidirectional) or a CCS connector (bidirectional).

System Integration

The information and communication technology integration into an overarching energy management system is carried out by adapting the Smart Grid Architecture Model (SGAM). This classification allows a methodical assignment of standardized protocols in and between the hierarchical zones. By defining data transmission and protocols, the developed communication structure (**Fig. 3**) enables bidirectional data exchange and therefore control and regulation possibilities. With regards to the electric bus, the protocols ISO/IEC 15118 for the communication between vehicle and charging infrastructure and the Open Charge Point Protocol (OCPP) for communication between infrastructure and a control center are investigated. Reflecting future developments, a local smart grid control system specifies charging and discharging schedules. This is achieved thanks to enhanced control algorithms to match demand and generation as required while ensuring the mobility needs of the electric bus.

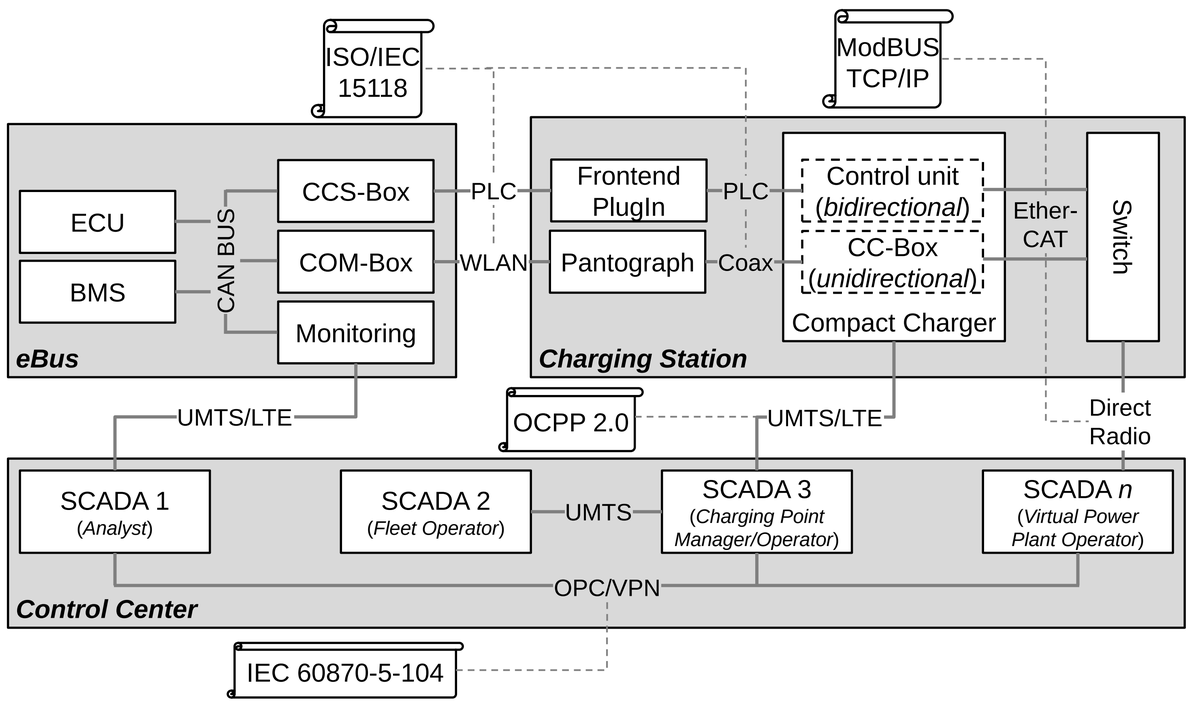

Fig. 3: Communication architecture

Conclusion

The poster addresses the implementation of an uni- and bidirectional charging infrastructure into a smart grid environment. The presented system integration approach enables a bidirectional data exchange between an electric vehicle, a charging station and different control centers. The developed approach is scalable and can be applied to similar application. In the further course, the approach will be detailed in hardware-in-the-loop experiments.

Contact:
[1] Mail: enrico.lauth@tu-berlin.de | +49 (0) 30 / 314 21429 | Department of Methods for Product Development and Mechatronics (MPM)

[2] Mail: andreas.raab@tu-berlin.de | +49 (0) 30 / 314 78837 | Department of Sustainable Electric Networks and Sources of Energy (SENSE)

Technische Universität Berlin
MPM
SENSE Sustainable Electric Networks and Sources of Energy
www.mobility2grid.de
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