The standard charging system for wire-conducted charging of electric and plug-in hybrid vehicles is the Combined Charging System (CCS), which is mandatory for all future fast charging systems in the European Union. All charging systems in Germany must therefore be installed according to the CCS standard. CCS uses the Combo2 connector in Europe, which allows both AC and DC charging. The digital communication between the electric vehicle and the charging infrastructure in the CCS via HomePlug Green PHY™ runs over the control pilot wire and uses the SLAC mechanism (Signal Level Attenuation Characterization) for establishing the connection. Since 2015, the CharIN e.V. (www.charinev.org) has served as an official committee for promoting the CCS standard and for decision-making regarding further development.

“Booster” of E-Mobility: Inductive Charging
Alongside the charging of electric vehicles via a wire, wireless charging (WPT – Wireless Power Transfer) will become an absolutely essential component of E-Mobility in the future. Automobile manufacturers are currently developing the first series generation of electric vehicles that support inductive charging. This will make vehicle charging much more convenient since the vehicle can recharge energy automatically regardless of whether it is at home or out and about. Correct positioning, connection establishment, and authentication are required for this. As the vehicle approaches the garage at home, for example, it is connected to the charging infrastructure there via Wi-Fi. A positioning aid enables the incoming vehicle to be directed to the correct position over the charging pad (ground pad) after which

Inductive Charging – From Evaluation to Standardized E-Mobility
Enhancements and additions to Edition 2 of ISO/IEC 15118

Alongside wire-conducted charging, inductive charging will play an important role in the future of electromobility. The automotive industry is now converting the results from the evaluation phase of ongoing development projects into specific products. A considerable part of the associated development effort is going toward wireless communication between the vehicle and the charging infrastructure. The standards development activities for this are in full swing and essential functions are being added to the existing ISO/IEC 15118 standard. For easy development of vehicle and charging infrastructure electronics, both embedded solutions and tools for simulating the respective counterpart electronics during subsequent testing are available.
the charging operation starts immediately. The driver no longer has to walk around the car, open the trunk, pull out the charging cable, and connect it to the charging system. Likewise, it is no longer necessary for drivers to unplug the cable and stow it in the morning when they are in a hurry.

For charging in public areas, services for reserving charging parking spaces will be available along with control systems that guide vehicles to available charging spaces. All of these convenience features, including automatic billing and payment transactions, will increase the acceptance of E-Mobility sustainably.

One of the most important prerequisites for uniform, compatible, and vendor-neutral implementation of this charging technology is the establishment of an international standard. This applies in particular to the communication.

In addition to wireless power transfer, the information exchange between the vehicle and the ground pad must also take place wirelessly. Various ISO/IEC 15118 working groups are working on this task and are in process of integrating WPT and other interesting functions in the standard.

Besides Wireless Power Transfer, the second edition of ISO/IEC 15118 will contain important new additions including energy regeneration and the Autoconnect Charging Device (ACD). The documents for ISO/IEC 15118-6 (Applications) and -7 (Network and Protocols) originally intended for the second edition will now not be stand-alone parts of the standard but will rather be incorporated into ISO/IEC 15118-1 and -2. Only ISO/IEC 15118-8 is being added to describe the Physical Layer and Data Link Layer of the Wi-Fi communication during charging.

With the possibility for energy regeneration, electric vehicles can now act as supports for intelligent power networks. This is likely to be feasible first in applications such as smart homes (Figure 1), while connection to public networks (smart grid) is probably still a ways off. The focus is on balancing differences between energy supply and demand. The increasing proportion of regenerative energy sources will naturally lead to greater variations. Owners of electric vehicles are thus able to temporarily store energy or recover a portion of their energy costs by charging opportunistically and supplying some of the energy back during expensive peak charging times (V2G – Vehicle-to-Grid). The standard explicitly defines another use case that might be of particular interest in Asia. Accordingly, electric vehicles can serve as an emergency power supply for households when public power supplies fail due to natural catastrophes or technical problems (V2H – Vehicle-to-Home). Finally, V2V functionality (Vehicle-to-Vehicle) gives electric vehicles the capability to perform roadside assistance. Stalled vehicles can thus be charged to the extent needed for them to reach the next charging station.

The new feature named ACD (Autoconnect Charging Device) targets operation of electric buses used in local public transit. For example, it allows charging at bus stops with high charging powers of 150 to 500 kW via a pantograph/DC busbar (Figure 2). Wi-Fi is provided for communication so that the bus establishes the connection, performs a compatibility check, and receives positioning signals in a timely way while it is approaching the bus stop.

The wireless communication introduced with inductive charging is available not just for charging electric buses but is an option for cable charging as well.

Wi-Fi with TLS Encryption
A dedicated frequency band for E-Mobility cannot be implemented internationally. However, the frequencies specified in ISO/IEC 15118 must be usable worldwide. For this reason, the ISO committee chose Wi-Fi in the IEEE802.11n specification as the physical transmission medium for wireless communication. IEEE802.11n provides dual-band sup-
different phases of development using a model-based approach in which the test scope and hardware interface can be customized to customer requirements. The Vector test system can be configured in such a way that the vehicle or charging infrastructure is simulated, depending on what is to be tested. The tests optimally cover Vehicle-to-Grid communication according to ISO/IEC 15118-2, the SLAC mechanism (Signal Level Attenuation Characterization) according to ISO 15118-3, and the DIN-SPEC-70121 (DC charging). As soon as the test documents (Parts 4 and 5 of the standard) are available in final form, expected by early 2017, Vector will integrate a corresponding conformance test suite in its solutions.

Fast Developing and Testing

The primary goal of standardization is cross-vendor interoperability, which means that every electric vehicle can ideally be charged on any charging system. To ensure this, vehicle and infrastructure manufacturers regularly participate in “Testivals” in which representatives of the respective companies test their ECUs, vehicles, and charging stations with one another over a 2-day period. Of course, engineers test their products in-house beforehand. Testing can quickly become a complex matter, especially since Parts 4 and 5 of the standard that describe the test modalities for conformance tests are not yet finished. Ideally, a suitable tool for simulating the respective counterpart is available, for example, from Vector, for testing in the lab. While developers of vehicle electronics need simulation of the charging station, manufacturers of charging infrastructure are dependent on vehicle simulations.

Electric vehicle manufacturers and charging infrastructure suppliers quickly come up with functional communication solutions when they use proven embedded modules. For example, Vector actively participates in the ISO standards development process and is able to promptly adapt its solutions to the current state of the standard. This is also the case for inductive charging. While MICROSAR.V2G is intended for charging ECUs in the vehicle (Figure 3), vEVSE implements the ISO/IEC 15118-compliant counterpart electronics on the grid side. Tests can be performed during

![Figure 3: Integration of MICROSAR.V2G modules in an AUTOSAR architecture](image)
Dirk Großmann
He is Senior Manager at Vector in Stuttgart/Germany where he is responsible for, among other things, development of the Vector E-Mobility solution. He studied electrical engineering and gained six years of automotive development experience in the area of ECU software before coming to Vector in 2003.

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