automotive engineering iav

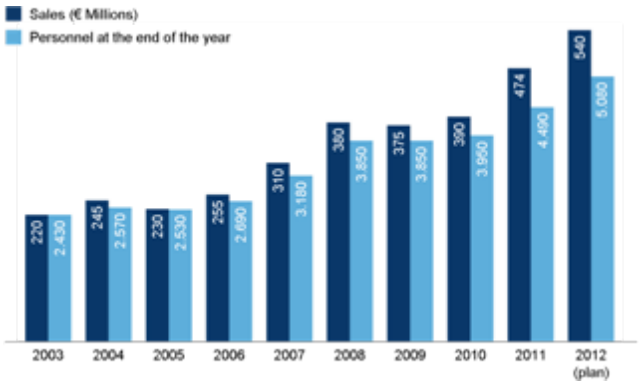
Standard Proposal for Resonant Inductive Charging of Electric Vehicles

AMAA 2012 - Session A: Electrification

Steffen Kümmell, Berlin, May 2012

IAV: Ingenieurgesellschaft Auto und Verkehr

Business volume and employees



IAV locations

Business Areas

- Vehicle Development
- Powertrain Development
- Powertrain Mechatronics

Division Technology Monitoring

- Mobility Concepts
- Thermoelectric
- Lightweight Construction
- Inductive Energy Transfer
- New Combustion Engine Technologies
- InDrive-Simulator

Expert engineering partner with more than 4,000 employees for many OEMs worldwide

Agenda

Benefits of Stationary Inductive Charing

DKE Working Group 353.01

Objective and Participants

Geometrical Definition

System Frequency and Electromagnetic Compatibility

System Control and Communication

Outlook

Benefits of Stationary Inductive Charging

- No action necessary on the part of the vehicle user
- No need to carry charging cables on board and for charging infrastructure above ground
- Higher safety against vandalism
- No weather influence and wear-free
- Automatic grid connection
  - Better usage of renewable energy possible
  - More frequent charging
- Key technology for new business models with EV's (Car-Sharing or Park & Charge)
- High overall efficiency proven
- Worldwide standard possible

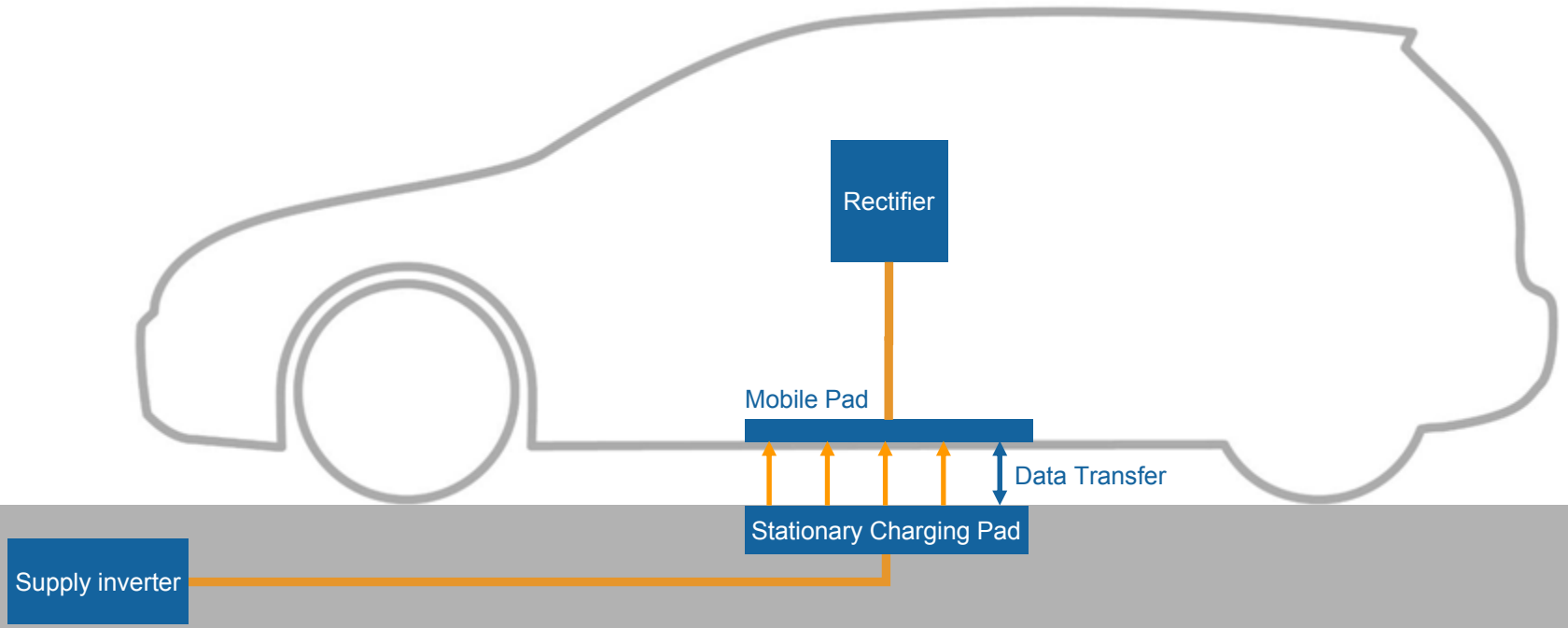
DKE Working Group 353.01

In January 2011 publication of application guide VDE-AR-E 2122-4-2 for Resonant Inductive Charging of Electric Vehicles as first step for standard proposal

- Chairman Samuel Kiefer (kiefermedia)
- 5 automotive manufacturers (Audi, BMW, Daimler, Porsche, VW)
- 4 technology suppliers (Bombardier, Conductix-Wampfler, SEW-Eurodrive, Vahle)
- 3 testing and certification institutes (EMC Test, IMST, TÜV Süd)
- 2 automotive suppliers (Bosch, Siemens)
- 1 energy provider (E.ON)
- Experts from research and science
  (Fraunhofer IWES, ifak, RWTH Aachen, TU Braunschweig)
- IAV
- Standardisation specialists from VDI / VDE
- Representatives: Federal Ministry for the Environment, Nature Conservation, Reactor Safety

➔ German Funded Projects Conductix, Indion and W-Charge (till 09/2011)

Geometrical Definition



Geometrical Definition II

Below surface

- Stationary charging pad completely embedded in the ground
- Distance between pads equal to ground clearance

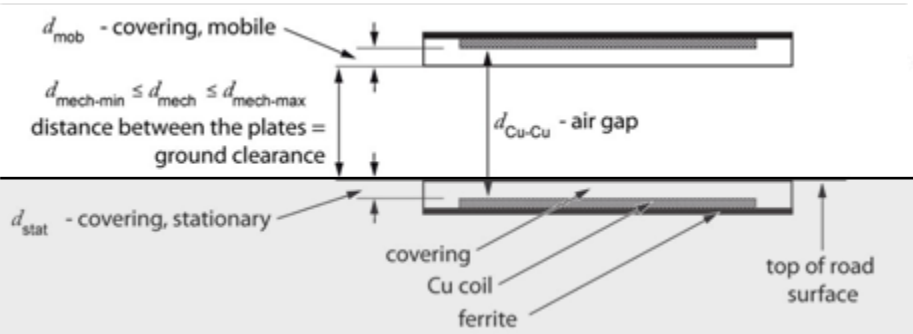
➔ Distance 100 - 170 mm

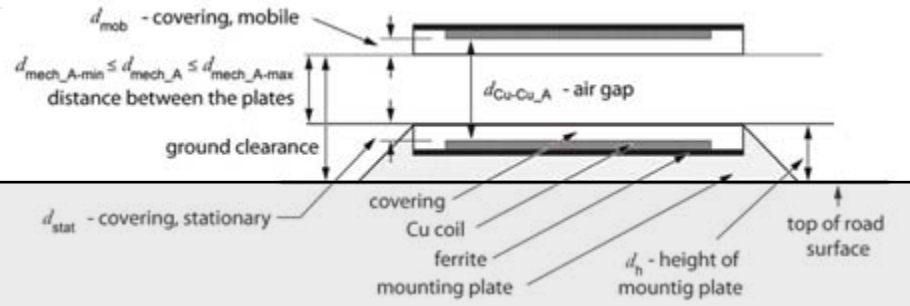
Above surface

- Stationary charging pad mounted on the ground
- Distance between pads smaller than ground clearance (e.g. 50 – 120 mm)

➔ Maximum mounting height regulation necessary

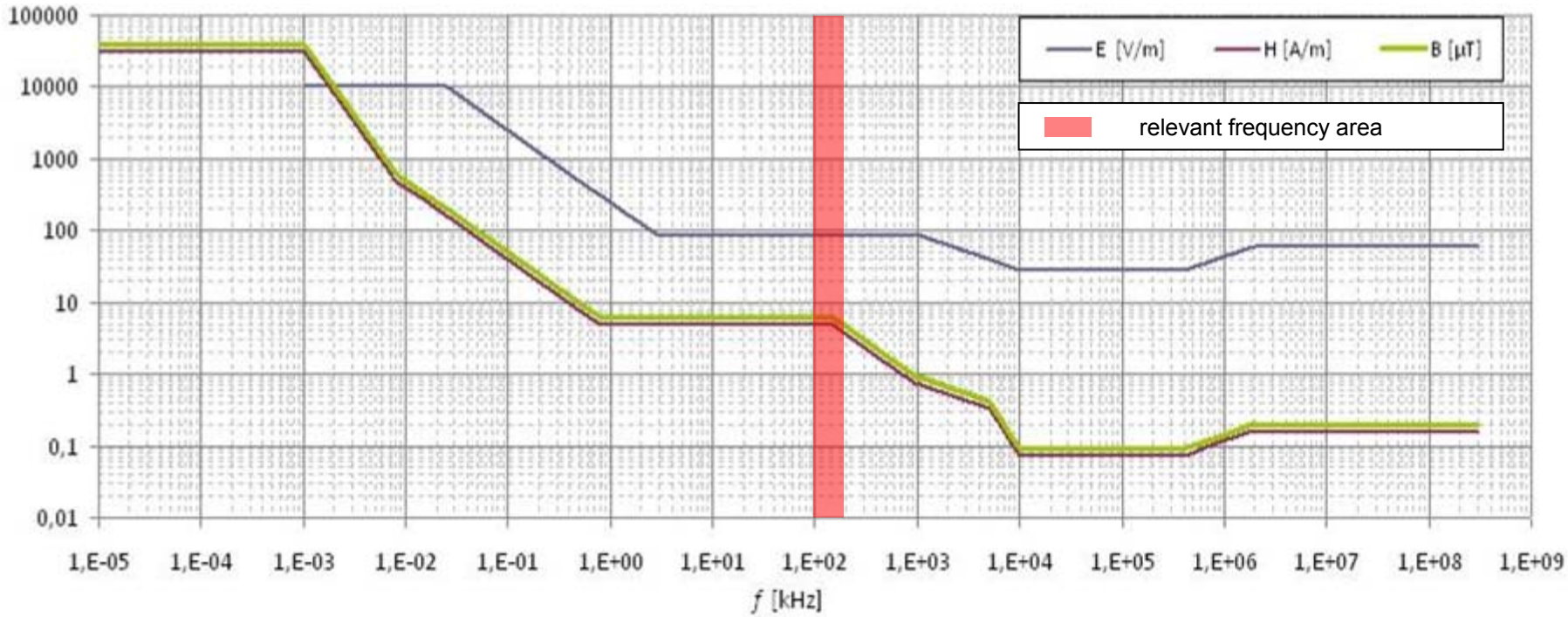
➔ Operating distance: ground clearence minus mounting height





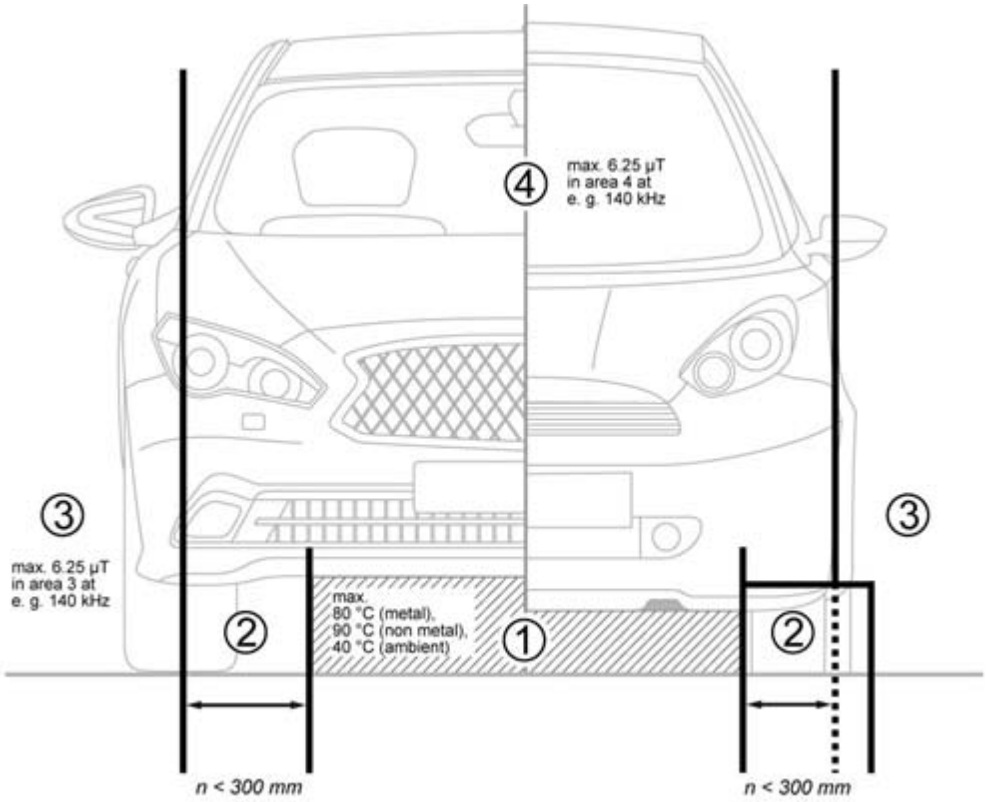
System Frequency

- Nominal system frequency at nominal position: fsys = 140 kHz
- Frequency range for resonance tracking (air gap and offset compensation): Δf –20 kHz to +50 kHz
- Trade-off between system frequency, area and power has to be optimised
- Working group approach: larger area to avoid high local flux densities



Electromagnetic Compatibility

- Protection of persons, livestock and property against electromagnetic fields
- Protection against direct effects of electromagnetic fields, particularly with regard to heating and consequent risk of burns or fire



Areas of Protection

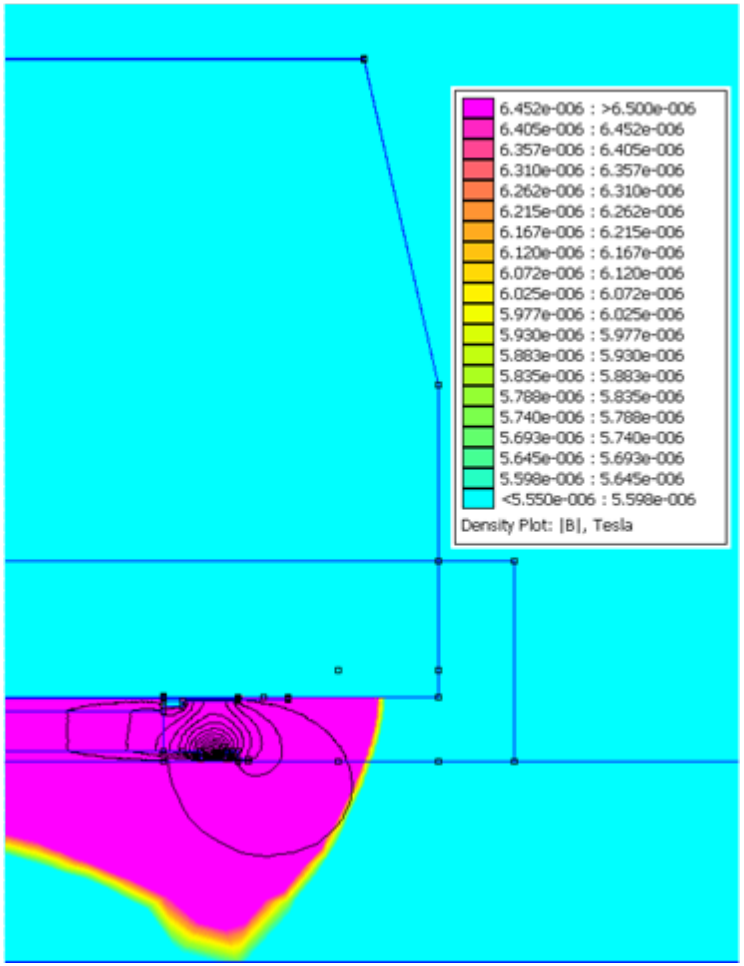
(1) Non-public area of operation – avoiding temperature rise about 80°C metal parts / 90°C non-metallic according to IEC 60364-4-42:2010-05

(2) Transition section between area of operations an public area

(3) Public area with field limit 6,25µT at 140 kHz (ICNIRP 1998)

(4) Vehicle interior with magnetic field limits analogical to area 3

IAV 2D Simulation



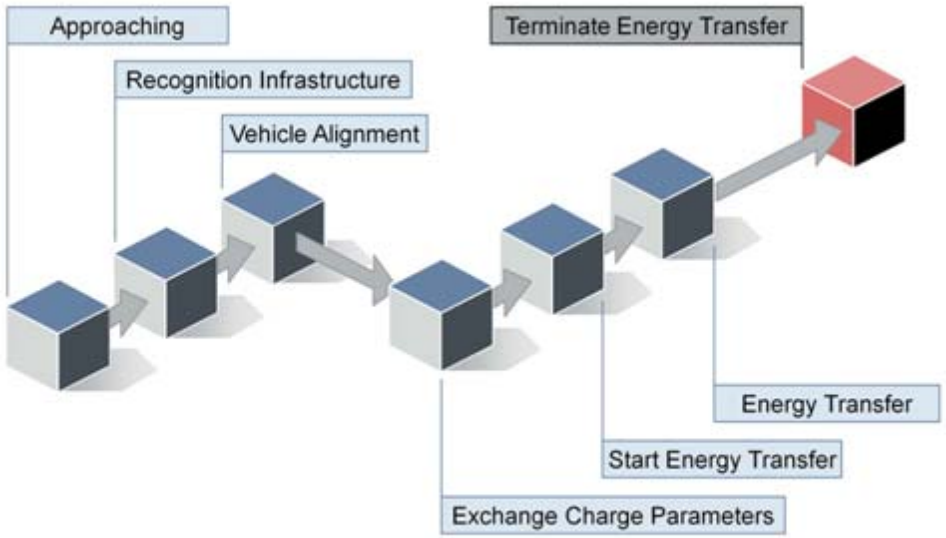
- Car body made of metal
- 140 kHz work frequency
- 3,2 kW simulated power
- 90% efficiency
- Skaling: ICNIRP limits of 1998

➔ Personal protection limits are observed in all public areas

Control and Communication

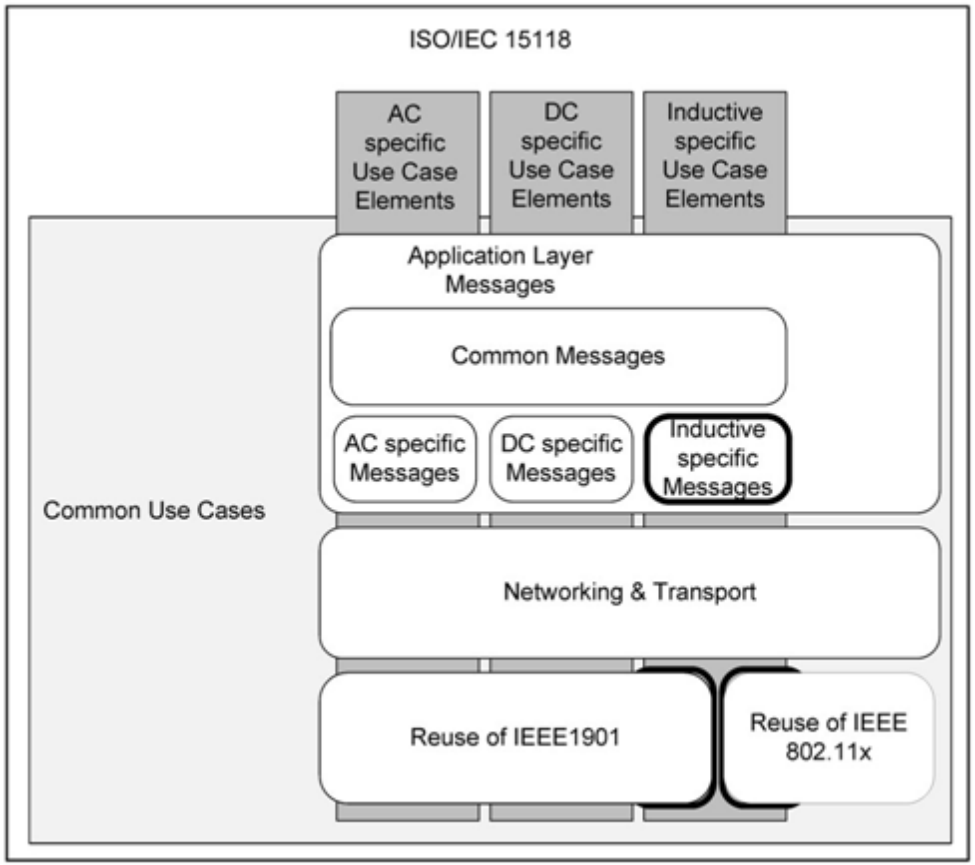
Operating states of the process in scope of the control communication

1. Monitoring to find charging infrastructure
2. Driver information
3. Automatic exchange of the charging parameters
4. Energy transfer under user specific needs (energy consumption, charging time,…)



- ➔ different scenarios of system usage must be considered
- ➔ flexibility to cover and support different technologies
- ➔ must support value added services for other applications
- ➔ designed to be self-secure and guarantee their task in case of unexpected system case

Communication Protocol



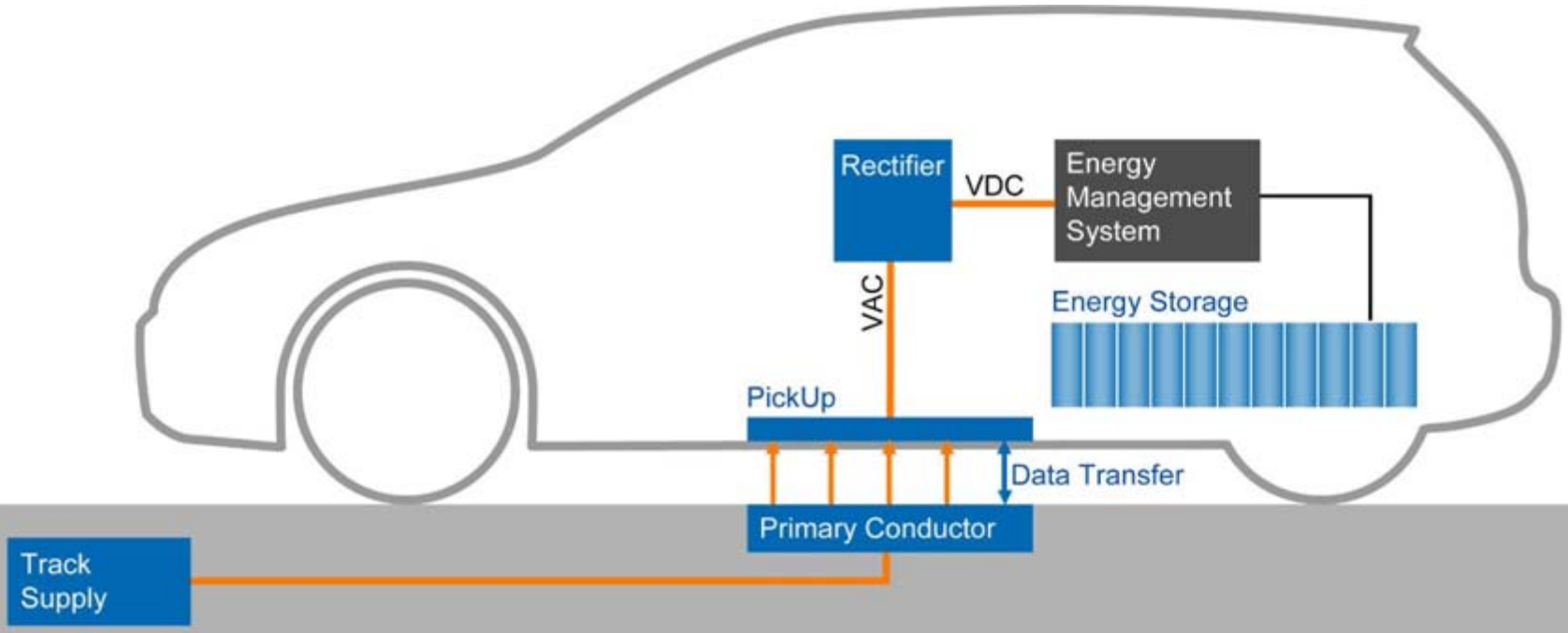
- Operation states overlap with those of cunductive charging

➔ Reuse protocols of ISO/IEC15118 where applicable

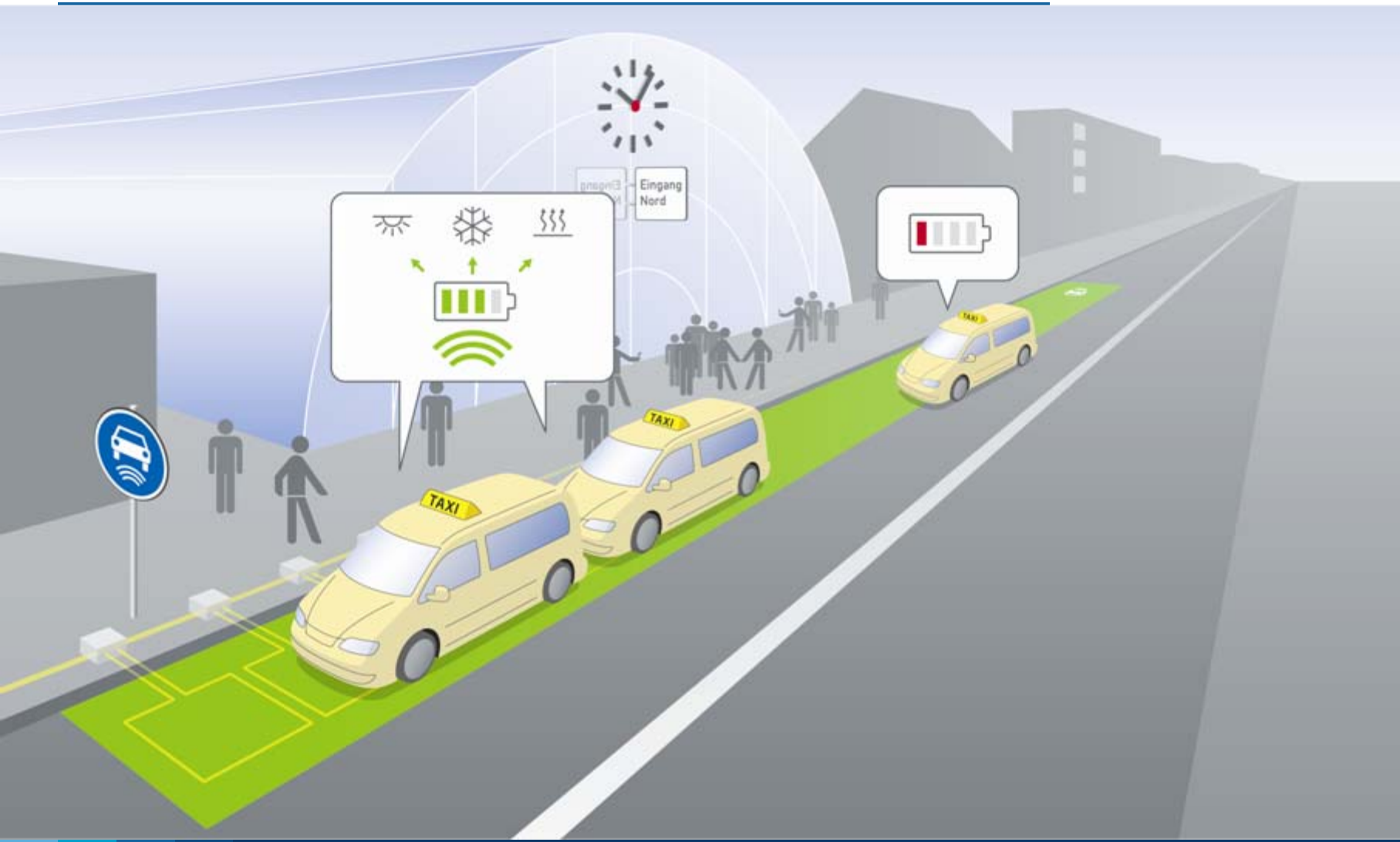
- Maximum reuse of core specification parts to fulfill the requirements of the different charging modes in the standard
- The different communication layers are defined with standardized interfaces
- Usage of adequate elements of IEEE1901, IEEE802.11x is regarded taking into account the requirements
- Investigation of adaptations on the basis of inductive near field communication

Specifications for DKE GAK 353.01

- Transmission performance 3,3 kW
- Frequency 140 (+50 kHz / -20 kHz)
- Air gap 50 - 170 mm
- Max. length x wide: 1m x 1m (both)
- Efficiency ≥ 90 % (at 135 mm air gap)
- Positioning tolerance: ± 100 mm
- Positioning support



Outlook - Taxi stand



Thank You

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