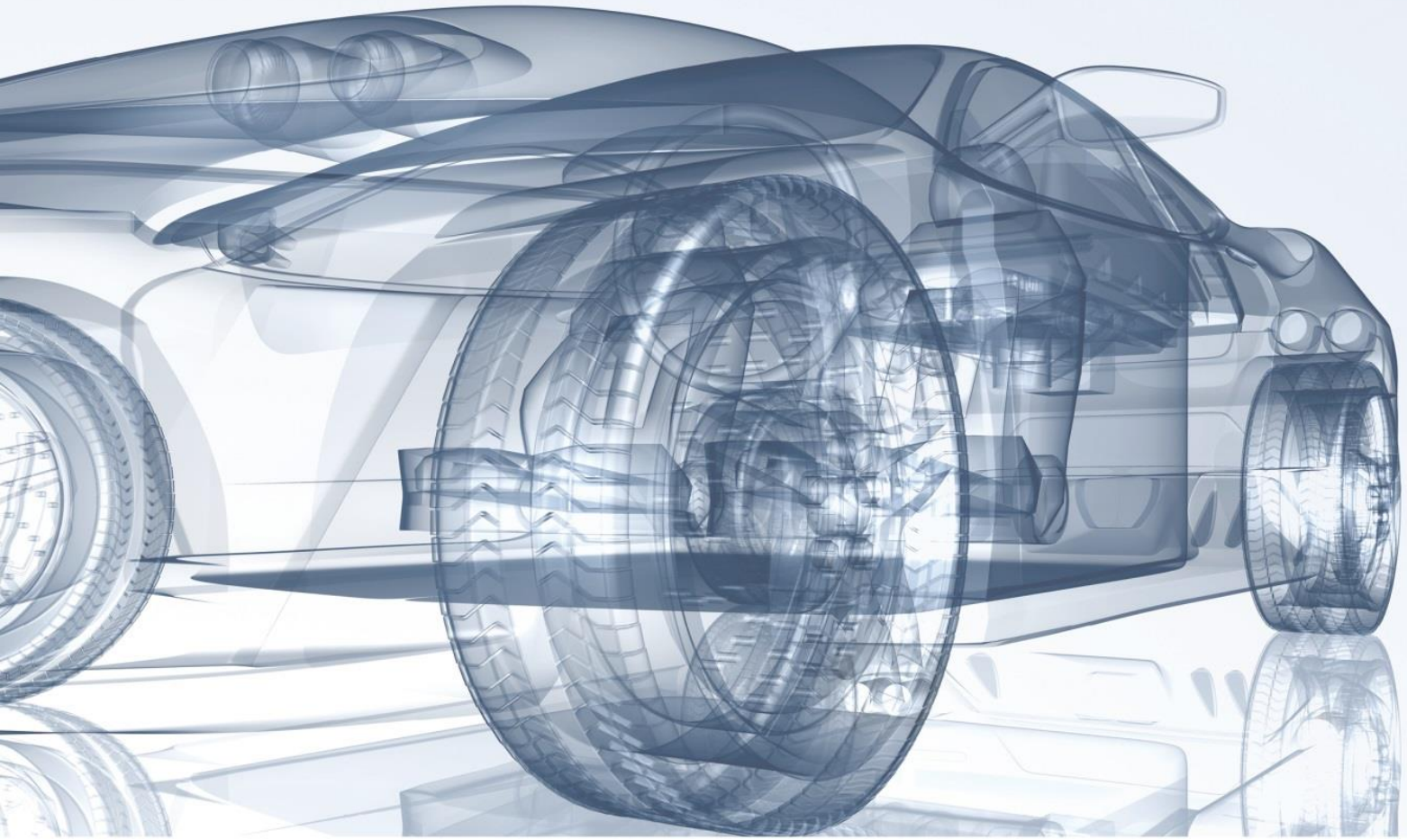
evs 30



The 30th International
Electric Vehicle
Symposium & Exhibition

October 9–11, 2017

Messe Stuttgart, Germany

www.evs30.org

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Integrated Mobility and Energy Infrastructures

–

Assessing Centralized and Decentralized Grid Integration of EVs

Sven Lierzer, BridgingIT GmbH

bridging IT
Menschen Methoden Lösungen

Goals and Partners

Goals

- Use of demand flexibility of electric vehicles via swarm-based charge management for private and commercial customers
- Optimized operating strategies for EV fleets, especially considering spontaneous bookings for the vehicle fleet
- Technical and economical assessment of grid support by EVs
- Analysis of the impact of socioeconomic framework conditions in Germany, Europe and worldwide on providers of electric mobility and smart grid solutions

Project partners

AMETRAS rentconcept

bridging IT
Menschen Methoden Lösungen

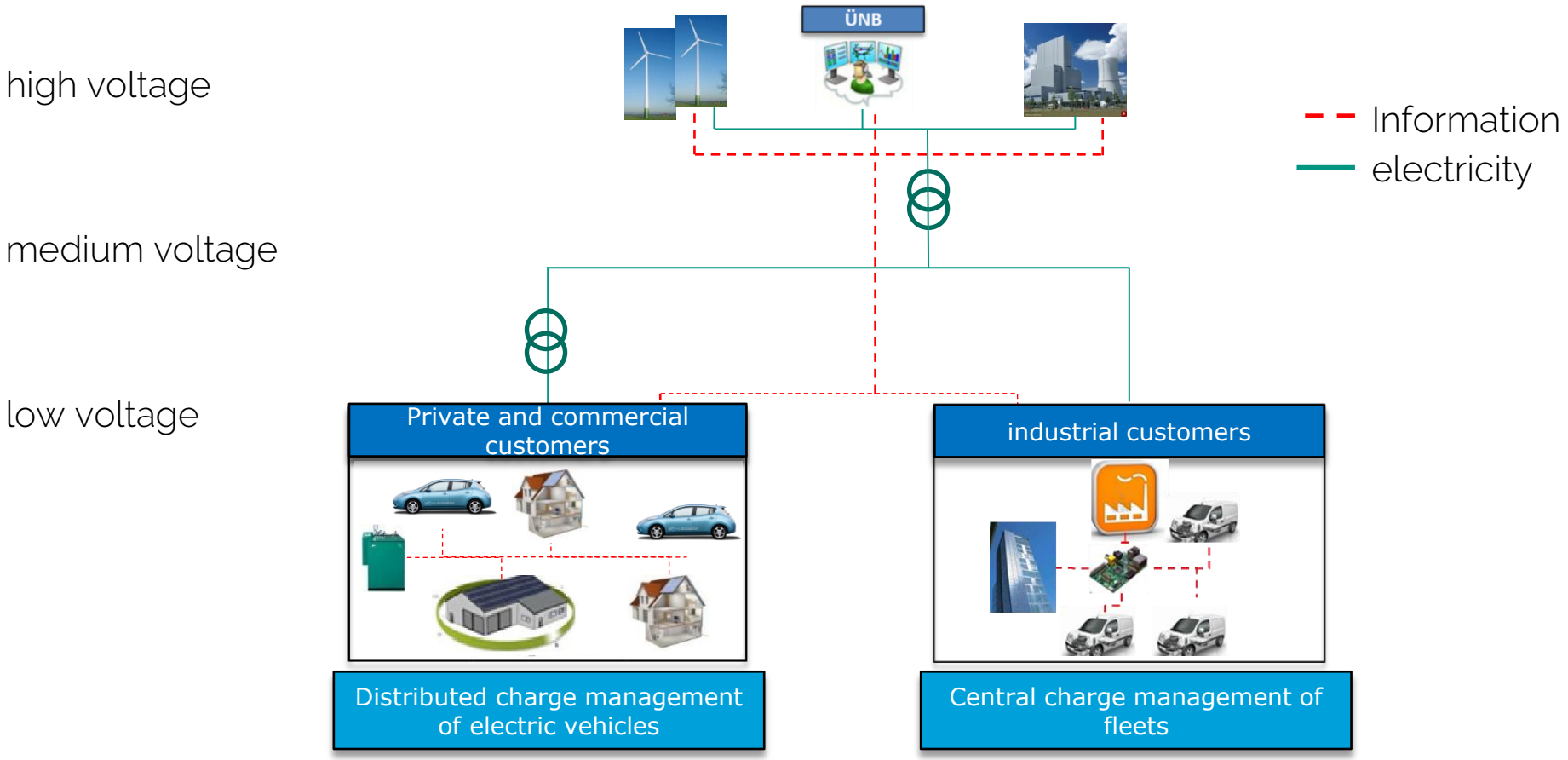
CarMedialab

ENERGY4U
An Atos Worldgrid Company

Fraunhofer IAO

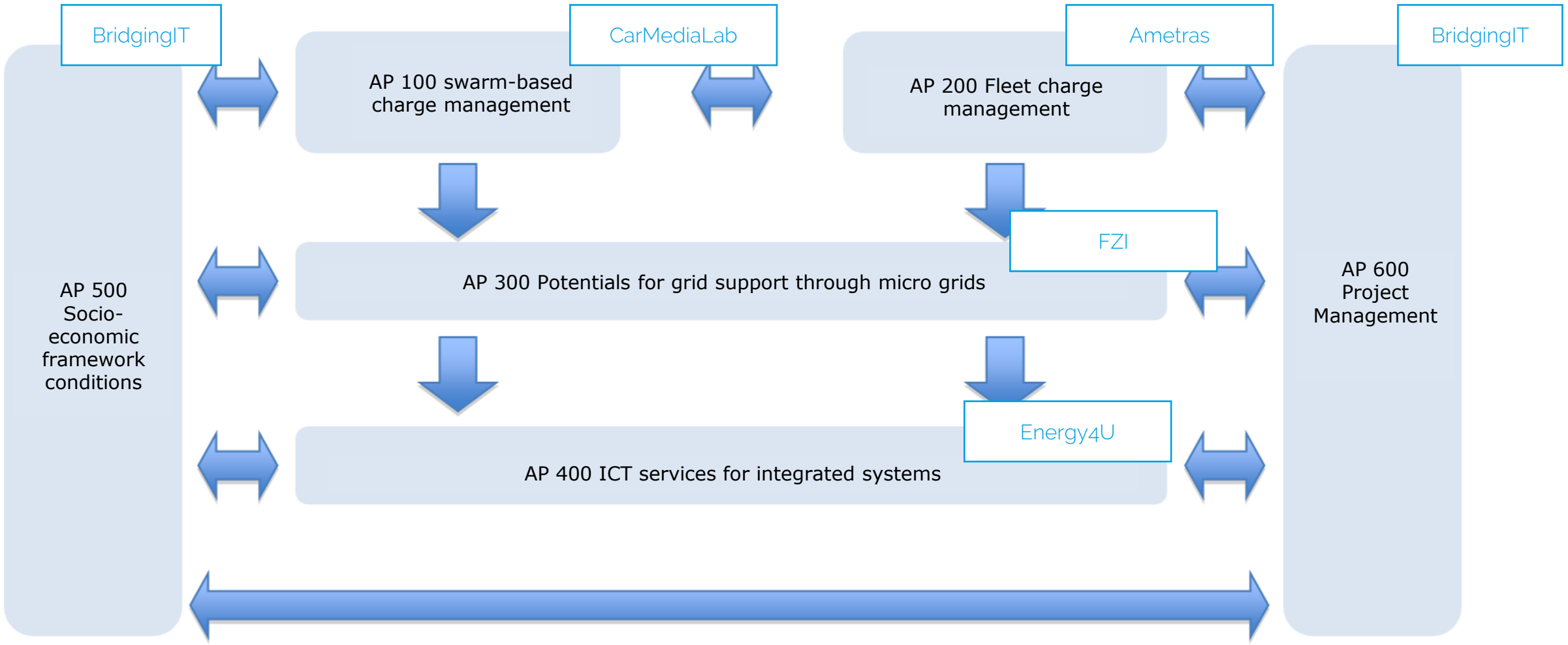
FZI

Application and research scenarios



Quantification and use of charge flexibility of EVs when used by private, commercial and industrial customers

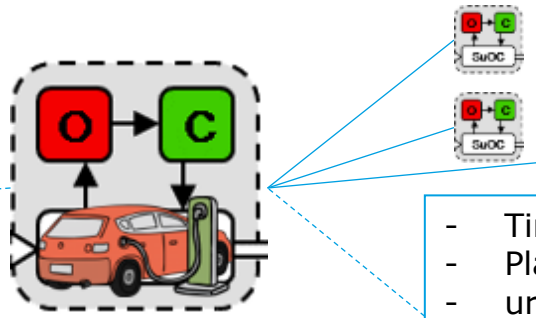
IMEI work packages



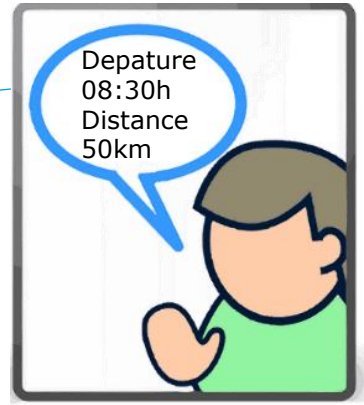
WP 100

swarm-based charging management with observer / controller architecture

- Current time
- SOC
- Usage

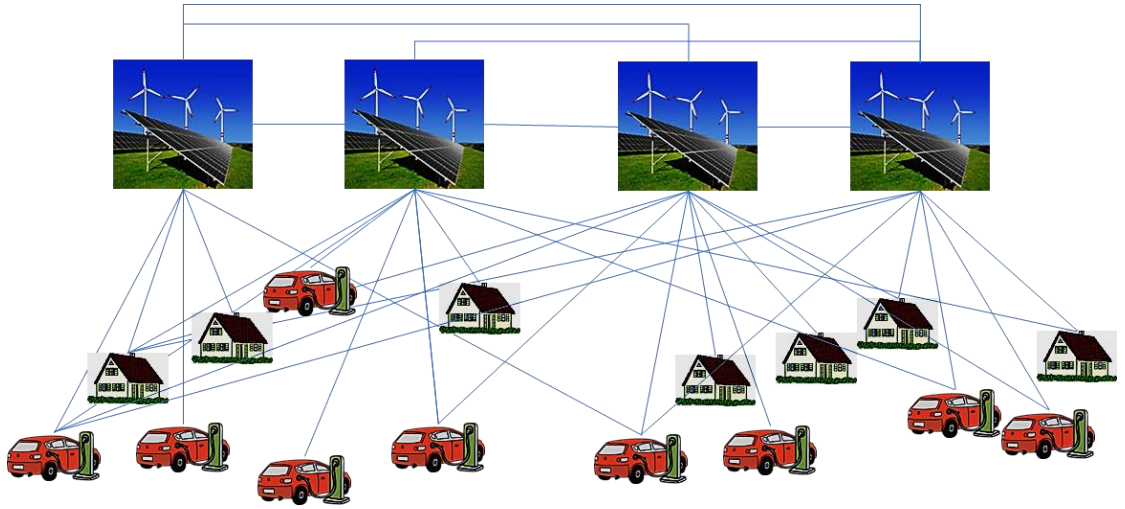


- Time of departure
- Planned route
- urgency quotient
- Charging signal / current
- Min SOC



Intra agent architecture

Inter agent architecture



Source: *Schmeck et al., 2011, Adaptivity and Self-organisation in Organic Computing Systems*

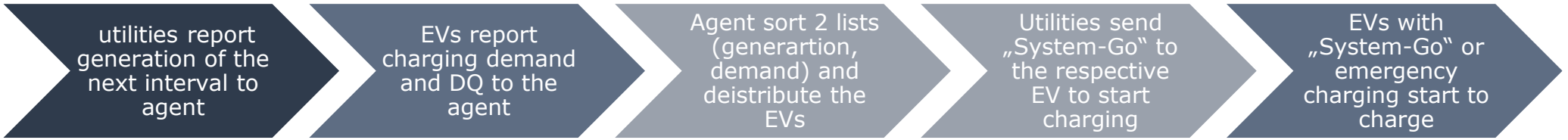
WP 100

The coordination takes place according to the "Least Laxity First" principle

Online Scheduling with adujusted „Least Laxity“ (LLF) procedure:

$$\text{Priority Quotient(DQ)} = \begin{cases} \dfrac{\text{Remaining time until next driving}}{\text{Required charging time for target SOC}} & \text{For SOC} < \text{Target SOC} \\ -\dfrac{\text{Battery Capacity}}{\text{SOC}-\text{Target SOC}} & \text{For SOC} \geq \text{Target SOC} \end{cases}$$

Schematic communication process



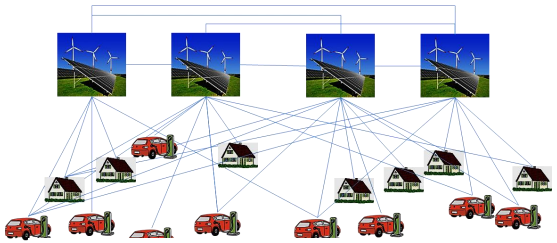
See: Dertouzos & Mok, 1989, Multiprocessor Online Scheduling of Hard-Real Time Tasks

WP 100

Extension of the process by architectural alternatives

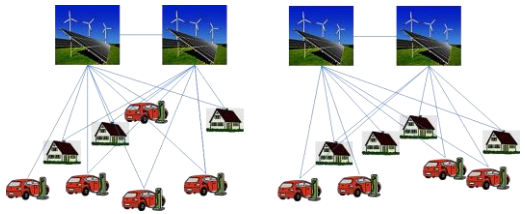
Architectural Alternatives for the Reduction of Process Complexity

Base Procedure



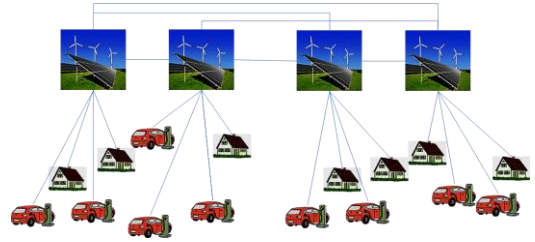
$$VK_{Grundverfahren} = 2 + N_{Agenten} + \left\lceil \frac{P_{k,peak}}{P_{i,max}} \right\rceil$$

Disjoint Pools (ADP)



$$VK_{ADP} = \frac{VK_{Grundverfahren}}{N_{Pools}}$$

Hierarchical Communication (AHK)



$$VK_{AHK} = 4 + N_{EE-Erzeuger} + \left\lceil \frac{N_{Haushalte} + 2 * N_{EF}}{N_{EE-Erzeuger}} \right\rceil$$

WP 100

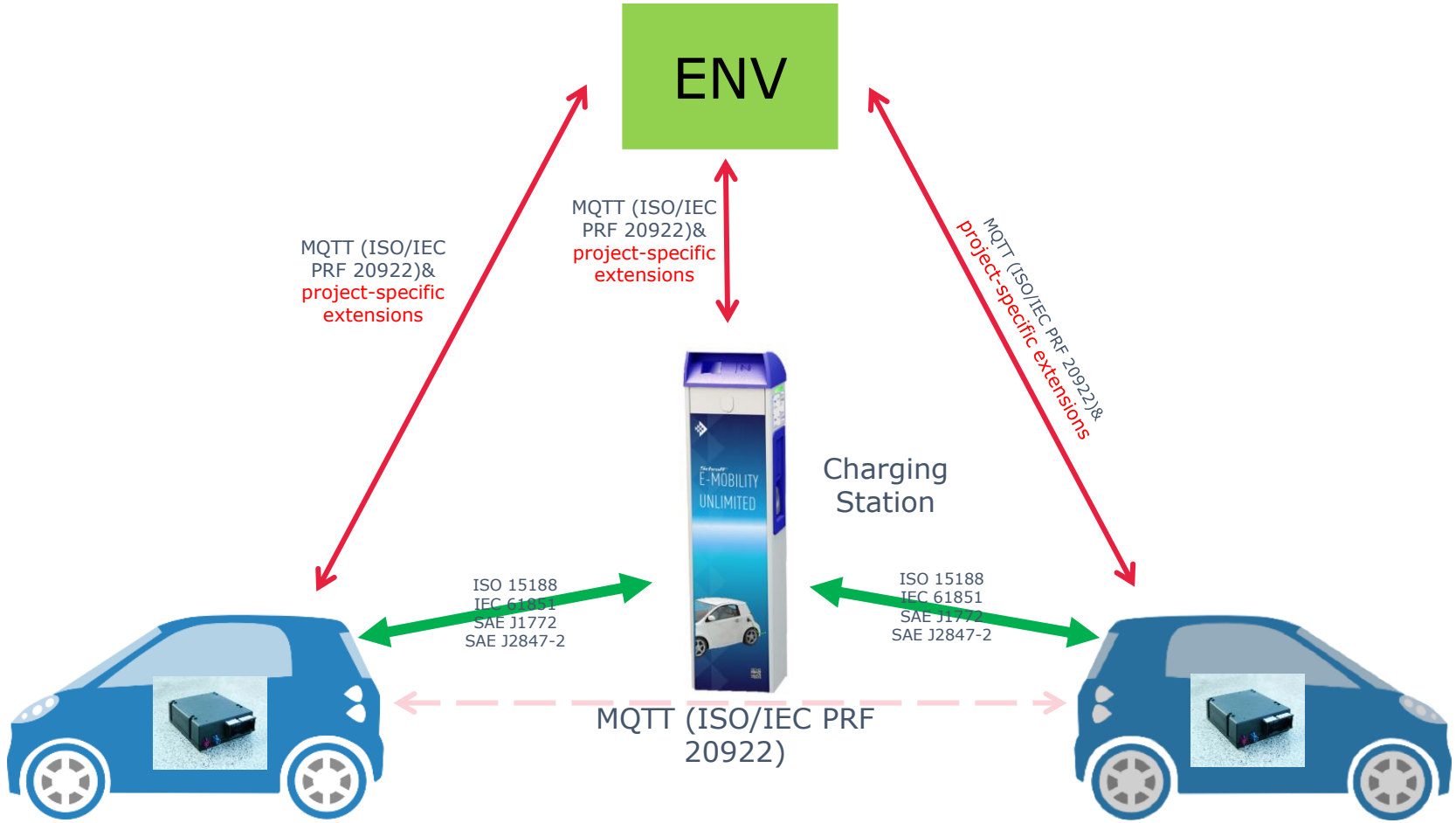
Communication Standards & Architecture Diagram

Communication Standards

- Vehicle 2 vehicle: GNUNet, M2M, MQTT, OCPP1.6
- Vehicle 2 infrastructure: OCPP1.5, OCPP1.6, ISO15118 PRE/FDIS/IS, SAE J2847-2, SAE J1772/IEC 61851, DIN 70121, HomePlug Green PHY, HomePlug AV

Necessary HW adjustments

- Flea3/3G, Flea3 EVSE, PLC Adapter Box, PLC/WLAN Interface Board

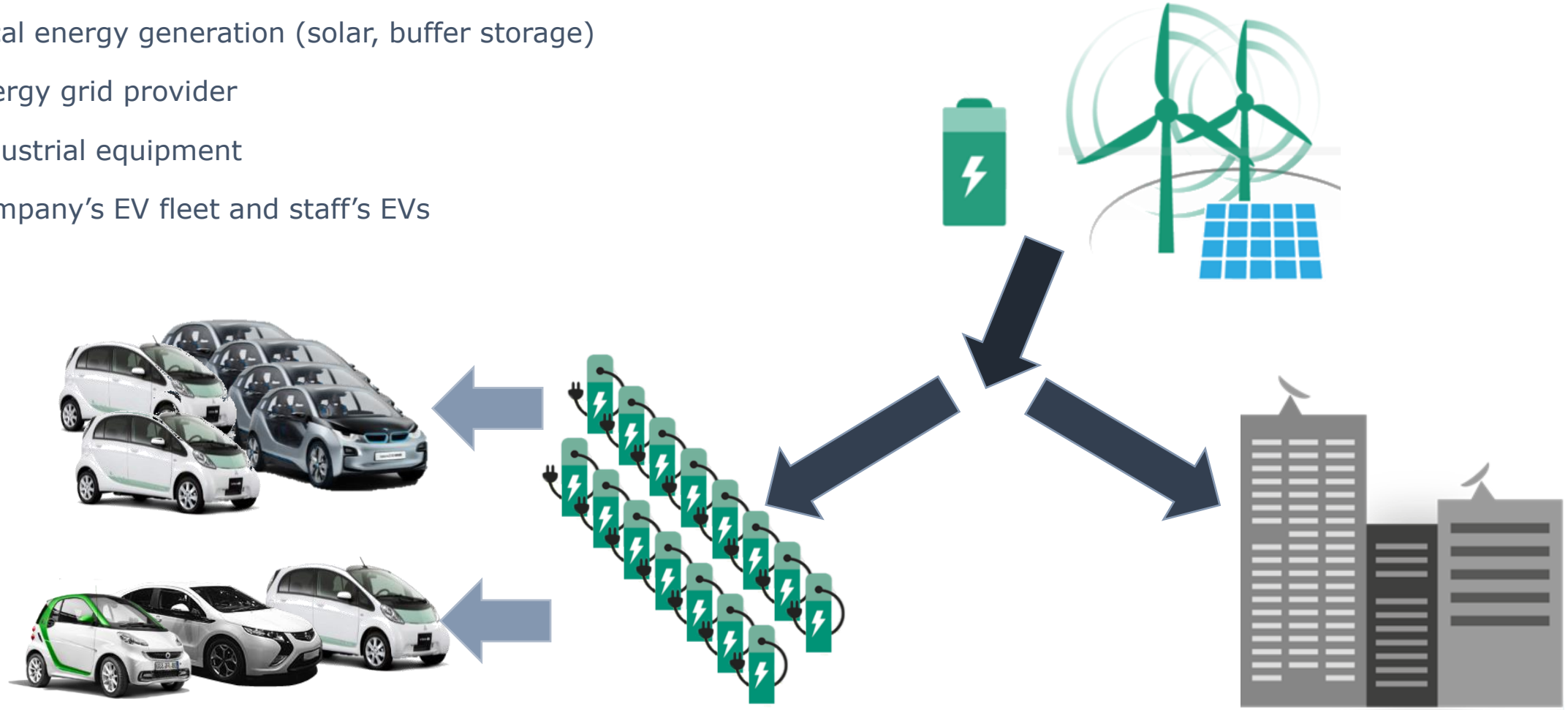


WP 200

Scenario description

Charging and load management at the industrial location

- Local energy generation (solar, buffer storage)
- Energy grid provider
- Industrial equipment
- Company’s EV fleet and staff’s EVs



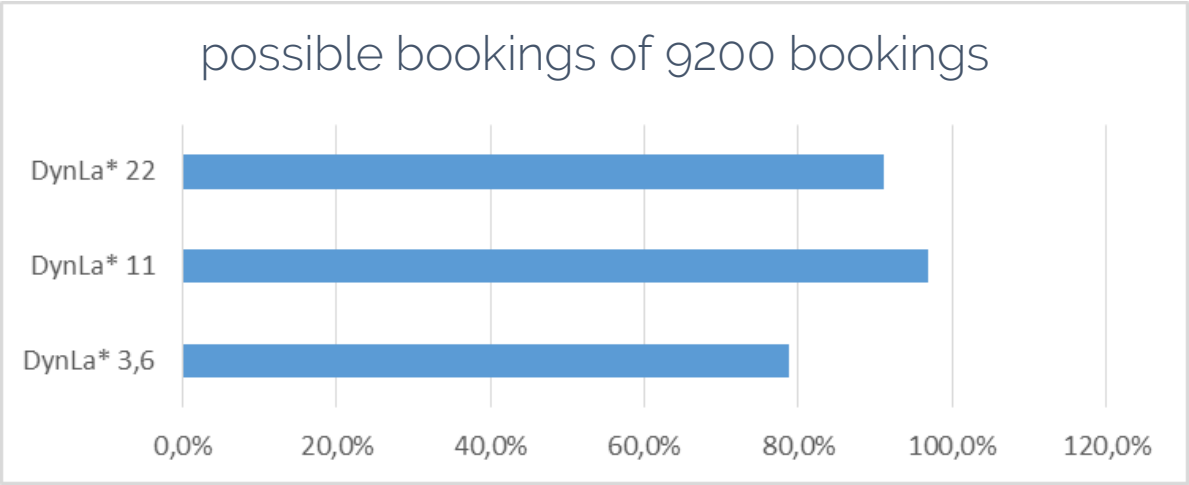
WP 200

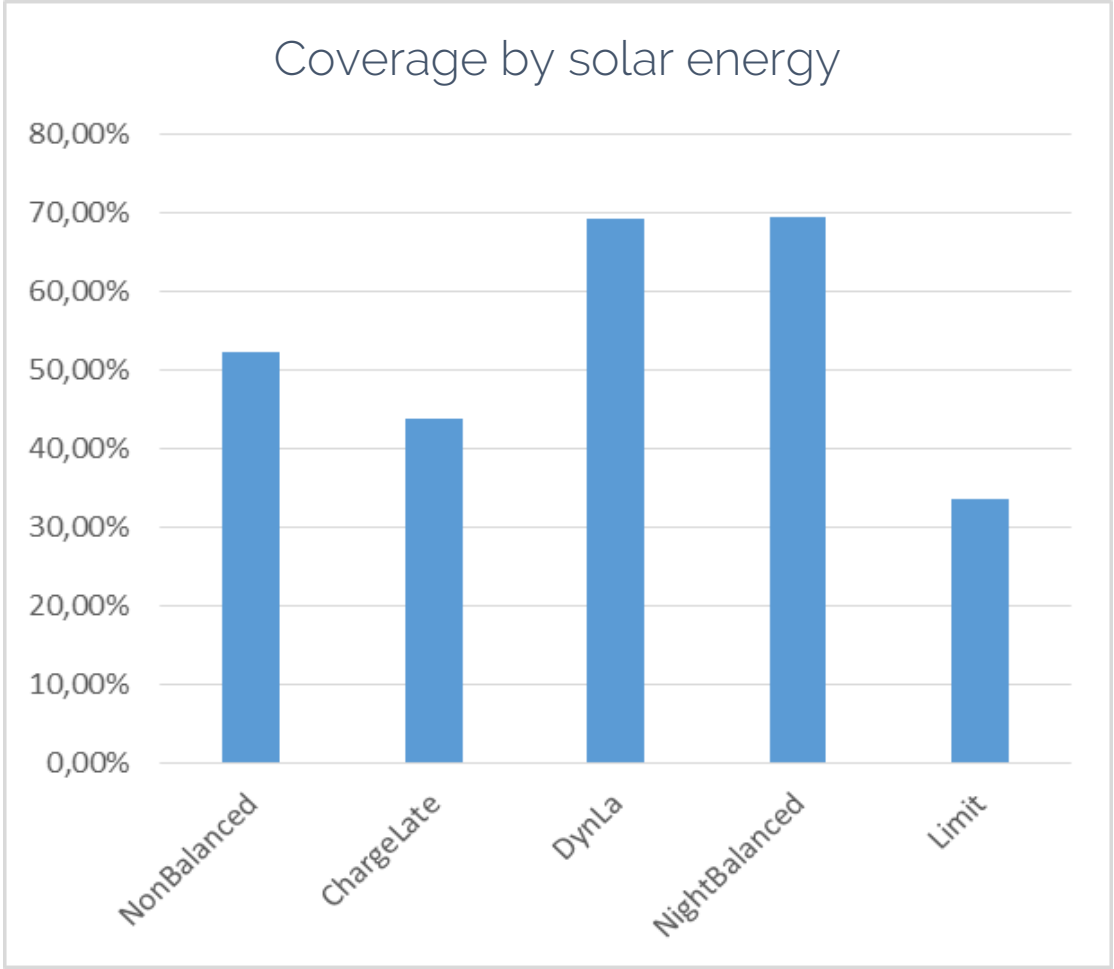
Goals of the algorithms

Algorithm	Provider-Limit	Photovoltaic generation	Buffer Storage	Load balancing	Peak shaving	Description
NonBalanced						Plug-in and immediate charging to SOC 100%
ChargeLate				■		Charging directly before departure (only as much as needed for the journey)
Limit	■					Preventing an overload / triggering of a fuse including the large consumer in the industrial compound
DynLa	■	■		■		Maximize the use of renewable energies
NightBalanced	■	■	■	■	■	Charge as much as possible via solar and night power, as well as charge-peak shaving

WP 200

Which algorithm performed best?





WP 300

Comparison of central and swarm bases charge management

Scenario

$N_{households}$	400	RE_{PV} / RE_{total}	50 %	SOC	03 kWh
N_{EV}	400	$RE_{total} / RE_{total, needed}$	100 %	$P_{i,max}$	3.6 kW
$N_{RE\ generation}$	100	SOC init	66 %	V_i	15 kWh / 100 km
With peak shaving (DQ_{limit} = 5, charging permission for lowest 7% of EVs					

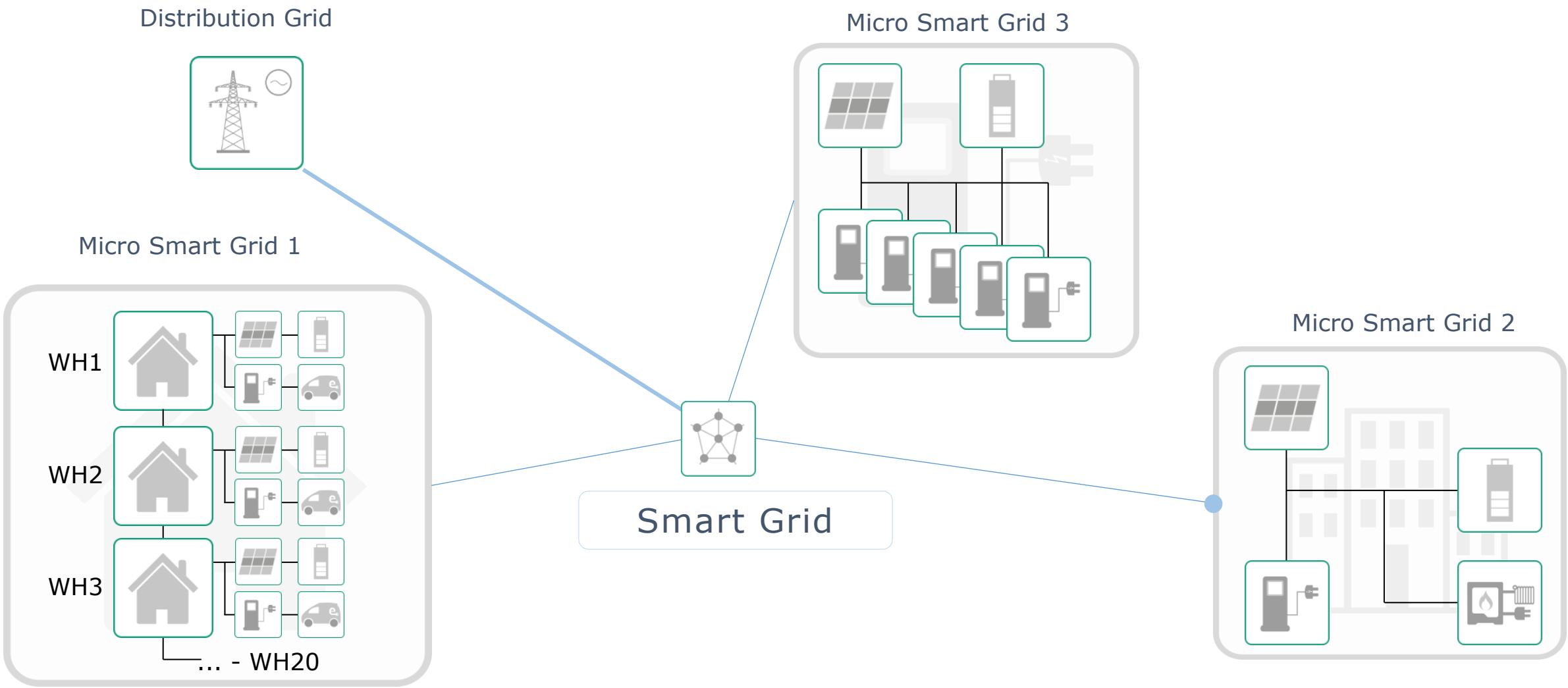
Quantitative comparison of swarm-based heuristics with central optimization

Method of coordination	% renewable energies	$Power_{consumption, max}$	Process Complexity	Solution quality
Uncoordinated	63,04 %	604 kW	0	78,50 %
Base procedure	**79,16 %**	**331 kW**	1005	**98,57 %**
Hierarchical Communication (AHK)	78,68 %	428 kW	116	97,97%
Disjoint Pools (ADP)	69,91 %	465 kW	**105**	87,05 %
Central optimization	69,53 %	512 kW	-	100 %

swarm-based heuristics

WP 300

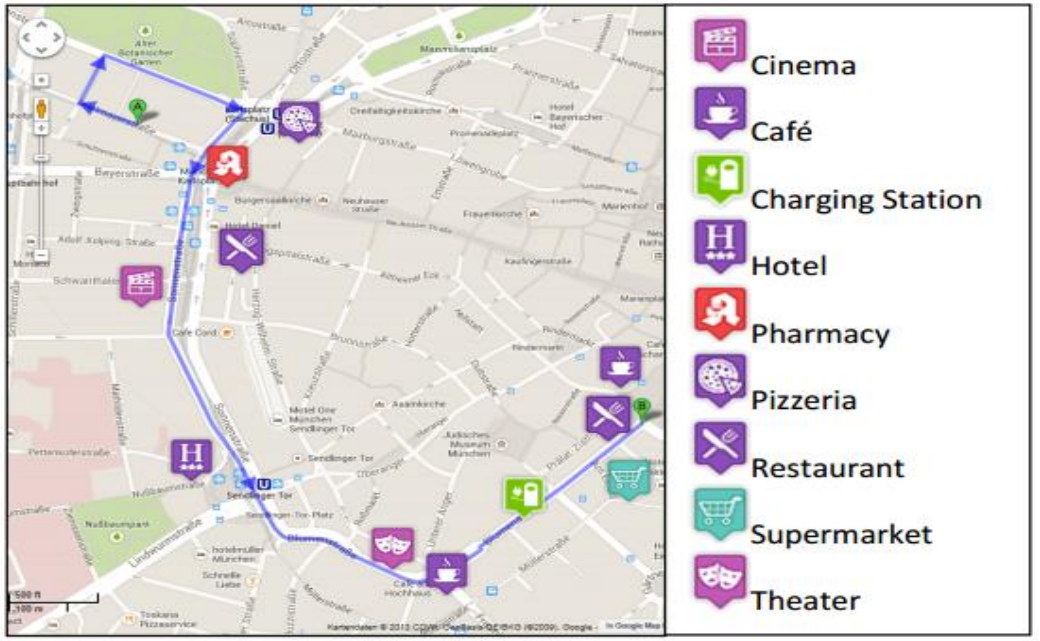
Networking neighbouring micro grids



WP 400

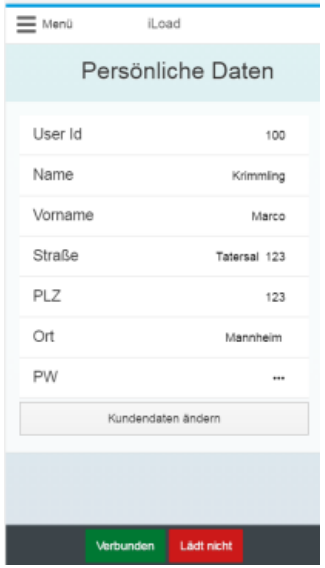
Scenario: In-Car Advertising

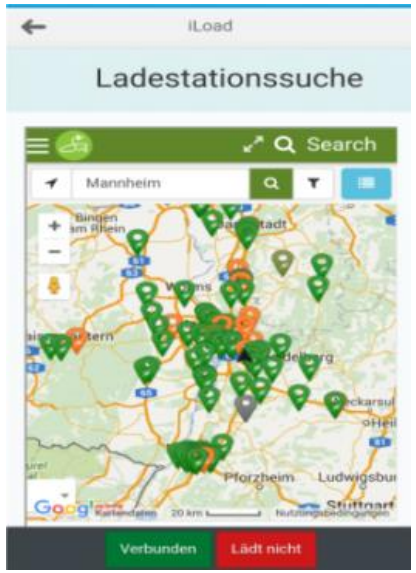
- Advertising in the vehicle by route
- Personalization via customer profile
- Display of restaurants or shops on the route
- Combination with discount vouchers

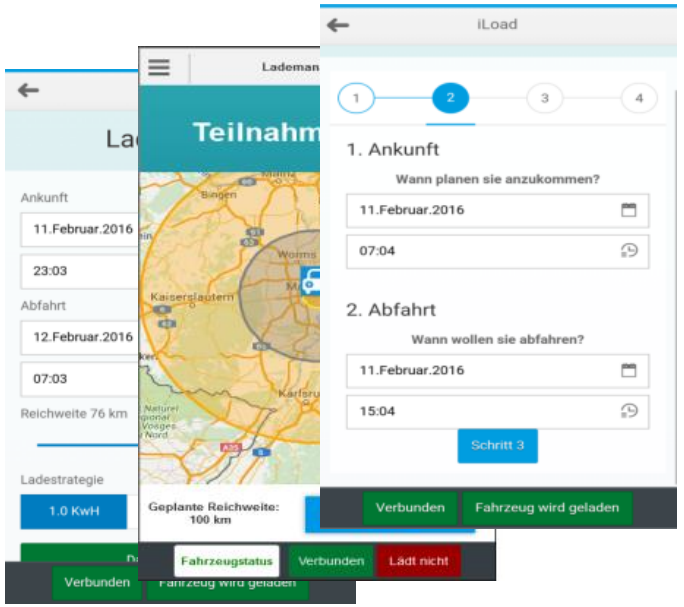


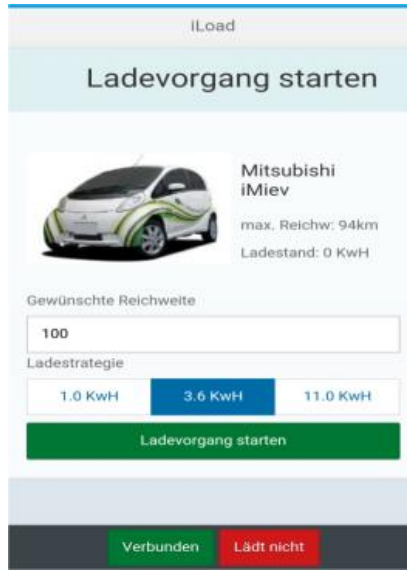
WP 500

Mobile application for capturing user preferences









Obtain customer data

Search for charging stations

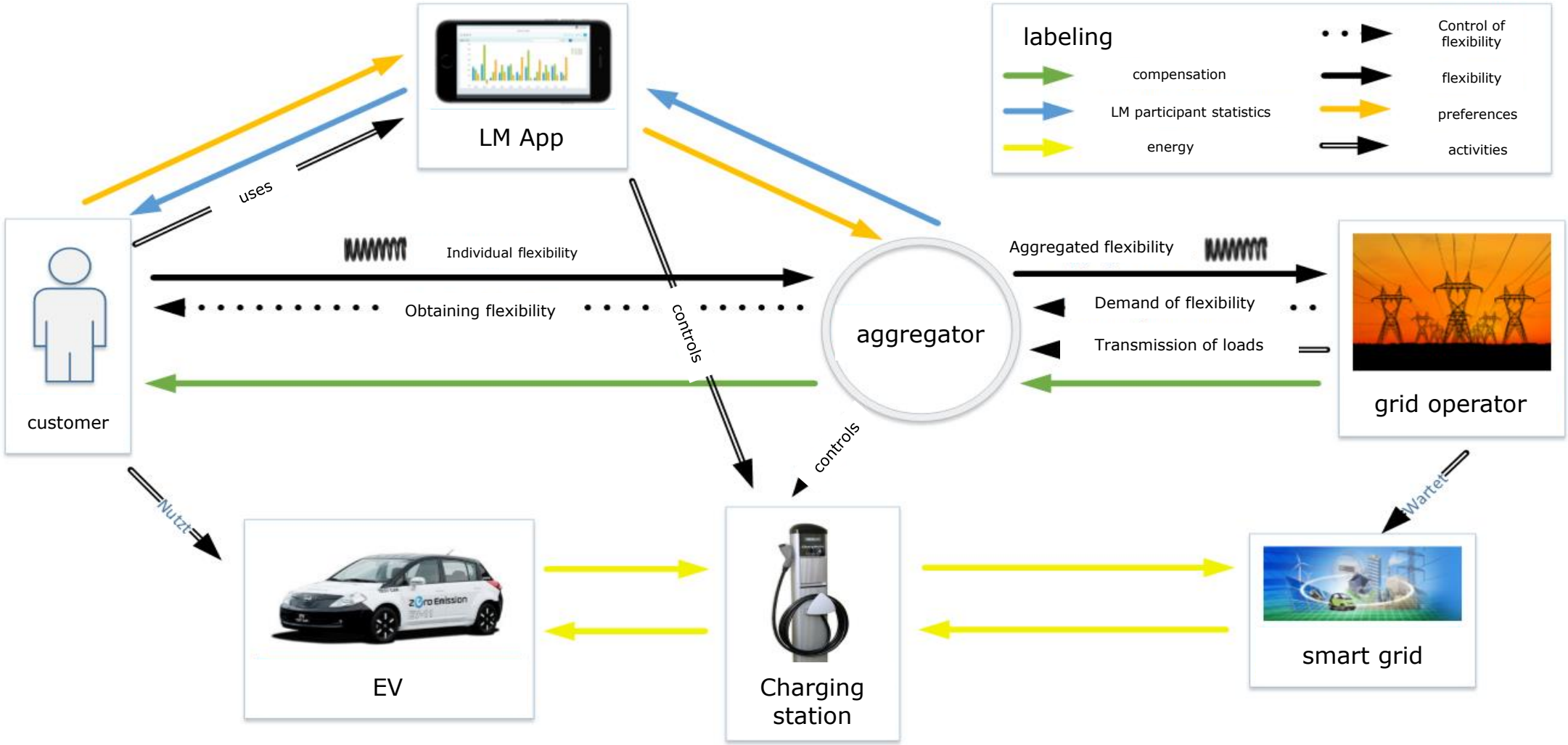
Capture user preferences (by form, interview or graphical)

Start charging (according to recommended charging strategy)

statistics

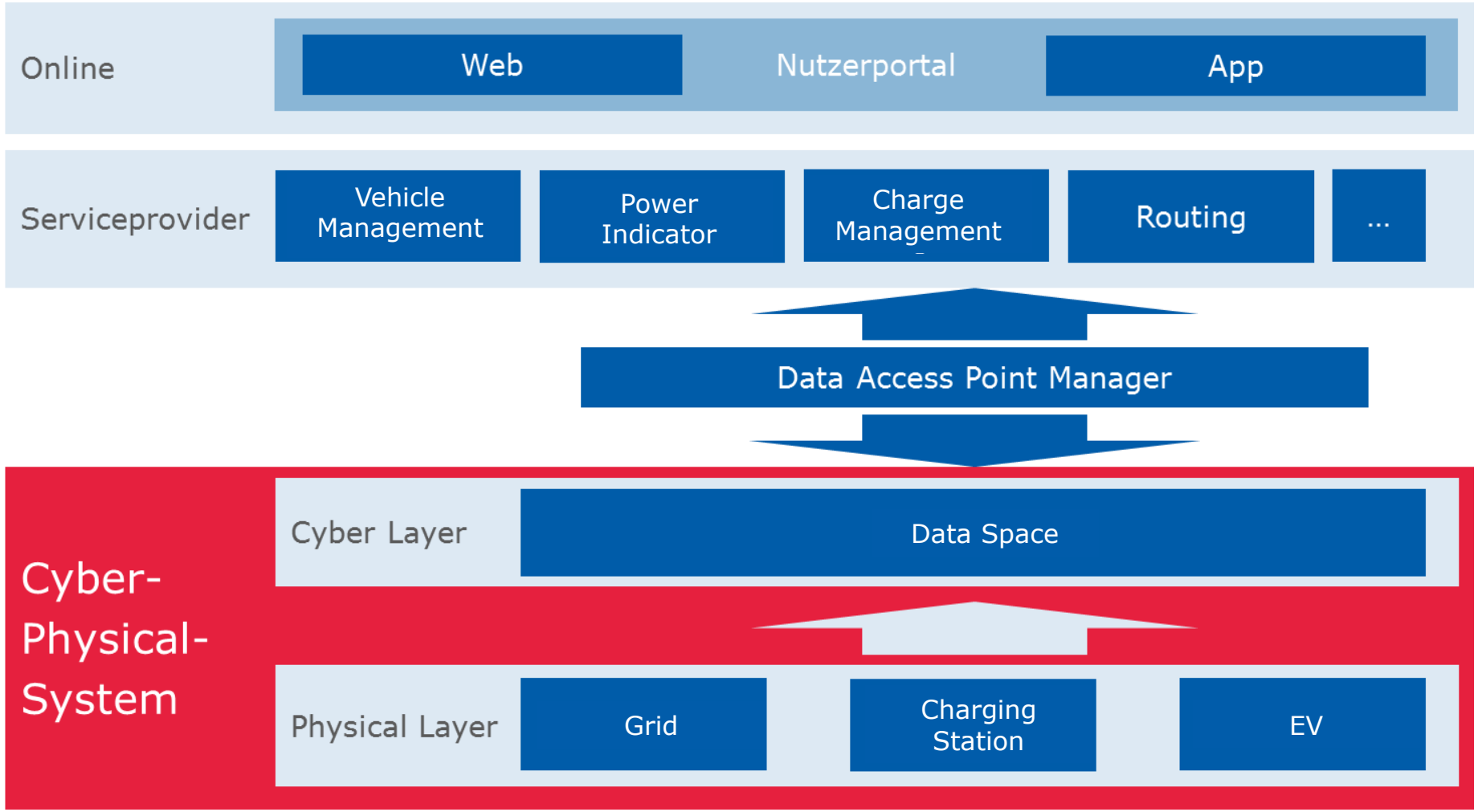
WP 500

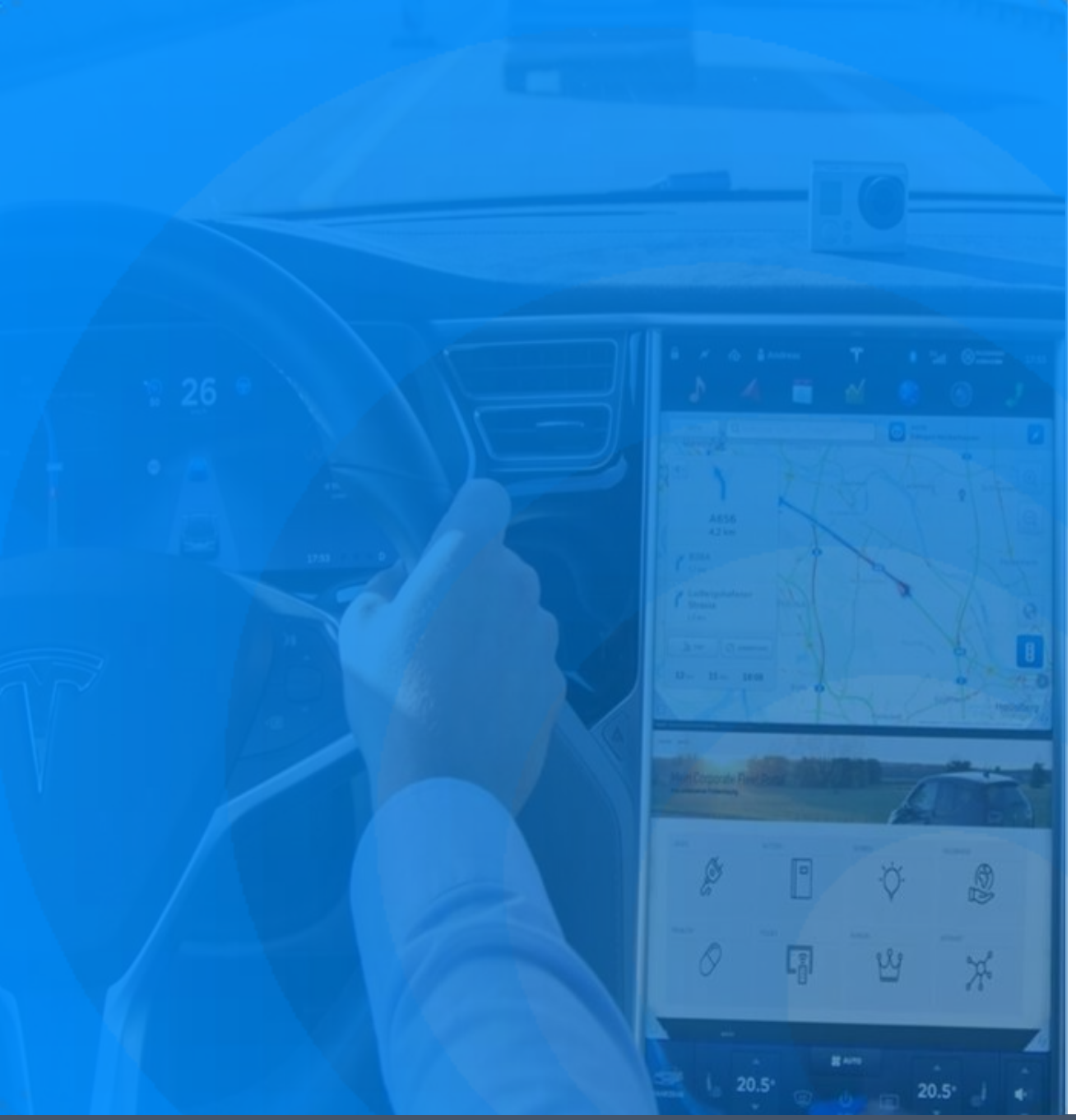
EV user flexibility process



WP 500

CPS architecture





Thank you for your attention!

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