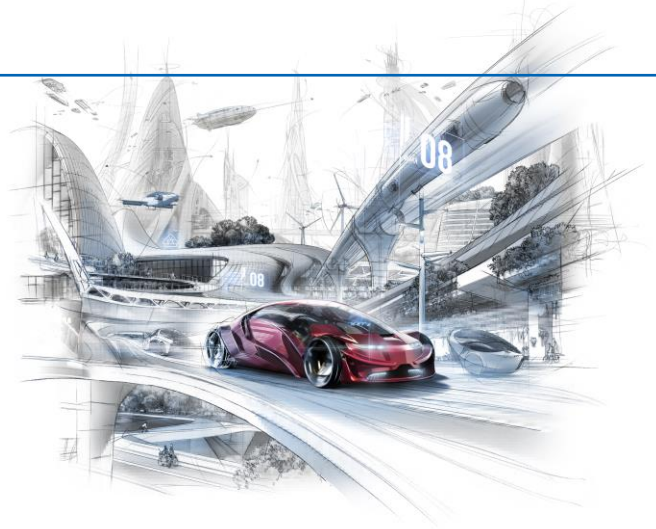
# VDE Fact Check



# Intermodal Mobility

These days, getting from A to B is no mystery. This task is only challenging when modern conditions are added: environmental friendliness, special requirements, speed, convenience. Therefore, determining the shortest travel route is no longer the only objective, but the optimum combination of means of transport must also be planned while taking the boundary conditions into account. New means of transport open new options, but also simultaneously increase the complexity with respect to organization. To ensure continuity and consistency, interoperable interfaces and concepts are needed, a clear case for standardization.


- **Ninmar Lahdo**
  Mobility Project Manager at DKE
  Tel. +49 69 6308-434
  ninmar.lahdo@vde.com
- **Artur Schmidt**
  Mobility Project Manager at DKE
  Tel.: +49 6308-354
  artur.schmidt@vde.com
- **Dr. Ralf Petri**
  Head of Mobility at VDE
- **Dr. Stefan Heusinger**
  Head of DKE Innovation
- **Nina Guckes**
  Project Manager New Technologies and Services at VDE
- **Hannah Pontzen**
  Mobility Working Student at DKE


## One route – many options

What does “route” mean in the mobility sector? In contrast to a “path”, a route refers to a person’s change in location which includes changing means of transport and places focus on the fulfillment of a specific purpose. Travel to and from a location are therefore always separate routes. Completing one or more changes in means of transport within a defined period is referred to as “multi-modality”; “intermodally” is a special form and refers to covering a route using various means of transport. To make this as smooth and efficient as possible, intermodal mobility also includes networking the various transport systems and cross-border interoperability. In addition to the constructed infrastructure, this also pertains to the networking of timetables and cross-transport system information.

There are various reasons for the fact that routes are increasingly traveled using a variety of means of transport: on the one hand, the lack of parking spaces, in cities, is increasing and, on the other hand, many stretches (segments) can be traveled more quickly using public transport (ÖPNV), on foot or by bicycle or e-bike. A very prominent and current example is electric scooters, now widely used for the “first” or “last mile”. In the future, additional alternatives can be expected, like air taxis and cable cars in urban areas. This increasing diversity of means of transport requires optimized, regulated transitions for each change, both technical (software) and “personal”, since each individual route includes personal preferences.

For instance, comprehensive apps could combine various means of transport and recommend the fastest and most convenient route taking personal preferences into account. To implement such a solution, interfaces between the individual (in the base case scenario, all) means of transport and mobile end devices must be standardized in a forward-thinking manner.

Another prerequisite is comprehensive, fast Internet and the willingness of the individual transport companies to provide data for a comprehensive mobility app. However, to date, there are no statutory regulations in Germany in the field of "open data". The Federal Ministry of Transport and Digital Infrastructure (BMVI) is currently reviewing legislative basis for the implementation of such apps.

## Mobility of the future

With respect to the future of mobility, various potential scenarios are in development, some more realistic than others. Among other things, guidelines1 for intelligent transport systems comprised of several providers are currently under development. A currently prominent scenario forecasts the complete autonomy of all vehicles. Interfaces must be defined and foreseeable potential in existing and planned systems must be considered. This autonomy requires, for instance, simplified connections to avoid complicated conductive filling or charging equipment. Designing these so they can be used by a wide variety of vehicles is a challenge.

Large hubs for maintenance, filling, charging, repair, etc., the development of which was observed when electrical scooters were introduced, could offer more comprehensive compatibility in the future. This would allow for a variety of autonomous vehicle models to utilize such hubs as needed. In fact, inductive charging offers several benefits here, even though the charging capacity is currently still comparatively low. Nonetheless, conductive systems are needed to, for instance, be able to automatically fill the number of fuel cell vehicles forecast by several studies. A certain parallelism with respect to the infrastructure is therefore unavoidable.

If autonomous means of transport do, in fact, assert themselves, they would constitute the fastest and most convenient option for traveling a route in the future, at least in densely populated cities. Such autonomy, with respect to new vehicle models and means of transport like drones, etc., requires a certain amount of intermodally. If, for instance, a transport drone has delivered all its packages, but its battery no longer has enough energy for the return journey due to the limited size, the drone must stop to charge in the interim. Why shouldn't it execute this (conductive or inductive) charging process on the roof of a moving bus whose route it knows, and which leads past the closest hub?

Or use the excess electricity of a local photovoltaic or wind energy system in a nearby resident's garden to charge? These considerations result in the next challenge in the field of intermodal mobility: uniform payment systems.

## Complex process – simple payment!

The objective is to make paying for all offers understandable and easy as possible for everyone. This requires, among other things, software that records all of the vehicles and kilometers traveled on a route or the respective usage period to avoid separate payment processes. In addition, incentives could be implemented that result in the user acting in the interest of the provider: if, for instance, a rented bicycle is to be parked at a specific location for better accessibility by other persons, discounts or free trips might be a suitable incentive.

Additional sectors would also have to be considered. If, for instance, the transport drone utilizes the excess electricity from residents, they would be entitled to compensation. To this end, the intelligent house would have to be capable of communicating with the drone and providing the necessary electricity and comparing the house's power requirements to determine whether storing the surplus in the home storage system might be more beneficial.

In the best-case scenario, all these calculations should be automated (if desired) without the user's intervention; the system then makes the most sensible decision based on the individual properties of the user or for our society, which, of course, results in many questions: in which cases is it justified to proceed at the user's expense in the event of an emergency? How can such emergencies be defined? To what extent to warranty claims change if private equipment is to be usable by public means of transport? Or will such equipment no longer be available for private purchase in the future and instead, will be public property?

[1] DIN CEN/TR 17401 "Intelligent Transport Systems - Urban ITS - Guidelines for Mixed Provider Environments"; in the area of urban intelligent transport systems, this document provides specifications for an operating concept that is intended for the integration and maintenance of a mixed user environment.

Questions that must be clarified bit-by-bit. However, they already demonstrate how important an interdisciplinary, cross-sector observation and design of all factors is to realize efficient, environmentally friendly, and networked mobility.

## Electricity or hydrogen? Both!

With a view to the future of mobility, questions continue to arise with respect to the preferred method of propulsion which span from electricity to hydrogen through to synthetic fuels. Here, vehicles purely powered by battery electricity are often compared to fuel cell vehicles. However, it is becoming increasingly clear that both technologies will compensate system-related disadvantages due to their respective benefits. Pure battery electric drives (according to the current state-of-the-art) are only limitedly suitable for heavy load transports due to the high battery weight, and they are also only a limited solution due to the limited range in comparison to fuel cell drives. Short distances, however, can be traveled significantly more efficiently with electricity or without the use of hydrogen or synthetic fuels.

Since fuel cell vehicles according to the current state-of-the-art always require a small battery, excess electricity from photovoltaic or wind power systems can be stored in the form of hydrogen and batteries can act as home storage units in their so-called "second like", various interfaces result that comprise several technologies or areas which include air and maritime traffic. Hydrogen is increasingly being tested as a means of propulsion in these areas (in the fluid aggregate state)

There are synergies with respect to the railway sector; here, hydrogen trains have already been comprehensively tested in real operation. The research on or optimization of battery technology is also in full swing, and due to the already mentioned need for a battery in fuel cell vehicles, progress is also an improvement for this type of propulsion.

All these interfaces, commonalities and potential must be recorded early on and approached in a manner that largely avoids parallel infrastructures. On the one hand, this simplifies the accessibility and use by all users and, on the other hand, valuable resources can be spared. The latter always must be considered to implement the transport revolution as quickly as possible. To realize environmentally friendly and networked mobility, standards and specifications are indispensable, which is why standardization goes together with sustainability.

## Competent committees

To optimize the entire infrastructure, comprehensive protocol and wireless standards, databases and filling or charging connections are essential. In this framework, after defining these interfaces, existing standards must be examined, and corresponding passages must be adapted or added. This requires a group of experts from a wide variety of segments to approach this task in an interdisciplinary manner and to take all aspects into account. DKE precisely brought these experts together in a workshop, worked with them to determine the challenges of intermodal mobility and established the “Mobility 1000” joint work group as a result; solving these challenges is the committee’s objective.

Since intermodal mobility is very comprehensive, there are many additional committees that contribute toward standardization. However, a superordinate committee is also required and has already been established by DIN and DKE as a joint committee; it deals with, among other things, aspects of intermodal and multimodal and cross-border traffic as well as operator interfaces. In addition to all the committees allocated to the mobility sector, it is also important to drive forward and support the integration, interoperability, and effectiveness of smart city systems with standards and specifications.

## Forecast

The first “building blocks” for our future mobility must be set with caution. A wide range of trends are currently emerging that are being pursued by many companies, start-ups cities, etc. To prevent complex, disorganized mobility, forward-thinking action must be taken to sensibly take these trends and promising technologies and innovations into account. Standards and specifications help achieve this.