Smart Mobility Usage Scenarios I

7

Stefanie Baumann and Michael Püschner

Abstract

Mobility is a basic human need. It promotes encounters between people and enables the exchange of goods. However, increasing mobility comes at the price of higher costs for people and the environment. Therefore, society requires new mobility solutions. Along with electric mobility, the connectivity and automation of transport will play an important role. In combination with autonomous shuttles and multi-modal transport services, alternative drivetrains will be changing our transport and conveyance systems. If the mobility transition succeeds, the classical boundaries between individual and public transport will dissolve in favor of new, innovative business models. This chapter attempts to structure the existing Smart Mobility appliances by means of a layer model for digital infrastructures. The wide range of examples testifies to the very advanced stage of some of the appliances.

Contents

S. Baumann (✉)
acatech, Berlin, Germany
e-mail: baumann@acatech.de

M. Püschner
VDA, Berlin, Germany
e-mail: pueschner@vda.de

B. Flügge (ed.), *Smart Mobility – Connecting Everyone*,
DOI 10.1007/978-3-658-15622-0_7

Mobility is a basic human need. It promotes encounters between people and facilitates the exchange of goods. In a highly interconnected world, with logistics networks spanning the globe, and travelling becoming easier by the day, mobility is a fundamental part of our economy and a critical success factor for a modern and competitive industrial society. In short: mobility creates prosperity.

Despite digital communication channels, the individual *demand for mobility* has increased dramatically. At the same time, owing to the exponential increase of online trade and the ensuing constant availability and "same day deliveries", the delivery sector is growing – both locally and globally. Neither efficiency improvements in logistics nor a lower global economic growth (e.g. due to lower growth rates in China, as is currently the case), will succeed in sustainably abating the traffic.

However, increasing mobility comes at the price of higher costs for people and the environment. Traffic growth engenders more congestion, accidents, and noise and has a higher environmental impact, for instance due to the sealing of large areas or to carbon emissions. Hence, our society requires new mobility concepts and solutions for a transport and conveyance system with the minimum of negative externalities. Another challenge will be to facilitate access to mobility in order to foster social participation. The issue of economic value creation will likewise have to be considered.

Along with electric mobility, the connectivity and automation of the transport sector will play an important role in the development of our mobility system. In combination with autonomous shuttles and multi-modal transport services, alternative drivetrains will act as drivers in the mobility transition, profoundly changing our present form of individual transport. This is accompanied by the development of new, innovative business models in the Smart Mobility sector.

From Smart Parking Solutions to Autonomous Public Transport Shuttles Smart Mobility implies the dissolution of the classical transport sectors: rail transport versus road traffic, passengers versus logistics. According to a target scenario for road traffic in 2030 drawn up by *acatech*, the National Academy of Science and Engineering [95], this strict separation will be a thing of the past. Rather, the system will center on the customer's wish to get from A to B – quickly, easily, cost-effectively, and sustainably. Mobility thus becomes a service and is less dependent on a specific mode of transport. The user will be conscious of only a fraction of the processes and interactions of the various players involved. Like with a smartphone, the applications in a "Smart Mobility World" will be running in the background.

Smart Mobility Requires Digital Platforms and Technical Infrastructure Based on technical infrastructure like the 5G technology (Smart Spaces), future vehicles and ideally other modes of transport (Smart Products) will be able to interconnect across different

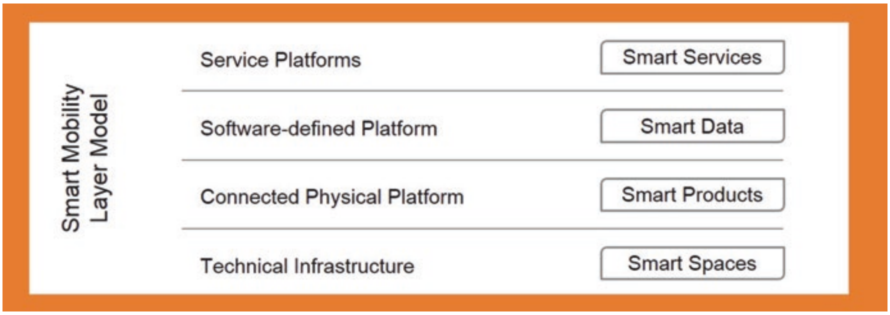

Fig. 7.1 Structural overview of the Smart Service World (with kind approval © acatech 2015)

manufacturers. The interconnected vehicles collect a variety of data that can be linked by means of intelligent algorithms, generating new information (Smart Data). This intelligent data is the basis for new services, combining, for example, digital applications for mobility options such as train, bus, rental bike, taxi, and car-sharing car. In 2015, an acatech working group headed by Henning Kagermann and Frank Riemensperger elaborated a structure for the Smart Service World, describing the different actors and their role within a digital ecosystem. The result for the mobility sector is outlined in Fig. 7.1.

The following applications and usage scenarios can be directly assigned to one of the layers of the mobility system shown in the above illustration of Smart Services, Smart Data, Smart Products, and Smart Spaces. Other usage scenarios illustrate the interaction between the users and Smart Mobility platforms. All scenarios have in common that they are centered on the user. New mobility solutions will only be successful if the user perceives an added value. This could consist, for instance, in time savings owing to optimized route planning or in a consistent, comfortable payment system for various modes of transport. In addition, the respective scenarios are complemented by examples that illustrate how much is possible even today.

7.1 Smart Services

7.1.1 Mobility Platforms for Route Optimization and Intermodal Ticketing in Transportation

The sharp separation between car, train, and bus constitutes an obstacle to a multi-modal transport and conveyance system. Mobility platforms are a first step in combining the hitherto physically separated transport modes. They indicate the optimal route and allow for intermodal ticket booking without determining one specific transport mode. If integrated into the navigation system of a vehicle, the mobility platform can not only propose an alternative traffic route in the event of an upcoming congestion, but can also suggest options for switching to a means of public conveyance such as the tube, the suburban railway, or a regional train.

If the driver opts for the switch, the vehicle will guide him to the next tube or train station, book the according ticket, and save it on the driver's smartphone or smart watch. In order to curtail the search for a parking space, the vehicle receives information as to free parking lots at the respective station and can immediately reserve a suitable parking space. Once the driver leaves his vehicle at the station, his smartphone or smart watch takes over for the rest of the trip, guiding him to the right platform by means of an indoor navigation system.

Examples for Mobility Platforms Even today, there is a substantial range of platforms that individually plot the best route from A to B. To this end, they combine public transport, car-sharing, taxis, rental bikes, and long-distance trains, sometimes even flights, providing the user with various route options to arrive at the desired destination. Most of these platforms serve purely informational purposes.

Mobility platforms like moovel [96] or Qixxit [97] go a step further: Via a personal account on these platforms and their applications, users can directly book and pay for car-sharing vehicles, taxis, or long-distance trains all over Germany. There is hence no need for a re-direction to the respective partner sites for the ticket booking. In Stuttgart, moovel has further succeeded in integrating the regional transport providers into the app. This enables customers to experience a seamless journey from planning to arrival.

7.1.2 Smart Parking Solutions

Automated parking services ("valet parking") in combination with intelligent parking guidance systems can significantly shorten the search for parking spaces and enhance the efficient use of available parking spaces. Particularly in metropolitan areas, this reduces the considerable traffic volume due to vehicles cruising for parking and facilitates the switch between different modes of transport.

Examples of Smart Solutions to Find and Book a Parking Lot In the research project City2.e 2.0 [98], Siemens joins forces with the Berlin Senate Department for Urban Development and the Environment, the VMZ Berlin (operator of urban mobility and traffic management for the city of Berlin), the Institute for Climate Protection, Energy and Mobility (IKEM), and the Robotics Innovation Center of the German Research Center for Artificial Intelligence (DFKI). On a section of 250 meters at Bundesallee (a main thoroughfare in the West of Berlin), the project demonstrates how the search of a free parking space in the street can in future be curtailed. Applications such as park pocket [99], parkenDD [100], or ParkMan [101] offer parking lot search and booking services, without requiring much technical equipment for the respective road sections. These applications are, however, limited to specific cases: Via Park Pocket, free parking lots can be found and booked in multi-story and underground car parks. ParkenDD currently offers this service for all public parking lots in Dresden, Ingolstadt, and Zurich. ParkMan, on the other hand, is based on a specific community duly reporting free parking spaces.

7.1.3 Automated Logistics

Smart Services allow for a fundamental restructuring of the "last mile" of the transport chains, the delivery to private and commercial customers. Automatically controlled transporters deliver their parcels to stationary deposit facilities or to mobile "deposits on wheels" that are either established in the city center or in respective residential areas or can be ordered. Automated vehicle control resolves many of our typical delivery problems. For instance, transport times are reduced, making a higher delivery frequency possible. Distribution hubs in the city centers allow for new business models, particularly in the food sector. For courier services, driverless vehicle fleets constitute a cost-efficient alternative for short-term small-distance deliveries. This opens new vistas for local service providers. Optimizing long-distance transport by means of driverless trucks constitutes an important pillar of these new business models. All in all, the entire transport chain gains in speed and efficiency.

Example for the Autonomous Last Mile The company Starship Technologies [11] offers a cost-effective delivery option for the last mile in the form of small automated vehicles, just big enough to hold two grocery bags. The customer can order the delivery via an application, determine an appropriate time slot for the delivery and track the position of the "delivery-bot". The app will also serve to open the bot's delivery box. Other companies are likewise experimenting with autonomous transport options for the last mile. Amazon, Walmart, and Deutsche Post (Germany's national post service) are considering drones.

7.1.4 New Flexibility in Public Transport

A mixture of car pool, taxi, and car-sharing, the automated public transport shuttle (PT-Shuttle) brings its passengers safely through the traffic. Depending on the specific purpose and on the local demand structure, the public transport shuttle has 2–10 seats. It can also be combined with logistical transport. Passengers use an app to order the desired shuttle option and board the shuttle at one of the many virtual stops marked on an online map. At these virtual stops, passengers can get on and off the shuttle without disrupting the surrounding traffic. The shuttle is able to automatically calculate an optimal route combination for different passengers and to predict the travel time in advance and with high accuracy.

Example of Digital Transport Services In the urban transport sector, we are currently confronted with several companies capable of assuming the role of game changer, i.e. of revolutionizing the rules of that entire market segment. These include taxi hailing, ride-sharing and ride-selling services such as Didi [102], Lyft [103], Flinc [104], or Wundercar [105]. Their respective transport services forward passengers to rental cars with driver, private drivers, or regular taxis. The platforms themselves do not own any vehicles, but can, even today, resort to an extensive pool of active drivers. The declared aim is to increase vehicle utilization and thus in particular contribute to reducing urban traffic. The dissolution of the traditional boundaries between individual and public transport has sparked off a broad public debate in Germany on the current Public Transport Act. Current developments indicate that several transport service providers such as Didi and Lyft are preparing to position themselves as providers of autonomous robot taxis – a goal that could indeed be realized in the foreseeable future.

7.2 Smart Data

Digital Maps Collect Real-Time Data to Generate New Information for Map Users The use of digital maps has become a matter of course for the majority of people who move by car, bicycle, or on foot. Once a critical mass is reached, the motion data which is thus collected helps to generate real-time traffic information. Thus, for instance, an alternative route can be proposed to the driver while on the road, helping him to avoid traffic jams. This saves time and reduces the environmental impact of congestions. The collected data are, on the one hand, spatial data, relating to geographical reference points and specific points in time. On the other hand, it is likewise possible to visualize data on leisure activities and cultural events, current weather and environmental data, or data on public facilities such as playgrounds or swimming pools. Here, open data, i.e. data that are freely available and freely usable, play an important role. A map-based mobility platform is centered on the harnessing of data: large amounts of unfiltered information are analyzed and pooled according to their possible use. The user of digital maps is only given the information relevant to him in the respective situation.

Examples of Application Fields of Digital Maps The map manufacturer HERE [106] is responsible for the equipment of a variety of vehicles with onboard navigation. The availability and analysis of data across the systems of different manufacturers improves the traffic information the user receives in real time. The intelligent routing system could, for example, suggest a re-schedule of the intended stop at the supermarket on the way home in order to avoid after-work traffic jams. Information like user preferences (based on past motion data) or the availability of charging stations can be considered in the route planning.

Smart localization services can also be used in order to realize social benefits. The company Aclima [107] has joined ranks with the US Environmental Protection Agency (EPA), several universities and Google to survey environmental data like, for instance, nitrogen and carbon pollution due to exhaust fumes and smog. In addition to the stationary measuring units provided by EPA, the sensor data of vehicles is collected on a platform. Thus, air pollution can be recorded over a day at different city locations. On this basis, solutions for the reduction of pollution can be found, such as mitigating congestion or introducing a speed limit on certain road sections. Alternatively, the smart navigation software can adapt the route so as to reduce the additional pollutant emissions to a minimum.

7.3 Smart Products

Communication Between Vehicles, Traffic Light Systems, and Public Transport Even today, field trials are experimenting with interconnecting vehicles, traffic lights, and local data centers. Objects are thus becoming smart. A prerequisite for the Internet of Things is the digital connectivity of products and objects. In other words, sensors collect such physical data from the surroundings as are available in real time – locally and globally. Vehicles, traffic lights, or lanterns serve as interconnected physical platforms. The collected data are exchanged via cloud-based platforms or directly with according objects or road users. Both the efficiency and the safety of traffic and transport can thus be significantly increased.

Optimizing the Traffic Flow – The Example of "Phased Traffic Lights" Owing to intelligent traffic lights ("smartPORT Traffic Light") [46], people and goods are transported more efficiently through the harbor area. The ever increasing port traffic is optimized by means of a phased traffic lights effect. In order to enable communication between traffic lights and trucks, the Hamburg harbor has launched a pilot project which equips trucks with RFID chips. The traffic lights will accordingly register an approaching truck. They then can switch to green earlier or, as the case may be, prolong the green phase to enable the truck to pass without stopping.

7.4 Smart Spaces

Technical Infrastructure as the Basis for Smart Mobility In order to ensure an effective interaction between the different transport modes and technologies, a basic technical infrastructure is required that will enable communication between users, vehicles, digital platforms, and infrastructure elements. In order to obtain a level of connectivity sufficient to meet the requirements of the traffic and transport structures, different information and communication technologies will have to be used. An extensive broadband infrastructure is necessary for real-time transmissions; the same applies to converged networks, i.e. fixed and mobile networks with a uniform standard (All-IP networks). In the future, not only will vehicles communicate with road users, but also the lighting systems or street signs, for instance to optimize the flow of traffic or to transmit information to the autonomous vehicle. 5G [85] is exemplary in the development of existing technologies towards innovative services in the mobility sector.

Example of an Intelligent Transport System Based on 5G The interlinking of transport modes and infrastructure elements is an essential prerequisite for the realization of a future transport system in which autonomous vehicles identify the best route or electric cars the next charging station. An Intelligent Transport System (ITS) therefore implies data communication via the mobile phone network. The fifth generation (5G) will be more than a mere evolution of the 4G data exchange system (LTE and LTE-A) as it will also take critical requirements of the mobility sector into account. These include lower latencies, reliability, and availability, as well as energy-saving communication protocols. The 5G networks will enable direct communication – vehicle to vehicle as well as between vehicles and other devices. In mobile applications, this is so far only possible to a limited extent.

7.5 New Concepts and Roles

The applications described above offer just a glimpse of the development potential in the field of Smart Mobility. Some applications are still at an early stage of development while others are already swiftly evolving; still others have already become part of people's everyday lives. The decisive prerequisite for the realization of Smart Mobility services is a *digital ecosystem*.