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## **The Role of IT in Future Mobility**

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### **Executive Summary**

We have goods manufactured wherever it is cheapest, we purchase strawberries in winter and order online. This age of mobility contributes to our traffic systems being overloaded [1]. However, digitalization, shared economy and autonomous driving will lead to new business models and revenue streams [10]. Associated industries from automotive to insurance and many others will however require help handling data and providing secure networks [12]. This paper will look into the role IT can play in their future mobility. Forms of partnership with varying levels of involvement will be described and compared to the business scenarios companies have already established.

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## 2 Digitalization and the Mobility Sector

Industry 4.0 and the digital platforms as well as the wide spread usage of smartphones have led to new mobility solutions [8]. However, this is only the beginning. Alternative propulsion systems, driverless and connected cars along with the shared economy will drive this change and give birth to new business models and revenue profiles [9]. Hence, the automobile industry is set to change as is the mobility ecosystem around it, affecting industries such as energy, telecommunication, public sector and logistics [8] as outlined in the table below. Big data and interconnectivity will be the core of future mobility scenarios [1] that will evolve around intelligent traffic management, on-demand public transport and sharing concepts and e-mobility [9].

Table 1: Cross Industry engagement in future mobility

<b>Industry</b>	<b>Example for engagement</b>
OEMs	Car and Ride-sharing, autonomous driving, electric vehicles
OESs	Sensors
Energy suppliers	Charging infrastructure
Telecommunication	Reserved parking
Logistics	Optimized fleet efficiency, secure driver break times, efficiency in inbound and outbound logistics
Public transportation	Online ticketing, sharing services to cover the last mile, multimodality
Cities / municipalities	Smart traffic systems, diesel ban, road fees
All	Operation of shuttle, rental of parking spaces (external), ride-sharing

The Acatech study “Neue Automobilität” (new auto-mobility, published in 2016) describes automated traffic of the future as a mix of different levels of automatization in which the interaction between all kinds of vehicles as well as non-motorized participants plays a key role. Future scenarios (Fig 2, Fig 3) will provide more flexibility in public transport through on-demand and ride-sharing services. Travel time will be reduced substantially, for instance by intelligent traffic management and valet parking, or be turned into time to work, sleep and consume. Supply chains will be enhanced by extension of home-delivery [9].

In the following, four exemplary scenarios describing the possibilities of future, connected mobility shall be highlighted:



Fig 2, Fig 3: Concept idea: future mobility scenarios in cities 2020 [9]

Scenario 1B - Internet of Things: A boy steps on the road behind an obstacle. He is in danger of being hit by an oncoming car. The sensors of a car from the other direction, however, have registered the boy and communicate the situation to the other car. The automatic breaking mechanism of this car is activated.

Scenario 2D/2E - E-Mobility and autonomous driving: A commuter takes her electronic vehicle to work. The “Städtische Verkehrsleitreechner” (municipal traffic master computer / data center) analyzes car data from all vehicles and optimizes the traffic flow (e.g. with traffic lights). The car coordinates the speed per the data it receives. At the underground car park of the office, the driver activates valet car parking. The car autonomously drives to its reserved spot with e-charging.

Scenario 3B - Public transport on demand and autonomous driving: A passenger uses a route planner to get to the city: based on his destination and maximal fare the route planner checks several options and then books the cheapest: the autonomous public shuttle.

Scenario 4D - Car Sharing and autonomous driving: A shipping service with autonomous vehicles uses an intelligent route planner for its daily business: they deliver goods and/ or transport people on optimized routes. At night, the service also uses public transport shuttles for the deliverances. It is also possible to use private vehicles for the courier service.

All scenarios prove that with digitalization and the Internet of Things, the traffic and mobility in cities in the future will become more environmentally friendly, more economical, less time consuming and safer for all participants. With individual and multimodal transport options, digitalization in the mobility sector can increase the quality of life and social participation.

With these emerging possibilities, new business models and requirements for this new mobility environment emerge: OEMs are becoming mobility providers, public transport will integrate door-to-door options [10] and the boundaries between transportation of people and transportation of goods will diminish. The study concluded that hardware in the vehicles should be standardized, while software, providing maintenance and additional services, gains impact and changes the “aftermarket”. Value-adding networks and platforms will replace the current relationship between manufacturer and supplier [9].

### 3 Vehicle Data will be Key in Future Mobility Scenarios

In all of the scenarios described above, moving assets will provide insights and these insights will lead to optimization, increased efficiency and also enable new scenarios. Vehicle data will hence be the central theme. It will be used in driver and passenger interactions, in exchanges with service and mobility providers, authorities, infrastructure and OEM service providers amongst others as described in figure 2 [1].

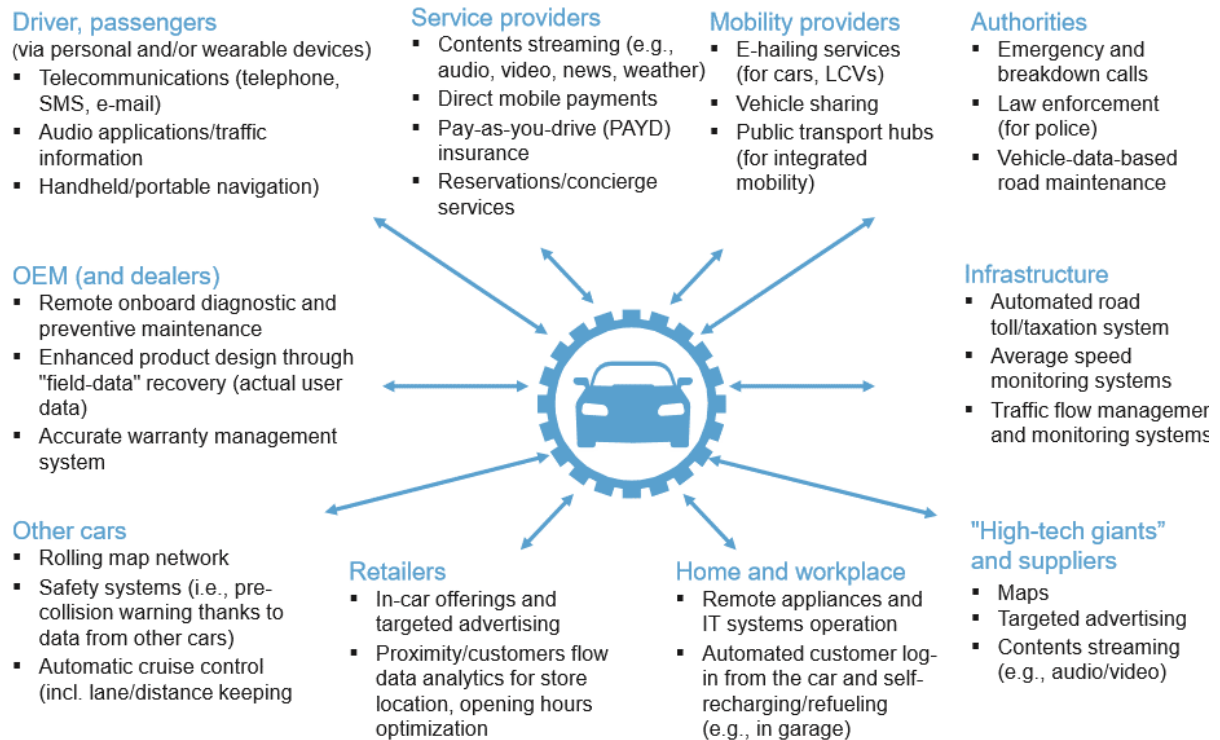


Fig 2: Future actors along the car data value chain [1]

The German Association of the Automobile Industry (VDA) identified data security as a key topic and suggests a two-tier concept for the transfer of vehicle data, i.e

1. The OEM acts as system administrator and is responsible for the safe transfer of data from the vehicle to a standardized B2B OEM Interface maintained by the OEM.
2. Third parties can access this vehicle data via this B2B OEM Interface or neutral servers based on specified B2B agreements; further services provided by these or other parties can only be offered downstream after these neutral servers.

Further measures that need to be considered for holistic security of all the involved stakeholders in mobility include to provide no direct third party access to vehicle data and equal access to all involved B2B partners, no monopoly of data for one or several OEMs [11].

For this to be realized, strong regulations based on different categorizations of data need to be implemented. The German Association of the Automobile Industry (VDA) identified the following layers:

- Data used for the improvement of road safety: An anonymized data set, like the activation of a car's hazard lights, is transferred e.g. to public traffic control centers
- Cross brand services: An anonymized data set which is provided by several OEMs is given to third parties, e.g. temperature of the car's surroundings, traffic.

- A) Brand specific services: An OEM specific, anonymized data set is used by the OEM or by partners of the OEM.
- B) Component analysis, product optimization: A differentiated, component specific data set is given exclusively to the supplier of the component for product optimization.
- Personal data: A specific data set by which the car or customer can be identified is given only to those parties the customer agreed to in exchange for specific services [11].

As data becomes more important, so does customer trust. Companies need to ensure that their handling and storage of data is top notch if they want to win over (OEM) partners and end users. As for the expansion and growth of the industry, security will be a key part of enabling new features and services to be further innovated [1]. Relying on in-house resources alone is therefore not the answer moving towards new mobility business models [12] as handling big data and interconnectivity has not been an essential part of their business model in the past.

High-tech giants can provide the necessary experience in handling huge amounts of data securely and through established communication tunnels. OEMs have already started cooperation with large IT companies: Toyota working with Microsoft, BMW with Intel [13]. Other industries have not yet established comprehensive strategies to look into the digitalization of mobility.

### 3.1 Types of Partnerships

In general, four options for those natural and imminent partnerships with IT companies exist with varying amounts of interaction and interweavement from mere provision of storage or delivery of solution elements to investment of manpower and other resources as describes in table 2.

Table 2: Modes of cooperation

	<b>Legal corporation form</b>	<b>Financial corporation form</b>	<b>Value contribution</b>
<b>Technology supplier</b>	Delivery and service contract	e.g. licenses are paid for using product components	IT company delivers solution elements Integration performed by business partner
<b>Technology partner (Co-Innovation)</b>	Delivery and service contract (optimized conditions)	e.g. license and revenue share	Integration performed by IT company
<b>Co-Business owner</b>	New company founded and ownership distributed (Joint Venture or Carve Out)	e.g. percentage of profit	Manpower and adaptation with better licensing conditions Potential financial investment
<b>Venture investor</b>		Shared via percentage of ownership	Financial investment

### 3.2 Current Role of IT in Approaches to Future Mobility

While OEMs identified, and started to tackle the challenge regarding secure handling and storage of data by building alliances with IT companies (see chapter 3 Vehicle Data will be Key in Future Mobility Scenarios), the big players in the automobile industry also tend to position themselves as co-business owners or venture investors by founding new companies to explore new business models around mobility such as Daimler with Moovel, Jaguar Land Rover with InMotion and Volkswagen with Moia.

Venture investments are the major strategic move of these newly established organizations to have an edge in Industry 4.0 Big Data Analytics [8]. They are also acquiring unique startups as to create the most innovative smart mobility brand. Moia for instance acquired the Finnish software startup Split Finland Oy to support the development of pooling algorithms with the goal to build an automated shuttle service in big cities and they need software that automatically analyzes the requests of the passengers and calculates the optimal route based on that [14]. Jaguar Land Rover's InMotion Ventures invests into Lyft to develop and test its mobility services [15] Ford currently tests several mobility services and evaluates their business models. One of the services could be on-demand ride hailing with autonomous vehicles in the form of joint ventures or alliances with existing platforms like Uber, Didi or Lyft [16].

In addition to collaboration with IT companies, founding joint ventures or care outs and the acquisition of startups, new research and innovations centers are being set up across the globe by different stakeholders in the automotive industry. The Toyota Research Institute focuses on blockchain technology to securely share driving and autonomous vehicle data, manage ride and car share transactions and store vehicle usage information [17] to make new business models. This is successfully realized through IT with the help of data scientists, identifying these new use cases. In Israel for instance, there is a huge startup wave on automation software development with novel initiatives that focus on electric mobility [18].

Outside of the automotive industry, there are few examples of the corporation between industries and high-tech companies let alone startups with regards to new mobility scenarios. However, SAP announced to invest €2 Billion Euros till 2020 to make sense of Big Data and capture the best of innovations in future mobility. With its new industry 4.0 packages for better business strategies and customer successes, SAP is focusing on the realization of new solutions through an explore, prototype and implement methodology to enable customers across all industries to realize the potential of digitalization of their moving assets [19]. The company has supported several successful projects as technology provider or co-innovation partner that enabled its customers to become more effective and sustainable.

Trenitalia, an Italian company handling passenger transport and logistics of more than 8.000 trains daily sought a way to prevent failures and maintenance downtime while optimizing equipment lifecycles through analyzing sensor and equipment data [20]

The city of Barcelona has launched a smart city app that connects people, sights and enterprises providing personalized information to the user [21].

Bosch has come up with a secure parking app for truck drivers that assists them in finding free parking spaces and drivers can even book parking spaces [22].

There are also other high-tech giants, that have moved into this direction, such as AT&T building smart city initiative with the Miami Dade region to improve traffic flow and lighting [23]. Cisco amongst others, provides solutions for smart and connected communities as well as a connected rail to improve train routing and customer service and connected [24].

## Conclusion

Future mobility scenarios are heavily developing around e-mobility, intelligent traffic management, autonomous driving and the sharing economy. Data storage, analysis and smart end user applications will play a central role in these future scenarios and IT will provide the backbone to store, handle and analyze the huge amount of data involved in such scenarios. However, the industries now looking into future mobility have usually not been handling such delicate data issues in the past and partnering with IT companies is therefore a logical consequence.

Whereas the automotive industry has already set up clear strategies by collaborating with IT companies, engaging or acquiring start-ups and extending their own research to establish new mobility business models, players in the other industries have not yet pursued such activities on a large scale and rather focused on applying the interconnectivity of things to their internal processes to improve efficiency.

Smart mobility connections need to be robust and resist external influences to create a safe environment; agile and adaptive systems are needed to make this possible as well as new reliable regulations and legislation [9]. Moving forward and leveraging the potential of the digitalization of the mobility sector, it is therefore essential to act now and establish partnerships not only with experts in IT but also in academia, governments, research institutes and associated businesses to create a more concrete 360 degrees view on mobility innovations [8].

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