DATA-DRIVEN BUSINESS MODELS IN CONNECTED CARS, MOBILITY SERVICES & BEYOND

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Executive Summary

Seven in ten of the world's most valuable brands are digital platforms with data-driven business models. While this new phenomenon is transforming the global economy, there is currently little academic research on the subject. To contribute to this nascent field, this study develops a definition of data-driven business models and suggest a first business taxonomy.

Interestingly, the world-leading internet platform players are currently all pushing into the automotive and mobility area rendering it a key battle ground for new data-driven business models in the dawning Internet of Things era. While tech players are investing billions in respective offerings (keyword: autonomous driving, connected mobility), OEMs are under pressure to develop their own data-driven value propositions. This race for the customer interface and successful data-monetization models makes automotive the perfect object of investigation.

The goal of this report is to examine the state of data-driven business models within the automotive industry and to provide an overview of future trends. To quantify the data opportunity for automotive, a forecast of the growth trajectory until 2050 is derived – based on a framework with three distinct business models including subsequent service domains and use cases.

The findings of this study suggest that OEMs are already active players in an increasingly data-driven environment. To become complete digital protagonists, they need to leverage digital ecosystems and enforce cooperation. Furthermore, OEMs must learn how to capitalize on their strong brand reputation within the digital service domain. The assessment also reveals important clues for strategic positioning: car makers should not seek to copy Uber or Google. On contrary. They possess a capability typical internet companies are now seeking to acquire: hardware manufacturing. In the cyber-physical world of the Internet of Things, *physical strikes back*. Whoever controls the complete chain – hardware, data, insights and digital services – can deliver the most superior brand experience.

Still, OEMs are currently overly product centric; to fully influence data-driven business opportunities, they need to open their activities beyond the car. Successful data-driven companies do not keep themselves restricted to only one area of activity; rather they know how to build a comprehensive ecosystem encompassing virtually all areas of life.

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1 Context and Scope

1.1 Defining data-driven business models

Data-related business models are entering the CEO agenda. Fueled by an unprecedented availability of data, business strategies are increasingly grounded on analytics. In the light of an accelerating *big data explosion*, this development is about to reach the next level: data do not only *enable* strategies, they become the strategy (Redman, 2015; Schrage, 2016). In other words: a growing number of organizations uses data not only to improve existing processes and functions, but to enable entirely new business models.

A business model defines the product a company provides and the way it interacts with customers and suppliers (Ovans, 2015). It relies on few key founding pillars: A superior value proposition, a profit formula that outlines how to convert value into revenue and the key resources and processes to deliver the proposition (Johnson, Christensen, & Kagermann, 2008). These key resources are among others brand, people, technology, partnerships and data. *Data as a key resource* for a firm's value proposition – and thus for its business model – is a very new field of research.

Of course, data can contribute in separate ways to a value proposition. Essentially, there are two main directions: data can *add value to a key resource* or they can *form the key resource* itself. Organizations doing the latter – i.e. using data *as their primary key resource* – are often startup companies without existing processes. They start from scratch and put data in the center of their strategy. This is easier for startups as they do not have the legacy or "organizational debt" (Dignan, 2016) of established companies – a situation often referred to as the "innovators dilemma" (Christensen, 2013). However, existing companies, not uncommonly large corporations, experiment with *data as a key resource* as well – an emerging field of activity and the core area of interest for this study.

If large corporations pivot to data-driven value propositions and smart services, with self-learning, prediction, personalization, language processing for example, they need to break up existing silos to fully leverage data towards the customer (Kagermann & Riemensperger, 2015). This would demand a different organizational approach. Data experts like Andrew Ng, former Chief Scientist of Baidu and Google, recommend such corporations to hire a Chief AI Officer into their C-Suite to adequately represent data matters within the board and within corporate strategy. The idea is: if data contribute to the core value proposition, they cannot be treated on a divisional level (Ng, 2016). A sector perspective on data might be sufficient, if data are used to automate existing processes and improve productivity – which will probably be true for the majority of businesses (Hammond, 2017). In cases of a data-driven Business Model transformation, data matters need representation at the board-level to avoid the traps and pitfalls of the *innovators dilemma*.

Besides organizational considerations, business transformation requires a clear strategic roadmap. Strategy entails a distinctive concept that can be put into operation. Here is a notable gap, astoundingly, data-driven business models are not well researched. Namely, there is no canonic or elaborated definition in place. The only common ground

seems to be the notion that data-driven business models leverage data as a *key resource* (Hartmann, Zaki, Feldmann, & Neely, 2014). This bears an important reference to resource theory, but has limited explanatory value (Barney, 1991; Barney, 2001; Lockett, Thompson, & Morgenstern, 2009). It is unclear how data function as a business resource and what their properties are compared to other resources. The typical requirements towards a resource – to be valuable, rare, imperfectly imitable and non-substitutable are not equally relevant for data in all cases, for instance if open and crowd-sourced information is concerned. *S*cholars, analysts and strategists only recently begun to question what this evolving market will look like and how to classify the emerging business models (Hartmann, Zaki, Feldmann, & Neely, 2014). Additionally, it will be important for organization to understand what kind of *dynamic capabilities* are needed to build and sustain data expertise within rapidly changing business conditions (Teece, Pisano, & Shuen, 1997).

This study aims to contribute to the data-driven strategy agenda by evaluating data-driven business models based on the example of a data-intensive lead industry. The starting point is the basic classification that refers to data as a key resource which is further developed by applying additional defining characteristics.

Data are valuable if they are used to apply a novel dimension to a prevailing business practice or enable new business types *sui generis*. The value dimensions can be summarized as *product or service* (what is offered?), *business processes* (how is it offered?) and *business model* (how is it monetized?). Business transformation usually entails all dimensions, yet they can also be addressed independently. An illustration could be the online-entertainment company Netflix – beginning as a DVD rental company distributing DVDs by postal shipping and without an overdraft fee (Process Innovation). Later they introduced a subscription model with a flat rate (Business Model Innovation). Years later, with maturing technology, they moved into video on demand and streaming media (Process and Business Model Innovation). The ultimate step was to enter content production (Product and Business Model Innovation) and to create personal recommendations (Product Innovation, Process Innovation, Business Model Innovation). The following section provides an overview of the three value dimensions:

Ad 1) Data-driven Product Innovation

Data-driven product innovation can be broken down into three sub-categories:

a) *Product Enhancement*: data are used to enhance an existing product, personalize it or optimize the customer experience. An example of this is Nike with NIKEiD and their contextual marketing approach.
b) *Product Augmentation*: data can augment a product and make it smart by using sensor data within the device or an accompanying cloud and ideally create a digital ecosystem around the product and its features. Smartphones and wearable devices are an example here as well as connected cars (Mühlhäuser, 2007).

c) *Data as a Product*: data can become the product itself. The most important use cases being advertising, location-based services, recommendation systems and predictions.

Ad 2) Data-driven Process Innovation

Process innovation leveraging data can be achieved in two ways:

a) *Enterprise Process Innovation*: data can be used to optimize internal processes and remove costs (e.g. car manufacturers can optimize their design and production process based on the usage of data).
b) *Customer Process Innovation*: data are used to optimize delivery or service processes with direct impact on customer experience (an example being Tesla's over-the-air-update process and remote maintenance). This can have cost effects or enhance customer satisfaction with possible indirect margin and revenue contributions.

Ad 3) Data-driven business model Innovation

Data-driven business model innovation describes the rare but powerful case when a company designs a complete new business model, which is ultimately the way it creates value to customers, based on data. There are two basic forms that can be differentiated in theory although they practically flow into each other in many cases.

a) *Value Model Innovation*: data are used to provide new methods of value generation for the customer. An example would be Google Search that uses advanced algorithms to crawl and index the world wide web to retrieve information. The value model is to provide 24/7 access to global information in separate categories (e.g. News, Videos, Pictures, Shopping, Books etc.) without cost.
b) *Monetization Model Innovation*: data are used to offer innovative ways of value recording for the company. In the Google Search example, the internet pioneer invented a free usage culture based on advertising that rendered users into a marketing product (*if you are not paying, you are the product*). This is a prime example for *indirect monetization*, that advanced to one of the most powerful revenue models for the web-based internet era.

Having been a neglected field of study in the past, there is a growing focus on business models and especially business model innovation in recent research (Wirtz, Göttel, & Daiser, 2016; Andreini & Bettinelli, 2017). This stream of research has demonstrated that successful startups are not merely focusing on product innovation but that they have a strong focus on business model innovation as well: "In recent times, more successful startups, such as Airbnb or Uber, have been spurred more by business model innovation than by product innovation" (Sorescu, 2017, p. 692). If a business model is the way in which an organization is capitalizing on its primal resources, innovating on a business

model means to invent novel ways to commercialize the underlying company assets (Gambardella & McGahan, 2010).

Taking all these considerations into account, an extended definition for data-driven business models can be derived that provides a better description of their properties and a more distinct demarcation to other types of business models.

📖 **Box 1. Data-driven business model Definition**

A data-driven business model is a business blueprint that describes how data are used as primary business resource to deliver value to customers and to convert this value into revenue and/or profit by means of direct or indirect monetization. Data are used – ancillary or constituent – to deliver value for products and services, internal and external processes or to innovate the way a firm operates itself. To this end, data-driven Business Models utilize advanced technologies – usually real-time capable and self-optimizing – that require dynamic capabilities to fully master the leverage of diverse big data sources. Required capabilities range from capital funding to organization and innovation management.

This definition has implications: firstly, it spans a wide range of business cases. Data can be used to create smart-connected products or to innovate processes – both towards clients and within internal operations. Value contribution from data will be direct and indirect. The highest form is, when data are used to innovate entirely new business models, i.e. innovative ways to engage with clients, develop products, and generate revenue. Secondly, the definition excludes companies that monetize data without leveraging technology. Selling data is a business model that has existed for centuries and does not need technology – one could think of credit reporting or insurance for example. The same is true for Business Model Innovation: "at its simplest, it demands neither new technologies nor the creation of brand-new markets" (Girotra & Netessine, 2014). These low-tech forms of innovation and data sales are deliberately not included in this definition, as mastering technology is a key characteristic of internet-driven *big data* business models, that face completely new technical challenges in terms of volume, velocity and variety of data (McAffee, Andrew, & Brynjolfsson, 2012).

This study tries to capture all forms of data-driven business conduct (product, process and business model innovation). Yet a special emphasis will be laid on business model innovation – not least because organizations that start to create and capture data need to invent a model first, in which the new asset can be commercialized via direct or indirect channels.

1.2 Data-driven business models in Practice

Data-driven business models are not merely an academic question. On the contrary: the growing interest from academia has its driver in today's business practice. Data are transforming markets in an unprecedented way, challenging traditional scientific models. The new strategic role of data as a key resource for superior value propositions has triggered massive investments in advanced analytics and artificial intelligence (AI). This has not only left marks in the balance sheets of tech companies; it has also recently re-shuffled the leader board in R&D spends (toppling VW from the throne for the first time in many years).
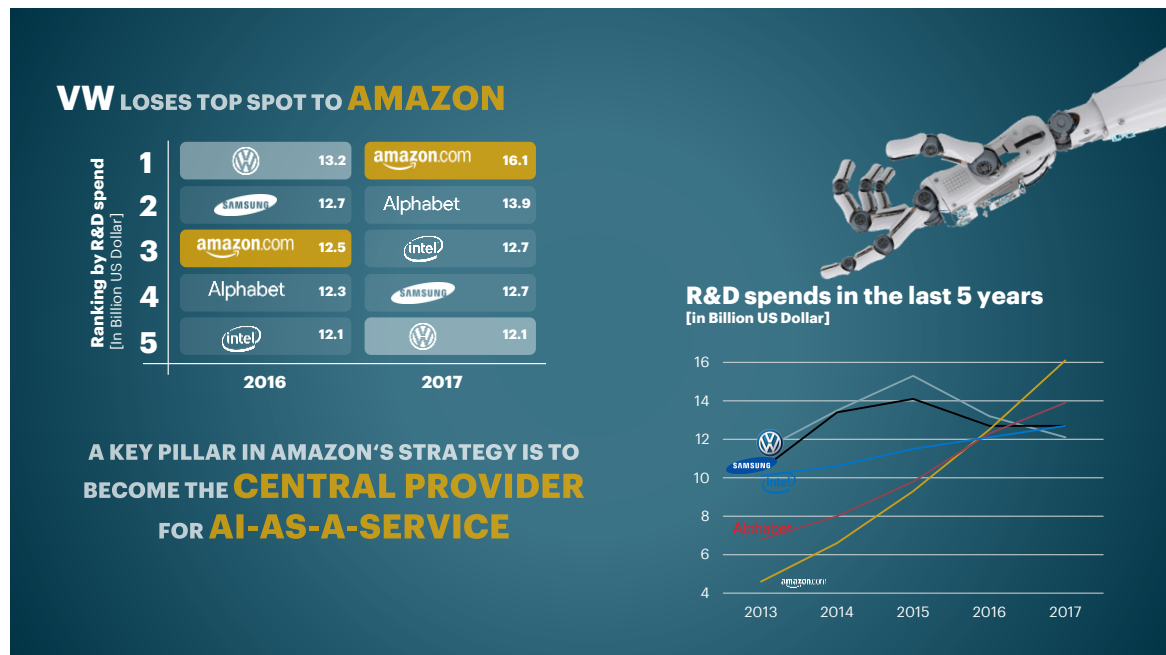
Figure 1: R&D spends driven by AI

Source: Strategy& (2016); CB Insights (2017)

There is one key driver behind this step change: Artificial Intelligence. Already earlier research has indicated that data-driven business models bear a superior quality allowing organizations to obtain a margin premium. In early studies, data-driven capabilities are modeled as intangible assets valued by investors and increasing output and profitability. The result: firms that adopt data-driven decision-making can have an output and productivity 5-6% higher than what would be expected given their other investments and information technology usage (Brynjolfsson, Hitt, & Kim, 2011). But the tech players are not looking for incremental optimization. They are looking for *big bang disruption*, that is characterized by "unencumbered development, unconstrained growth, and undisciplined strategy" (Downes & Nunes, 2013). Data – or more broadly artificial intelligence – are at the core of this endeavor.

The real world importance of data-driven businesses can be illustrated by comparing the values of the world's top five data businesses (Apple, Alphabet, Microsoft, Amazon and Facebook) with the value of the entire DAX (German Stock Index). In October 2017, the five tech giants' market capitalization amounted to USD 3.35 billion, while the

capitalization of the DAX companies totaled USD 1.24 billion (Nasdaq, 2018; STOXX Ltd., 2018). Only the world's five leading tech companies are therefore 2.7x worth the leading companies of Germany, the world's fourth largest economy (International Monetary Fund, 2017).

Market capitalization
[in Billion Dollar]

5 largest US Tech companies		5 largest German companies	
Company	**Oct 2017**	**Company**	**Oct 2017**
Apple	904.80	SAP	140.00
Alphabet	722.50	Siemens	122.00
Microsoft	652.30	Bayer	109.00
Amazon	545.90	Allianz	104.80
Facebook	521.70	BASF	102.60
SUM	**3,347.20**	**SUM**	**578.80**
		DAX 30	1,236.00

Figure 2: Market capitalization

Source: Nasdaq (2018); STOXX Ltd (2018); International Monetary Fund (2017)

Data are not only transforming isolated markets, they transform the whole world economy: in the past, major energy companies and banks have constituted the world's most valuable companies by market capitalization. In 2007, eight in ten of the biggest companies belonged to one of the two categories. The picture has completely turned from 2017: now seven out of ten leading companies are tech players that have embraced data-driven business models (Bloomberg, 2017).

Figure 3: The world's most valuable companies are data-driven

Source: Bloomberg (2017)

While industries with digital goods and "zero marginal costs" (Rifkin, 2014) – such as the internet- and media-industry – have changed tremendously through digital transformation and the embrace of data-driven business models, asset heavy producing trades like manufacturing and automotive were rather marginally concerned in the past. This is currently changing: the so-called *Internet of Things* (IoT) promises even larger disruption potential going forward, especially in mobility – an industry that operates at the intersection of many data-heavy IoT domains.

1.3 Data-driven business models in the Automotive Industry

The following section investigates how data-driven business models affect the automotive industry, a global lead industry with significant R&D investments. On one hand, automotive is an industry that sells physical products (*hard assets*) and has per se limited benefit from zero marginal costs – a fact that is gradually changing with an increasing share of value generated by software (Winkelhake, 2017). On the other hand, automotive is one of the industries with the most data volume being generated and IoT is enforcing industry convergence creating numerous data-enabled business opportunities (Seiberth, 2015). Driven by an ever-growing appetite for data, the automotive industry is on the brink of a profound digital transformation. The leading tech players from US and China – and the most valuable companies of the world – are all investing heavily into their automotive capabilities and seek to become interface owners in today's and tomorrow's vehicles. The rationale is clear: tech players are aware that the next big computing platform will be the (autonomous) car – and vehicles will be strongly interconnected with all IoT domains. If tech companies own the interface in the car, they have a chance to own the platform and gain data to enhance their AI capabilities and further improve their customer access.

Seven out of ten of the most valuable companies are pushing into automotive business – an overview of their key activities:

- **Apple** wants to become a relevant leading player not only with their CarPlay system but also with software related to autonomous driving (Huynh, 2017; Webb & Chang, 2017)
- **Google** offers Android Auto, a smart driving companion bringing information such as destinations, appointments, and weather conditions to the driver (Huet, 2014). Google's sister company Waymo is at the forefront of the development of self-driving technologies (Fairfield, 2016)
- **Microsoft** offers intelligent services in the car, including virtual assistants, business applications, office services and productivity tools with their Connected Vehicle Platform (Johnson P. , 2017; Korosek, 2017)
- **Amazon** brings their voice-controlled, intelligent personal assistant Alexa into cars, thereby creating a seamless transition from home to the car (Ong, 2017; BMW Group, 2017)
- **Alibaba** is pushing for the car and the Internet of Things by developing their own operating system, AliOS, which includes touchscreens, GPS maps and other smartphone-like functionalities (Clover & Fei Ju, 2017)
- **Tencent** is the last entrant into the crowded autonomous driving space. It was a surprise when the news emerged in November 2017 that the Chinese Facebook is developing an own autonomous driving system

The movement started in *Silicon Valley*, but the current momentum seems to come from *Zhongguancun*, China's corresponding technology hub in Beijing. China is the most important automotive market and the Chinese government is pushing domestic companies to take the lead in internet technologies. Driven by these forces, China is

increasingly entering the battle field for customer interface and mobility ecosystem. The famous triumvirate of Baidu, Alibaba and Tencent – collectively known as BAT – is strongly dominating the Chinese internet landscape and is ramping up own automotive capabilities. While Baidu competes with Apple and Google for the customer interface with their CarLife system, Alibaba and Tencent cooperate with Chinese automotive OEMs to create what they call "smartphones on wheels" – which are intelligent and connected cars (Millward, 2015). Alibaba works together with Shanghai carmaker SAIC, while Tencent joined forces with Guangzhou Automobile Group Company (Clover & Fei Ju, 2017). Beyond the connected car, the BAT is also leveraging their traditional core strengths in data science and artificial intelligence to enter the race for intelligent and self-driving cars. Navinfo, a Chinese HD mapping company, strives to become the digital brain of intelligent driving with ultraprecise location information and automotive-grade semiconductors for Advanced Driver Assistance Systems (ADAS) and autonomous driving. Being the leader in navigation and traffic information in China, they are now pushing to become one of the most trustworthy autonomous driving solution providers in the China market and beyond (self-claim).
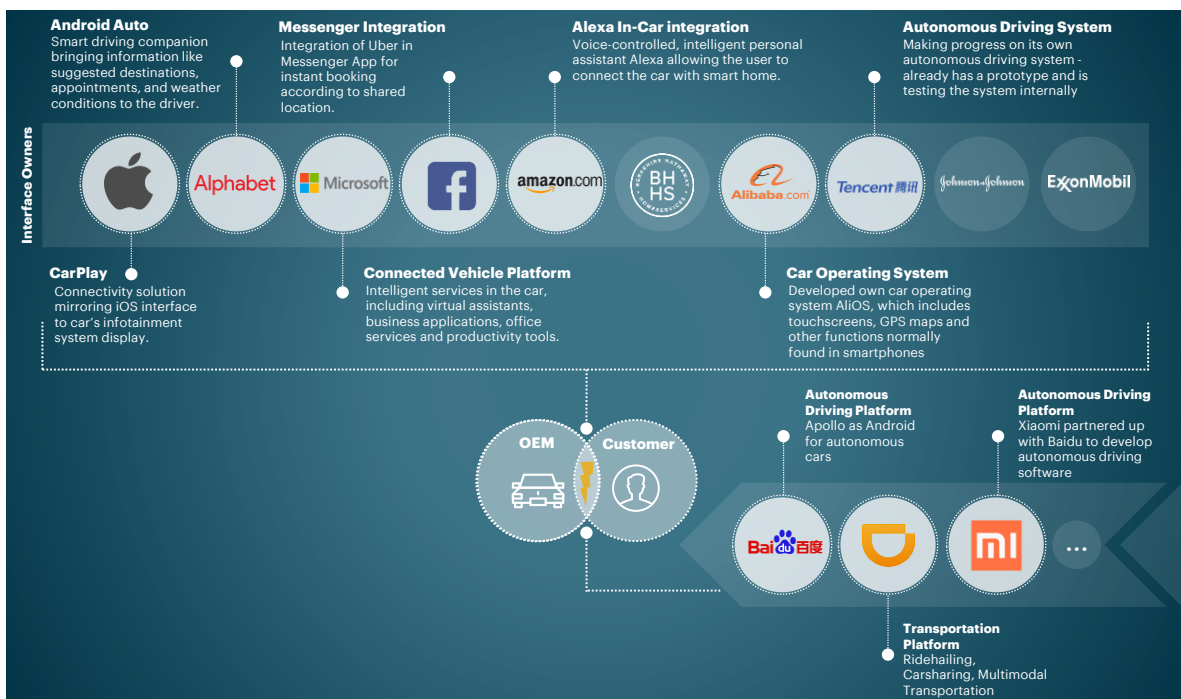
Figure 4: Tech companies are claiming the customer interface in the car

Source: Accenture

Not yet listed in the world's top ten, but part of the top ten valued internet companies in China are three additional tech giants with automotive ambition: Baidu, Xiaomi and Didi Chuxing.

- **Baidu** has launched Apollo, an open software platform for autonomous driving that is often referred to as Android for self-driving cars. Baidu has gathered a network of more than 50 partners – from OEMs like Daimler or Ford via software vendors like Microsoft to electrical equipment suppliers like Nvidia, Intel, Bosch, Continental and ZF.

- **Didi Chuxing**, formerly Didi Kuaidi, is the Chinese Uber having started with ride-hailing, they now diversified into Artificial Intelligence and autonomous technology. Their ride hailing offerings include taxi, private cars, social-ride sharing, chauffeur services and even bike-sharing. After its latest financing round in December 2017 they are becoming the most valuable startup company in the world – finally beating their paragon Uber. And they are the only company to have all of the Chinese tech giants – Baidu, Alibaba and Tencent – as investors.
- **Xiaomi** is a Chinese electronics company and the second largest smartphone manufacturer in China behind Huawei. In December 2013 they even briefly became number one. Besides smartphones they also produce smart home devices. Xiaomi recently teamed up with Baidu to enter the arms race across next-gen markets like IoT gadgets, AI platforms and autonomous vehicles. Both companies want to catch-up with Tencent in the battle for autonomous driving software. It was also rumored end of last year that Xiaomi wants to build electrical vehicles for India.

All these activities from the leading tech players of the world exert a lot of pressure to act on the automotive industry, especially the market leaders in Germany. Although German OEMs have introduced connected car services relatively early (BMW launched their ConnectedDrive service already in 2002), auto manufacturers are currently endangered to fall behind regarding data-driven business models. While they are aware that they obtain a massive pool of data (BMW Group, 2016), OEMs do comparatively little investment into their data science capabilities apart from autonomous driving with two major acquisitions so far: Ford with Argo and GM with Cruise. Different from tech companies who proclaim an *AI first* strategy and have been investing in AI companies for more than 5 years (Google, for example, was acquiring more than ten companies in that period, some as important as DeepMind), OEMs have not yet shown a consistent AI approach. They successfully pivoted to digital services and are now trying to build up open ecosystems, but AI is a blind spot and the next chance for tech players to gain early-mover advantages to monopolize the customer interaction.

It is not that OEMs have not realized the massive potential of data-driven services – on the contrary, great sums are invested into the field of digital business. BMW was already called a "German Apple" (Freitag, 2015) and Daimler already expects revenues of several hundred Euros from digital services (Reimann, 2017). Audi have even been presenting a concrete expectation: half of the automotive OEMs revenues should come from digital services already by 2020 according to their internal ambition (Schneider, 2016). Still, OEMs do not have a clear idea on what the role of AI will be and whether they need to view this as a core competence or whether it is enough to buy and partner. Significantly, Google, Apple, Facebook and Amazon – collectively known as GAFA – have declared and described an overarching AI strategy unlike all the OEMs. The discussion around a Chief-AI-Officer in the internet world has no equivalent in the automotive industry. Automakers and suppliers seem to recognize data as a key resource to their strategies, but they currently invest too little in the respective structures and capabilities in building data-driven business models. They also struggle to lift data out of the existing silos (divisions, brands, markets etc.) to centrally manage *data lakes* and develop advanced analytics capabilities. Interestingly, rather suppliers lead the race here, namely Bosch that have invested millions in a captive AI Center.

2 Digital Ecosystems as Market Opportunity for OEMs

Data-driven business models are happening in digital ecosystems. These ecosystems have the tendency to blur industry boundaries and cause convergence. Incumbent OEMs will need to respond and adapt to these new revenue sources to compete with already established data-driven companies and new entrants. In that transformation, OEMs will create or join interconnected ecosystems and forge new partnerships and consortiums. An example of a new form of partnership would be the alignment of BMW with Intel/Mobileye and other partners. The joint acquisition of the map provider HERE – belonging, among others, to Daimler, Audi and BMW – is an example of a syndicated form of cooperation.

The shift in revenue streams and the increase in automotive and mobility-related revenues create a new competitive playing field – a new *value network* (Peltoniemi, 2004). This poses the question of how this network will configure itself in the future and who the key players will be: incumbent OEMs and suppliers will share the pie with tech firms, telecoms and new entrants.
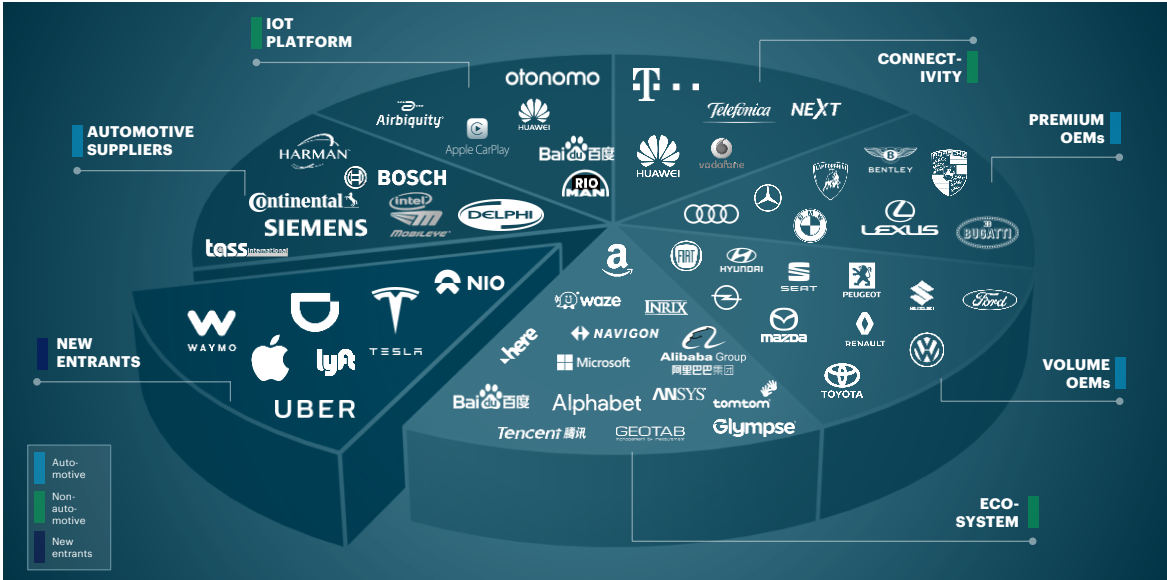
Figure 5: The value network of the connected mobility sector

Source: Accenture

Ultimately, the crucial aspect of the new value network configuration is to find out who will own the customer interface and hence be able to own the business model. Foxconn for example, while producing the iPhone, is subordinate to Apple's business model as it has no own customer access and no ecosystem. The ecosystem is a crucial point, as another example illustrates: Samsung. While Samsung has own customer access, they leverage Android's ecosystem. This seems to contribute to reduced profitability: Samsung's share of global profits is over five times lesser than Apple's, although the Korean's are the world's largest smartphone manufacturer, selling over 50% more smartphones than Apple (Chau, Govindaraj, Reith, & Nagamine, 2017; The Korean Herald, 2017).

The difference: Apple is controlling the whole customer journey – from product via software to digital ecosystem. Samsung, on the other hand, is only providing the product while software (Android) and digital ecosystem (Play Store) are provided by Google, which needs multiple firms to cooperate in terms of value creation (Chesbrough, Vanhaverbeke, & West, 2014). *Digital Content and Services* contribute 30 billion dollars to Apples balance sheet and have with 23% the strongest growth rate, largely driven by App Store sales (Apple Inc, 2017). Apple's revenues from transaction fees alone reach some 12 billion dollars in 2017 (store revenue multiplied with a 30%, transaction fee).

The combination of a superior product, a comprehensive open – yet controlled – ecosystem, and the ownership of the customer interface allows Apple to generate price premiums: "iOS users spend more and are more loyal than those on alternative platform, thus qualifying the platform as 'premium' and resultantly adding to its value in the eyes of developers, content producers and service providers" (Dediu, 2017).
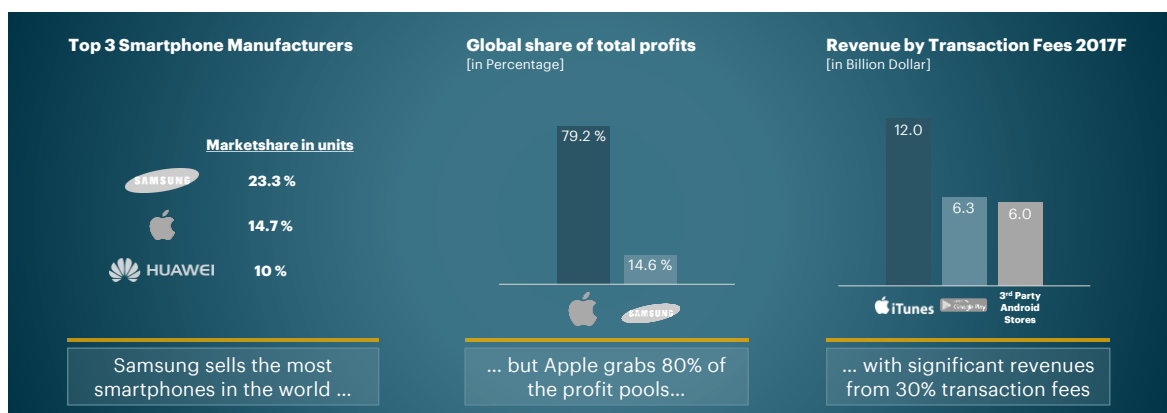
Figure 6: The Apple example: combine premium product with superior ecosystem

Source: The Korean Herald (2017); Chau, Govindaraj, Reith, & Nagamine (2017) App Annie (2018), own calculation (30% of total App revenues)

The combination of superior products and a superior ecosystem – just as in the preceding example of Apple – demonstrates the *sweet spot* that OEMs could reach when innovating on product and business model simultaneously. Still there is an important caveat: Apple's strategy is unparalleled and very difficult to replicate. Therefore, OEMs will not be able to fully control all three value sources: *product*, *operating system*, *ecosystem*. To which degree operating system and ecosystem will be proprietary and self-owned by car makers is an interesting open question. Currently there are three options and all are experimented with in parallel: 1) own proprietary operating systems, 2) open or proprietary 3rd party operating systems (Car Play, Android Auto), 3) industry alliances (Genivi, MirrorLink, Here). The question of the operating system is so important, because the operating system hosts the app store, which is the basis for any ecosystem monetization.

As they lack critical mass, OEMs might not be able to pursue a full Apple model themselves. They would probably rather follow a hybrid approach, combining proprietary elements with data exchange across shared platforms.

The *sweet spot* positioning is depicted in the following matrix:
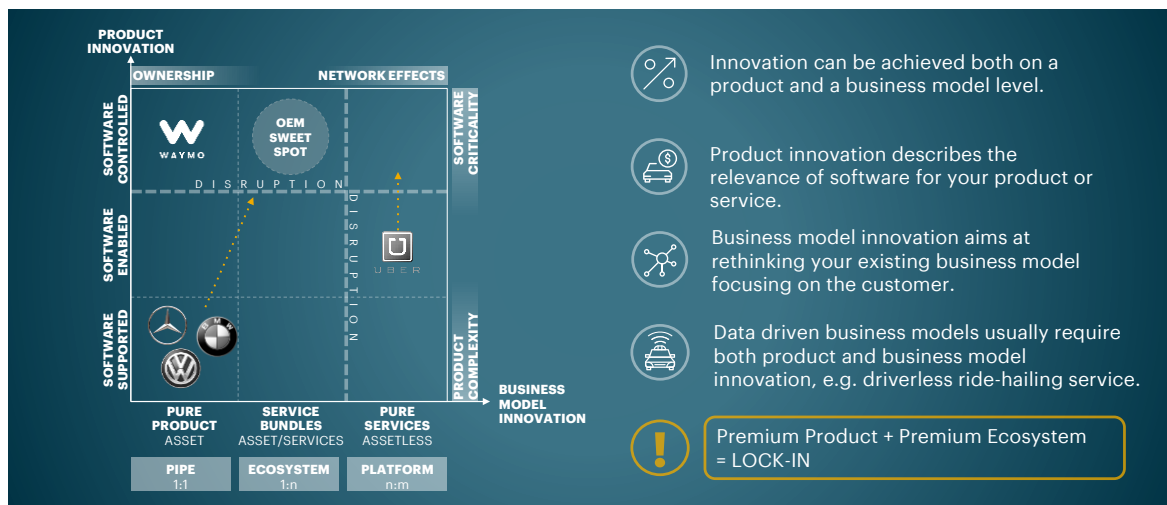
Figure 7: The OEM sweet spot

Source: Seiberth (2015)

Pure asset less platform models like Uber are not a sensible strategic positioning for OEMs: they cannot just abandon their heritage and being able to design and build physical cars is a real asset. Yet, in some selected areas, OEMs can also develop non-asset services (a multi-modal transportation platform being an example).

Today, the automotive business models still mainly focus on physical products that are only software *supported*. To reach the *sweet spot*, OEMs therefore need to rethink their business models and provide service bundles in an ecosystem containing both assets and services. Additionally, they need to increase the relevance of software for their products and services to become *software-controlled*.

Once OEMs have successfully combined their premium products, vehicle connectivity and a user interface application platform, a lock-in effect can be achieved (Lynch, 2017). Customers are discouraged to switch to a competing ecosystem for rising switching costs. Subsequently, OEMs can benefit from the profits and generate a recurring stream of revenues. However, they must speed up: once an ecosystem is established, clients are locked-in and a switch is difficult to motivate. Hence, the first mover will gain a tremendous advantage.

3 Quantifying the Data Opportunity in Automotive

3.1 Development of Automotive Profit Pools

Digital Services are strongly growing and will take an ever-increasing share of the OEMs business. Audi's claim to generate 50% of their revenues with digital services by 2020 seems to be overambitious. This estimation was ostentatiously bold – and never repeated. Regardless of timing, the direction is right. This research indicates, that this scenario will become reality, but only in 2050 – 30 years later.
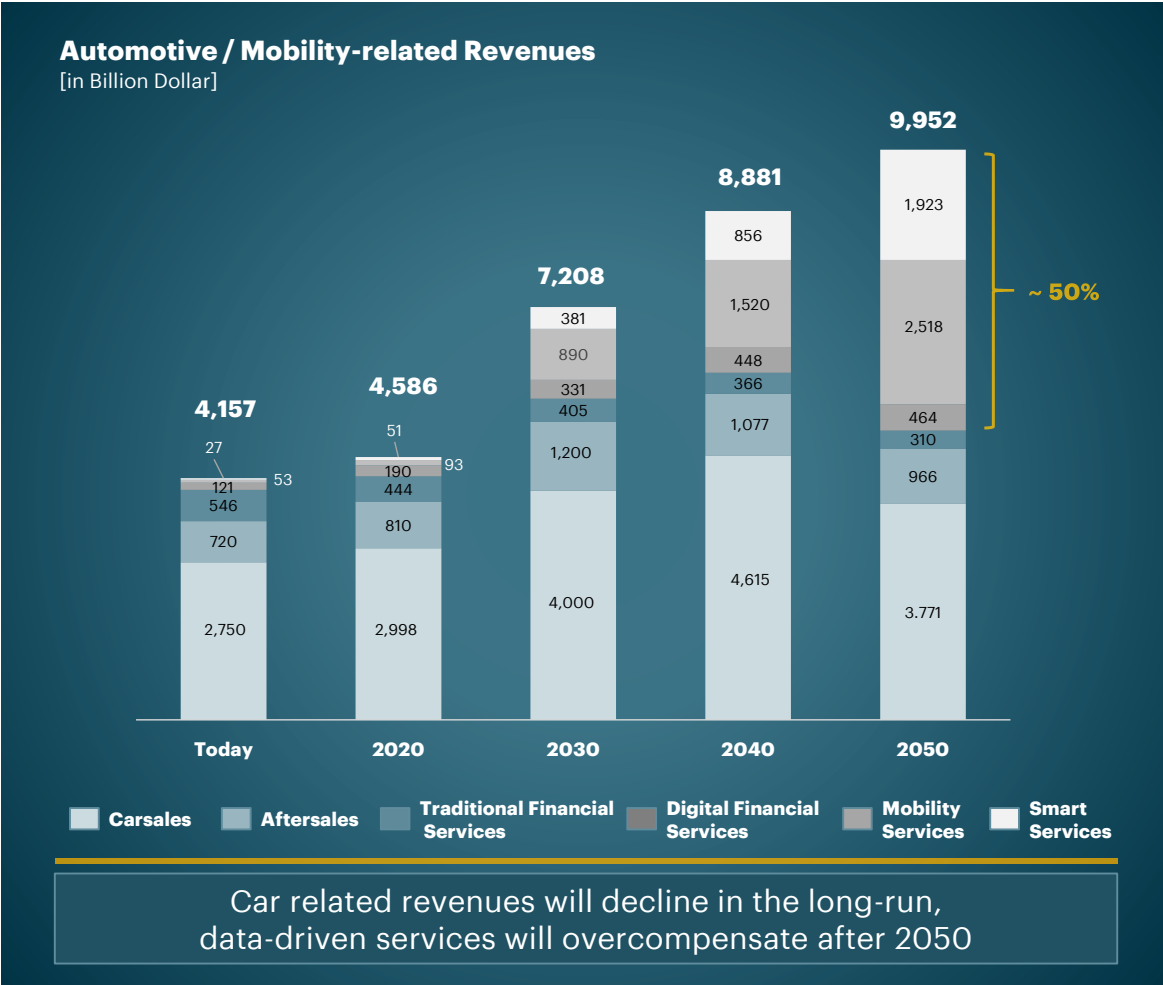
Figure 8: The value network of the connected mobility sector

Source: Accenture based on ABI Research (2016); Allied Market Research (2015); Quartier (2017); Mohr, Kaas, Gao, Wee, & Möller (2016); IHS Markit (2017), McKinsey&Company (2016) , own calculation

The revenue forecast for the traditional car sales is usually not extended after 2025 or 2030. Predictions until 2050 are rare. Obviously, this restraint is sensible, as long-term predictions are a long way from accurate. In contrast, the largest impact on data business models will happen after 2030. This is why an own model was developed. It is based on various analyst sources and macroeconomic data combined with own observations. Obviously, this is just indicative. The development is based on a few key assumptions that are outlined in the following:

1) The traditional OEM business (new car sales and aftersales) will decline until 2050 – after a peak in 2030, especially driven by increasing Mobility-as-a-Service models.
2) Traditional aftersales business will decline after 2030, because electrical cars are easier to maintain and over-the-air updates will substitute a larger share of personal workshop visits.
3) Traditional financial services business will steadily grow until 2040 and then gradually decline as autonomous car-induced growth of sharing models will diminish financing demands. In parallel digital financial services business will rise, comprising payment in the car, usage-based insurance or blockchain-based services.
4) Mobility services including shared mobility will see accelerated growth after 2030, driven largely by growing penetration of car fleets with autonomous vehicles.
5) Smart services will develop to an independent business with twice the size of today's aftermarket business driven by AI and innovative ways of big data monetization.

A key question – that influences most other factors – is the development of new car sales in the upcoming decades. Pessimists refer to a high sharing rate, especially of autonomous cars – there are forecasts that one shared autonomous car will replace eight traditional cars – and claim the *end of ownership*. On the other hand, there is continued macroeconomic growth in emerging economies like China, India, but also Latin America, Russia and Africa. And experts believe that electrical cars will be replaced in shorter cycles due to reduced battery life combined with an over proportional share of battery value compared to overall vehicle costs. Analysts expect more travel via car than ever, but fewer cars needed by individuals, shifting car sales from personal to fleet economics (Marn, 2017). Also, OEM attention will turn to vehicle miles travelled (VMT) rather than cars sold.

On balance, the effects from future mobility can be expected to outweigh the effects from macroeconomic growth in developing markets. Thus, while revenues from car sales and aftersales will peak in 2030, revenues from shared mobility and data-driven services will overcompensate this decline, leading to a further increase of total revenues in the automotive sector. By 2050, about 50% of all automotive and mobility-related revenue will account for digital services.

Successful data-driven services meet three core criteria: they need to be context-aware, personalized and make use of prediction. This requires high quality and real-time data. To systematize the business models in which these advanced data-services can be delivered, a taxonomy has been developed that helps classify the respective business model types.

4 Data-driven business model Framework

As data-driven business models are a nascent business practice, there is no general taxonomy in place and no comprehensive collection of key resources, activities and use cases. A first business model taxonomy was developed by Hartmann et al (2014) based on an analysis of 100 startup companies. From this, an individual classification approach was developed to better fit to the subject at hand.

The framework provides an overview of data-driven business models and sets them into context of the nature and sources of data, types of channels as well as different value add-levels.

4.1 Framework Overview

The analysis structure of this framework comprises four dimensions. All of them are to be understood as continuums and not as distinct partitions. The framework takes following dimensions into account: nature of data, data source, typical channel model and generated value added.

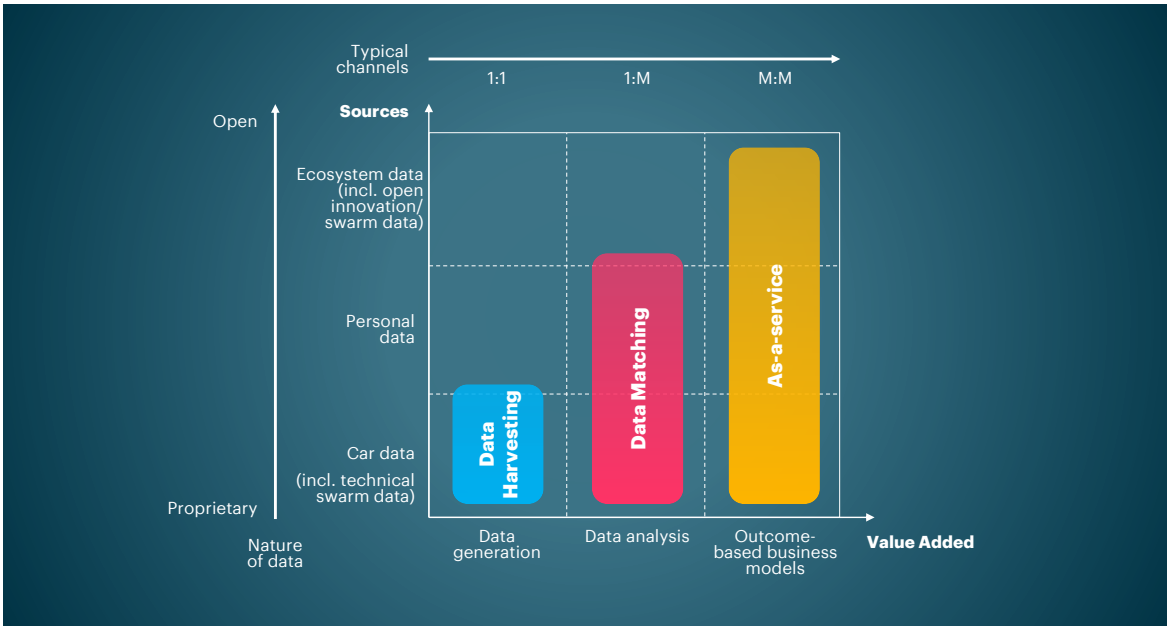*Figure 9: Three basic types of data-driven business models OEMs can apply*

Source: Accenture

4.2 Business Typology

The dimensions – explained below – are used to derive three main types of data-driven business models.

- **Nature and source of data**

To understand potential revenue sources, it is important to understand where the data is generated (source) and by whom it is controlled (nature). Data can be generated by

proprietary hardware (e.g. vehicle) or software (e.g. search engines, e-commerce platforms). This can include data that is fused from different sensors. Proprietary data can be real time or historical. An OEM collecting technical data from their vehicles to predict wear&tear being an example for historical data; swarm data connecting multiple vehicles and distributing information about their environment (for example local hazard warnings like heavy rainfall or dangerous curves) illustrate the use of real time data.

Another case is the use of open data including crowdsourcing or *swarm intelligence*. An example would be GNU-licensed projects like Openstreetmap.org. These data are freely available – under certain restrictions – and do not generate a competitive advantage. An advantage can be generated though, if combined with commercial offerings e.g. the crowd-based parking service by Waze (taken over by Google).

A special case is data that is personal or can be related to a person. Obviously, this form of data is very attractive as it is the basis for product personalization and personalized customer communication. Yet, this data is subject to data protection regulations and needs a documented and reverseable consent by the user. This category is not sharply distinguished from the other data forms, as it is argued, that technical data, e.g. car data, can be related to a person and should thus also be subject to privacy regulations.

▪ Channels
The *channel* dimension refers to the communication or sales channels a business model applies. 1:1 channels denote the traditional pipe model where a manufacturer sells to a client (van Alstyne, Parker, & Choudary, 2016). 1:n channels describe the case where one service is consumed by different users, e.g. a live traffic consumption model. n:m channels are platform based models where an unlimited number of providers interact with an unlimited number of users. Uber would be an example, where the match is made between demand and supply based on an advanced algorithm.

▪ Value Added
Value from data is derived from key activities, that are often modeled in a value chain. The chain of activities in analytics are usually described in the following way: data generation, data acquisition, data aggregation, data contextualization and analytics. For the current purpose, three core value activities can be differentiated: data generation, data analysis, and outcome-based business models.

Data generation means the collection of data including sensor fusion data, like heavy rainfall warning or cruise automation. Also real time analytics – for example Real Time Traffic Information – would be counted here.

Data analysis refers to the combination and analysis of different data sources with the goal of identifying patterns and applying algorithms to provide advanced analytics like personalization, prediction and location-based services. Ride-hailing (Uber) would be an example.

Outcome-based business models are the highest stage of value creation as they do not only provide insights but guarantee a desired result. These models are still in development. Emerging fields are travel (measured by miles traveled) or logistics.

4.3 Deriving Generic Business Models

The data-related Business Model-framework allows to identify generic business models that can be used for comparison and analysis. Three main models are derived: Data Harvesting, Data Matching and As-a-Service. They form a rough typology to describe the span of value provided. The three generic archetypes build on each other but do not need to be applied at once.

4.3.1 Data Harvesting

Data Harvesting business models co-evolved with the rise of smart, connected products in the *IoT* (Porter & Heppelmann, 2015). Increasingly, hardware components are replaced by software, which enables users to maintain, monitor and control products through various interfaces. By adding connectivity, a product becomes a node in a wider network of things. This product connectivity, often referred to as telematics, is the combination of location technology, wireless communications, and in-vehicle electronics. This business model is predominantly focused on product innovation.

In connected cars, equipped with on-board computers and embedded mobile broadband, dozens of sensors and around 40 microprocessors collect telematics and driver data. Every driving hour, a connected car produces up to 25 gigabytes of data and uploads them to the cloud (Balcells, 2016). The ongoing connection of cars to the internet supports various applications like road safety, location-based services, smart and green transportation, and in-vehicle internet access.

The Tesla car Model S for example, is able to receive software updates through the cloud, which continuously allows the improvement and optimization of the car without visiting a dealer.

Data Harvesting applies in the area of data generation and mainly focuses on car-related data. Data can be collected through different sources in smart, connected cars. The typical sources are CAN-bus (ECU, Battery, Brake, Gear Box, etc.), Sensors, and GPS. In the area of connected cars, Advanced Driver Assistance Systems (ADAS) play a major role and form the basis of self-driving cars. A variety of sensors are used simultaneously to analyze surroundings, among them:

- Long-Range Radar (Adaptive Cruise Control)
- LIDAR (Emergency Breaking, Pedestrian Detection, Collision Avoidance)
- Camera (Lane Departure Warning, Traffic Sign Recognition, Surround View, Park Assistance)
- Short-/Medium Range Radar (Cross Traffic Alert, Rear Collision Warning)
- Ultrasound (Park Assistant)

Collecting this data and putting it into context, leads to first business models (e.g. navigation, location-based services, and recommendations for action).
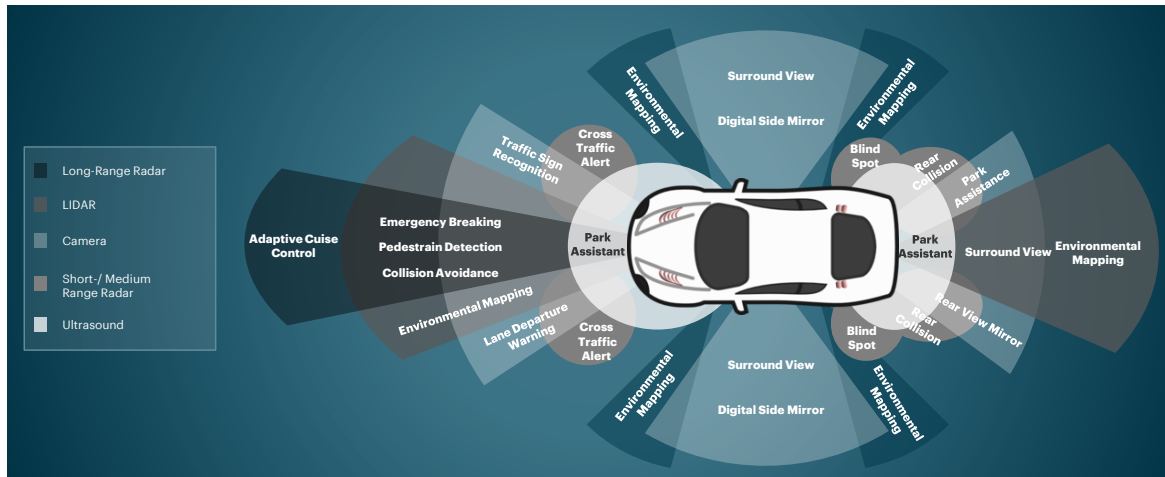
Figure 10: Advanced Driver Assistance Systems in the Connected Car

Source: Accenture

The real-time use of data results in new features, often safety related. For example, once a warning of heavy rain or traffic is generated, the estimated time of arrival is adjusted and updated. Another feature is local hazard, where data sensors, sent to the cloud, are used to identify areas or places of hazard and displayed in the head unit of the car. Therefore, different indicators are used from fog lamps, ESP, and windscreen wiper. The cloud identifies a high frequent usage of the windscreen wipers, the switch-on of fog lamps as well as a frequent intervention of the ESP at a certain location and subsequently the system flags this location as a local hazard. This local hazard is then transferred to all other connected cars.

Data collected from connected cars can also be used for product optimization, which promises substantial cost savings. In addition, car manufacturers are building open telematics platforms to syndicate their data to third parties. This allows for innovation sourcing and additional revenue streams from transactions. A well-known example is usage-based insurance, where insurance companies use driving data to personalize their insurance premium.

4.3.2 Data Matching

Data matching refers to the contextualization or matching of information by means of a digital platform. This allows for more advanced and scalable business models with so called network effects (Shapiro & Varian, 1999). Platform business changes the focus from resource control to resource orchestration, internal optimization to external interaction, and from customer value to ecosystem value (van Alstyne, Parker, & Choudary, 2016). This business model is largely – but not exclusively – focused on process innovation.

These platforms refer to a two (or multi)-sided market operation, which enables interdependent groups of users to prosume value (Ritzer & Jurgenson, 2010). The basis is data collection, which is required for the offered services from the platform, for example a social network saves user profiles. However, these data can also be used to enhance and expand existing services to tailor new business models according to users interests. Based on interests and behavior, Google or Facebook collect information cross-platform and perform target advertising. A famous example out of the automotive industry is Uber and its ride-hailing platform, where supply and demand of ground transportation get matched by smart algorithms. Together with Lyft, who are catching up, they command 65% of the business traveler ground transport (Goldstein, 2017).

Platforms are powerful intermediaries. They interpose themselves between the user and the asset owner and define the rules of the engagement: and whoever owns customer access, owns the business model. Data matching business models often emerge – sometimes experimental – out of the initial business idea. Google and Facebook for example started with search and social and are now selling advertising, Amazon started with selling books and now operates a third-party marketplace for virtually the entire product spectrum. So, all of these platform providers capitalize their customer access, which emerged to be the most central asset. Google AdWords for instance started early to become a platform by owning and selling customer access to third parties – though never letting their customers pay directly.

The e-commerce platform Amazon Marketplace is a typical n:m channel, where third party sellers get access to Amazon's customer base to sell their new or used products without investing in additional infrastructure. This emergence from e-commerce to platform is a common strategy. Zalando for instance started as a shoe dealer and are now seeking to evolve themselves into a fashion platform.

The most common business models of platforms are *Freemium* (Kumar, 2014), base membership for free, premium access for a subscription fee, (example: LinkedIn), or *Transaction Fee*, making a match of demand and supply for a commission (example: Uber, the model was initially developed by credit card platforms). Another model is *Long Tail-Subscribers* where fractional payments are added up over a longer period (a model invented by WhatsApp).

4.3.3 As-a-Service

As-a-Service approaches constitute the premium class of business models. Their basis are smart, connected products, open ecosystems and digital platforms (World Economic Forum, 2015). The main focus of this business model is business model innovation.

As-a-Service or outcome-based models transition companies from selling a product through a single transaction to providing a service with a guaranteed outcome, often usage-based or in a gain/risk share model. Selling the result instead of the product is shifting ownership, risk and maintenance responsibility back to the provider. An example would be Michelin's early attempt to sell *tires-as-a-service*. Instead of letting the customer bear the upfront investment and the risk of replacement in case of damage,

Michelin's service offered to share that risk for nominal monthly fee, so long as the customer allowed for continued monitoring of the tire conditions. If the monitored KPIs remained in a certain threshold and recommendations were followed, Michelin would guarantee a specified performance, allowing for significant cost savings in the fleet (main lever was reduced fuel consumption and lower maintenance costs). While this value proposition is striking, it was obviously too early for Michelin to bring it to the market. Currently it is not further offered, leaving space for competitors like Continental who such launched a similar service. Still, alike usage-based-insurance, this is a market that will develop over decades.

A yet to be established example from automotive industry is *Functions on Demand*, i.e. the provisioning of temporary car features that can be activated on demand and paid by consumption. Here, the customer is owning the car, but flexibly *renting* enhanced functionality. Such on-demand functions are *outcome-oriented* (used only when needed) and thus fitted for as-a-service models with flexible pricing. This monetization approach is inspired by the *in-app-purchases* model from the smartphone industry and allows for a continuous customer relationship and ongoing upselling potential.

The next level is not to flexibly rent a car function but to flexibly rent car access (*Car-as-a-Service*): A recent example being the pilot project *Mercedes Me Flexperience*. The customer closes a flat rate subscription contract with Mercedes-Benz Bank covering insurance, maintenance, repair, tires and total mileage. The rest is handled via a mobile app: choice of a car-class, color, motorization and optional equipment – even key transfer is online. All cost drivers are managed by Mercedes, relieving the customer from associated risks. It is likely that future autonomous cars will be sold As-a-Service in most instances.

The ultimate model is to buy access to mobility (rented or paid by consumption). This is the most complex end-to-end approach in transportation – usually called Mobility-as-a-Service (MaaS) (Smith, Sochor, & Karlssona, 2017). Mobility-as-a-Service refers to integrated mobility and multimodal transportation offerings based on a single contract. In an advanced stage, it would also allow for subscription models with defined service-levels or guaranteed uptime. For this, the Mobility-Service-Provider would purchase transportation capacity and match it to predicted customer demands possibly linked to a dynamic pricing mechanism. This would be more than just roaming. The Mobility-Service-Provider would own and sell the capacity themelves, similar to Virtual Mobility Network Operators (VMNO) in the telco space. It would also be possible that a platform provider is trading transport capacity like energy exchanges trade energy. In this context it is distinguished between pure match making of demand and supply like in the case of Uber – which is subsumized in the "match making" business model. In this terms, Uber would qualify as as-a-service as soon as they would start to buy and manage their own fleets or at least, as a starting point, would start having employee contracts with their drivers, a question that is currently also treated in court (Omni, 2017; Marn, 2017).

5 Service Domains

5.1 Domains Definition and Use Cases

After having looked at the business models, the next step is to understand what kind of activities can be applied to extract business value from data. These activities translate into either customer services or internal cost optimization with direct and indirect monetization options. Customer services can be directed at consumers (B2C) or businesses (B2B) and can have different effects: they can provide additional features (e.g. parking), increase convenience (e.g. in-car payment) or reduce cost (e.g. usage-based-insurance). Also, services can be used to increase safety (e.g. hazard warning), manage health (e.g. heart rate monitoring) or even engage with the manufacturers' brand (e.g. event booking).

> "Highest potential for OEMs is as-a-service strategy, since customer moved to center of attention."
>
> - Daimler AG

To categorize data-driven services, seven core service domains are developed that can be used for classification and market potential determination. But there are two important caveats here: a) cost savings cannot be measured in terms of market volume (i.e. revenues); these savings will reach very significant dimensions, but are not quantified here; b) services that drive customer experience are very important in terms of brand recognition, customer satisfaction and loyalty – factors that can impact the customer lifetime value. The market value for customer experience service is not showing the full picture for two reasons: firstly, these services are usually free of charge and secondly, the indirect revenue impacts cannot be considered.

The seven core service categories are:

- **Mobility Services**: additional services that go beyond the current product business (e.g. Parking).
- **Customer Experience**: new channels to establish a direct and recurring customer interaction (e.g. Companion App); these services are partially directly monetized (e.g. media subscription) and partially free of charge for the user (e.g. user app).
- **Connected Car Services**: typical smart, connected services that augment the car with additional features (e.g. in-car payment).
- **Safeguarding**: services that enhance safety and security by leveraging data and connectivity (e.g. emergency call); these services are partially directly monetized and partially part of the product price.
- **Digital Life**: driven by internet players that create value propositions along the complete customer journey, OEMs try to enlarge their "share of mind" beyond the car too and gain relevance in fields other than transportation; services are only gradually emerging; fields of activity will be based around digital assistants, location-based services, or augmented reality.
- **Internet of Things**: growing connectivity of devices in the physical world will drive business opportunities along the intersection of different industries, like smart grids, smart cities, logistics, health or financial services.

- **Bottom Line Savings** (not included in market figures): services that generate cost reductions either for the car manufacturer (e.g. stock level optimization) or the customer (usually B2B customer, e.g. Fleet Management).

	Mobility Services	Connected Car Services	Safe-guarding	Internet of Things	Digital Life	Customer Experience	Bottom Line Savings
Harvesting		• Personalized Settings (seating position, radio,...) Remote Services • Automated Logbook • Concierge service • Fuel Prices	• Driver's condition monitoring • Video surveillance (CCTV) • Home Security	• E-Horizon • Health Services • Smart Logistics	• Delivery to Trunk	• Bonus/loyalty schemes • Companion Apps • Infotainment	• Product Optimization
Matching	• Car Pooling • Vehicle Sharing • E-hailing • Platooning • Crowd-sourced Logistics	• Predictive Maintenance • Driving Style • Online appointment booking • Maintenance Service	• E-Call • Driver coaching • Anti-theft tracking • Hazard Warning	• Road sign recognition and traffic law monitoring • Parkingspot Finder • Usage-based insurance	• Departure Alert • Personal Travel Planer • In car Entertainment • Smartphone Apps • Digital Identity • Mobile Payment	• Performance Apps • Gamification • Experience Apps • Smart Workshop Planning	• Reduction of warranty costs • Stock level optimization • Optimization of R&D expenditure • Fleet Management
As-a-service	• Mobility-as-a-Service (MaaS)	• Charging Service • In-Car-Payment Services • Functions-as-a-Service	• Breakdown Call	• Electric Grid Services		• Drone Delivery	• Fleet Uptime
	Mostly Direct Monetization			**Mostly Indirect Monetization**			

Figure 11: Example services assigned to the different data business models

Source: Accenture

Especially in the first three categories, there will be a rise of transaction fees as a new revenue generation model for OEMs. That model was developed in the credit card business and perfected by Apple that used the model to monetize their app store and expand it to in-app purchases (Hsiao & Chen, 2016). It will be applicable to different data monetization approaches, e.g. intermodal transportation, usage-based insurance or media streaming. In addition, OEMs are building their app stores too and will charge costs to developers or other interested third parties. This will generate revenue streams beyond the end-user and will become the most important profit pool over time. Other developing models will be subscription, for example car subscription instead of leasing and subscription-based mobility services, or outcome-based payments. The other categories largely rely on indirect monetization, with advertising, data sales or cost optimization (Singh, 2018).

5.2. Service Revenues and Growth Trajectory

The revenue potential of the six service domains that allow for direct monetization can be found in the following table:
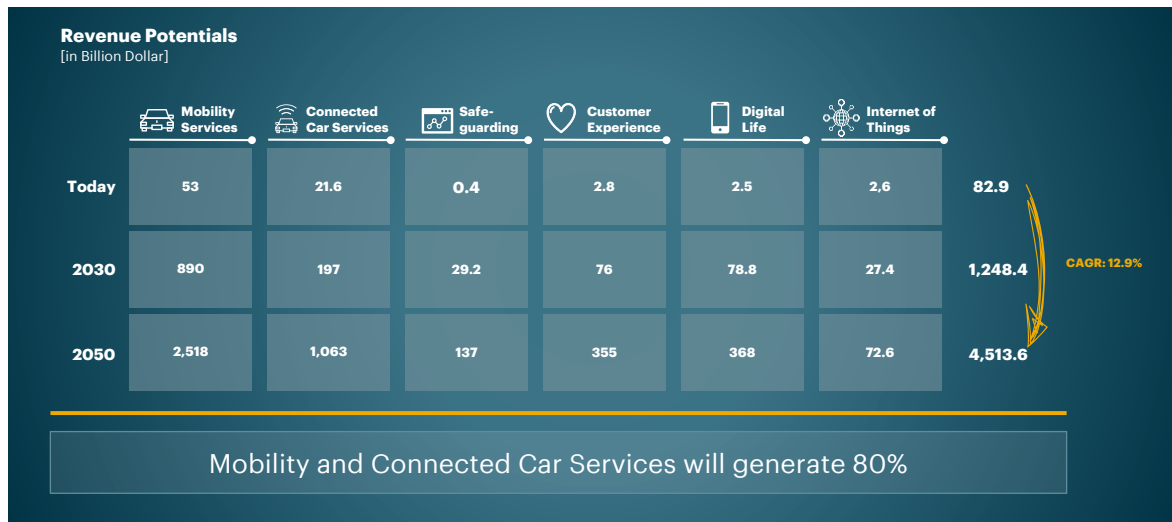

Revenue Potentials [in Billion Dollar]	Mobility Services	Connected Car Services	Safe-guarding	Customer Experience	Digital Life	Internet of Things		
Today	53	21.6	0.4	2.8	2.5	2,6	82.9	
2030	890	197	29.2	76	78.8	27.4	1,248.4	CAGR: 12.9%
2050	2,518	1,063	137	355	368	72.6	4,513.6	

Mobility and Connected Car Services will generate 80%

Figure 12: Revenue Potential of the different service domains

Source: Accenture based on Allied Market Research (2015), Quartier, D. (2017, May 19), Analysys Mason (2016)

From a base of USD 82.9 billion, the market will grow by 13% each year (Compound Annual Growth Rate - CAGR). Thereof, the greatest portions are *Mobility Services* and *Connected Car Services* with USD 53 and USD 21.6 billion respectively. In total, the revenue will reach USD 4,513.6 billion in 2050. *Mobility* and *Connected Car Services* will generate the lions share with 80% of total revenue. *Safeguarding*, however, shows the highest proportional increase.

These findings are in line with the OEM strategies, yet it is important to keep in mind that Customer Experience and Safeguarding have very significant indirect effects of the car makers value proposition. Besides monetization potential, the ramifications for the brand positioning are of utmost importance. These two factors are discussed in the next section.

5.3. Service Positioning – Between Monetization and Brand Impact

To determine the best strategy for the development of digital services, it is important to balance both perspectives: monetization and brand impact. This is, of course, especially true for passenger cars and consumer oriented mobility solutions, but B2B services also need to keep an eye on that factor.

Why is brand impact so important? Brand is a carrier of emotion and trust, which both contribute to brand loyalty or eventually even attitudinal loyalty (Chaudhuri & Holbrook, 2001). If digital services can be charged with brand value, a difficult task to achieve, this will fundamentally support customer-stickiness within the own ecosystem boundaries – the ultimate goal of each platform play (Farrell & Klemperer, 2007). OEMs have a good starting position, as they possess a high brand value which they already convert into brand loyalty. Alternatively, typical internet companies possess very valuable brands, as

they are well known, but lesser brand loyalty. They attract their users, usually the term customer cannot be applied, via *utility value*: if Google has the best search algorithm, people will capitalize on it. But no one obtains a gain of distinction by using the (free) Google search service. *Utility value* can create lock-in effects only as long as it lasts and is thus more prone to attrition: as users have no emotional tie to utility value, they easily and unsentimentally switch if another product provides more effectiveness. And they do not prefer to take all offerings out of one hand, impeding cross-selling within the ecosystem: people that use Google search do not automatically use the social network Google+ if Facebook is the stronger alternative. And users do not necessarily stick to Facebook, if Instagram is trending. This appears to be a general tendency: new technological twists create own specialized startups. Snapchat being another example. This is an interesting contrast to the own goal of tech players to diversify into conglomerates. Remarkably, tech players only found a very traditional answer to this problem: Mergers & Acquisitions (Instagram, Youtube and WhatsApp being prominent examples of such defensive takeovers).

"We rather need to compare ourselves to luxury fashion brands – and their advanced multi-channel digital service approach."

- Daimler AG

Apple is an interesting exception in this list. From the beginning they chose a different approach: Apple controls the user experience by controlling all links in the chain: hardware, software, and content. Especially the hardware component seems to be central for Apples positioning – and for brand loyalty (Martindale, 2017). This is not a free pass for customer success though: Apple had a successful content platform and pioneered online sale of music, yet Spotify popularized music streaming and Netflix occupied the media streaming market. Still, Apple has more brand loyalty and knows how to use it to cross-sell into other segments (apps being the most relevant illustration). The key: Apple creates an emotional connection with their customers (Goodson, 2011). And they combine their value proposition with confident pricing. By maintaining – and even increasing – price level, a gain of distinction is created. Internet services, by contrast, are usually free for the user (the user is the product). A free offer cannot provide gains of distinction, the haptic quality of a physical good seems to be a stronger carrier for emotion and serves as a projection screen for desires.

It can be concluded from that excursus, that digital services work differently than physical products. This has great advantages (zero marginal costs) but also significant disadvantages (focus on utility value with little brand loyalty). The Apple case shows that both can be combined and – if played correctly – they can even reinforce each other. Therefore, the other GAFA try to copy that model (Amazon developing smartphones and tablets, Google overtaking Motorola and HTC, Facebook buying Occulus Rift).

In the context of data-driven business models for automotive companies an important lesson can be derived: if OEMs possess a strong brand they need to closely watch the interplay between brand and digital services. They need to leverage their hardware competence and seamlessly combine and augment it with software and digital services. Customer experience is key in that endeavor. It is not enough to look to the absolute market size and growth rates. It is very important to invest into customer-experience-driven services, although they will in many cases not generate direct revenue and

indirect monetization effects are difficult to quantify. In other words: OEMs should thrive to use their brand to charge digital services with emotion and infuse brand loyalty. That also means: it is important not to dilute brand awareness with too many free offers and they should refrain from treating customers as a *product* for advertising.

The following diagram depicts OEM service domains in a matrix of revenue potential and brand impact:
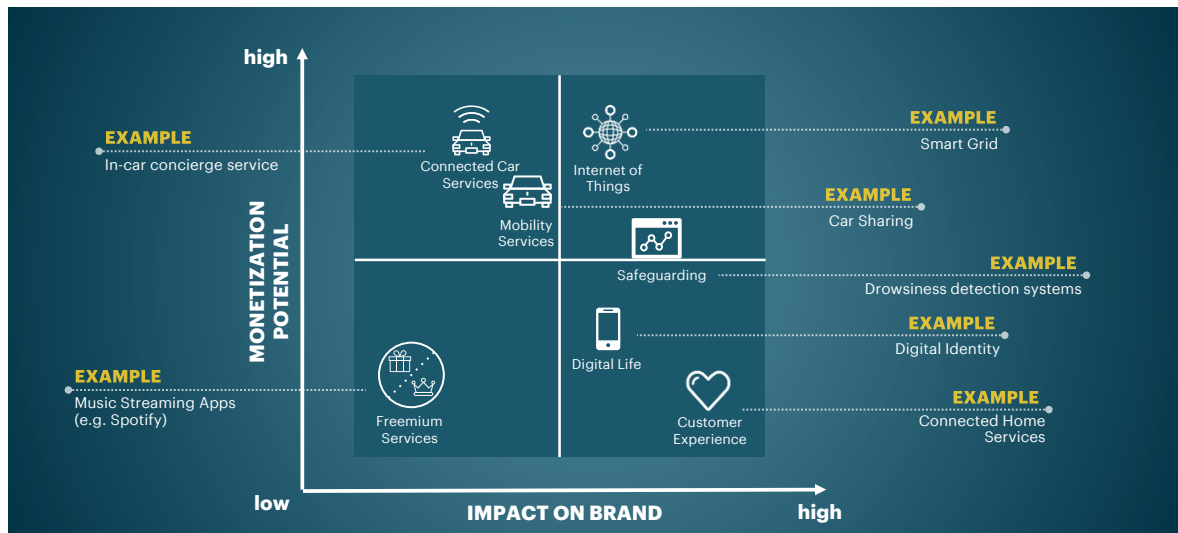
Figure 13: Service domains of OEMs

Source: Accenture

There are following take-aways:

- Depending on their kinds, data-driven services can have an impact on OEMs' brands.
- If played rightly, OEMs can leverage the power of different data-driven business models for their brand image.
- Offering free or ad-based services can have a negative impact on the brand image, especially for premium brands as the offer is not considered as exclusive anymore.

6 Status Quo of data-driven business models in Automotive

6.1 Study Design

This study follows a hybrid approach combining qualitative interviews with representatives of relevant market players with own quantitative desk research. Empirical data is derived from semi-structured interviews complemented with observations and documents. In addition, subject matter experts from the global Accenture network and the larger BVDW ecosystem were activated.

Key considerations:

- This research is based on the opinion of individual company representatives from relevant areas of expertise.
- Interview partners stem from every dimension of the data-driven business model landscape
- In total 25 in-depth interviews were conducted, mostly coming from (digital) strategy, business development or product strategy departments.
- Attention was given to ensure that all stakeholders of the ecosystem were represented to prevent a biased perspective; it is worthwhile to note though that only German entities were considered; their strategies are not limited to the German speaking world, yet global differences were not explicitly reflected. To represent Chinese players, Alibaba was included in the set. The company decided not to disclose the contents of this conversation though, as data-driven business strategy for Germany is not yet finalized. That occasion illustrates how important regional differences are – still they will not be treated in this examination.
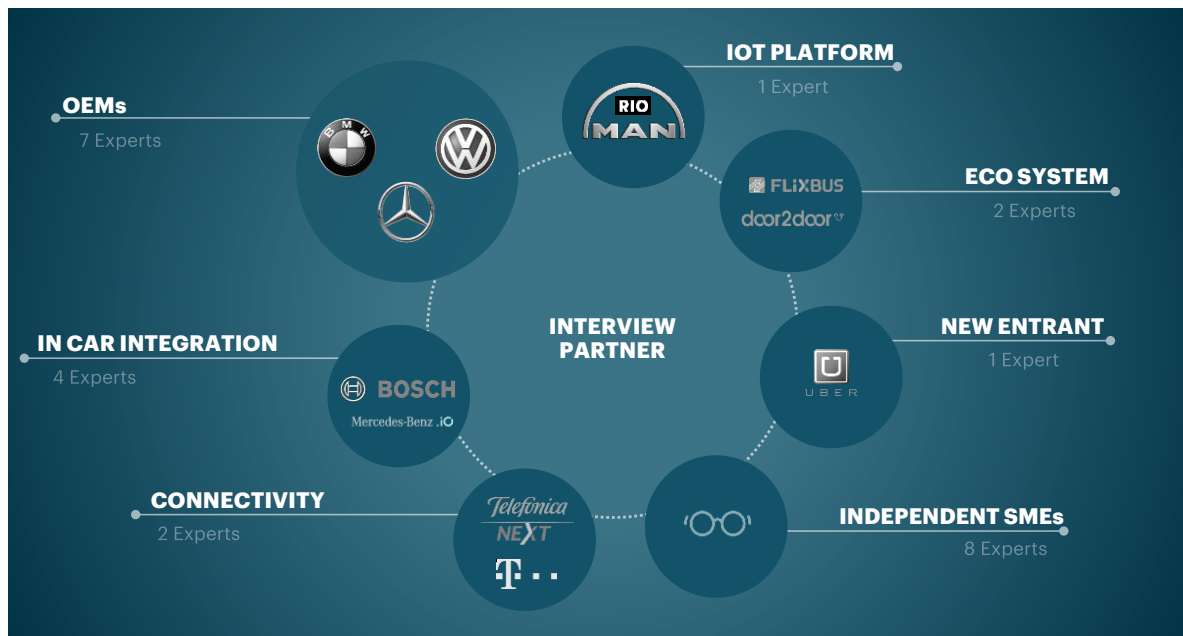

Figure 14: Interview partners of this study

Source: Accenture

6.2 Foundation of data-driven business models

6.2.1 Prerequisites for data-driven business models

Before having a closer look at data-driven business models, two fundamentals need to be considered in terms of readiness: customer and technology. Interview participants were asked if, in their experience, customers are willing to share data and pay for services. Also, it was asked whether the OEMs feel equipped with the necessary technologies. The results reflect the point of view of the interviewees, though they do not represent the general opinion of the respective company.

The aggregated valuation shows a clear perceived readiness of customers to embrace data-driven business models. The providers of data-driven services expect the foundation for respective business models to be in place now.

Figure 15: Findings in terms of customer and technology readiness

Source: Accenture

This assessment is largely consistent with the results of very broad quantitative studies Accenture have carried out elsewhere (World Economic Forum, 2015). Even though customers are ready for data-driven services, technological readiness enabling these services are lacking.

6.2.2 Emerging Technologies

According to industry experts some enabling technologies are upcoming but not yet (fully) available:

1) 5G infrastructure

The transition to faster communications with 5G will provide major advantages in terms of downlink speed, device density and latency. Also, it will allow the ability to move the cloud closer to the car (*edge computing*, *fog*), performing data processing nearer at the source of data (GSMA, 2017).

> "Next generation mobile networks will handle much more data volume, connect many more devices, significantly reduce latency and bring new levels of reliability."
>
> - BMW AG

2) HD Maps

"For self-driving cars, maps need to be ultra-accurate – and also ultra-up-to-date."

- Daimler AG

Ultra-precise, high-definition maps are important for highly automated vehicles. They allow cars to localize themselves on the road and provide real-time data on road environment and conditions. Besides, they are the foundation for location-based services. The importance of HD maps is underlined by the acquisition of the map provider HERE by Audi, BMW, and Daimler.

3) Quantum Computing

Constant communication, processing and analysis between many vehicles at the same time requires huge processing power. The quantity of processed data goes beyond everything carmakers know today. Therefore, they are currently investing in capabilities. Volkswagen for example recently announced to partner with Google for quantum computing – to optimize traffic flows, develop AI and explore battery materials (Volkswagen, 2017). Due to a lack of real-live readiness, there is no broad in-practice use of this technology today.

"Quantum Computing is a prerequisite to manage increasing amounts of data."

- Volkswagen AG

4) Blockchain

"Blockchain is a very promising, yet not fully mature technology. Now is the time to look deeper into it. Therefore, we joined Hyperledger. "

- Daimler AG

Open ecosystems form themselves as transactional value-networks in which several types of organization are loosely coupled to jointly provide customer value. These networks form a nexus of – sometimes *ad hoc* – micro-contracts that govern the relationships and recursive value activities. Decentral ledger technologies like blockchain can help to provide smart contracts for these ecosystem inhabitants and could also form a potential form of inter-device micropayments with minimized transaction costs (Glaser, 2017; Delmolino, Arnett, Kosba, Miller, & Shi, 2016; Swan, 2015).

Considering both factors – willingness to pay and technological readiness –, it becomes apparent that all included companies see a critical threshold exceeded. There might be some important future technologies missing – or in their infancy, still it seems that all key ingredients for successful data-driven models are provided. Now it is decisive who connects the dots first and is most determined to break new grounds. Are established corporations ready to outrun specialized and very nimble startups or data-driven tech giants?

6.3 Current Applications of data-driven business models in Automotive

6.3.1 Maturity Model

Based on that conclusion, the next section thrives to take stock on how advanced OEMs are in terms of data-driven business models – both in strategy and existing services.

To judge the readiness of OEMs and compare the status of their progression, a high-level maturity model was created that helps to categorize different approaches – and roughly link them to monetization strategies and revenue models.

The framework draws layers of service diversification around the current business model of OEMs. Starting with data-based enhancements of the physical product – ADAS and connected car – the model combines two main development lines: from car to mobility and from product to platform.

"IT companies are closer to the customer than OEMs (e.g. Android on the smartphone). OEMs need to build an ecosystem to observe client behaviors. IT companies have a large advantage here. As of today, they will always come faster into information."

- FLIXBUS

There is an ultimate positioning for data-driven business models that goes beyond the connected car and even beyond future mobility: it is a combination of connected life and the Internet of Things. In that final state, data create relevancy for as many aspects of everyday life as possible – what somehow elucidates the totality of the service pretension. Google is the epitome of this approach: home, work, mobility, logistics, life sciences and education – there is hardly an aspect that Google (or now rather the holding company Alphabet) does not embrace. Certainly, OEMs will not go this far but there are hard factors driving them into that direction: while focusing on mobility, OEMs will be relevant only for a very fractional time span (WNYC, 2017) – and are thus vulnerable for competition from more wholistic data players. These platforms will strive to lock-in their customers in as many dimensions as possible and monopolize the customer interface along the complete user journey. If OEMs do not want to be subordinated to someone else's business model – for example supplying cars to Uber – they need to free themselves from the *mobility trap*, gain more relevancy throughout their users' digital life and experiment with additional revenue models.

This ascending level of complexity is considered in the layer-model. Thus, the initial hypothesis is that OEMs begin their digitization efforts in concentric circles around their core business. In the last ten years, OEMs have successfully connected their products and introduced data-enabled advanced driver assistant systems to automate the driving process. This development will accelerate a lot by the gradual introduction of new technologies like HD maps or faster connectivity, but it will not entirely change the mode of operation. This more fundamental transformations will occur in the consequent layers. Each layer will present new rules, new players and new revenue models. So, the timespan for adoption will increase equally with each layer.
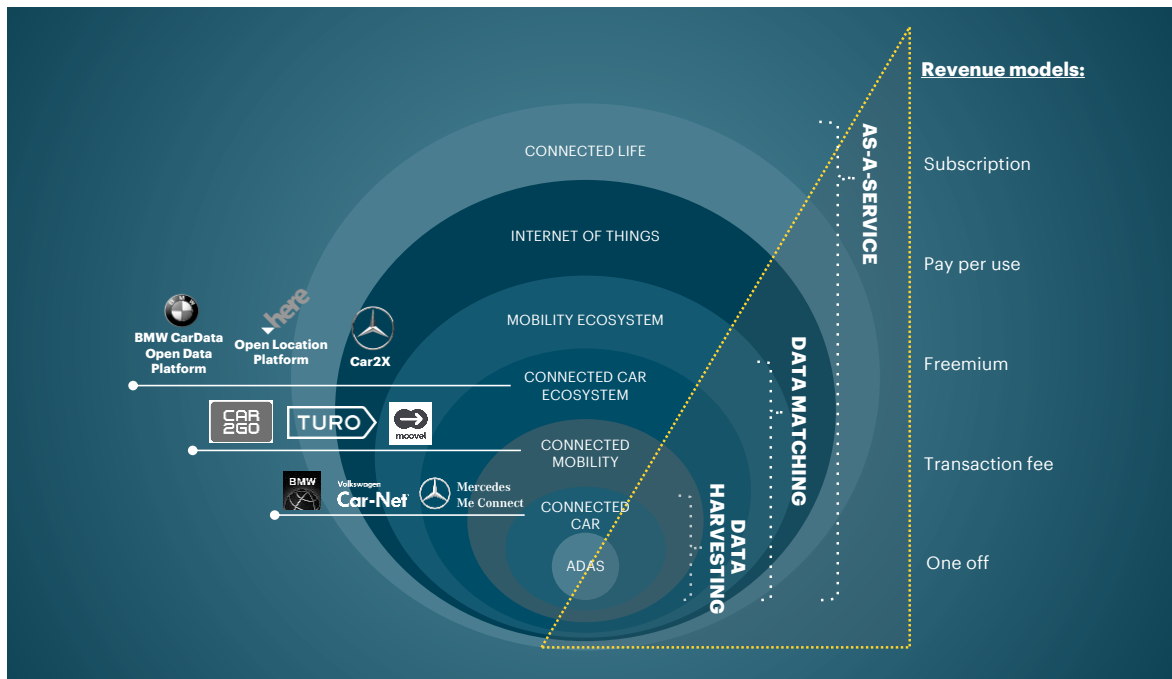
Figure 16: The model of concentric business model innovation

Source: Accenture

In line with the *concentric circle hypothesis*, this research indicates that despite existing awareness on monetization strategies, OEMs are still struggling beyond their original domain. Business models outside the traditional sphere remain rather uncharted and also other revenue models like advertising, transaction fees, or subscription find use in very nascent stages – at best.

OEMs are currently entering the *Connected Car Ecosystem* layer, experimenting with open innovation, location-based services, and transaction fees. It will take OEMs the next two decades to fully master this sector. Beyond that – on the horizon – there will be the rise of integrated mobility platforms (not pure match making like car sharing and mobility apps today) and connected digital life. The development of these markets will co-evolve with another automobile mega trend: autonomous driving. On the intersection of these trends, there might be the self-driving car as *ultimate mobile device* and *third place* besides work and home – but this will take a lot more time than the initial hype suggested (Marshall, 2017). Besides, there will be an increasing industry convergence under the label *Internet of Things*, presenting additional opportunities in B2B or even M2M (machine to machine) markets (Haijin, 2009; Baums, 2015).

With their current portfolio, OEMs are focusing on connected car and connected mobility. They are strategizing mobility-as-a-service but are not there yet. Moovel as a mobility app, for example, only focuses on matching demand and supply and has a very limited coverage of two German municipalities if it comes to booking public transportation (a status quo that took the startup more than five years to reach – illustrating the complexity of real multimodal transportation). By contrast, DriveNow and Car2Go are closer to traditional leasing than mobility platforms. As they operate with

own fleets, making it very difficult to break even, they significantly limit possible network effects. Thus, the creation of an equally represented Joint Venture (Daimler, 2018) to build an integrated ecosystem for on-demand mobility including car-sharing, ride-hailing, parking, and electric-vehicle charging, is a logical step in the attempt to confront start-ups like UBER and Lyft (The Verge, 2018). On the other hand, ownership of assets is an aspect that reaches beyond mere match-making. Only if a transportation capacity is truly owned, it can be offered *As-a-Service*, i.e. based on a guaranteed service level. Analysts believe that MaaS-providers will own their own fleets, leading to 10 million cars purchased by the MaaS industry in 2040 compared to 300,000 in 2017 (Marn, 2017). To own and combine capacity of different transportation means (e.g. by buying public transport seats and reselling them) is the step leading from *data matching* to *as-a-service* business models. As the latter is much more complex and preconditional, the two forms are differentiated here. And to be clear: startups like Uber and Lyft are operating on the *data matching* model. Currently, there is no real *as-a-service* offering in terms of mobility in this stricter sense of the term. This definition might not be generally accepted, yet, it helps to be more precise in the determination of maturity levels and trajectories.

Box 2. Automotive Platform Examples

Moovel

Within the last years, Daimler became very active in the startup scene. In this respect, their investment activities show a quite broad range, reaching from battery and transport companies to mobility and ride-hailing services. In the field of mobility, myTaxi and their subsidiary moovel are amongst the best-known acquisitions (CB Insights, 2017). Moovel offers multimodal mobility uniting several public transport providers under one roof, thus offering users a seamless mobility experience with one interface. Signing up different transit agencies proves a difficult yet more than necessary task to reach the next level of multimodality. Currently the multimodal booking service is live in Stuttgart and Hamburg. There are benefits for all players: moovel participates in the revenues of tickets and the agencies have access to generated data providing important information on movement profiles.

BMW CarData

In 2017, BMW discerned and made use of their data power. As OEM, they are located at the source of data on a massive scale. The integrated SIM offers the necessary junction to harvest and make use of the data. BMW differentiate three categories: condition-, usage-based- and event-data. In a next step, CarData is their initiative to offer these data to third parties against fees. This opens up to open innovation and idea sourcing, giving access to a wider pool of creative designers. The respective third-party companies in turn develop new products and business models based on the acquired data. Being aware that Data-driven Business Models are not yet a core competency, BMW still accomplishes to monetize their abundant data (Boeriu, 2017).

HERE Open Location Platform

The HERE Open Location Platform is born from the thought that data needs to stem from different sources and be put into a wider context to offer even more value to those who work with them. Data gathered from car sensors enter the platform as well as data from smart city systems or other IoT platforms. This data pool not only serves to enhance existing real-time services but also offers both OEMs and third parties the possibility to use it for the development of additional services (Beutnagel, 2017). In the context of connected mobility, an exhaustive data pool like the HERE platform offers the opportunity to develop advanced location-based services, thus representing an important step towards autonomous driving.

VW Truck & Bus – RIO

The enhancement of the global supply chain is a goal of Volkswagen's Truck and Bus group. Headed by Volkswagen's daughter MAN, the whole supply chain, i.e. shippers, dispatchers, carriers, drivers and more, will be connected via a uniform information and application system where data from different sources comes in and is then analyzed. The data stems from all around the vehicle, including trailers, bodies and drivers, and is in a subsequent step enriched by environmental data such as weather or traffic. Manipulated through distinct algorithms, this data can be used to deduct action recommendations and thus improve processes along the supply chain. Thinking ahead to the future, the initiative aims to integrate even more services into their system, e.g. a driver-facing interface to provide drivers' relevant information or a route management system to maximize loading along the way (MAN, 2016).

6.3.2 Industry Convergence and The Car in the Internet of Things

The ongoing industry convergence with increasing interconnectedness of then separate domains under the headline of the Internet of Things will not only transform value chains, it will eventually transform markets themselves (Winter, 2017). The car – and transportation in a wider sense – will be a vital element of this Internet of Things.

The synoptic perspective on intersecting but disjunct industry domains is a typical trade of many internet startups. Uber mission, for example, is to provide convenient and safe transportation in different areas of life. Uber combines the traditional ride hailing service with Uber Eats, a delivery service for food. Further combinations of services are possible, home health care for example. The aim of Uber is to provide convenient and safe transportation in potentially all different areas of life.

> "The car is turning into a central platform of the future. The interconnection of different services is becoming more and more important."
>
> - Uber

Already today, OEMs are also developing convergent business opportunities by cooperating with various companies to connect different living domains.

Exemplary areas of practice are energy (smart grids), chemicals (battery materials, chemical feedstock), logistics and insurance. Electrification is one driver: BMW, for example, cooperates with Viessmann regarding digital energy solutions (Kaesberg,

2016). Daimler's subsidiary Accumotive is building batteries and home energy storage units for private homes. Also, other IoT domains are interesting areas for diversification: all OEMs experiment with logistics solutions, be it delivery to trunk scenarios or last mile delivery of goods leveraging drones. Additionally, the OEMs seek for partnerships to deliver location-based services, usage-based insurance and payment. Daimler for instance recently overtook Paycash Europe to fund Mercedes Pay, and BMW acquired Parkmobile. Toyota just launched Japan's first usage-based insurance service (G-Link automobile insurance).

All these new digital services are data-enabled. Artificial Intelligence as the most important *general-purpose technology* of today is driving this domain convergence (Brynjolfsson & McAffee, 2017). Companies that possess data processing capabilities can try to adapt their algorithms to fit the requirements of other industries. Therefore, most of the large internet companies diversify at some point in time and eventually transform themselves into conglomerates. Because of this, OEMs see them as *frenemies* and hesitate to work too closely together to avoid dependency. On the other hand, OEMs need to diversify themselves, leveraging their data and their analytics competence. Still, this service proliferation has its limits, as the list of discontinued projects at Google demonstrates (Gabbert, 2015). This reconfiguration of value chains will lead to new forms of collaborations, *frenemy* being a good heading, the rise of industry consortiums and cross-industry collaborations combined with a constant reassessment of make-or-buy decisions (Wirtz, 2001; Wirtz, Göttel, & Daiser, 2016). In fact, in many cases it will not be make-or-buy, but make-and-buy – giving rise to hybrid forms of collaboration with shared IP, like software developed on a ready-to-use *Platform-as-a-Service* stack.

> "When it comes to data services, collaboration is key. No car maker can tackle the challenges on its own."
>
> - Audi AG

Especially, to operate in the connected lifestyle area or the Internet of Things, it is inevitable to cooperate. Competitive advantage will be determined by the strength of partners and ecosystems rather than by the strengths of a single company (Carbone, 2009).

OEMs are already exploring several forms of syndicated collaboration, both intra- and cross-industry. The business fields in which those models are applied are constantly growing. Currently it ranges from HD Maps and location-based services via Charging and Autonomous Driving to Federated Identity. The economic logic is always the same: as OEMs, especially the premium brands, do not have critical mass, they rather join-up before they leave an important field to the tech giants. To the extent in which platform players widen their reach, OEMs react with collaborative approaches. For example: while Facebook, Google and Twitter are successfully proliferating their federated logins, OEMs run danger of losing data and customer contact. In order to prevent this, Daimler and HERE joined Verimi, a cross-industry initiative, that strives to provide a common digital identity. Whether all these initiatives will succeed or not is open. It is interesting, how fast and creative OEMs are reacting to those threats by embracing different forms of collaboration.

Figure 17: Converging areas of the Internet of Things

Source: Accenture

Box 3. Industry-led Consortiums

HERE

The core competency of Europe's biggest map provider lies in the creation and provisioning of high-definition map data, a prerequisite for autonomous driving. Having understood the need for collaboration in this field, the German premium OEMs Audi, BMW and Daimler acquired HERE in 2015. Virtually displaying the environment on a sufficient level of detail is nothing one OEM can accomplish on its own but requires an interaction between all participants. This cooperation is a strong antipode to Google's supremacy in the field of environmental data and thus a major step in the race for autonomous cars (Hucko, 2018).

Car2Go / Drive Now

The race for mobility services is on, yet not finally settled. With taxi services like Didi and Uber pressing into more and more markets, the German answer is an equally represented Joint Venture between the two car sharing services Car2Go and DriveNow – in total serving a customer basis of around 4 million people. Their fusion will save considerable costs through the integration of the IT infrastructures of both providers that will still be run under their independent brand names (Daimler, 2018).

Autosar

Autosar is a collaboration of several automotive companies, including BMW Group, Daimler, Bosch, Continental, Ford, GM, PSA, Toyota and Volkswagen with semiconductor manufacturers, software suppliers and tool suppliers. The aim is to establish a de facto open industry standard for an automotive software architecture.

Hubject/Ionity

To promote customer acceptance of e-mobility, OEMs and other relevant ecosystem players cooperate on different e-mobility initiatives. To this end, BMW, Bosch, Daimler, EnBW, Innogy and Siemens founded Hubject in 2012, enlarged by Volkswagen in 2016 (Volkswagen, 2016). Hubject is Europe's largest e-roaming platform offering a billing integration system to abolish isolated solutions and create a seamless charging experience (Hubject, 2018). Towards the end of 2017, the German OEMs allied again in the field of e-mobility, taking on board Ford. With Ionity, they start one of the biggest initiatives to date for super-fast charging stations. Their goal is to build a network of charging stations along highways across Europe enabling long-distance traveling with electric vehicles similar to Tesla's Supercharger network (Hägler & Mayr, 2017).

Car Connectivity Consortium (CCC)

The CCC is an industry collaboration in developing global standards and solutions for smartphone and in-vehicle connectivity. The 75 plus members represent more than 70% of the world's auto market. The technology portfolio includes MirrorLink, Digital Key and Car Data. After the successful launch of MirrorLink, which is available in millions of cars, CCC has also expanded its portfolio to Digital Key, where smartphones are used to gain access to the car, and Car Data, which builds ecosystems for services such as usage-based insurance, diagnostic, driver health/behavior monitoring, ride hailing and sharing etc.

GENIVI

GENIVI is a nonprofit industry alliance with more than 140 participating companies. From OEM side it comprises BMW Group, Honda, hyperloop/one, Hyundai, JLR, Daimler, Nissan, PSA, Renault, and Volvo Cars. The alliance joins connected car stakeholders with software developers to provide a free, open source middleware for In-Vehicle Infotainment (IVI) software and other open technology for the connected car.

5G Automotive Association (5GAA)

The 5G Automotive Association (5GAA) is a global cross-industry alliance with strong automotive involvement. It focuses on end-to-end solutions for future mobility and transportation services (Cooperative Intelligent Transportation Systems). Created in 2016, the 5GAA unites a large member base from automotive, technology, and telecommunications industries, including eight founding members: AUDI, BMW Group, Daimler, Ericsson, Huawei, Intel, Nokia, and Qualcomm. A key enabling technology is wireless V2X communication (vehicle-to-everything) including vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), vehicle-to-network (V2N), and vehicle-to-pedestrian (V2P). 5GAA seeks to make 5G the ultimate communication platform for mission-critical driving functions.

Mobility Open Blockchain Initiative (MOBI)

In May 2018, a group of auto and tech companies formed a consortium to develop automotive-related blockchain use cases. Among the members are Ford, GM, BMW, Renault, Bosch and ZF. Hyperledger is listed as an affiliate. The goal of MOBI is to identify blockchain use cases around the entire mobility services chain, starting with vehicle identity and history. Other possible areas of use are congestion fees, pollution taxes, usage based insurance, car and ride sharing, mobility commerce and autonomous machine payments.

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Box 4. Cross-Industry Consortiums

Verimi
Pressured by federated login solutions of internet companies like Facebook, Google and Twitter, several players of different industries teamed up to form a Europe-wide alternative. Verimi is a consortium of numerous renowned players such as Axel Springer, Deutsche Bank, Allianz, Daimler, Lufthansa, HERE, the thinktank Core, Deutsche Telekom and Bundesdruckerei. Their aim is to build one master login to their customers to enable easier and safe online business. In the long run, Verimi aim to become the German answer to existing platform business models, helping the participants to build and develop their digital competencies and giving customers the chance to build their own digital identity while keeping their data superiority within Europe (Lipinski, 2017).

BMW-Intel-Mobileye: Autonomous car partnership
Back in 2016, BMW, Intel and the Israeli camera expert Mobileye started a cooperation with the intent to build up a technological platform for autonomous driving. Turned into a business model it can be sold on to other OEMs (BMW Group, 2016). All participating partners see great chances in combining their respective competencies and thus increase influence and speed while reducing costs (Reuters, 2017). Over time, the alliance took in new members from different backgrounds, such as car parts supplier Continental, system integration specialist Delphi, or the Korean auto manufacturer Hyundai (Handelsblatt, 2018).

Volkswagen-Nvidia-Bosch: AI cockpit
In 2017, German OEM Volkswagen and the Artificial Intelligence computing specialist Nvidia entered into a strategic partnership to develop an AI cockpit with a self-learning intelligent assistant to assess user needs based on situational data (Volkswagen, 2017). Also, Volkswagen's subsidiaries like Audi are to benefit from this cooperation. Just shortly after the announcement of the cooperation, Nvidia partnered up with Bosch who are currently developing an AI super computer to be integrated into autonomous vehicles based on Nvidia's technology. For the AI specialist, Bosch opens an extensive network for sales activities across industries while the German auto industry supplier benefits from Nvidia's AI tech advances (Etherington, 2017).

Hyperledger
Hyperledger is an open source initiative hosted by The Linux Foundation. It has the goal to advance cross-industry use of blockchain. To that end, it combines companies from finance, banking, Internet of Things, supply chains, manufacturing, and technology. The mission is to build a new generation of transactional applications that establishes trust, accountability, and transparency, while streamlining business processes and legal constraints. The result is an operating system for marketplaces, data-sharing networks, micro-currencies, and decentralized digital communities. In 2017 Daimler joined as a premier member and obtained a seat in the Hyperledger Governing Board.

Concluding, one can say that together with an ecosystem of complementary partners (value network), OEMs can reach further from their existing service portfolio and also tap the potential of more complex and mature services (Christensen & Rosenbloom, 1995; Allee, 2000; Peppard & Rylander, 2006).

7 How to Master the Next 30 Years Ahead

Figure 18: Recommendations derived from the study

Source: Accenture

1)   As prerequisites are given, start experimenting with new monetization models

In the formative years of the internet era, a constitutional principle of the developing *internet society* was a pronounced *free and sharing culture* including open access, open source, and peer-to-peer sharing. This culture was aggravating the development of business models and hampered the commercial use of web services and mobile apps. Still, that led to creative indirect monetization models like freemium or advertising maintaining the free use culture and yet introducing commercialization options. That boosted innovation sourcing and flourished independent app development. Nowadays, the culture has changed, the internet has commercialized and new monetization models like transaction fees, in-app-purchases or subscription models arose. Users are willing to pay for enhanced services that generate value. And the parallel advancement of technology leads to more mature digital value propositions. In this day and age, users are fully accustomed to fee-based streaming services (Spotify, Netflix, …). Unlike the media industry, OEMs do not need to initially explore the kind of services users are willing to pay for. They should rather develop value proposition based on different monetization models. One example where that currently takes place is fractional car ownership (like the startup Orto where up to four people can own a luxury car together) or subscription-based mobility services (Singh, 2018).

2)   Expand beyond mobility to conquer share of mind

OEMs need to reach beyond the car and widen the focus to customer-centric, end-to-end mobility platforms. This will evolve into rich as-a-service business models. To do so,

they will experiment with different augmentations to their current value proposition to close existing gaps in a comprehensive customer journey. OEMs will build customer-centric models, underpinned by customer experience design, to keep the customer on own touchpoints for as long as possible. A good example is Renault who recently bought shares in a media company – a publisher of five magazines – in order to respond to new ways of content distribution, especially in the context of automated driving (Hezard, Texier, & De Latude, 2017). Daimler took over Paycash Europe and transformed it into Mercedes Pay to benefit from the trend of e-payment transactions in evolving customer ecosystems. BMW and Daimler, like Tesla, try to diversify into home energy storage, a small but growing market that will help to connect cars to the energy grid – and eventually enable decentral prosumer business models around the smart city (Muoio, 2017). In 2017 Daimler has acquired a stake in Anagog, a mobility status company, to widen its reach into smartphones and everyday life. The startup has developed a software which analyses user behavior directly in the mobile phone or other wearables with the aid of the various on-handset sensors, without the need for backend servers. On the basis of AI, it predicts future movement scenarios. Through this data analysis, the mobile handset understands what the users are doing and the environment in which they are located. This means that various contextual services can be generated to improve user experience across the user`s daily life journey.

3) Build digital ecosystems, leverage open innovation, foster platform business models and build-up value networks

Ronald Coase has theorized commercial corporations in his classic 1937 essay on the *nature of the firm* as contractual entities that use internal organization to reduce transaction or information costs within its boundaries (Coase, 1937; Moore, 1993; Moore, 1996). Ecosystems – a contractual nexus in itself – will add a new chapter to this theory (Kilpi, 2015). They constitute contractual relationships outside a firm that – leveraging internet technologies – provide considerably less transactional costs than corporations can, and increase competitive advantage (Dovev, 2006; O'Reilly, 2015). Digital ecosystems are based on technologies like APIs, event-driven architectures, microservices, or decentral verification technologies like blockchain. They are open, customer-centric, end-to-end oriented and offer standardized means of transaction between various diverse, multi-industry-based entities (Chesbrough, H. W., 2006; Schlagwein, Schoder, & Fischbach, 2010). They lock-in clients and constantly strive to diversify to serve ever-broader customer needs. Digital business ecosystems offer access to global capabilities in an unprecedented way (Gawer & Cusumano, 2014). OEMs need to adapt their positioning and either join existing ecosystems, forge their own, or do a combination of the two. This increasingly means that collaboration between OEMs – especially for premium brands – is essential in order to reach a critical mass. This gradually evolving frenemy model between competing OEMs – that will also eventually blur company boundaries – needs to be iteratively spelled out, especially in terms of operating model, revenue sharing, talent distribution, and monetization strategy.

4) Reach beyond the car and even beyond mobility to tap into cross-industry opportunities

Cross-industry ecosystems will reconfigure today's value chain into a value network of *prosumers* that alternately produce and consume data in co-creation (Ancarani & Shankar, 2003; Venkatraman, El Sawy, Pavlou, & Bharadwaj, 2014). Industry convergence gradually surfaced in 1995 when Hotmail started to converge postal industry and information technology leading to a tremendous shift in communication. Beforehand distinct areas like smart home, smart city, smart grid, logistics, health, financial services and others get connected by digital technologies and emerge into an end-to-end seamless customer journey. This is what convergence is about: the merging of distinct areas into a unified whole. The Internet of Things does exactly this – a development that presents one of the most fundamental growth opportunities for organizations today. Based on digital technologies, digital convergence will redefine industry boundaries by shifting the focus from individual products to cross-industry value experiences. Since decades ago, IT has been used by organizations, traditionally focusing on efficiency and productivity of labor. Current digital technologies bring process automation to the core of the business, enabling real transformation that impacts products and customer relationships. As IT is integrated to cars, transport systems, payment tools, postal services, medical devices, household appliances, and many other products and services, companies orchestrating the customer journey can analyze the customers' digital footprint to better understand their behavior and create personalized value propositions. Organizations that first launch these digital business innovations have the potential to disrupt their industry and leapfrog their competitors.

For OEMs that is a threat and an opportunity alike. On one hand, they can diversify into a myriad of novel business areas, on the other hand, their core business can be absorbed by other organizations, in pursuit of their convergence objectives. The success of any cross-industry value experience depends on a thorough ecosystem strategy with the right choice of partners and a carefully executed industry expansion strategy.

5) Update your organizational model

Digital businesses need a different organization. This is not just about agile and self-organized processes, to an extent it is also about new roles and business archetypes. Examples are: platform managers, ecosystem orchestrators, co-creation leads, data monetization managers, digital quality managers, and chief AI-officers. Such new roles require novel capabilities, not just as individuals, but also as an organization, especially regarding culture. Organizations will pull different levers – from digital labs, incubation, open innovation and digital ventures, *acqui-hiring* and others – to acquire the right skills and startup like cultural elements.

8 Conclusion

In 2050, OEMs will generate 50% of their revenue from data-driven services. They will have very different operating models compared to current times (ecosystem, alliances, consortiums, …). To get there, they will need to undergo a monumental cultural transformation in at least four dimensions:

- OEMs need to anchor AI on group level and route it deep in their corporate strategy – this requires new roles and capabilities – Chief-AI-Officer or Ecosystem Orchestrator would be an example.
- OEMs need to capitalize on additional rents that are generated by hosting digital ecosystems – organizational repercussions are not yet reflected but there will be totally new processes, revenue models, incentive schemes, and roles that need to be managed at board level.
- Hardware will be augmented by software and algorithms. The smartest interplay of the three will generate the best customer experience and thus provide the best customer lock-in.
- Premium car manufacturers possess a very valuable asset: an emotionalized brand. This is an advantage they have over tech companies which they need to leverage for digital services. This will demand for a rigidly customer-centered approach with a clear focus on end-to-end experience.

This cultural transformation will be a gradual one. Unlike fears in the past, digital transformation in automotive will not be a big-bang disruption. It appears that the shift from "zero marginal cost economics" to the "Economics of Internet of Things" (Niyato, Lu, Wang, Kim, & Han, 2016, p. 136) will rewrite the rules of the game. The new digital services will be *asset-based*, requiring engineering capabilities and brand assets. Tech players expected that they could attack the automotive industry by the same rules as they did with other industries – which proved wrong. On the way, the GAFA needed to bury many of their visions, especially the ambition to build cars themselves. This stunted momentum and gave initiative back to OEMs. They have all introduced digital service units and now have enough time to prepare for more disruptive change around what they call CASE or ACES (Autonomous, Connected, Electrical, Shared). These trends are taking place more gradually than expected, leaving OEMs with possibilities to shift their budgets and build capabilities.

There is also additional threat from reshuffling cards that presents itself to OEMs: due to pressure from tech players, they have pivoted their business to digital and astonishingly quickly adopted key success factors. The industry is in front of a next frontier – Artificial Intelligence – and OEMs need to be very careful that they do not miss to catch-up. As they successfully managed the first wave of transformation, there is a danger that they do not rest on their laurels. They could be tempted to underestimate the threat as they have successfully mastered the first wave of disruption. That stance would not only be a misjudgment of the ongoing forces, but it would also put OEMs in danger of missing out on a fundamental opportunity to lead the way into a new paradigm where they can play out the core strengths of their business DNA.

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