Chapter 5
Vision Digitised Automotive Industry 2030

In the previous chapters, the relevant drivers, determining factors and influencing criteria were described as the basis for the development of a vision and roadmap of digitisation in the automotive industry. The performance and the spread of IT are advancing with unreduced momentum and exponential growth. The basic statement of exponential performance remains as Moore's Law will continue to apply with new technologies such as neuromorphous chips which are moving towards product maturity. Digital Natives enter the labour market, and with their experiences and their own value system they bring new behavioural patterns to the corporate and customer world. There are a variety of "disruptive technologies", such as Cognitive Computing, 3D printing, Robotics with ever more flexible and efficient devices, or in the future the Nanotechnology with Foglets.

As a result, there are many technical possibilities to address digitisation in an expedited manner and to maintain and expand competitiveness. Traditionally, however, the automotive industry is comparatively slow in the implementation of comprehensive changes and transformations. This industry is accustomed to operate in the development periods of new vehicles with cycles of 4–6 years and is thus in no way compatible with the rhythm of, for example, the smartphone or App development, to which, as a rule, successor products are presented within 1 year. Parallel to the implementation of digitisation, the industry faces many other challenges. The market demands electric drive, connected services and autonomous-driving cars. The new car buyers are slowly approaching the life stage of "best agers", while the young people of today assign less importance to owning a vehicle. Many young persons do not even hold a driving license. Instead, mobility services and sharing models are in demand.

To date, the automotive industry has been in a secured position against new entrants due to the capital-intensive manufacturing facilities, the extensive marketing and sales structures and also the required after-sales services. However, this situation is changing fundamentally. New framework conditions and opportunities along the digitisation are now encouraging new competitors from other sectors as well to enter the automotive market. They put pressure on the established companies

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which must fundamentally transform themselves in order to maintain market positions. In addition to Tesla Motors with its focus on electric drive and direct distribution over the Internet, Apple, Google and Faraday Future are particularly noteworthy, which are pressing ahead a lot with autonomous driving. In China, corporations from outside the automotive industry, such as Baidu and Alibaba, signalise their upcoming market entry. These companies have comprehensive IT experience and bring this knowledge to the electrification, connected service and mobility services. These newcomers will surely use established suppliers, in analogy to Apple with their Chinese production partner Foxconn, to cost-effectively manufacture large portions of the vehicles. This allows to launch new vehicles faster. Large factories with a high manufactoring depth level are no longer in a distinguishing position in the market. Rather, IT-driven solutions, connected services and innovative drive technologies are increasingly in demand as a buying criterion.

In this situation, it is vital for the established automotive companies to tackle the necessary changes under a comprehensive digitisation strategy and roadmap. This is developed in the following. The starting point is an analysis of the future expectations of the market and the customers, as well as a brief assessment of the current strategies of selected manufacturers. This will be compared with a vision of how the automotive industry could develop and how it could look in 2030 with the implementation of digitisation initiatives. Understanding customer expectations is the key for recommendations to adapt the business strategy in line with an integrated digitisation strategy. For this purpose, a framework is developed in Chap. 6, which ensures that all necessary measures are addressed in an integrated program or on the basis of a holistic roadmap.

5.1 Development of the Automotive Market

The car market is currently developing differently, depending on the country. Despite all warnings, the market in China continues to grow, currently at a moderate single-digit annual growth rate. China is and remains the most important car market in the coming years with regard to sales volumes and also increasingly as an innovation driver. The USA, the second largest market in the world, is similar to Central Europe on a stable level following recovery. Challenges have to be adressed in Brazil and Russia. The market in these countries will continue to stagnate in the medium term. There is a wealth of opportunities in ASEAN, especially in Indonesia, and also increasingly in Africa. The global car market has a total volume of approx. 78 million units sold in 2016, and an annual growth of approx. 3.4%, thus overall a stable situation [Dud15]. This is underpinned in a study by McKinsey in collaboration with Stanford University, from which Fig. 5.1 is lent.

The study estimates on the basis of comprehensive expert interviews in Asia, Europe and the USA that the sales of the global automotive industry will go up from approx. $3.5 trillion in 2015 to about $6.7 trillion in the year 2030. This would correspond to an annual growth rate of 4.4%. Within this overall turnover, new mobility

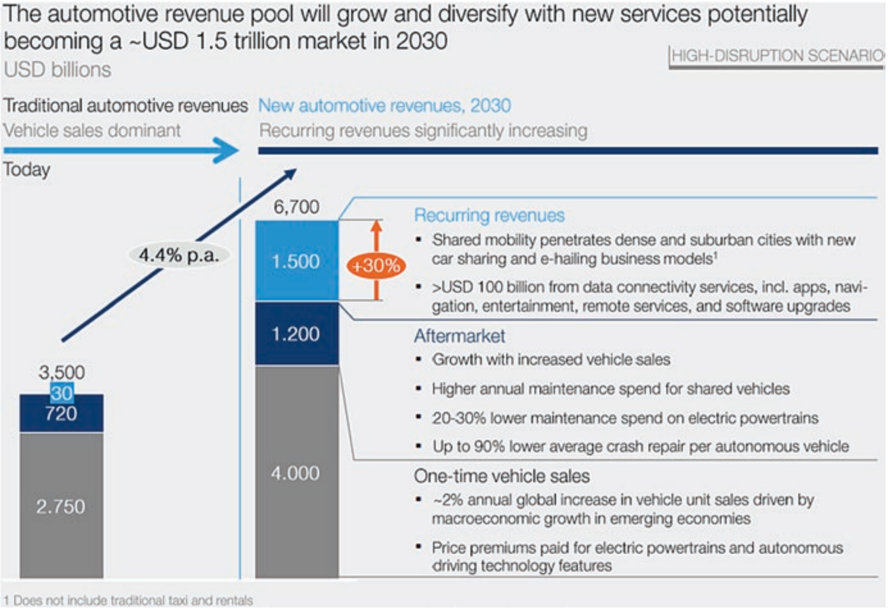


Fig. 5.1 Development of the automotive market by 2030 [Kaa16]

offers and revenues from Connected Services are growing at an annual rate of 30% and thus are the driver of the overall rise. The revenue share from traditional vehicle sales is moderately rising at 2%, similar to revenues from the after-sales business, which are rising from $720 to $1200 billion, despite the reduction due to lower service costs for vehicles with electric drive and less revenue from accident repairs due to falling accident numbers in the area of autonomous vehicles. These revenue reductions are more than compensated for by the increase in the number of vehicles and by additional services from the "shared vehicles" segment.

Even if growth in vehicle sales and revenue is projected, the automotive market is undergoing a massive upheaval, on the one hand due to the new market participants and technologies, on the other hand due to a fundamental change in customer behaviour. This is characterised by the following overarching trends:

- Urbanisation … with the consequences of traffic congestion and environmental pollution
- Cars generally losing their character of a status symbol … use instead of ownership
- Digital Natives behaviour pattern … focus on connectivity, sharing, mobile work
- Environmental awareness and ecological aspects of driving
- Flexible mobility services … mobility easy to retrieve, without brand reference
- Growing health and physical awareness … bicycle instead of car
- Lifestyle customisation / individualisation

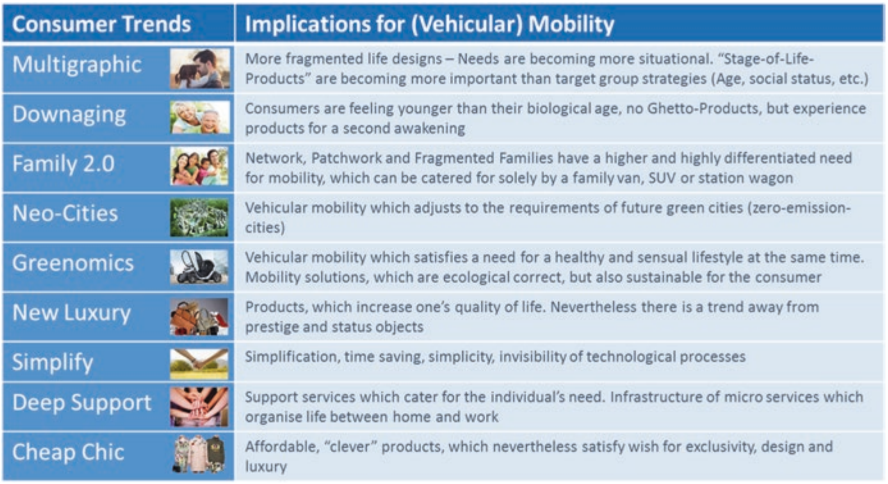
These trends will have a major impact on future market development.

5.2 Future Customer Expectations in the Passenger Car Area

In addition to these trends, there are various consumer trends which reflect social developments and the spirit of time. With the "Digital Natives", one of these behavioural patterns has already been explained in Chap. 3. In addition, there are further consumer trends. These must also be analysed and reflected in future vehicle and mobility offers. A clear summary of other consumer trends is shown in Fig. 5.2. Some of these trends are briefly discussed below.

The consumer trend of "multigraphy" describes the social situation that today, compared to the times of our parents, there are more and shorter life stages, which are also each designed and equipped with mobility. For example, there are often several partnership phases and also several employers with different occupational focuses. The personal hobbies have become more demanding and are often assigned to life phases as well, from wind surfing and skiing to golfing. The requirements with respect to vehicles and mobility offers are determined situationally as per these relatively short-term life stages. For the automotive industry, this trend indicates, that the segmentation of vehicle types will continue, and high individualisation is also required of mobility offers. One example of this are the innovative Audi offers "Select" and "Shared Fleet" [AUDI16].

In the Select offer, the customer does not acquire a specific single vehicle yet the rights of use on up to three different types of vehicles from a pool of young attractively equipped used cars, which are then appropriately used one after the other, such as the convertible for the summer period, the estate with loading space for phases with renovation works, and the sedan for long business trips. Another example of flexible usage models is the "Shared Fleet" offer, which is aimed at companies with a vehicle fleet for employees. A car sharing solution enables via a booking portal the flexible use of individually selectable Audi models of employees, both for work and private trips, outside of working hours. Through this opportunity of pri-



Consumer Trends	Implications for (Vehicular) Mobility
Multigraphic	More fragmented life designs – Needs are becoming more situational. "Stage-of-Life-Products" are becoming more important than target group strategies (Age, social status, etc.)
Downaging	Consumers are feeling younger than their biological age, no Ghetto-Products, but experience products for a second awakening
Family 2.0	Network, Patchwork and Fragmented Families have a higher and highly differentiated need for mobility, which can be catered for solely by a family van, SUV or station wagon
Neo-Cities	Vehicular mobility which adjusts to the requirements of future green cities (zero-emission-cities)
Greenomics	Vehicular mobility which satisfies a need for a healthy and sensual lifestyle at the same time. Mobility solutions, which are ecological correct, but also sustainable for the consumer
New Luxury	Products, which increase one's quality of life. Nevertheless there is a trend away from prestige and status objects
Simplify	Simplification, time saving, simplicity, invisibility of technological processes
Deep Support	Support services which cater for the individual's need. Infrastructure of micro services which organise life between home and work
Cheap Chic	Affordable, "clever" products, which nevertheless satisfy wish for exclusivity, design and luxury

Fig. 5.2 Consumer trends in the automotive market [Win15]

vate use, companies can increase the utilisation of their fleet while offering their employees interesting mobility alternatives. Similarly, many offers may be devised to take up the multigraphy trend.

Another important consumer trend is the “downaging”, especially relevant to the automotive industry, as the elderly are a very important group of solvent buyers. The life expectancy continues to increase, and people, even at the age of retirement, are of increasingly better physical fitness and more and more behave like younger people. This generation of “best agers” has developed into an active social class to which cars are an important part of their lifestyle. More than a third of all new car buyers are older than 60 years [Wit15]. In addition to an overall concept that emphasises the sporting lifestyle, one purchasing criteria is also comfort which meets the personal needs. A higher, more comfortable entrance into the vehicle, seat- and steering wheel adjustment as well as electronic assistance systems are frequently selected equipment features. These are interesting for the margins of automobile manufacturers. Previously often ridiculed staid sedans with the crocheted paper roll cover on the parcel shelf are definitely no longer in demand. As the downaging trend will grow in the future along with the corresponding economic power, the automotive industry should continue to focus on this customer group with vehicle and mobility offerings, in particular in terms of user-friendliness.

The “neo-cities” trend reflects, on the one hand, the trend of increasing urbanisation and the growth of the population in the big cities and, on the other hand, the efforts of many cities to become ecologically cleaner or “greener”, up to “zero-emission” targets. Copenhagen was certainly a pioneer with its dedicated promotion of bicycle traffic within inner-city areas, but nowadays many other cities are taking initiatives in this field. One example of this is the eco-programme “Future London – Footprints of a Generation” [Wen12]. The aim of the project is to promote the green lifestyle in the metropolis. In addition to advice on sustainable behaviour, there are tips for Londoners on stores with organic food and fair trade products.

The offerings of the automotive manufacturers must fit in with such environment. To embrace this trend through green mobility offers could even lead to additional market opportunities. London is just one example. In many other cities, too, efforts are made to reduce the individual car traffic through different restrictions. For example, in Sao Paulo, vehicle usage is only permitted on every second day, being administered by the even/odd vehicle identification number. In Beijing, the total number of vehicle licences is severely limited, and in Singapore only vehicles with at least three occupants are allowed at peak times. This, incidentally, brings up quite new odd jobs: getting on the car as a “third man”, so the required number of passengers is reached. These examples reveal that this trend also has a major impact on the vehicle industry.

The same applies to the trend summarised under “Greenomics”, which not only affects mobility yet also affects other industries as well as cities and regions. A healthy and sustained lifestyle is establishing in all population sections. In nutrition, sports and travel, these aspects are more and more included in the planning and purchase decision. This is also increasingly true for vehicle acquisition or rather the fundamental decision whether a car is purchased at all, or mobility offers are used instead. A purchase decision is grossly influenced by fuel consumption and climate-

1. Greenovator	Mobility is closely linked to careful use of resources. Members are well-informed about consequences, cost, etc. of mobility and are looking for innovative solutions
2. Family Cruiser	Families are becoming increasingly fragmented, which leads to a growing degree of mobility. Modern family set-ups are characterised by a growing mobility effort
3. Silver Driver	They are consuming a lot and happily, are mobile, variously interested and very active in their leisure time. High willingness to spend, modern consumer habits, sense of quality of life and pleasure
4. High-frequency Commuter	Highly mobile people, which demand for mobility mainly relates to the regional areas. Big City commuters, which need to be flexible and mobile especially within metropolitan areas
5. Global Jet Setter	People who move regularly between different global cities. The change in the values is obvious: targeted search for exclusivity within the premium segment
6. Sensation Seekers	Mobility is closely tied to attributes like freedom, fun and lifestyle, Mobility is still related to status and prestige, "Pure Driving Pleasure" will stay an element of the modern lifestyle
7. Low End Users	This group relies on mobility and will downgrade the related effort if generally possible. Looking for the cheapest offers to secure the necessary mobility

Fig. 5.3 Mobility types in the "mature markets" [Win15]

relevant values. In the case of mobility offers, simplicity of use and sustainability are the most important criteria, and the price/performance ratio is rather of minor importance, whereas in contrast to earlier days, engine output and maximum speed almost do not matter anymore. This fundamental change in values has captured many people, especially in the established countries, and will develop even more in the face of climate change and resource shortages. This is also an important trend for the automotive industry.

The consumer trends shown in Fig. 5.2, such as "New Luxury", with the attitude turning away from prestige towards immaterial values such as quality of life, "Simplify", with the strong trend towards the focus on the essentials, "Deep Support" with the desire for complexity reduction and simple support services, or "Cheap Chic" with its focus on quality and premium at reasonable prices, are also very relevant to the automotive industry and provide hints with regard to the future orientation of products and range of offerings. Also, there are certainly further trends, such as the "DINKs" (double income, no kids), which are an interesting customer segment just because of their purchasing power. Furthermore, individual consumer trends and the megatrends described are often overlapping.

For this reason, it is important to carry out an appropriate target customer segmentation, depending on the market. The relevance of the outlined trends varies according to the "maturity" of the market and the specific market position of the manufacturer. For example, for some Chinese or Indian customers in some customer segments, prestige and engine performance are buying criteria, while the German "Greenomics" focus on sustainability and CO_2 emissions. For the Internet and sports-minded Brazilians with tight budgets, smaller SUVs with easy-to-use Connected Services are important. On the basis of the trend patterns, mobility types can be defined, which, in turn, represent possible customer target segments, which are to be addressed. In the "mature markets" such as the countries of central Europe, Japan and the USA, between the following mobility types shown in Fig. 5.3 can be distinguished in future, refining the insights from Fig. 5.2 and the cited study.

One of the most relevant mobility types is the "Greenovators" (an artificial word derived from Green and Innovator), which will account for more than 30% of the population in North America, Western Europe and Japan by 2020 [Kaa16]. As the term expresses, this group is focusing on sustainability and innovation. Quality of life, conservation of resources and environmental compatibility, in line with the interest in new drive technologies, are important criteria in decisions to purchase a vehicle. This does not necessarily mean ownership, but also mobility- or sharing models. Important are coherent ecological concepts. “Silver Driver”, “Global Jet Setters” and “Sensation Seekers” certainly are typical consumer groups of established markets. In contrast, the emerging markets are not so finely segmented. These are more about attracting the basic consumers, yet in parallel the prestige-oriented luxury buyers as well.

However, further deepening of this aspect is not expedient at this point, so please refer to available studies on the Internet and in the literature, e.g. [Kaa16]., [Wen12], [Sta15]. This abstract’s objective was to highlight the importance of this topic. From the outset, the customer and market understanding must be taken into account in the business and digitisation strategy and roadmap to be derived from it. The change is massive and challenging in particular for established manufacturers who have to carry out this analysis on an in-depth basis, since the proven customer segmentation of the past is certainly not the target orientation of the new market players. Against this background, the question arises as to how well automobile manufacturers are currently positioned when it comes to customer orientation and especially digitisation.

5.3 Digitisation Situation in the Automotive Industry

To this end, a brief study on the digitisation circumstances of some established automobile manufacturers was carried out. A large number of information sources, such as annual reports, investor relationship publications of companies and specialist articles, were analysed and evaluated on the basis of uniform criteria (as of 08/2016). For this purpose, the following parameters have been defined, since these allow, from the author’s point of view, the assessment of the respective digitisation strategy:

- Orientation towards customer expectations
- Transformation Sales / After-Sales
- Development of company culture towards digitisation
- Digitisation of business processes; Industry 4.0 up to Business 4.0
- Connected Services
- Mobility Services
- Autonomous Driving
- Collaboration with incubators
- Transformation of IT

Especially the changing customer expectations should be the basis of the business strategy and the derived digitisation strategy. Proper products, offered through preferred sales channels and flanked with desired after-sales services are success requirements. To this extent, it was analysed as to whether the manufacturers define a clear market and customer segmentation and are already active in projects for transformation of the sales channel. Today, the Internet already plays an important role at least for product analysis and comparison in the run-up to product acquisitions. The importance of the Internet as a sales channel will continue to rise significantly, thereby heavily changing the role of car trading.

An important success criterion for digitisation is the transformation of the whole enterprise culture towards a willingness and also "an appetite" to tackle this topic with openness and joy. This is not about individual organisations or just "the IT". The topic is a broad project and concerns everyone in the enterprise. Especially Germans like to remain in established procedures and tend to see changes as a threat rather than an opportunity. The transformation measures must however begin with changing this attitude, so that company-wide digitisation can be achieved, thus enhancing competitiveness, or at least maintaining it vis-à-vis the new competitors. Thus, in this field, the analysis evaluates the extent to which transformation initiatives are already being implemented in the companies.

Another realm of research is the digitisation of processes, both in production with Industry 4.0 initiatives as well as in all other business areas. From this perspective, it can be assumed that nearly all business processes can already be automated with today's IT solutions. However, economic considerations are frequently in the way since necessary solutions are in many cases still more expensive than human labor. With the increasing efficiency of the applications, the degree of automation of the business processes will increase significantly in all domains. In this respect, the research evaluates the extent to which the manufacturers are already in the subject of process digitisation.

Many customers expect at least the Apps that are used by the smartphone to be available in the vehicle too. The handling and the flexibility of Connected Services provided by manufacturers should be just as easy – including updates of the solutions to eliminate problems or to add additional functionalities. Many manufacturers or solutions currently offered are often still far from this. Nevertheless, this vision is the benchmark, and the analysis rates the extent to which Connected Services are available and what the response of the customers is.

Furthermore, it was examined whether the manufacturers already offer mobility services or at least have established closer partnerships with corresponding service providers. The entry into autonomous driving and cooperation with incubators to speed up digitisation activities was analysed as well as transformation initiatives to dynamise IT and position it as a core component of a reoriented company. It is important that the traditional IT work more closely with the IT in the car development in order to create mutual synergies and ensure compatibility between the "embedded IT" in the vehicles and the traditional IT.

The difficulty with the evaluation of the publicly accessible sources for the analysis is that the sustainability of the projects and initiatives reported can not be assessed due to a lack of internal detailed knowledge, and the unclear probability of realization of announcements, which roll over each other in the "hype topic" of

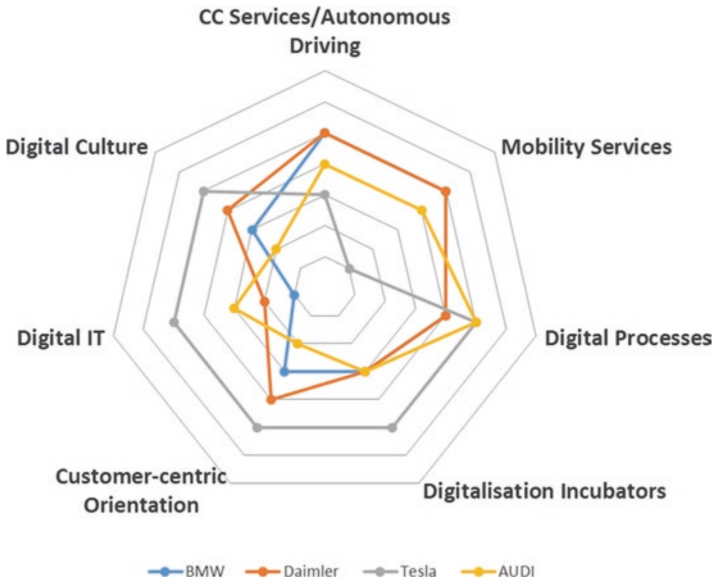


Fig. 5.4 Digitisation depth premium manufacturers (basis: Internet research author 08/2016; details in Annex A2)

digitisation. The following presentation and the benchmark are to be looked at against this background. Nevertheless, since this applies to all analysed manufacturers, the overall trend should be meaningful. A summary of the research results is given in Figs. 5.4, 5.5 and 5.6. Details and background of the research can be found in Annex A2.

Figure 5.4 shows that the premium manufacturers are more advanced than the volume producers in the digitisation activities. In particular, there are more reports on initiatives to transform the company culture, and also the cooperation with incubators is established. Tesla Motors is the benchmark amongst the premium manufacturers. As a new company in the "born on the web" industry, it is precisely its customer centricity, the digital company culture and the automated processes based on a highly efficient IT Cloud which the established manufacturers cannot cope with. Sales exclusively via the Internet, just supported by a small number of showrooms mainly in large shopping centers, as well as the update of the vehicle software "over the air", are benchmark as well. It is interesting however that the established manufacturers apparently are ahead with offers on mobility services, or Tesla does not yet see a focus here but can catch up relatively quickly.

For the volume producers, the result is a mixed impression (Fig. 5.5). Volkswagen seems to be well on track in cooperation with incubators, autonomous-driving plans, and initiatives to transform corporate culture, while the company lags behing with respect to mobility service offerings, business process digitisation, customer orientation, and transformation of the IT. In the field of process digitisation, Toyota

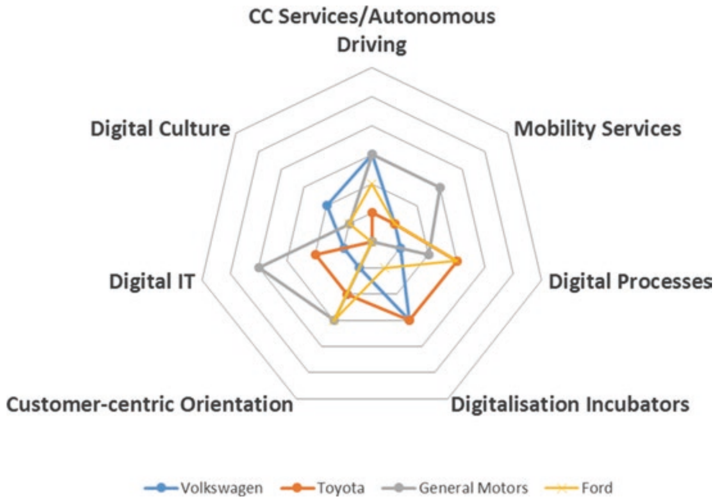


Fig. 5.5 Digitisation depth volume manufacturers (basis: internet research author 08/2016, details in Annex A2)

reports broad initiatives. Ford and General Motors are leading the field in customer-oriented sales/after-sales.

The study summarises the current digitisation state of affairs in the automotive industry in Fig. 5.6. The subject was launched by all companies with high priority. In summary, the following backlogs and uncertainties arise from the study:

- Definition of target customers or markets
- Adaptation of business strategy and focus
- Definition of adjusted sales structure incl. target figures
- Integral digitisation strategy – vision; roadmap
- Roadmap for the transformation of corporate culture

These deficits are to be addressed through an integrated business and digitisation strategy. Before this is developed as a proposal, the following is a description of how the automotive industry could look by the year 2030.

5.4 Vision Digitised Automotive Industry

The author draws now a vision of the automotive industry in 2030. This outlook is based on many years of experience and practical insights in the IT sector in various business areas of various manufacturers in Germany and abroad. These experiences

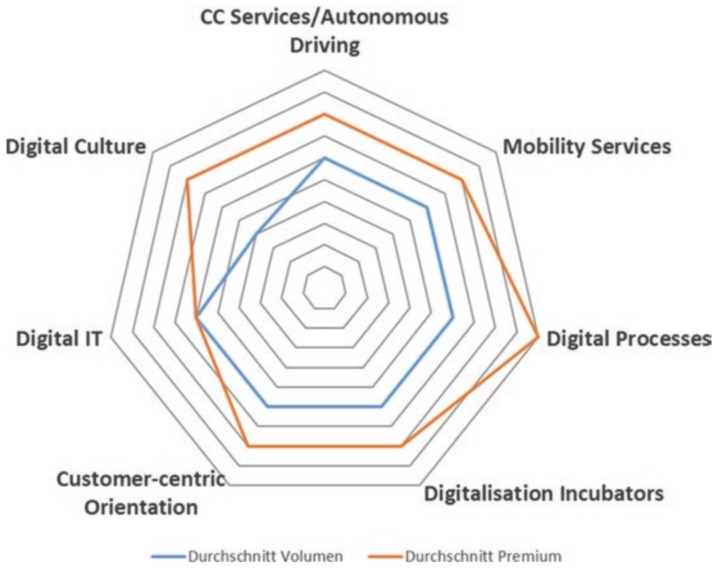


Fig. 5.6 Digitisation depth mean values premimum and volume manufacturers (basis: Internet research author 08/2016, details in Annex A2

are supplemented by cooperation in expert committees, and the implementation and evaluation of IBM Automotives studies [Sta15]. Furthermore, the drivers and influencing variables of the digitisation and the changing market expectations and situations explained in the preceding chapters are taken into account. Against this background the following hypotheses will characterise the digitised car industry by the year of 2030:

- In the industrialised countries, especially in the big cities, the ownership of cars will fade into the background, and the market will be characterised by mobility services. In today's emerging economies there is still a buying market, particularly in the basic and luxury segments, whereas in the megacities vehicle ownership is also retreating into the background.
- Mobility services are mostly accessed via brand-independent platforms. These include intermodal connections, i.e. the integration of different types of traffic and also the integration of inner city offers.
- There will be new forms of mobility services. For example subscription or flat rate concepts, similar to today's mobile phone contracts. Also price stagings depending on vehicle type or the willingness to drive together in vehicles, similar to a shared taxi will come up.
- In order to optimise capacity utilisation and reduce congestions and waiting times, mobility providers are using a higher-level of traffic control, comparable to today's airspace monitoring of air traffic.
- Autonomously driving vehicles, in particular buses, taxis and also the cars of new mobility providers, make up at least 30% of the vehicles in the large cities,

covering more than 50% of the mobility needs in the cities, taking into account the increased levels of utilisation.
- Electric drive and extensive Connected Services, also from vehicle to vehicle, are integrated in all new vehicles and support new mobility concepts. Updates of the embedded software are supplied in short cycles “over the air”.
- Connectes Services of the vehicles and Apps on the smartphone are fully synchronised so that the same solution environments are available in both worlds in the same functionality and on the same data status.
- The “embedded vehicle IT” is based on central servers, additionally with backup servers for security and as an accident recorder, quasi a “black box”, similar as in today’s aircrafts.
- Vehicles are no longer designed on component platforms, but the core element becomes the central computer, similar to the approach of smartphones. Many equipment elements are connected by software as required, similar to today’s server equipment.
- Augmented Reality is established as an essential part of the car development process, so that the number of prototypes required is halved, and test drives take place to a considerable extent in virtual environments.
- The sale of vehicles takes place at least 50% via brand-independent portals directly over the Internet. Virtual Reality solutions support the vehicle configuration. The presentation is done in the “home megaplex centre”, quasi a temporary virtual private sales room.
- The number of traders in the industrialised countries is massively reduced. Successful traders are involved in the provision of mobility services.
- The production structure of the manufacturers is adapted to the markets: in the emerging markets, the focus is on mass or rather assembly line production; in the “mature countries” for ever more customised vehicles, manufacturing islands with a high level of robotics in close collaboration with workers characterise the manufacturing environment.
- 3D printing of components and spare parts is part of new production and logistics concepts.
- There is an surplus of production capacity. New providers use this in open production networks.
- IT services are at 80% based on Cloud environments. These are not operated by the manufacturers yet rather by special providers from their mega data centres. Desktop systems are completely replaced by mobile terminals, which are operated by voice and gesture control.
- Assistance systems are established in many business areas and also directly in the vehicles. These support the users proactively and constantly learn to increasingly better satisfy the customer requirements individually.
- At least 50% of the business processes of the automotive enterprises are automated.

The main hypotheses are explained and substantiated in the following.

5.4.1 Mobility Services Instead of Vehicle Ownership

The urbanisation keeps progressing massively. Today more than half of the world's population already live in so-called megacities of more than ten million inhabitants. This trend continues, and in 2030 more than two-thirds of the world population will be living in such cities, with likely some giant cities with more than fifty million inhabitants, as well as a large number of new megacities which as per today one would not necessarily expect to grow to this level [Gri15], [Dob15]. As many of us may have personally experienced during long hours in traffic jams, today's traffic situation is no longer acceptable at peak times in the big cities, such as Sao Paulo, Beijing, Mexico City, Paris and Moscow for instance. Environmental impacts and also time losses due to the viscous "flow" of traffic are forcing new technologies and mobility concepts. Also the other consumer trends towards sustainability and acceptance of sharing rather than ownership especially appeal to younger customers, at least in the cities,.

That is why in 2030 the private car traffic in the cities will be reduced significantly, and the street scene will be characterised by autonomous-driving cars used in open mobility concepts. The charging infrastructure will be established, along with greatly improved ranges, especially due to improved battery technologies [Thi15]. In the cities, the image of car ownership will be similarly stigmatised as is smoking in "mature countries". The situation in the "new emerging countries", such as Indonesia, Namibia, Colombia, China and India, and also inevitably in rural areas, such as the "vastness" of the USA for example, will be different. In these regions there continues to be a buying market, whereby the vehicles are bought on the one hand with smaller, highly efficient engines and appropriate equipment in the low, highly competitive price segment, and on the other hand the luxury segment with corresponding prestige character will be in demand.

The mobility services are easily accessible via internet platforms. In addition to vehicle mobility, other services are also offered, for example, "traffic-type-overarching" or intermodal bookings, incorporating the complementary transport systems, such as ferries or suburban railways, which are necessary, or just as an alternative, to get to the destination. Optionally, further offers such as ticket systems for the theatre, hotel bookings or Smart Home functions can also be requested, for example, for the timely start of house heating.

The use of the mobility service platform is voice-controlled. The solution recognises multiple users and supports them individually during the booking process, taking into account habits and preferences from previous bookings. Different service levels for mobility are offered, ranging from luxury class cars from specific manufacturers with chauffeur for individual journeys, to shared services with several passengers, using available ride capacities, regardless of any specific model, with some halts along the way. The price structure will be based on the respective service level, with subscription and flat rate models being available as well. Today's providers such as Uber or Lyft already offer creative commercial concepts and also very flexible options to require a service, and it can be assumed that this trend leads to further new business models.

Similar to today's air traffic, there will be a higher-level traffic control, also comparable to the digital shadow in the subject area of Industry 4.0 (see Sect. 5.4.9). In this higher-level traffic management system, all vehicles are recognised precisley by their current location and usage, not only autonomously driving cars, yet private vehicles with a driver can arrange to get recognised as well and thus receive information on traffic management and also become a potential provider of rideshare opportunities. The traffic management system will handle mobility service requests according to the required service level, and also organise the routing of traffic with minimum congestion. This information can also be used in new service models.

The use of mobility services via the platform and with the supported technologies is very convenient for the customer, and especially in the cities, more and more users will accept this offer instead of car ownership. Enterprises with company car fleets will establish alternative models and offer their employees the necessary mobility services instead of investments in individual vehicles. Due to the high levels of utilisation, prices for the services will be on the decrease and lead to growing acceptance, in the sense of the chicken/egg effect. From the author's point of view, brand-independent platform operators will gain an edge over the manufacturers as operators, since the breadth of the offering, similar to today's overnight accommodation platforms, is rather accepted by customers in the "neutral" offer. Furthermore, customers request mobility services independent of the brand, i.e. brand loyalty becomes of minor relevance.

5.4.2 Connected Services

Another important business area for the automotive industry is Connected Services. Today approx. 30% of all new vehicles are equipped with this technology. In 2030, however, all new vehicles will be "connected". The market for these services is establishing itself and is expected to grow from approx. €100 billion in 2020 to a volume of €500 billion by 2025. Over the service life of an interconnected vehicle, it is possible to generate additional revenues in this field of approx. €5000 [Gis15]. These figures impressively underline the importance of this topic. Connected Services not only are an essential prerequisite for the efficient design and comfortable use of mobility services but also provide the basis for new business models. Figure 5.7 examplarily shows an overview on possible services and functions [Wee15].

In addition to the mobility solutions presented in the centre of the display, solutions are also presented which are of interest to drivers, such as navigation, weather and office services, as well as services to interact with urban infrastructure, such as toll and road conditions, and also services in after-sales, such as remote diagnostics and maintenance. Moreover, examples from the infrastructure, such as car parks, as well as from the insurance sector for personalised policies taking into account the individual driving behaviour, are shown. This diversity of topics underscores the

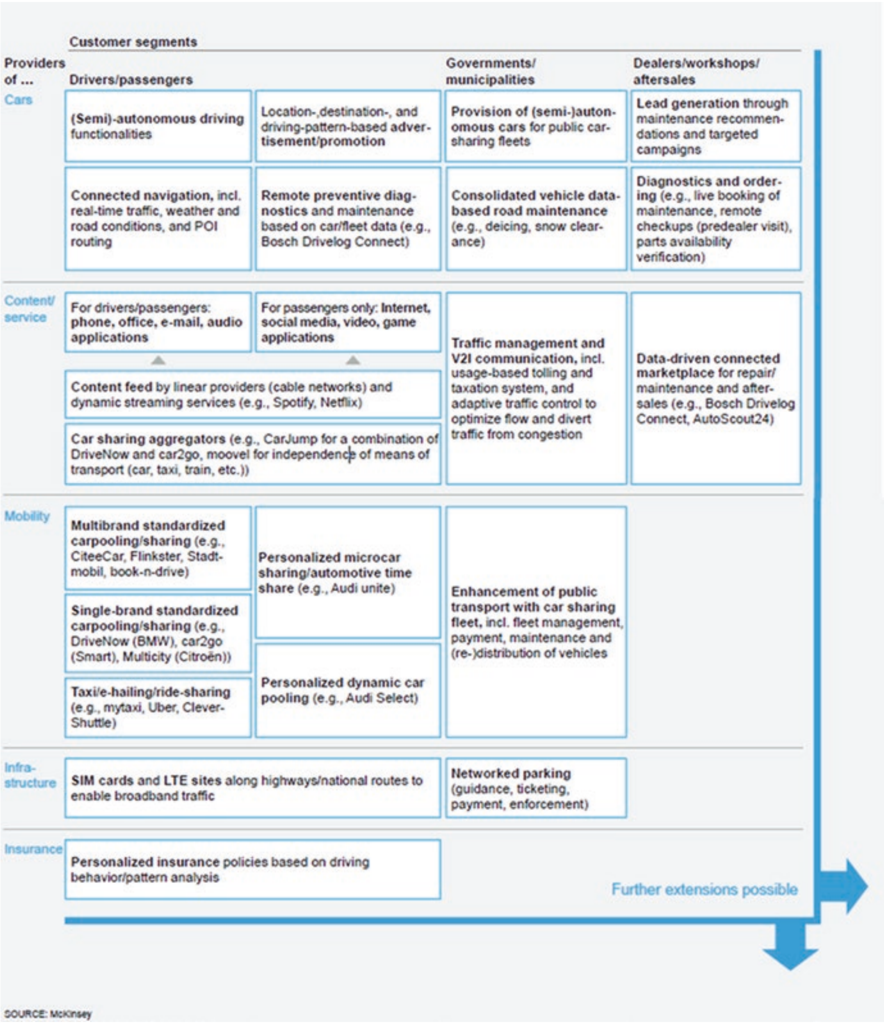


Fig. 5.7 Services and functions in Connected Services [Wee15]

fact that Connected Services are desired by almost all customers and seen as an important differentiating feature in choosing a car.

In addition to the examples shown, further possibilities arise through innovative use of the immense amount of data available via the Connected Services. A large volume of data is generated by the signal transmitters integrated in the mechatronic components for process monitoring and control. The growing number of sensors and cameras required to run systems for driving assistance up to autonomous driving provide a high volume of data as well. This information can be connected and evaluated with data from the vehicle environment and the Connected Services. This results in valuable new insights, such as patterns of driving behaviour, details for the generation of high-precision maps, or precise information on the background of wear and failure. This information can, in turn, form part of new business models.

These examples underpin the potential of Connected Services to open up new business areas. It is therefore to be assumed that by 2030 new providers are established in this sphere and in the business use of "Big Data". In addition to the purely vehicle-oriented offers, new business opportunities will be created through the integration of Smarter Cities and accompanying services such as in insurance and marketing. This naturally raises the question for the manufacturers of which positioning in this new business environment can be taken. During the Automotive News World Congress 2016 in Detroit, Audi America's Chairman, Scott Keogh, summed it up by saying that through the competition and the decision on the leadership in Connected Services and its relating platforms it is being decided of who will in the future be the one who operates the "profitable bar in the hotel".

5.4.3 Autonomous Driving

Similar to Connected Services is the topic of Autonomous driving as an objective and vision with every manufacturer and also with new competitors and suppliers on the agenda of many initiatives and projects. After first research projects and pilot activities were published in the 1990s, the topic received special attention when Google announced such vehicle project in 2010 and subsequently introduced a fully autonomously-driving car in 2014 without pedals and steering wheel [Cac15]. Meanwhile the Google test fleet operating in California around Mountain View, where the Google HQ is located, is a common sight in the everyday street scenery. Other manufacturers are also in road tests with pilot vehicles; for example, Delphi and Audi with tests in the USA, Volvo in Oslo, Daimler-Benz in Germany, also with autonomously-driving trucks, and first driverless taxis in Singapore [Gro16]. Autonomous driving therefore constantly develops into production maturity. On the way to this, more and more automation and assistance functions are offered in today's production vehicles. For this technology field, standardised classification steps are established in gradation of the evolutionary transition of the control function from humans to automats. In addition to definitions of the German Bundesanstalt für Straßenwesen (Federal Institute for Highways), the classification of the SAE (Society of Automotive Engineers) is established, as shown in Fig. 5.8 [SAE14].

In the first three stages, starting from "technology-free driving" through assistance up to partial automation, the supremacy over the vehicle while driving is in all situations in the hands of the driver, such as acceleration and steering, or the observation of the traffic situation, with all the necessary responses. Only general functions, such as keeping lane and distance, are taken over automatically by a system in level 2. In Level 3 to Level 5, three stages of automation are classified, from highly automated through to complete automation in which the vehicles without steering wheel also move without a driver. The development towards autonomous driving takes place with the established manufacturers in evolutionary steps. In series vehicles, especially in the upper segments, systems of Levels 2 and 3 and thus the introduction to automation are established. Market demand and customer acceptance are

Level	Name	Narrative Definition	Execution of Steering and Acceleration/ Deceleration	Monitoring of Driving Environment	Fallback Performance of Dynamic Driving Task	System Capability (Driving Modes)
***Human driver* monitors the driving environment**						
0	No Automation	the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a
1	Driver Assistance	the *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	Human driver and system	Human driver	Human driver	Some driving modes
2	Partial Automation	the *driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	**System**	Human driver	Human driver	Some driving modes
***Automated driving system* ("system") monitors the driving environment**						
3	Conditional Automation	the *driving mode*-specific performance by an *automated driving system* of all aspects of the dynamic driving task with the expectation that the *human driver* will respond appropriately to a *request to intervene*	System	**System**	Human driver	Some driving modes
4	High Automation	the *driving mode*-specific performance by an automated driving system of all aspects of the *dynamic driving task*, even if a *human driver* does not respond appropriately to a *request to intervene*	System	System	**System**	Some driving modes
5	Full Automation	the full-time performance by an *automated driving* system of all aspects of the *dynamic driving task* under all roadway and environmental conditions that can be managed by a *human driver*	System	System	System	**All driving modes**

Fig. 5.8 Definition of automation levels for system-assisted driving [SAE14]

		Technological Maturity	Potential for Innovation
Technology within Vehicle	Sensory Monitoring of Driving Behavior	High	Low
	Sensory Monitoring of Environment	Medium	High
	Control Unit and Vehicle Software	Medium	High
	Human-Machine Interaction	Medium	High
	Actuator Technology	High	Medium
	Trip Data Storage	High	Low
Technology outside of Vehicle	Location and Map Material	Medium	High
	Car2X Communication	Medium	High
	Telecommunication Infrastructure	Medium	Low

Fig. 5.9 Maturity and innovation potential of automated driving solutions [Cac15]

constantly increasing in line with the offered comfort and attractiveness of prices. The required technology components for achieving further automation levels are available, but these are in different degrees of maturity, as shown in the overview in Fig. 5.9 [Cac15].

The figure shows the technologies, both inside and outside the vehicles which are required to establish solutions for automated driving. The respective technical maturity as well as the innovation potential of the components are assessed. The degree of maturity is, for example, in sensor technology, in the communication capabilities and in the map material in the upper middle range or "near-series state", and the innovation potential is mostly high. From the experts' point of view, there is thus no

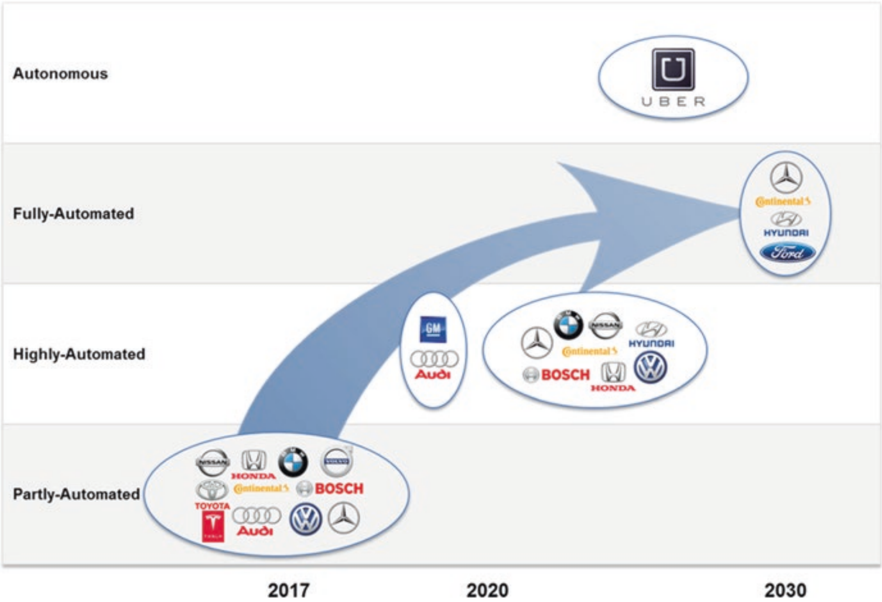


Fig. 5.10 Roadmaps for automated driving [following Cac15]

obstacle to a market introduction of highly automated driving in 2020. Consequently, many manufacturers and also suppliers are envisaging fully-automated vehicles by 2030, evaluated in the IAO study, and shown in Fig. 5.10.

The graph shows the announcements made by manufacturers and suppliers as to when production maturity of vehicles in different degrees of automation will be achieved. It can be assumed that due to the competitive pressure and the large number of announcements, the target of fully automated vehicles will certainly be reached by 2030, despite minor setbacks. In addition to the evolutionary steps of the established manufacturers, new suppliers, such as Uber and Tesla, and certainly further suppliers as well in the future, such as Baidu and Alibaba for instance, will "attack" directly at the level of Autonomous Driving. By 2030, the currently widely discussed legal framework will have been created precisely with regard to liability issues. The operational performance of the communication infrastructure will also be established to ensure the necessary vehicle/vehicle and vehicle/manufacturer-backend dialogues, as well as communication from the vehicle to any new business model partners.

This development towards autonomous driving is clearly marked and developing continuously, so that this technology can not be qualified as disruptive in character as there is no surprise moment. Autonomous Driving is however bringing outright new possibilities to redesign the mobility services offerings. In this field, new business models are to be expected, which will put established offers into question entirely. Some ideas are these:

- Autonomously-driving shared taxis
- Urban district mobility … residential areas intelligently sharing autonomous vehicle fleet

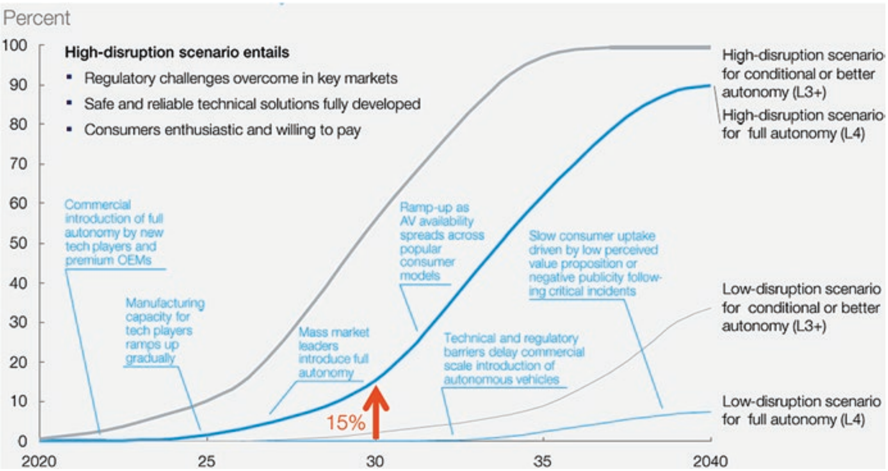


Fig. 5.11 Share of autonomous vehicles in the new car business over time [Kaa16]

- Company platforms … mobility instead of company cars
- Logistics cloud … e.g. autonomous delivery services for spare parts
- Supply chain platforms … autonomous delivery of production lines
- Medical service by health insurers … autonomous vehicles for elderly persons to transport to the doctor
- Autonomous delivery services of purchases
- …

The common characteristic of these ideas is that services and autonomous mobility are bundled into new, comfortable offers and then become easily accessible via internet-based platforms. Operators of the platforms are often IT-affine new competitors, which then due to the scalability of the Internet solution and the fast market maturity of the new service ideas quickly take significant market shares from often established providers. The manufacturers must (re-)position themselves here as well and prepare for this type of competition if they are to succeed.

With the constantly improving general conditions and also the growing possibilities on the basis of this technology to open up new business opportunities, the share of autonomous vehicles in the new car business is continuously increasing. Figure 5.11 shows a forecast.

The picture depicts the development of the share of autonomous cars in the new car business by the year 2040. Four different scenarios are analysed, which each differ in the vehemence with which the new technologies and business models are absorbed by the market. Furthermore, it is assumed that today's barriers in the areas of law as well as remaining technological hurdles are resolved. Within this framework, a market share of 15% is predicted in the middle scenario by 2030, between 4% in the conservative scenario and 50% in the progressive scenario. Beyond the year 2030, another significant share of business is seen, partly with exponential growth.

It can be assumed that most autonomous vehicles are not used by private individuals, but are used within new mobility and service models, especially in large cities. From this, the author deduces his hypothesis that in 2030 at least 30% of the vehicles drive autonomously in the Megacities. This is taking into account the higher levels of utilisation covering more than 50% of the mobility needs in the cities, so that through the autonomy and the new mobility services offered by platforms a "disruptive" upheaval in the automotive industry is imminent. As a result of the increased use of vehicles in mobility services, the new car market will at least be significantly reduced in the megacities, certainly for the time being still being compensated by the growing demand in the emerging countries.

5.4.4 Electromobility

The currently increasing traffic density, namely in the big cities, leads to massive environmental pollution, for example by carbon dioxide, particles and noise, too. This development is not acceptable anymore and many efforts are underway to change this situation. In addition to offering mobility services, the automotive industry also aims to reduce consumption and pollution levels by using lighter materials, design measures and the use of smaller engines. These technological methods are not to be detailed within the framework of this book. However, electromobility is to be discussed here as another area for solutions to environmental issues, since this technology also plays an important role in the topic of digitisation. In addition to the environmental aspects, a driver of electric mobility also is the fact that the supply of fossil fuels is limited.

At the beginning of the car introduction, electric drives were the preferred drive technology around the turn of the century, and around the year 1900 most cars were driven electrically in the USA. In competition, however, the combustion engine quickly began to dominate. The arguments were the higher range and a fast growing petrol station infrastructure and thus the very parameters, which are the focus of the current discussion about the spread and acceptance of the electric drive. Furthermore, in this discussion the environmental balance of electric drives in comparison with combustion engines is now questioned frequently. In this context, not only the energy consumption for the driving but the entire life cycle of the vehicle type should be compared, for example, with respect to production, service and also scrapping. Furthermore, it is decisive for the assessment of the environmental balance of how the required electricity is generated. Regenerative processes, which increasingly contribute to the energy mix in Germany, are particularly environmentally friendly. With the proportion of this "green power generation" currently being achieved in Germany and observing the entire life cycle, electric mobility achieves significantly better environmental values than internal combustion engines [VDI15].

Combustion engines using natural gas or biofuels are also considered clean. Advantages of the electric motor are in its high energy effectiveness with an efficiency of more than 90%, while combustion engines perform at around 35% [VDI15].

In addition, the assembly of electric vehicles is considerably simpler, since many parts such as gearbox, fuel system and exhaust system are eliminated, making them considerably easier to manufacture and also significantly cheaper in terms of maintenance. The special feature of the "engine brake", i.e. he fact that the vehicle can be decelerated without using brakes, adds to the high efficieny and also to low brake wear; the brake energy can be fed into the battery, while in the conventional brake system it just fizzles out as heat.

The electrical energy required for the operation is currently provided by batteries as energy storage for almost all vehicles. The energy density of today's batteries is considerably lower than that of diesel or petrol. This low density leads to very large-volume, heavy batteries and to a relatively short range of electric vehicles. For this reason, many research projects around the world aim to improve battery technology, thereby improving the range at acceptable weight, volume and price. An alternative to the battery, and a parallel development focus, is to produce the energy on board the vehicles via hydrogen fuel cells. The maturity of this technology clearly lags behind that of the battery.

As a result of the massive research efforts undertaken by all manufacturers as well as the clear consensus among policy makers and customers that electricity is the preferred climate-friendly and sustainable solution, it is to be expected that by 2030 a considerable proportion of the new cars will have a pure electric drive. Available serial cars of some manufacturers underpin this hypothesis. Especially Tesla Motors, currently benchmark in the range of its standard vehicles, with its investment in charging infrastructure and the construction of a gigantic battery factory together with Panasonic in Nevada, is the driver of the development [Lan16]. Many manufacturers offer hybrid drives, i.e. the combination of combustion and electric drive, to bridge the range problem. From the author's point of view, these will by 2030, with the solution of energy supply, be less in demand and play just a minor role.

In Germany, according to the ideas of the Federal Government, one million electric vehicles will be on German roads by 2020, with the aim of reducing the carbon dioxide emissions by 2020 by 40% below the 1990 level. China plans to launch five million electric vehicles by 2020 and initiated support programmes and infrastructure projects. Also the UK, France, Norway and Japan have ambitious targets, and purely battery-driven electric vehicles gain market significance. There is extensive literature and numerous studies on electromobility, which also provide prognoses for development [VDI15], [Kor12], [Wie13], [Bra16]. For example, Fig. 5.12 shows the situation of the most important markets.

The graph shows the sales figures in major automotive markets in a year-on-year comparison of 2014/2015 as sums for purely electrically-powered vehicles versus hybrid models. By far the leading market for electromobility by volume and also growth is China, thus underpinning the strategy of technology leadership. The considerable state support shows effective there, with the goal of achieving a strategic position through technology leadership. The US is behind certainly also as a result of the currently low petrol prices, while in Europe the UK, France and Norway are characterised by high growth rates and Germany by growth at a low level. The

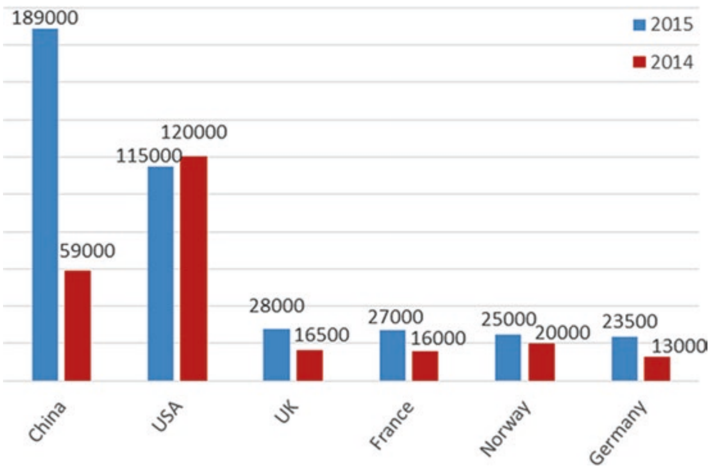


Fig. 5.12 Electric vehicle sales situation (incl. hybrid vehicles) on a year-to-year basis 2014/2015 [Bra16]

above studies assume that the market will grow heavily, and the share of new car business is predicted to be at 30% by 2030.

The trend is clearly confirmed this way and very interesting and important from the point of view of digitisation, as the considerably simplified structure of electric vehicles also results in new business models in production, assembly and logistics, as well as in sales and after-sales. The software ratio in the vehicles is also increasing massivelly, for example for electronic controllers. This results in options in the vehicle configuration, for example, to change parameters for the driving behaviour via the setting of software parameters. In 2030, necessary updates of the software will, in analogy to the update of the software of smartphones, only be “over the air” without much effort, flexible and demand-orientated, without a visit to the garage which nowadays is often still required. Because of this affinity for digitisation subjects, manufacturers should align their plans for electromobility and digitisation, so as to exploit synergies and strengthen their competitiveness. This is particularly important as electromobility allows the possibility of revolutionary approaches and thus lowers market entry barriers. The opportunity will be taken by new competitors, namely from China.

5.4.5 Centralised Embedded IT Architecture

Electromobility is another significant step of the car towards the “Driving IT System”. This statement is supported by a survey of the so-called “embedded IT” which is established in today’s serial vehicles. The development of the software is shown in Fig. 5.13.

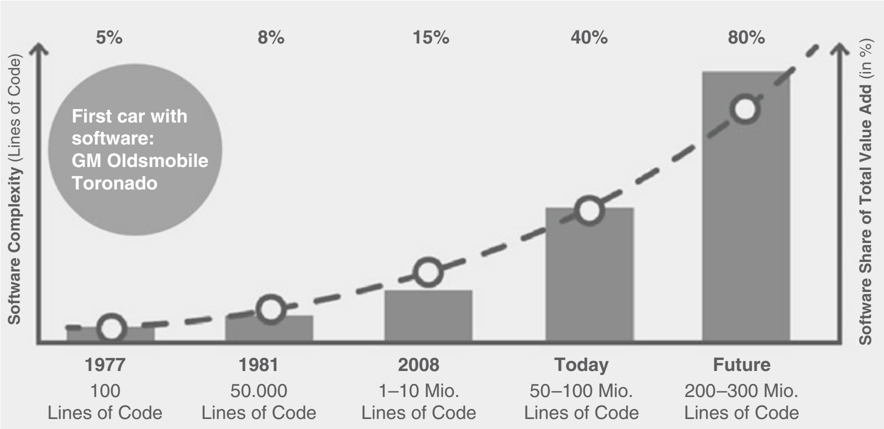


Fig. 5.13 Volume of software in cars [Sei15]

The engine and chassis control system is becoming ever more complex. Also, more and more automation, assistance and comfort functions such as, for example, automatic wiper control, ABS, or air conditioning systems with individual climate zones are added to the vehicles. This leads, as the figure shows, over time to an increase in the volume of software used in vehicles, measured in "Lines of Code". At the same time, the complexity and the software costs as a portion of the vehicle costs increased exponentially over time from 5% share in 1978 to 40% in 2015. This trend will continue, and in the coming years the software ratio will grow up to 80% for hybrid and electric vehicles. To illustrate this immense amount of software: In 2015, the Ford GT included more Lines of Code than the Boeing Jet Airliner [Ede15]. Similarly, the number of control units installed in the vehicles, quasi individual computer systems, for controlling vehicle system units further develops. Now more than a hundred control units are used in today's premium vehicles.

It is therefore clear that IT will become the formative technology in the automotive industry, and the majority of manufacturers in 2030 will be IT companies with "attached vehicle production".

This inevitable development is meanwhile recognised, but is often not taken into account adequately. Adequate measures and transformation initiatives are missing in many manufacturers. Today, ECUs (Electronic Control Units) are mostly seen as part of traditional development projects and are typically assigned island-wise as "blackbox" to provide required functions as a supply part, for example, an integrated hardware/software solution for climate control. Independently of one another, further locally optimised "control device islands" are created, for example, to enable comfortable automatic driver-specific seat settings or to control engine optimisation or driving behaviour. In this way, today's embedded IT architecture, which has evolved over decades, is based on the vehicle structure and often oriented on the organisational structure of the vehicle manufacturers. In addition the control units are supplied by different suppliers. The required wiring between the control units and connected actuators, signal transmitters and control elements has resulted in kilometres of cable trees. Various network topologies and communication protocols are used. The manufacturers are trying as a total integrator to ensure a fail-safe interaction of all IT components through comprehensive integration tests.

The grown architectures of the embedded IT have led to a massive and barely manageable complexity, and it requires a very high effort for development, integration test, operation, updates and adjustments. Extensions within this architecture, not to speak of fundamental adjustments in the life cycle of a vehicle, are only possible with considerable effort. The error rate and failure frequency due to IT and electronic errors is high. The implementation of new functions, especially in the area of "drive by wire", i.e. the transmission of mechanical control to electronics, such as braking or steering, are delayed by the performance deficiencies of today's embedded IT. This unsatisfactory overall situation has been recognised, and attempts are made to achieve harmonisation and simplification, through standardisation for instance. In particular, the Automotive Open System Architecture (AUTOSAR) initiative is to be mentioned here, in which numerous manufacturers have formed a consortium [Sch12].

From the author's point of view, even these standardisation efforts will not suffice for the evolutionary improvements of the established IT architecture to continue successfully into the year 2030, since their sustainability for future requirements, e.g. for electric drive and autonomous driving, no longer exists, at least not in economic terms. Therefore, it can be assumed that by then completely new "disruptive" architectures have established themselves [Wei16]. At the very least, new market participants will follow this path and thereby overtake established manufacturers who for (too) long stick with the "status quo", thus adapting themselves more sustainably to the future requirements of the automotive industry. Characteristics of the architecture which will be established in 2030 are under technological and functional aspects:

- Integration of embedded IT to manufacturer backend via open platform
- Hardware: central computer, plus a black box
- Middleware for the integration of sensor system and applications
- Software/Applications: groups / domains of Functions … multitier architecture
- Embedded broadband communication: Ethernet as the main technology
- Car-to-Backend, Car-to-Car and Car-to-Infrastructure communication near real-time
- High proportion of equipment/functional elements can be connected by software
- IT updates as well as on-demand control of functions "over the air"
- Openness to the connection of neighbouring IT – for example smartphones, mobility service providers, charging stations, transport infrastructure
- Vehicle concepts built on a central computer

Based on future customer expectations and new business models, the implementation of these aspects happens by taking into account the tried and tested concepts and experiences of traditional IT, such as decoupling, virtualisation, separation of data storage and logic. Established Open Source solutions are part of the technology

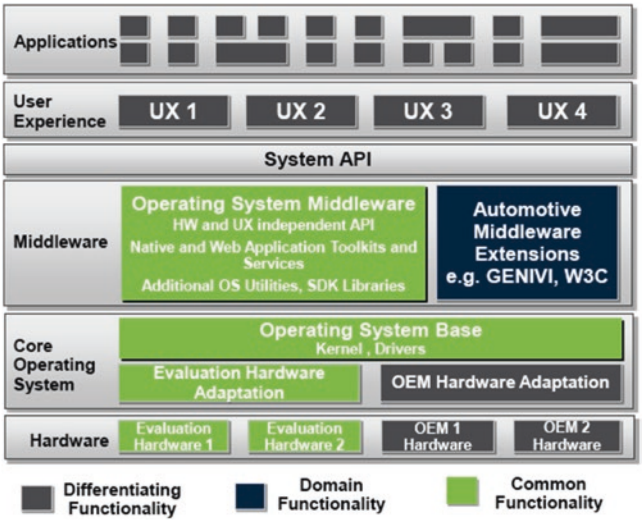


Fig. 5.14 Architectural concept for an open infotainment platform [Bre15]

platform in order to exploit the innovative power of the interested "crowd" and also to achieve cost advantages. The implementation also takes account of the concerns for a smooth interaction of mechanics, electronics and software. The new approach also focuses on harmonisation and standardisation, thus reducing technological diversity. The simple overall approach and the low complexity that can be achieved in this way lead to comparatively high operational reliability, low costs for development and operation, and easy expandability in order to be able to map future requirements as well as new business models.

In light of these objectives, initiatives by providers and manufacturers are underway to design appropriate architectures. Figure 5.14 shows an example of a Linux-based concept for an open infotainment platform.

Based on the operating system, the middleware level provides standardised services as a central element, which integrate the applications via the standardised interface (API) – also in different user-specific representations, called User Experiences (UX). Similarly, the various control units, actuators and signal transmitters are flexibly integrated via the hardware layer. Within the shown architecture, the latest technologies such as WiFi, Bluetooth, multimedia and so-called "location based services" (LBSs) are also supported [Bre15].

Many manufacturers pick up these new integrated architectural concepts and try to drive the evolutionary further developments of existing approaches in this direction, e.g [Ain13, Ber16]. However, from the author's point of view, a new approach is more promising. New vehicle series, but especially electric vehicles, should be used to form a new architectural approach in a "green field". An integral approach by Audi AG is shown in Fig. 5.15.

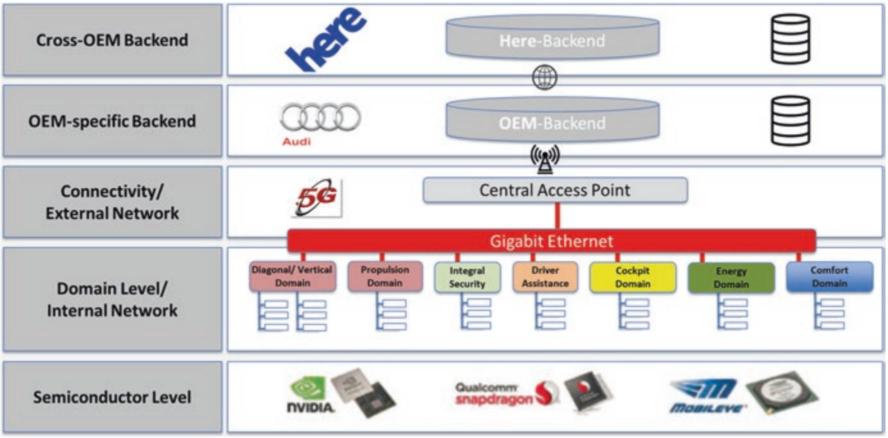


Fig. 5.15 Structure of an End-2-End architecture [Hud16]

The IT architecture in the vehicle, shown as an overview in the centre of the figure, is based on a domain structure, for example for services in the area of the cockpit, the drive and also for driver assistance. The in-vehicle communication is based on fast Ethernet technology. Different control units and signal generators are combined in the semiconductor level and are integrated via a flexible, non-displayed, adapter layer. Outside the vehicle the integration into the so-called backend systems of the manufacturer (OEM) takes place via fast 5G communication standards. In the OEM backend are applications that work together with the Connected Services of the vehicle, for example, for a concurrent diagnosis to prophylactically detected maintenance requirements, or to provide the driver with individual operating instructions. The OEM backend holds protected data, for example on the vehicles, on customers or also on motion profiles. Also provided is an integration from the vehicle or manufacturer environment, and the integration of the map service "here" is shown exemplarily at this point.

These integration options are also used, for example, to integrate vehicles into mobility services or to display information to the driver from the surroundings, for instance to parking facilities or even restaurant offers, in the vehicle display. On the basis of the architecture, also the communication from vehicle to vehicle and from vehicle to infrastructure is implemented and basis of new services.

The future software and application structure requires high computer and communication performance. For this reason, a changed IT hardware structure will be established in the vehicles by 2030. Instead of numerous distributed control units, often with a single function reference, a few central high-performance computers, secured by backup systems, will provide the required performance. This consolidation will simplify networking. Software development and testing are carried out to a high degree automatically.

These topics, briefly presented as a perspective, shall not be discussed in more detail here. Instead, please refer to the relevant specialist literature, for example a roadmap study with further sources [All15]. For the digitisation focus of this book, it is important that manufacturers take measures to establish a future-proof architecture for embedded IT. A new approach seems to offer time and cost advantages over an evolutionary method. With the architecture, a comprehensive integration and communication capability must be achieved in order to enable, for example, mobility services, autonomous driving and the integration into new services and thus new business.

5.4.6 Prototype-Free Process-Based Development

The development of new vehicles from the idea through to serial production is generally described in the so-called Product Development Processes in accordance with the German VDA Standard 4.3 [VDA11]. The development area is divided into components and vehicle subsystems, for example, there are organisational units for the chassis, powertrain and interior. The embedded IT is often a separate organisational unit.

Vehicle development has been taking place for years with the help of IT solutions. For example, CAD applications with different versions are used for manufacturing drawings incl. calculations and simulations. They often work with workflow solutions as well as Bill of Material Systems. The basis for the development is the mechanical vehicle structure and a component-oriented approach. The embedded IT is designed along with the respective components, often as an isolated solution and without an integrated IT overall architecture. This approach does not adequately reflect the increasing penetration of vehicles with electronics and software. The result are current development times of several years for new vehicle projects, massive efforts for adjustments, changes and inadequate use of the IT possibilities.

As a way out, functional views are becoming increasingly established in addition to the traditional component-oriented approach. This means, assemblies of a vehicle are viewed integrally under functional aspects, thus making mutual influences and effects transparent, for example, in the determination of consumption or also of driving behaviour and for checking the interaction of mechatronic components. This concept of a function-orientated approach will be established universally by the year 2030. The current IT applications are being expanded to support this methodology, and new vehicles are automatically developed using cognitive engineering solutions based on functional structures. Augmented Reality solutions quickly show the first presentations of the new vehicle design and, in connection with virtual environments, the construction of prototypes and test runs largely become obsolete [Run16]. The development period of new vehicles will drastically shorten, according to the author's opinion to below 1 year. Customer-specific adaptations of existing vehicles can be entered daily.

In addition to tool support and automation, a further prerequisite for this is to give up in development projects the method of the so-called "waterfall" procedure and to rather achieve rapid results with agile methods close to the requirements with interdisciplinary teams and creative approaches.

This also applies to the safe elimination of vehicle problems, which are identified in the so-called fault elimination process. To this end, in 2030 company data from various sources, information from after-sales and service, as well as publicly accessible data, are automatically and continuously assessed by means of extensive "analysis agents" in order to detect problems and faults of serial vehicles in the market at an early stage. These findings are continually considered in the development, where they are prompting rectifications. These are bundled with further adaptations directly into production and are transmitted, if necessary, as preventative measures in after-sales and service as "Update over the Air" into the respective vehicles.

This close fault elimination process, the functional orientation and also the comprehensive use of Virtual Reality technologies towards prototypless development as well as the automation of the development processes by "IT-machines" are focussed on in the industry by some manufacturers, and corresponding transformation projects are being implemented.

A major challenge remains that all these initiatives are still based on the traditional component-oriented vehicle approach. The embedded IT is managed as a separate module. From the author's point of view, this approach does not adequately take account of the massive entry of IT into the vehicles. More and more parts are determined by IT components. Future overarching IT architectures with common service elements, which are then used in different components, must then be maintained by means of cross-references or, again, special IT lists. This leads to considerable complexity and a great deal of effort, especially with respect to Bill of Matarial explosion for material requirements planning and also with regard to the updating in after-sales for maintenance.

In the view of the author a disruptive approach can therefore be foreseen here as well. It is to be assumed that in 2030, at least with electric vehicles having 80% IT-related value added share, the central processor of the embedded IT will be the basis of vehicle architectures and thus of the Billl of Materials Systems. Similar to the development of smartphones, the processor will become the dominant component of these vehicles and will replace the mechanical basic structure. To support this hypothesis, Fig. 5.16 shows the hardware architecture of a smartphone.

The picture shows that the central processor dominates the sub-assemblies of the device. Both sensor and camera systems are controlled as well as communication, energy management and the user display. All these functions already play an important role in vehicles today. The typical driving topics in close connection with assistance systems and the control of the electric drives come in here as well. There are only few mechanical parts left that are not integrated with IT.

In this respect, in the view of the author, the trend towards processor-oriented development is also to be foreseen as the basis for BOM processing, material requirements planning and further follow-up processes. It is up to the established manufacturers to decide to embrace this disruptive approach of a processor-oriented development. The development of new electric vehicles could provide a suitable entry. It can be assumed that new manufacturers are pursuing this path and thus create further pressure to drive the transformation of the development process.

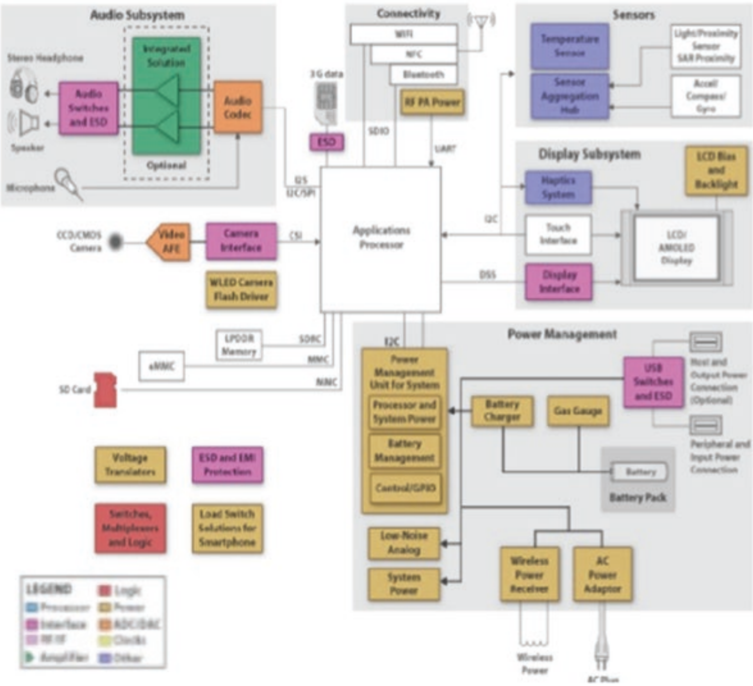


Fig. 5.16 Hardware architecture of a smartphone [Ram13]

	Marketing	Sales	After Sales /Service	Connected Services	Mobility Services	Intermodal Mobility	Third-Party-Business
Importer	Focus Manufacturer			New Sales Sectors			
Dealer							
Vehicle Customer	Focus Dealer						
Mobility Customer							

Fig. 5.17 Transformation of automobile sales (Source: Author)

5.4.7 Internet Based Multichannel Distribution

Another sector which has to undergo comprehensive transformation in the context of digitisation is the sales department. The pressure for change is driven by new technologies around the Web 2.0, smartphones and social media, through changed customer expectations and also changed buying behaviour. This situation was explained in detail in Chap. 2 and also in Sect. 5.2. Furthermore, the transformation is absolutely necessary because the established structure no longer meets the new market requirements and the changing supply. This situation is illustrated in Fig. 5.17.

In the overview, the long-established main processes of sales are set against the acting parties. In today's distribution structure, shown in the upper left part of the matrix, the manufacturers do not have a direct end customer link. Marketing, sales, after-sales and service support are provided to importers by the manufacturers in the countries and markets. For example, when launching a new vehicle, manufacturers arrange advertising and television spots and provide marketing material for sales support. The manufacturers also provide vehicle configurators and call centers for customer support. These services go to the dealers in the countries through the importers, who often make their own market-specific additions. Dealers, in turn, are often organised in commercial chains and are thus large enough to carry out their own sales campaigns or to use own local application solutions, for example so-called dealer management systems (DMS). The dealers are currently the end-user of the sales channel of the manufacturers and in direct contact with the vehicle customer. In addition to vehicle sales, the focus of the dealer is in particular the after-sales service business, including the luctrative spare parts business.

In the future, this sales structure will change drastically as new offers and business segments will arise alongside the vehicle and service business. If manufacturers wish to offer Connected Cervices, mobility services, the provision of intermodal transport, i.e. the use of different means of transport during a trip, as well as third-party business, such as the booking of hotel accommodation with the help of the Connected Services of the vehicle, appropriate sales channels have to be established. These must then be specifically tailored to the customer. In the future, these will be both vehicle buyers and new customers for whom the new offerings are interesting, irrespective of the specific vehicle. This situation with the new distribution fields is also shown in Fig. 5.17. The larger area of the new distribution sectors in the simplified presentation illustrates the considerable need for change in sales.

A very heterogeneous ownership structure is complicating the necessary adjustments to the current sales structure. Different ownership structures are established among manufacturers, often in mixed forms, which differ even further depending on the markets. In many cases, manufacturers own importers in strategically important markets and also hold selected trading companies in some markets, often also established as “flagship stores” in large cities. In some cases, exclusive contractual relationships with independent trading partners are established, or the distribution is exclusively via free companies. This heterogeneous ownership structure and the indirect ways of customer access and mixed customer management as well are complicating the necessary transformation. The following unambiguous trends for the orientation towards the year 2030 have to be considered in the transformation of sales:

- The sale of vehicles and spare parts via the Internet will rise massively.
- Big Data and Analytics through the evaluation of different data pools (for example, social media, manufacturer data, dealer information) create detailed findings about potential new customers so that these can be “developed” until purchase with personalised offers in the sense of “next best action”.
- Virtual Reality will be of great importance in the sales process, also used for example in the configuration test and for virtual test drives.

- The number of dealers will decrease significantly. Dealers are successful if they are part of larger organisations or commercial chains and are directly involved in the sale of offers from the new business segments.
- Customers expect to get the same experience on all sales channels, and that the level of information is synchronised, for example, to interests or inquiries.
- The Internet-based sales are carried out to a large extent via multi-brand platforms. Complementary products such as financing, insurance, and service are also handled via these platforms.
- The financing organisations and Banks are, just as the main business part, an integral part of sales platforms.
- Vehicle ownership will shrink in favour of mobility services, particularly in large cities.
- The traditional vehicle business with the focus on ownership takes place in "emerging markets".
- Mobility services are provided to a high proportion by autonomously driving vehicles. Electric vehicles make up a high percentage of fleets.
- Mobility services are managed to a significant extent via non-brand platforms. Also complementary services such as intermodal transport, booking of tours or chauffeur service as a premium option for special events.
- Brands play a minor role in mobility services. Main consideration will be a competitive price/performance ratio at the desired service level.
- The loyalty to mobility platforms is achieved through commercial models and customer programmes.
- Manufacturers will develop new business fields. For example, integrated Connected Services can be used to refer vehicle users at a "handling fee" as customers to hotels or restaurants.
- Manufacturers sell insights gained from vehicle and motion data to insurance companies or component manufacturers for instance.

These trends are clearly visible, they will intensify in the future and thus drive the transformation of sales. It is absolutely essential for the established manufacturers to swiftly and successfully push the necessary restructuring since the new business segments will in the future make a considerable proportion of the sales and profit share of the industry, and these topics are particularly competitive and being addressed by new entrants as well. This situation is underlined by some current studies and books, e.g. [Bra15], [Lau16], [Köh14]. The expected business development and division is impressively illustrated in Fig. 5.18, taken from one of these studies.

It is predicted that the revenue share from pure vehicle sales, including related Connected Services, will decrease continuously and will be 50% by 2035. By contrast, business with mobility services and new sales spheres, such as data trading and intermediary channels, will grow to as much as 50%. The study also examines profit shifts. In this respect the prognosis is that the margins of today's profit drivers, after-sales including spare parts and financial services, will decrease considerably, and profits shift to the new business segments. These statements confirm the substantial pressure on manufacturers to position themselves clearly in the changing business environment and to organise sales in an adequate manner.

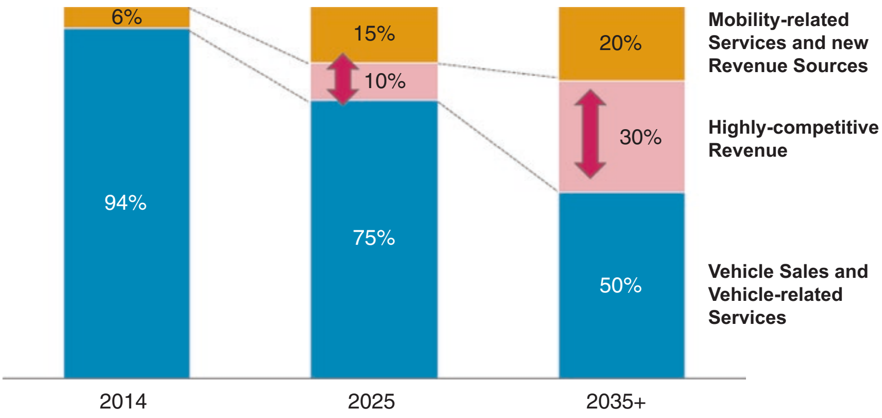


Fig. 5.18 Development of global industry turnover passenger cars by 2035 [Bra15]

From the author's point of view, the battle with competitors like Google, Apple, Uber, Alibaba and Baidu will take place with the focus on mobility services in sales. Undoubtedly, the products and offerings must be developed and made available by the manufacturers. It is however important to establish these at an early stage close to the customer in order to secure "air sovereignty". Other fields are also contested. For example, established online retailers such as Ebay and Amazon compete for market shares in the spare parts business and so-called "Fintechs", quasi platform banks such as Auxmonex, Kreditch or also LendingClub, provide fierce competition to the financial services of the manufacturers. In addition, it can be assumed that other start-ups and also established companies from other sectors, such as electricity suppliers, retailers or railways, try to enter the profitable new area of the automotive market.

In order to stay successful, the established manufacturers must transform the sales structure into a "multichannel" structure with many customer accesses, thus attracting customers directly via online channels as well as through traditional indirect approaches. The customer should at all times through a variety of different ways be addressed in a uniform approach, based on a consistent information base, and be in dialogue with the manufacturer. To achieve this, manufacturers are required to dissolve established organisational islands and to create a new integrated structure, involving the importers and dealers, the after-sales organisation, the in-house financial organisation and new web-based services. In the context of digitisation it is necessary to create a cross-departmental integration of processes, applications and data. In addition, a culture must be created for the provision of new products, such as integrated mobility services or the trading of data, to cooperate with strategic partners and incubators in order to quickly develop competitive offerings for the traditional car business. Dealers and importers must also be actively involved in this transformation. While first beacon projects have started at the manufacturers, dealers and importers have so far shown little readiness to transform [Lau16].

5.4.8 *Digitised Automotive Banks*

As already outlined in the description of the sales trends, the automotive banks are also undergoing a complete transformation. The wave of digitisation has already captured the general banking sector as one of the first industries years ago. The majority of all banking transactions are processed online today, and as a result, the traditional counter areas for private customers have been reduced to a minimum. A similarly complex restructuring is now underway at the banks of the automobile manufacturers. On average, 75% of all car sales are financed in Germany by a loan, of which 46% are accounted for by automotive banks [AKA16]. The overall objective of the automotive banks is the promotion of sales through attractive financing solutions. In addition, they finance investments by "their" manufacturers as well as by importers and selected dealers. The used-car business is becoming increasingly important. More and more private banking and complementary mobility services are being offered as well. In many cases is, in the author's opinion, namely in these new fields of business, the overall strategy and orientation remains unclear in comparison with the manufacturer's activities.

The traditional distribution path of the automotive banks leads to the customer via the car dealer. Interested car buyers in this day and age get information online about equipment features of the vehicle, financing and service options as well as prices. The purchase is carried out on the basis of the information obtained beforehand, in the majority of cases still after a test drive at the dealer. The product information and prices offered on the web by the atomotive banks are often of a generic nature and not specifically tailored to the current customer situation. This continues in many ways, and financing packages available at the car purchase are completed in tandem, partly with added insurance or service packages.

Direct, online-based interactions between the automotive banks and end users are currently taking place in complementary business segments, for example in the savings sector, but without any connection to the other business relationship between the customer and the manufacturer. There is no integrated customer profile about his private vehicle ownership, including vehicles of different brands, service history and other business connections. An extended view on the customer in the run-up to the car purchase on the basis of comprehensive network information is not available either at the dealer or at the automotive bank for the potential creation of a customer-specific leasing offer. This situation opens large improvement potentials for process adaptations and digitisation measures. Figure 5.19 gives a good overview of how the customer-oriented processes will be digitally supported in the future.

The entire leasing process, shown on the left in the picture, from the inquiry, detailed coordination and provision of financing documents, as well as the conclusion of the contract, can be processed online via smartphones, if necessary in dialogue with a consultant via live chat. The same technology in the interface with the same "look and feel" is used for the processing of payments, questions for clarification and also the re-marketing of used vehicles. In the background, a central support organisation is available around the clock, across all processes. A parallel continuous analytical system at any time provides an integrated view on the customer for

Fig. 5.19 Digitisation of the customer processes in automotive banks [Pan14]

the support as well as for the sales and service organisation. With this solution, technical problems on the ground but also customer dissatisfaction can be detected at an early stage in order to then implement preventive measures to improve the situation. This full digitisation of the customer processes significantly increases efficiency and quality in process handling. The same also applies to the digitisation of the other business processes of automotive banks. More details on the topic of process automation can be found in Sect. 5.4.10.

5.4.9 Flexible Production Structures/Open Networks/ Industry 4.0

Sales reliably works together with Production in the programme planning and the feasibility testing and fine trimming of customer orders. This interface will also be more closely integrated in the future due to the increasing individualisation of the vehicles and will be supported by Big Data methods. This is just one facet of the digitisation of production. This is driven by the Initiative "Industrie 4.0" and the accompanying Internet of Things approaches already with the implementation of projects (see Sects. 4.2, 4.3 and 4.4). It needs to be investigated whether these initiatives cover the entire field or the whole digitisation potential. This assessment is based on the following hypotheses as to how the production may look like in 2030, and which parameters are relevant. The following constitutes the author's appraisal:

- In the high-wage countries, assembly-line production will be replaced by highly flexible production islands in which robots and workers produce customer-specifically configured vehicles in close cooperation.
- Assembly line production will mostly be in "emerging markets". High-volumes of vehicles are produced there for the local mass market and also for the fleets of mobility services providers for use in the established markets.
- Production make-to-stock is massively declining, and production to individual customer requirements predominates, especially in the premium segment.
- Industry 4.0 technologies are installed widely and enable the cost-effective production of customer-specific vehicles with lot size 1.
- Suppliers are already closely involved in the planning, so that the customer-specific production is continued in the supply chain.
- "Digital shadows" of production and logistics chains are established for proactive control. By using cognitive solutions, analyses and preliminary planning are possible on this basis, which create the required reaction times in the supply chain.
- A company-wide production monitoring is established for control and surveillance. From the overall view, manufacturers can zoom from individual plants down to individual tools or components. Self-learning application systems provide the control team with action plans which are implemented step by step, and automatically.
- New suppliers will be established, especially for electric vehicles, which do not have their own production capacities and rather solely use contract manufacturers as supply partners.
- There is an surplus of production capacity which makes it easy for new suppliers to find manufacturing partners.
- In addition to robots, 3D printers determine production. These produce just in sequence also hand-in-hand with workers in the production area.
- A high proportion (50 + %) of spare parts are produced on demand locally in the large markets based on 3D printing and flexible production cells.
- In Production, Augmented Reality technology is used to a high degree. Simulation of plant layouts, feasibility testing, management of workers and also training are typical fields of application.
- Recycling of end-of-life vehicles will increase massively. Ecologically degradable substances, such as those based on hemp, are used.
- In the further development of the RFID technology, the vehicles get a "lifetime chip" which is already used in production where the vehicle autonomously moves between the manufacturing cells. This chip remains in the vehicle and is then in active dialogue in after-sales and also for individualisation in Connected Services.
- Materials will contain communicable elements which can then be incorporated into the control system, for preventive maintenance works for instance. Foglets (see Sect. 4.9) are tested in pilot areas.
- Application software as well as robots are programmed in human language.

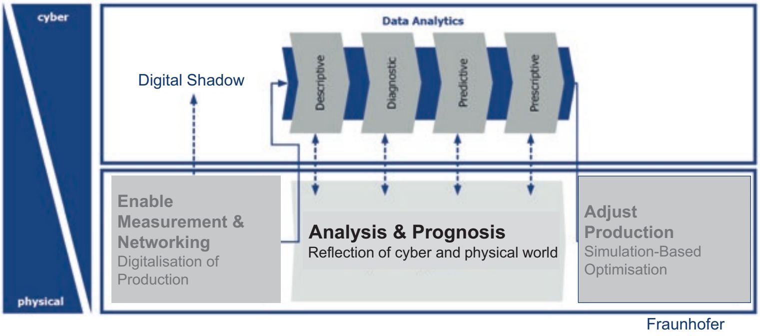


Fig. 5.20 Measures for production adjustment [Bau16]

Many research projects and pilot projects are under the heading "digital shadow" tackling one of the main topics of the digitisation of manufacturing [Dom16], [Sch16]. This shadow means a virtual image of the production with all the data relevant to the value creation of the lines and also of adjacent systems. From this data, a time-based virtual model is created, often also called a digital twin, which is used for evaluations and analyses. The approach is illustrated in Fig. 5.20.

In the lower part of the picture the physical level of production is shown. This provides the basic data for the generation of the digital shadow and of the virtual image plus continuously further current data, for example, regarding utilization, machine and logistics data. This information is analysed in the virtual model, and operating instructions are given, but also preventive measures for production improvement are derived, supported by simulations. In the development of the measures, the systems take into account production-relevant requirements, for example with respect to the inventory level or the set-up sequence. This integrated control and optimisation based on a digital shadow is still in the research stage, and there are first pilot testings. By 2030 though, this approach will be widely established.

Today's initiatives and projects among the established manufacturers have often been launched in the context of evolutionary improvements, for example for the continuous raising of the degree of automation, and are being addressed even more focused within the framework of the Industry 4.0 initiative. However, this is often a question of just individual projects, and there is a lack of a paramount objective, which is proposed in the implementation recommendation for Industrie 4.0 [BMB13]. The aim is in the horizontal integration to address the entire value chain across all company organisations and beyond company borders. The vertical integration seeks to facilitate a dialogue between the company's management level and individual machines. The challenge thereby is to establish digital consistency and continuous integration of the engineering throughout the entire product life cycle and the manufacturing system.

In this holistic sense, the digitisation progress in the production of the established manufacturers today is too slow from the author's point of view, and there is a risk that new entrants will right from the outset begin at a significantly higher level in their new production facilities. For example, Tesla Motors' factory in which it will produce its Model 3 is designed to operate without direct worker participation, since people along the line slow down the speed to that of humans [Pri16].

In order to achieve this goal, "disruptive" concepts are required which are addressing a challenging overall objective. Established manufacturers find this particularly hard to do. One reason is that the highly automated lines are trimmed to efficiency and are closely integrated in their processes, for example in the communication structure and in the logistics networks. Far-reaching changes to these structures often mean operating risks which one wishes to avoid, so one is content with smaller optimisations.

In addition to the technological challenges addressed in Chap. 6, another important reason for the slow progress is the heterogeneous organisation and the different objectives of the project participants. It starts with the IT. In many cases, the plant IT is part of the production organisation and is responsible for IT solutions around the plant and plant-oriented objectives, whereas the central IT as a staff function often reports to the financial sector and has more general objectives. The application solutions of the central IT are often developed separately and use different technologies than the plant solutions. The communication technology in the areas is also often different. It is an exciting point in the projects when IT people and the production managers are to communicate project objectives using different technical terms. This example illustrates the need for an overarching governance model that brings together all parties involved in a project with a common understanding and the same prioritisation. It is important at this point to recognise that the evolutionary approach of the established manufacturers is too short-sighted from the author's point of view and is also too slow to adequately counter the attack by the industry newcomers and to secure competitiveness on a sustained basis. Rather, holistic concepts are required, which are implemented together in a straightforward manner.

5.4.10 Automated Business Processes

Today the production processes are being pushed forward with the focus on the Industry 4.0 initiative for digitisation. In addition, there is high potential in all other company divisions as well to increase efficiency and quality through digitisation and thus to secure competitiveness. Overall, according to the author, the following trends are characteristic for this topic, so that the vision for the year 2030 is as follows:

- In the administrative areas, for example in the financial, personnel and administrative areas, 80% of the business processes are executed automatically without manual intervention.
- In business areas where higher interaction and coordination are required, such as in engineering, quality assurance, order management or marketing, many business processes are automatically processed, but the degree of automation will be less, around 50%.

- The "process automata" are based on cognitive software technologies. These are integrated into the respective existing systems of the process areas and further develop by "self-learning".
- The blockchain principle is also part of the company-internal platforms and enables a simplification or shortening of business processes by the elimination of testing tasks.
- The machines are integrated into platforms. The service call is performed via voice control based on intelligent mobile devices.
- In line with the concepts of the platform economy of today's Web 2.0 economy, internal company-wide central business platforms will be established for handling administrative tasks. These service platforms support all brands of larger manufacturers. Brand-specific organisations that provide these services today, will cease.
- The platforms will provide open interfaces so that the platform's functionality can be easily expanded by third-party components.
- Today's rollout projects of large software programmes will completely disappear and be replaced by "roll-in" projects, i.e. the extension of functions by third party components can easily be performed.
- Employee workplaces are equipped with assistance systems. These proactively support the user while, for example, prioritising of work and preparing information search, as well as handling many tasks automatically, such as the booking of trips or the invitation and coordination of all parties involved in a meeting.
- The number of employees in the administrative and in the indirect sectors will decrease significantly.

The high degree of automation of the business processes and the establishment of business-internal business platforms, which are used as a "shared service" by all corporate brands, represent a significant increase in efficiency and quality compared to today's handling of business processes with a relatively high proportion of manual work. Similarly, assistant systems at the workplace greatly enhance productivity in day-to-day work. The first approaches on this path are now being evaluated in initiatives and tested in first pilots with small work contents. The approach of in-house platforms for the finance sector is shown as an example in Fig. 5.21.

The core functionality of the in-house platform includes, for example, access management (single sign-on), security, data integration as well as analysis, business process control- and automation functions. Through an integration layer, existing financial applications are flexibly linked, so that existing know-how and investments made are protected. The App and mobility layer provides access to the financial solutions via mobile devices such as smartphones or cameras for the recording of gesture control. This allows users to work with the existing "legacy system environment" through modern access methods. New functionalities are integrated from the outset as Apps via this level. The overall concept is based on a "roll-in" approach. The companies can connect themselves to the platform via defined interfaces and gradually start using the platform functionalities and step by step reduce or deactivate the legacy systems. The platform concept thus enables an evolutionary transformation from a heterogeneous legacy system environment to a global, harmonised

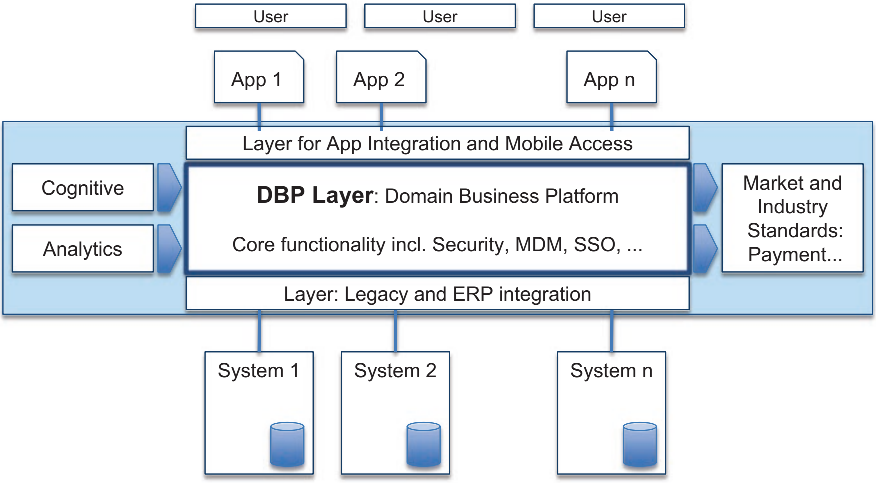


Fig. 5.21 Concept of an internal company financial platform (Source: Author)

solution platform, which can be expanded flexibly and appealingly to users through Apps. This platform also enables step-by-step automation of business processes.

The concept explained examplarily can be applied to many company sectors such as purchasing, human recources and quality management. There are many companies that face the challenge of entering new solutions from an existing, historically grown application environment. A proposal for the implementation of the approach is given in Chap. 6. In addition to the in-house solutions, cross-industry platforms will also be established as a marketplace between manufacturers and suppliers, for example in the handling of logistics services. The goal here is to increase the efficiency of the transactions and the process transparency.

5.4.11 Cloud-Based IT Services

In the implementation of business platforms as well as in all other digitisation activities, efficient IT services are a basic prerequisite. The provision of these services will in the future be based on fundamentally different structures and on the basis of new methods and concepts compared to the current situation. Typical for the IT in 2030 are, according to the author, the following aspects:

- The manufacturers obtain 80% of the required computer and storage capacity from Cloud environments "out of the socket" on the basis of flexibly agreed upon service levels.
- Cloud environments are run by special providers from mega computing centres. These are flexibly linked to the manufacturer's IT systems in so-called Hybrid Cloud concepts.

- Unlimited data storage will be available almost free of charge on the Internet. Data storage is carried out via software layers (software defined storage).
- Mobile devices such as smartphones, wearables and smartscreens are integrated into furniture, clothing and machines. Computers controlled via voice command or gestures have replaced desktop systems entirely. The performance of the devices equals that of today's supercomputers.
- IT projects with a long runtime as well as comprehensive rollout projects are a matter of the past. Instead, App-like solution components are created within days, and roll-in concepts are implemented on the basis of integration platforms.
- Agile project methods replace the "waterfall method" [Zwe16].
- Programming or software development is through voice control based on microservices architectures.
- Applications for the evaluation of the massive data stocks with recommendations up to the automatic implementation of reactions will make up a high proportion of the software offerings.
- The creation and operation of platforms for both in-house services and marketplaces will account for a large proportion of IT services.
- The monitoring of IT infrastructures is carried out by means of so-called agent systems which are active in the application systems. These detect emerging problems early and automatically take corrective action.
- One of the essential IT cost drivers are the necessary security systems for the defense of cyber attacks. Quantum computers are first used primarily in the field of security, for example in cryptographic procedures for company protection.
- Public internet is available free of charge with sufficient bandwidth. Speeds of over 500 megabits per second are established.
- A new Internet structure based on IPv6 addressing will be established. A distinction is made in this regard between a private and a commercial area, which facilitates different services.
- The "Internet of Everything", a comprehensive linkage of all kinds of things, is established [Tho15].

Figure 5.22 shows in summary the challenges facing IT to establish a solid platform or basis for the transformation and digitisation.

The IT is represented in the figure as platforms, evolutionarily beginning from a centrally organised structure in stage 1, over distributed client/server architectures currently prevalent in stage 2, up to the future "3rd Platform" which must be able to process "Millions of Apps, Billions of Users, Trillions of Things" in the companies. This can, as discussed in the trends, only be achieved with very flexible hybrid architectures which can then scale in terms of both the computing power and the storage capacity by means of Cloud environments. Big Data technologies with deep analytical abilities are to be employed, based on which, for example, solutions from the field of artificial intelligence can be used for automation and the support of users. The mobile workplace with the always-on mentality is supported by the IT environments as well as new forms of collaboration based on "social business" solutions.

Fig. 5.22 Cloud-based IT platform [Sch15]

A highly efficient, agile IT is the basis of digitisation initiatives, which are often based on the relevant technologies already described in Chap. 4, such as 3D Printing, Robotics or even Cognitive Solutions as an innovation driver. This is not about one-time projects, but the key is in the continuous transformation both in the company and in the entire value-added network, taking into account the transformation among the customers and the suppliers. This holistic approach is explained in the following by means of a case study.

5.5 General Electric – An Example of Sustainable Digitisation

To explain the topic of digitisation exemplarily with well-known "Valley based" companies such as Apple, Google or even startups, would actually be obvious. Uber, with its affinity to the industry targeted in this book, also is a valid candidate however will later be taken up in Chap. 6. As a comprehensive example of a profound and sustainable transformation based on digitisation, rather the company General Electric (GE) is acknowledged here. This company, with an age of almost 130 years, is a founding member of the electrical industry and the only company that has been listed in the Dow Jones Index from its beginnings in 1896. With its origins in the lighting sector based on Edison's light bulb which was patented in 1879, the company developed into a globally active conglomerate with more than 300,000 employees and acting in more than 100 countries. The product portfolio includes plants, machines and components, for example, for the healthcare sector, the basic material and aerospace industries, as well as integrated solutions for industrial plant construction and the public infrastructure sector, as well as related maintenance services. GE's aspiration is technological leadership through innovation. In this context, continuous development and transformation is a fundamental feature of the company and guarantees its long-term successful existence [GE16].

At about the beginning of the second millennium, when the Internet had established itself as a business platform, more and more new competitors were entering this market of capital goods which supplemented their machines and systems with software solutions. For this purpose, data from the machines and from the application environment was used to improve utilisation possibilities and reduce downtime on the basis of innovative algorithms.

This trend was perceived by GE as a risk and at the same time an opportunity and led to the decision that a drastic change in strategy and direction was needed. In order to prevent the risk of "commoditisation", CEO Jeff Immelt clearly explains the GE strategy in 2011: "The goal is to create a global network of connected machines that GE uses to provide customers with significant operational improvements." In 2013, the CEO added: "We know there will be a partnership between the industrial and the Internet world. We just can not accept the fact that the data collected in our world are used by other companies. We must be part of this development." [Buv15].

These findings invigorate the motivation to what can be described as a total reversal in the direction of a company which is characterised by industrial goods towards a data-based service company. In order to speed up and secure this transformation, GE has initiated significant actions and bold steps, which are surely of exemplary relevance; here is a summary [GE16], [Buv15], [GE16], [Pow15].

- Clear definition of a vision underpins clear objectives. A top-down approach to communicate and cascade the vision and goals.
- Establishment of a transformation programme for the development of corporate culture around innovation initiatives and the "FastWorks" programme (tools and methodology) to establish a start-up and entrepreneurship behaviour across all levels.
- Founding of a software house for the development of innovative software solutions in the fields of Big Data, Analytics, Cognitive, Mobile, App and Industrial Internet with a basic funding of $1 billion.
- An investment of $1.5 billion to acquire smaller software companies from the Analytics and Big Data sphere in order to expand the company's internal capabilities.

- Hiring senior executives with appropriate digitisation experience, for example, as head of the new GE software company, as CTO and as sales manager for the new offerings and as the leader of the transformation. Parallel hiring of software architects, programmers and project managers to develop internal skills.
- Opening up of proven software solutions for interested software houses, so that they develop their own solutions to create a GE Ecospace, for example around the IoT platform “Predix”. To quote GE Executive Dave Barlett: “We want Predix to become the Android or iOS of the machine world”.
- Cooperation with technology companies such as Amazon Web Services, CISCO and Intel, as well as incubators such as LemnonsLab, RockHealth or Breakout Labs, as well as crowdsourcing partners, to discover new ideas and to temporarily bring specific expertise into projects.
- Creation of a venture capital unit (GE Ventures) and establishment of a start-up network in relevant fields of innovation and thus early adoption of ideas and trends.

The overview gives a good idea of the multitude of actions and measures that drive GE’s transition towards a data-based service company. It is important to assign clear performance figures to the respective initiatives and to communicate them. For example, Fig. 5.23 shows the goals for the Internet of Things platform from the GE Annual Report 2016.

The picture shows some measurable specifications for moving forward with the digitisation in the field of the Internet of Things. In 2016, at least 200,000 machines should be interconnected, the Ecospace around the Predix platform be expanded to 20,000 developers and 50 partners, and more than 100 Apps available in the industry store. With these clear guidelines, GE underlines the strategy of providing sus-

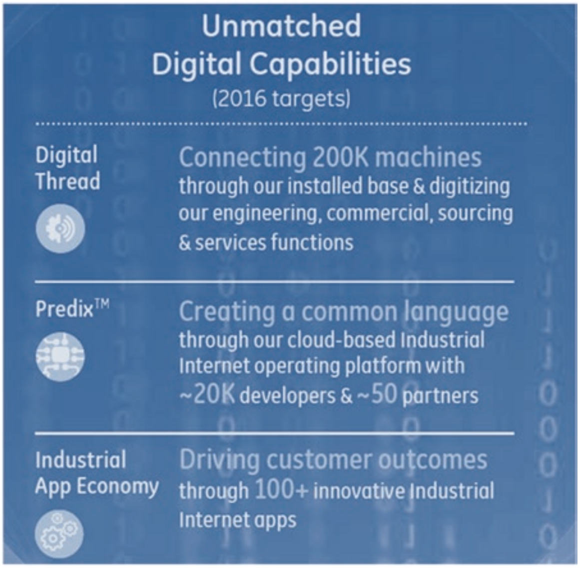


Fig. 5.23 Goals for stabilising the IoT platform at GE [GE16]

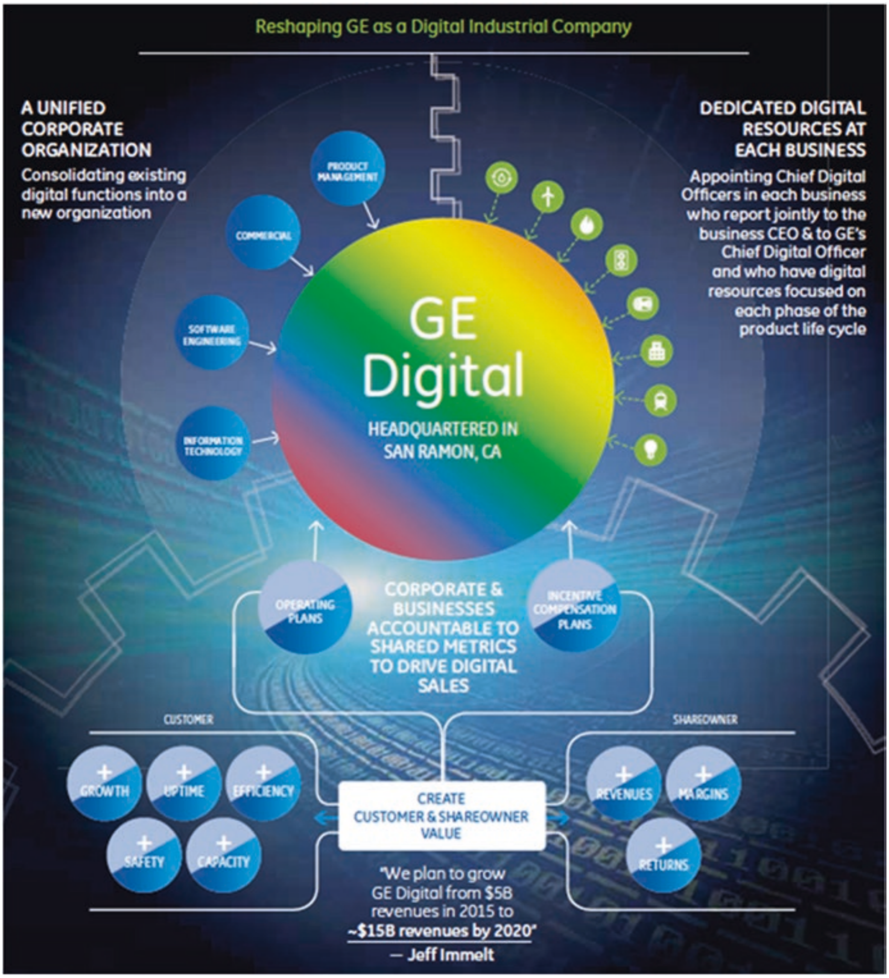


Fig. 5.24 Objectives – General Electric en route to a data-based service company [GE16]

tainable benefits to its customers in the area of IoT services. In the annual report, it is also said that the platform towards the Digital Shadow or Twin will be enhanced in order to create a basis for forward-looking, intelligent solutions (see Sect. 5.4.9).

The strategy for comprehensive digitisation is not limited to the IoT example yet also applies throughout the whole company. Figure 5.24 shows a central picture of the annual report 2015.

The picture shows a comprehensive overview of the strategic initiatives in the transformation programme. Next, it is important to establish digital knowledge in each organisational unit. For this purpose, digitisation leaders with staffing shall be appointed in each unit. At the same time, the currently decentralised organisations are to be consolidated in one unit. The distribution responsibility for digital offers is assigned to all organisations in a matrix responsibility. According to CEO Jeff Immelt, GE aims to triple the direct revenue of the digital division from $5 billion in 2015 to $15 billion by 2020.

All these measures are bound into an integrally structured approach which is driven top-down [Buv15]. Although GE has already made a significant step forward in digitisation, it is important to understand that the transformation is being pushed forward continually, and that the environment must still be monitored very carefully in order to detect emerging disruptive trends, to address them, and to adjust structures and focuses in order to create new business potential.

Annex A2

For a more detailed assessment of the digitisation situation of some established automobile manufacturers, the author conducted a study on the basis of a variety of information sources such as annual reports, investor relationship publications of companies and specialist articles. The analysis was based on the following criteria (as of 08/2016):

- Connected services/autonomous driving
- Mobility services
- Digital processes
- Digitisation incubators
- Customer-focused orientation
- Digital IT
- Digital culture

Manufacturers were graded according to the evaluation criteria and rated in the groups of volume and premium manufacturers in a range from 1 (bad) to 7 (very good). A result of this are the spider diagrams shown in “Figs. 5.4, 5.5, and 5.6: Digitisation depth of vehicle manufacturers: premium and volume manufacturers”.

The following table summarizes the individual valuations.

	BMW		Daimler		Audi		Tesla		Volkswagen		Toyota		General Motors		Ford	
Connected services/ autonomous driving	IFTTT ConnectedDrive Intel&MobileEye Cooperation	**5**	MB me connect Future Truck 2025 F015 Luxury in Motion	**5**	Audi connect Speed Up! 2025 Audi RS7 piloted driving concept	**4**	EVE Connect Tesla Summon Tesla Motors App	**3**	LG Cooperation Together 2025 Car-Net	**4**	KDDI Cooperation SmartDeviceLink Automotive Grade Linux	**2**	Cruise Autmation Company Lyft	**4**	FordSync MyFord SmartDeviceLink	**3**
Mobility services	DriveNow moovit	**5**	Car2Go moovel myTaxi	**5**	Audi select Audi shared fleet Audi on demand	**4**	AirBnB Cooperation Super-& Destionation Chargers	**1**	GETT	**2**	Uber TMF Pilot	**2**	OnStar Maven CarUnity	**4**	Sync FordPass Wink Cooperation	**2**
Digital processes	Smart Logistics Smart Watches Plant Digitalisation NUMBER ONE > NEXT	**4**	Digital Design Digital Prototyping Smart Factory	**4**	Digitalisation Production Process Digital Economy Award IoT Platform Speed Up! 2025	**5**	Connected Production Multi-Task Robots In-House Component Production	**5**	VR in Production und Sales Smart Factory 3D Printing Together 2025	**2**	TOAD Big Data Control Tower	**4**	Digitalised Competitor Benchmarking Digital Test Tracks	**3**	3D Printing Digital connected production Virtual Testing	**4**
Digitalisation incubators	BMW iVentures BMW Start-Up Garage BMW Future Lab	**3**	Daimler Mobility Services Center of Competence Digital Vehicle and Mobility	**3**	Audi Electronics Venture Audi Urban Future Initiative Audi Business Innovation GmbH	**3**	Born Digital	**5**	Digital Lab Group Future Lab Data Lab	**4**	Smarter Mobility Society Toyota Connected Inc. Toyota Research Institute	**4**	-	**1**	Ford Smart Mobility LLC	**2**
Customer-centric focus	BMW Retail Online BMW Brand Stores Product Genius	**3**	MB me finance & MB me inspire Best Customer Experience (2020) Mercedes me Store	**4**	Audi City myAudi	2	Exklusive Online & Direct Sales over-the-air-Updates WeChat Payment (China)	**5**	Online Booking Testdrive After Sales Digital Reception (UK)	**2**	iOS App Customer Configurator Direct Acceptance App	**3**	myOpel	**4**	FordPass myFord FordHubs	**4**
Digital IT	Postgraduate Program IT for Engineers	**1**	Project 100/100	**2**	-	**3**	Born Digital	**5**	200 Mio€ for Digitalisation Projects	**2**	Advanced IT for Manufacturing (NA) Single Point of Truth iOS App (Toyota Motor Europe)	**3**	Dissolution HP Outsourcing Consolidation DCs Central Datawarehouse	**5**	-	**1**
Digital culture	SVP Digital Strategy Bündelung aller Digitalisierungs-projekte	**3**	VP Digital Vehicle and Mobility DigitalLife@ Daimler Digital Life Day	**4**	Chief Digital Officer Audi Speed Up! 2025	**2**	Born Digital	**5**	Chief Digital Officer Department Digitalisation Strategies Organisation 4.0	**3**	-	**1**	VP Urban Mobility Programs	**2**	Digital Worker Program	**2**

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