Automation

From Driver Assistance Systems to Automated Driving
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Going on holiday was never as relaxed as this: the whole family is sitting down to a board game while the car drives itself – as shown in this picture from 1956. Back then, the possibility of turning this into reality lay in the distant future, but the idea behind it was obvious.

The car expands its potential, becoming mobile living space. The vision of automated driving has been around for almost as long as automobiles themselves, mostly as a scenario in science fiction novels and films. Yet as early as in 1939, the vision was very close to reality. At the New York World’s Fair, the idea was presented in the “Futurama” exhibition. By 1960, it was said, this should be realized.

That was premature, as it turned out. Yet in the 1950s, engineers were already developing the first concepts for fully automated long-distance drives on the American highways. Their idea was to combine infrastructure measures and vehicle technology: before setting off, one simply had to inform the traffic control center of one’s destination, and the automated journey could begin – in vehicles powered by gas turbines. Even then the guiding notion was already that future technologies should offer people a degree of comfort and safety that had never been dreamt of before.

Developments have now progressed a long way. Today’s systems use signals from a wide variety of sensors around the vehicle to support the driver. Modern cars have a large number of advanced driver assistance systems that help the driver in driving and parking situations, and can even take over some tasks completely.

For example, today the lane departure warning system already alerts the driver to an unintended lane change. More advanced systems keep the vehicle in the lane automatically. In addition, there are parking systems that inform the driver of a suitable parking space and if desired can actually maneuver the vehicle into it.

The future as seen yesterday is set to become reality today and tomorrow. Besides, automation is more than the realization of a long-cherished vision. It lays the foundation stone for successfully overcoming the many and varied global challenges for mobility.
The mobile world of tomorrow

The world of tomorrow will be urban

The year 2007 marked a historic shift in the history of mankind. Since that time, around the world more people have been living in towns and cities than in the country.

This development cannot be stopped. By 2050 the proportions will be 70 to 30. But the cities themselves have changed too – they have become megacities. Since antiquity, even the large metropolises failed to exceed the number of one million inhabitants, and it was only in the mid-twentieth century that New York broke through the barrier of ten million inhabitants. Today that is no longer unique. There are already 28 megacities with over ten million inhabitants (see figure), and the number is expected to swell to around 40 by 2030.

Urbanization, and in particular the emergence of megacities, reflects the growth in the global population and economy. Mobility and transport form the backbone for society’s increasing prosperity and people’s greater participation in it. At the same time, managing traffic in these urban agglomerations represents a special challenge because more and more people live not only in the towns themselves, but also in the surrounding areas, and they commute between home and work every day. The towns continue to expand, and urban agglomerations themselves turn into cities.

In developing countries and emerging economies in particular, many towns and cities are growing so fast that infrastructural measures and urban planning can hardly keep up. The most visible consequence is long traffic queues and too few parking spaces. This means that time is lost and it also annoys the drivers. If the traffic does not flow, trade and productivity also suffer, which has negative effects on the economy.

The world of tomorrow is automated

Increasing traffic density – that is, the sum of all road users in a traffic flow at one point in time on a particular stretch of road – is not limited to the emerging economies and the Asian megacities. It represents a worldwide challenge – here in Germany as well. Here drivers already spend 36 hours on average in congestion per year (see figure). In some towns and metropolitan areas the figure is much higher: in and around Stuttgart and Karlsruhe, for example, it is in fact over 60 hours.

Vehicle density is not going to decrease in the future. The German Federal Ministry of Transport expects that the number of passenger cars on German roads will rise by at least 10 percent by 2025. One reason for this is that we are becoming older all the time. And those who are no longer very good on their feet will tend to use the car or some other form of motorized transport. For freight traffic, the ministry actually forecasts a rise of 30 percent. And the trend is similar for the European Union. Freight traffic on Europe’s roads is predicted to increase by up to 80 percent as compared with today’s figure. The global passenger car fleet will almost double by 2030.
Growing towns and cities – shrinking villages

PROPORTION OF URBAN POPULATION (IN PERCENT), BY REGION

The largest agglomerations in the world

INHABITANTS (IN MILLIONS)

<table>
<thead>
<tr>
<th>Rank</th>
<th>City</th>
<th>2014</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>TOKYO, JAPAN</td>
<td>37.8</td>
<td>37.2</td>
</tr>
<tr>
<td>2</td>
<td>SHANGHAI, CHINA</td>
<td>25.0</td>
<td>26.1</td>
</tr>
<tr>
<td>3</td>
<td>MEXICO CITY, MEXICO</td>
<td>23.0</td>
<td>30.1</td>
</tr>
<tr>
<td>4</td>
<td>SÃO PAULO, BRAZIL</td>
<td>20.8</td>
<td>23.9</td>
</tr>
<tr>
<td>5</td>
<td>MUMBAI, INDIA</td>
<td>20.8</td>
<td>23.4</td>
</tr>
<tr>
<td>6</td>
<td>OSAKA, JAPAN</td>
<td>20.7</td>
<td>27.8</td>
</tr>
<tr>
<td>7</td>
<td>BEIJING, CHINA</td>
<td>20.1</td>
<td>20.0</td>
</tr>
<tr>
<td>8</td>
<td>NEW YORK, USA</td>
<td>19.5</td>
<td>18.4</td>
</tr>
<tr>
<td>9</td>
<td>CAIRO, EGYPT</td>
<td>18.6</td>
<td>24.5</td>
</tr>
</tbody>
</table>
An answer for tomorrow’s world: automation

Growth and prosperity – and participation in them – require people and goods to be mobile. We will need innovative solutions for secure mobility and transport to act as the motors driving the future. It is no longer possible simply to “carry on as before.” In view of population growth and urbanization, traffic flows, which are precisely what up to now has been the basis for greater prosperity for more people, would be restricted. Automated driving has the potential to contribute to resolving the challenges accompanying global development trends.

The primary objective is to make road traffic even safer. The challenge lies in accomplishing this while the volume of traffic continues to rise, especially in the “megacities.” Developments in Germany are positive. The number of people injured in road traffic has fallen by 23 percent since 1993, and the number of deaths has actually fallen by 66 percent. This has come about even though the total mileage covered – i.e. the sum of the distances traveled by all vehicles – increased by 23 percent in the same period. The reasons for this are that cars have become safer and safer, and above all the introduction of driver assistance systems. Developments in other Western countries are similar.

Automated driving makes traffic not only safer, but also more efficient and comfortable. Optimized traffic flow and less congestion bring about a decisive reduction in CO₂ emissions. During rush hour in particular, drivers of automated passenger cars and commercial vehicles gain a newly won freedom and enjoy a better quality of driving. Furthermore, they can leave parking to their vehicles. In short, automated driving functions support drivers and offer them greatly improved driving comfort and flexibility.

Yet despite all this progress in automation, drivers remain in control. Just as today they can already decide whether they would like to have an assistance system in their vehicle, they can also decide while driving whether they want to use an assistance system that has been installed, such as adaptive cruise control.

<table>
<thead>
<tr>
<th>Vehicle type</th>
<th>Road type</th>
<th>Proportion with system switched on</th>
<th>Reduction in critical situations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cars</td>
<td>Highways</td>
<td>51%</td>
<td>32–82%</td>
</tr>
<tr>
<td>Cars</td>
<td>Rural roads</td>
<td>31%</td>
<td>32–45%</td>
</tr>
<tr>
<td>Cars</td>
<td>Built-up areas</td>
<td>19%</td>
<td>32%</td>
</tr>
<tr>
<td>Trucks</td>
<td>Highways</td>
<td>42%</td>
<td>14–36%</td>
</tr>
</tbody>
</table>

Example: If 51 percent of passenger cars on the highways have adaptive cruise control and rear-end collision warning switched on, the number of critical situations is reduced by 32 to 82 percent. Source: PWC Insurance Monitor
Safety due to automated driving

Increasing efficiency by optimizing the traffic flow

**SAFETY ASPECT IN ROAD TRAFFIC**
The system warns the driver of the hazard in good time.

**ADVANCED DRIVER ASSISTANCE SYSTEMS (ADAS)**
are additional electronic devices in vehicles.

**ALL-ROUND VISION DUE TO SENSORS**
Radar, lidar, cameras, ultrasound
Evolution of automation and connectivity

**AUTOMATION**

- Valet parking (driverless parking)
- Traffic jam (driving in congestion)
- Key parking
- Highway driving assistant
- Park assist
- Automatic emergency braking
- Traffic sign recognition
- Lane keeping assist
- Blind spot monitoring
- Parking steering assistant
- Adaptive forward lighting
- Adaptive Cruise Control
- Lane departure warning
- Braking assistant
- Electronic stability program
- Traction control
- Antilock braking system (ABS)
- Cruise control

**CONNECTIVITY**

- 2020
  - HD map
  - 5G network
  - eCall (legal framework)
- 2015
  - LTE network
  - Using app in vehicle
- 2010
  - Integration of smartphone in vehicle
  - Pilot project Car2X (SimTD)
  - Smartphone
  - 3G network
- 2000
  - Mobile Internet in vehicle
  - Mobile navigation system (PDA)
  - iPod connection in vehicle
  - Bluetooth
  - Mobile online services
  - Vehicle telematics
- 1990
  - 2G network
- 1980
  - World Wide Web
- 1970
  - Cell phone (D network)
- 1960
  - Radio traffic information
Automobiles are unlike any other industrial products because they are an expression of the German art of engineering. The car was invented in Germany, and here it is reinvented over and over – with more than 6,700 patent applications per year.

The German automotive industry produces the most efficient and the safest vehicles in the world. Every year, 30 billion euros are invested in research and development in order to extend the industry’s leading position. A large proportion of this investment feeds into the continual improvement of safety. The objective is to prevent accidents from occurring in the first place.

However, hazardous situations arise again and again in road traffic, caused by adverse conditions or human error. A large number of safety systems and driver assistance systems now exist to support the driver. They help in performing the tasks of driving. Acting in different ways, depending on their requirements and applications, they make it easier for the driver to operate the vehicle.

The German automotive industry has always played a key role in the development of driving safety and assistance systems. “ABS” was first introduced onto the market for mass production in October 1978. It prevents the individual wheels from locking when the brakes are applied, with the result that the driver can still steer the vehicle during an emergency braking maneuver.

In 1995 the Electronic Stability Program (ESP) marked another milestone in driving safety. A microcomputer monitors the signals from the ESP sensors and registers when the vehicle becomes unstable or starts to skid. By selectively applying the brakes on individual wheels and throttling engine output, ESP restores the vehicle’s stability so that it does not leave the roadway but stays on course instead.

Many innovative driver assistance systems created to increase driving comfort originated in the development centers of German vehicle manufacturers and the supply industry. Adaptive cruise control (ACC), available on the market since 1998, actively helps the driver maintain a safe distance from the vehicle in front by either braking or accelerating. The adaptive cruise control systems currently in widespread use are in fact able to brake independently, bringing the vehicle to a standstill, and to move off again automatically after a signal from the driver. Both for passenger cars and for commercial vehicles, ACC principally has a comfort function that relieves some of the stress on the driver on the highway or in constant nose-to-tail traffic. Moreover, automatic ACC also improves road safety because it helps avoid sudden emergency braking situations that arise when the vehicle is too close to the one in front or the driver’s attention lapses.

For many years now, drivers of passenger cars and commercial vehicles have widely accepted driving safety systems and advanced driver assistance systems as devices assisting them in road traffic. Today’s vehicles contain up to 100 control units, most of them in the field of engine management. Their safety potential has been proven many times over in studies and practical trials. Some systems, such as ABS and ESP, are in fact now either legally required in new vehicles or else they are installed as standard on the basis of a voluntary undertaking by the European automotive industry.

Innovations delivered by German engineering
Today a large number of driver assistance systems is available for almost all vehicles. They ensure stability in critical situations, maintain a safe distance to the vehicle in front, and support the driver while parking. Monitoring the surroundings in all directions requires data and information from the vehicle's sensors (ultrasound, radar, cameras).

The capabilities of the sensors and the data processing by the control units are continually growing, and highly advanced software is used to analyze this information in fractions of a second. In the future, passenger cars and commercial vehicles will have a complete image of the surroundings in real time.

Radar sensors that are usually located in the front and rear of the vehicle can detect other vehicles and obstacles. The rear sensor detects traffic approaching from behind and vehicles that are overtaking. The traffic in front is monitored by long-range radar. The short-range radar surveys the vehicle's immediate surroundings.

Cameras are used, for instance to recognize lane markings, traffic signs, traffic lights, and other road users.

Ultrasound sensors have been installed in vehicles from the beginning of the nineties, to help drivers maneuver into parking spaces. Since then, their range of functions has increased markedly. They can measure parking spaces while the vehicle is in motion, and detect vehicles driving in an adjacent lane.

In the past, radar, cameras, and ultrasound sensors were used for separate functions, but now all the relevant data can be linked intelligently and simultaneously by sensor fusion. That makes automated driving possible in the first place. Special attention is paid to functional safety.

The inclusion of redundancies and plausibility checks – that is, the system's internal check on whether the environmental data have been recorded correctly – prevents erroneous interpretation of the data. The signals from the vehicle sensors are compared with one another. Only if the data are consistent will the system actuate the steering and the engine.

The automated driving functions include “highway driving,” which in the case of highly automated driving will be used up to a defined speed on highways and similar roads. The driver can choose when to activate the system and does not have to monitor it continuously. This takes away some of the stress of driving, and in certain situations they will be prompted in good time to resume the task of driving. In the case of fully automated driving, the driver does not have to monitor the system at all. In the distant future, in built-up areas the driving function “urban driving” will make it possible to drive on various routes without the driver intervening at all. In this case the driver will be free to use the time on the road as they choose.

Automated driving will contribute to a new quality of mobility.
Sensors for advanced driver assistance systems (ADAS)

**LIDAR - LIGHT DETECTION AND RANGING:**
measures distances from objects and relative speeds, using ultraviolet or infrared radiation, or visible light.

**MONO OR STEREO CAMERA:**
supports the detection of obstacles and hazards, e.g., vehicles and human beings.

**INFRARED CAMERA:**
night vision systems for detecting human beings and wild animals.

**RADAR:**
measures distances from objects and relative speeds, using microwaves.

**ULTRASOUND SENSORS:**
measure distances from objects at close range.

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**Braking assistant (BAS) and automatic emergency braking**

If the driver fails to react to a potential collision, initially partial braking is activated. If the driver still does not react, and does not decelerate the vehicle himself, automatic emergency braking is activated.

If the driver does not brake strongly enough, the braking assistant applies sufficient braking pressure to avoid a collision.
Into the future step by step

The path to automated driving will appear familiar to many: today a customer can configure their desired car such that on the one hand it has today’s driver assistance features (e.g. lane keeping assistant, adaptive cruise control with emergency braking, and highway driving assistant) for driving on the highway. On the other hand, they can decide to go without all the parking assistance systems that support the driver during maneuvering. In the future customers will still have this freedom of choice.

The available driving and parking functions for assisted and partially automated driving and parking already relieve the driver of some tasks. For example, the driving function “Adaptive Cruise Control” (ACC) can take over the continuous operation of the gas and brake pedals. The driver has to monitor the system and if necessary must resume the driving task himself.

In a few years from now, the first vehicles will be equipped with the necessary sensor systems and information processing that enable functions for high and full automation in specific use scenarios. To start with, we may expect automated driving functions for driving on highways and in traffic queues. In the more distant future, we will also see increasing driver support on journeys across country and in urban areas. The path to high and full automation is, however, not only one of technology, but it will also require amendments to both national and international legislation.

Six levels have been defined from 0 to 5 for national and international use to classify the degree of automation of the individual systems (see figure). This technical classification describes which tasks the system carries out, and which tasks/requirements the driver has to fulfill.

At **Level 0** there are no automated driving functions. The driver performs the longitudinal control of the vehicle (i.e. maintaining speed, accelerating, and braking) and the lateral control (i.e. steering). There are no systems that intervene, only those that issue warnings.

At **Level 1** a system can assume either longitudinal or lateral control of the vehicle, while the driver continuously performs the other task.

It is only at **Level 2** that one speaks of partial automation, because the driver can now relinquish both tasks, i.e. longitudinal and lateral control, to the system in a certain use case. The driver continuously monitors the vehicle and the traffic during the journey. At all times they must be in a position to resume control of the vehicle immediately.

At **Level 3** the system independently recognizes its limits, that is, the point at which its functions can no longer cope with the environmental conditions. In this case, the vehicle requests the driver to resume the task of driving. The driver no longer has to continuously monitor the longitudinal and lateral control of the vehicle. However, he must be able to resume driving when the system signals him to do so, with some extra time in reserve.

From **Level 4** onwards, the driver can hand over the entire task of driving to the system in specific use cases. These scenarios refer to the type of road, the speed range, and the environmental conditions.

The last development level is that of driverless driving, **Level 5**. The vehicle can completely independently perform the task of driving in full on all types of roads, in all speed ranges and under all environmental conditions. At present nobody can say when this level of automation will be achieved. The research and development is initially focusing on the automation levels for partially, highly, and fully automated driving. Fully automated driving on highways will probably become possible in the decade after next.
Levels of automation for automated driving

- **LEVEL 0**: DRIVER ONLY
  - Driver continuously performs the longitudinal and lateral dynamic driving task.
  - No intervening vehicle system active.

- **LEVEL 1**: ASSISTED
  - Driver continuously performs the longitudinal or lateral dynamic driving task.
  - The other driving task is performed by the system.

- **LEVEL 2**: PARTIAL AUTOMATION
  - System performs longitudinal and lateral driving task in a defined use case.

- **LEVEL 3**: CONDITIONAL AUTOMATION
  - Driver must monitor the system at all times.
  - System performs longitudinal and lateral driving task in a defined use case.
  - Driver must be capable of resuming dynamic driving task.

- **LEVEL 4**: HIGH AUTOMATION
  - Driver does not need to monitor the system at all times.
  - System performs the lateral and longitudinal dynamic driving task in all situations in a defined use case.
  - System performs the entire dynamic driving task on all road types, speed ranges and environmental conditions.

- **LEVEL 5**: FULL AUTOMATION
  - Driver continuously performs the longitudinal or lateral dynamic driving task.
  - Driver must monitor the system at all times.
  - No driver required during entire journey.

* Use cases refer to road types, speed ranges, and environmental conditions

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Introduction of automated driving and parking functions

- **LEVEL 0**: DRIVER ONLY
  - Lane departure warning

- **LEVEL 1**: ASSISTED
  - Lane keeping assistant
  - Parking keeping assistant
  - Adaptive cruise control

- **LEVEL 2**: PARTIAL AUTOMATION
  - Highway driving
  - Key parking
  - Parking steering assistant

- **LEVEL 3**: CONDITIONAL AUTOMATION
  - Traffic jam / driving in traffic queues
  - Highway driving assistant
  - Parking steering assistant

- **LEVEL 4**: HIGH AUTOMATION
  - Urban driving
  - Valet parking (driverless parking)

- **LEVEL 5**: FULL AUTOMATION
  - Highway driving
  - Traffic jam / driving in traffic queues

* Assuming the existence of a legal framework
Commercial vehicles at the forefront of innovations for automation

For many years, commercial vehicles have driven the automotive industry forward with their huge range of different constructions, concepts, and innovations. The automatic gearbox and electronically controlled braking and emergency braking systems are just some of the technologies that were initially introduced in commercial vehicles before they were also offered in passenger cars.

With the high mileages they cover, commercial vehicles are predestined for automated driving. Whereas a passenger car in Germany travels an average of about 14,000 kilometers every year, long-distance commercial vehicles cover about 100,000 kilometers. However, development has always aimed for the same goals as those for passenger cars: efficiency, safety, and reducing CO₂ emissions.

Developments in commercial vehicle technology
The information and functions both of tried-and-tested and of future driver assistance systems are being bundled into an overall system in commercial vehicles just as in passenger cars. The systems include adaptive cruise control (ACC), the lane keeping assistant, and the emergency braking system – to name but a few examples. Then there are also innovations such as digital 3-D maps. With their aid, the vehicle’s handling is adapted to the features of the road immediately ahead. So a truck can accelerate while approaching an incline in order to build up momentum and ultimately reach the brow of the hill more economically. These systems can very easily be expanded by car-to-X communication. Sharing information with other road users results in additional improvements in safety and efficiency.

Automated driving functions are especially attractive to fleet operators. Fuel consumption and emissions fall considerably because the traffic can flow more evenly. This means that higher average speeds are possible without the need to increase the top speed. Transport times are more predictable and there is less wear on the engines in trucks using the new features, owing to the smoother driving style.

Relieving the stress on drivers is an important factor in further development. Today’s truck drivers are subject to extreme demands. When driving in very dense traffic, they have to remain attentive at all times and are often under time pressure. In the more distant future they will be able to rely completely on the technological systems in their truck, and the truck itself will drive to its destination safely and efficiently thanks to its sensor systems and the sharing of data with its surroundings. This will make a lot of things easier for the drivers, who will be able to turn their attention to other tasks, such as flexible organization of the current route or planning future journeys.
VDA MAGAZINE – AUTOMATION

VII. AUTOMATED DRIVING FOR COMMERCIAL VEHICLES

MERCEDES-BENZ FUTURE TRUCK 2025

TELEMATICS IN COMMERCIAL VEHICLES
Automated driving and connectivity
Intelligent connectivity and digitization, both inside and outside the vehicle, will play an ever more important role in the future.

Automated driving refers to the capability of a vehicle to drive itself independently to a destination in real-world traffic, using its onboard sensors, associated software, and maps stored in the vehicle so that it can recognize its surroundings.

Depending on the use case, the vehicle is therefore able to carry out the relevant driving task. However, the automated driving functions may be considerably expanded in the medium and long term with the aid of connectivity.

Connectivity is the name given to communication between one vehicle and another, and between a vehicle and the infrastructure, for instance with traffic lights or traffic control systems. Within the field of connected mobility, car-to-X communication (C2X) refers to direct communication both between vehicles (car-to-car/C2C) and between vehicles and the stationary infrastructure (car-to-infrastructure/C2I). Car-to-X communication enables vehicles to collect information in a fraction of a second – for example about traffic light sequences and construction sites – either from preceding vehicles or from traffic management systems – and to process this information immediately.

The most important aspect here is road safety. Car-to-X communication warns and informs the driver within a short time about hazardous situations such as accidents, black ice, breakdown vehicles, and congestion along the route, even if they are not yet visible from the vehicle. During an automated journey, the vehicle could brake independently in such cases, or change lanes to pass the hazard at a safe distance without the driver having to intervene. Under adverse environmental conditions such as snow, fog, or dirt on the road surface, information that cannot be collected in full by the vehicle’s sensors can be supplemented with information arriving via car-to-X communication. This represents an ideal addition to automated driving.

Furthermore, innovative technologies make it possible to achieve greater comfort and significant time savings for the driver and the passengers. Intelligently connecting vehicles and parking spaces offers the potential of markedly shortening the time needed to find a parking spot and of the car simply parking itself at the press of a button. For example, a fully automated vehicle can find its allocated parking space in connected parking lots – without any driver. The driver first parks the vehicle in a special transfer zone and then activates the parking function. To pick up their vehicle, the driver activates the function in this zone and the vehicle arrives by itself to meet the driver.

Worldwide connectivity in the field of traffic, as part of the digital revolution, suggests possible solutions that combine greater safety, sparing use of resources, and mobility, plus growth and participation in that growth. Exchange of information, communication, and the use of telematics, that is, linking the fields of telecommunication and information technology, will all be of key importance for the future of automobiles and of traffic.
The continuing progress in automation and connectivity generates additional data and information flows within the vehicle. These flows are needed firstly for the assisted and automated driving and parking functions, and secondly for expanding the options for using information and for entertainment. Data protection and data security are of special importance in the development of these technologies. In order to ensure data protection and security, in 2014 the German automotive industry compiled a set of data protection principles to serve as the basis for secure and transparent data processing.

These principles include transparency, the right to control what happens with one’s own data, and data security. However, before the use of data can be discussed, it must be clear exactly which data we are talking about. When a vehicle is used, a large amount of information is continuously generated and processed, most of which is of a technical nature (machine data). However, the data created during motor vehicle use may, under certain circumstances, also be personal data in the meaning of the data protection legislation. The following categories may be distinguished to facilitate an understanding of the type of data in the vehicle:
DATA GENERATED IN FULFILLMENT OF LEGAL REGULATIONS
Starting on April 1, 2018, the automatic emergency call will be legally required in all new passenger car models. When a severe accident occurs, information including the time and location of the accident and the direction of travel will be transmitted to an emergency call center. This enables initiation of rapid recovery measures.

DATA GENERATED BY TECHNICAL PROCESSES
This is technical data recording the status of the system and the environmental conditions. The information is generated by sensors, and evaluated by the relevant electronic systems in the vehicle. Most of it is transitory in nature and is stored only if an error is detected.

MODERN DATA SERVICES WITH A CONTRACTUAL BASIS
When vehicle services and online services are to be used, such as a concierge service, updating the navigation map, or personal Internet access in the vehicle, data are sent and received by the manufacturer’s server. For freight transport, telematics systems can help in managing the vehicle and the transport.

DATA PROTECTION PRINCIPLES OF THE AUTOMOTIVE INDUSTRY

Transparency
The customer has many ways of obtaining an overview of all the data categories and the purpose of the processed data, for instance from online services, portals, and user manuals.

Right to control over one’s data
The customer can independently deactivate certain services and delete stored data. At any time, they can withdraw their consent to data already provided being used by services. For additional services, data will then be transmitted only on the basis of either a legal permit or a contractual agreement.

Data security
Customers should be protected against manipulation and misuse of their data. This demands continual active further development of data security that is oriented to ongoing developments in IT.

The automotive industry provides the technical and organizational measures for protecting the data generated in the vehicle. The VDA collaborates with the automotive industry to ensure that standards are established and continue to be developed for the software and hardware architectures in the vehicles and for remote access to the vehicle via the telecommunication networks. A high level of technical security can thus be guaranteed at all times; this includes the use of appropriate encryption technologies.

Sensitive areas within the vehicle are completely excluded from communication. Gateways and firewalls seal off those areas in the vehicle that are security-sensitive. This means that the vehicle can be used securely and continuously in all operating situations. It will never “freeze” like a computer because it incorporates features such as operating systems that are specially optimized for use in vehicles.

The automotive industry regards data protection and data security, transparency, and the customers’ right to determine what happens with their data as the basis for a relationship of trust.
A secure legal framework for automated driving
To push automated driving forward, the automotive industry needs a secure legal framework – both at national level and in the global context. The right conditions should be put in place so that vehicles can assume tasks that today only the vehicle’s driver is allowed to perform.

The “Vienna Convention” of 1968 states that the driver must be in control of their vehicle at all times. In March 2014, the relevant working group of UNECE (the United Nations Economic Commission for Europe) approved an amendment to the corresponding article. According to this amendment, highly automated systems that continue to have a driver ready to take over the driving functions, and who can override the system and switch it on and off, will in the future be in accordance with the “Vienna Convention.” The amended convention still demands that every vehicle must have a driver. Therefore another amendment process will be necessary to permit driverless vehicles. The road traffic legislation (e.g. the German Road Traffic Act (StVG) and German Road Traffic Regulations (StVO)), will require reforms to accommodate Level 3 upwards (see figure “Levels of automation for automated driving” on p. 15). It would also be expedient to amend the German traffic rules for highly automated driving functions in order to make the driver’s obligations more specific and to legitimize the use of onboard infotainment systems during highly automated journeys, and in general for transferring driving tasks to systems. And finally, the international legislation governing motor vehicle registration will have to be adapted so that automatic steering systems, for instance, can be introduced for operation at speeds over 10 km/h.

From today’s standpoint, there are still legal, ethical, and social challenges that would have to be resolved for automation Levels 3 and 4 upwards. The VDA and the German automotive industry are bringing these issues proactively into the public discourse in a transparent, responsible, and sustainable approach to this future technology. If dilemmas occur, the technical system should never weigh up human lives, but must minimize the consequences of an accident by braking and taking evasive action. In such circumstances, a highly automated system reacts faster, more rationally, and with better anticipation than the human driver. Sensors such as radar, cameras, and laser scanners are able to detect cyclists and pedestrians. However, at present they cannot differentiate, e.g. by age, and that will not be possible in the near future either. Without this information, many of the constructed dilemma situations do not currently occur for the technical system. The German automotive industry is working on internationally harmonized requirements for vehicle users. German national law will also have to be amended so that Germany can set the pace of developments in this area. The secure legal framework that should be established at national and international level for automated driving will simultaneously bring about investment security for the manufacturers and suppliers on their home market.

For Germany, digitization of mobility represents an opportunity to become the international leader in this field. Expertise in development leads to expertise in solutions. The German companies operate within and appreciate our legal framework. If we do not lead the field, then others will, with different legal foundations. And against this backdrop Germany should play a pioneering role in the global network.
A to Z of automated driving

Adaptive cruise control (ACC)
Adaptive cruise control is a system regulating the vehicle’s speed, which also automatically maintains a safety distance from the vehicle in front by accelerating and braking.

Advanced driver assistance systems (ADAS)
Additional electronic devices in motor vehicles for supporting the driver in certain driving situations. They focus on safety aspects, and on enhancing driving comfort.

Agglomeration
The region around one or more core towns that are surrounded by a closer, densely built-up belt of suburbs and a geographically wider catchment area that is sometimes rural.

Anti-lock braking system (ABS)
Prevents the wheels from locking during braking. It regulates the braking pressure so the driver can still steer the vehicle.

Automation
Describes the increasing automation of driving and parking functions. Depending on its type, a function can take over longitudinal and/or lateral control of the vehicle.

Blind spot monitoring
Blind spot monitoring detects objects in the driver’s blind spot and informs/warns them of a potential collision when they intend to change lanes.

Car-to-car communication (C2C)
This form of connected communication is the exchange of data between two or more vehicles via WLAN 802.11p, which warn one another of obstacles on the road, aquaplaning, and other hazards.

Car-to-infrastructure communication (C2I)
This approach involves wireless communication via WLAN 802.11p between vehicles and elements of the infrastructure.

These infrastructure components may be intelligent traffic lights or wireless nodes used for establishing communication via the Internet to infotainment platforms or to the vehicle manufacturer.

Car-to-X communication (C2X)
Refers to the exchange of data between vehicles, the infrastructure, traffic control centers, and Internet applications using WLAN 802.11p. Individual cars both send and receive data. Other players such as traffic control centers receive, process, and forward the information.

CO₂ emissions
The CO₂ emissions value expressed in grams per kilometer or as a mass of gas emitted over a certain distance traveled.

Connectivity
The increasing exchange of information between vehicles and their surroundings.

Driving safety systems
Additional electronic devices that intervene in the driving process in critical situations, in order to preserve vehicle stability. It is not possible to override them during the intervention.

Electronic stability program (ESP)
Recognizes critical driving situations and vehicle instability on the basis of sensor data. It prevents the vehicle from going into a skid by intervening in the braking system and engine management.

Highway driving
The driving function “highway driving” assumes lateral and longitudinal control during highly automated driving on highways. The driver must consciously activate the system, but does not have to monitor it at all times. Under certain circumstances the system prompts the driver to resume control.
Key parking
Before a car is maneuvered into a parking space, the driver gets out and uses the display key so the car drives into the space, and later pulls out of it again.

Lane departure warning
A video camera behind the windshield detects the course of the lane. The system evaluates the lane markings and warns the driver if the vehicle leaves the lane unintentionally.

Lateral control
Vehicle steering function.

Lidar (Light Detection And Ranging)
System for measuring distances and relative speeds, using ultraviolet or infrared radiation or visible light.

Longitudinal control
Regulation of the vehicle’s speed by accelerating and braking.

Manufacturer
Vehicle manufacturer.

Megacities
Cities with at least ten million inhabitants.

Mileage
The distance traveled by vehicles (usually expressed in kilometers).

Parking steering assistant
In certain parking scenarios the system assumes lateral control. The driver activates the parking steering assistant, which then performs the task of steering. The driver brakes the vehicle only at the end of the parking space.

Radar (RAdio Detection And Ranging)
A measuring system using radio waves to pinpoint objects, their positions, and relative speeds.

Sensors
The ultrasound, radar, lidar, and cameras that supply the vehicle with data and information about its surroundings, for example.

Sensor fusion
The combination of data from various sensors with the aim of recording the vehicle’s surroundings more exactly and with greater safety by comparing the data.

Suppliers
Companies that are part of the automotive industry’s value chain and supply the vehicle manufacturers with products, components, systems, etc.

Telematics
Links the areas of telecommunication and information technology – linking information from at least two information systems using a telecommunication system and a special form of data processing.

Traffic control center
Collating all traffic information at one place allows targeted guidance of urban traffic, and disruptions can be minimized or even prevented entirely.

Traffic density
The sum total of all vehicles in a traffic flow at one point in time on one stretch of road.

Traffic jam assistant
In congestion the car drives within its own lane and keeps its distance from the vehicle in front. The driver must monitor the system all the time and intervene immediately if necessary.

Ultrasound sensors
System for measuring the distance to close objects.

Urban driving
The driving function “urban driving” can cope with complex roads in cities. At low speeds the vehicle operates without any intervention by the driver. The driver does not have to monitor the system at all.

Urbanization
Here, the growth of cities.

Use case
Describes the type of road (highway, urban street), speed range, and environmental conditions (weather, condition of road surface), for which an automated function can be used.

Valet parking (driverless parking)
This means that parking maneuvers are carried out fully automatically by the vehicle. The driver places the vehicle in the entry area of the parking lot/garage and activates the function (e.g. via a smartphone). As soon as they wish to continue their journey, they recall the vehicle and take charge of it in the exit area.

Vehicle density
Number of vehicles per square kilometer, per kilometer of road, or per inhabitant.
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