Die
Bundesregierung

Strategy for Automated and Connected Driving

Remain a lead provider, become a lead market, introduce regular operations

Contents

1 Introduction

The motor car was invented in Germany. We have revolutionized it time and again. And today, we are still at the top of the international league table when it comes to innovations in the automotive sector. All the major innovations associated with the car – from the four-stroke engine to the anti-lock braking system – come from Germany. Our leading role in the field of automotive innovations has been, and continues to be, the foundation for growth and prosperity in our country.

Now, digitalization is about to usher in a historic revolution in the field of mobility – automated and connected driving. As a result, mobility will assume an entirely new dimension – it will evolve into "Mobility 4.0". The car will turn into another important place in people's lives alongside their offices and homes. Driving will evolve from an activity that is necessary for getting from A to B into a new, productive time window. Real-time car-to-infrastructure data communication will make traffic flows predictable, combat congestion and reduce the number of accidents. By connecting them with their surroundings, vehicles will become fully digitalized mobility, information and communications platforms. In a related development, new players will enter the market and the boundaries between industrial sectors will become blurred.

It was less than 15 years ago that the first connected car conquered the mass market. Today, modern production vehicles are no longer conceivable offline, and they already have a software code that is more complex than that of a space shuttle. Up to 70 computers collect a huge amount of driving information and process over 25 gigabytes of data per hour of driving. Technologies such as brake and lane keeping assist have been in mass production for a long time. Automated and connected driving brings these systems together and is the next qualitative step. This is the digital innovation cycle – and its frequency is rising. However, these innovations not only involve significant potential. At the same time, the challenges regarding data protection, safe operation and cyber security and ensuring that users have freedom of choice will become greater.

The crucial impetus for these innovations comes from Germany. We want it to stay that way – and we want Germany to determine the digital innovation cycle. Our country is to further consolidate its position as a lead provider and become a lead market. Our aim is for key Mobility 4.0 technologies to be developed, researched, tested and produced in Germany.

That is why we have put together a package worth billions of euros to provide universal superfast broadband coverage as a fundamental contribution for automated and connected driving. That is why we are taking the laboratory to the road and constructing the first "digital motorway test bed" on the A 9 motorway, where we are trialling the latest technologies in collaboration with the automotive manufacturers and digital companies. And that is why we have launched an "Automated Driving Round Table" with points of contact from industry, academia and government and engaged in an intensive exchange of views on the correct regulatory framework for the promotion of automated and connected driving.

For 130 years, Germany has been a leading innovator in automotive engineering. It is now imperative that we roll this success story forward in the digital era. Against this background, we have joined forces with the "Automated Driving Round Table" to develop a strategy on how we can further advance automated and connected driving. It is our guide for further strengthening Germany's position as the world's number one car manufacturer – and for exploiting the opportunities for growth and prosperity inherent in Mobility 4.0.

2 Fundamentals

Automated and connected driving means a fundamental paradigm shift – from driver to autopilot. This development will take place in a dynamic process of consecutive phases of innovation. Together with the "Automated Driving Round Table", the Federal Government is developing uniform definitions of the various levels of automation and forms of connectivity.

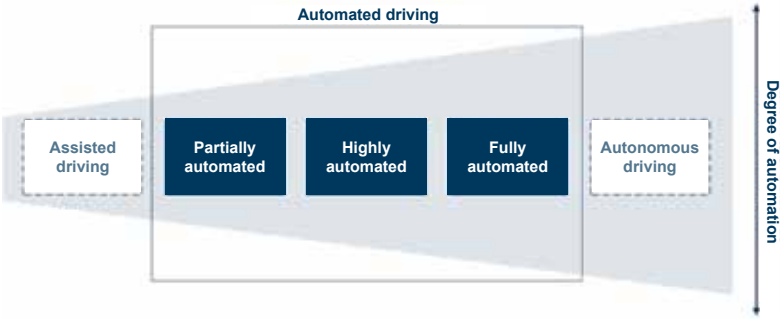
- Driver assistance systems are the preliminary stage on the road towards automated driving. These systems assume, within certain limits, either the longitudinal or lateral control of the vehicle. The driver has to constantly monitor the system and be ready to intervene. Examples of such assistance systems are adaptive cruise control and park assist.

- Partially automated driving means that the system assumes both lateral and longitudinal control of the vehicle for a certain period of time or in specific situations. However, the driver still has to constantly monitor the system and be able to resume full control of the vehicle at any time. One example is the traffic jam assist.

- A major distinguishing feature of highly automated driving functions compared with the previous levels of automation is that the vehicle assumes longitudinal and lateral control for a certain period of time or in specific situations and the driver no longer has to constantly monitor the system. However, he must always be able to resume full and safe control of the vehicle after being prompted to do so and with a sufficient time buffer.

- In the case of fully automated driving functions, the system assumes full control of the vehicle in a defined scenario, thereby automatically handling all related situations.

- Autonomous driving ("driverless vehicles") is the highest level of automation. The system assumes full control of the vehicle from its starting point to its destination. In this case, all persons travelling in the vehicle are passengers.



Classification of progressive vehicle automation

Connected driving is based on two communications channels: car-to-car communication (C2C) and car-to-infrastructure communication (C2I). C2C data exchange significantly improves the traffic information received by individual road users. The fact that the data are up-to-the-minute enables immediate – in some cases even automated – adaptation to current traffic situations. If the car in front automatically detects an accident or a traffic jam ahead, the vehicles behind it are informed in real time. If these vehicles are operating in automation mode, they can decelerate accurately and comfortably. C2I communication comprises the exchange of data between cars and the infrastructure and adds digital connection with the overall

system to the traffic information base for road users. This enables, among other things, direct, automated adaptation to the traffic environment, for instance in areas where there are speed limits or traffic control signals.

3 Potential

The mobility of the future will be safe, secure, clean and efficient – and will present enormous opportunities for growth and prosperity in our country. Automated and connected driving will significantly improve traffic flows, reduce the incidence of critical situations, optimize the handling of corresponding scenarios, relieve the pressure on drivers and the environment, generate added value and create new jobs. As market penetration grows and the degree of automation rises, the benefits that can be derived from these developments will increase. In concrete terms, automated and connected driving will produce potential in four fields, and we want to exploit this potential by implementing the "Automated and Connected Driving Strategy".

3.1 Increasing traffic efficiency

Our traffic forecast for 2030 predicts growth of 13 percent in the passenger transport sector and 38 percent in the freight sector[1]. This is a tremendous challenge. But it is also a great opportunity. Because growth and a high degree of mobility are inextricably linked.

Given the spatial and economic constraints on capacity enhancement, the key to exploiting this opportunity lies in greater traffic efficiency and better utilization of existing capacity. By enabling drivers to adapt their driving style and choice of route to the current traffic situation, automated and connected driving can make a major contribution towards better coordinating traffic and, as a consequence, optimizing the flow of traffic. In particular, the traffic waves that occur in heavy traffic and the resultant congestion can be significantly reduced by automated and connected driving, even in mixed traffic with non-automated vehicles.

[1] Federal Ministry of Transport and Digital Infrastructure (2014): Verkehrsverflechtungsprognose 2030.

If there is sufficient market penetration, this will significantly increase the capacity utilization of the existing road network and enhance traffic efficiency.

3.2 Enhancing road safety

Accident statistics show time and again: the principal cause of road accidents is human error – triggered, for instance, by inappropriate speed, failure to pay attention or not keeping a safe distance from the vehicle in front. Thus, in 2014, around 90 percent of accidents were attributable to human-related causes, whereas not even one percent were due to technical deficiencies[2].

Accordingly, the provision of support to the driver by assistance systems offers enormous potential for enhancing road safety, especially in critical driving and traffic situations. The evolution of such systems, from anti-lock braking systems at the end of the 1980s to complex technical systems such as lane keep assist or advanced emergency braking systems, is already a success story today. This is illustrated by the trends in the number of road traffic casualties. Despite the fact that the volume of traffic has been rising sharply over the years, there has been a significant increase in road safety.

The evolution and consolidation of existing and proven assistance systems to form automated and connected vehicles will further expand the positive contribution towards enhancing road safety. Additional indirect effects are likely to result from the fact that the sensor technologies that are improved through the development of automated driving functions will also be used in conventional assistance systems. This will make it possible to operate non-automated vehicles more safely in the expected mixed traffic.

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[2] Federal Statistical Office (2015): Verkehrsunfälle 2014. In: Fachserie 8, Reihe 7, Wiesbaden..

3.3 Reducing emissions from transport

Bumper-to-bumper traffic or congestion cause an increase in fuel consumption and, as a consequence, higher emission levels compared with moving traffic[3]. By progressively optimizing the flow of traffic, automated and connected driving will result in fewer braking and acceleration manoeuvres, even when deployed in mixed traffic, and thus in lower fuel consumption and levels of emissions from vehicles. Furthermore, the increasing market penetration by such innovations will significantly reduce congestion and slow-moving traffic, which will additionally result in lower emissions from transport. In combination with electric drivetrains, in particular, automated and connected driving can enhance ranges and increase the utility value, for instance by means of automated charging.

3.4 Making Germany a more competitive site for economic activity and a more attractive location for innovative businesses

The German automotive industry is one of the leading suppliers in the world and, with a workforce of around 750,000, is among the major employers in Germany[4]. Today, already, German companies are at the forefront of innovation in automated and connected driving, and as such are making a major contribution towards the introduction of new vehicle technologies and assistance systems. This makes our country very competitive on the international market.

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[3] Institut für Verkehrswesen (2011): Torsten Herzog – Strategien und Potenziale zur Verbrauchsreduzierung bei Verkehrsstaus. In: Schriftenreihe Verkehr der Universität Kassel, Heft 20, Kassel.

[4] Federal Ministry for Economic Affairs and Energy (2015): http://www.bmwi.de/DE/Themen/Wirtschaft/branchenfokus,did=195940.html; retrieved on 30 June 2015

One of the key foundations for the high innovative capacity of the German automotive industry is a broad structural base with large corporations and small and medium-size enterprises. In fact, German SMEs are acknowledged to be an internationally successful driving force behind technological progress. In addition, extensive and highly productive research is conducted, with a spectrum ranging from basic to applied research. Here, there is close collaboration between the research community and industry. Another factor that makes Germany a competitive site for economic activity is a high level of trust in the German legal system. On the international stage, the very good business environment is reflected in the excellent image of the "Made in Germany" brand, which also supports the marketing activities of key Mobility 4.0 technologies from Germany.

The active promotion of automated and connected driving will help to further strengthen the German automotive industry's role as a leading innovator and lend a further boost to adjacent growth markets for information and communications technologies and innovative digital services. This will result in numerous new jobs and potential added value worth billions of euros[5].

[5] Example: Roland Berger Strategy Consultants (2014): Think Act – Autonomous Driving, Munich/McKinsey & Company (2014): Connected Car, automotive chain unbound, Düsseldorf.

4 Objectives

The Federal Government has set itself three objectives in order to progress Germany further along the path towards automated and connected driving and ensure that our country leads the way in this crucial phase of innovation.

1. We want to remain a lead provider. Our country is at the forefront of innovation in automated and connected driving – and that is where it is to remain. The Federal Government is committed to creating an optimum regulatory framework and favourable conditions that will make it possible to research, develop, trial and produce key Mobility 4.0 technologies in Germany.

2. We want to become a lead market. Germany has one of the densest and best road networks in the world and is home to an automotive industry that is a world leader. We want automated and connected vehicles to be not only built but also driven here and Germany to become the number one in terms of market penetration.

3. We want to put automated and connected driving on the roads. If Germany is to become a lead market, we have to pave the way for this – from trial operations to readiness for mass production and regular licensing. In the first step, the focus will be on highly automated driving functions. On the basis of the current status of technological development, two scenarios are realistic: the deployment of highly automated vehicles in the structured, less complex traffic environment of motorways and near motorway standard roads[6] and the deployment

[6] This scenario will be implemented in two consecutive phases. In the first stage, the motorway congestion system will be introduced, which allows highly automated driving at a maximum speed of 60 km/h when following vehicles in traffic jams. In the second stage, the motorway system will be introduced, which allows highly automated driving at a maximum speed of 130 km/h on long-distance journeys.

of fully automated driving functions in the low-speed range in complex traffic environments such as multi-storey car parks[7].

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The innovation cycle of automated and connected driving is influenced by a large number of factors such as international competition, technological advances, consumer acceptance and the policy framework. Simultaneously, it describes a highly dynamic process. Against this background, the objectives outlined here are to be seen as milestones, going beyond which we will use the years ahead to join forces with industry and academia and prepare higher levels of automation and interconnectivity.

[7] The multi-storey car park system on which this scenario is based comprises fully automated parking and manoeuvring in defined parking environments.

5 Action areas and measures

The evolution of automated and connected driving is a cross-cutting activity that affects a large number of spheres. Five generic action areas can be defined, within which the foundations will be laid for Germany to play a pioneering role: infrastructure, legislation, innovation, interconnectivity plus cyber security and data protection.

5.1 Infrastructure

Mobility 4.0 innovations need intelligent and connected transport infrastructure – with high-speed data transmission, sensors in structures and traffic signals that collect information on the traffic situation and environment, communicate with vehicles in real time and independently report congestion and wear and tear. The regular operation of automated and connected driving is thus directly linked to the digital capacity of our infrastructure and the seamless connection of road users to superfast broadband.

1. Digital Infrastructure

   - With regard to broadband roll-out, the Federal Government has set itself the objective of ensuring basic universal coverage at a speed of at least 50MBit/s by 2018. To this end, the Federal Ministry of Transport and Digital Infrastructure has founded the "Network Alliance for a Digital Germany" with the companies that are willing to invest and innovate, which have pledged to invest billions of euros in the deployment of broadband. Where there are value-for-money gaps, the Federal Government's financial assistance will provide financial incentives worth billions of euros for upgrading the network.

- Regarding coverage of the federal trunk road network, the Federal Government imposed conditions when auctioning the 700 MHz frequencies (Second Digital Dividend) which oblige the purchasers to ensure that the motorways are connected with a bitrate of at least 50 MBit/s per antenna sector by 2018.

- The Federal Government sees basic coverage of 50 MBit/s as an interim target and is supporting the focused deployment of higher bandwidths. This includes, but is not limited to, advances in the field of real-time data transmission going as far as the 5G mobile communications standard on the Digital Motorway Test Bed (see 5.3).

2. Standards for intelligent roads

   - On the "Digital Motorway Test Bed", we are cooperating closely with partners from industry and academia to trial and assess, inter alia, intelligent road requirements associated with automated and connected driving. Findings that already exist are also to inform the considerations. To address specific issues, we will create appropriate testing areas. On the basis of intelligence obtained from this and corresponding research findings (see 5.3), we will develop standards for the digitalization of the federal trunk road network and implement them within the scope of future structural maintenance, upgrading and construction projects.

5.2 Legislation

The deployment of automated and connected vehicles needs legal certainty. This applies both to the motorists and to automotive manufacturers. The following principle must apply: the proper use of automated and connected vehicles is not a breach of the driver's duty to exercise due diligence.

1. International regulatory framework

   - The Vienna Convention must be opened to the deployment of all automated driving systems. We will press ahead with the necessary amendments to the Vienna Convention in all the competent international bodies. The definition of the term "driver" in Article 1(v) has so far only made provision for a person as driver. This provision should be widened such that, in the future, automated systems with full control of the vehicle are put on an equal footing with a person.

   - At international level, we are lobbying to ensure that the maximum authorized speed for the deployment of automated driving systems is increased from the current limit of 10 km/h to 130 km/h and that automated lane-changing is allowed. Adaptation of the relevant UN regulations, especially the provisions governing steering equipment (UN Regulation No 79), has already been initiated by Germany and is being emphatically pursued..

2. National regulatory framework

   - In the future, German road traffic law must permit the deployment of automated and connected driving systems to the

full extent. The Road Traffic Act must stipulate that vehicles with such systems may use the roads.

- The proper use of automated and connected vehicles must not, per se, be used to accuse drivers of breaching their obligation to exercise due diligence. They must not be encumbered with any additional liability risks as a result of this. The Federal Government will review the regulatory framework governing automated and connected driving and, where necessary, adapt it to the latest developments. Consideration should be given to whether traffic law should reflect the fact that, in certain situations, it is no longer the driver but the system that performs the driving task.

3. Driver training

- Automated and connected driving will provide drivers with new functions that are currently not subjects taught in driver training. New requirements, such handing over and resuming control of the vehicle, will be incorporated into the framework plan for driving instructor training at driving instructor training centres, the Learner Driver Training Regulations and the Driver Licensing Regulations.

4. Type approval and technical inspection

- Type approvals and inspection procedures ensure that automated and connected driving systems are in working order. To this end, it is necessary that general requirements for highly automated vehicle technology be established at international level. The Federal Ministry of Transport and

Digital Infrastructure therefore advocates widening the scope of application of the tried-and-tested "European Code of Practice" for the safe design of driver assistance systems to cover automated and connected driving systems.

- We have joined forces with the automotive industry to develop appropriate system structures and system tests for the testing and approval procedure for highly automated driving functions, to assess existing testing facilities and, if appropriate, establish new ones. For the periodic technical inspection (PTI), requirements to be met by the main inspection and safety inspection will be established. The Federal Government is lobbying to have the corresponding PTI inspection criteria incorporated into Directives 2014/45/EU and 2007/46/EC and into the corresponding UN regulations.

5.3 Innovation

The potential for growth and prosperity inherent in automated and connected driving will be leveraged where there is development, research and production. The trialling of appropriate technologies in real-life situations plus intensive research into new issues in connection with their deployment is a key prerequisite for confirming that these systems work properly and are safe and for assuming a position at the forefront of market introduction and penetration. For this reason, we want to create an optimum framework in Germany for the promotion of Mobility 4.0 innovations – by optimizing the possibilities for trialling automated and connected driving and by promoting the activities of the scientific and technological community to address the issues involved.

1. Digital Motorway Test Bed

   - On the A 9 federal motorway in Bavaria, the Federal Government has joined forces with companies in the automotive industry and the digital technology sector to operate a "Digital Motorway Test Bed", on which it is possible to trial, assess and evolve Mobility 4.0 innovations.

   - The "Digital Motorway Test Bed" is a technology neutral offer to industry and the research community and can be used by all stakeholders from the automotive industry, the digital technology sector (including the cyber security sector) and academia who are interested in testing their innovations.

   - On the "Digital Motorway Test Bed", the Federal Government is promoting trial operations of highly automated to fully automated vehicles. In addition, the focus is on connected driving using car-to-car and car-to-infrastructure communications with sophisticated sensor technology, high-precision digital maps and real-time communications with the latest transmission standards.

   - The dynamic development of the "Digital Motorway Test Bed" will be accompanied by scientific research. In the interests of an open transfer of knowledge, advances will be evaluated and documented in an innovation report to be published at regular intervals.

2. Research funding

   - The focus here is on pre-competitive research and the interlinking of research activities. This involves launching

research programmes with structured contents, incorporating the research clusters identified by the "Automated Driving Round Table", which will address, in particular, mobility-related issues of human-machine interaction, functional validation, the social dimension and transport infrastructure.

- The Federal Government is providing financial assistance, as far as resources allow, to research projects in the field of automated and connected driving. An overarching research framework is to define priorities and ensure that the activities of the individual departments complement one another in an appropriate manner.

5.4 Interconnectivity

Interaction between vehicles and infrastructure presupposes the collection, processing and intelligent linkage of data. Automated and connected driving requires accurate information on the traffic situation, spatial conditions, the state of the infrastructure, the weather situation, traffic rules and regulations or manoeuvres by other vehicles. Here, there is a direct link between the diversity of data on the one hand and the potential inherent in Mobility 4.0 for efficiency and wealth creation on the other hand.

1. Mobility data and spatial data

   - Building on the lessons learned from the "Digital Motorway Test Bed" (see 5.3), the Federal Government will make available traffic-related mobility and spatial data in an open-source approach and consolidate them on a data cloud.

- Using the "DAB+" digital radio standard, vehicles are to be provided with detailed real-time traffic information for their current location. To this end, we are seeking a swift changeover to digital radio and universal network coverage. The Federal Ministry of Transport and Digital Infrastructure's "Digital Radio Board" will provide active support to this process.

- The swarm intelligence of road users offers enormous potential for increasing the diversity of data on the traffic situation and infrastructure. To exploit these data, a digital application is to be provided that collects mobility and spatial data and makes them available – and acts as an interface for other services.

2. Interlinking of traffic signs

   - The intelligent interlinking of road signs, signals such as traffic lights, and telematics systems can optimize the flow of traffic. For several years now, the Federal Government has been intensively supporting the implementation of appropriate schemes. This commitment is to be further extended. The Federal Government will join forces with partners from industry and academia to develop and trial innovations for the interlinking of traffic signs and their deployment in rural areas.

3. High-precision map systems

   - High-precision map systems are a key technology for automated and connected driving. The Federal Ministry of Transport and Digital Infrastructure believes that the development of appropriate data sets is primarily the responsibility of the market. The Federal Government is supporting the companies

by providing financial assistance to innovations within the scope of the "Digital Motorway Test Bed" (see 5.3).

5.5 Cyber security and data protection

The digitalization of mobility and the associated increase in the amount of data are creating new requirements to be met by vehicle safety and infrastructure and the protection of personal rights. Automated and connected driving systems thus require clear cyber security standards and data protection requirements. We want our country to take the lead in this field and we want German cars to continue to be the safest in the world in the digital era. Germany is to set international standards so that automated and connected driving systems can perform their functions safely and reliably across national borders and the rights to individual mobility data are clearly regulated. Our objective is to ensure that vehicles are protected from external interference and manipulation. And the principles of general data privacy law apply to data protection.

1. Standardization of cyber security

   - As the automation and interconnectivity of driving functions increases, the issues of data encryption and cyber security will become more important. To prevent non-authorized external access (hacking) to vehicles, automotive manufacturers, component suppliers and service providers must guarantee the secure encryption of data and communications. They must ensure that there is adequate protection against manipulation and misuse both of the technical structure and of the data and processes. Measures such as inspection of the systems by external bodies and the introduction of certification for

technology and data processing procedures or control processes should be considered.

- The Federal Government is thus developing guidelines for protection against non-authorized external access, which are to be submitted to the UN Economic Commission for Europe (UNECE) and adopted by the Member States. These guidelines will constitute an indirect obligation for manufacturers, because they will have to be regarded as "state of the art". If a manufacturer fails to comply with the requirements of the guidelines, they must guarantee security in a similar manner. The appropriate UNECE Working Party on Intelligent Transport Systems and Automated Driving (WP ITS/AD) has already given its consent to this approach.

- In addition, the Federal Government is lobbying at international level to ensure that, along the lines of the already applied technologies for immobilizers (UNECE Regulation No 116: Protection of Motor Vehicles against Unauthorized Use), mandatory security-related requirements for the approval of automated and connected driving systems for road traffic are implemented. At the same time, international standard ISO 26262, which establishes standards for the functional safety of safety-critical electric and electronic components/systems in vehicles, is to be expanded to reflect the increasing proportion of digital technology in automated and connected vehicles.

- At national level, the Federal Government's "Data Panel", taking as its basis the technical guidelines and protection profiles of the Federal Office for Information Security, will coordinate the fleshing-out and further improvement of the cyber security and encryption standards and incorporate ongoing Federal

Government activities. In concrete terms, for instance, the cryptographic requirements for Federal Government projects (BSI TR-03116) will be augmented by separate technical guidelines for the field of Intelligent Transport Systems in order to enhance protection against external access in appropriate use cases. A protection profile that defines the requirements to be met by technical components, focusing on the use of signature keys and the secure generation of digital signatures, will be applied to automated and connected driving.

2. Data protection

   - The principles of general data protection law must be respected, especially the principles of data minimization and purpose limitation.

   - Greater use must be made of anyonymization and pseudonymization techniques in the collection, processing and interlinking of data.

   - The principle of informational self-determination applies. Users (vehicle keepers and/or drivers) must be provided with comprehensive information as to what data are collected and processed in the deployment of automated and connected driving systems, for what purposes and by whom, so that they can give their consent to the collection and processing of their data on an informed and voluntary basis. It must be possible for them to give their consent selectively and to withdraw it if it involves functions that are not necessary for the operation of their vehicle or for road safety.

- In addition, the industry is responsible for designing data processing systems installed in vehicles such that they are data protection friendly, i.e. taking data protection and cyber security aspects into account when planning the components (“privacy by design”) as well as designing the basic factory settings accordingly (“privacy by default”).

6 Implementation

Implementation of the “Strategy for Automated and Connected Driving” will be continuously monitored and strategically controlled at state secretary level under the auspices of the Federal Ministry of Transport and Digital Infrastructure. There will be close coordination between the Federal Ministry of Transport and Digital Infrastructure and the other government departments; the lead responsibility of other departments for individual sectors affected will remain unaffected in implementation of the strategy. Operational programme control for all action areas and measures will be exercised by a programme group whose composition is to be coordinated between the departments involved and within which project teams with relevant experts and stakeholders from civil society will be formed. The aim is to implement the individual items swiftly in order to progress the development of automated and connected driving. In addition, the programme organization will ensure that all relevant players and the general public are informed in a timely fashion and comprehensively about the progress made by the “Strategy for Automated and Connected Driving”.

The “Automated Driving Round Table” has proved its worth as a central platform for societal participation. This interdisciplinary and cross-institutional expert body has identified important technical, legal and social challenges that the “Strategy for Automated and Connected Driving” is to tackle. To safeguard and widen the knowledge base and network of experts that have been established, all players involved in the “Automated Driving Round Table” agree with the Federal Government that the successful activities should be continued. This forum will continue to provide a suitable framework for identifying the tasks that will arise from the evolution of automated and connected driving.

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