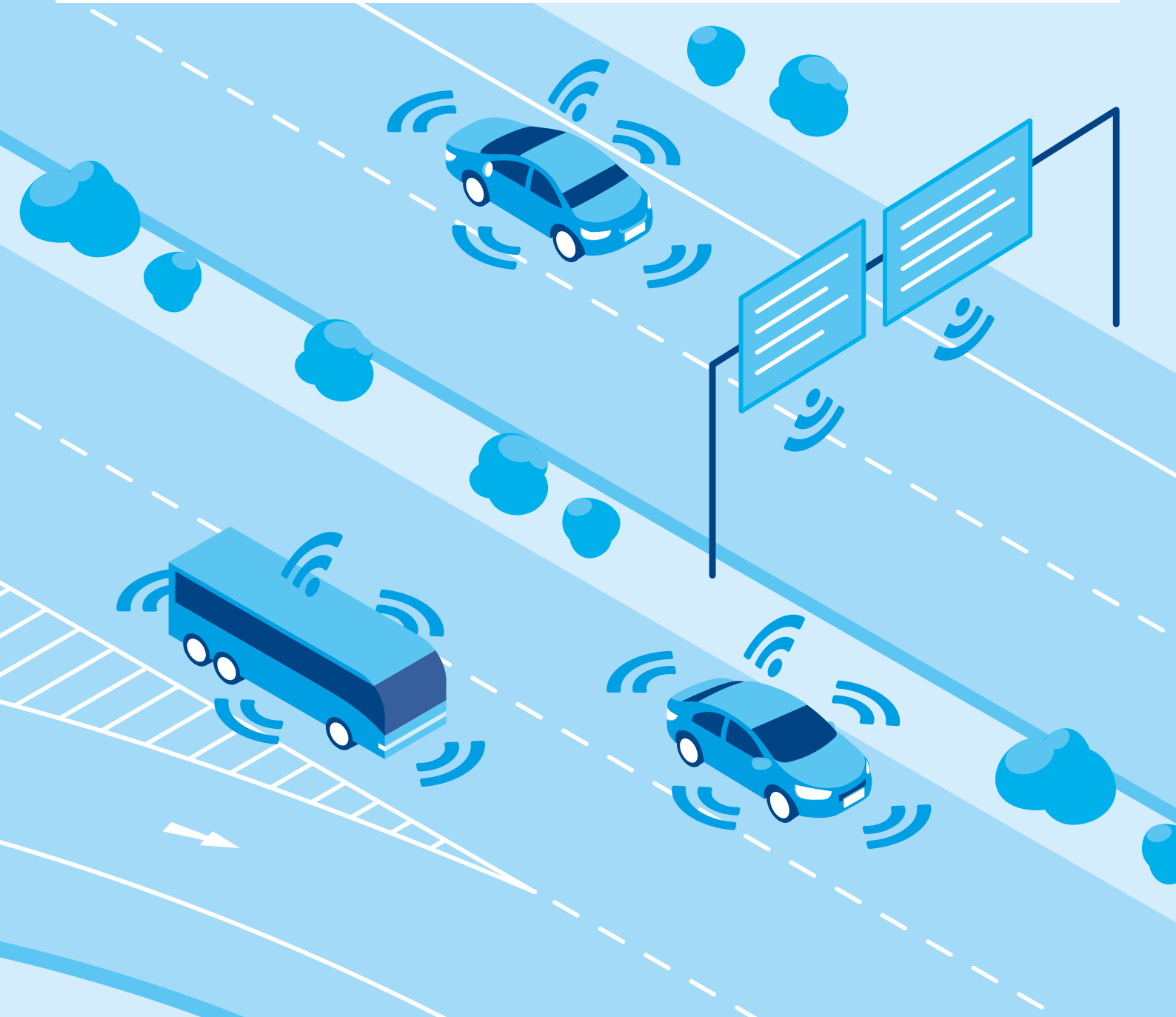
VDA | Verband der Automobilindustrie

Standardization Roadmap for Automated Driving

Edition 2019



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Content

Foreword

Lieber auf geehrten,
liebe Fans of the automotive,

People are currently changing their mobility behavior more rapidly than ever before. Both customers and society expect solutions for environmentally friendly, sustainable and safe mobility. It is our mission to meet these expectations. The change in mobility is shaped by the automotive industry. Our industry has initiated a transformation process that is fundamentally changing products, technologies and services. We will reinvent the car and mobility. Two areas of innovation will be of outstanding importance: electro mobility and alternative drives on the one hand, digitalization and automated driving on the other. A simple look at the worldwide patent applications for automated and connected driving shows how successful we are: around half of the patents in this field are filed by German companies. Consequently, the German automotive industry occupies the first place internationally.

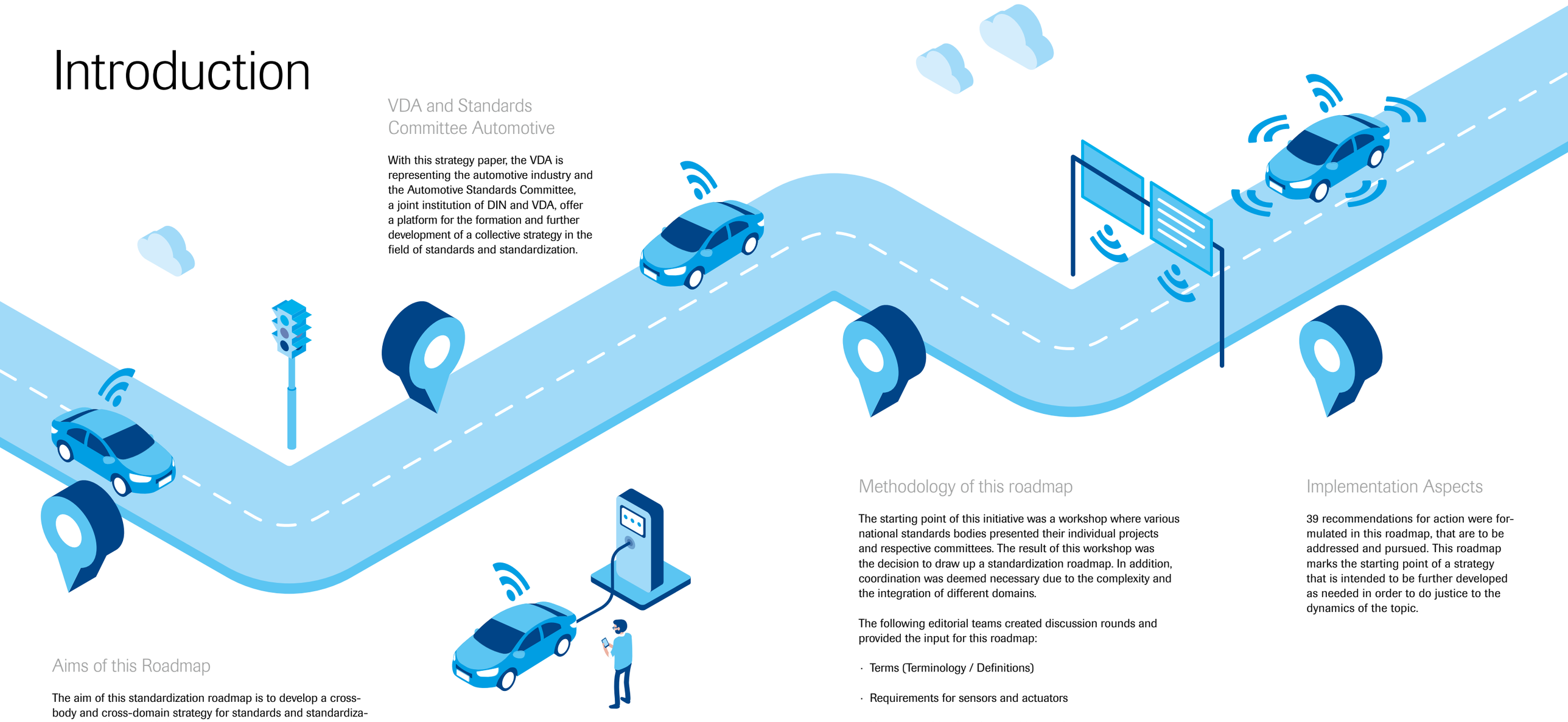
Standards are a strategic tool of the industry. With its external DIN standards committee for automotive engineering, the VDA assumes its role for the automotive industry at the national and international level to create a normative framework. This standardization roadmap sets the strategic guidelines for automated driving in the process of setting standards, which were drawn up jointly with the member companies, and thus provides an overview of the standardization activities already underway.

Bernhard Mattes, President
German Association of the Automotive Industry e. V.

Introduction

VDA and Standards Committee Automotive

With this strategy paper, the VDA is representing the automotive industry and the Automotive Standards Committee, a joint institution of DIN and VDA, offer a platform for the formation and further development of a collective strategy in the field of standards and standardization.



Aims of this Roadmap

The aim of this standardization roadmap is to develop a cross-body and cross-domain strategy for standards and standardization of products and infrastructure concerning the automated driving of vehicles on public roads. Furthermore, this roadmap provides an overview of the existing standardization bodies and projects that affect automated and connected driving.

Automation and connectivity cause an increase in product complexity as well as in interoperability and infrastructure requirements. The automotive industry incorporates unified norms and standards to reduce the costs and improve the robustness of products and services. In standards and publicly accessible standardization, it is important to utilize the potential of standardization accordingly at the precompetitive stage. In the automotive industry internationally oriented standardization is a given, while consortium standardization is gaining new significance. This roadmap serves as a starting point for a new assessment of and approach to standards and standardization in order to operate in a more active and needs-oriented manner in the future.

Methodology of this roadmap

The starting point of this initiative was a workshop where various national standards bodies presented their individual projects and respective committees. The result of this workshop was the decision to draw up a standardization roadmap. In addition, coordination was deemed necessary due to the complexity and the integration of different domains.

The following editorial teams created discussion rounds and provided the input for this roadmap:

- Terms (Terminology / Definitions)
- Requirements for sensors and actuators
- Human-machine interface and interaction
- Data communication and data formats
- Driver assistance systems / Driving functions
- Simulation model requirements
- Management and development process requirements

Subsequently, a core editorial team was created to further refine the document.

Chapters 1 to 5 are aimed at technical, political and strategic decision-makers; chapter 6 contains details for experts regarding which projects are being worked on in which committees and should be discussed in the future. The final chapter contains a management summary that summarizes the essential statements.

Implementation Aspects

39 recommendations for action were formulated in this roadmap, that are to be addressed and pursued. This roadmap marks the starting point of a strategy that is intended to be further developed as needed in order to do justice to the dynamics of the topic.

Standards in the Context of Automated and Connected Driving

Automated and connected driving supports the goal of further reducing the number of accidents, increasing road safety and reducing environmental pollution. In an ageing society, it also serves to maintain mobility and reduce the macroeconomic costs of transport. This requires the development of highly automated driving functions. It also enables the implementation of new mobility services such as “car-on-demand”, “robot taxi” and public shuttles, as well as more efficient use of space in urban areas.

Standards are industry-driven and offer the industry an ideal tool to independently publish the current state of the art in automotive technology through a recognized, open and transparent procedure supported by the VDA and DIN Automotive Standards Committee.

In a complex and innovative field, the use of management and engineering standards is an efficient way to define horizontal requirements for processes and at the same time remain open to new technologies.

In the future, the importance of publishing the state of the art in a timely manner, virtually accompanying development, will increase. ISO offers two possibilities to publish documents at the level below an “International Standard” (IS), as a “Public Available Specification” (PAS) or as a “Technical Specification” (TS). These guidelines allow content to be published, which can then be further developed into an IS.

The “Technical Report” (TR) offers the opportunity to keep a record of recommendations for future developments and to publish first experiences with new technologies.

Affected and interested experts can be involved in the process of setting standards. The interests of all participants are balanced by the recognized and transparent process. At the same time, however, this advantage of standardization means an obligation for all participants to adhere to the specified process.

Due to the range of different topics, the landscape of standards bodies is diverse, making the creation of an overview challenging and always in flux. New, agile approaches to the coordination of standards activities are urgently needed in order to make efficient use of existing resources within the industry.

In addition to classical standards, consortium standardization is particularly important in the field of automated and connected driving. This landscape of standards bodies, and thus the focus, are subject to constant change.

Standards promote and accelerate customer acceptance.

The standardization process is worldwide accepted and transparent.

Industrial nations such as China and Japan use standardization strategically as an instrument, shaping the state of the art by standardizing technical solutions. The German automotive industry partly neglect standardization.

Recommendations for action

01

Standards are an industry-driven tool that allows the industry and all interested parties to independently design technical specifications. Standards can only be successful, if potential is analyzed early on and translated into action across bodies. It is essential to design a normative framework in a pro-active international manner, enabling new technologies and creating a uniform understanding within the industry.

02

All available instruments for setting standards should be used (IS, PAS, TR and TS). The use of standards that define methods or requirements for development and management processes should be intensified. Standards that are open to various technologies are powerful tools that have proven their worth.

03

ISO is the preferred platform for global, precedent-setting standards. For particular technical content, consortium standardization can be a suitable instrument.

04

Activities concerning standards and standardization require central coordination within the VDA. Requirements and capacities of coordination are:

- Creation of an overview of tools for standards and standardization as well as active refinement of committees and consortia.
- Development of central strategies; the implementation of individual standardization projects obviously remains industry-driven.
- Fast consensus building within the automotive industry, wherever it does not contradict the idea of competition.

05

The further need-based development of standards, standardization and regulation as tools for the automotive industry should be coordinated by the VDA.

Funded Research Projects and Standards

Due to its social and economic importance, automated driving meets strong political support. This is reflected, among other things, by the formation of a strategy for automated and connected driving at the political level. This support will still be continued in the 20th legislative period. In addition to enabling automated driving in the context of road traffic law, the support is also visible in the initiation and funding of research projects. These projects are carried out at both the German and European levels, for example as part of the framework programs “Horizon 2020” and “GEAR 2030”. The results of this research must be examined to determine the extent to which meaningful standardizations can be derived from them.

The German automotive industry plays a significant role in shaping the future of autonomous and connected driving. In doing so, it is setting current and future standards by developing attractive vehicle functions and innovative products. Funded projects see the need for standardization in many areas of the automation of driving functions and the subsequent step to autonomous (driverless) driving.

The VDA supports these objectives to provide a basis for effective standards work through funding projects via the VDA flagship initiative.

Recommendations for action

01

Due to the increased importance of standardization in funded research projects, the DIN Automotive Standards Committee should be involved. The aim is to ensure that the results of the funded project are used sustainably in standards, and that synergies are exploited. The preparation of concrete standards drafts as partial project results accelerates the process and ensures the use of the project results.

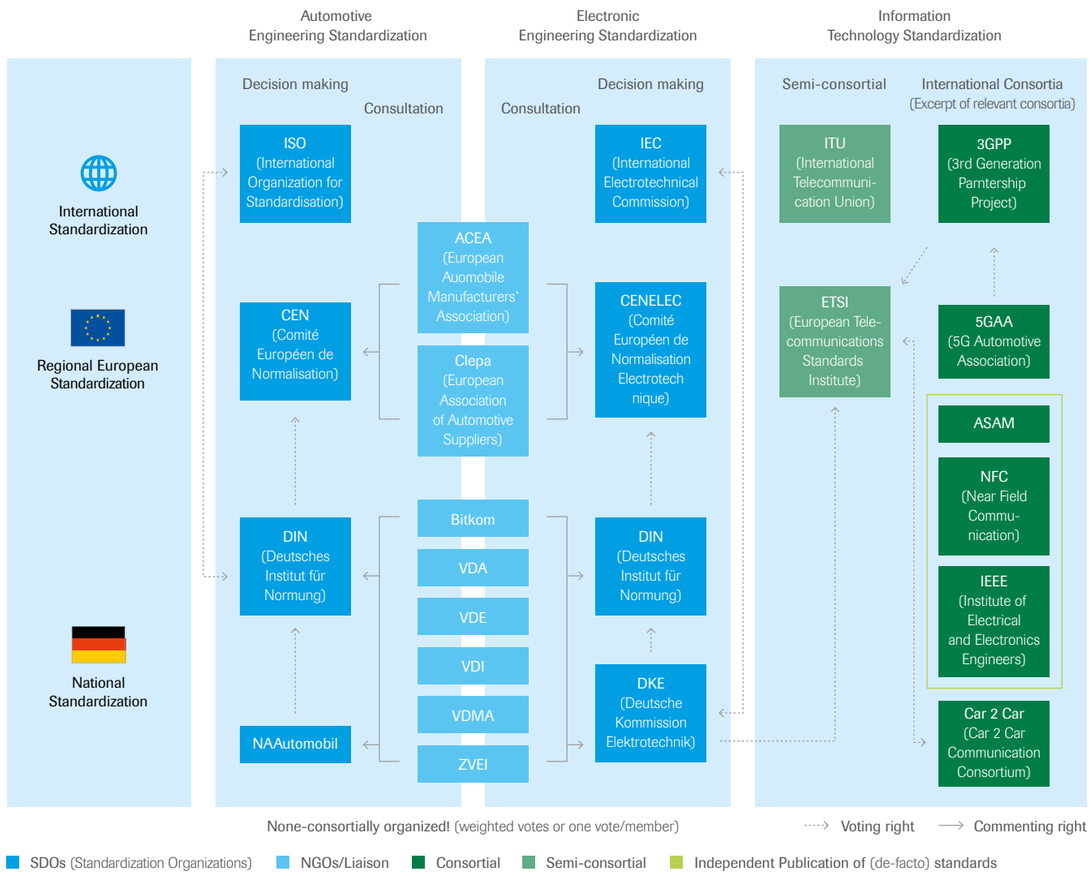
Funded projects should support a systemic approach to standardization.

Landscape of Bodies and committes

The landscape of bodies working on automated and connected driving is constantly growing in contrast to the area of standards, which is rather focused on limited topics. The cross-body commitment of the participating partners and the participation of the consortium standardization organizations are unavoidable and are already the case for the automotive industry. This roadmap pursues a cross-domain approach.

ISO has a large number of committees and working groups that include automated and connected driving projects. ISO TC22 “Road Vehicles” and ISO TC204 “Intelligent transport systems” form the core of the activities in the respective focus areas of both TCs. It is urgently necessary that close cooperation in a spirit of partnership is practiced, because of the many interfaces, and that an active exchange is established. In recent years, there have been frequent talks and agreements have been made to support this cooperation.

Landscape of Bodies and committees



Source: VDA

The toolbox for standards and standardization is being sorted to facilitate the use of the “right” tool.

Topics of this Map

Terminology

Management / Engineering Standards

Driver assistance / Driving functions

Testing

Networks, data and their interface definition

HMI (Human Machine Interaction)

Terminology

Description

In the context of standardization, terminology includes the determination and definition of a given term. The associated requirement to use a uniform scope of terms is all the more important when working together across domains. Furthermore, a uniform language strengthens the acceptance of new technologies by the customer.

In standards, there are various approaches and levels regarding the scope at which terminology is applied.

1. No determination within a document.
2. Terms are defined within a document and thus a uniform interpretation is ensured at least for the contents of the document.
3. Uniform definitions are used within a committee or a document series.
4. Uniform terms are set and defined within a standardization body.

ISO and IEC have each implemented the third level through an online database. Through the OBP (Online Browsing Platform), ISO offers various search options, including definitions or general keywords. At the IEC, the IEV (international electro technical vocabulary) defines different classes of terms that can be searched for.

Moreover, further approaches and, above all, different definitions of terms exist at the various consortium standardization organizations.

Recommendations for action

01

There are numerous and redundant definitions of terms, so no new competing definitions should be introduced. Cross-domain harmonization should be pursued.

02

Terms should be adopted from other standardization bodies or consortium standardization. The following principle should be adhered to: “Terms should be kept by there origin. Do not introduce new competing definitions!”

03

The SAE J3016 “Taxonomy and Definitions for Terms Related to Driving Automation Systems for On- Road Motor Vehicles” is a central document for the definition of the various levels of automation.

Constructive accompaniment and review of the SAE’s newly planned project to also create a document including a user-friendly definition. It should be examined to what extent this harmonizes with or contradicts the current approach of “supportive”, “automated” and “autonomous”.

04

Global guidance should be given; there is an urgent need for coordination between ISO and IEC.

Step 1 within ISO and IEC

Step 2 between ISO and IEC

The aim would be consolidation at the ISO OBP.

05

Investigation and definition of levels of artificial intelligence in automobiles

Standardized management and engineering process requirements ensure technological openness.

Management / Engineering Standards

Description

Management and engineering standards define framework conditions and process requirements. Since new technologies are always highly relevant to competition, management and engineering standards offer the possibility to achieve a generic standardization independent of concrete and detailed technical solutions without the need to disclose content relevant to competition. Such standards are already widespread in many areas of application and becoming increasingly important.
In this section standardization projects are analyzed that specify framework conditions for the introduction of automated driving functions. These framework conditions affect requirements concerning vehicle development, vehicle operation and the necessary infrastructure. The focus here is not on specific product requirements or technical requirements for components and systems, but on management requirements aimed at ensuring the framework conditions for the development and safe, reliable operation of automated driving functions.

Projects:

- Functional safety requirements for E / E systems and components ISO 26262-1 to -12 “Road Vehicles - Functional Safety”
- Requirements concerning the safety of the intended function ISO PAS 21448 “Road Vehicles - Safety of the Intended Functionality”
- Requirements concerning data security management ISO/SAE 21434 “Road vehicles - cybersecurity engineering”
- Quality management requirements for the automotive industry IATF 16949 “Quality management system requirements for automotive production and relevant service parts organizations”
- Project idea for software update requirements during vehicle operation

Recommendations for Action

01

Requirements must be provided concerning infrastructure facilities (road markings, traffic signs, etc.) that are necessary for the introduction and safe and reliable operation of automated driving functions. A distinction must be made based on the type of infrastructure facility and the associated requirements depending on the type of driving function and the systems required in the vehicle (video camera, laser, and radar).

02

Management requirements must be defined to ensure the interaction between vehicle and infrastructure facilities for the entirety of its life cycle. The project describes interfaces and requirements for organizations providing automated driving functions (OEM) and authorities providing the necessary infrastructure (road traffic authorities, etc.).

03

Requirements concerning operators of highly automated vehicle fleets are to be defined, including associated initial and periodic inspections. The suitability and competence of the operator, as described by a standard, should be confirmed by certification. Changes in the business activity of the operator (e.g. Taxi versus delivery service) or the extension/alteration of the functionality of the operated vehicles should be taken into account as well as requirements concerning these change processes.

04

Requirements concerning the operational management of automated vehicles and vehicle fleets should be described normatively. This affects the operation of vehicle fleets for passenger and freight transport including availability management, parking, service, refueling, access authorization and fault management. Requirements are defined for the management, the employees and the organization of the company.

05

The recognition of vehicles in emergency situations such as operations by police, emergency physicians or firefighters during the use of an automated driving function must be reliably guaranteed. Requirements on the operation and testing of signaling devices of emergency vehicles and on automated vehicles with regard to optical/acoustic recognition or the introduction of additional identification possibilities via data transmission must be described normatively.

06

Standardized management rules can support the cooperation of vehicle manufacturers, testing organizations and authorities involved in the approval of vehicles with automated driving functions. This ensures the certification of the parties involved and the process flow on the basis of corresponding standards.

Recommendations for Action

07

High-precision maps contain all the information required for automated driving, including traffic signs and traffic guidance systems. The nature of the information and the formats used in providing this map data, as well as the algorithm and the requirements for timely dynamic adaptation of the maps in the event of a change of traffic signs are to be standardized.

08

Regulatory requirements must be met for the approval of automated driving functions. In the future, these regulatory requirements will be examined using several building blocks. An analysis is recommended as to how the future approval process can be supported by standards.

09

An important requirement in emergency situations is for the vehicle to follow a defined specification in a human-oriented manner. Research on this topic has a clear focus, which should be based on the specifications of the ethics committee. In the medium term, it would be necessary to analyze whether standards and legal requirements can support vehicle developers. In the shorter term, it would be necessary to clarify the procedure and testing requirements of the handover routine in case the vehicle is no longer able to perform the driving task. This also includes specifications as to what the vehicle must do depending on the concrete situation if the driver does not assume the driving task in accordance with the specifications.

10

The introduction of automated driving functions is intended to make traffic safer and to minimize human "inadequacies" in the performance of driving tasks. Human performance and the acceptance of possible and tolerable errors in society must serve as a comparison for the "performance of the vehicle". The automated vehicle must be better but cannot be "infallible".
A socially recognized model as the basis for comparability and a benchmark for "safe automated driving functions" could be described in a standard.

11

The AI requirements for automotive applications should be described normatively. A first step would be the definition of different AI levels for vehicle application.

12

The extension of IATF 16949 by the introduction of a "Life Cycle Management" is recommended.

13

Requirements for automated driving in mixed operation with non-automated vehicles should be described normatively. In order to guarantee optimal safety during mixed operation, the project should carry out investigations on mixed operation as well as define rules, test procedures and standards.

14

Requirements concerning the use of automated vehicles across borders should be described normatively. The project should investigate the necessity of technical measures and develop them if necessary.

Driver Assistance / Driving Functions

Description

This chapter deals with driving functions and driver assistance systems. A distinction must be made between comfort-oriented functions and functions that increase safety. Driver assistance systems may well serve both objectives. The usual standards procedure in the past 20 years was to specify standards for these functions after assistance systems were introduced on the market, placing minimal requirements on the system.

The growing importance of assisted and automated driving for the automotive industry has led to an increasing number of projects that carry out standardization without systems already being available on the market. Adequate requirements must be defined for these projects.

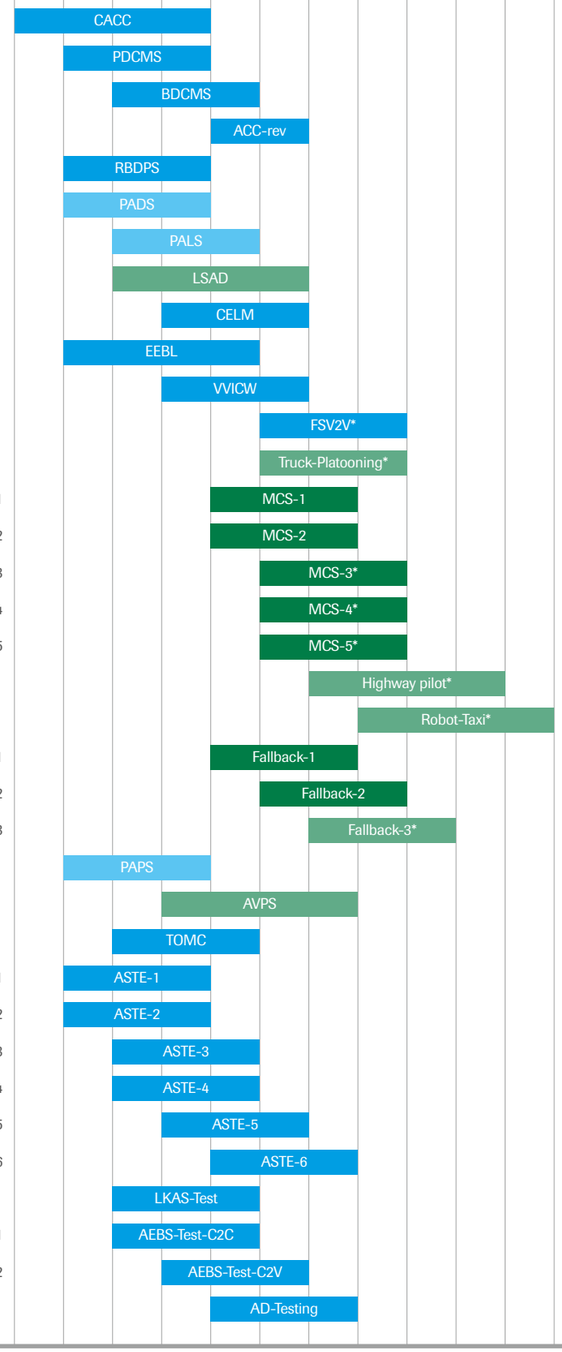
New WG14 Project Ideas:

- Minimum risk condition
- Map based automated speed adaptation system
- Highway chauffeur / pilot
- Crossing intersection system with low speed
- Automated merging system on highway
- Truck Platooning (Functional safety)
- Truck Platooning (Control strategy)
- Automatic lane change without driver confirmation
- ITS-station security services

The WG14 “Vehicle/roadway warning and control systems” of the ISO TC204 “Intelligent transport systems” has published numerous projects that can be found in the standards directory. New WG14 project ideas include an emergency stop system (“Dead man system”) for level 4. German cooperation is planned but should also be arranged for levels 2 and 3. The “Highway chauffeur/pilot”, a level 3 system, is also under discussion; German participation has not yet been secured here. Also, for the new projects “Automated merging system on highway” for level 3 and “Crossing intersection system with low speed” no German participation is planned. There are project ideas for “Truck Platooning” (“Functional safety” and “Control strategy”), which, however, do not show any progress as of now.

Ongoing and planned ISO projects:

TC	ISO-No.	Description of function:
TC204/WG14	20035	Cooperative ACC system incl. V2V and V2I
TC204/WG14	19237	Pedestrian protection
TC204/WG14	22078	Bicyclist protection
TC204/WG14	15622	ACC systems with external input of speed
TC204/WG14	19638	Road Boundary Departure Prevention System
TC204/WG14	21717	Partially automated in-lane driving system
TC204/WG14	21202	Partially Automated Lane Change System
TC204/WG14	22737	L4 driving at low speeds
TC204/WG14	23375	Collision evasive lateral manoeuvre system
TC204/WG14	20901	Emergency electronic brake light system
TC204/WG14	23376	V2V intersection collision warning system
TC204/WG14	22377	Functional safety for V2V cooperative functions
TC204/WG14	Open	Controlstrategy for truck platooning
TC204/WG14	23792-1	Motorway chauffeur – general specification
TC204/WG14	23792-2	Motorway chauffeur without lane-change (L3)
TC204/WG14	23792-3	Motorway chauffeur with lane-change (L3)
TC204/WG14	23792-4	Motorway chauffeur including merging (L3)
TC204/WG14	23792-5	Motorway chauffeur including routing (L3 or L4)
TC204/WG14	Open	Highly automated driving on highways (L4)
TC204/WG14	Open	Urban automated taxi (L4)
TC204/WG14	23793-1	Fallback functions – general specification
TC204/WG14	23793-2	Fallback functions for L3-systems
TC204/WG14	23793-3	Fallback functions for L4-systems
TC204/WG14	20900	Partially automated parking systems incl. remote
TC204/WG14	23374	Valet parking
TC22/SC33/WG16	22133	Kommunication for functional tests
TC22/SC33/WG16	19206-1	Test-target for rear-end of passenger cars
TC22/SC33/WG16	19206-2	Test-target for pedestrian
TC22/SC33/WG16	19206-3	Test-target for 3D-passenger cars
TC22/SC33/WG16	19206-4	Test-target for cyclist
TC22/SC33/WG16	19206-5	Test-target for motorcycles
TC22/SC33/WG16	19206-6	Test-target for animals
TC22/SC33/WG3	22735	Test for lane keeping
TC22/SC33/WG3	22733-1	AEB-Test method Car-to-Car
TC22/SC33/WG3	22733-2	AEB-Test method Car-to-Vulnerable Road User
TC22/SC33/WG9	Open	Set of standards for test szenarios



Level ≤ 1 Level 2 Level 3 Level 4 *start of project not confirmed.

Recommendations for Action

01

The WG14 of ISO TC204 contains a large number of new project ideas. These ideas do not necessarily reflect the strategy of the German automotive industry for the introduction of new AD systems. An analysis concerning which projects should be supported or supplemented and which should be classified as critical would be desirable.

02

An analysis concerning the minimum risk condition is necessary. A discussion is currently taking place on the regulatory side. A recommendation as to whether and how supplementary standardization could be helpful should be sought (cf. New project ideas WG14 “Fallback Functions”).

03

In addition to the definition of driving functions, driver assistance systems and corresponding requirements and tests, measurement and, in principle, evaluation of customer acceptance are also important. An analysis as to whether standardized procedures are necessary and carry potential for setting standards would need to be carried out.

04

An analysis of the manufacturer-independent use of driver assistance systems using connectivity technologies such as V2V and V2I should be carried out.

05

An analysis of security requirements for future AD systems (cf. New project ideas WG14 “ITS- Station Security Services”) is necessary.

06

Harmonization of projects with valid legal requirements or legal requirements that are to be changed.

07

SAE is also very active in the field of assisted and automated functions. An overview should be created and an exchange about future activities should be carried out.

Demand-oriented standards promote technology acceptance.

Testing

Description

In the field of testing, standards are of great importance to increase the reproducibility and comparability of results. The aim of setting standards was not to evaluate system performance, but merely to use standards to increase the comparability of test results and reproducibility. A list of vehicle dynamics and chassis components standards contained in ISO TC22/SC33 is included in the list of standards. These driving maneuvers anchored in the standard form only a basic set of maneuvers. In order to evaluate the driving behavior of a vehicle, a large number of tests and driving maneuvers are necessary to cover the specific requirements of certain vehicle types, drive architectures, markets and manufacturers.

In addition to the standardization of driver assistance systems in ISO TC204, there are new ISO projects in WG3 "Driver assistance and active safety functions" of ISO TC22/SC33 to increase comparability in system evaluation.

Test Scenarios

The development and testing of automated and autonomous driving functions, on the other hand, poses new and extensive questions to be answered that reach into all new topics needed to make this technology possible and that have not been part of the core competencies of the automotive industry so far. For this purpose, WG9 "Test scenario of autonomous driving vehicle" was newly founded in ISO TC22/SC33. In a first step, this working group will define the required contents of test scenarios, including the definition of terminology. Furthermore, classifications, principles, concepts, requirements for data collection and data storage will be defined, if necessary. Due to the significantly higher complexity, and to allow for the greatest possible flexibility and free competition while making use of the potential of standardization, engineering standards have been identified as a solution for this area, as well.

Simulation

Simulation is another important tool for development and testing. International standards that place requirements on simulation models in order to ensure the validity of the results for defined driving maneuvers have already been published. In order to validate future driving functions and systems for automated vehicles, simulation offers a very efficient way to obtain fast and reproducible results by modifying individual parameters. These results are well documented and thus facilitate discussion across domains. Therefore, a very concretely formulated new project idea for standardization in the context of simulation already exists, which can also be classified as an engineering standard. The objective is to create a normative structure with firmly defined terms and a uniform method for the application of models and their characteristics with regard to driving dynamics, driver assistance systems and automatic driving.

Test Equipment

Finally, test equipment is another important factor to increase reproducibility when testing automated driving functions and to set uniform data acquisition requirements. In the WG16 "Active safety test equipment" of the ISO TC22/SC33, two parts of the ISO 19206 series of standards in 2018 were published in 2018, which, in part 1, define requirements for a vehicle rear test body and, in part 2, for a pedestrian test body. Further parts of this series of standards are currently being developed.

Projects of ISO TC22/SC33/WG3 "Driver assistance and active safety functions":	
ISO 22733-1	Road vehicles – Test method to evaluate the performance of autonomous braking systems – Part 1: Car to car
ISO 22733-2	Road vehicles – Test method to evaluate the performance of autonomous braking systems – Part 2: Car to vulnerable road user
ISO 22735	Road vehicles – Test method to evaluate the performance of lane-keeping assistance systems

New proposal of ISO TC22/SC33 in WG11 "Simulation":	
ISO 11010-1	Passenger cars – Simulation model taxonomy – Part 1: Vehicle dynamics maneuver

Test scenarios are the driving maneuvers for automated and connected driving.

Recommendations for Action

01

Active involvement in the WG9 “Test scenarios” of ISO TC22/SC33 in order to use the potential of standardization for system evaluation.

02

It is already visible in the naming of the ISO 11010 project proposal “Part 1: Driving maneuvers” that a complete series of standards may be developed here. In the area of sensor modeling, environment simulation, etc., further potential is visible to define a methodology analogous to the project proposal currently being worked out. However, the experts at AK11 “Simulation” are specialized in mapping driving behavior. Therefore, the working group should be extended with further experts.

03

Development of the ISO 19206-5: Motorcycle as a Target. It would be necessary and urgent to develop a standard analogous to the ISO 19206 series. Especially camera-based recognition of the motorcycle from the front is important for further development work and a uniform test body would be advantageous. In France, UTAC has created a corresponding project. However, there is no discernible implementation and project management for a completion in the foreseeable future, as of now.

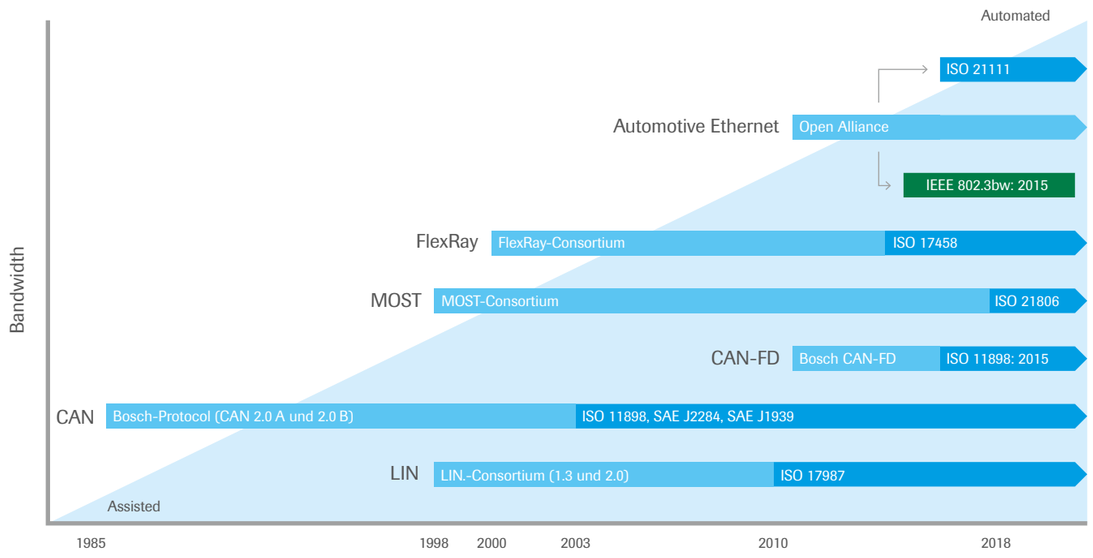
Projects of the ISO TC22/SC33 in the WG16 “Active Safety Test Equipment”:	
ISO 19206-1	Road vehicles – Test devices for target vehicles, vulnerable road users and other objects, for assessment of active safety functions – Part 1: Requirements for passenger vehicle rearend targets
ISO 19206-2	Road vehicles – Test devices for target vehicles, vulnerable road users and other objects, for assessment of active safety functions – Part 2: Requirements for pedestrian targets
ISO 19206-3	Road vehicles – Test devices for target vehicles, vulnerable road users and other objects, for assessment of active safety functions – Part 3: Requirements for passenger vehicle 3D targets
ISO 19206-4	Road vehicles – Test devices for target vehicles, vulnerable road users and other objects, for assessment of active safety functions – Part 4: Requirements for bicyclist targets
ISO/PWI 19206-5	Road vehicles – Test devices for target vehicles, vulnerable road users and other objects, for assessment of active safety functions – Part 5: Requirements for powered two-wheeler targets
ISO/PWI 22133-1	Road vehicles – Test object monitoring and control for active safety and automated/autonomous vehicle testing – Part 1: Communication protocols and interfaces
ISO/PWI 22133-2	Road vehicles – Test object monitoring and control for active safety and automated/autonomous vehicle testing – Part 2: Test scenario description formats

Systems, Networks, Data and their Interface Definition

Automobile Networks

With the transition from assisted to automated driving, the requirements of in-vehicle communication with regard to higher bandwidths and lower latency, as well as error-free data transmission are increasing. The figure shows various standards and their emergence.

Automobile Networks



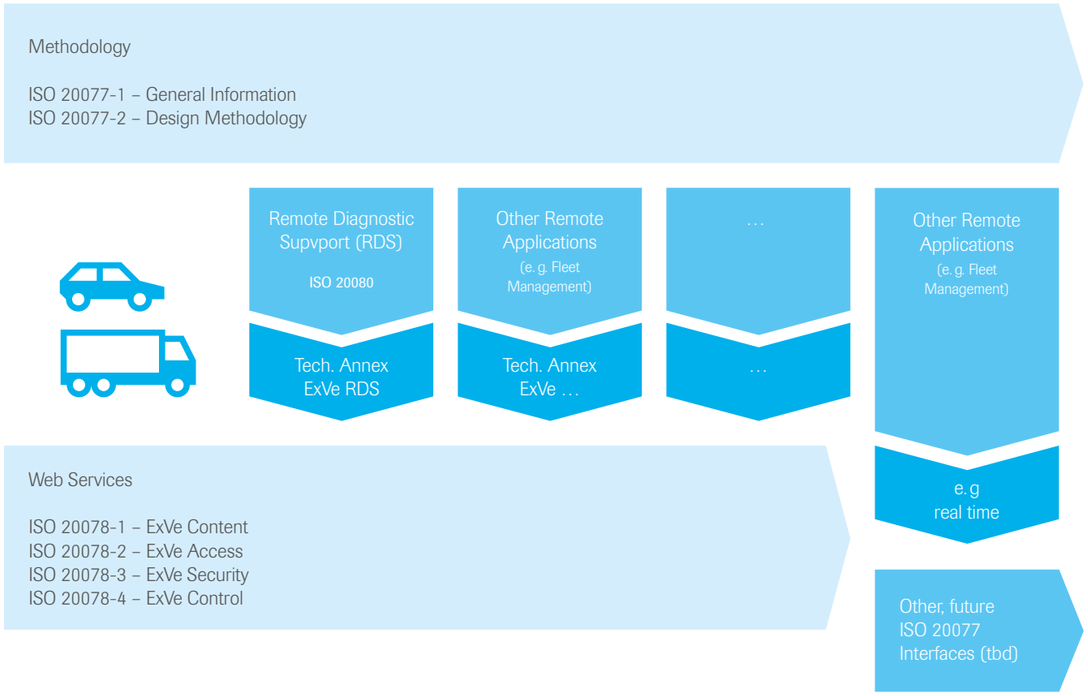
Source: VDA

“Extended Vehicle”

Since 2014, the WG6 “Extended vehicle/remote diagnostics” of the ISO TC22/SC31 “Data communication” has been working on the large-scale standards project “extended vehicle”. The goal is to create a web-based platform that external service providers can use to access vehicle data in a secure and standardized manner. The automotive industry is already creating the technical prerequisites to enable external service providers to offer mobility services to drivers in the future. This way, providers can retrieve and receive data via the manufacturers’ IT centers (backend servers). The web platforms themselves are designed individually by each manufacturer. However, the necessary standards and norms are developed within the framework of ISO, which define, for example, structures, processes and, above all, safety mechanisms.

The ISO project “Extended vehicle” comprises several series of standards. ISO 20077 describes methodological requirements for the use of vehicle data via the web interface, as well as general terms. The ISO 20078 series of standards defines the requirements for the web interface proper regarding data content, safety and access control. ISO 20080 defines a first “Extended vehicle” application, radio-supported diagnostic access for repair service providers.

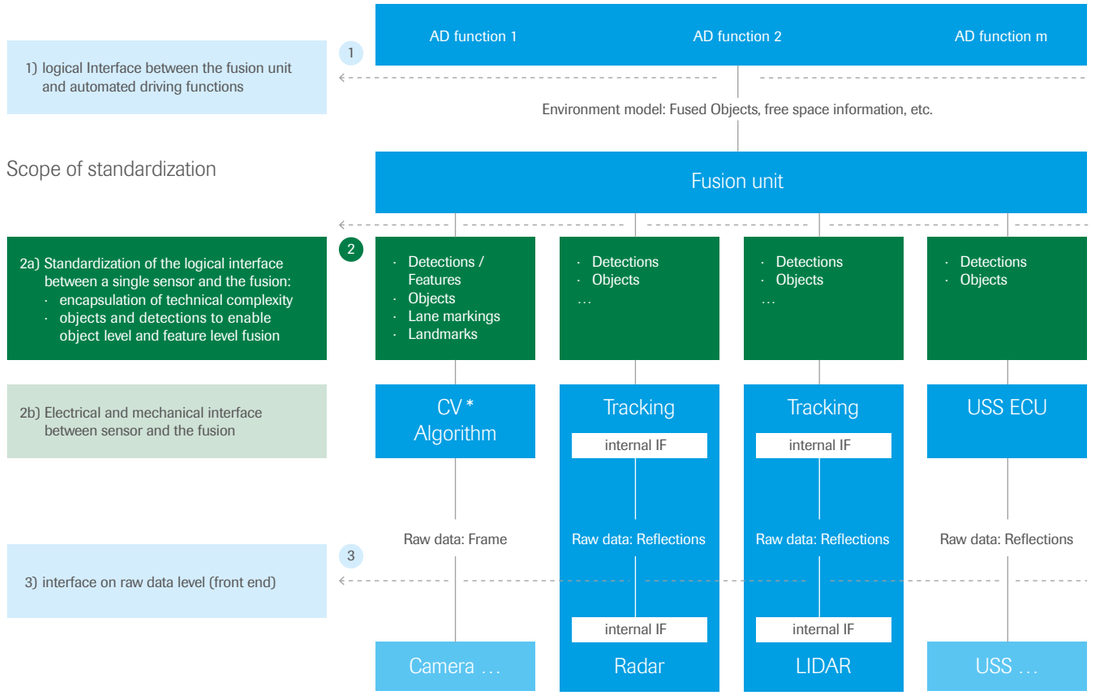
„Extended vehicle“



Sensor Interfaces

In the ISO TC22/SC31 the WG9 “Sensor interface for automated driving functions” was newly founded to work on a new project to define the logical interface between individual sensors and their fusion. The image shows the complex structure of functions, sensors, the fusion unit and raw data. The aim of the project is to reduce the complexity of automated driving functions by standardizing the output signals of radar, lidar, cameras and ultrasonic sensors.

Sensor Interfaces



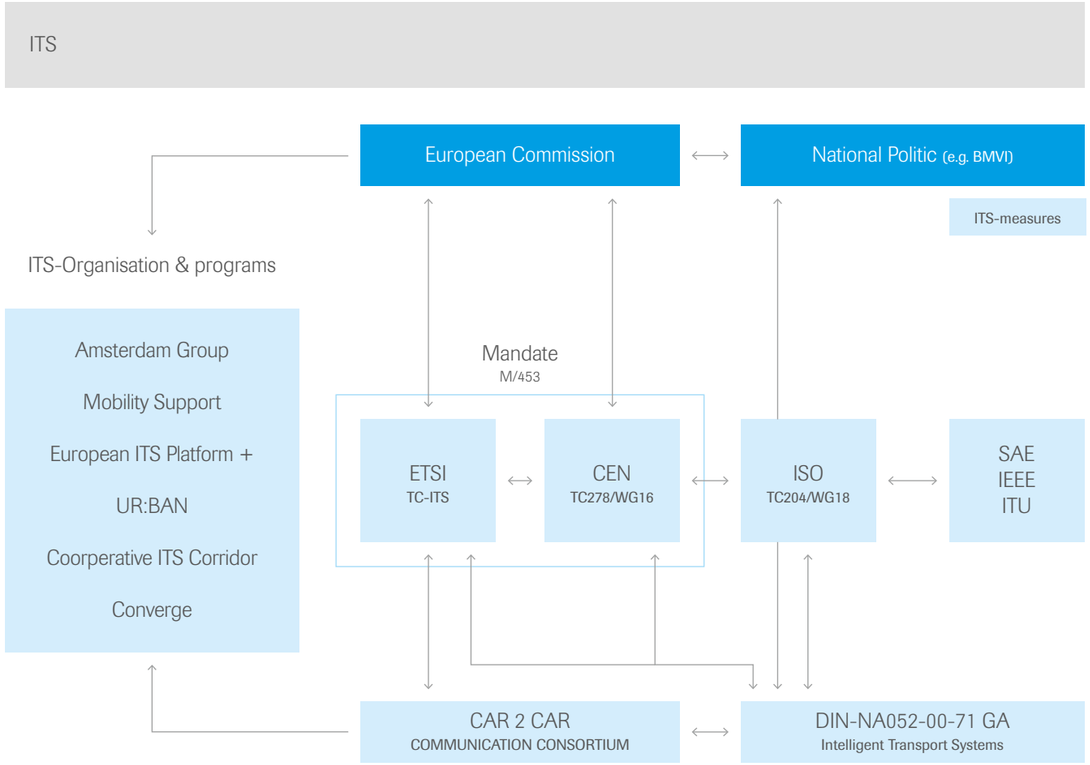
Intelligent Transport System (ITS)

Further technical reports and specifications have been published in ETSI under the following C-ITS domains:

- (Interoperability) tests
- Requirements concerning dedicated C-ITS applications
- OSI-layer (facility, transport, network)
- Management
- Security

For automated driving, on-board sensors, appropriate software and highly accurate maps are required in order to reliably map the environment of a vehicle. In addition, automated driving functions can provide significant support in the medium and long term with the help of connectivity. Connectivity may refer to either communication between vehicles (Car-2-Car) and/or between vehicles and infrastructure, for example communication between vehicles and traffic control centers (Car-2-Infrastructure).

Since communication in the field of "Intelligent traffic systems" requires standardized interfaces, the European Commission has been investing in various research projects in this field since the beginning of the new millennium. The results of these research projects have also been transferred to standards (mainly in CEN and ETSI). The European mandate M/453 EN to set standards for co-operative ITS (C-ITS), which was directed at CEN and ETSI, can be regarded as one of the most important standards mandates in the field of ITS. It promotes standards in the information and communication technologies segment of cooperative ITS and thus indirectly contributes to automated driving. The following image shows the interactions between national activities concerning the creation of European and international standards for cooperative systems within the framework of national and European legislation.



Source: VDA

The list of standards lists all essential standards that were developed under mandate M/453 and that are currently relevant for the introduction of ITS, and thus also for automated and connected driving.

5G

Ten years ago, IEEE developed a WiFi variant that enables the implementation of ITS-applications for C2C communication. IEEE 802.11p defines the main requirements of the physical OSI-layer. On this basis, international (Wireless access in-vehicular environments, Wave) and European (ETSI-ITS-G5) standards were published on the higher OSI-layer (see also the previous tables).

In addition to direct ITS communication (C2C and C2I) via WiFi, the continuing development of mobile radio standards has brought these into the focus of C-ITS-applications, as well. Although the standards developed in 3GPP (3rd Generation Partnership Project) such as 3G or 4G (LTE) still suffer limitations compared to ITS-G5 (or WAVE) for C-ITS applications, the introduction of the fifth generation of mobile radio (5G) indicates that the performance of ITS-G5 can be surpassed. Founded in 2016, as a representative in 3GPP the 5G Automotive Association (5GAA), a global group of the telecommunications and automotive industries, is advancing the introduction of 5G for C-ITS.

In Europe, 3GPP publications will be delivered to ETSI to be recognized as EN standards. The following project proposals are under consideration:

- ETSI TR 138 900: LTE; 5G; study on channel model for frequency spectrum above 6 GHz
- ETSI TS 133 185: LTE; 5G; security aspects for LTE support of vehicle-to-everything (V2X) services
- ETSI TR 121 914: digital cellular telecommunications system (Phase 2+) (GSM); universal mobile telecommunications systems (UMTS); LTE; 5G

System components

The introduction of automated and autonomous functions increases the complexity of the systems. In this respect it makes sense to investigate the standardization of certain system components, e.g. requirements concerning energy supply, vehicle electrical systems.

Testing requirements

The introduction of new communication technologies also requires standardized test procedures to ensure the validity of vehicle networks, their interfaces and communication.

Recommendations for action

01

Regarding intelligent transport systems, many standards have already been developed and published. Others are under development. The essential step, the field introduction of C-ITS, is still pending. For standards this means the future introduction of C-ITS in Europe and the world will lead to the application of many existing standards and will cause revisions during the introduction, which will require to be actively accompanied by the automotive industry.

02

Standardized conformity tests will play a key role in the successful introduction of automated and connected driving. These tests will be necessary not only for communication, but across domains. Missing standards for conformity tests must be developed (analysis necessary) and existing standards revised, if necessary.

03

Urban ITS is another new field of action mandated by the EU, which has been directed at the standards bodies CEN and ETSI. It is relevant for the automotive industry and for automated driving regarding the following fields of application, and should be actively supported by the automotive industry:

- Optimized Traffic flow control
- Geofencing in terms of reducing environmental pollution; communication with other road users

HMI (Human Machine Interaction)

Description

With the increasing automation of individual traffic, the task of the driver of a vehicle, and thus also the interaction between driver and vehicle, are changing. In order to keep the manufacturers' promise "Automation makes driving more comfortable and safer", high quality requirements must be applied in the design of the human machine interface. Innovative displays and operating concepts are intended to facilitate the monitoring of an automated vehicle and enable driver intervention in a safe manner.

Various useful standards have already been developed at the international level, such as the ISO 15008 "Specifications and test procedures for in-vehicle visual presentation".

Recommendations for Action

01

Based on a second ISO workshop on automated driving, the following future fields of action have emerged and should be pursued by the automotive industry:

- Determining the effects of automated driving transitions on the performance of the transfer
- Collecting measurement results of the transfer performance from test drives as well as extensive field studies in technical reports and derive corresponding recommendations.
- Defining Driver Interaction with Level 2 Vehicles
- Determining human influence in different transition scenarios

Current projects of ISO TC22/SC39 "Ergonomics" and SAE projects on HMI:		
ISO/TS 14198	Road vehicles	Ergonomic aspects of transport information and control systems – Calibration tasks for methods which assess driver demand due to the use of in-vehicle systems
ISO 15007	Road vehicles	Measurement and Analysis of driver visual behaviour with respect to transport information and control systems
ISO/TR 21959-1	Road vehicles	Human state, performance in human state and performance in automated driving systems (ADS) – Part 1: Terms and definitions of human state and performance
ISO/TR 21959-2	Road vehicles	Human state, performance in human state and performance in automated driving systems (ADS) – Part 2: Experimental guidance to investigate human takeover state and performance
ISO/TR 21974		Naturalistic Driving Studies – Defining and Annotating – Safety Critical Events
ISO/TR 23049	Road vehicles	Ergonomic aspects of external visual communication from automated vehicles to other road users
SAE J3134™		ADS Equipped Vehicle Signal and Marking Lights (Work in Progress)

Management Summary

This cross-body and cross-domain standardization roadmap has resulted in 39 recommendations for action. These recommendations for action include both content-related and process-related aspects and will increase the effectiveness and significance of standardization for automated and connected driving.

As an instrument of the economy, standards and standardization projects offer the opportunity to publish the state of the art through recognized, open and transparent procedures.

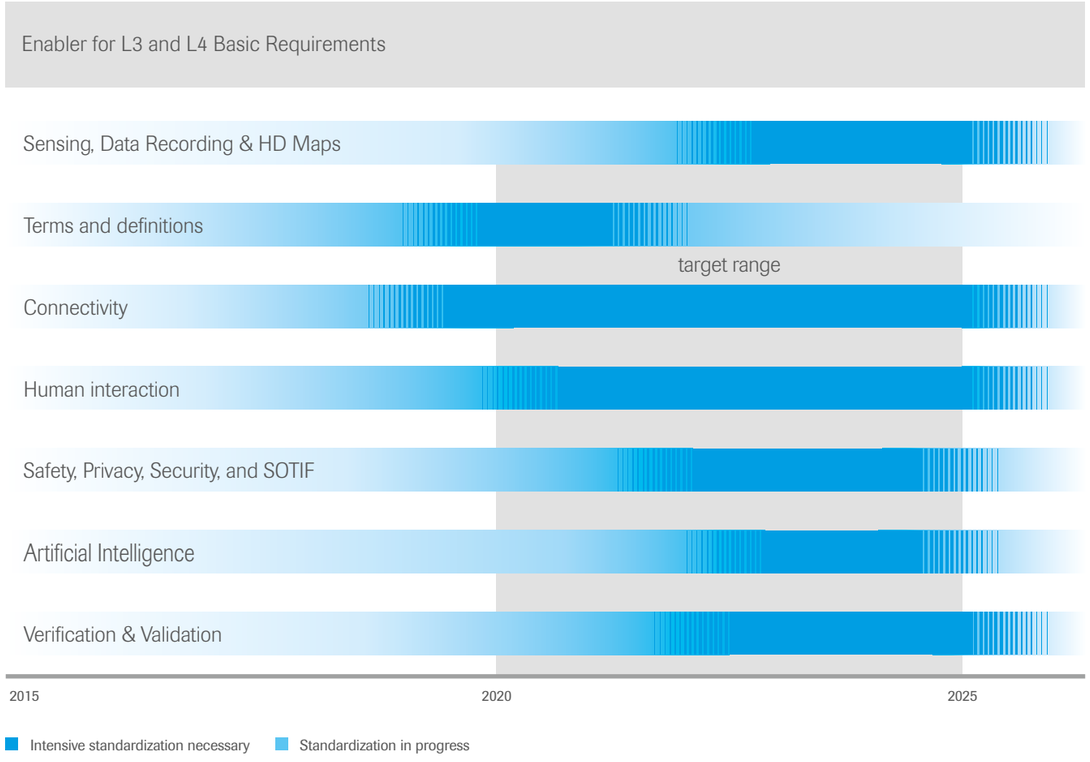
For innovative fields, the need to put new technologies on the road and to provide a state of the art for certain regulatory guidelines is of great importance.

The following topics were clustered across bodies and evaluated in terms of the time span (light blue/blue bars) in which significant standards and standardization activities can be expected with regard to the importance of introducing Level 3 systems:

- Terms & Definitions
- Human Interaction
- Safety, Privacy & Security
- Verification & Validation
- Sensing & Data Recording & HD Maps
- Connectivity
- Artificial Intelligence

There will be particular time spans with a very high workload (blue area) for which the provision of sufficient capacities for standards work should be planned. In principle, concentration and cooperation are always required in standards and standardization in order not to leave the creation to other stakeholders, but to take it in one's own hands and adapt it to one's own needs.

The VDA including the DIN Automotive Standards Committee provides the platform and the necessary support for standards tasks to NAAutomobil. Success and effectiveness depend on the active participation of experts. This document and its further, needs-based, refinement provide the basis for the advancement of standards and standardization activities in the field of automated and connected driving.



Standards Directory

ISO TC204/WG14 „Vehicle/roadway warning and control systems":		
ISO 11067	CSWS	Intelligent transport systems – Curve speed warning systems (CSWS) – Performance requirements and test procedures
ISO 11270	LKAS	Intelligent transport systems – Lane keeping assistance systems (LKAS) – Performance requirements and test procedures
ISO 15622	ACC	Transport information and control systems – Adaptive Cruise Control Systems – Performance requirements and test procedures
ISO 15623	FVCWS	Transport information and control systems – Forward vehicle collision warning systems – Performance requirements and test procedures
ISO TS 15624	TIWS	Transport information and control systems – Traffic Impediment Warning Systems (TIWS) – System requirements
ISO 16787	APS	Intelligent Transport Systems – Assisted Parking System – Parking with reference to other parked vehicles – Performance and Test Procedures
ISO 17361	LDWS	Intelligent transport systems – Lane departure warning systems – Performance requirements and test procedures
ISO 17386	MALSO	Transport information and control systems – Manoeuvring Aids for Low Speed Operation (MALSO) – Performance requirements and test procedures
ISO 17387	LCDAS	Intelligent transport systems – Lane change decision aid systems (LCDAS) – Performance requirements and test procedures
ISO 18682	HNS	Intelligent transport systems – External hazard detection and notification systems – Basic requirements
ISO 19237	PDCMS	Intelligent transport systems – Pedestrian detection and collision mitigation systems (PDCMS) – Performance requirements and test procedures
ISO 19638	RBDPS	Intelligent transport systems – Road Boundary Departure Prevention Systems (RBDPS) – Performance requirements and test procedures
ISO TR 20545	RoVAS	Intelligent transport systems – Vehicle/roadway warning and control systems – Report on standardisation for vehicle automated driving systems (RoVAS)/Beyond driver assistance systems
ISO 22178	LSF	Intelligent transport systems – Low speed following (LSF) systems – Performance requirements and test procedures
ISO 22839	FVCMS	Intelligent Transport System – Forward Vehicle Collision Mitigation Systems – Operation, Performance, and Verification Requirements
ISO 22840	ERBA	Intelligent transport systems – Devices to aid reverse manoeuvres – Extended-range backing aid systems (ERBA)
ISO 26684	CIWS	Cooperative Intersection Signal Information and Violation Warning Systems (CIWS)

Vehicle dynamic standards of ISO TC22/SC33 „Vehicle dynamics and chassis components"	
ISO 3888-1:2018	Passenger cars – Test track for a severe lane-change manoeuvre – Part 1: Double lane-change
ISO 3888-2:2011	Passenger cars – Test track for a severe lane-change manoeuvre – Part 2: Obstacle avoidance
ISO 4138:2012	Passenger cars – Steady-state circular driving behaviour – Open-loop test methods
ISO 7401:2011	Road vehicles – Lateral transient response test methods – Open-loop test methods
ISO 7975:2018	Passenger cars – Braking in a turn – Open-loop test method
ISO 9815:2010	Road vehicles – Passenger-car and trailer combinations – Lateral stability test
ISO 9816:2018	Passenger cars – Power-off reaction of a vehicle in a turn – Open-loop test method
ISO 12021:2010	Road vehicles – Sensitivity to lateral wind – Open-loop test method using wind generator input
ISO 13674-1:2010	Road vehicles – Test method for the quantification of on-centre handling – Part 1: Weave test
ISO 13674-2:2006	Road vehicles – Test method for the quantification of on-centre handling – Part 2: Transition test

ISO 14512:1999	Passenger cars – Straight-ahead braking on surfaces with split coefficient of friction – Open-loop test procedure
ISO 15037-1:2018	Road vehicles – Vehicle dynamics test methods – Part 1: General conditions for passenger cars
ISO 17288-1:2011	Passenger cars – Free-steer behaviour – Part 1: Steering-release open-loop test method
ISO 17288-2:2011	Passenger cars – Free-steer behaviour – Part 2: Steering-pulse open-loop test method
ISO 21994:2007	Passenger cars – Stopping distance at straight-line braking with ABS – Open-loop test method

ISO TC22/SC31/WG 6 „Extended vehicle/Remote diagnostics“

ISO 20077-1	Road Vehicles	Extended vehicle (ExVe) methodology – Part 1: General information
ISO 20077-2	Road Vehicles	Extended vehicle (ExVe) methodology – Part 2: Methodology for designing the extended vehicle
ISO 20078-1	Road Vehicles	Extended vehicle (ExVe) ‘web services’ – Content
ISO 20078-2	Road Vehicles	Extended vehicle (ExVe) ‘web services’ – Access
ISO 20078-3	Road Vehicles	Extended vehicle (ExVe) ‘web services’ – Security
ISO TR 20078-4	Road Vehicles	Extended vehicle (ExVe) ‘web services’ – Content
ISO 20080	Road Vehicles	Information for remote diagnostic support – General requirements, definitions and use cases

ETSI TC ITS

Standard	Title	Domain
EN 302 665	Communication architecture	General
EN 302 931	Vehicular communications: geographical area definition	Network & transport
EN 302 895	Vehicular communications; Basic set of applications; Local Dynamic Map (LDM)	Facilities
EN 302 686	Radiocommunication equipment operating in the 63 GHz to 64 GHz frequency band	
EN 302 663	Access layer specification for ITS operating in the 5 GHz frequency band	Access network & media
EN 302 637-2	Vehicular communications; Basic set of applications; Specification of Cooperative Awareness Basic Service (CAM)	Facilities
EN 302 637-3	Vehicular communications; Basic set of applications; Specification of Decentralized Environmental Notification Basic Service (DENM)	Facilities
EN 302 636 (parts 1–6)	Vehicular communications; Geonetworking;	Network & transport
EN 302 571	Radiocommunication equipment operating in the 5 855 MHz to 5 925 MHz frequency band	

CEN TC278 (WG16)/ISO TC204 (WG18) „Cooperative ITS“ (extract)

Standard	Title	Domain
EN ISO 17427-1	Roles and responsibilities in the context of cooperative ITS based on architecture(s) for cooperative systems	General
ISO 21217	ITS communication architecture	General
EN 16157 (part 1–7)	DATEX II data exchange specifications for traffic management and information	Traffic management
EN ISO 17419	Globally unique identification	Management
EN ISO 17423	ITS application requirements for selection of communication profiles	Management
ISO 24102 (part 1–6)	ITS station management	Management
ISO 14296	Extension of map database specifications for advanced driver assistance systems (ADAS) and cooperative systems	Facilities
EN ISO 14816	Automatic vehicle and equipment identification – Numbering and data structure	Facilities
ISO 14825	Geographic Data Files (GDF) – GDF5.0	Facilities
CEN ISO/TS 17429	Profiles for processing and transfer of information between ITS stations for applications related to transport infrastructure management, control and guidance	Facilities
ISO 17572 (part 1–4)	Location referencing for geographic databases	Facilities
EN ISO 18750	Local Dynamic Maps	Facilities
ISO 10711	Interface Protocol and Message Set Definition between Traffic Signal Controllers and Detectors	Application
ISO 13185 (part 1–3)	Vehicle interface for provisioning and support of ITS services	Application
ISO 14813 (part 1–6)	Reference model architecture(s) for the ITS sector	Application
ISO 14827 (part 1–3)	Data interfaces between centres for transport information and control systems	Application
ISO 15784 (part 1–3)	Data exchange involving roadside modules communication	Application
ISO 16461	Criteria for privacy and integrity protection in probe vehicle information systems	Application
CEN ISO/TS 19091	Using V2I and I2V communications for applications related to signalized intersections	Application
ISO 22837	Vehicle probe data for wide area communications	Application
ISO 29284	Event based probe vehicle data	Application
ISO 21210	IPv6 Networking	Network & transport
ISO 21218	Medium service access points	Access & media

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