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Comparison of Sino-German Connected and Automated Vehicle Standardization Roadmap

Working Group on Sino-German ICV Standards and Regulations | August 31, 2019

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Preface

Intelligence and connectivity will be two important directions of the international automobile industry in the future and also the strategic priority of world-wide governments and industries. As an important member of international automotive community, Germany and China hold highly consistent recognition and judgement of intelligent and connected vehicle (ICV) technology and industry development trend, and are vigorously facilitating innovative coordinated development of ICV-related industries. Both sides acknowledge that standards are of great importance to advancement of ICV technologies and industry development: appropriate standards can be a facilitator to technological and industrial development which might be hindered otherwise.

In order to secure standardization in a leading and supporting role in ICV technologies and industry development, Ministry of Industry and Information Technology (MIIT) and Standardization Administration jointly released Guideline for Developing National Internet of Vehicles Industry Standard System (Intelligent & Connected Vehicle) (hereinafter referred to as Standards System) in December 2017. VDA also issued Standardization Roadmap for Automated Driving (hereinafter referred to as Roadmap) that presents strategic planning on ICV standardization priorities and directions in early 2019.

In July 2018, under the auspices of the Chinese premier and German chancellor, MIIT and the Federal Ministry of Economic Affairs and Energy (BMWI) and the Federal Ministry of Transport and Digital Infrastructure (BMVI) jointly signed the Joint Declaration of Intent on the Cooperation in the Area of Automated and Connected Driving (hereinafter referred to as Joint Declaration of Intent) and strengthened cooperation on ICV technologies, industries and standardization so as to give full play to complementary advantages in technology, industry and marketplace. In December of the same year, MIIT, BMWI, and BMVI hosted the Director General level Kick-off Meeting of Sino-German Cooperation on Intelligent and Connected Vehicles which identified cooperation matters specified in Joint Declaration of Intent and designated NTCAS (SAC/TC 114/SC 34) and VDA/VDA to take the lead in full and in-depth cooperation on ICV standardization fields.

In line with the guiding principle of the Joint Declaration of Intent and the Meeting, learning from industry suggestions, the two leading entities have developed a comprehensive work plan that decides to start with comparison of Sino-German ICV standardization roadmap, objectively analyses the similarities and differences in planning and construction of Sino-German ICV Standard System from overall structure, construction goals, standards system and action plans, and systematically underlies common topics on Sino-German ICV Standardization to provide useful recommendations for reinforced ICV standardization cooperation.

I. Both sides are highly consistent in recognition and strategic positioning of the role of standardization in promoting and backing ICV technologies and industry development.

Both sides are uniformly aware of the importance of standardization in the evolution of automated driving and connectivity technology and acknowledge that appropriate standards can be a facilitator to technological application and industrial development or otherwise a hindrance to technological advancement and innovation.

Both sides reach a consensus on phased strategies and set 2020-2025 as the key timeline for standardization construction of ICVs, especially automated driving.

Both sides hold that ICVs are still in rapid development phase and its technologies, functions and products have not yet been well established. Standards system/roadmap shall adjust and optimize along with technological and industrial development dynamics.

Both sides agree that ICV standards research and formulation are still in infancy worldwide, which provides a good time window for coordinated international standards and regulations.

Both sides acknowledge the positive impact of standardization activities conducted by ISO and other international organizations on promoting and facilitating global technological innovation and free trade and show interest in standards formulation and coordinated activities according to their respective technological and industrial development.

II. Both sides are basically consistent in overarching principles, construction goals, technical logics, system framework and key fields among others

Both sides pay attention to vehicle intelligence, especially the functional safety issues due to the adoption of complex electronics architecture, the information security issues related to vehicle connectivity, and the SOTIF needed for supporting automated driving, taking functional safety and information security as an important common standard. In regard to specific standard projects, China puts forward

specific operational guidelines based on the ISO standard to accelerate the establishment of industry-wide safety and security system; Germany focuses on methodology and basic rules and encourages enterprises to take down-to-earth measures independently.

Both sides figure out that as vehicles turn into a moving robot from man-controlled actuator, automated vehicle test requires a new scenario-centric evaluation system with mixture of "simulation and field test". Concerning specific standard projects, China adopts test scenario as a general specification and integrates specific test methods into various "product and technology application" projects; Germany highlights the necessity of new test methods by listing test scenarios, simulations and test tools separately.

Both sides are aware of the technical complexity in boosting vehicle automation. From the aspects of technology perception and decision control, with specific user scenarios as the carrier, both sides keep an eye on the formulation of advanced driver assistance system (ADAS) standards and have implemented relevant standard projects as per functional planning of automated driving. In terms of specific standard projects, China's standard projects are categorized by decision warning, assist control, automated control, etc. Germany sets forth standards based on different driving automation levels and scenarios.

Both sides emphasize the importance of 5G mobile communication technology for automated driving and recognize the supporting role of connectivity in realizing automated driving (especially advanced automated driving). Both sides figure out the significance of building a new connected vehicle system based on the notion of "vehicle + network". Regarding specific standard projects, China takes the in-vehicle communication protocol as the basic automotive electronics standard, without incorporating it into the ICV Standard System; Germany presents in detail in-vehicle network, connected vehicles, sensor interfaces, network protocols, etc. Both sides regard the evolving HMI technology as a pivotal step in ICV development. Considering the differences between HMI-powered ICVs and traditional vehicles, especially the special requirements of driving mode switchover on system, we have put forward HMI standard projects. On specific standard projects, China evaluates HMI from signal alarm level, alarm priority, driver and passenger comfort, etc.; Germany pushes forward standardization by technical reports and other approaches.

Additionally, both sides recognize that software upgrade and HD maps play an important role in automated driving functions and bring about new standards or research projects accordingly.

III. Both sides understand and respect the discordance in technologies, industrial development phases and standardization laws and regulations.

Issued by the government department, China's Standards System not only mirrors the demand of automotive and relevant industries for standardization, but also government's expectation to promote technological innovation and industrial development by means of standardization. Germany's Roadmap, as released by VDA, reflects more of the industry-wide demand for a lower cost and higher product quality and stability through standardization.

China's Standards System builds on the standardization scope in China with recommended technical standards as the focus and also proposes some mandatory standards, or compulsory "technical regulations". Germany's Roadmap is only limited to recommended technical standards other than technical requirements.

The Standards System takes the development of ICV technologies and industry in China into account and develops a standards system aligning with China's national conditions, emphasizing "adhering to openness and actively participating in the formulation and coordination of international standards and regulations", campaigning for calibration and consistency with international standards. Over one hundred years of development, the automotive industry in Germany has a proven track from markets and technologies to standardization which has been fundamentally connected with international society. It is mostly stressed how to achieve high efficiency of resources and costs in global automotive industry through internationally coordinated and consistent standards.

IV. Both sides will strengthen exchange, coordination and cooperation on the principles of "mutual understanding, mutual respect, seeking common ground while reserving differences, equality and voluntariness, mutual benefit and reciprocity".

Holistically, Germany and China hold highly consistent recognition and judgement of intelligent and connected vehicle (ICV) technology and industry development trend and are highly consistent in recognition and strategic positioning of the role of standardization in promoting and backing ICV technologies

and industry development. Both sides share much closeness on overarching principles, construction goals, technical logics, system frameworks and key fields of standardization roadmaps.

The governments of both sides are highly supportive and industries show high intention to participate in the exchange, coordination and cooperation on the standardization of ICVs, so as to complement each other in light of technologies, industries and markets, and jointly promote innovation of ICV technologies and coordinated development of industries.

Both sides understand and respect each other's differences because of varied technologies, industrial development stages, standardization laws and systems. We will strengthen exchange, coordination and cooperation on the principles of "mutual understanding, mutual respect, seeking common ground while reserving differences, equality and voluntariness, mutual benefit and reciprocity", and make joint efforts and contributions to ICV international standardization.

Both sides agree to make standardization cooperation an avenue for supporting and participating in the communication, exchange and cooperation of Chinese and German governments and industries on ICV technological development, demonstration operation, application promotion, innovation management, science education, etc., and jointly promoting the technological advancement, industrial development and innovation management of ICVs around the globe.

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I. BACKGROUND

As intelligent and connected vehicles (ICVs) are becoming the priority of auto industries worldwide, Germany and China boast advanced technologies and vast markets, and are furthering and deepening cooperation on ICVs while serving as two important members of the global auto industries.

In July 2018, under the auspices of the Chinese premier and German chancellor, ministries and commissions of the two countries signed the Joint Declaration of Intent on Cooperation in the Field of Automated and Connected Driving. In December of the same year, the Ministry of Industry and Information Technology of China, Bundesministerium für Verkehr und digitale Infrastruktur and Industriepolitik of Bundesministerium für Wirtschaft und Energie hosted the Kick-off Meeting of Sino-German Cooperation on Intelligent and Connected Vehicles, at which it is clearly instructed that NTCAS and VDA are commissioned to take the lead in in-depth cooperation on ICVs. As per instructions, ICV and VDA have developed an exhaustive work plan and proactively implemented the cooperative agreement between the two governments.

Amidst the development of the automotive industry, especially new technologies, both sides figure out that standardization can regulate market behavior, achieve optimal order and social benefits, while moreover promoting the development and application of new technologies greatly and enabling technological progress. Germany and China therefore released standardization roadmaps respectively in 2017 and 2019.

On this basis, ICV and VDA place comparative analysis of Standardization Roadmap for Automated Driving and Guideline for Developing National Internet of Vehicles Industry Standard System (Intelligent & Connected Vehicle) on top of agenda, thoroughly comparing and analyzing ICV standardization roadmaps from overall structure, construction goals, standard system and action plan, etc. so as to find similarities and differences and provide valuable advice for the two countries to further strengthen cooperation on ICV standardization.

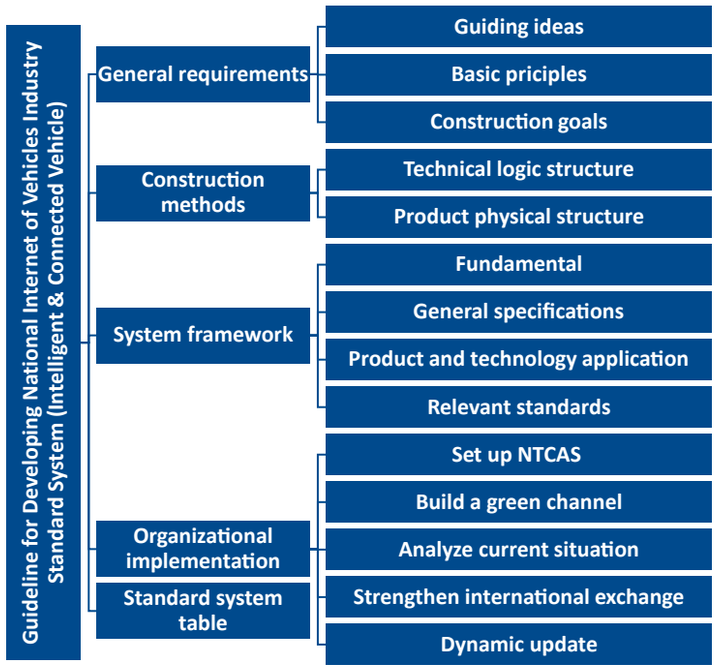
II. COMPARATIVE ANALYSIS OF OVERARCHING STRUCTURE

2.1 Overview

China's Standard System consists of general requirements, construction methods, standard system, organizational implementation and standard system table. Whereas, Germany's Roadmap extends by introduction, standardized significance of automated and connected vehicles, standardized research projects, standardization organization overview, roadmap framework, summary and standards list. These two documents are different in the methods of promoting standard project establishment, standard system fields and logics yet similar in overall ideas, such as the architecture, international standardization cooperation, and the entity responsible for standards release and implementation.

2.2 Comparative Analysis

China's Standard System is based on the following framework:



China's Standard System is based on the following framework:

1) General requirements are set forth as follows:

a) Guiding ideas are to strategically implement Made in China 2025, build a safe, efficient, healthy, intelligent automotive society in the future, and establish a transdis-

ciplinary ICV standard system catering to technological and industrial development in China;
b) Basic principles are to make holistic planning based on national conditions; firstly, lay a foundation and deal with emergency; encourage collaboration among enterprises;
c) Construction goals are to initially establish an ICV standard system that underpins driver assistance and low-level automated driving by 2020; systematically form an ICV standard system that applies to advanced automated driving by 2025.

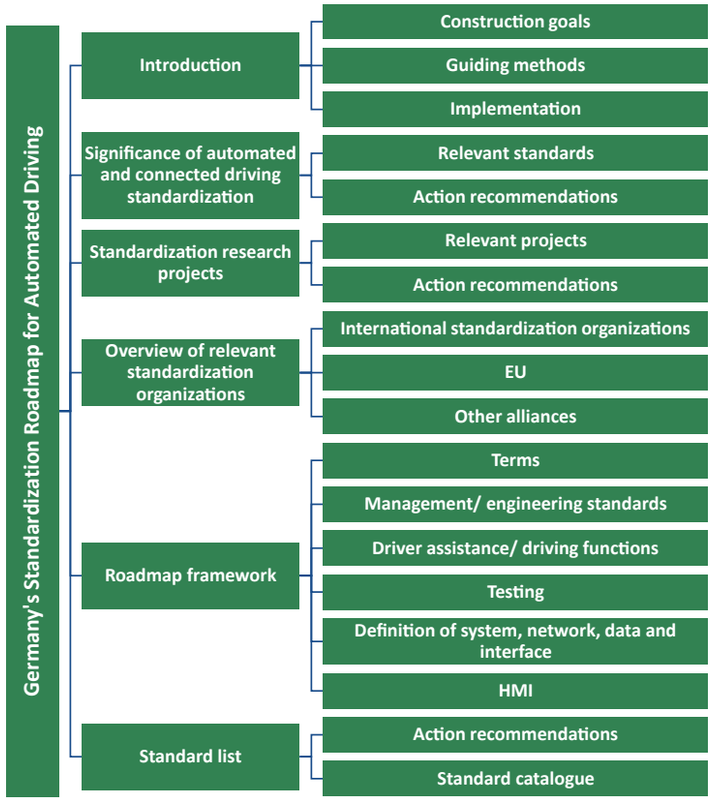
2) The construction method is expounded from technical logic structure and product physical structure:
a) From technical logic structure, the construction of ICV technologies revolves around "information perception" and "decision control". Its development is centered at information perception, decision warning and intelligent control enabled by the system which will gradually replace driver to perform driving tasks and finally perform all driving tasks completely in an autonomous manner;
b) From another perspective, the physical structure of ICV is to consolidate "information perception" and "decision control" functions contained in the technical logic structure onto a physical carrier. Vehicle control system, vehicle terminal, transportation facility, external device, etc., transmit, process and perform the collected or received information via network channels, software or platforms according to different purposes, finally enabling different functions or applications.

3) Standards system is finalized as follows:
a) System framework: According to the construction method of ICV's technical logic structure and product physical structure, combining various functional requirements, product and technology types, and information flow between sub-systems, ICV standard system framework is built on "fundamental", "general specifications", "product and technology application" and "relevant standards";
b) System content: The table of ICV standard system consists of fundamental (100), general specifications (200), product and technology application (300) and related standards (400);
c) Immediate plan: It is proposed to prioritize the research and formulation of basic and general standard specifications, as well as proven, widely applied product and technical standards related to national strategies.

4) Organizational implementation process is identified below:
a) Set up NTCAS of the National Technical Committee of Auto Standardization;
b) Build a green channel for the approval, formulation, release and implementation of standards;
c) Analyze the provisions in current standardization regulations relating to ICV technologies;
d) Strengthen international exchange and cooperation, and hold international forums on standardization regulations for intelligent and connected vehicles;
e) Implement dynamic update and improvement on the mechanism along with the changing technologies and applications.

5) The table of ICV standard system is presented herein.

Germany's Roadmap is outlined below:



1) A general introduction is made to Verband der Automobilindustrie, NA Automobil, and the goals, methods and implementation of the Roadmap: The Roadmap aims at developing a transdisciplinary strategy for standards and standardization of the products and infrastructure of automated vehicles on the road. Additionally, it outlines current standardization institutions and projects relating to automated and connected driving.
   The 39 action recommendations in the Roadmap will be put into action successively. The release of the Roadmap marks the inception of automated and connected driving standardization and will adapt as appropriate with the evolving standardization topics.
1) Relevant standards and action recommendations on automated and connected driving are specified. Five specific action plans are proposed to develop an internationally coordinated standard framework, adopt standardization auxiliary tools, identify an international standardization platform, allocate resources necessary for standardization, and take full advantage of the coordination functions of VDA.
2) Action recommendations are made to study project promotion standardization at the German and EU levels, for example, providing direction and foundation for standardization with the results of the Horizon 2020 and GEAR 2030 research projects.
3) Automotive, electronic, and information technology standardization organizations are outlined at the international, EU and German levels.
4) The Roadmap mainly have the following themes:
   a) Term description and action recommendations;
   b) Management/engineering standard instructions and action recommendations;
   c) Driver assistance/driving function description and action recommendations;
   d) Test instructions and action recommendations;
   e) Definition of system, network, data and interface and action recommendations;
   f) HMI (Human Machine Interaction) introduction and action recommendations.
   5) In the executive summary part, the transdisciplinary roadmap proposes 39 action recommendations which relate to the standardization both in content and process and will boost the efficiency and importance of automated and connected driving standardization.
6) Standard catalogue is presented.

The analysis results through the above comparison are listed below.

Commonness:

1) In general, China's Standard System and Germany's Roadmap have far-reaching implications for ICV industry development. Both sides acknowledge intelligence and connectivity as the development directions of automotive industry and the need to make a standardization roadmap at the national and industrial levels.

2) Both sides have specified construction goals and implementation plans in addition to exhaustive system content. Both sides have requirements on the main components of ICV standardization, including terms, functional safety, information security, assisted driving and automated driving, testing, HMI, etc.

Similarities:

1) Both sides call for further exchange and cooperation around the globe. In China, the standardization roadmap is government-led. This means that Chinese government establishes appropriate standard system in line with national development strategies, and meanwhile hosts international forums on ICV standardization regulations, organizing bilateral or multilateral communication and exchange, actively participating in the formulation of ISO and other international standardization regulations. Germany also emphasizes internationalization of standards and interaction with ISO, IEC and other international standardization organizations and hopes to develop a transdisciplinary standardization strategy by partnering with them.

2) China's Standard System and Germany's Roadmap are compiled by industry experts under the leadership of the standardization committees. China's Standard System are jointly issued by MIIT and the Standardization Administration and Germany's Roadmap by Verband der Automobilindustrie.

Differences:

1) Ways to precipitate standardization projects:
   From a holistic perspective, China makes planning on standardization projects from top to bottom; Germany normally speaks for itself by research projects and promotes the formulation of standards from bottom to up.
   China generally starts from the top design, navigates standardization work in a planned, purposeful, and targeted way, and improves the standardization system. Ger-

many promotes automated driving standardization work through funding research projects and calls NA Automobil of DIN to participate in the projects so that project results can be continuously applied to standards.

2) Scope of the Standard System:
China prioritizes vertical extension and therefore the guideline only relates to ICV standard system while the construction of systems standards of information communication, electronic products and services is subject to other guidelines. Germany focuses on horizontal extension and campaigns for full-ecology communication.
China's standardization roadmap focuses on core technologies and key products of intelligent driving and sets forth clear requirements, aiming at accelerating the development of ICVs. Germany's standardization roadmap elaborates on products, technologies, services, processes, etc. and puts forward macro instructions.

3) Logic of the Standard System:
China's roadmap is more rigorous in logic and more detailed in content, and can be regarded as action plan. Germany's mainly proposes directional and principled recommendation for action and can be considered as guiding advice which needs to be further materialized.

III. COMPARISON OF CONSTRUCTION GOALS

3.1 Overview

In this chapter, China emphasizes the establishment of ICV standard system should be conducted in a top-to-bottom fashion, ultimately guiding and propelling efficient and safe development of relevant industries and constantly hiking international competitiveness. Germany punctuates to develop more extensive international standards in the field of ICVs, with VDA and NA Automobil as the basic platform on which transdisciplinary strategies are formed, thereby facilitating automotive industry players to reduce costs and improve stability of products and services.

3.2 Comparative Analysis

Both Germany and China acknowledge the importance of standardization tools in the development of the industry, and hope to promote the coordinated development of ICV technologies across industries by virtue of standardization tools, improve the stability of products and services, and enhance universality of related technologies, products and services. Both sides take ICV standardization as development priority.

China puts forward construction goals for the timeline between 2020 and 2025: by 2020, initially establish the ICV standard system applicable to driver assistance and low-level automated driving; by 2025, systematically form the ICV standard system that supports advanced automated driving.

Germany lists like this:

As shown above, Germany also takes 2020 and 2025 as key nodes, and seeks to complete L3 and L4 standardization between 2020 and 2025, including perception, data recording, and HD maps; terms and definitions; connectivity; human machine interface (HMI); safety, security and SOTIF; artificial intelligence; verification and validation.

Similarities:

Both sides are planning to establish a portfolio of ICV standards that are in line with the international standards: China intends to navigate and promote the development and application of ICV technologies and products, create an independent innovation environment for ICV technologies, and enhance the overall technical level and international competitiveness; Germany hopes to adopt uniform norms and standards that helps lower costs and improve the stability of products and services.

Differences:

Apart from ICV module, Germany also encompasses supporting infrastructure in the roadmap. Whereas, because of the inclusion of infrastructure-related standards in the Guideline for Developing National Internet of Vehicles Industry Standard System (Intelligent & Connected Vehicle) issued by MIIT and Standardization Administration of China, infrastructure knowledge is not available in China's roadmap.

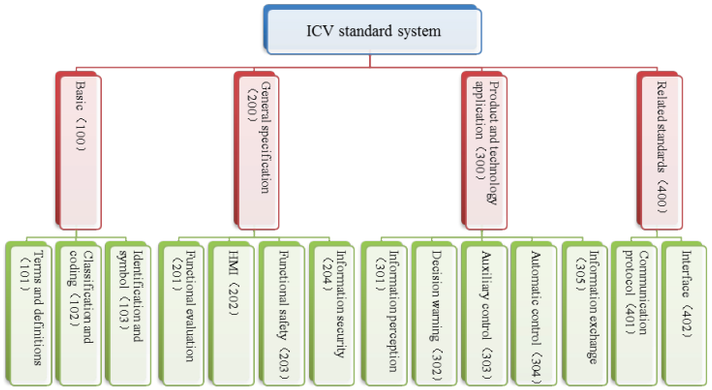
IV COMPARISON OF SYSTEM FRAMEWORK

4.1 Overview

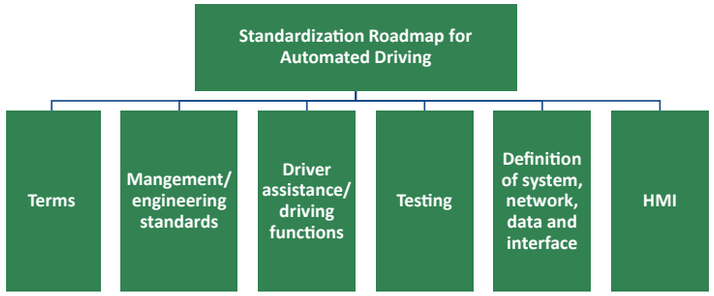
System framework provides an overview of the Standard System and is on top of standardization objectives, construction methods and standard project planning. In developing the Standard System and the Roadmap, both Germany and China have formed the system framework and roadmap theme based on their understanding of ICV technologies and industries, and analysis of the strategic significance of standardization and basic construction methods. In light of the minor difference in standard management mechanisms, China has formed a system framework using a mixture of technical logic structure and product physical structure. Germany has created a wide range of roadmap themes by means of technical and functional logic classification methods.

4.2 Comparative Analysis

ICV standard system framework:



Germany's system framework:



According to the logic structure of ICV technologies, the framework of China's Standard System is divided into four parts: "fundamental", "general specifications", "product and technology application" and "relevant standards", which are subdivided into 14 sub-components in view of the commonness and difference of various standards in content and technical levels.

Germany has developed a wide range of roadmap themes through the use of technical and functional logic classification methods, namely "terms", "management/ engineering standards", "driver assistance/ driving functions", "testing", "definition of system, network, data and interface" and "HMI", without subdividing them however.

China's Standard System and Germany's Standardization Roadmap for Automated Driving unanimously relate to ICV technologies and key management dimensions, in addition to basic standards for terms, technical standards for products and functions, safety and security management/ engineering standards, and network and infrastructure interface standards, providing guidance for research and management in automotive industry and relevant industries.
In light of the minor difference in standard management mechanisms, China has formed a system framework using a mixture of technical logic structure and product physical structure. Germany has created a wide range of roadmap themes by means of technical and functional logic classification methods.

Germany's Standardization Roadmap for Automated Driving depends mainly on international standards and partially on European standards, and incorporates a spectrum of technical interfaces and test methods. China's ICV Standard System introduces function evaluation standards in addition to technical interfaces and test methods.

In terms of management/ engineering standards and test standards, both sides have proposed safety and security standard projects. Nevertheless, China's Standard System incorporates test standards into each of function standards instead of placing them in a separate part. Germany's Roadmap defines HMI as an independent category.

V. COMPARATIVE ANALYSIS OF STANDARD PROJECTS

5.1 Standard of Terms

5.1 Standard of Terms

5.1.1 Overview

Germany and China both recognize the need to create a unified standard library of ICV terms that will strengthen transdisciplinary exchange and communication on technologies and miscellaneous affairs and advance deployment of ICV technologies. China focuses on establishing specific standards and unified ICV concepts so as to lay a foundation for collaboration across industries and facilitate the formulation of sibling standards. Germany emphasizes narration of methodology and suggests to follow the terms and definitions in existent international standards and adjust the controversial parts, thereby enhancing users' recognition of new technologies.

5.1.2 Comparative Analysis

Comparative Analysis

No.	Category	China	Germany	Relation
1	Purpose	Standard of terms and definitions is used to unify ICV's basic concept and lay a foundation for industry-wide collaboration.	During transdisciplinary collaboration, it's increasingly important to use unified terms among others.	Same
2	Role	It also facilitates the formulation of sibling standards.	A unified language can boost customers' recognition of new technologies.	Similar
3	Project	101-1 ICV term and definition 101-2 ADAS term and definition 101-3 Vehicle security term and definition	Methods and levels of term application are listed in the standard. 1. To be determined in documents. 2. Terms are defined in specific document, so consistent interpretation should be made to these documents. 3. Unified definitions are used in the documents of committee or other counterparts. 4. Unified terms are set within the scope of standardization organizations.	Different
4	Application	/	ISO and IEC implemented L3 via online database. Through Online Browsing Platform (OBP), ISO provides a variety of search options, including definitions or general keywords. IEC has defined a wide range of traceable terms in its IEV.	Different

Detailed comparison is shown below:

Commonness:
China's Standard System and Germany's Roadmap denotes it necessary to establish a unified standard library of terms which is conducive to transdisciplinary exchange and large-scale commercial application of automated vehicles.

Similarities:
China focuses on establishing a unified standard library of ICV terms that will lay a foundation for collaboration across industries and facilitate the formulation of sibling standards. Germany emphasizes enhancing users' recognition of ICV technologies.
Differences:

1) China stresses construction of specific standards and has started early research and formulation according to specific standard project plans. Germany prioritizes elaboration of methodology and recommends to follow the terms and definitions in existent international standards and adjust the controversial parts.
2) At the time of developing the Standard System, China ensures the consistency of standard ICV terms through the coordination mechanism where automotive industry takes the lead and relevant industries collaborate. Germany suggests to achieve higher-level unification of terms via OBP in its Roadmap.

5.1.3 Recommendations

Germany and China should strengthen cooperation on standardization of terms and definitions and jointly promote the creation of unified standard library of terms so as to advance transdisciplinary exchange and cooperation.

5.2 Functional Safety and Information Security

5.2 Functional Safety and Information Security

5.2.1 Overview

Functional safety and information security are an integral part of Sino-German ICV standardization roadmaps which promise research framework and process as well as safety and reliability of automated driving function.

In order to deliver a more comprehensive set of feasible technical requirements, China makes security and safety a secondary sub-item of the Standard System, and subdivides security and safety standards by product. Germany consolidates safety and security standards into corresponding management/ engineering standards, and only adopts a general standard in security and security fields. Furthermore, Germany introduces the SOTIF standard in face of safety challenges in automated driving due to system constraints.

5.2.2 Comparative Analysis

Comparative Analysis

No.	China	Germany	Relation
1	GB/T 34590-2017 Road Vehicles – Functional Safety (Part 1-10)	ISO 26262:2018 Road Vehicle - Functional Safety Engineering (Part 1-12)	Similar
2	Anti-failure requirements and evaluation methods for ICV HMI system	/	Different
3	Safety requirements for vehicle interaction interface	/	Different
4	Safety requirements for vehicle information perception system	/	Different
5	Safety requirements for vehicle decision-making pre-warning system	/	Different
6	Safety requirements for vehicle assisted control system	/	Different
7	/	ISO 21448 Road Vehicles – SOTIF Engineering	Different
8	/	ISO 21434 Road Vehicles – Information Security Engineering	Different
9	General technical conditions for vehicle security protection	/	Different
10	Full-vehicle security risk assessment specification	/	Different
11	General requirements for vehicle data protection	/	Different
12	General technical requirements for in-vehicle operating systems and application software	/	Different
13	General test and evaluation methods for vehicle security	/	Different
14	Security technical requirements for vehicle information sensor	/	Different
15	Security technical requirements for in-vehicle ECU information	/	Different
16	Security technical requirements for in-vehicle hub system information	/	Different
17	Security technical requirements for vehicle gateway information	/	Different
18	Security technical requirements for in-vehicle T-BOX information	/	Different
19	Security technical requirements for OBD interface information	/	Different
20	Technical requirements for connected vehicle identification system	/	Different
21	Safety requirements for vehicle software upgrade	/	Different
22	Security technical requirements for vehicle telematics communication	/	Different
No.	China (relevant content)	Germany (relevant content)	Relation (Same/Similar/Different)

It can be seen from the above table that Germany and China have consensus on the importance of safety and security standards. In developing supporting standards, China seeks to make its standards more extensive and product-oriented while Germany gravitates towards a consistent methodology. Details are shown below.

Commonness:
Both sides hold the same on a methodology dimension, unanimously attaching great importance to safety and security standards and application in ICVs (automated driving), and proactively participating in the formulation of ISO standards as follows:

In terms of safety-related use cases of ADS under expected use conditions, electrical and electronic failure should be controlled to achieve the necessary level of safety. This is especially important for advanced ADSs (L3 and above) as human driver will no longer intervene when the system is performing an automated driving task.

Fueled by a myriad of connectivity elements introduced in automated driving, automotive industry is subject to large-scale change. Introduction of security rationale and practices can be a pivotal step in preventing attackers from controlling vehicles and avoiding spread of attack.

On this basis, it's necessary to analyze safety-related use cases to secure an ideal level of safety and systematically evaluate possible damages arising from expected use and predictable misuse of ADS. In addition to safety design and development process, validation is also a key step during evaluation of ADS, as analyzed and tried from time to time. Different standards provide support from varied angles.

As technologies evolve, safety can be realized from a holistic perspective. During the implementation of ISO 26262 Road Vehicles - Functional Safety Engineering and ISO/SAE 21434 Road Vehicles - Information Security Engineering, processes and methods can be combined organically.

Similarities:

China has revised ISO 26262:2011 Road Vehicles - Functional Safety Engineering and released GB/T 34590-2017 Road Vehicles - Functional Safety Engineering. Germany has adopted the most updated ISO 26262:2018 Road Vehicles - Functional Safety Engineering. Compared to the first version, it is more well-structured and rigorous and applicable to more complex electronic and electrical systems for vehicles.

China should pass some time before formally changing its adoption of international standard to national standard. Therefore, the new version of ISO 26262:2018 Road Vehicles - Functional Safety Engineering has not been issued.

Differences:

1) In order to deliver a more comprehensive set of feasible technical requirements, China refines technical requirements for security and safety based on specific products. Germany holds that OEMs should undertake to conduct risk analysis and raise requirements before sending update to suppliers.

2) In terms of validation, China believes that it should be pursuant to the lowest requirements for specific products. Germany argues that it's necessary to collate demands and specifications from top to bottom as input of validation following the V model.

3) The ISO 21434 Road Vehicles – Information Security Engineering, SOTIF standard and ISO 21448 Road Vehicles - SOTIF Engineering are not included in China's Standard System.

4) Compilation and application of safety and security standards has long been a reality in Germany's automotive industry where a good safety and security ecosystem has been established. Therefore, the standards adopted by Germany focus more on methodology. Considering the safety and security reality in China's automotive industry, China seeks to guide industry practices by more detailed technical requirements and quickly improve the overall level of safety and security in the industry. Its standards are content-richer and more segmented.

Note: Due to the release time, China's Guideline for Developing National Internet of Vehicles Industry Standard System (Intelligent & Connected Vehicle) does not list ISO 21434 Road Vehicles - Information Security Engineering and ISO 21448 Road Vehicles - SOTIF Engineering. After release, China has a clear planning for corresponding national-standard conversion projects.

5.2.3 Recommendations

1) Germany should vigorously assist China in developing recommended national standards pursuant to ISO 26262:2018 Road Vehicles - Functional Safety Engineering.

2) Both Germany and China should actively participate in the formulation of ISO 21434 Road Vehicles - Information Security Engineering and ISO 21448 Road Vehicles - SOTIF Engineering and bring about proposals which will be supported mutually.

3) Germany shall facilitate China to formulate recommended national standards with reference to ISO 21434 Road Vehicles - Information Security Engineering and ISO 21448 Road Vehicles - SOTIF Engineering.

5.3 Driver Assistance and Automated Driving Standards

5.3 Driver Assistance and Automated Driving Standards

5.3.1 Overview

Germany and China believe that driver assistance system and automated driving function need to encompass both higher comfort and safety. Both sides acknowledge the need to define driver assistance and automated driving systems and functions in detail.

In the part of driver assistance system and automated driving function in China's Standard System, decision warning, assisted control and automated control are outlined from a functional perspective with safety as the prerequisite. In formulation of standards, "safety, comfort, energy efficiency and environmental protection" are key considerations. The ultimate goal is to embrace a new generation vehicle that is fully autonomous.

Germany set up the standards for driver assistance system and automated driving function from the angle of scenario and function, developing innovative functions and products related to automated driving and autonomous driving while actively participating in standard projects of different automation levels to develop and influence current and future standards.

5.3.2 Comparative Analysis

Comparative Analysis

No.	Category	China	Germany	Relation
1	Adaptive cruise control system	303-2 Adaptive cruise control system (ACC) performance requirements and test methods 303-3 Full speed range adaptive cruise control performance requirements and test methods	ISO 20035 Collaborative Adaptive Cruise Control (CACC) system ISO 15622 Adaptive Cruise Control System	Similar
2	Collision mitigation system	302-3 Pedestrian monitoring system performance requirements and test methods 302-8 Rear passengers reminder system performance requirements and test methods 303-9 Forward collision mitigation system performance requirements and test methods	ISO 19237 Pedestrian detection and collision mitigation system ISO 22078 Bicycle Detection and Collision Mitigation System ISO 22733 Autonomous emergency braking system	Similar
3	Lane keeping assist system	302-6 Lane departure warning system (LDW) performance requirements and test methods 303-6 Passenger car lane keeping assist system (LKA) performance requirements and test methods 303-7 Commercial car lane keeping assist system (LKA) performance requirements and test methods	ISO 19638 Road edge anti-deviation system ISO 21717 Partially automated in-lane driving systems (PADS) ISO 22735 Lane keeping assist system ISO 17387 Lane Change Decision Aid Systems (LCDAS)	Similar
4	Low-speed automated driving	302-12 Low-speed driving handling assistance performance requirements and test methods 303-1 Low-speed follow system performance requirements and test methods 304-2 Traffic jam automatic follow system function, performance requirements, and evaluation methods	ISO 22737 Low-speed automated driving	Similar
5	Autonomous emergency braking system	303-4 Passenger car autonomous emergency braking (AEB) system performance requirements and test methods 303-5 Commercial car autonomous emergency braking (AEB) system performance requirements and test methods	ISO 23793 Emergency parking system ISO 22733 Autonomous emergency braking system ISO 19377 Heavy commercial vehicles and buses: Emergency braking on designated roads	Similar

Commonness:

China's standards for driver assistance system and automated driving function keep in line with ISO's L1-L4 on the dimension of assisted and automated control and involve most of scenarios and functions related to driver assistance and automated driving.

Technically, both sides develop the standards from the aspects of technology perception and decision control. With specific user scenarios as the carrier, both sides standardize longitudinal and lateral control of automated vehicles via driver assistance or automated driving function from term definitions, technical requirements, test methods, etc.

6	Parking assist system	302-11 Parking distance warning device performance requirements and test methods 302-13 Extended-range backing aid systems (ERBA) performance requirements and test methods 303-12 Parking assist system performance requirements and test methods	ISO 16787 Parking assist system ISO 20900 Partially automatic parking system	Similar
7	Automated parking system (APS)	304-1 Automatic parking system function, performance requirements, and evaluation methods	ISO 23374 Auto valet parking system	Similar
8	Emergency steering assist system	303-10 Emergency steering assist system performance requirements and test methods	ISO 23375 Anti-collision lateral maneuver systems (CELM)	Similar
9	Automated highway driving system	304-3 Automated highway driving system function, performance requirements, and evaluation methods	ISO 21202 Partially automated lane change systems (PALS) ISO 23792 Highway automated driving assist system ISO Highway high-speed automated driving	Similar
10	ADAS	304-4 ADAS function, performance requirements, and evaluation methods	ISO 3450x Automated driving test ISO 23792 Highway automated driving assist system	Similar
11	Forward-collision warning system (FCW)	302-5 Forward-collision warning system (FCW) performance requirements, and test methods 302-10 Pre-Crash-System performance requirements, and test methods	ISO 15623 Forward-collision warning system (FCW) ISO 23376 V2V Crossroads Collision Warning System	Similar
12	Blind spot monitoring system	302-2 Blind spot monitoring system performance requirements and test methods 302-7 Door opening blind spot warning system performance requirements and test methods	ISO 17387 ISO 17387 Lane change decision aid systems (LCDAS)	Similar
13	Speed warning system	302-9 Intelligent speed limit reminder system performance requirements and test methods 302-14 Cornering speed warning system performance requirements and test methods	ISO 11067 ISO 11067 Cornering speed warning system (General Safety Working Group is drafting relevant standards at the same time)	Similar
14	Commercial vehicle ESC system	303-8 Commercial vehicle ESC performance requirements and test methods	UN-ECE R13 includes relevant provisions	Similar
15	Remote control assist	303-13 Remote control assist system	ISO 20900 Partially vehicle parking system	Similar
16	Emergency electronic braking light system	Active safety involved. No relevant standard in the standard system of automated driving	ISO 20901 Emergency electronic braking light system	Different

Differences:

China's standards for driving function/ driver assistance system mainly stretch from decision warning, assisted control and automated control while Germany composes according to automation levels (L1-L4).

China's standards elaborate more on decision warning and focuses on blind spot monitoring system, alcoguard, door opening blind spot warning system, etc. Germany's standards also pertain to active safety, functional safety, test object and many others.

China subdivides the standards by function and each standard is inclusive of any expected scenarios while Germany establishes the standards based on various scenarios. Put differently, China's standards are of top-down design while German's are of bottom-up design.

5.3.3 Recommendations

Both sides are suggested to cooperate on urban automated taxi (intelligent mobility).

17	V2V functional safety	Functional safety involved. No relevant standard in the standard system of automated driving	ISO 22377 V2V functional safety	Different
18	Truck fleet	No relevant standard in the standard system of automated driving	ISO truck fleet control strategy	Different
19	Automated taxi	No relevant standard in the standard system of automated driving	SO Urban automated driving taxi	Different
20	Test object monitoring	Test object involved. No relevant standard in the standard system of automated driving	ISO 22133 Test object monitoring	Different
21	Testing device	Test object involved. No relevant standard in the standard system of automated driving	ISO 19206 Targeted testing device for evaluating active safety function	Different
22	Commercial vehicle warning system	302-1 Warning system of road commercial vehicles weighing more than 3.5 tons.	No relevant standard in the standard system of automated driving	Different
23	Alcoguard	302-4 Alcoguard performance requirements and test methods	No relevant standard in the standard system of automated driving	Different
24	Longitudinal and lateral control system	303-11 longitudinal and lateral control system performance requirements and test methods	No relevant standard in the standard system of automated driving	Different

5.4 Test Evaluation Standards

5.4 Test Evaluation Standards

5.4.1 Overview

As a key component of the ICV development full cycle, test evaluation is of great importance to ICV safety. Construction of the "test" standards by China's Standard System in hands with Germany's Roadmap shares the common ground of the "test scenarios" on one hand while diverges in terms of standard framing methods and arrangement on the other hand. Germany tends to interpret the "test" standards from three dimensions including test scenario, simulation, and tools adopted. In comparison, China focuses on automation and connectivity test situations/scenarios, as well as various functions and product test evaluation standards, yet does not separate simulation and testing tools in its standardization system.

5.4.2 Comparative Analysis

Comparative AnalysisChinese VS German Test Evaluation Metric

No.	China	Germany	Relation
1	201-3 Auto Intelligent Application Working Conditions 201-4 Automobile Connectivity Application Working Conditions	A standard plan is available. Step 1, the ISO TC22/SC33/WG9 work team defines the content required for test scenarios, including definitions of the terms. Moreover, if necessary, it will also define the classifications, principles, concepts, data collection, and storage requirements etc.	Same
2	No separate plan for the "simulation" standards	A "simulation" standard plan is available: ISO 11010-1 Passenger Car-Simulation Model Category-Part 1-Vehicle Dynamic Control	Different
3	No "testing tools" standard plan available	A standard plan for "testing tools" is prepared: ISO 19206 Road Vehicles-Testing devices for target vehicles, vulnerable road users and other objects	Different

From the comparisons above, both China's Standard System and Germany's Roadmap have prepared plans to develop the "test scenario" standards. Due to their diverged technical focuses, China exerts extra efforts on the scenario standards based on connectivity technology on top of those which based on intelligence technology, but has made no separate standards for simulation and testing tools.

With different standard framing approaches and purposes, Germany designs "test" standards of the standardized automated driving roadmap from three dimensions of test scenario, simulation and testing tools.

Commonness:

Both sides attach great importance to "test scenario" and consider it the groundwork for carrying out ICV tests. Launched in 2017, China's Standard System did not bring up the concept of scenario at that time and named the pertinent as "working condition" standards based on its understanding of the automobile industry back then. With development of automated driving, consensus has been reached across the automobile sector in which the concept of "scenario" has been gradually recognized. The concept and content of "working condition" and "scenario" standards agree with each other. In China, the word "scenario" will be adopted when developing new standards in the future.

Differences:

1) The purpose of standard developing

   China believes that the standards should be playing a basic supportive and leading role in terms of key technology, core product and function application in the ICV industry, and it is planning to roll out the "general specifications" and the "product and technology application" standards for accessing functionalities of the relevant products and techniques.

   From the perspective of Germany, the standards are of great importance to improve reproducibility and comparability of the results. The purpose of setting up standards is not to evaluate the system's functionality but to improve comparability and reproducibility of the test results.

2) Testing standard system

   As China creates the standard system framework by combining the technical logic structure with the products' physical structure, the related test and assessment standards belong to a systematic frame by function. Test scenarios/working conditions related product and technical standards are classified as "general specifications", while those related to information perception, decision warning, assisted and automated control are classified as "product and technology application".

   Based on its understanding of the standard purpose and test methods, Germany plans and develops separate "test" related standards from three aspects including test scenario, simulation and testing tool. The relevant product and technical standards are put under the driver assistance/ automated driving category instead of the "test" standards.

5.4.3 Recommendations

In terms of the standard system framework, China is suggested to add simulation and test equipment standards.

5.5 Connectivity and Transmission Standards

5.5 Connectivity and Transmission Standards

5.5.1 Overview

Connectivity and transmission in the ICV standards stand as the foundation for interconnection between automated vehicles and the information, communication and infrastructure. Both Germany and China give definition and make plans for the network protocol, data and transmission interface when developing the Standard System and the Roadmap. China's Standard System mainly targets the ICV core technology and key product application and guides work with the ICV standardization in the internet of vehicles sector for a specific purpose, by a prepared plan, and with a particular focus. The System mainly covers the communication protocol about interaction between vehicles and external information as well as the relevant standards on software and hardware interfaces. Apart from standards on communication interface and sensor interface, Germany covers a rock-bottom communication protocol with in-vehicle networking. Moreover, in terms of the communication protocol of vehicles' external communication, China mainly includes LTE and 5G communication protocol and interface, while Germany covers LTE, ITS-G5 and 5G related communication protocol and interface.

Comparative Analysis

No.	Category	China	Germany	Relation
1	In-vehicle networking	/	Standards such as CAN, LIN, MOST, Flex Ray and Ethernet	Different
2	Connected vehicles	/	ISO 20077-1 Road Vehicles -- Extended vehicle (ExVe) methodology -- Part 1: General information	Different
3		/	ISO 20077-2 Road Vehicles -- Extended vehicle (ExVe) methodology -- Part 2: Methodology for designing the extended vehicle	Different
4		/	ISO 20078-1 Road vehicles -- Extended vehicle (ExVe) 'web services' -- Part 1: ExVe content	Different
5		/	ISO 20078-2 Road vehicles -- Extended vehicle (ExVe) 'web services' -- Part 2: ExVe access	Different
6		/	ISO 20078-3 Road vehicles -- Extended vehicle (ExVe) 'web services' -- Part 3: ExVe security	Different
7		/	ISO 20078-4 Road vehicles -- Extended vehicle (ExVe) 'web services' -- Part 4: ExVe control	Different
8		/	ISO 20080 Road vehicles — Information for remote diagnostic support— General requirements, definitions and use case	Different
9	Sensor interface	/	ISO TC22/SC31 creates the new WG9 "Sensor Interface Used for Automated Driving Function" in particular for the new project, whose task is to define the logical interface among individual sensors and their integration. The project aims to reduce complexity of the automated driving function via output signals of standardized radars, laser radars, video cameras and ultrasonic sensors.	Different
10	Network protocol	401-1 Mid- and Short-range Communication Protocol Based on LTE-V	Apart from direct communication via Wi-Fi (excluding C2C and C2I), continued development of the mobile radio standards has made them the focal point of C-ITS application. Although limitation can be found in the 3GPP (3rd Generation Partnership Project) including the 3G and 4G development standards about C-ITS application compared with ITS-G5 (or WAVE), the launch of the 5th generation mobile radio shows that ITS-G5 functionality could be surmounted. The 5G Automotive Association (5GAA) was established in 2016, and as a representative of the 3GPP, it is a global telecommunication and automobile industrial group and is now promoting introduction of C-ITS 5G. In Europe, 3GPP publications will be delivered to ETSI, and will act as EN standards once approved. The following projects proposals are under consideration: -- ETSI TR 138 900: LTE; 5G; Research on Channel Model in Frequency Bands above 6 GHz -- ETSI TS 133 185: LTE; 5G; Security Aspects of LTE Support for Automotive Wireless communication Technology (V2X) Services -- ETSI TR 121 914: Digital Cellular Communication System (Phase 2+) (GSM); Universal Mobile Telecommunication System (UMTS); LTE; 5G	Similar
11		401-2 5G-based Wide-area Communication Protocol		
12		402-1 Mid- and Short-range Communication Interface Based on LTE-V		
13		402-2 5G-based Wide-area Communication Interface		
14		402-3 Auto Safety Communication— Dedicated Short Range Communication Interface		
15		402-4 Vehicle Location and Navigation System Interface Technical Requirements		
16		402-5 Vehicle and External Terminal Physical Interface Technical Requirement		
17		402-6 Vehicle and External Terminal Software Interface Technical Requirements		

5.5.2 Comparative Analysis

The table above implies extensive consensus between China's Standard System and Germany's Roadmap in terms of connectivity and transmission standards. But slight differences can be found in terms of in-vehicle networking, sensor, and connected vehicles.

Commonness:

Both sides acknowledge that connectivity functionality is able to support achievement of automated driving (especially high-level automated driving). Connectivity and transmission

under the ICV standards can facilitate interconnection between the autonomous vehicles and information, communication and infrastructure so as to accelerate realization of automated driving. In terms of connectivity, both sides value standards for this function and transmission technology. In the methodology of connected vehicles, both sides share broad consensus about creating a new connected vehicle platform based on "automobile + network".

Both sides emphasize the importance of the 5G mobile telecommunication technology to the realization of automated driving and connected vehicles, and both are making efforts on the top-level planning for standards while coordinating in rolling out the ISO related standards.

Differences:

1) In-vehicle networking
   China's Standard System focuses on the core technology and key product application of ICVs, and guides the standardization endeavor with a specific purpose, by a prepared plan, and with a particular focal point. China believes that the in-vehicle networking, as one of the basic standards, serves both ICVs and traditional automobiles, and its relevant standards have been in plan in other fields; Germany's Roadmap covers the communication protocol standards of in-vehicle networking, such as CAN, LIN, MOST, and FlexRay etc.

2) Connected vehicles
   Mainly based on the series standards of ISO 20077, ISO 20078 and ISO 20080, Germany formulates roadmap for connected vehicle methodology and network platform, which is not covered by China in its current Standard System. But China has already considered to add this part into the follow-up standard-making process, and has launched the ISO 20077 conversion program.

3) Sensor interface
   In the ICV Standard System, China mostly plans for specific products and application technology that are related to information perception, such as night vision system and head-up display (HUD) system, which mainly target the ICV core technology and key product application.
   Germany defines the "sensor interface used for automated driving function" at the level of ISO/TC 22/SC 31, which is able to reduce complexity of the automated driving function via output signals of standardized radar, laser radar, camera, and ultra-sonic sensor.

4) Network protocol
   China mainly carries out research and develops the automobile function and application standards that are based on the mobile communication technology C-V2X. By partnering with National Technical Committee on Communication of Standardization Administration of China and National Technical Committee on Traffic Management of Standardization Administration of China, it aims to promote research and development of the relevant standards related to C-V2X information communication technology and its application in the automobile and transportation sector. The standard system mainly covers the LTE and 5G communication protocol and interface.
   Germany rolls out the related standards that are based on ITS-G5 and mobile communication technology under the Cooperative Intelligent Transportation Systems (CITS), which for the most part covers the communication protocol and interface pertinent to LTE, ITS-G5 and 5G.

5.5.3 Recommendations

1) As for the connected vehicle methodology and for creating a network-based platform, both sides could study and promote together the ISO 20077 series standards on top of their shared understanding.

2) In terms of standards about sensor interface and drive-by-wire parts, both sides could work on further details about the interface technology standards based on the ISO 23150 standards in order to promote development of ICVs and automated driving technology.

3) In studying and developing technical standards for mobile communication, both sides could further the collaboration between National Technical Committee of Auto Standardization, National Technical Committee on Communication of Standardization Administration of China and National Technical Committee on Traffic Management of Standardization Administration of China. With the objective of supporting and realizing automated driving, they could try to apply connectivity technology on vehicles so as to promote research and development of the connectivity function standards based on LTE and 5G against the background of globalization.

5.6 Human Machine Interaction (HMI)

5.6 Human Machine Interaction (HMI)

5.6.1 Overview

The arrival of ICVs is constantly changing the way drivers interact with the vehicle systems. Both sides value the relevant technology and standards and intend to guide the HMI technology advances from the perspective of comfort and safety. Meanwhile, considering the respective driving responsibility and system security issues involved in human-machine control switch, both sides highlight research and development of the relevant standards. However, as HMI technology is required to sync up with automated driving function, both sides only have plans for basic research before application of advanced automated driving function so as to protect potential technology diversity without specific requirements.

5.6.2 Comparative Analysis

Comparative Analysis

No.	China	Germany	Relation
1	/	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	/
2	/	ISO 15007 Road vehicles Measurement and Analysis of driver visual behavior with respect to transport information and control systems	/
3	202-4 Vehicle Human-Machine Control Switch System Function Requirement and Test Method	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	Similar
4		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	
5	/	ISO/TR 21974 Naturalistic Driving Studies – Defining and Annotating – Safety Critical Events	/
6	/	ISO/TR 23049 Road vehicles Ergonomic aspects of external visual communication from automated vehicles to other road users	/
7	202-2 ICV Alarm Signal Priority Technical Requirements	SAE J3134™ ADS Equipped Vehicle Signal and Marking Lights (Work in Progress)	Similar
8	202-3 Vehicle Alarm Signal General Specifications		
9	202-1 Vehicle HMI Interface System Assessment Method	/	

Commonness:

With a similar position, both sides regard the evolution of HMI technology a crucial part of ICV development. Both China's Standard System and Germany's Roadmap have considered the differences between the ICV HMI and the traditional automobiles.

Differences:

China conceives HMI from multiple dimensions including signal warning grade, warning priority level, and driver/passenger comfort based on safety and industrial demand. Differences between ICV and traditional vehicles also empower China to exert more efforts on research and deployment regarding human-machine control switch and the relationship between HMI and driving safety.

Germany's Roadmap emphasizes the role of ergonomics. Relying on the existing ISO and SAE standards, it compiles technical reports and carries out the standard-setting task step-by-step in a research-oriented manner. Studies on the current ISO standards about HMI are listed hereof, most of which are presented as research reports, including how to quantify driver behaviors, how automated vehicles can interact with road users, and fundamental researches on key safety events. While calling for peers to update their perception, it encourages innovation of interaction approaches on the precondition of system safety.

5.6.3 Recommendations

4) Currently, a mature system has yet to be found regarding HMI by either Germany or China. It is suggested that both sides could play their respective advantages, strengthen cooperation and communication, absorb and improve the current works (ISO/TS, ISO/TR) available around the globe, and reach a common ground in the future standard-developing endeavors.

5) Both sides could conduct intended cooperation and research on the relevant standards on drivers' take-over capability in the human-machine control switch so as to establish a shared standard system.

5.7 Other Standards

5.7 Other Standards

5.7.1 Overview

Apart from the above projects, Germany and China have also referred to software update, HD maps and artificial intelligence grading which are not within the scope of above comparisons and therefore included in other standards for comparative analysis.

5.7.2 Comparative Analysis

Comparative Analysis

No.	Catagory	China	Germany	Relation
1	Software upgrade	201-5 Automotive Software Upgrade Technical Conditions and Function Evaluation Specifications	Idea on the project of software upgrade demand during vehicle operation	Same
2	Map	/	HD maps include all materials required for automated driving, including traffic signs and traffic guide systems. The nature of information, the format of roadmap data, and the algorithm and requirement for timely map modification in change of traffic signs will all be standardized.	Different
3	Artificial intelligence	/	Specifications of artificial intelligence applied in the automotive field should be provided, starting from the different level of such application.	Different

** China published the Technology Standard Requirement for High-Definition Maps in Automated Driving in May 2019.*

Commonness:

With development of automated driving technology, in-vehicle software is encountering increasingly frequent upgrade. Therefore, China's Standard System and Germany's Roadmap make the software update a part of future standards planning.

Differences:

What Germany mentioned in the Roadmap that all necessary information should be included in HD maps and what it emphasized about the nature of information and the format of data, as well as the algorithms and requirements for timely and dynamic map modification in case of traffic sign changing will all be standardized.

Germany hopes to standardize artificial intelligence technology applied in the automated driving sector, and proposes the suggestion that "the standardization can begin with grading artificial intelligence technology applied in automobiles".

5.7.3 Recommendations

HD maps, software upgrade, artificial intelligence are becoming integral parts of the evolving ICV technologies. Standardization and internationalization cooperation are conducive to the healthy development of industries in Germany and China.

1) Both sides should conduct active exchange on software upgrade and HD maps to advance standardization construction;
2) Germany and China should cooperate to facilitate artificial intelligence grading.

VI. COMPARATIVE ANALYSIS OF ACTION PLANS

6.1 Overview

In terms of action plans, both sides suggest to allow the enterprise to play a dominant role based on the current standard framework, so that a standard system suitable for ICV development requirement through extensive cross-sector exchanges and cooperation. Due to differences in management model, certain divergences can be spotted in both sides with regard to driving force and standardized tools and procedures.

6.2 Comparative Analysis

Action Plan Comparison

		Germany	China
Same	General goal	Developing a framework and system suitable for the ICV development requirement with enterprises as the dominant part.	
	International exchange	Actively participating in international exchanges and cooperation for promoting and improving an international ICV standard system.	
	Research support	Funding research projects to facilitate the relevant standardization program.	
different	Driving force	With the requirements of the automobile industry as the premise, it coordinates tool specification, standardization and regulation development.	differences
	Standardization tools and procedures	It makes use of the existing standardization tools such as IS, PAS, TR and TS in an active and extensive manner.	It establishes projects for standard development, lays down and releases green channel in order to satisfy the demands for rapid development of the ICV industry.

6.3 Comparative Analysis

Commonness:

Both sides suggest that enterprises should play a dominant role based on the existing standard framework so as to form a new framework suitable to the requirements for the ICV development via extensive cross-sector exchange and cooperation.

China suggests that a sub commission under the National Technical Committee of Auto Standardization should be set up to construct a standard teamwork mechanism with the automobile industry as the major part and the relevant industries in coordination, and ensure construction of an ICV standard system "with a scientific top-level design, a clear hierarchical structure, explicit scope of responsibilities, and smooth cooperation and teamwork". Meanwhile, in terms of international standard coordination, the suggestion is to enhance international exchange and cooperation, hold international forum for ICV standards and regulations, and organize bilateral or multi-lateral communication and exchanges.

Germany suggests to conduct extensive cross-sector discussions and potential analysis as soon as possible, and actively participate in improving the international standard system in line with development and application demand of ICV technologies on the precondition of not breaking the consensus of competition idea.

Differences

1) Driving force

Local regulatory bodies, industrial organizations, higher educational institutions are encouraged to participate more than before. In terms of action plan, the relevant terms about ICV technologies is analyzed on the basis of the existing standards and regulations in a bid to eliminate standards and regulatory obstacles gradually that constrain automotive new technology development. An improved mechanism on dynamic update should be implemented according to diversity and development requirement of the future technology and application. ICV Standard System will be upgraded and improved on an irregular basis by continuously enhancing coordination among different departments and industries. Germany suggests to coordinate the tools

specification, standardization and the development of regulations and policies based on demand of the automobile industry.

2) Standardization tools and procedures
China suggests to prioritize the study and development of the fundamental and general specifications, as well as the standards targeting products and mature technologies in extensive application or under the national strategies, and to establish standard-setting programs, enact and release green channel to meet the requirements for rapid development of the ICV industry. Germany suggests that the existing standardization tools should be actively and extensively leveraged, such as IS, PAS, TR, and TR, and work should be carried out under the standardization organizational framework including ISO, CEN and DIN, etc.

VII. SUMMARY AND RECOMMENDATIONS

7.1 Summary

Holistically, Germany and China hold highly consistent recognition and judgement of intelligent and connected vehicle (ICV) technology and industry development trend and are highly consistent in recognition and strategic positioning of the role of standardization in promoting and backing ICV technologies and industry development. Both sides share many common grounds and much closeness in overarching principles, construction goals, technical logic, system framework and key fields of the standardization roadmaps.
Both sides pay attention to vehicle intelligence, especially the functional safety issues due to the adoption of complex electronics architecture, the information security issues related to vehicle connectivity, and the SOTIF needed for securing automated driving, taking functional safety and information security as an important common standard. In regard to specific standard projects, China puts forward specific operational guidelines based on ISO standard to accelerate the establishment of industry-wide safety and security system; Germany focuses on methodology and basic rules and encourages enterprises to take down-to-earth measures independently.
Both sides figure out that as vehicles turn into a moving robot from man-controlled actuator, automated vehicle test requires a new scenario-centric evaluation system with mixture of "simulation and field test". Concerning specific standard projects, China adopts test scenario as a general specification and integrates specific test methods into various "product and technology application" projects; Germany highlights the necessity of new test methods by listing test scenarios, simulations and test tools separately.

Both sides are aware of the technical complexity in boosting vehicle automation. From the aspects of technology perception and decision control, with specific user scenarios as the carrier, both sides keep an eye on the formulation of ADAS standards and have implemented relevant standard projects as per functional planning of automated driving. In terms of specific standard projects, China's standard projects are categorized by decision warning, assist control, automated control, etc. Germany sets forth standards based on different driving automation levels and scenarios.

Both sides emphasize the importance of 5G mobile communication technology for automated driving and recognize the supporting role of connectivity in realizing automated driving (especially advanced automated driving). Both sides stress the significance of building a new connected vehicle system based on the notion of "vehicle + network". Regarding specific

standard projects, China takes the in-vehicle communication protocol as the basic automotive electronics standard, without incorporating it into the ICV Standard System; Germany presents in detail in-vehicle network, connected vehicles, sensor interfaces, network protocols, etc.

Both sides regard the evolving HMI technology as a pivotal step in ICV development. Considering the differences between HMI-powered ICVs and traditional vehicles, especially the special requirements of driving mode switchover on system, both sides have put forward HMI standard projects. On specific standard projects, China evaluates HMI from signal alarm level, alarm priority, driver and passenger comfort, etc.; Germany pushes forward standardization by technical reports and other approaches.

Additionally, both sides recognize that software upgrade and HD maps play an important role in automated driving functions and bring about new standards or research projects accordingly.

7.2 Next Steps

Both sides fully understand the existing differences in their respective ICV standard system due to divergences in technology, industrial development and national conditions, with full respect for each other's plan and arrangement of their own ICV standard system, are willing to enhance communication, exchange, coordination and cooperation based on free will and common interests, and are willing to strengthen coordinative cooperation and mutual support on topics of common interest in terms of international standardization.

Guided by the understanding and principles above, both sides are suggested to seek further cooperation on ICV standardization as follows:

Learn from how the working group on automated driving system test scenario works and further cooperate on international standardization for a win-win result.

Further cooperation on automated driving test scenario, SOTIF, information security and other relevant international standard projects, with real-time communication and mutual support.

Take HMI as priority and mobilize member institutions to exploit the avenue for standardization cooperation and research and raise proposals as the case may be.

Focus on automated parking function and jointly explore vehicle driving automation levels and evaluation approaches. Research results can be made public or a shared proposal.

Make joint efforts to study the antenna system for ICVs and performance evaluation methods. Research results can be proposed jointly as the case may be.

Strengthen communication and exchange on automated vehicles related ethic problems and impact on technical solutions and settle next plans as appropriate.

Comparison

	Programs under plan by both sides	Programs under plan by either side
No standard available	Both sides will select the appropriate program for cooperative research and will actively promote its international standardization; China will kick off developing national standards in the course of making international standards, and working on conversion towards international standards at the same time.	Both sides can discuss the possibility of including a certain aspect into their system.
Existing standard	Both sides establish a communication mechanism based on the standardization program and how it is implemented, select an appropriate program for joint research if necessary, which could facilitate subsequent revision simultaneously and provides references to each other.	For standards that have been developed by China but that have not been included by Germany, both parties will discuss the possibility of rolling out a set of international standards based on the Chinese national standards. They will choose a suitable program and work together to promote development of the relevant set of international standards. For standards that under Germany's plan or its programs to the international standards but that have not been planned by China, both parties will conduct research together and discuss the possibility of converting a set of international standards towards one applicable in China. Under feasible conditions, they will choose a proper program for conversion endeavor.

VIII. CONCLUSION

Despite the existence of discordance in technologies, industrial development phases and standardization laws and regulations, both sides are highly consistent in recognition and judgement of ICV technologies and industry development trend, recognition and strategic positioning of the role of standardization in promoting and backing ICV technologies and industry development, and also basically consistent in overarching principles, construction goals, technical logics, system framework and key fields among others.

The governments of both sides are highly supportive and industries show high intention to participate in the exchange, coordination and cooperation on the standardization of ICVs, so as to complement each other in light of technologies, industries and markets, and jointly promote innovation of ICV technologies and coordinated development of industries.

Both sides will strengthen exchange, coordination and cooperation on the principles of "mutual understanding, mutual respect, seeking common ground while reserving differences, equality and voluntariness, mutual benefit and reciprocity" and make joint efforts and contributions to globe-wise standardization of ICVs.

Both sides agree to make standardization cooperation an avenue for supporting and participating in the communication, exchange and cooperation of Chinese and German governments and industries on ICV technological development, demonstration operation, application promotion, innovation management, science education, etc., jointly promoting the technological advancement, industrial development and innovation management of ICVs worldwide, navigating global automotive industries towards an intelligent and connected trend, and building a safe, efficient, energy-saving and orderly ICV ecosystem.

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