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Study on Construction Status and Development Suggestions of Intelligent Connected Vehicle Test Area in China

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ABSTRACT

Intelligent connected vehicle is the key to the competition in the second half of the automotive industry reform As a key link before technical iteration and commercial application, the test, evaluation, and demonstration application of intelligent connected vehicles have been highly valued by the state and local governments This paper focuses on summarizing the construction of the intelligent connected vehicle test area zone in China, analyzing the construction progress and advanced achievements of the main test zone and pilot zone, and then summarizing the advanced achievements, studying and judging the problems existing in the development of the test area zone, and pushing forward target measures and suggestions to help The high quality development of the intelligent connected vehicle industry in China.

KEYWORDS

Intelligent connected vehicle; Test area; Measures and suggestions; High quality development

1. INTRODUCTION

The intelligent connected vehicle industry, as a key carrier for the integration of automobiles with energy, transportation, information and communication fields, has become a key direction for countries around the world to focus on [1]. China also attaches great importance to the development of the intelligent connected vehicle industry. The policy environment has been further optimized, the number of enterprises has been further increased, and the recognition of intelligent connected vehicles by users has been improved, comprehensively promoting the development of China's intelligent connected vehicle industry [2]. According to statistics, as of the end of 2023, the penetration rate of L2 level and above intelligent connected passenger vehicles in China has reached 41%, effectively promoting the commercial operation of intelligent connected technology. At the same time, in order to promote the demonstration and operation of higher-level intelligent connected technologies, China has further promoted the construction of open road testing and demonstration zones. A total of 16 national level testing demonstration zones for intelligent connected vehicles have been formed nationwide, providing a solid guarantee for the high-quality development of China's intelligent connected vehicle industry [3].

This article focuses on sorting out the regional layout of national level intelligent connected vehicle testing demonstration zones, and summarizes the current situation and development experience of core demonstration zones and four leading zones through research. At the same time, it analyzes the problems in the construction of intelligent connected vehicle demonstration zones, proposes targeted policy measures and suggestions, and helps to promote the high-quality construction and development of intelligent connected vehicle testing demonstration zones in China.

2. DEVELOPMENT OVERVIEW OF INTELLIGENT CONNECTED VEHICLE TESTING DEMONSTRATION ZONE

As of the end of 2022, the relevant national departments have cumulatively awarded 16 national level test demonstration zones (fields) for intelligent connected vehicles, as shown in Table 1. Among them, 9 were awarded licenses by the Ministry of Industry and Information Technology, 1 was jointly awarded licenses by the Ministry of Industry and Information Technology and the Ministry of Public Security, 3 were jointly awarded licenses by the Ministry of Industry and Information Technology and the Ministry of Transport, and 3 were awarded licenses by the Ministry of Transport; Four pilot areas have been awarded by the Ministry of Industry and Information Technology. In addition, in order to promote the coordinated development of smart city infrastructure and intelligent connected vehicles, the Ministry of Housing and Urban Rural Development and the Ministry of Industry and Information Technology approved a total of 16 cities in May and December 2021, including Beijing, Shanghai, Guangzhou, Wuhan, Changsha, Wuxi, Chongqing, Shenzhen, Xiamen, Nanjing, Jinan, Chengdu, Hefei, Cangzhou, Wuhu, and Zibo, as pilot cities for the coordinated development of smart city infrastructure and intelligent connected vehicles (hereinafter referred to as "double intelligent" cities) [4]. With the rapid development of China's intelligent connected vehicle industry, in order to further promote the development of the higher level autonomous vehicle industry and accelerate the commercial operation, the Ministry of Industry and Information Technology plans to further carry out the application work of "intelligent connected vehicle access and road access pilot" in 2022, enabling the industrial application of intelligent connected vehicles.

Table 1. Status of National Intelligent Connected Vehicle Testing Demonstration Zones

City	Name of testing demonstration area	Approval unit
Changchun City	National Intelligent Connected Vehicle Application (Northern) Demonstration Zone	Ministry of Industry and Information Technology
Beijing, Hebei Province	National Demonstration Zone for Intelligent Vehicles and Intelligent Transportation (Beijing Hebei)	Ministry of Industry and Information Technology
Beijing	Autonomous driving enclosed field testing base	Ministry of Transport
Tianjin City	Tianjin (Xiqing) National Leading Zone for Connected Vehicles	Ministry of Industry and Information Technology
Xi'an City	Autonomous Driving Closed Field Test Base (Xi'an)	Ministry of Transport
Wuxi City	Jiangsu (Wuxi) National Leading Zone for Connected Vehicles	Ministry of Industry and Information Technology
Wuxi City	National Intelligent Transportation Comprehensive Testing Base (Wuxi)	Ministry of Industry and Information Technology, Ministry of Public Security
taixing	Intelligent Connected Vehicle Autonomous Driving Closed Field Test Base (Taixing)	Ministry of Industry and Information Technology, Ministry of Transport
Shanghai City	National Intelligent Connected Vehicle (Shanghai) Pilot Demonstration Zone	Ministry of Industry and Information Technology
Shanghai City	Shanghai Lingang Intelligent Connected Vehicle Comprehensive Testing Demonstration Zone	Ministry of Industry and Information Technology, Ministry of Transport
Zhejiang Province	Zhejiang 5G Internet of Vehicles Application Demonstration Zone	Ministry of Industry and Information Technology
Wuhan City	National Intelligent Connected Vehicle (Wuhan) Test Demonstration Zone	Ministry of Industry and Information Technology
Xiangyang	Xiangyang City Intelligent Connected Vehicle Road Test Closed Test Field	Ministry of Industry and Information Technology, Ministry of Transport
Changsha City	National Intelligent Connected Vehicle (Changsha) Test Demonstration Zone	Ministry of Industry and Information Technology
Changsha City	Hunan (Changsha) National Leading Zone for Connected Vehicles	Ministry of Industry and Information Technology
Guangzhou City	Guangzhou Intelligent Connected Vehicles and Intelligent Transportation Application Demonstration Zone	Ministry of Industry and Information Technology
Chongqing City	National Intelligent Vehicle Integration System Test Area (i-VISTA)	Ministry of Industry and Information Technology
Chongqing City	Chongqing (Liangjiang New Area) National Leading Zone for Connected Vehicles	Ministry of Industry and Information Technology
Chongqing City	Autonomous Driving Closed Field Test Base (Chongqing)	Ministry of Transport
Chengdu	Sichuan Experimental Base for Sino German Cooperation in Intelligent Connected Vehicles and Connected Vehicles	Ministry of Industry and Information Technology

Local governments have deeply improved policies related to road testing of intelligent connected vehicles, accelerated the layout of testing scenarios, and as of the end of 2023, more than 30 provinces and cities have issued detailed rules for the management of road testing of intelligent connected vehicles. Among them, Shanghai, Hainan, Changsha, and Cangzhou have clearly defined the relevant content of highway testing, while Guangzhou and Changsha allow testing to be conducted without the driver, and have issued remote testing licenses to some enterprises. The relevant policies for intelligent connected vehicle testing demonstrations in major regions are shown in Table 2 [5].

Table 2. Policies related to the testing and demonstration of intelligent connected vehicles in major regions

region	Policy Name	Highway testing	Manned testing	Load testing
Shanghai	Shanghai Intelligent Connected Vehicle Testing and Application Management Measures	have	have	have
Qingdao	Implementation Rules for Road Testing and Demonstration Application Management of Intelligent Connected Vehicles in Qingdao City (Trial)	nothing	have	have
Beijing	Implementation Rules for Road Test Management of Autonomous Driving Vehicles in Beijing (Trial)	have	have	have
Shenzhen	Guiding Opinions of Shenzhen on Promoting the Demonstration of Intelligent Connected Vehicle Applications	nothing	have	have
Hainan	Management Measures for Road Testing and Demonstration Applications of Intelligent Vehicles in Hainan Province (Trial)	have	have	have
Changsha	Implementation Rules for Road Test Management of Intelligent Connected Vehicles in Changsha City (Trial)	have	have	have
Wuhan	Wuhan Intelligent Connected Vehicle Road Test Demonstration Application Management Measures (Trial)	nothing	have	have
Chongqing	Draft for Comments on Chongqing Autonomous Driving Road Test Management Measures	have	have	have
Yinchuan	Implementation Rules for Road Testing and Demonstration Application Management of Intelligent Connected Vehicles in Yinchuan City (Trial)	nothing	have	have
Guangzhou	Guiding Opinions on Road Testing of Intelligent Connected Vehicles	nothing	have	nothing
Henan Province	Henan Province Intelligent Connected Vehicle Road Test Management Measures (Trial)	nothing	have	have
Jiangsu Province	Jiangsu Province Intelligent Connected Vehicle Road Test Management Rules (Trial)	nothing	have	have
Chengdu	Implementation Rules for Chengdu Intelligent Connected Vehicle Road Test Management Specification	nothing	have	have

Local governments are deepening the testing and demonstration of intelligent connected vehicles, and regional competition is becoming increasingly fierce. At present, with national demonstration zones as the center, China has initially formed four major intelligent connected vehicle industry clusters: Beijing Tianjin Hebei, Yangtze River Delta, Chongqing Hunan Hubei, and Pearl River Delta. In order to further compete for testing scenarios, competition among different regions is becoming increasingly fierce. According to incomplete statistics, as of the end of 2023, more than 30 provinces and cities in China have opened over 4000 kilometers of testing roads, and over 60 national/provincial/municipal level intelligent networking demonstration zones/pilot zones/testing sites have been built, covering all first tier cities and some second tier cities, providing rich scenarios for testing. In addition, more than 80 enterprises have applied for nearly 800 road testing licenses, passenger and load testing permits, and the safety testing mileage has exceeded 10 million kilometers. Through intelligent connected testing and demonstration operations, drive the synchronous development of upstream supporting industry chains [6].

3. PROGRESS IN THE CONSTRUCTION OF MAIN INTELLIGENT CONNECTED VEHICLE TESTING AREAS

3.1. Jiangsu (Wuxi) Internet of Vehicles Pilot Zone

Wuxi started the construction of the C-V2X city level demonstration application project (Phase I) and the national intelligent transportation comprehensive testing base as early as 2018. In 2019, it received support from the Ministry of Industry and Information Technology and became China's first national level vehicle networking pilot zone. In 2021, it was also approved as a "dual intelligence" city, providing significant assistance for the construction of the pilot zone. By the end of 2021, the pilot area of the Internet of Vehicles in Jiangsu (Wuxi) has completed the intelligent transformation of 410 square kilometers and 796 points and sections, deployed more than 1200 sets of intelligent road network facilities such as roadside communication units, millimeter wave radars, edge computing equipment, and opened 177 kilometers of public test roads, including a variety of characteristic test areas such as typical road testing of intelligent connected vehicles, typical application testing of vehicle road collaboration, testing of special operation vehicles, ADAS testing based on the Internet of Vehicles, and testing of new intelligent roadside facilities. According to different positioning, the open testing roads in Binhu District and Economic Development Zone of Wuxi City mainly rely on the advantages of the Internet of Vehicles pilot zone and the national intelligent transportation comprehensive testing base to build intelligent connected vehicle open roads in the Internet of Vehicles environment; Xishan District is building a demonstration cluster area for the connected car industry around the Xidong connected car town; The open testing roads in Xinwu District are mainly aimed at special scenarios such as logistics and factory freight transportation.

Wuxi City focuses on top-level design support such as policies, and takes policies as the guide to promote the high-level construction of the pilot zone. In 2021, Wuxi City issued the "14th Five Year Plan for the Internet of Vehicles Industry in Wuxi City", which plans to achieve 100 Internet of Vehicles application scenarios and a penetration rate of 50% for Internet of Vehicles users by 2022; By the end of 2025, the core industry scale of Wuxi's Internet of Vehicles will exceed 80 billion yuan, achieving 200 application scenarios for Internet of Vehicles and a penetration rate of 80% for Internet of Vehicles users. At the same time, the "Implementation Rules for the Management of Road Testing and Demonstration Applications of Intelligent Connected Vehicles in Wuxi City (Trial)" will be further introduced to clarify the regulatory and legal issues faced by intelligent connected vehicles in areas such as license plate registration, road use, operation, traffic accidents, and insurance. At the standard level, Wuxi City has formulated a total of 24 relevant standards, accelerating the implementation of various testing methods and processes.

Based on a strong foundation in the automotive networking industry and testing, the upstream and downstream industrial chain of the automotive networking in Wuxi has been further improved, with more than 140 core automotive networking enterprises gathered, covering various links such as traditional vehicle components, intelligent terminals and chips, vehicle manufacturing, roadside equipment, vehicle road collaborative system integration, automotive networking platforms and services, and other industrial supporting facilities. In 2021, the industrial scale reached 26 billion yuan.

3.2. Tianjin (Xiqing) Connected Vehicle Pilot Zone

The Tianjin (Xiqing) Internet of Vehicles Pilot Zone was approved in December 2019 and has achieved significant results in infrastructure deployment, demonstration application of Internet of Vehicles, and promotion of industry standards. It has also rapidly promoted the exploration of Internet of Vehicles technology and gradually implemented it. As of the end of 2023, the pilot zone has completed the intelligent transformation and upgrading of more than 350 intersections, achieving the digitization of traffic signals. At the same time, in combination with future smart transportation forms, more than 100 vehicle to road application scenarios have been developed and vehicle to road collaborative application software has been launched, achieving a deep correlation between vehicle to road applications, infrastructure, and convenient services. In addition, the Tianjin (Xiqing) Internet of Vehicles Pilot Zone has established the first multi pillar testing and verification system in China. Based on "virtual simulation", "closed field", and "open road" testing and verification, a digital twin hybrid verification system has been proposed, further promoting the empowerment of intelligent vehicles to smart cities and smart transportation. Among them, the digital twin hybrid verification system can support the government in intelligent traffic monitoring and management, assist in efficient smart teaching and new engineering construction, and serve enterprises in vehicle networking technology research and visual display. It has served enterprises more than 200 times in total.

The Tianjin (Xiqing) Leading Zone for Connected Vehicles has deeply promoted the formulation of related standards for connected vehicles, relying on the National Automobile Standardization Committee to participate in the development of national standards for intelligent connected vehicles. In 2021, participating in standard projects, 6 national standards have been released, 12 national standards have been submitted for approval, supporting the development of 15 international standards. At the same time, it has promoted the integration and development of a series of standards by multiple standards committees including the Automobile Standards Committee, ITS Standards Committee, Communication Standards Committee, Transportation Standards Committee, and Confidential Standards Committee, achieving the interconnection and sharing of industry chain technologies related to the Internet of Vehicles.

The Tianjin (Xiqing) Internet of Vehicles Pilot Zone has established the first vehicle road collaborative natural scene data system in China. In order to meet the needs of vehicle active safety control and road collaborative management for multi-modal data processing, information fusion, and real-time information interaction between vehicles and vehicles, the pilot zone has built a vehicle road collaborative natural scene data system based on high-precision, fully digital, and full lifecycle roadside spatiotemporal environment collection and processing, to support the development and large-scale deployment of vehicle road collaborative systems. At present, the database covers 80 types of road traffic environment data under different meteorological conditions and lighting time periods, over 200 types of vehicle driving behavior data in different road traffic environments, and 100 types of data on the behavior of different vulnerable traffic participants. The accumulation of data is basically at a global leading level, which will also play a great role in promoting the research and development of V2X communication functions.

3.3. Hunan (Changsha) Internet of Vehicles Pilot Zone

The Hunan (Changsha) Internet of Vehicles Pilot Zone began planning and construction in June 2016, with a planned area of about 15 square kilometers and a total investment of about 1.896 billion yuan. It is divided into five main functional zones: management research and development and debugging zone, off-road testing zone, highway testing zone, rural road testing zone, and urban road testing zone. There are 228 intelligent connected vehicle testing scenarios in the testing area, with the most simulation scenario types, leading comprehensive performance, excellent testing service matching, wide 5G coverage, and the ability to support closed intelligent connected vehicle function research and development testing for different application scenarios. At present, the demonstration zone has built about 100 kilometers of smart highways and 157 kilometers of smart city roads based on "C-V2X+5G", and has created the first intelligent public transportation demonstration line in the country to achieve 7.8 kilometers of L3 level autonomous driving in an open urban road environment through vehicle road cloud collaboration. It has built 35000 5G base stations and successfully transformed the first mover advantage into an industrial advantage.

The pilot zone has established a relatively complete road traffic scene and infrastructure, which can meet the testing needs of different types of autonomous driving functions. Among them, the testing field includes 22 security related scenarios, 3 efficiency related scenarios, 3 information service related scenarios, 14 communication related V2V scenarios, and 14 V2I scenarios. It has a rich range of network related testing scenarios and functions, which can meet the testing needs of multiple types of autonomous vehicles.

3.4. Chongqing (Liangjiang New Area) Pilot Zone for Connected Vehicles

The Chongqing (Liangjiang New Area) Connected Vehicle Pilot Zone was approved in January 2021 and is the fourth national level connected vehicle pilot zone in China and the first in the western region. At present, the pilot zone project involves an area of 580 square kilometers, and has built 128 kilometers of bidirectional demonstration roads on highways, nearly 100 kilometers of urban demonstration roads, and industrial park demonstration roads. It has achieved more than 30 types of vehicle networking applications such as signal light green wave traffic, pedestrian crossing detection, and unmanned sanitation cleaning.

The pilot zone will deeply implement national technical standards for new energy and intelligent connected vehicles, strengthen research on technical standards for roadside equipment, battery swapping equipment, intelligent vehicle control systems, OTA software upgrades, explore the integration technology of ETC and C-V2X, promote cross platform application development, take the lead in issuing technical guidelines for the construction of vehicle road collaborative infrastructure in the city, and actively participate in the construction of national standards for new energy and intelligent connected vehicles. At present, the pilot area has completed the infrastructure construction of a bidirectional 128 kilometer expressway in the Fufeng section of the G5021 Shiyu Expressway, as well as 88 kilometers of urban roads in the Lijia area, Collaborative Innovation Zone, Xiantao Data Valley, etc., taking into account the complex road traffic characteristics of mountain roads, overpasses, tunnels and other environments. More than 500 sets of RSU roadside equipment have been installed.

4. PROBLEMS IN THE INTELLIGENT CONNECTED VEHICLE TESTING DEMONSTRATION ZONE

4.1. Inconsistent Testing Procedures and Barriers to Collaborative Mutual Recognition

Various types of intelligent connected vehicle demonstration zones lack unified standards and testing processes in terms of site construction, data collection, testing standards, equipment construction

specifications, etc. Most of the local areas operate independently and establish one-on-one cooperation with enterprises or institutions through strategic cooperation frameworks. Most testing zones have not achieved mutual recognition and trust of test results. In addition, the management agencies of the testing area have different levels of understanding of the testing procedures, and the regulatory requirements of the competent authorities are inconsistent, resulting in inconsistent testing procedures and standards for various types of intelligent connected vehicle testing areas, leading to barriers to collaborative mutual recognition. As a result, enterprises applying for testing licenses in different locations still need local third-party testing agencies to provide closed testing scenario testing reports, increasing the burden on testing subjects.

4.2. Inconsistent Construction Standards and Uneven Levels of Demonstration Zone Construction

There are significant differences in the construction plans and investment levels of each testing demonstration zone. Although some institutions have also formulated design technical requirements for intelligent connected vehicle testing sites, it is still necessary to quickly introduce the minimum requirements for site construction and traffic scene construction. At the same time, it is necessary to standardize traffic engineering facilities such as signal lights and signs and markings, so as to keep the closed testing site as consistent as possible with the actual road environment, in order to reduce unnecessary debugging work during enterprise testing. In addition, for key scenarios such as highways, urban roads, ramps, tunnels, and S-bends, due to site limitations, some sites do not yet have highway scenes, and there are relatively few closed testing sites that can be integrated into specific road sections for testing on ramps, tunnels, and S-bends.

4.3. High investment and Operation Costs Lead to Difficulties in Profitability for Operating Entities

The construction of intelligent connected vehicle demonstration zones mainly involves two approaches: new construction and renovation of old sites, both of which require investment in land, buildings, equipment, systems, and other aspects, and are costly. The National Intelligent Connected Vehicle (Changsha) Demonstration Zone covers an area of 1232 acres, with a total initial construction investment of 1.896 billion yuan; The Sino German Intelligent Connected Vehicle Sichuan Test Base is expected to have an investment of 3.5 billion yuan; The first phase of the planning for the Integrated Test Site of Intelligent Connected Vehicles (East China) covers an area of 10000 acres, with an investment of 1 billion yuan excluding land. This poses high requirements for both the investment subject and local finance, and also poses significant challenges to the long-term development of the demonstration zone. From the construction and use of testing sites in various demonstration areas, it can be seen that there is severe functional overlap, significant homogenization competition, unclear business models, and poor self generating ability of operating entities, leading to difficulties in profitability.

5. SUGGESTIONS FOR THE CONSTRUCTION OF INTELLIGENT CONNECTED VEHICLE TESTING DEMONSTRATION ZONES

5.1. Accelerate the Development of Testing and Evaluation Standards, and Continuously Promote Mutual Recognition of Test Results

Guided by the Guidelines for the Construction of the National Connected Vehicle Industry Standard System (Intelligent Connected Vehicles), we will actively leverage the role of the National Automotive Standards Committee's Intelligent Connected Vehicle Sub committee and the China Intelligent Connected Vehicle Industry Innovation Alliance. We will leverage the complementary and coordinated advantages of government led national and industry standards with market led group

standards, increase effective supply of standards, accelerate the research and development of urgently needed different levels of standard specifications for intelligent connected vehicle autonomous driving function testing, testing site construction specifications, testing scenarios, and data specifications, and guide the actual testing and verification work in various testing demonstration areas. We will promote the sharing and mutual recognition of test results through a combination of basic exemption items and special addition items, laying a foundation for the collaboration and sharing of test data.

5.2. Accelerate the Overall Supervision of Testing and Evaluation, and Promote the Evaluation of Testing Site Level

Establish an evaluation mechanism and system for the testing and demonstration of intelligent connected vehicles, and regularly evaluate the indicators of closed testing, park demonstration, urban area testing environment, and public road testing and demonstration work in various demonstration areas in China. Evaluate and identify the testing process and methods, provide guidance and improvement measures for testing demonstration areas with substandard testing capabilities, unify the management and assessment of data in each testing demonstration area, and strictly control testing standards and behaviors.

5.3. Establishing an International Exchange and Communication Mechanism to Promote International Collaborative Testing Demonstrations

Intelligent connected vehicles are an important industry for international collaborative development. Each testing demonstration zone should fully understand the testing needs of domestic and foreign testing subjects, strengthen information exchange and experience sharing, build characteristic testing scenarios based on geographical environment and climate, create testing characteristics according to its own positioning and core carrying capacity, explore differentiated testing scenarios, avoid functional overlap and resource waste, promote the improvement of comprehensive testing service level, support the realization of market-oriented operation, and promote the sustained and healthy operation of testing demonstration zones. Make full use of development opportunities such as Xiong'an New Area and smart town construction, and focus on promoting large-scale and urban level intelligent connected vehicle testing and demonstration. Taking the cooperation between China and Germany as an opportunity, research and explore cross-border testing and demonstration projects, conduct analysis of the impact of large-scale testing and demonstration on transportation and safety, and lay the foundation for the commercial promotion and application of intelligent connected vehicles.

6. SUMMARY

This article focuses on analyzing the construction and layout of intelligent connected vehicle testing demonstration zones in China, and analyzes the current situation and progress of the construction of core national level intelligent connected vehicle demonstration zones and vehicle networking pilot zones. It evaluates the advanced experience and development problems of various demonstration zones and proposes targeted policy measures to help China's intelligent connected vehicle testing demonstration zones achieve high-level and high standard construction.

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