

Analysis on current situation of China's intelligent connected vehicle road test regulations

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Abstract. This paper first elaborated the technological development status of the intelligent connected vehicles (ICVs) and sorted out the “intelligent connected vehicle road test management regulations” jointly formulated by the Ministry of Industry and Information Technology (MIIT), the Ministry of Public Security and the Ministry of Transport, and related regulations for major cities in China. The domestic is compare with foreign ICVs road test status and policy. The differences between the national regulation and municipal regulations for the test subjects, test drivers and test vehicles are analysed and enumerated. By comparing the domestic and international road test regulations, it is concluded that the safety is the prerequisite of vehicle road test. It is compulsory to conduct the closed field testing before conducting public road tests.

1 INTRODUCTION

The Chinese government attaches great importance to the development of the intelligent connected automobile industry. “China Manufacturing 2025” has listed the smart Intelligent and Connected Vehicle (ICV) as one of the ten key development areas, and clearly promoted the development of the smart intelligent Connected Vehicle to the national strategic height as a standard of market behaviour, leading the foundation for the healthy development of automobile industry. With the maturity of domestic intelligent connected technology and the rapid expansion of market scale, the development of ICV has become the primary issue that the government needs to face. In the past two years, all circles of industry, academia and research institutes and governments have focused on this new technology and sought breakthroughs from all aspects, including research and development of new technologies, improvement of the top-level design of intelligent network- connected technologies, and development of related policies and standards

According to the road map for energy-saving and new energy vehicles issued by the Chinese Society of Automotive Engineers, intelligent and connected vehicles has been clearly defined. Intelligent and Connected Vehicles are equipped with advanced onboard sensors, controllers, actuators and other devices, and the integration of modern communications and network technology, to achieve intelligent information exchange and sharing between vehicle and X (cars, roads, people, clouds, etc.), with complex environmental awareness, intelligent decision-making, collaborative control and other functions, can achieve safety, high-efficiency,

comfort, energy saving driving, and finally realize a new generation of cars to replace people to operate [1]. Intelligent Connected Vehicle can provide safer, more energy-efficient, environmentally friendly, and more convenient travel modes and integrated solutions, which is an internationally recognized future development direction and focus of attention [2]. Road testing is an indispensable link in the development and application of intelligent connected vehicle technology. The autopilot function requires a large amount of tests and verifications, and must be fully tested in a real traffic environment before it is officially introduced to the market.

2 Intelligent connected vehicle industry technology overview

According to the National Intelligent Connected Technology Roadmap for Automotive Technologies, the market share of vehicles with driving assistance (DA) and partial autopilot (PA) in China will be about 50% from 2015 to 2020; the occupancy of DA and PA vehicles will be maintained from 2020 to 2025. The percentage of stable, highly automated (HA) vehicles is about 15%; by 2025-2030, the market share of fully automated (FA) vehicles is close to 10%. Through “three horizontal and two longitudinal”, we realize the vision of safety, efficiency, energy saving, emission reduction, comfort, convenience and humanity. [1]

The “three horizontal and two vertical” technical architecture not only summarizes the key technical conditions of the intelligent networked vehicle itself, but also describes the external infrastructure of the vehicle and the vehicle platform, as shown in Figure 1.

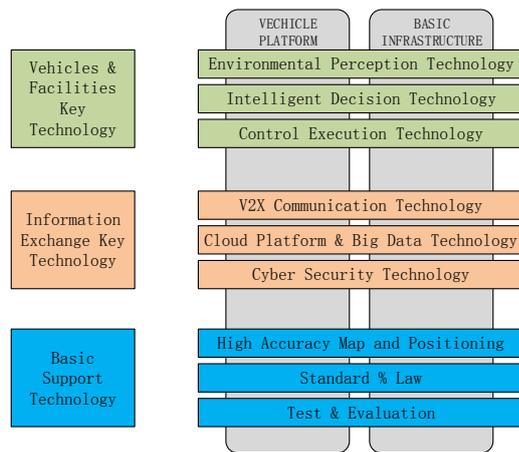


Figure 1. Three horizontal and two vertical technical architecture.

The environment-aware system uses vehicle sensors to detect and calculate the vehicle environment, which mainly consists of machine vision recognition system, radar system, ultrasonic sensors and infrared sensors. Machine vision has a wide range of detection and large information capacity, but it has a large amount of data to process and is widely used in the research field of intelligent vehicles. The millimeter wave radar system can obtain the target distance, speed, azimuth, etc., and the operation is in good performance of real-time, and the measurement range is far. However, there is no concrete and accurate description of the appearance of the detected object. The laser radar can just make up for the insufficiency of the millimeter-wave radar. The measurement accuracy is high and the speed range is high, but the measurement distance is relatively short. In addition, the cost of laser radar in the market is high, especially multi-line laser radar. In order to maximize the advantages of various types of sensors and cost reduction, many R&D institutions use sensor fusion solutions. For instance, HESAITECH and BAIDU Apollo released a "Lidar + camera" integrated sensor can provide multi-sensor fusion and perception algorithms, and finally in the form of sensor fusion suite (shown in Figure 2).



Figure 2. The effect of sensors fusion.

The intelligent decision system makes use of the sensor's traffic environment and high-precision maps and positioning systems to make decisions on the vehicle's driving path and vehicle movement posture. Currently used decision-making methods include state machines, decision trees, deep learning and enhanced learning [3-5]. The control execution system is responsible for executing

the instructions of the intelligent decision system, acting on the vehicle power, braking and steering systems to follow the planned paths. At present, the main control system technologies include PID control (proportion-integral-derivative), sliding mode control, fuzzy control, model predictive control, adaptive control, and robust control.

The vehicle-mounted communication technology will adopt LTE-V2X technology in the future. Compared with the traditional V2X technology, LTE-V2X has a wider propagation distance, shorter delay, and greater communication capacity on the one hand, especially the reliability of multi-vehicle communication in high-density scenarios has been greatly improved, solving the problem of the limited capacity of multi-vehicle scenarios in the traditional way. On the other hand, LTE-V2X is able to freely connect to the Internet anywhere and anytime with the help of an optimized mobile broadband network. On the other hand, LTE-V2X is able to freely connect to the Internet anywhere and anytime with the help of an optimized mobile broadband network, and to provide cloud network collaborative data capabilities and implement applications such as traffic monitoring, remote alarms, and information push. Currently, many automotive industries have carried out extensive vehicle networking (LTE-V2X) test validation to promote the maturity of technology and rapid development of the industry.

In addition, automotive information security systems have become an important area of development for the automotive industry. Traditional vehicle information framework is generally divided into body control system, entertainment information systems, powertrain and chassis safety systems. The high-speed CAN network is used for the powertrain and chassis safety system, the medium-speed CAN network is used for the body control and entertainment information system, and MOST network with higher communication speed is used in the entertainment system of some in-vehicle networks. Some intelligent execution modules use low-speed LIN network connection, High-speed CAN and medium-speed CAN network communicate through the gateway. Traditional vehicle information system is relatively closed, which does not need to ensure the security of information technology to ensure the reliability of vehicle network systems [10].

The port of the vehicle information can be divided into three parts according to the functional classification. The first part is the basic control function of the vehicle, including the power control, steering control and energy control of the vehicle. The second part of the auxiliary driving function of the vehicle, which is the future of intelligent vehicles, the most important part of the intelligent driving class with the development of the vehicle content and constantly expand the content of the current industry generally recognized intelligent driving vehicle grading using the United States the SAE classification method is classified into six grades. The third part of the vehicle infotainment function, consumers, especially Asian consumers believe that Internet entertainment is the basic function of the car, smart phones and wearable equipment can be perfectly

integrated with the car, the current specific products such as music downloads, restaurant recommendations and other functions; The car will serve as a mobile WI-FI hotspot. The fourth part is the V2X function part, which is the main function of the intelligent network vehicle. It is mainly used to realize the mutual communication between vehicles (V2V), vehicle and transportation infrastructure (V2I) communication and vehicle cloud communication (V2C) [11].

3 Typeset text the status of foreign intelligent network road testing in foreign countries

3.1 United states of america

The U.S. Federal Government has issued policy documents such as the Autopilot Car Policy Guide and Automated Driving System 2.0: Security Vision. The House of Representatives has also passed the Automated Driving Act; more than a dozen U.S. states have opened public road tests, such as California, which has begun to allow driverless tests on public road. As of the end of 2017, Washington, DC, and 21 states have passed legislation on autonomous vehicles. At present, the two largest piloted demonstration areas in the United States are located in Detroit in the east and Silicon Valley in the west. The M-City is the world's first area for intelligent vehicles and V2X vehicles test.

3.2 Europe union countries

In 2014, the European Union launched a "Adaptive" (smart vehicle automated driving application and technology) project with more than a dozen automobile manufacturers and parts suppliers in Europe, aiming to develop partial or complete driving on urban roads and highways. The European Union has issued a series of policies and a self-driving roadmap to promote the research, development, and application of intelligent connected vehicles, and to guide the development of the intelligent connected automotive industry in member countries. Germany amends current road traffic laws and regulations to allow highly autonomous or fully automated driving systems to replace autonomous driving by humans and has specifically developed test sections on highways. In May 2017, Sweden issued a decree on the testing of self-driving cars, which is reviewed and conditionally granted by the Swedish Transport Agency.

3.3 Japan

The Japanese government has actively played an inter-departmental synergy to promote the implementation of the intelligent connected vehicle project. In May 2016, Japan's IT comprehensive strategy headquarters established the road map for autonomous driving, which will allow unmanned passenger vehicles to be used in some areas in 2020. In the same period, the Japanese National Police Agency issued the Guidelines for Road

Testing of Self-driving Vehicles. It also initiated the revision of the "Road Traffic Law" and "Road Transport Vehicles Law". In April 2017, the government concluded motor traffic accidents during autopilot as a target for auto insurance. In June 2017, the Japanese Police Agency issued the "Standard for Processing Permissions for Road Test of a Remote Autopilot System" to allow vehicles to perform on-the-spot tests while driving without a driver.

3.4 United nations

In March 2016, the United Nations also formally revised the "Convention on Road Traffic in Vienna" to allow automatic driving technology to be used in transportation, and it has also swiftly established technical regulations related to autonomous driving technology. Singapore set up a self-driving car motion committee to supervise the research and testing of self-driving cars. In early 2017, Singapore's automated driving shuttle bus service started operations. At the end of 2017, an automated driving test route was opened to allow self-driving cars to carry out public road tests within the permitted range.

4 Sections analysis of china's icv road test policie

This year, the Ministry of Industry and Information Technology, the Ministry of Public Security, and the Ministry of Transport jointly issued the "Intelligent Networked Vehicle Road Test Management Regulations (Trial)", in which make a series of requirements on test applications, audits and test management subjects, test drivers and test vehicles. Before this, Beijing, Shanghai, Shenzhen, Chongqing and other places have successively issued guidance documents for ICVs on-the-road testing. Subsequently, Changsha and Changchun cities have also issued ICVs road test management regulatory documents.

4.1 Test management agencies and responsibilities

In the national policy, it is defined that the provinces, autonomous regions, municipalities directly under the Central Government and separately listed cities, the Xinjiang Industry and Construction Corps' industrial and informatization administrative departments, the public security traffic management departments and the transportation and transportation departments as the management department.

In cities that have already issued road test management methods, the local municipal Economic and Credit Commission, the Municipal Public Security Bureau, and the Municipal Communications Bureau have established relevant working groups. For instance, Shanghai and Chongqing established the advancing working group, and Beijing, Changsha, Chongqing and Shenzhen established joint working group. Although the names are different, the nature and duties of the working group are basically the same.

The basic responsibilities of the working group are as follows

1. Review the company's test application
2. Issuing test notices
3. Organize relevant assessment work
4. Matters related to the implementation of the coordination method

The responsibilities of expert Committee are to regularly convene an expert group review meeting to demonstrate the road test application submitted by the test subject and finally provide an expert group opinion.

The third-party institute is responsible for the whole process supervision and closed testing of intelligent networked automotive, including application acceptance, material review, test tracking, data collection and analysis, and supervision and management of testing. Third-party agencies are the specific implementing agencies of the regulatory agencies, but not all cities have yet identified specific units.

4.2 Requirements of test subjects, test drivers and test vehicle

4.2.1 Test subjects:

In the national management specification, the seven point requirements are put forward for the test unit's unit character, business scope, accident compensation ability, test evaluation ability, remote monitoring ability, event record analysis ability and compliance with laws and regulations, as shown below:

- Independent legal entity registered in the territory of the People's Republic of China.
- Competence of intelligent ICV-related businesses, such as automobile and parts manufacturing, technology research and development, or testing and inspecting.
- Sufficient civil compensation ability for the loss of personal and property that may be caused during the test of the intelligent networked car.
- Having intelligent network connected auto driving function test evaluation procedures.
- Ability to perform real-time remote monitoring of test vehicles.
- Ability to record, analyze, and reproduce test vehicle events.
- Other provisions stipulated by laws, regulations and rules [12-16]

The requirements of test subjects in these six cities' local management methods are different from those in the national management standards. The management methods in Shanghai and Changchun directly refer to the national regulations. See the Table I below.

Table 1. Table captions should be placed above the table.

City	Requirement
Shanghai	Same as national regulations
Beijing	Only make explicit requirements for the nature of the independent legal entity of the test subject; at the same time, the test subject is required to promise to install the supervision device and accept the daily supervision of the third-party authorized

City	Requirement
	institution.
Shenzhen	There are only three requirements for the test subjects. Their requirements are the same as those of the State's "Management Regulations," and their expressions are slightly different.
Changsha	On the basis of the seven articles of the "Regulations for Management" of the country, an article was added to the test subject "Need to purchase a certain amount of production safety liability insurance."
Changchun	Same as national regulations
Chongqing	There is only one requirement on drive subject that test subject is a complete vehicle company, a modified vehicle manufacturer, a parts and components company, an electronic information enterprise, a research institute/college, a transportation company, or other technology-based enterprise that has autonomous driving technology and product development or production capabilities.

4.2.2 Test driver and test vehicles:

Test driver and test vehicles: the test drivers should sign labor contracts or service contracts, pass autopilot training, no major traffic violation records, etc. The test vehicles should be registered and pass mandatory inspection, and the vehicle should have man-machine control mode conversion and data recording function.

Table 2. The difference of requirements on test driver and vehicles of 6 cities.

City	Requirement
Shanghai	1. There is no clear requirement for signing labor contracts with test subjects 2. Add the requirement that test driver's experience in autopilot system operation with more than 50 hours, of which more than 40 hours apply for the test project's driving experience
Beijing	Comparing with national management regulations, add the requirement that the test driver should take over the test vehicle under dangerous scene conditions operating time more than 50 hours
Shenzhen	The test driver should meet basic requirements" without clear rules
Changsha	Same as national regulations
Changchun	There are two major differences with respect to the national regulations for management. The following requirements are added: 1. Severe traffic violations such as non-driving passenger vehicles over the past year 2. Testing the driver's operation of more than 50 hours of smart network system certification (should include more than 40 hours specified smart network connected car test scenarios driving example)
Chongqing	There are two major differences with respect to the national regulations for management. The following requirements are added: 1. The test driver shall undergo professional training in road testing for not less than 50 hours, including professional training for

City	Requirement
	taking over test vehicle control in dangerous scenarios, where the driving management training time for the requested test function is not less than 40 hours. 2. Test drivers must fully understand the automatic test vehicle performance and test driving requirements

In the requirements for test vehicles, test safety is regarded as the primary requirement in both national and local test management regulations. It is mainly reflected in the fact that the test vehicle must meet mandatory inspection project requirements, and it must not reduce vehicle safety performance. Furthermore, it must have manual operation and autopilot modes, which must be ensured that the driver can immediately switch the manual mode in dangerous situations. In addition, in order to ensure the safety of public road tests, Shanghai, Beijing and Changsha also require that vehicles be equipped with devices that provide reminder functions. When an autopilot system fails to act, the device should immediately remind the test driver to take over the vehicle.

Another important requirement is that the test vehicle must have monitoring equipment installed to monitor the vehicle status and to store records. This requirement is the same as the national regulation in the specifications of the three cities of Changchun, Changsha and Shanghai. The stored data includes the vehicle control mode, vehicle position, and vehicle motion status, so that accident analysis and processing can be performed in the event of a traffic accident.

4.3 Test application and audit requirements

In order to strengthen the normative participation in the road testing enterprise's behavior, the national and local management requirements separately request the company to apply for the testing process, mainly to request the integrity of the application materials. According to the specifications of the test subjects, test vehicles and test drivers, it is required to submit a series of materials to prove the technical ability, security and responsibility of test subjects and vehicles. In terms of technical capabilities, companies need to provide certification materials for test subjects who had carried out actual vehicle tests in certain areas such as closed roads and venues, and the test reports of autopilot functions issued by third-party test agencies that are recognized by the national or provincial authorities for conducting automotive-related business. Test programs including test road sections, test times, test items, test procedures, risk analysis, and response measures are also needed.

4.4 Test Management Requirements

In order to strengthen the road traffic management and safety supervision during the testing process, the "Management Rules" also put forward requirements for the test parties to carry notifications, apparent target

indications, takeover operation, vehicle transitions, and reporting test summaries during the testing process. Furthermore, the situation of provincial and municipal government should cancel the test notice and recall the temporary number plate is defined.

5 Summary

Intelligent connected vehicles (ICVs) can provide safer, more energy-efficient, environmentally friendly, and more comfortable travel modes and integrated solutions. They are an important part of the urban intelligent transportation system and a core element in building a green car society. Its significance lies not only in the upgrading of automotive products and technologies, but also in the reshaping of the entire industry and value chain system in automobiles and related industries. The implementation of intelligent network-linked public road testing will help China's intelligent network-linked automotive technology upgrade and product promotion. By comparing and analyzing domestic and foreign road test regulations, the OEMs should conduct abundant of closed field test before conducting public road test. Furthermore, the OEMs should also have the capability of assuring the safety of vulnerable group and compensation capacity when traffic accidents happen. This paper provides a brief description of current technology status and policy of intelligent connected vehicles, and analyzed and compared the public road test regulations of six major cities in China, aiming at promoting the comprehensive technology capability of ICVs and leading to the right direction of development of ICVs in China.

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