Analysis of the Influence of Internet of Vehicles on Driverless Technology

Yunlong Bai[1, a], Kaixin Yang[1, b], Xiaowei Chen[1, c], Jinwei Guo[1, d] and Haibo Dong[1, e]
[1]*Automotive Data CenterChina Automotive Technology&Research Center Co. Ltd, Tianjin 300000, China*

Keywords: Internet of vehicles, automatic driving, V2X.

Abstract: The Internet of vehicles technology is derived from the Internet of things, which is based on the in-vehicle network, the inter-vehicle network and the vehicle-mounted mobile Internet, wireless communication and information exchange are conducted in the car and X (X: car, road, pedestrian and internet, etc.), according to the agreed communication protocol and data interaction standards. Internet of vehicles technology can realize intelligent traffic management, intelligent dynamic information service and intelligent vehicle control, which is a typical application of Internet of things technology in the field of transportation system. With the development and promotion of communication technology and Internet of vehicles, the future development of driverless technology is very worth looking forward to. V2X technology, which is indispensable for driverless driving and smart transportation, has gradually become the research key point of Internet of vehicles technology, as a specific application of the Internet of things, V2X technology can play a great role in driverless vehicles. With the continuous development of technology, V2X technology has also been developed rapidly in China. This paper introduces the key technologies and technical standards of V2X, summarizes and forecasts the application of V2X technology in driverless technology.

1 INTRODUCTION

Internet of vehicles is the network connection between vehicles and vehicles, vehicles and roads, vehicles and people, vehicles and service platforms through information and communication technology, which can improve the intelligent level and automatic driving ability of vehicles. The Internet of vehicles is typical application of Internet of things in automobile field (Li Feng, Fang Jiayu, Zhao Li, 2016); its core is V2X wireless communication technology, including dedicated short range communication (DSRC), 5G-V2X, LTE-V2X and so on. With the help of V2X wireless communication technology, the technical bottleneck of the automobile in intelligent development and automatic driving function can be broken through. At present, the international mature V2X wireless communication technology has two technical routes; one is DSRC technology based on IEEE 802.11p, the other is V2X wireless communication technology based on LTE (LTE-V2X) (Liu Fuqiang, Xiang Xueqin, Qiu Dong, 2007; Chen Qianbin, Chai Rong, Cen Ming, 2015; Cheng Gang, Guo Da, 2011). There are some shortcomings in the Internet of vehicles technology based on DSRC, the Internet of vehicles technology based on 4G network can provide faster transmission rate and has a good promotion effect on the development of automatic driving (Li Zhongdong, 2014).

2 COMMUNICATION TECHNOLOGY OF INTERNET OF VEHICLES

2.1 Internet of Vehicles Technology Based on DSRC

The DSRC consists of the physical layer standard IEEE 802.11P and the network layer standard IEEE1609. On this basis, Society of Automotive Engineers (SAE) issued the SAE J2735 and SAE J2945 standards and regulated the information content and structure. The DSRC system includes Onboard Unit (OBU) and Road Side Unit (RSU), the two provide two-way transmission of information, and the RSU transmits traffic information to the back-

Bai, Y., Yang, K., Chen, X., Guo, J. and Dong, H.
Analysis of the Influence of Internet of Vehicles on Driverless Technology.
DOI: 10.5220/0009397701280133
In *Proceedings of 5th International Conference on Vehicle, Mechanical and Electrical Engineering (ICVMEE 2019)*, pages 128-133
ISBN: 978-989-758-412-1

end platform (Wang Jianbiao, 2013). The advantages of DSRC technology are high reliability and strong real-time transmission, however, since the physical layer technology of DSRC is the same as the WiFi commonly used in people's lives, the communication distance advantage is not obvious, the coverage distance is short, and large-scale renovation and investment in roadside facilities is required in practical applications (Zhao Jing, 2018).

2.2 Internet of Vehicles Technology Based on LTE

LTE-V2X is based on LTE technology, which is divided into LTE-V-Cell and LTE-V-Direct. The former uses existing spectrum and base station for cellular communication, while the latter AS Ad hoc network is used for V2X communication in small scale. The LTE-V2X can reuse existing cellular infrastructure and spectrum, and operators do not need to deploy dedicated RSU and provide dedicated spectrum (Xu Zijian, Yu Mei, 2016). LTE-V2X mainly solves the problem of shared sensing among traffic entities, it can expand the vehicle-mounted detection system from tens of meters to hundreds of meters or more, and improves effectiveness of AI, and achieves assisted driving in relatively simple traffic scenarios. In comparison, DSRC technology has first-mover advantage, long verification time and more mature technology, and keeps one step ahead in network security. The advantage of LTE-V2X is that it does not require new roadside facilities, its cost is lower, and network covers longer distances, and can smoothly evolve to 5G.

3 DEVELOPMENT HISTORY OF V2X TECHNOLOGY

In 1986, experts from scientific research institutions, transportation bureaus, etc. discussed the future traffic regulations and believed that the future transportation system must simultaneously ensure safety, solve congestion and protect the environment. In 1990, in Texas, the discussion on this issue reached a climax, participants proposed the concept of IVHS, namely intelligent vehicle and highway system, later, and it evolved into the intelligent transportation system ITS. In 1991, the ITS concept became part of the Intermodal Surface Transportation Efficiency Act (ISTEA). In addition, ISTEA has invested $6.6 billion in research and testing of ITS systems for the next six years.

In 1992, the US Department of Transportation (USDOT) launched the Automated Highway System in the ITS research to liberate the driver's hands and feet, the vehicle needs to travel on a road with magnetic nails, this is the first time in history that the interconnection of vehicles and highways has been achieved. After the Automated Highway System test, the USDOT launched the Intelligent Vehicle Initiative in 1997 to accelerate the deployment of anti-collision systems. Based on the smart vehicle program, USDOT puts forward new demands on improving traffic congestion and electronic communication technology. At the 10th ITS World Congress in Madrid in December 2003, USDOT announced distribute 75MHz spectrum at 5.9GHz for DSRC research, and proposed the VII project, the goal of the project is to apply V2V and V2I technologies in a small range. In December 2006, USDOT and the five major automakers jointly tested the role of V2V and V2I in anti-collision systems and established new communication-based safety facilities, including roadside networks and on-board vehicle equipment. Only when there are enough vehicles on the road to support V2V communication, the role of V2V can be fully reflected. To this end, in August 2014, NHTSA and USDOT proposed the FMVSS No. 150 Act; this act mandated that new light vehicles support V2V communication.

The generation of DSRC technology is based on three standards: the first is IEEE 1609, which defines the architecture and flow of the network, the second is SAE J2735 and SAE J2945, which define the information carried in the message packet, these data include information from sensors on the car, such as location, direction of travel, speed and brake information, the third standard is IEEE 802.11p, which defines the physical standards for DSRC. The DSRC top-level protocol stack is developed based on the IEEE 1609 standard, the V2V information exchange uses the WAVE Short Message Protocol instead of WIFI; and the TCP/IP protocol are used for V2I and V2N information interaction. The DSRC underlying layer, physical layer, and radio link control are based on IEEE 802.11p. The IEEE 802.11 standards use the WIFI ecosystem, but WIFI was originally designed for fixed communication equipment, and later IEEE 802.11p supported mobile communication devices.

With the development of cellular communication technology, the role of cellular communication is becoming more and more important; at present, cellular communication technology has changed from simply transmitting sound to transmitting audio and data, changes from person-to-person to machine-to-machine, V2X technology is an application of machine-to-machine transformation. C-V2X is a V2X technology based on cellular communication, which is defined by 3GPP (3rd Generation Partnership Project), it includes LTE-based and future 5G V2X systems, and it is a powerful complement to DSRC technology. It uses the existing LTE network facilities to realize information interaction of V2V, V2N, V2I, the most attractive features of this technology are: it can keep up with the changes, adapt to more complex security application scenarios, meet low latency, high reliability and bandwidth requirements.

4 CONCEPT OF V2X TECHNOLOGY

V2X, just as its name implies, is vehicle-to-everything, which hopes to achieve information interaction between the vehicles and all entities that may affect the vehicles, V2X mainly includes vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), vehicle-to-network (V2N), and vehicle-to-pedestrian (V2P), as shown in Figure.1. These four types of cooperation are important links for automatic driving and smart transportation. Vigorously developing V2X vehicle networking technology cannot only reduce the probability of traffic accidents, improve the safety of road traffic, but also provide low-cost, easy-to-deploy support and infrastructure for realizing automatic driving and intelligent transportation.

V2X was mainly based on DSRC in the early days; the full name of DSRC is dedicated short range communication. DSRC has been developed and tested in the United States for many years, later, with the development of cellular mobile communication technology, C-V2X (Cellular V2X, V2X based on cellular communication technology) technology emerged. The diagram of C-V2X technology is shown in Figure.2.

The main purpose of application V2X technology in smart transportation system is to improve road safety, solve traffic problems and optimize traffic management, vehicles needs to communicate with surrounding roadside units and vehicles, accurately transmitting vehicle state information collected by sensors or RFID installed on the vehicle, etc. After the information is collected, data analysis and processing are used to extract effective information, which provides intelligent decision-making basis for vehicle travel. The key technologies involved in this process are wireless communication technologies; it supports real-time reliable communication when the vehicle is driving at high speed, sensing technology is used for obtaining accurate position of the vehicle and mass data processing technology.

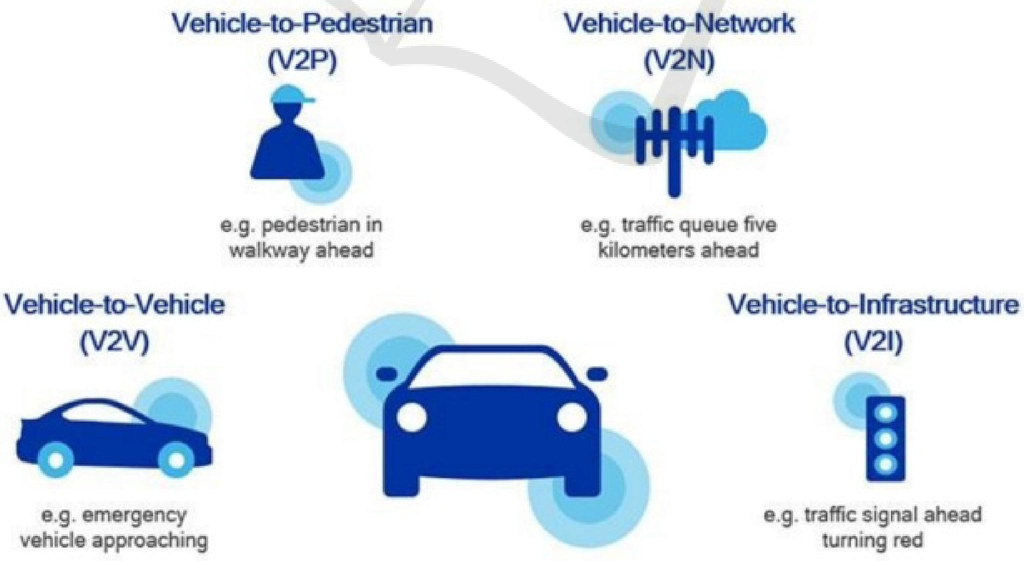

Figure 1. V2X classification diagram.

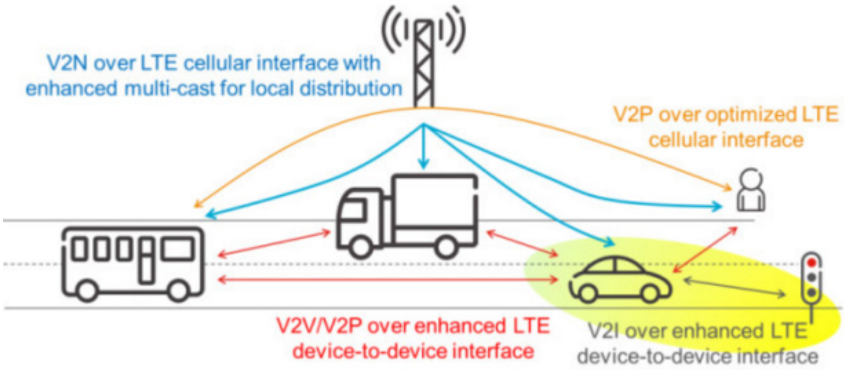

Figure 2. Diagram of C-V2X technology.

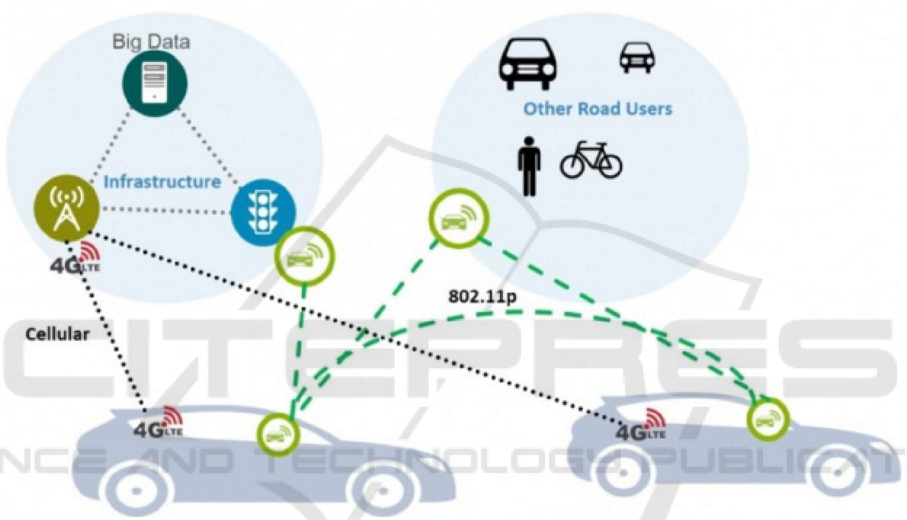

Figure 3. Introduction to DSRC and C-V2X technology.

4.1 Wireless Communication Technology

The V2X network system realizes information interaction through wireless communication technologies. The key to the implementation of this technology lies in the timeliness of wireless communication technology, namely it is necessary to ensure that the network access time is the shortest, the transmission delay is low, and the reliability and security of information transmission are required as well. In order to realize inter-vehicle communication within a certain range, not only the spectrum reuse should be realized to meet the communication bandwidth requirements, but also the core network needs to be established, and the special components of the system are used to complete the information transfer and transmission.

4.2 Vehicle Sensing Technology

Real-time and accurate vehicle state sensing technology is an important foundation for Internet of vehicles, and it is very important. Sensing technologies of vehicle state generally include sensing technology for vehicle motion conditions and sensing technology for driving environment. Through these technologies, the motion state of the vehicles and the surrounding vehicles are sensed, thereby analysing whether there is a safety hazard or not. When sensing the motion state of the vehicle, CAN (Controller Area Network) is used to collect real-time state data generated by each ECU (electronic control unit) and sensor equipment in the vehicle, the motion state of the vehicle is obtained by comprehensive analysis of the information. Among them, it is especially important to obtain accurate vehicle position information by position sense, position sense is usually divided into absolute position sense and relative position sense, different position sense technologies and precision are required to be applied to different roads.

Vehicle environmental information sensing technology is mainly used to obtain information on the surrounding environment of the vehicles, such as road line shape, surrounding non-motorized vehicles and road surface conditions. The route information can be obtained through the traffic geographic information system, or on-board equipment uses pattern recognition technology to complete linear online recognition. Infrared sensors and on-board radars can be used to sense information on roadside pedestrians and non-motorized vehicles. Information on road conditions, snow and ice, etc. can be detected and collected by laser, video and infrared technologies.

4.3 Data Processing Technology

The intelligent assisted driving system based on V2X can comprehensively analyses and evaluates the mass data generated by the vehicle through information fusion and data mining, and then makes intelligent decisions based on the processing results. Information fusion is data fusion, it can be summarized as using computer technology to correlate and analyse the information collected by sensors from various information sources, and optimize the information processing according to the algorithm optimization criteria, and finally obtain the effective information needed for intelligent decision-making. In the Internet of vehicles system, information fusion technology mainly processes and integrates information from various parts of the Internet of vehicles, thus obtaining effective information required by vehicle travel. Data mining is the basis for processing mass data that continues to grow; it generally consists of three steps: find preliminary data, explore data rules and represent rule.

5. INTERNET OF VEHICLES AND AUTOMATIC DRIVING

5.1 Traditional Automatic Driving

In the field of existing automatic driving research, Google, Tesla and other enterprises are generally based on information input of sensors, radars, and cameras, the decision of vehicle is made through artificial intelligence technology, and the vehicle itself can be driven to a certain extent. However, the single vehicle has great limitations, in the bad weather such as night, rain, snow and fog, at the intersections, corners, etc.; the radar and camera cannot observe them. Developing more powerful sensors for these scenarios will need substantial funds that ordinary consumers can't afford.

5.2 Automatic Driving under the Internet of Vehicles

In the field of Internet of vehicles and driverless driving, 1ms may determine the moment of life and death. 3GPP defines several low-latency scenarios from 1ms to several ms, which are mainly on automatic driving. The reaction time such as braking in automatic driving is a system response time, including the time for network cloud computing processing, workshop negotiation processing, and the vehicle's own system calculation and braking processing time. If the braking speed of 100km/h is not more than 0.3m, the overall response time of the system should not exceed 10ms, and the response time of the best F1 driver is about 100ms. From the perspective of security, the system response time is as low as possible, and the requirements for communication delay will be higher. In the future, network can provide good stability while achieving less than 1ms communication delays. Therefore, the low-latency scenarios of automatic vehicles require the cooperation of other parts of the system. In the realization of vehicle automatic driving scenarios, V2X is a necessary technology; even if the vehicle itself can achieve partial automatic driving, the performance can be further improved Internet of vehicles technology, it also reduces the cost of deploying sensors for vehicles and reduces the reliance on high-precision sensors.

6 CONCLUSIONS

At present, although there are many breakthroughs in technologies of automatic driving and Internet of vehicles, the research progress is still little, the fundamental reason is that the basic technology still has bottlenecks. The ultimate goal of the Internet of vehicles is to automatic driving and fully network, liberates the drivers' hands and feet; and V2X technology will lay a solid foundation for the integration of automatic driving and Internet of vehicles.

REFERENCES

Cheng Gang, Guo Da. Research on the Status and Development of Internet of Vehicles. Mobile Communications, 2011, 35(17): 23-26.

Chen Qianbin, Chai Rong, Cen Ming. Future Direction of Internet of Vehicles. ZTE Technology Journal, 2015, 21(1): 47-51.

Li Feng, Fang Jiayu, Zhao Li. Introduction of Standard and Technology of LTE-V in 3GPP. Telecommunications Network Technology, 2016(06): 40-45.

Liu Fuqiang, Xiang Xueqin, Qiu Dong. Research of DSRC Technology and Communication Mechanism. Shanghai Auto, 2007(8): 35-38.

Li Zhongdong. V2V System Open New Era of Motor Vehicle Safety. Automobile Maintenance 2014(23): 28-29.

Xu Zijian, Yu Mei. An Application and Improvement of V2V Technology in Intelligent Transport System. Technological Development of Enterprise, 2016, 35(13): 33-36.

Wang Jianbiao. V2X Internet of Vehicles and Its Key Technologies. Information Technology & Informatization, 2013(5): 60-64.

Zhao Jing. Current Status and Prospects of V2X Technology. Guangdong Communication Technology, 2018(1): 6-9.