How will 5G unleash the potential of autonomous driving?

Abstract-With the development of 5G communications, new probability have been provided for the further implementation of autonomous driving, A review will be made of the relevant solutions and the challenges it may face.

I.INTRODUCTION

The vehicle is one of the most important transportation in modern human life. Since the first modern vehicle was born, people have continuously improved it. Now, with the breakthrough of various technologies, smart cars have begun to enter people's eyes [1].

There is no doubt that the ultimate goal of smart cars is to achieve autonomous driving. Although to a certain extent, autonomous driving can be realized, but But due to the limited information processing capacity of the on-board computer, products in current market can basically be at Level 2 among the six levels established by The Society of Automobile Engineers (SAE) for autonomous driving standards (Fig 1), and only a very small number of industry leaders can reach Level 3 [2].

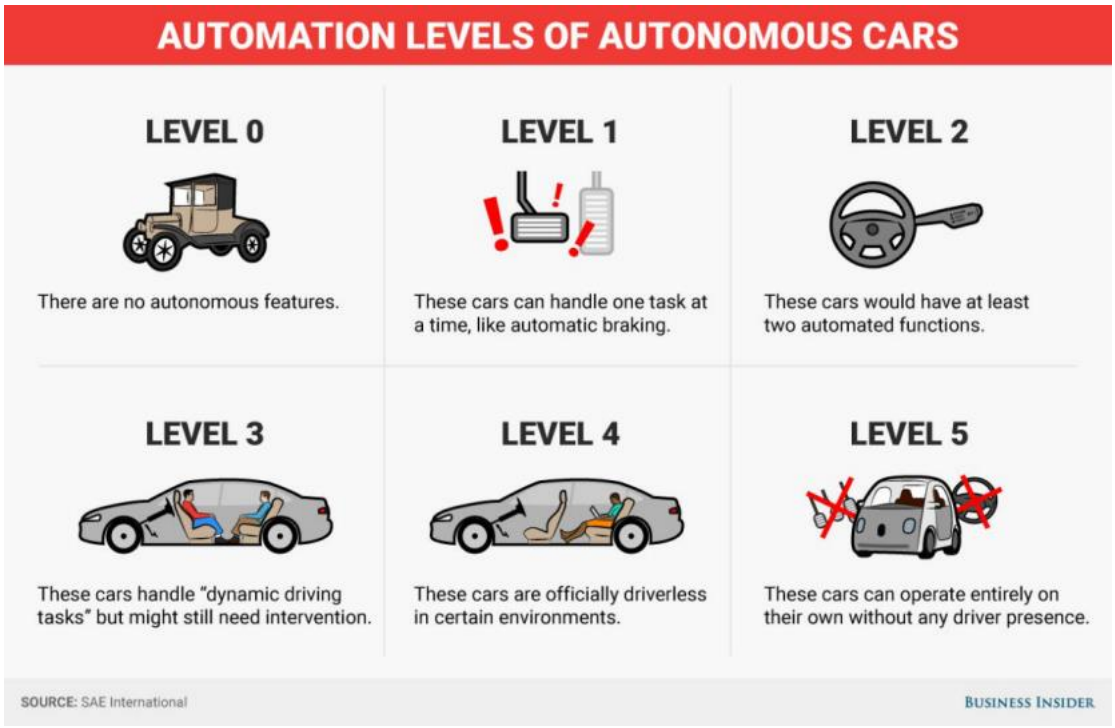

Fig 1, Automation of autonomous car [2]

Therefore, in a strict sense, the current "autonomous driving" can only to be "assisted driving."

However, with the development of 5G in recent years, it has provided further possibilities for the realization of real "autonomous driving". This article will concisely explore the technical support that 5G will provide for the realization of autonomous driving, and give unique insights by analyzing existing challenges.

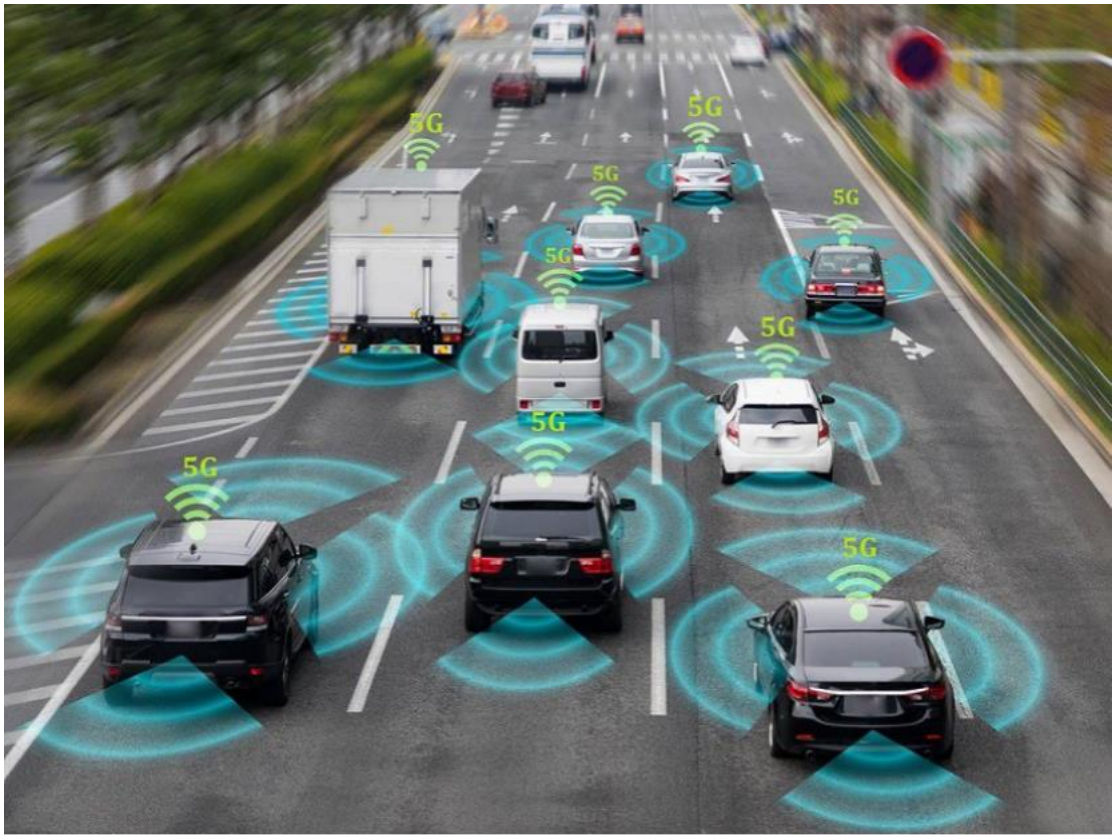

Fig 2,5G-based autonomous vehicles[3]

II.5G-BASED AUTONOMOUS DRIVING

Autonomous vehicles have a huge market. The global autonomous vehicle market size is projected to be valued at $ 54.23 billion in 2019, and is projected to garner $ 556.67 billion by 2026, registering a CAGR of 39.47% from 2019 to 2026 [4]. However, the current technology has yet to meet consumer expectations. For example, Tesla, which people are most familiar with, the implementation of autonomous driving basically uses sensors and cameras for collecting data on road conditions. Use software and programs to make real-time analysis and decision-making in the on-board processor, and finally feed back the information to the motion control module to control the motor [5]. This implementation process will bring two problems:

- This information processing process is largely independent and lacks communication to maximize the utilization of information.
- The information is processed by in-car processor. Therefore, due to the limitation of the processor's capacity, it is impossible to get more data processed, and it is impossible to completely get rid of driver’s intervention.However, due to 5G communication’s characteristics of high speed, low latency, and large capacity, the above problems can be solved in two ways:

1. Vehicle to Everything (V2X)

V2X (Vehicle to Everything) refers to the interconnection between the vehicles and all connectable devices. These include vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), vehicle-to-pedestrian (V2P), and vehicle-to-network(V2N) communications.

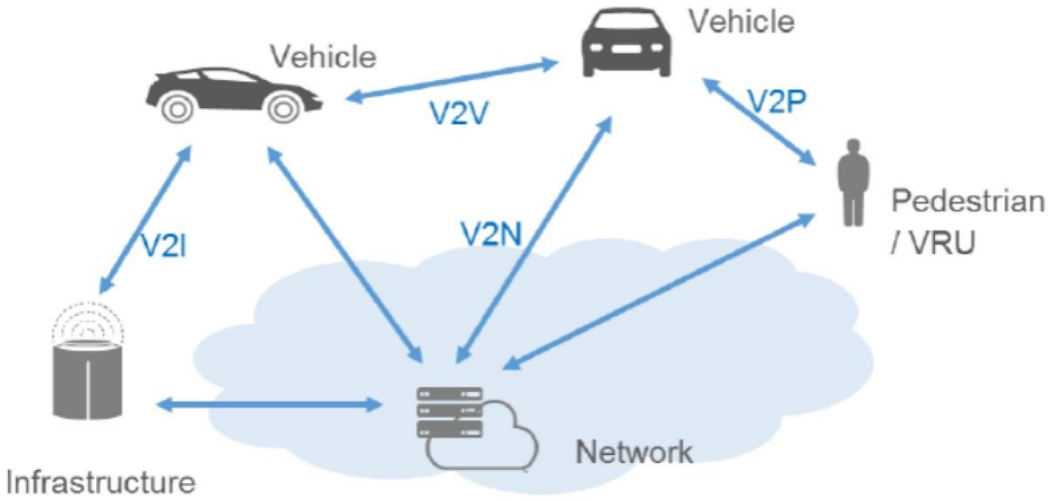

Fig 3, V2X types [6]

In this network, each participant can broadcast their own information or collected information in the form of broadcasting, so as to achieve the sharing of their respective positions, states, intentions, and processed information. In this way, greatly reducing the task of independent information collection for each car, which not only reduces the cost to a certain extent, but also improves the efficiency of information collection [7]. According to the statistics of the United States Highway Safety Administration (NHTSA), the benefits of V2X technology for society are reflected in the three aspects:safety, efficiency, and convenience. In terms of safety, medium and light vehicles can avoid 80% of traffic accidents; in terms of efficiency, traffic congestion will be reduced by 60%, and existing road capacity will be increased by 2 to 3 times. For convenience, the driving time can be reduced by 13% to 45%, and the fuel consumption can be reduced by 15% [8]. 5G communication technology can realize V2X in two aspects:

1.1 Perception

General speaking, perception is to let the car know exactly where it is and what is around it. 5G can provide ultra-high-precision maps for cars, allowing them to accurately grasp where they are on the road. In addition, 5G capabilities can be used to effectively communicate between vehicles, and roadside equipment can be used to assist vehicles in sensing the environment. The traditional autonomous driving perception method can only detect objects within the line-of-sight range, and it is difficult to obtain accurate information when it is restricted by weather factors. However, based on 5G V2X technology, the vehicle's sensing range can be greatly expanded.

1.2 Decision-making

5G can make vehicles and vehicles form a connection. They are no longer independent individuals in the process of driving, but are like a football team who cooperate with tacit teammates to make collaborative decisions to get the most reasonable driving plan. In addition, the low-latency and large-bandwidth characteristics of 5G also provide the possibility for remote driving. When a vehicle

encounters an extremely complicated scene and cannot make a decision, it can allow staff located at remote service centers to participate in the vehicle. Driving until you get out of the complex environment.

2. Cloud processing

Obviously, in order to achieve V2X-based autonomous driving, the car needs to collect the surrounding data in real time through hundreds of sensors, and the data generated at this moment may be explosive. At the same time, these data must be processed in a very short period of time, so as to make corresponding responses and control. Such a challenge is unprecedented. If you rely on the on-board processor to complete these tasks, it will be subject to the performance of on-board computing and memory devices, and it will be almost impossible to achieve. In addition, we need to face the risk of processor failure.

But the existence of 5G can make data processing not only exist in the vehicle processor. 5G-based autonomous driving will be able to make full use of cloud computing and storage capabilities to transfer some computing tasks to the cloud for processing. This will provide better stability and reliability than the vehicle itself, and it can also provide real-time services such as road conditions, real-time weather, and entertainment content enhance the user experience of autonomous driving [9].

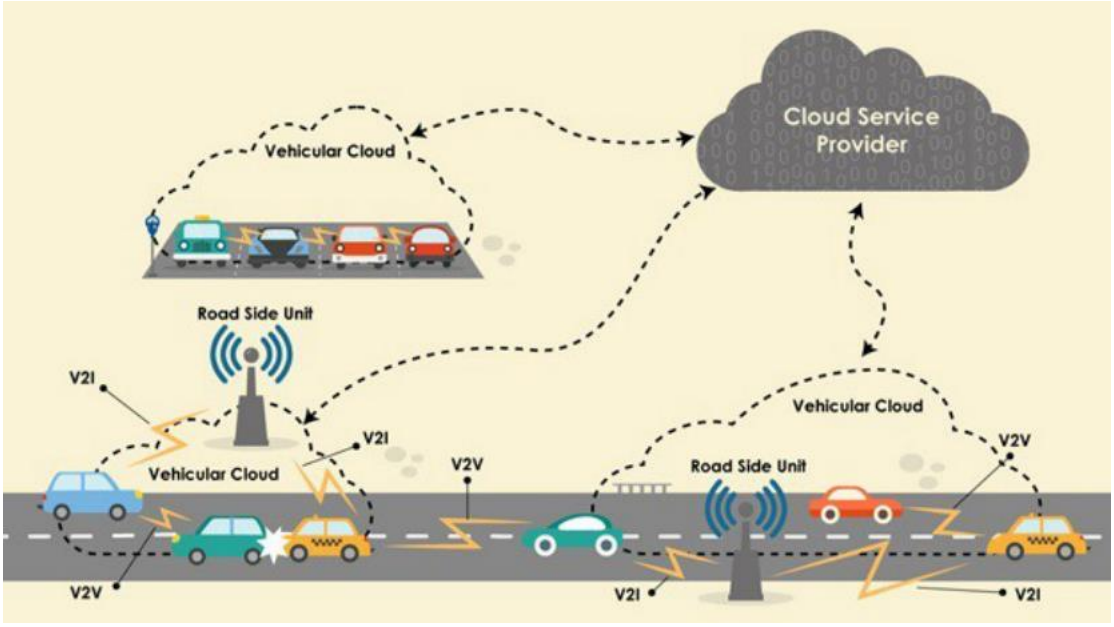

Fig 4,Autonomous vehicles with Cloud[3]

III.DISCUSSION AND CONCLUSION

Although so far, relatively mature 5G-based autonomous driving applications have not appeared on the market. This is mainly because there are many challenges in the transition from theory to practice. In terms of technology, 5G is currently in the initial stage of commercialization. Many core technologies have not been completely solved, and performance has not yet reached expectations. Even 5G base stations have not yet been extensively built, let alone use them in autonomous driving. In addition, there are a number of social, economic, and legal challenges that limit the development of autonomous driving.

However, it cannot be denied that 5G-based autonomous driving can indeed bring huge benefits to consumers and the social environment, and people have also recognized this very early. From 2015, 3GPP has opened up 5G-V2X Requirements and standardization studies. Technology companies in major industries such as Waymo, ARGO AI, etc [10]. are also working to achieve real autonomous driving. We have reason to believe that 5G-based autonomous driving will appear in the near future.

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