Differentiated Service Mechanism According to Vehicle Environment in Vehicular Edge Network

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***Abstract*—With the rapid development of communication technologies such as 5G, vehicular applications and transmission information are exploding. Mobile edge computing (MEC) as a new technology can transfer the information more quickly and accurately. Providing differentiated services for the information can affect the performance of the applications. In this study, based on 802.11p EDCA protocol, we propose a new differentiated service scheme called DD-EDCA (Differentiating Density Enhanced Distributed Channel Access) in vehicular edge network. Firstly, we use MEC Server to calculate the road density and average velocity to distinguish the vehicle scenarios. Secondly, we quantify the urgency of information under different scenarios, and let the information enter the corresponding access categories (ACs) according to the urgency. Finally, different solutions have been designed according to different vehicle density environment requirements. For example, the displacement trend is considered at a low density, and the multi-hop broadcast information is preprocessed at a high density. And the schemes for dynamically adjusting EDCA parameters are designed. Simulation results show that our method reduces latency and packet loss rate, and improves the throughput.**

Keywords*—*vehicular edge network; transmission information; differentiated services; QoS

I. INTRODUCTION

With the development of science and technology such as 5G [1], not only become more and more vehicles, but also the types of the application are on the rise. However, the traditional vehicular cloud computing cannot meet the growing demand for transmission, mainly because it has the following problems: 1) the cloud server is far away from the user, which makes it difficult to obtain the user's location and surrounding environment information in real time; 2)the backhaul link delay is large [2]. To improve user experience and enrich user satisfaction, mobile edge computing (MEC) [1] can be integrated with vehicular ad hoc networks, leading to vehicular edge network, wherein service providers directly utilize MEC servers to serve users at the network edge. In vehicular edge network, various kinds of information will be transmitted, such as safety, efficient, infotainment, comfort-related information [3], as shown in Fig 1. Differentiating these four types of information and guaranteeing their QoS will hopefully improve applications' reliability and reduce network's delay [4]. IEEE 802.11p uses 802.11e's Enhanced Distributed Channel Access (EDCA) mechanism which has four access categories (ACs) to support QoS [5]. And each AC set different EDCA parameters --minimum competition window($CW_{\min}$), maximum competition window($CW_{\max}$), Transmission Opportunity (TXOP), and Arbitration Frame Interval (AIFSN) to distinguish information's priority. Moreover, different vehicle density scenarios can affect the transmission of information [4]. For example, in a high-density scenario, the channel competition is large and the message collision rate is high, which results in high packet loss rate and large delay. Conversely, in a low-density scenario, channel resource utilization is insufficient. However, in vehicular edge networks where topology changes at high speeds, EDCA cannot differentiate the vehicle scene and cannot dynamically adjust EDCA parameters with vehicle scenarios.

In order to overcome the shortcomings of EDCA, we propose a scheme to implement differentiated services based on the scene in vehicular edge network. Our scheme considers the above four types of information. The specific improvements are as follows: First of all, let the Rode Side Unit (RSU) [6] collect the vehicle position and velocities returned by the ground sensor and pass them to the MEC server which is installed on the base station [7]. Then, let MEC server calculates the vehicle density and average velocity in the RSU service area, which uses the edge offload technology. And divide the scene into high and low vehicle densities. Secondly, we quantify the urgency of information under according to density and average velocity. Thirdly, we considered the displacement trend to adapt to the rapidly changing topology in low vehicle density. When the vehicle density is high, due to the existence of 'broadcast storm', the temporal and spatial correlation of the message is considered for preprocessing. Finally, different methods for dynamically adjusting EDCA parameters are designed in different scenarios.

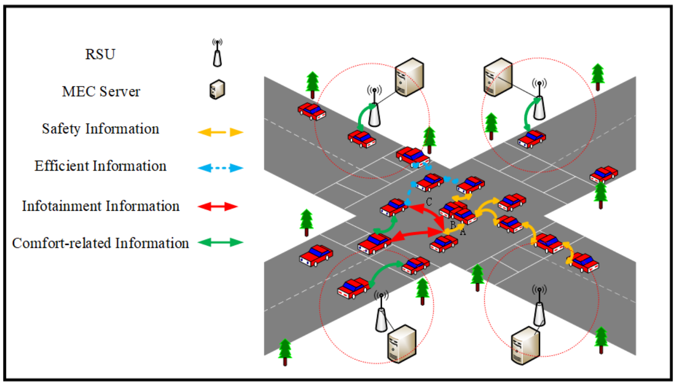

Fig. 1. Vehicular edge network

Our contributions are three folds:

1) We take advantage of edge computing to reduce latency and distinguish the vehicle scenarios firstly, which have the characteristics of 'prescription for remedying' compared with other mechanism.

2) Quantify the urgency of messages under the different scenarios, which make full use of the characteristics of different messages in different scenarios with different urgency [4][8].

3) Consider the vehicle's mobility when the vehicle density is low. And the emergency safety information is pre-processed to solve part of the broadcast storm when the vehicle density is high.

The rest of the paper is organized as follows: In section II, we introduce related work. Section III introduces common work that needs to be completed under different scenarios. And the specific algorithms under different vehicle densities are introduced in the section IV. The fifth section is the simulation and analysis of our design algorithm. Finally, we summarize the work we complete.

II. RELATED WORK

Researchers commonly used methods include: set different priorities, adjust the EDCA parameters and other ways to implement differentiated services. Research [8] mainly used DSRC's seven channel bands to set different priorities for real-time security information transmitted. And messages of the same priority were sent using strict priority queue (SPQ) priority traffic differentiation techniques. Different retransmission mechanism was designed for each prioritized message, whose priority are assigned based on urgency [4]. Hidden terminal problem and broadcast message strict priorities are considered in [9]. However, these solutions that only take into account the priorities of different safety messages are unable to meet the current business need. So, many researchers designed an EDCA-based differentiation scheme. An earliest time-based carrier sense multiple access (EDF-CSMA) to dynamically adjust the real-time flow priority to avoid collisions, which was based on EDCA, was proposed in [10]. Research [11] distinguished the network environment and then dynamically adjust the transmission energy and the contention window to improve QoS. A new EDCA network analysis model, which can dynamically adjust the back off parameters to optimize the network throughput performance, was prosed in [12]. Based on EDCA, QoS-assurance-based EDCA (QA- EDCA) and QoS-assurance-and-mobility-based EDCA (QAM-EDCA) were proposed in [13]. The former was to assure the real-time of two high priority traffics, the latter was to solve the unfairness problem for two low priority traffics to access channel due to different vehicle speed. A fuzzy inference system to derive vehicle environmental severity measures and relate the vehicle's driving behavior to its environment was prosed in [14]. Previous research [15] considered safety information and non-safety information, and applied the wired DiffServ idea to EDCA to optimize the EDCA mechanism. Finally, the simulation analysis was carried out in three density scenarios of high, medium and low.

From the above scenario, we can see that some researches have the following problems: 1) they only consider the priority of the safety message; 2) they do not consider the urgency of the message under different vehicle density; 3) they do not use the computing advantage of vehicular edge network.

III. VEHICLE DENSITY ESTIMATION AND SUBDIVISION AC QUEUES

In this section, we describe how to calculate vehicle density and average velocity. Then, quantify the urgency of information under different vehicle scenarios.

A. Vehicle Density Estimation

Previous research [16] focuses on the impact of vehicle density and EDCA parameters on the performance of IEEE 802.11p protocol networks. Its results show that the vehicle nodes may be in a sparse and sometimes dense network environment, so the vehicle density will have an important impact on network performance. When the number of vehicles is small, the network is sparse and the communication link is unstable. Many destination nodes are unreachable, which results in large delay and packet loss rate. When the number of vehicle nodes continues to increase, congestion occurs due to increased network load, resulting in increased packet back-off and collisions, and retransmission of packets after node retreat will cause more collisions, resulting in increased network packet loss rate and low acceptance rate. So, vehicle density is a useful metric to divide different vehicle scenarios [11]. And the relatively velocity is also an important factor to evaluate the vehicular environment [17].

There are many papers [9][18][19] that define vehicle density as the number of vehicles per unit length, and we also use this method. If the work of calculating the vehicle density and velocity are given to the cloud server, there is a problem that the delay is relatively large. The vehicle topology is changing at high speed, so the extra delay leads to inaccurate results. So we will offload [6] the calculation of vehicle density and velocity to the MEC server as shown in Fig 2, which can be done in milliseconds.

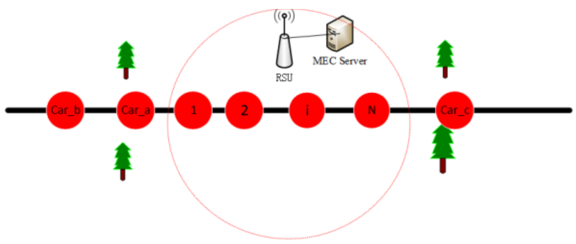

Fig. 2. Calculate the density and average velocity

The specific steps are as follows:

1) The RSU collects location and velocity of vehicle through the road sensor and packages them, and then transmits them to the MEC server through a wired connection;

2) When vehicles are distributed on the road, they can be abstracted into one point (x_{car_a}, y_{car_a}). After MEC server receives the information, it counts the number of these points. Then, it uses Eq. (1) to calculate the average distances of these points {1, 2, ..., i, ..., N} (each time only before (x_i, y_i) and after (x_{i-1}, y_{i-1}) the point of separation).

$$\mathrm{InterCarD}_i = \sqrt{(x_i - x_{i-1})^2 + (y_i - y_{i-1})^2}$$
$$\mathrm{InterCarD}_{\mathrm{average}} = \frac{1}{N-1}\sum_{i=1}^{N-1} InterCarD_i \quad (1)$$

3) According to the $\mathrm{InterCarD}_{\mathrm{average}}$, the reciprocal is the vehicle density, as shown in Eq. (2).

$$\rho = 1/\,InterCarD_{average} \text{[7][20][21]} \quad (2)$$

4) Average velocity is calculated by Eq. (3).

$$\beta_{averagevel} = \frac{1}{N}\sum_{i=1}^{N} car\_vel_i \quad (3)$$

5) RSU send the density and velocity results to the vehicles in its service area. Since the vehicle topology is rapidly changing, it is necessary to set an update time $T_{threshold}$ to update the vehicle density and velocity. $\rho_{threshold}$ and $\beta_{threshold}$ are thresholds for density and velocity. When the vehicle density is less than $\rho_{threshold}$, it is high density; when the vehicle density is less than or equal to $\rho_{threshold}$, it is low density. The same division principle is adopted for the velocity.

B. *Quantify the urgency of information*

Based on the calculation results of the Section III (A), we divide the vehicle environment into four vehicle scenes and give them different priorities according to the current density and average velocity, as shown in the Table 1. And in the vehicle environment, the information transmitted is mainly divided into four types: safety, efficient, infotainment, comfort-related, and we give them a corresponding priority of 4, 3, 2, 1. Since different information has different urgency in different vehicle environments, we add the priority of different environments and the priority of different information to get the new priority of the information in different environments. Then, let the new priority be 8, 7, 6 enter AC (3), enter AC (2) for 5, enter AC (1) for 4, enter AC (0) for 3 and 2 inspired by [14], as shown in Table 2.

TABLE I. VEHICLE ENVIRONMENTS AND THEIR PRIORITIES

Vehicle density	Average velocity	Priorities
high	fast	4
	slow	3
low	fast	2
	slow	1

TABLE II. NEW PRIORITY

Priorities of vehicle environment	Priorities of information	New priorities	AC(i)
4	4	8	3(voice)
	3	7	3(voice)
	2	6	3(voice)
	1	5	2(vedio)
3	4	7	3(voice)
	3	6	3(voice)
	2	5	2(voice)
	1	4	1(best-effort)
2	4	6	3(voice)
	3	5	2(vedio)
	2	4	1(best-effort)
	1	3	0(back-ground)
1	4	5	2(vedio)
	3	4	1(best-effort)
	2	3	0(back-ground)
	1	2	0(back-ground)

IV. DIFFERENTIATED SERVICE MODEL

In this section, we will give the overall design scheme firstly. After that, the DiffServ algorithm at different vehicle densities is discussed in detail.

A. *General Idea of Design*

General idea of design is shown in Fig 5. Firstly, the vehicle determines the current environment according to the method of calculating density introduced in section III A. Please note that here we are only blurring the density to distinguish the scene and not using the velocity. Secondly, get information's new priorities using the method of section III B and enter the AC queue. Then, a spatiotemporal correlation function is designed to measure multi-hop broadcast information's (safety information mostly spread by multi-hop broadcast) urgency in high vehicle density. When the vehicle density is low, the vehicle's displacement tendency is taken into consideration because the vehicle's position changes relatively quickly. Finally, different methods for dynamically adjusting EDCA parameters are designed to improve QoS performance in both scenarios.

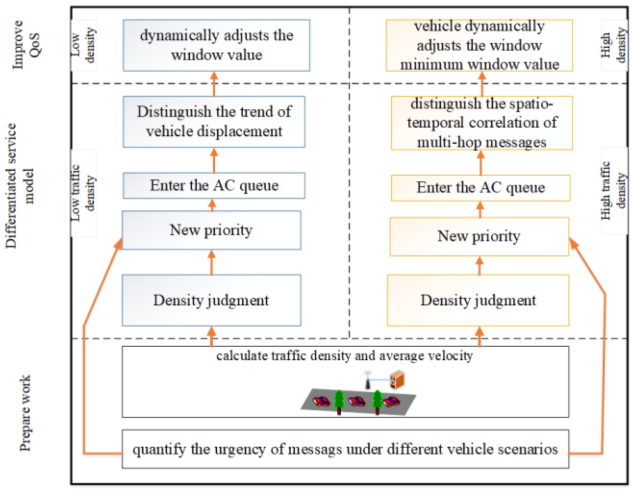

Fig. 3. General idea of design

B. *Low Vehicle Density*

Vehicles compare with the threshold value with its vehicle density returned by RSU. When the vehicle density is determined to be low, enter the service algorithm for low vehicle density. Note that according to Section III A, when the density is equal to the threshold, it is also classified as low density.

1) Scene Analysis

Under this scenario, the distance between vehicles is large, the network topology is highly dynamic change, and the link life is short [20]. And competition in low-density scenarios is not particularly intense. Therefore, there are problems such as low throughput and waste of resources in this scenario. So we use the following two methods to solve these problems.

2) Vehicle Displacement Trend

There are three kinds of displacement trend relations between vehicles: disjoint, opposite, and relatively static. These three different relationships lead to different communication opportunities between vehicles. We mainly consider the trend of displacement of unicast information (such as comfort-related information) between two vehicles, so as to distinguish the priority of information transmission under different displacement trends and improve QoS.

We propose a new concept DT_IFS (Displacement Trend Inter-frame Spacing) based on AIFS. The design formula is as shown in Eq. (4). Among them, RS_k represents three kinds of displacement trends, $DT\_IFS[RS_k]$ represents the value taken under three kinds of displacement trends.

$$DT\_IFS[RS_k][AC_k] = (DT\_IFSN[RS_k] + AIFSN[AC_k]) \times aSlotTime + SIFS \quad (4)$$

Next we discuss how to determine the vehicle's displacement trend. Assuming time $t_{current}$, the coordinates of car a and car b are $(x_{current\_a}, y_{current\_a})$ and $(x_{current\_b}, y_{current\_b})$ obtained by GPS. The distance between the two cars is Eq. (5).

$$CurrentDis = \sqrt{(x_{current\_a} - x_{current\_b})^2 + (y_{current\_a} - y_{current\_b})^2} \quad (5)$$

After t seconds, the coordinates of car *a* and car *b* are $(x_{later\_a}, y_{later\_a})$ and $(x_{later\_b}, y_{later\_b})$. At this time, the distance between the two cars is Eq. (6).

$$LaterDis = \sqrt{(x_{later\_a} - x_{later\_b})^2 + (y_{later\_a} - y_{later\_b})^2} \quad (6)$$

Calculate $\Delta \mathrm{Dis} = LaterDis\text{-}CurrentDis$. If ΔDis <0, the two cars are facing each other; if ΔDis >0, the two cars are apart; otherwise they are relatively stationary. Finally, set the value of $DT\_IFS[RS_k]$ according to the trend of displacement. The value is set as shown in Table 3.

TABLE III. VALUE OF DT_IFS[RS]

Vehicle displacement trend	$DT\_IFS[RS_k]$
disjoint	-1
opposite	1
relatively static	0

3) Dynamic Adjustment Window

When the vehicle density is low, the distance between vehicles is relatively long, which may result in low throughput. The binary back-off adjustment window in the original EDCA mechanism has the following problems: the window value is doubled directly when the transmission fails, but the channel resources are not tense at this time. So, doubling the window value will waste resources.

Therefore, we will focus on the adjustment of window values when sending fails. We use the current vehicle density and vehicle density thresholds to judge the network conditions at low vehicle density, and then slowly adjust the value of the competition window, as shown in Eq. (7).

$$\begin{cases} CW_{\mathrm{new}} = \min(CW_{old} + CW_{tmp}/\rho_{threshold}, CW_{\max}), \mathrm{Failed} \\ CW_{new} = CW_{\min}, Successful \end{cases} \quad (7)$$

Among them, $CW_{\mathrm{tmp}} = CW_{old} \times \rho$.

C. High Vehicle Density

When it is determined that the vehicle density is high, it will enter the service algorithm for high vehicle density.

1) Scene Analysis

Under this scenario, the following problems exist: 1) the distance between vehicles is small, and the reaction time of the driver is short; 2) multi-hop broadcast messages are easily transmitted outside its influence scope, resulting in the waste of resources; 3) the channel competition is intense and the acceptance rate of broadcast messages is low [21]. In order to solve the above problems, the following two methods are mainly used.

2) Multi-hop Broadcast Message Preprocessing

The safety information belongs to multi-hop broadcast messages. The original EDCA mechanism uses fixed delay to limit the transmission of multi-hop broadcast messages. However, as the distance between time and space increases, the urgency of multi-hop broadcast messages is getting lower and lower for receiving vehicles. Therefore, a space-time density correlation function is designed to dynamically describe the priority and urgency of multi-hop broadcast messages. The function is Eq. (8). If the f is less than 0, the message will be discarded. Otherwise, it will be sent again.

$$\begin{cases} f = \mu \bullet f_1(\Delta Time) + v \bullet f_2(Dis\_\mathrm{Re}cCar\_SendCar) + IniP, (\mu<0, v<0, IniP>0) \\ \Delta \mathrm{Time} = \mathrm{Rec}Time - SendTime, Dis = \sqrt{(x_{rec\_car} - x_{send\_car})^2 + (y_{rec\_car} - y_{send\_car})^2} \end{cases} \quad (8)$$

f_1 is a function of ΔTime, ΔTime represents the time elapsed since the car received the emergency message sent by the source car. f_2 is a function of d which demonstrates the distance between the received car and the source car, $(x_{\mathrm{rec\_car}}, y_{\mathrm{rec\_car}})$ and $(x_{send\_car}, y_{send\_car})$ indicate the positions of the received and source car. IniP indicates the initial priority, u and v are the correlation coefficients. f denotes the new priority.

3) Dynamically Adjust The Minimum Window Value

When the vehicle density is relatively large, the neighbor nodes of the vehicle are also relatively large. A fixed and relatively small contention window will result in a low broadcast acceptance rate [16]. Adjusting the minimum window value is expected to increase the acceptance rate of broadcasting. Therefore, we dynamically adjust the minimum window value according to the number of neighbor nodes of the vehicle, as shown in Eq. (9), where ne_num (ne_num>19) represents the number of neighbor vehicles [16].

$$CW_{\min} = \frac{3ne\_num^2 + 7ne\_num + 4 + [(ne\_num+1)^2(3ne\_num+4)^2 - 16(ne\_num-1)^3]^{1/2}}{8(ne\_num-1)} \quad (9)$$

HELLO message (single-hop broadcast information) is used to obtain the number of neighbor nodes of the vehicle k.

D. Overall Algorithm

Algorithm 1 details the our overall algorithm under two different vehicle densities.

Algorithm 1. Overall Algorithm

Input: Current vehicle density and average velocity calculated by the MEC Server, threshold value of $\beta_{threshold}$ and $\rho_{threshold}$, four types of information.

```
If( ρ <= ρ_threshold )
    Four types of information enter the AC(i) queue according to the new
    priority based on the Section III B;
    While("messages are sending") do
        If(messages are unicast to a specific vehicle)
            Consider the displacement trend between the two cars and
            adjust the AIFS based on the approach mentioned in Section
            IV (B);
        End;
        If(Sent failed)
            Adjust CW based on the approach mentioned in Section IV B
            (3);
        End;
    End;
End;
If( ρ > ρ_threshold )
    Four types of information enter the AC(i) queue according to the new
    priority based on the Section III B;
    While("messages are sending") do
        If(there are multi-hop broadcast message)
            Preprocessing multi-hop broadcast messages based on Section
            IV C (2);
        End;
        Adjust  CWmin based on the approach mentioned in Section IV C
        (3);
    End;
End;
```

V. SIMULATION ANALYSIS

A. Simulation Environment

We use NS-3, SUMO [22] as the simulation platform for this experiment. NS3 is used to simulate the entire vehicular environment, SUMO simulates the movement of vehicles. Firstly, we suppose that the vehicle is running in a 1km one-way lane. Secondly, [23] defines the height of the high/medium/low vehicle to be 30, 15, and 10 meters. So we set [30, 60, 100] vehicle/km to represent low vehicle density, medium vehicle density, and high vehicle density. Thirdly, the acceleration/deceleration is set to 0.9 and 0.5 m/s^2 [16]. Finally, we assume that in a particular scenario, the density of the vehicle remains the same, that is, although the vehicle has mobility, the average distance does not change much.

TABLE IV. SIMULATION PARAMETERS

Parameters	Value
Scene size	1km*1km
Simulation Time	300s
Speed	0-30m/s [11]
Nodes	30、60、100
Mac layer protocol	802.11p
Link layer type	LL
Safety/Non-safety data size	200byte/1024byte [23]
RSU communication range	300m
Routing Protocol	AODV
Density threshold	1/15 (vehicle/m) [23]
Velocity threshold	48km/h [17]
Vehicle density update times	5s
Generation rate	10 packets per second [14]

B. Analysis of Simulation Results

We compare our scheme with the original EDCA mechanism and the literature [15] (called 'QoS') in terms of throughput, latency, and packet loss rate in three density scenarios. There is no comparison of packet loss rates in [15], so the packet loss rate is only compared with the original EDCA. Finally, in order to compare the performance at different densities, we compared the average delay, throughput and packet loss rate in the three scenarios.

1) Low Vehicle Density

In the low-density scenario, the delay simulation results are shown in Fig 4. From Fig 4, we can be seen that the scheme we proposed has the lowest delay. That is because we considered the urgency of the information and gave priority to more urgent messages and took into account the vehicle's displacement trend. Moreover, the contention window was not increased to twice the original when the message fails to send, but was increased slowly according to the density, which also reduced delay to some extent.

Fig 5 shows the throughput change. Compared with EDCA and [15], throughput of DD-EDCA increases. The reasons are as follows: First, messages increased within the unit time because of considering the trend of vehicle displacement. Second, because the channel access delay was reduced, more and more messages are sent within a certain period of time.

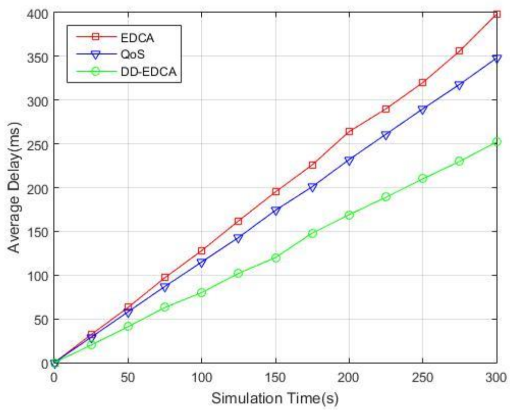

Fig. 4. Delay comparison at low vehicle density

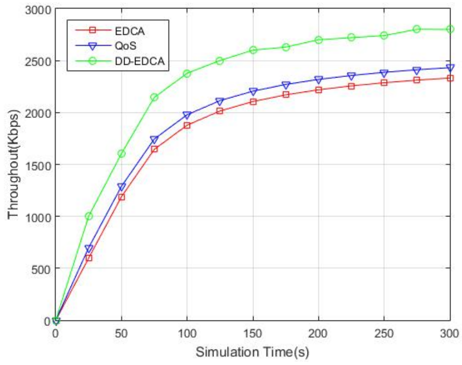

Fig. 5. Throughout comparison at low traffic density

Fig 6 reflects the trend of the packet loss rate over time. It can be seen that the performance of the proposed scheme has improved. We have summarized two reasons as follows: 1) the window size was smaller than the original EDCA mechanism after adjustment, which makes the resources more fully utilized. And we have increased the transmission opportunity of opposite relationship, which also reduced the packet loss rate.

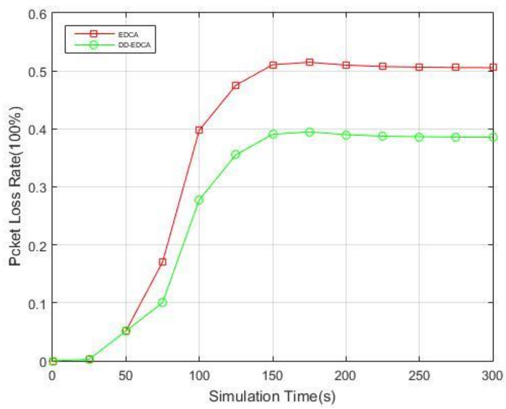

Fig. 6. Packet loss rate comparison at low traffic density

2) Medium Vehicle Density

At medium density, we still use the low-density differentiated service solution according to Section IV B. The graphs of delay and throughput when the vehicle density is medium are respectively shown in Figs 7 and 8. The overall trend change of the two maps is the same as that in the low vehicle density. The difference is that the change of the delay and throughput was not very large. One reason is that the value of the competition window does not change much compared to EDCA according to Section IV B (3). In addition, when the vehicle density was moderate, the change in the displacement trend of the vehicle was not as intense as the low density.

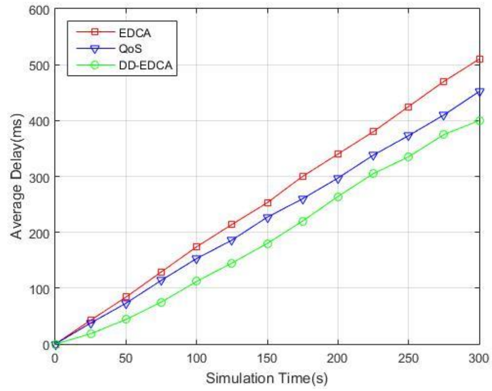

Fig. 7. Delay comparison at middle traffic density

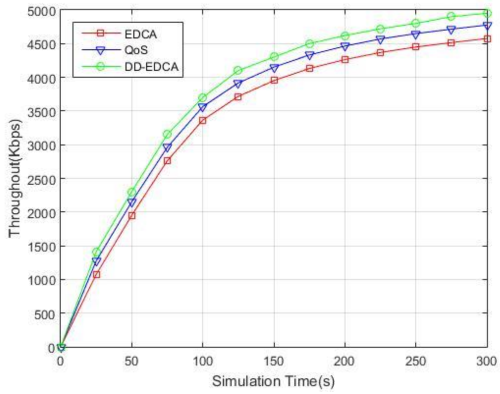

Fig. 8. Throughout comparison at middle traffic density

Fig 9 reflect that the drop rate is not particularly noticeable. The reason is that when the vehicle density was medium, the environment was not changing drastically at this time, so the change in packet loss rate was not obvious.

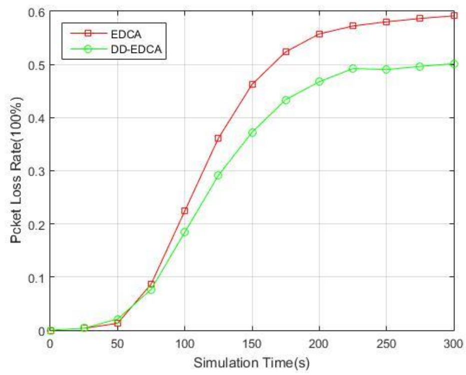

Fig. 9. Packet loss rate comparison at middle traffic density

3) High Vehicle Density

The changes in the delay and throughput of high vehicle density are shown in Figs 10 and 11. The difference between the previous is that the performance improvement is more obvious. The reasons are mainly as follows: We assign high-emergency information to high-priority ACs based on the urgency of the information, thus reducing latency and increasing throughput. And we pre-processed multi-hop broadcast information, discarded those messages with a priority lower than 0, which reduced channel competition pressure.

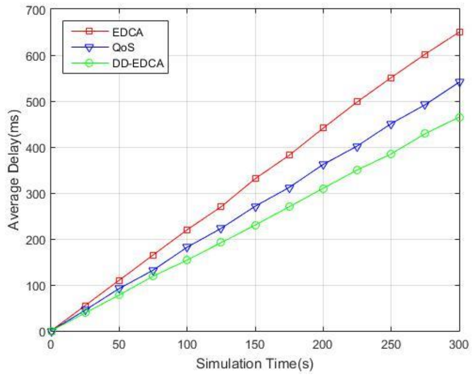

Fig. 10. Average delay comparison at high traffic density

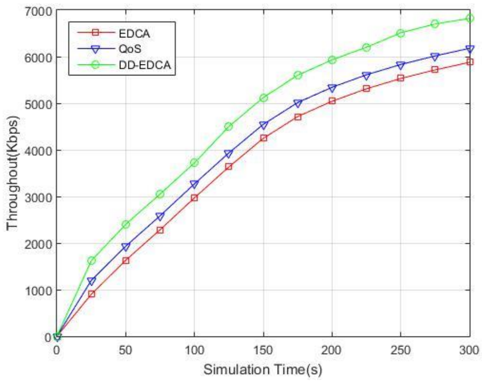

Fig. 11. Throughout comparison at high traffic density

Fig 12 shows the packet loss rate. Our scheme first used pre-processing broadcast messages to reduce the network load, and secondly increased the acceptance rate of broadcast messages. As a result, the packet loss rate eventually was significantly reduced.

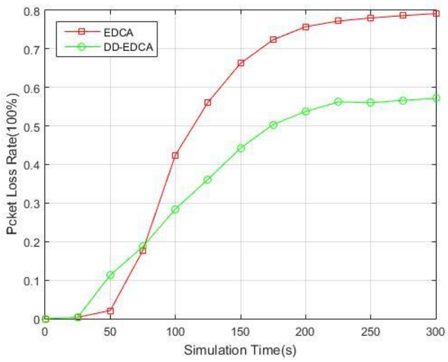

Fig. 12. Packet loss rate comparison at high traffic density

4) Overall Analysis

In this section, we will compare the performance of the proposed scheme with the EDCA in three scenarios. The purpose is to analyze performance trends and overall performance in different scenarios, so there is no longer a comparison with 'QoS'. From Fig 13, it can be seen that in the three scenarios, the delay of the higher vehicle density scene is the largest, and the delay of the lower vehicle density scene is the smallest. That's because that channel competition increased as the density increased.

Fig 14 shows the throughput change. The reason why the throughput in the high vehicle density is relatively high is that the link is stable and the number of vehicles is large. On the contrary, the throughput at low vehicle density is the lowest.

From the above analysis, it can also be concluded that a high network load at high density will result in a high packet loss rate, which is shown in Fig 15.

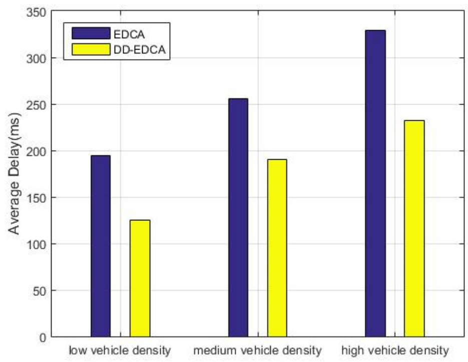

Fig. 13. Mean Delay of three traffic density

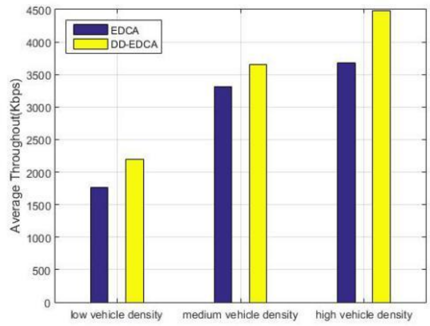

Fig. 14. Mean throughout of three traffic density

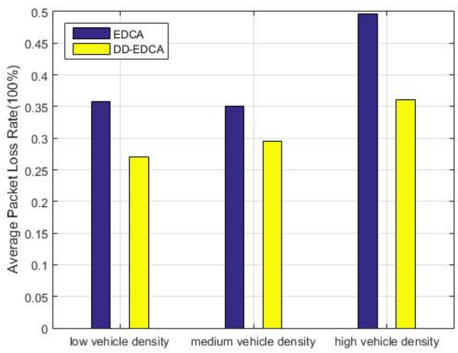

Fig. 15. Mean packet loss rate of three traffic density

VI. CONCLUSIONS

In order to distinguish the priority and urgency of the information and eventually achieve the goal of improving traffic safety and efficiency, we propose a new solution for differentiating transmission information in vehicular edge network. We first use the traffic density and average velocity calculated by the MEC server to determine the current vehicular environment. Then, we quantify the urgency of information. After that, in different density environments, the more detailed DiffServ algorithm is designed mainly from several aspects such as scenario analysis, and dynamic adjustment of parameters. The algorithm can adapt to the dynamic change of traffic density, and has the characteristic of 'prescription for a remedy'. The simulation results show that our scheme deuces latency and improves throughput. In the future, we can optimize in quantifying the urgency of information.

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