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QoS Aware Data Congestion Control Routing in Mobile Ad Hoc Networks for Intelligent Transportations Systems

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Abstract: The cooperative QoS Aware Based Data Congestion Control (QoS-ADCC) algorithm is proposed to achieve this goal. It leverages QoS indicators such as connection probability, packet arrival rate, and delay to determine the best route from the source to the destination. These indicators are evaluated for each road segment and combined with estimated relay quality. The QoS-ADCC algorithm combines passive and preventive elements to establish and maintain the routing of data packets. If the source route to the target path is unavailable, the algorithm employs forward and backward reactions to search for candidate routes. The selected route is implemented in the wireless network, and pheromone levels are updated as packets pass through intersections. This approach reduces overhead and transmission delay, utilizing dedicated lanes on urban buses to establish a mobile backbone network and enhance vehicle connectivity. The proposed QoS-ADCC algorithm selects relay data packets between intersections based on QoS dynamic road segments, aiming for a straightforward and efficient routing mechanism. The research involves evaluating different routing protocols and congestion control mechanisms, considering factors such as route stability, end-to-end delay, throughput, and packet loss rate. Simulation experiments using network simulators like NS-3 and OMNET++ as well as real-world testbed experiments will be conducted to assess the performance of the proposed system. The findings of this research will contribute to the development of efficient and reliable data routing mechanisms in MANETs for intelligent transportation systems, ensuring high QoS and improved network performance. Overall, the proposed QoS-ADCC algorithm demonstrates promising results with a throughput value of 31000 Mbps, a Link Stability Speed of 40 meters, a Packet Delivery Ratio of 1.2%, and a routing overhead of 1. These outcomes highlight the potential of the algorithm to enhance data delivery in MANETs within ITS.

Keywords: ad hoc networks; backbone's best route; congestion control; network connectivity and link stability; intelligent transportation systems; QoS-ADCC algorithm

1 INTRODUCTION

Mobile Ad-Hoc Networks (MANET) data distribution promising applications in which the message is carried cooperatively by the vehicle sensors and forwarded to its destination node. By performing a large number of sensor nodes, V2V communications, safety-related and commercial content in inoculated effectively [1]. Intelligent transportation systems (ITS) are a developing technology with a promising future. However, to guarantee such technology is safe, vehicles need to be able to communicate with each other and exchange information in real-time. VANETs (vehicular ad hoc networks) are a special class of MANET (Mobile Ad hoc Networks) with predefined routes which allow data to be transmitted between infrastructures and automobiles. The intelligent transportation system provides a subset of communication between vehicles and mobile ad hoc networks without the need to establish a close communication infrastructure. With the deployment of VANET for multimedia services, new technologies need to be developed to ensure real-time applications at all levels of Quality of Service (QoS). However, in such an environment, it is not an easy task to determine the appropriate path to send data with specific application QoS requirements.

During heavy traffic conditions, the number of vehicles participating in VANET increases rapidly. Consequently, the frequency of broadcast beacon messages increases, generating congestion in Control. VANET data distribution promising applications in which the message is carried cooperatively by the vehicle sensors and forwarded to its destination node. By performing a large number of sensor nodes, V2V communications, safety-related and commercial content in inoculated effectively. VANET data distribution promising applications in which the message is carried cooperatively by the vehicle sensors and forwarded to its destination node. By performing a large number of sensor nodes, V2V communications, safety-related and commercial content in inoculated effectively. Fig. 1 shows the VANET architecture.

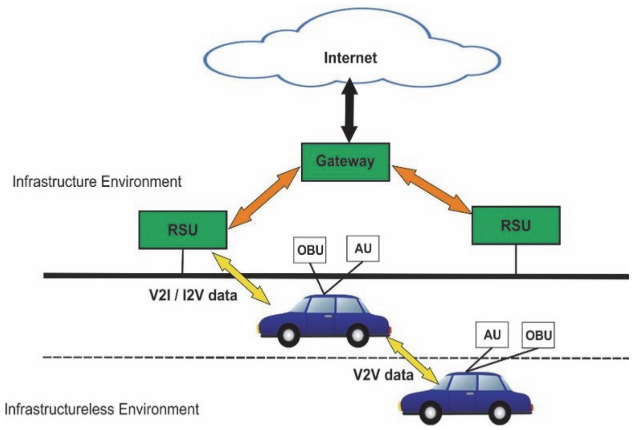

Figure 1 VANET architecture

Based on broadcast or geographic technology, entrepreneurial vehicles are cautious and prominent in reviewing vehicle data distribution close to two main categories. The main reason is that the groaning broadcast technology has the processing that vehicles do not always care about every event, and different scenarios are expensive. Without exception, rely on the propagation of information to all vehicles that are useless in the network. This shortcoming has led to the emergence of another alternative: the distribution of vehicles in specific areas based on the information allowed by Geo-cast technology. Geo-casting is the most feasible data distribution method for VANET applications, especially in security applications [2]. Security incidents stand close to the occurrence of events and are aspiring to cars within a specific range.

Provisioned QoS leads to frequent routing path interruptions because of their functions, a real challenge in

VANET. The data package is obtained within the guaranteed delivery time and the Guarantee Service (GS) is reduced to overbuffer flow. Multimedia application types generally have minimal data transmission rates and delays, and many other points of QoS requirements. Most current MANET routes include meeting these two needs, and the difficulty of designing VANETS with protocols and QoS is due to the following reasons. It is easy to catch some people but fails to lease neighbour availability information [3]. QoS guarantees usually come from the throughput, packet loss rate, and average delay of a given bandwidth allocation. In some schemes, the quality of service is provided by the Mobile Ad Hoc Network (MANET) guarantee. Therefore, the implementation of an appropriate network topology does not determine the conference's QoS requirements. Multi-channel communication method based on the MAC protocol without contention/synthesis cluster distributed cluster. Therefore, the multi-funnel architecture within V2V QoS minimizes data congestion to ensure the real-time transmission of security messages.

The main contribution of this work is the development of a dynamic QoS-aware data congestion control mechanism for mobile ad hoc networks (MANETs). The mechanism incorporates a dynamic routing algorithm that considers real-time traffic conditions and congestion levels to make optimal routing decisions, while also introducing congestion-aware packet-dropping techniques to alleviate congestion-induced packet losses. It proposes adaptive QoS metrics that can be adjusted according to different network scenarios and application requirements, ensuring flexibility in meeting diverse QoS needs. Through comprehensive simulations and performance evaluations, the proposed mechanism demonstrates superior network throughput, reduced packet loss rate, and improved overall QoS satisfaction compared to existing approaches. Additionally, the mechanism emphasizes scalability and real-time performance, making it suitable for large-scale MANETs and enabling efficient adaptation to dynamic network conditions and congestion changes.

2 RELATED WORK

They are used for aggregate traffic information on multi-hop, two-layer, distance-dependent protocol high-speed broadcast network support. The use of control messages and the random size of the first layer depends on the distance to ensure that each hop sent is as fast as possible. Each vehicle is named a cluster-based expert collaboration algorithm optimized link-state routing protocol, used to infer reliable and low-cost routing an added new mechanism for the QoS algorithm. The CACA algorithm [4] was introduced to improve the ability to maintain longevity.

Adaptation decisions should be based on the current situation of VANETS. Therefore, it is characterized by VANETs transitional measures that need to be evaluated in the HCR-VANET (High Load Cognitive Radio), application service into a Secure Application Service (SAS) and insecure application services. It not only increases the probability of receiving SAS but also maximizes the likelihood of SAS [5] based on the channel allocation scheme SMDP (SMDP-CAS).

Network-wide QoS can be decomposed through attacks and operations in the routing process of routing control messages. The new secure service constrains VANET's quality multi-aware routing algorithm. Ant Colony Optimization (ACO) technique to calculate the target VANET plurality of possible routes QoS constraints to determine the type of data traffic. It extended the implementation of verification by exchanging routing control messages between vehicles to the VANET-oriented Evolution Map (VoEG) model [6].

However, the basic channel access mechanism for access to enhanced distributed channel access is unpredictably not due to random and guaranteed QoS. To solve this problem, a method based on the so-called early carrier sense multiple access to a new channel access method. According to the time limit, providing a QoS guarantee in the flow multi-channel environment, to avoid real-time collision [7] introduced the priority of the access control strategy.

The reliability of routing also requires special care because communication links often break [8] VANETs. Multi-objective optimization, and the implementation of fuzzy logic to make appropriate gateway decisions based on the QoS scheme. This standard relates to the signal strength, load, and vehicle link connection time received by the cluster head and candidate gateway on the vehicle [9].

However, the dynamic characteristics of VANETs have a significant impact because of the vehicle's fault detection performance and a communication link failure high fluidity. Therefore, it is very meaningful to design the appropriate fault detection to deal with the dynamics of VANET. Multiple applications for fault detection can adapt to dynamic network conditions and meet the requirements of VANET [10]. The quality of service conforms to different qualities.

However, with the increase in vehicle routes and cooling methods from packet loss rate (PLR) and frequent video playback, the results suffer from a limited lifespan and low connection probability. PLR minimizes mass quality parameters (number of meetings and the quality of frozen delay constraints for transmitting video data packets) to distribute video data packets by multiple pathways simultaneously while satisfying quality of service (QoS) [11].

The highest QoS routing protocol data packets to the intersection by the adaptive destination, and the selected route index has three QoS constraints: connection probability, packet arrival rate, and delay. To achieve these goals, have developed to solve this problem on a mathematical algorithm based on the routing problem [12] by an Ant Colony Optimization (ACO) constrained optimization problem.

The priority and resource management algorithms priority packet processing priority issues, such as a backpack punishment more common ground, and to prove that it is an NP-hard problem. Therefore, using the formula Can use the general process of the received vehicle network packet. [13] develop a real-time version of loose inspiration.

For a limited time, the traffic density change will be transmitted in two reliable packets. MAC protocol must adapt to variable flow density in this case. The coverage and reliability delay MAC to the MAC and DCC (dispersion congestion control) stable state [14] of the evaluation.

Channel to be measured using the level data detection channel congestion. These messages are collected, filtered, and then clustered through machine learning algorithms. Based on the message's size, the validity of the message, and the message clustering algorithm K-means message. The data congestion control unit determines the transmission rate for each cluster range [15], with appropriate values for the contention window size and arbitration frame interval.

In a congested network, the shared wireless channel may become congested, and broadcast messages may not be delivered, potentially affecting the reliability of the application. Scalability issues have been identified as one of the large-scale deployment-faced vehicle safety networks [16] to meet the challenge.

Due to the congestion of the VANET solution, the literary studies of some works are congested and controlled. However, they consider packet loss as an indication of channel congestion regardless of channel conditions: the transmission power and data rate perceived by the channel congestion control algorithm. For packet loss, such as severe fading channel congestion and diagnosis, consider the received signal strength to diagnose [17] packet loss.

To maximize the level of consciousness, the congestion control mechanism should avoid collision light damage in dense traffic environments. In addition to congestion control, it is the most suitable for its own power and security applications, and vehicle sharing network bandwidth requirements. There are many problems with the current congestion control mechanisms, including overhead, fair, just, and conscious control information [18].

They distributed Congestion Control algorithms for adjusting the specified channel not only to avoid congestion but also to meet the age information. The application of safety-critical C-ITS (Cooperation in intelligent transportation systems) [19].

However, how to design an efficient real-time information-sharing mechanism, travel time estimate (TTE), and dynamic path planning and real-time implementation remains a challenge. According to the roadside traffic distributed system, it initially has a real-time traffic information-sharing mechanism with low redundancy and low computational complexity.

3 MATERIALS AND METHODS

One of the key requirements is to meet QoS while transmitting data in the vehicle environment. To achieve this goal, the VANET cooperative QoS Aware Based Data Congestion Control has been proposed. The QoS-ADCC algorithm's goal is to find some QoS indicators, the best route from the source to the destination: connection probability, packet arrival rate, and delay. These indicators are frequently used for each road segment and combined with estimated relay quality. As mentioned earlier, the QoS-ADCC algorithm associates passive and preventive elements to establish and maintain the routing of data packets. If the source route from the target path is not available, first search the candidate route for the reaction forward ant and the reaction backwards, by the source, the reaction route is implemented in the wireless network the best route for building and updating the pheromone as they pass through intersections.

3.1 QoS Estimation Method

Keep in mind that the most advanced solutions can be used in the VANETs route in many countries, and these solutions are not sufficient to provide QoS for different applications in these networks. This is high mobility within the node's VAENTs, resulting in a constant topology change. The new solution needs to send this information to its final destination within constraints that are effectively associated with a given time. Keeping all the above points in focus, a new routing QoS-ADCC algorithm is the fastest path from any source of packets to the destination. The main goal here is to achieve the shortest amount of high PDR with minimal overhead in time. Fig. 2 shows the proposed block diagram.

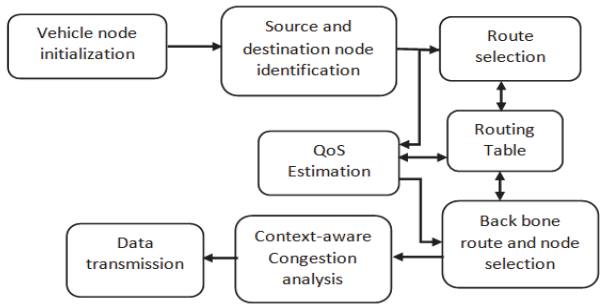

Figure 2 Proposed method block diagram

Propose QoS-ADCC algorithm recovery to avoid fault-tolerant and fast quality of service QoS in case of link failure. The residual of the neighbour and the QoS requirements for entering the streaming service are necessary for sending data. Therefore, bandwidth estimation is considered to provide QoS services Ad hoc networks. Bandwidth estimation is a difficult task because each host has network status, and dynamic link changes inaccurate knowledge.

Link stability: The maximum bandwidth that the link must have.

Distance: The concentrated distance from the destination.

Speed: Towards a destination having the maximum vehicle speed is given priority.

3.1.1 Algorithm

Step 1: Link stability factor (LS) and distance is the ratio of the busy time divided by the duration of the packets.

if (distance new [S, D] < distance ex) then
distance [t] = distance new
else
distance [] = distance ex
end if
return distance [t]

When the vehicle leaves the source vehicle in front of the shortest distance, the vehicle leaves, leaving an intermediate link or network stability.

Step 2: The actual data rate for data transmission needs to be computed, i.e., throughput. It is the packet size (in bits), which is going to be transmitted by the time of the transmission of these bits for segmentation.

Step 3: But the vehicle is moving in the packet, and frequent speed changes of priority in the network topology, routing VANET, therefore, lead to more complex routing problems.

Number of data packets = $\{p_1, p_2, ..., p_n\}$

For each data packet, P_i Vehicles do

If the packets generated low-priority applications then $s_p i = 1$;

End if;

If packets generated medium priority application then $s_p i = 2$;

If packets generated high-priority applications then

$s_p i = 3$;

If packets generated equal priority send the data packets equal time.

$s_p i$ = given equal priority;

From a functional point of view, the original route is a mechanism for setting the criteria from the source node to the destination node through the data packet communication network.

3.2 Contexts-Aware Congestion Resolution

A new context-aware congestion resolution is determined by the minimum calculated desired time (MCDT), VANET, and intelligent data distribution. Using this MCDT, connection stability is calculated first. The peak stability region is then used for virtual connection with the nodes configured as estimates. For the link to use the minimum angle is also proposed deletion recovery module. This QoS-ADCC method can be in a wide range of industrial applications, where the need for low latency and more precise transmission of information is used in environmental awareness. The proposed QoS-ADCC method is evaluated by changing parameters such as vehicle speed and density in different network scenarios. In the safety-related events discussed, the communication overhead introduced to/from the central control node, vehicle-to-vehicle notification, and context-aware information can be huge, the final design model is unrealistic, and the event may fail. As a result, distributed and self-organizing capabilities are sometimes expected in VANET, especially for delay-sensitive applications. The probability of successful transmission decreases as the vehicle density increases. As the density increases, there is at least overhead for MCDT ((MinimumCalculated Desired Time) to exchange messages and to lose overhead packets.

$$\begin{aligned} &Miniumum\ Calculation\ Desired\ Time = \\ &= actual\ connestion / potential\ connection \end{aligned} \quad (1)$$

The temporal and spatial characteristics of VANET traffic conditions can range from very sparse to very dense spatial variation. For example, the time, of a region depends on the time of day. As a result, real-time, accurate quality of service is very difficult to estimate VANET city. Fig. 3 shows the flow diagram for Context-Aware Congestion Resolution.

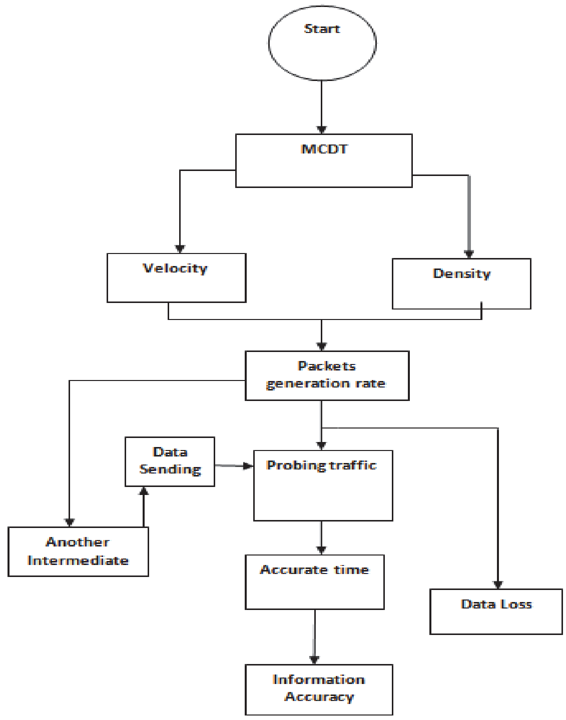

Figure 3 Context-aware congestion resolution

The congestion control strategy relies on transmit power adjustments, the design goal is a balanced tradeoff between power and data packet generation rate. Although higher packet generation rates tend to improve the accuracy of updates and information, uncontrolled strategies can also easily lead to saturated media. Similarly, messages are sent with high transmit power, reaching long distances and increasing the level of interference with other ongoing transmissions.

3.3 Backbone Best Route Estimation in VANET

More specifically, it studies the problem of discovering the backbone of traffic networks. It considers the topology of a network and a traffic log, recording the amount of traffic that is incurred between the source and destination

Step 1: The public transportation network map can be described as $B = \{T, D, A\}$, so the public transportation network map between any two public transportation stations and all public transportation routes are guided routes.

Where T is all public transportation stations of the group, D is the public transportation route of the group and is from any public transportation station. A is all public transportation routes of the collection group.

Step 2: The input includes the set route, and the output can reach the station start T and the terminal station A.

Step 3: for all $T \in A$ do

$T_1, \ldots, T_n$ = : traffic station

$D = (A; T_1, \ldots, T_2, \ldots, T_n)$

initial conditions for $i = 1, \ldots, n$ and $I = 1, \ldots,$ max

Backbon Network M

If(($T_{1, \dots, n}$) + ($D_{1, \dots, n}$) then

Step 4: If T and D can be reached directly, then, until a feasible is to obtain the starting T at the time of change, change three times, the routing information of the exit and the exit are recursively transmitted and can reach the end.

By increasing the connectivity in the network to provide infrastructure, you can create a complete ad hoc, live backbone network through simulation and analysis models, through real data and evaluation, and statistical analysis [20-24].

4 RESULTS AND DISCUSSION

This section introduces the evaluation of the QoS-ADCC algorithm of various recommendations. The reason for choosing the urban network solution run by the network simulator NS-2 tool is to verify the performance parameters affected by the relay selection index.

The performance of each program is examined by using Network Simulator 2 (NS2). Experimental results show that its performance changes the QoS-ADCC method and QoS-based congestion control in VANET. The Experimental results show the comparison of existing system Ant Colony Optimization (ACO), Cluster-based Adept Cooperative Algorithm (CACA), and Channel Allocation Scheme Based on a Greedy Algorithm(CASGA). Tab. 1 shows the simulation settings parameters.

Table 1 Simulation Parameters

Parameters	Value
Simulation Time	200 second
Application Type	CBR (Constant Bit Rate)
Number of Mobile Vehicles	70
Transmission Range	250 m
Routing protocol	SAODV (Secure Ad Hoc On-Demand Distance Vector)
Propagation Range	Radio-Propagation Model

4.1 Throughput

Simulation results show that the throughput decreases CR-VANET (Cognitive Radio) as the vehicle speed increases. The throughput QoS-ADCC in CR-VANET can be greatly improved. Fig. 4 shows the packet throughput analysis.

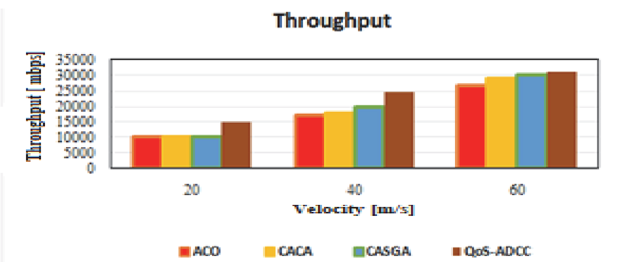

Figure 4 Throughput

$$Throughput = \frac{Packets\ \ Received\left(n\right) \times Packet\ size}{200} \tag{2}$$

where n = number of nodes.

The Throughput of the proposed QoS-ADCC (QoS Aware Based Data Congestion Control) is 31000 in Mbps compared to the existing ACO (Ant Colony Optimization) in 27000 in Mbps, CACA(Cluster-based Adept Cooperative Algorithm) 29000 in Mbps, CASGA (Channel Allocation Scheme Based On A Greedy Algorithm) 30000 in Mbps methods.

4.2 Link Stability Speed

The speed estimation model proposed includes forwarding the intermediate region between each pair of nodes, the probability distribution of expected hops speed, packets, and the estimated probability of a next hop node link stability duration found. Fig. 5 shows the link stability speed analysis with the existing method.

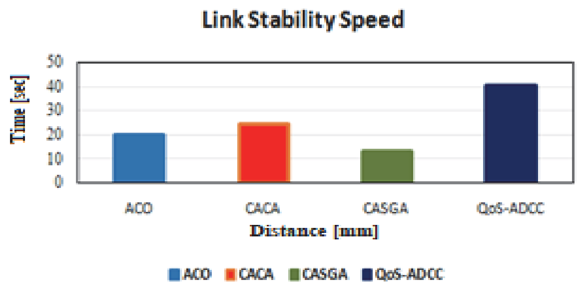

Figure 5 Link Stability Speed Analysis

$$\text{Speed}\left(S\right) = \text{Distance}\left(D\right) / \text{Time}\left(T\right) \tag{3}$$

These vehicles, roadside infrastructure and vehicles between, and characterized by processing between the message, deriving the propagation velocity of the message, and the message is provided in the instantaneous distribution of distance and time available. Based on the existing algorithms ACO (Ant Colony Optimization) in 20 meters, CACA (Cluster-based Adept Cooperative Algorithm) 24.3 meter, CASGA (Channel Allocation Scheme Based on a Greedy Algorithm)13.3 meter methods and the proposed QoS-ADCC in 40 meters.

4.3 Packet Delivery Ratio

In VANET most critical problem is the high mobility routing failures due to frequent automobiles, an increase in the network, the control message due to overload, and to increase in the packet transmission time. Fig. 6 shows the packet delivery ratio analysis.

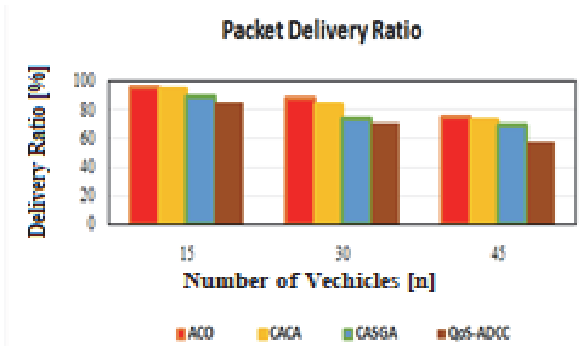

Figure 6 Packet Delivery Ratio

The vehicle destination will calculate the remaining time to route to and from the destination of the vehicle if the source vehicle data packet has been sent. If the remaining time is less than the data packet transfer direction, the average time for the source vehicle to initiate new routing requests. Otherwise, it will send the packet.

4.4 Routing Overhead

The routing overhead advantage is that it provides on-demand routing paths; flow needs not to be used by a node to inform its existence to its neighbouring packet period. Control costs through effective use of information. It has been found that the data packet transmission route from the route cache access by the node, but traffic routes proposed to reduce this overhead, breaking the local network link's maintenance are not in the line maintenance process.

$$\begin{aligned} &Routing\ overhead\ = \\ &=sum\ of\ routing\ packets/sum\ of\ data\ packets \end{aligned} \quad (4)$$

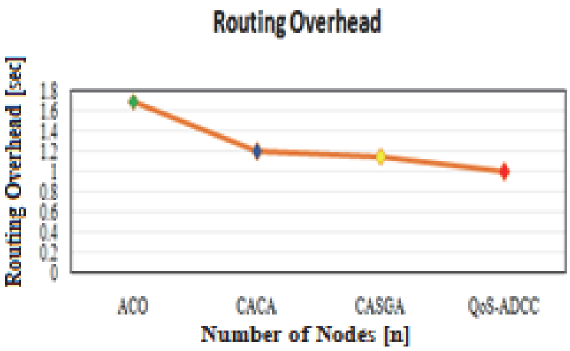

Figure 7 Routing overhead

As shown in Fig. 7, the routing overhead rate schemes vary. QoS-ADCC algorithm shows the routing overhead value1 and then the existing algorithms CASGA in 1.15, CACA in 1.2, and ACO in 1.7 overhead values.

Table 2 Performance analysis

Approach	QoS Considerations	Congestion Control	Routing Protocol	Performance Evaluation
Proactive	Yes	Yes	AODV	Simulation (NS-3)
Reactive	Yes	Yes	DSR	Experimental (Testbed)
Hybrid	Yes	Yes	OLDER	Analytical Model
Proactive	Yes	Yes	DSDV	Simulation (OMNET++)
Reactive	Yes	Yes	DYMO	Simulation (OPNET)

5 CONCLUSION

QoS based on congestion control is a difficult task to provide these networks with the special characteristics of Intelligent Transportations Systems. The development of wireless technology is very rapid, but most users still need high data rate applications they use, especially when they are from one place to another. In this regard, maintaining QoS Ad Hoc networks for various applications of vehicles is a difficult task. To solve this problem, VANET recommends a new cooperative QoS-ADCC. The QoS information is transmitted back to the found vehicle through the route response processing source. Investigation agents guarantee forward to explore the entire route to the destination network discovery. It also found that the routing information collected in the course of its routes. Finally, the proposed QoS-ADCC algorithm gives better results of throughput value is 31000 Mbps, Link Stability Speed of 40 meters, Packet Delivery Ratio is 1.2% and routing overhead is 1.

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