HOQC-MAC: QOS AWARE CLUSTER-BASED MAC PROTOCOL FOR VANET USING HYBRID OPTIMIZATION ALGORITHM

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Abstract

Numerous safety-related applications have several safety-related programs designed to improve road traffic on VANET networks. As the demand for wireless security and non-security applications increases, so does the need for efficient bandwidth usage and reliable data transmission. Various communication services and applications reduce the radio frequencies provided to them. The IEEE 802.11P standard, which allows wireless access to the hard drive via DSRC bands, does not give enough spectrums to send reliable information over busy channels. Recent ITS developments require a reliable MAC protocol to support high-priority security message broadcasts.

Additionally, the IEEE 802.11P standard, which allows wireless access to the VANET DSRC frequencies, does not provide enough spectrums for the lossless exchange of information over congested channels. This paper proposes a QoS aware cluster-based MAC protocol (HOQC-MAC) for VANET using a hybrid optimization algorithm. First, we introduce a tree-seed induced coyote optimization (TSCO) algorithm for clustering to group the vehicles, improving energy efficiency. Second, we develop a chaotic transient search optimization (CTSO) algorithm to monitor the channels and guide the RSU to enhance channel utilization and subcarrier collision problem. Third, we illustrate an extreme learning-based artificial neural network (EL-ANN) decision-making technique to compute the proper communication candidates, minimizing the lossless data transfer. Finally, you can simulate a specific HOQC-MAC protocol and compare it to existing protocols such as carrier contention, latency, packet delivery speed, and bandwidth.

Keywords: VANET, HOQC-MAC, CTSO algorithm, TSCO algorithm, EL-ANN technique

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1. INTRODUCTION

The intelligent transport system (ITS) structure is a framework for modern road transport infrastructure. Automatic line elevation in case of damage; Operations management promotes public safety goals such as traffic jams and collisions. Equipping vehicles with various onboard sensors and vehicle-to-vehicle (V2V) communication capabilities will allow you to gain further understanding, decision-making, and control measures to achieve these goals. 5.9 GHz or 75 MHz is licensed in the typical short telecommunication network, supporting seven different channels and providing short-term multimedia content for future vehicles [1]. Divide both direct and unreliable time transmission and quality of service (QoS) requirements for vehicle ad hoc network (VANET) [2]. Pocket lag and data swelling significantly increase compared to the number of vehicles competing with standard wireless devices, and vain discrepancies increase substantially [3]. Clustering is an effective technology to reduce data congestion and support QoS over wireless networks. They offer a district-based multichannel communication program that provides QoS, reduces data traffic through the V2V networks, and integrates clustering with Media Access Control (MAC) protocols under the DSRC multilateral framework [4][5]. Temporary car networks are of great interest to academics and experts. In particular, VANETs have recently been explored using popular technology. Data security and integrity in cloud-automated networks, for example, have been investigated [6] [7]. In addition, for successful usage of cloud search engines, some of the essential ranking search engines include cloud data. Security-related use of VANETs is made more accessible with V2V and V2I communications.

Road cars, in particular, can communicate with one another through temporary multifunctional connections. [8] [9]. RSUs, which are the fundamental purpose of VANET, provide access to the Internet and other broadband services. [10] [11]. When the vehicle exits the RSU radio coverage area, it can be placed in the coverage area between two neighboring RSUs and used as a relay for neighboring vehicles to enter the RSU. Temporary Road Networks are primarily designed to improve road safety [12]. They can improve traffic management and get information about the board, such as the Internet and video streaming. VANET is an example of mobile ad hoc networks (MANET), but with its peculiarities: High-level mobile traffic and mobile nodes have sufficient power and computing power [13][14]. The MAC protocol used in conventional wireless networks is incompatible with VANET due to the changeable topology. In the United States, the IEEE 802.11P and IEEE 1609.4 standards define the usage of the Wireless Access (Wave) architecture for Venetian communications. To connect with VANAT, one control channel (CCH) and six service channels (SCH) are assigned by default [15] [16]. However, Wave Mac's current configuration does not support lazy apps due to the contentious media access technique and standard CCH Intervals (CCII) and SCH Intervals (SCII). In this instance, VANET will need to create a reliable and efficient MAC protocol to ensure package delivery [17]. However, from an access transmitter understanding, CSMA/CA impacts the hidden terminal problem that occurs when a receiver and two transmitters overlook each other. The hidden terminal problem as network load increases leads to a drastic performance reduction [18]. CR-VANET (CCRV-MAC) [19] is used for companion MAC security applications, enabling vehicle cooperation by transferring channel status reports for active channel switching in the initial user form. The adaptive multi-priority distributed multichannel (APDM) MAC protocol [20] is used by Markov to analyze the potential of pocket transmission.

Our contributions. A QoS aware cluster-based MAC protocol (HOQC-MAC) is proposed for VANET using a hybrid optimization algorithm.

- A tree-seed induced coyote optimization (TSCO) algorithm is proposed for clustering to group the vehicles, improving energy efficiency.
- A chaotic transient search optimization (CTSO) algorithm monitors the channels and guides the RSU to enhance channel utilization and subcarrier collision problem.
- Extreme learning-based artificial neural network (EL-ANN) decision-making technique is used to compute the proper communication candidates, which minimizes the lossless data transfer.
- Finally, the proposed HOQC-MAC protocol can evaluate through different simulation scenarios. The performance of the proposed protocol can be compared with the existing state-of-art protocols are TDMA-MAC [21], GAH-MAC [22], AMC-MAC [23], SCMAC [24], CCHI-MAC [25], DCI-MAC [26], SDN-MAC [27], MP-MAC [29], SOM-MAC [30], OEC-MAC [31], CB-MAC [32] and AHT-MAC [33] in terms of carrier collisions, latency, packet delivery ratio and throughput.

The rest of the paper is organized as follows: Sect. 2 describes the recent works related to the MAC protocol for VANET. Sect. 3 provides the problem definition and network model of the proposed HOQC-MAC protocol. This section discusses the proposed HOQC-MAC protocol's detailed validity. 4 Models that are related mathematically The examination of simulation results and comparison of the HOQC-MAC technique are described in this part. 5. The essay concludes with interest. 6

2. Related Works

Cao et al. [21] proposed a novel adaptive Multiple Access-based MAC. It has been proven by mathematical analysis and simulation experiments that VAT-MAC can significantly improve system scalability and throughput. MAC protocol plays an essential role in VANETs to provide efficient broadcast service for safety applications. However, the character of the van is rapidly changing due to its high mobility and dynamic topology, which degrades the performance of existing MAC protocols. Tianjiao et al. [22] presented a game-based TDMA MAC protocol (GAH-MAC) to solve the VAT-MAC problem. This lowest class is immediately loaded into the body to play with the reservation protocol between nodes, even if it is accurate and creates a new reservation slot. Thus, it is possible to fully use the time and open the reservation, but at the speed of the base stations. Simulation results showed that GAH-MAC outperforms high-density networks by increasing network throughput success and reservations. Tripti et al. [23] presented an asynchronous multichannel mark, the path that allows you to broadcast different channels simultaneously for a specific service. The specific program that will enable you to control access to the lymphatic channel dynamically will let you listen and does not use the control channel associated with the working channel. The scheme is compared with IEEE 1609.4 in terms of throughput and channel utilization. IEEE 1609.4 suite in WAVE is responsible for the multichannel operation in VANET. This layer supports better QoS but requires synchronization. Cao et al. [24], to support regular beacons on the VANET control channel, we designed SCMAC, a significant integrated MAC protocol. SCMAC relies on the dependability and scalability of its communication protocol. Even when cooperating with hostages, Union credibility is the light of faith. This means that the minority is coming in via the hole, and the node density drops. On the other hand, reserving an active slot closes the idle gap as quickly as possible and links more nodes to the network. The findings of this simulation reveal that a specific protocol provides the SCMAC scale and periodic signals to the motor environment. As a messenger, this protocol machine is as frequent as finishing a service channel interval (SCHI) with a calm SCHI and commencing a control channel interval (CCI) (CCHI). With continual resource loss and unnecessary delay between CCHI and SCHI, VANET performance increases.

Furthermore, until all security messages have been issued, CCHI will increase. Multiple channels covering the pot head and separating the grape bowl members from it answer the problem's final boundary. Specific protocols have been evaluated using analytical models for packet delivery speed, throughput, security message latency, and packet loss rate. Modeling evaluation entails a lengthy analytical process that identifies the model's optimal protocol compared to the IEEE802 protocols currently in use.11p.

Singh et al. [26] have proposed a Dynamic Control Channel Interval (DCI) MAC diagram that can effectively change the time interval between SCH and CCH. This task now divides the SCH time into time categories according to the current network traffic load. Intelligent Transport Systems (ITS) provide road users driving assistance and multimedia services. Temporary vehicle networks are among the most critical areas for improving ITS services to improve Intelligent Transport Systems. The temporary vehicle network uses a multichannel media access control scheme that complies with the IEEE 1609.4 standard design. Luo et al. [27] proposed an SDN-based MAC protocol using ROFS is designed as a load material controlled by an open flow controller. SDN-MAC can be divided into two tiers: controller-based ROFS management (MA-ROFS) and ROFS-based vehicle management (MA-VEH). Each ROFS allocates seats based on this shared information, distinguishing the management flatness from the data tray. This separation provides SDN-MAC with faster maneuverability and more incredible speed and agility to deal with different densities of the vehicle. SDN-MAC protocol has been shown to meet the security requirements of VANET cooperation better. Nguyen et al. [28] Introduced IEEE 802.11p-based multichannel MAC protocol RSU-enabled RAM for VANET. It also comes with a tool to incorporate secure pockets that can't be transferred because of hidden nodes. Based on the packet delivery rate of safe and controlled packets, simulation findings reveal that RAM may not only send secure packets using existing MAC protocols but also break existing MAC methods. Chaurasia et al. [29] proposed a motion parameter-based cluster medium access control (MPMAC) protocol. The vehicles are lined up without messages in headless clusters. Cluster members are not migrated and can be assigned to different lines. Each group is assigned a channel that has the flexibility to use duplicate channels owned by other clusters. Safe news is a top priority on one of these channels. RSUs monitor canals and regularly advertise on canal utility maps to increase canal usage and avoid hidden station issues. The MPMAC protocol enhances system performance by increasing channel usage and improving channel access in traffic conditions such as Phantom traffic jams, route changes, and congestion. Ağgün et al. [30] proposed a self-organizing multichannel MAC (SOMMAC) where channel maintenance is allowed the mobile vehicle to quickly switch to the following RSU network without being disconnected from the network when it is at the intersection of two adjacent RSUs. Karabulut et al. [31] have proposed a novel OFDMA-based effective coordinated MAC protocol (OEC-MAC) for VANET has been suggested. This company provides subcarrier channel distribution and access systems. This method is intended not only for selecting the optimum to transmit mode but also for selecting the optimal relay. Analytical investigation using Markov chain models is used to validate the OEC-MAC protocol. The OEC-MAC protocol delivers a significant boost in bandwidth and is fully compliant with VANET security notification delays, according to numerical data. Shah et al. [32] studied the performance of the CB-MAC protocol optimized for VANET by improving the transfer probability according to the cluster size. Each machine must obtain the optimal transfer probability in the cluster, which is obtained by adjusting the number of VANET clusters. Therefore, the optimal number of clusters is determined based on the number of vehicles in the VANET. Analytical studies based on Markov chain models are given. The formula for the optimal transfer probability and the optimal number of clusters is obtained. The micro-motion model is generated by SUMO for real-life scenes. Table 1 describes the summary of the research gap.

3. Problem methodology and network model

3.1 Problem methodology

Cao et al. [33] have proposed a high throughput and adaptive multichannel MAC protocol (AHT-MAC) to support data transmissions over SCHs in VANETs. The service resource block (SRB) management plan allows nodes to identify mutually available SRBs based on information collected directly from beacons received from CCH. This handshake process continues to protect SRP from conflicting resolution systems. Clicking on the AHT-MAC achieves a high probability of success, and SCH can maximize time from throughput. To address the research gaps, we propose QoS aware MAC routing protocol for VANET, which allows dynamic allocation of channels in the band adjacent to the DSRC band. The main objectives of the proposed protocol are as follows:

1. To introduce mobility-aware clustering technique to optimize the dynamic allocation of channels.
2. A novel searching algorithm is used to continuously monitors the channel to enhance channel utilization and carrier collisions.
3. To introduce a decision-making algorithm to compute the proper communication candidates and prepare available resources before transmissions.
4. The proposed MAC protocol is used to enhance the QoS metrics, i.e., improve the packet delivery ratio and throughput and reduce the subcarrier collision and latency.

3.2 Network model

Fig. 1 shows the network model of the proposed HOQC-MAC protocol consisting of high-density vehicles and roadside units (RSU). Data such as average speed, waiting time, and the number of parked cars. In front of the advertisements, there is an RSU traffic control system. Some HOQC-MAC methods are successful in sending data from the CM to the RSU's CH. The information acquired by the CM is forwarded to the appropriate CH via the cluster channel. The automobile (CM) must calculate the distance from CH and choose the shortest distance as CH when referencing a car at an intersection. Cluster passive routes are used to forward data to CH neighbors. The movement of a vehicle depends on various factors such as road topology, moving speed, and direction for the forwarding decision.

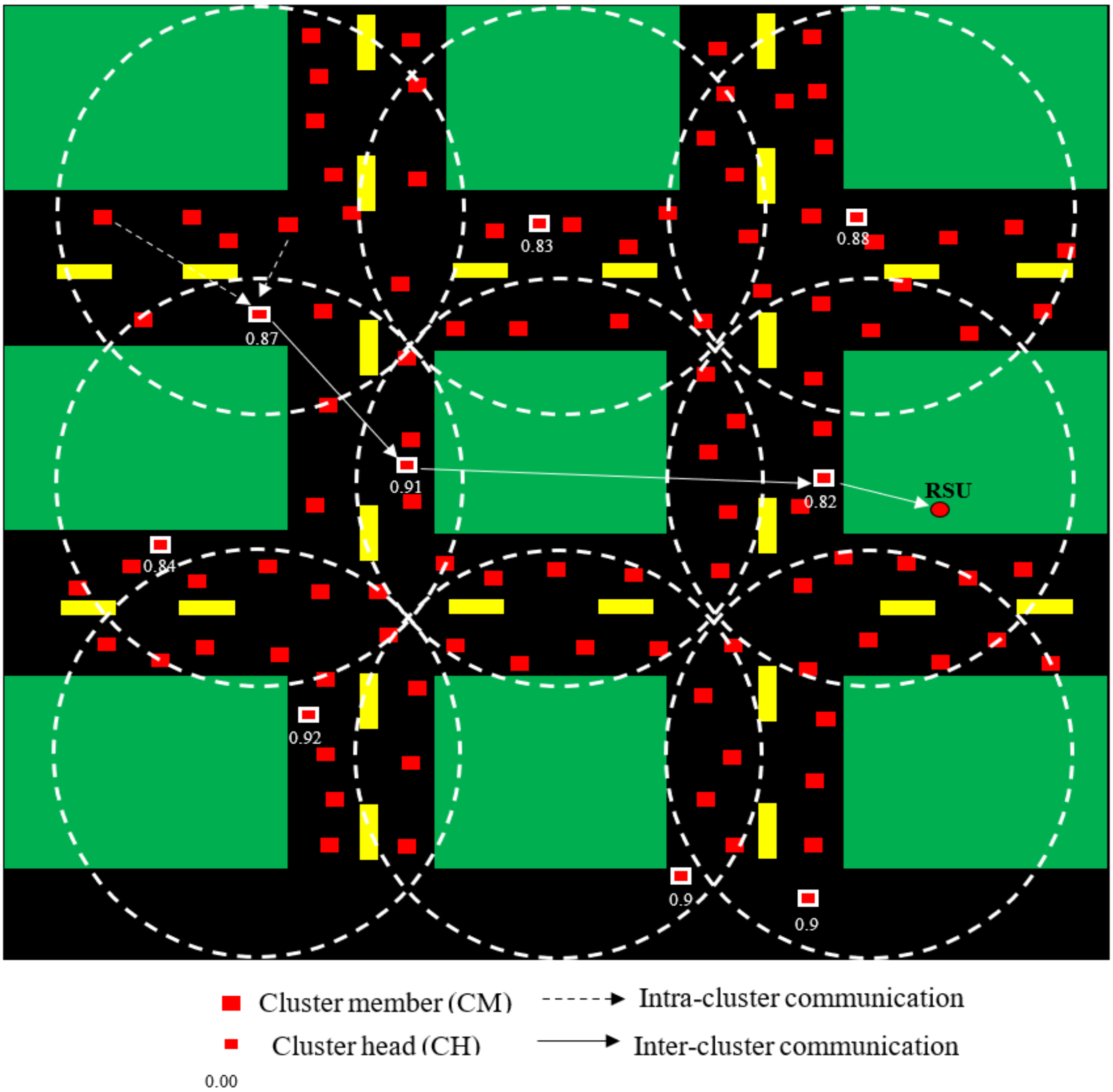

Fig. 1 Network model of proposed HOQC-MAC protocol

4. Proposed HOQC-MAC protocol

The working process of the HOQC-MAC protocol consists of three folds. The clustering process (clustering and cluster head (CH) selection) is discussed in the following sub-section 4.1. Then, the process of channel monitoring and RSU guidance is described in sub-section 4.2. The proposed routing is given in sub-section 4.3.

4.1 Clustering using tree seed induced coyote optimization (TSCO) algorithm

Clustering is one of the most important ways to evaluate large amounts of important information as it can provide valuable information for transportation planning as it can better understand groups and their travel characteristics to understand important differences. At the same time, grouping them according to their travel characteristics is an important way to test the performance of specific groups in the overall population of the vehicle and in the travel profile. Here we applied a tree-seed induced coyote optimization (TSCO) algorithm for clustering to group the vehicles, which improves the energy efficiency. The coyote population in COA is divided into two groups M_q consisting of M_d each coyote; in the first suggestion, the number of coyotes in each pack is constant and consistent across all packs. As a result, multiplying the algorithm's total population yields the total population of the algorithm $M_q \in M^*$ $M_d \in M^*$.

In addition, the social situation of the d^{th} coyote in the forest q^{th} cram in the T^{th} current time is specified.

$$soc_d^{q.T} = \vec{y} = (y_1, y_2, .. y_C) \qquad (1)$$

where C shows how many decision factors there are, it also implies that the coyote has adapted to its surroundings $fit_d^{q.t} \in S$. In the establishment of the social situation of the d^{th} coyote in the forest, q^{th} a collection of i^{th} A vectors specifies the dimension.

$$soc_{d.i}^{q.T} = Wa + s_i.(va_i - Wa_i) \qquad (2)$$

where Wa_i and va_i represents, respectively, the range's bottom and upper bounds i^{th} variable of choice and s_i is a genuinely random number generated within the bounds of the range [0, 1] Using a probability distribution with a uniform distribution. To assess each coyote's fitness function or adaptation to the environment, $M_d \times M_q$ given their socioeconomic circumstances, coyotes in the environment.

$$fit_d^{q.T} = f\left(soc_d^{q.T}\right) \qquad (3)$$

In the case of a minimization issue, the alpha of the solution q^{th} crams in T^{th} a moment in time.

$$alpha^{q.T} = \left\{soc_d^{\backslash q.T} \middle| \arg_{d=\{1,2....M_d\}} \min g\left(soc_d^{q.T}\right)\right\} (4)$$

The COA connects all of the coyote's data and calculates each pack's cultural tendency:

$$cul_i^{q.T} = \begin{cases} o_{\frac{(M_d+1)}{2}.i}^{q.T} & M_d \; is odd \\ \dfrac{o_{\frac{M_d}{2}.i}^{q.T} + o_{\left(\frac{M_d}{2}+1\right).i}^{q.T}}{2} & .otherwise \end{cases} \qquad (5)$$

where oq T indicates the social status of all coyotes in the area q^{th} cram T^{th} at each instant of time I in the price range [1, C]. The alpha influences coyotes at the same time (δ_1)and by the pack's other coyotes (δ_2)

$$\delta_1 = alpha^{q.T} - soc_{ds_1}^{q.T} \qquad (6)$$

$$\delta_2 = cult^{q.T} - soc_{ds_2}^{q.T} \qquad (7)$$

The alpha δ_1 Influence denotes a cultural distinction from a random pack coyote Ds_1 to the leader coyote. In contrast, the pack's influence δ_2 indicates a difference in culture from a random coyote Ds_2 to the pack's cultural tendencies. There are two types of agents in the basic TSA for effectively searching the solution space. This is a collection of seeds and trees. The trees, known as stands, are randomly sown to the search space during the algorithm's initialization.

$$t_{j.i} = W_i + s_{j.i} \times (E_i - W_i) \qquad (8)$$

Where $t_{j.i}$ represents j^{th} tree location on i^{th} the dimension, W_i and E $_i$ are the solution space's bottom and upper boundaries, respectively, and $a_{j,i}$ is a uniformly generated random number in the range [0, 1].

$$A = \arg\min\left\{g\left(\vec{t}\right)\right\} \qquad (9)$$

Two alternative equations can be employed to generate fresh seeds from this stand.

$$R_{T.i} = t_{j.i} + \alpha \times (A_i - t_{z.i}) \qquad (10)$$

$$R_{T.i} = t_{j.i} + \alpha \times (t_{j.i} - t_{z.i}) \qquad (11)$$

Where j and z the indices should not be the same, and α scalability factor. An important aspect in the process is which equation is utilized to update the dimension of a seed that will be generated for a tree. The working function of Tree seed induced coyote optimization is described in algorithm 1.

Algorithm 1 Clustering using TSCO

Input : Population
Output: Seed

1 Initialize the parameters
2 Compute the objective function value
$$soc_{d.i}^{q.T} = Wa + s_i.(va_i - Wa_i)$$
3 Determine the problem solution
$$fit_d^{q.T} = f\left(soc_d^{q.T}\right)$$
4 Compute the equation
$$alpha^{q.T} = \left\{soc_d^{\backslash q.T} \middle| \arg_{d=\{1,2....M_d\}} \min g\left(soc_d^{q.T}\right)\right\}$$
5 Compute the alternative equations

$$R_{T.i} = t_{j.i} + \alpha \times (A_i - t_{z.i})$$

6 End procedure

After the cluster formation, BS collects vehicle information such as mobility, received signal strength, node vacant, and congestion rate for the CH selection process. The conventional metric of transmission resolution produced with practically all horizontal transmission algorithms is Signal Acceptance Power (RSS). RSS is the most widely used standard since it is simple to assess and is directly related to service quality. RSS feeds and the distance between a mobile device and its connection has a strong correlation. Wireless node with high power The amount of power consumed is determined by the size and distance of the data. The energy consumption of a node is proportional to the square of distance (D^2) when the propagation distance (D) less than the threshold distance (D_0). Otherwise, it is proportional to (D^2). The total energy consumption of each node in the network transmits and receives n a bit data packet.

$$E_{total} = T(n, D) + R(n) \quad (12)$$

where $T(n, D)$ and $R(n)$ are energy consumption of transmitting and receiving nodes.

$$T(n,D) = \begin{cases} n \times E_{elec} + n \times \varepsilon_{fs} \times D^2; & if\ D < D_0 \\ n \times E_{elec} + n \times \varepsilon_{mp} \times D^4; & if\ D \geq D_0 \end{cases} \quad (13)$$

$$R(n) = n \times E_{elec} \quad (14)$$

where E_{elec} the energy is dissipated per bit to run the transmitter or receiver circuit, The transmitter amplifier model determines the amplification energy for the free space and multi-path models, as well as the threshold transmission distance. All attacks are regarded to be liable for energy use. The distance and transmission energy determine RSS. If the node transmits a packet with energy $T(n,D)$, the nodes received signal strength RSS, with the distance of D, can be expressed as follows:

$$RSS = \frac{T(n,D)}{4\pi D_i^2} + T_{a,a_1/a_2} \quad (15)$$

Mobility, The selected locations that meet the strength and restrictions of the currently selected signal accurately determine distance and relative velocity, but such points do not exist in the sample domain. The signal intensity of a node is determined using a variety of reference sites. This graph calculates the vehicle's relative speed. 3. In the equation, somewhere (10)

$$D_{i_1}^2 = D_{i_2}^2 + a_1 a_2^2 - 2D_{i_2} \cdot a_1 a_2 \cdot \cos(\alpha) \quad (16)$$

$$D_{i_3}^2 = D_{i_3}^2 + a_1 a_2^2 - 2D_{i_2} \cdot a_1 a_2 \cdot \cos(\beta) \quad (17)$$

The current position of the node is a, and can move to a_1 and a_2 in two reference points, respectively. Consider $\cos(\alpha) = -\cos(\beta)$ and simply the above equation to compute velocity (v) as follows:

$$2a_1 a_2^2 = D_{i_1}^2 + D_{i_2}^2 - 2D_{i_3}^2 \quad (18)$$

$$v = \sqrt{\frac{2\left(D_{i_1}^2 + D_{i_2}^2 - 2D_{i_3}^2\right)}{2\Delta t}} \quad (19)$$

The movement duration for a mobile node from the current position a to the moved position a_1 a_2 is expressed as the distance $T_{a,a_1/a_2}$ divided by the node's velocity, and it can obtain by sign law as follows:

$$T_{a,a_1/a_2} = \frac{R \cdot \sin \vartheta}{\sin \beta \cdot v} \quad (20)$$

Applied formulation (14) in to (18) and we got,

$$M = T_{a,a_1/a_2} = \frac{\Delta t \cdot R \cdot \sin \vartheta}{\sin \beta \cdot \sqrt{\frac{\left(D_{i_1}^2 + D_{i_2}^2 - 2D_{i_3}^2\right)}{2}}} \quad (21)$$

The cooperation rate of a vehicle defines the correlation between the vehicle and BS. The cooperation rate at a time between time t, is gotten the hang of utilizing a weighted customary of the attestation rating factors given by focus fixations having a place with the neighbors set off the middle. Likewise, to fulfill a certain examination of focus point practices, keep up a key section from mixed up zone in light of affiliation breaks, and certification that the fixations which are changed non-strong due to their obliged assets are not rejected from the structure, with a thought of the immaterial effect on the evaluation of the last intrigue respect. The condition is used to compute the cooperation rate of vehicle (i) at time interim (t).

$$C(i,t,F) = disatnce(x_i(t), BS(t)) \quad (22)$$

The load on the vehicle is calculated using the reset indicator. Swelling can be found in each intermediate vehicle here, and parents can be notified to have their luggage delivered at a slower rate based on the level of swelling. For each car, the minimum fare is calculated as follows:

$$CR = v_i = \frac{\sum_{i=1}^{N} PI(P_i) - PI(P_i)}{\sum_{i=1}^{N} PI(P_i)} \quad (23)$$

where the vehicle's base rate i is v_i and $V = \{v_i, 1 \le i \le m\}$; $PI(P_i)$ is The vehicle importance index is a quantitative indicator that is computed. It can be defined as follows:

$$PI(P_i) = \sum_{n_i \in L_{ij}^m} C(n_i) \quad (24)$$

Where $C(n_i)$ The connectedness degree describes how near the vehicle is to its surroundings. To indicate the degree of connectedness, we utilize a coverage probability. It is possible to acquire it by

$$C(n_i) = |\sigma_{ij}(n_k)| \quad (25)$$

where $\sigma_{ij}(n_k)$ represents the edge number from n_i to n_k on a vehicle L_{ij}. Then, the rank of each vehicle is computed as follows:

$$R_i = RSS + M + C + CR; \qquad i = 1, \ldots, n \; (26)$$

Finally, the CH will select as follows:

$$CH = \max(R_0, R_1, \ldots, R_n) \quad (27)$$

4.2 Channel monitoring using chaotic transient search optimization (CTSO)

Channel usage is statistics that represent the specific frequency of the channel or the use of air. Traffic transmissions will increase with increasing channel usage. The aim of this document is to combine basic lessons and best practices at the highest level. Technology related to cars is still emerging technology. Here we applied Chaotic Transient Search Algorithm (CTSO) to monitor the channels and guide the RSU to enhance channel utilization and subcarrier collision problem, which is a new physics-based met heuristic algorithm that mimics the unstable switching behavior of circuits such as inductors and capacitors. The movement is roughly controlled by the following equation:

$$y_{jc}(T) = y_{jc}(T-1)e^{3-\psi_c y_{jc}(T-1)} \quad (28)$$

Describe the process of changing the position

$$\text{d}\begin{cases} x_j(T) = x_j(T-1)^{(1+s_j)} \\ y_{jc}(T) = (y_{jc}(T-1) + U_{jc}) \times e^{(1-e^{-bx_j(T)})}(3 - \psi_c(y_{jc}(T-1) + u_{jc})) \\ \qquad + (q_{jc}(T-1) - y_{jc}(T-1))e^{(-2bx_j(T)+c)} - U_{jc} \end{cases} \quad (29)$$

Where Tis according to the current frequency, and (t − 1) is According to the previous repetition. Clustering is a data mining approach that automatically categorizes things into groups (clusters) without the need for prior information. Sample datasets are available.

$$R = \{y_1, y_2, \ldots y_m\} \quad (30)$$

The main purpose of the cluster is to identify the z cluster

$$D = \{D_1, D_2, \ldots D_z\} \quad (31)$$

which satisfied

$$\begin{cases} \cup_{j=1}^{z} D_j = R; \\ D_j \cap D_j = \theta,\ j, i \ne 1,2\ldots,z;\ j \ne i \\ D_j \ne \theta, \qquad j = 1,2\ldots..z \end{cases} \quad (32)$$

Similar (or related) data in one cluster and objects (or unrelated) in other clusters are the criterion for this classification. In terms of mathematics, the cluster D_j can be determined using

$$\begin{cases} D_j = \{y_i \,\|\, y_i - k_j \,\| \le \|\, y_i - k_q \,\|, y_i \in R\} \\ q \ne j, \quad q = 1,2,\ldots,z \\ k_j = \dfrac{1}{|D_j|}\sum_{y_i \in D_j} y_i, \qquad j = 1,2,\ldots,z \end{cases} \quad (33)$$

where ||·|| indicates the distance of two data points in the sample set. k_j Is the engraving center D_j; it is the average (average) value of all points in the cluster. We can see that D_j it is written by some nearby data unitsto k_j. As a result, clustering can be thought of as a process of selecting k centers of interest $\{D_1, D_2 \ldots, D_z\}$. The sum of square error (SSE) is a general criterion for calculating cluster results:

$$SSE = \sum_{j=1}^{z} \sum_{y_i \in D_j} \| y_i - k_j \|^2 \qquad (34)$$

This creates a problem of functional optimization and objective work

$$g = Arg\ Min_{k1,k2\ldots kz} \sum_{i=1}^{m} Arg\ Min_{1 \le q \le z} \left\| y_i - k_q \right\|^2 \quad (35)$$

The frequency of the CTSO algorithm is given on the basis of the equation

$$\begin{cases} x_j(T) = x_j(T-1)^{(1+s_j)} \\ k_{q\,jc}(T) = (k_{q\,jc}(T-1) + u_{jc} \times e^{(1-e^{-bx_j(T)}(3-\psi_c(k_{q\,jc}(T-1)+u_{jc}))} \\ \qquad + (kBest_{q\,jc}(T-1) - k_{q\,jc}(T-1) \times e^{(-2bx_j(T)+a)} - u_{jc} \end{cases} \quad (36)$$

T: the current iteration step, and (T− 1) is the previous stage of repetition; (2) $k_{q\,jc}$ (T): the current state of ant j's qth desired center's cth dimension (c = 1, 2, C). In algorithm 2, the functioning function of channel monitoring using CTSO is described.

Algorithm 2: channel monitoring using CTSO

Input : Position
Output :Optimization

1 Initialize the parameters
2 Describe the position using

$$\begin{cases} x_j(T) = x_j(T-1)^{(1+s_j)} \\ y_{jc}(T) = (y_{jc}(T-1) + U_{jc}) \times e^{(1-e^{-bx_j(T)})}(3-\psi_c(y_{jc}(T-1)+u_{jc})) \\ \qquad + (q_{jc}(T-1) - y_{jc}(T-1))e^{(-2bx_j(T)+c)} - U_{jc} \end{cases}$$

3 The sample data is given as

$$R = \{y_1, y_2, \ldots y_m\}$$

4 Compute the cluster formation using

$$\begin{cases} D_j = \{y_i \,\|\, y_i - k_j \| \le \| y_i - k_q \|, y_i \in R\} \\ q \ne j, \quad q = 1,2,\ldots,z \\ k_j = \dfrac{1}{|D_j|} \sum_{y_i \in D_j} y_i, \qquad j = 1,2,\ldots,z \end{cases}$$

5 Determine the functional optimization using

$$g = Arg\ Min_{k1,k2\ldots kz} \sum_{i=1}^{m} Arg\ Min_{1 \le q \le z} \left\| y_i - k_q \right\|^2$$

6 End procedure

4.3 Routing using extreme learning-based artificial neural network (EL-ANN) algorithm

ANNs are made up of artificial neurons. Which neurons are linked to a person's weight? The network layer stores neurons and the solution travels from one layer to the next. As a result, ANN can be used to investigate regression issues and anticipate their output or outcome. Activated functions, weights, estimated weights, input and output neurons are all common components of ANN models. The strength of the through neuron connection is measured in weight (z_{ji}); here, it represents the function's result. The input of the neuron is referred to as phase. The following equation is used to calculate the basic neural network model.

$$(m)_i = \sum_{j=1}^{m} z_{ji} y_j + a \qquad (37)$$

In a distribution network, each layer's neurons are only connected to the following layer. Each layer's neurons are independent of one another. The following layer inputs are created by the layer solution: Weights are used to create linkages between the layers. In future feed ANNs, data (uncounted) nodes act as input neurons in the input layer, scaling data in the latent and output layers. Depending on the desired outcome, numerous neurons can be used in the ANN's input and output layers. The ANN model's activation function varies based on the problem's structure, and there are various functional functions. The activation function in this investigation is a sigmoid. Euler's number is denoted by E. The sigmoid activation function utilized in this investigation is defined by the equation below.

$$g(m)_i = \frac{1}{\left(1 + E^{-\alpha(m)_i}\right)} \qquad (38)$$

Gradient-based solutions are traditionally used to produce ELM. Here, $z, a \, and \, \beta$ they are determined by using this.

$$\| h(z_1,....z_M, a_1,.....a_M)\beta - t \| = Min z_j a_j \beta \| h(z_1,....z_M, a_1,.....a_M)\beta - t \| \qquad (39)$$

where h is denoted as output matrix hidden layer; the vector weight is represented as z; the bias value is indicated as a respectively. Among the output nodes and j^{th} node, then vector weight is indicated as β respectively. The matrix's target value is denoted by the letter t. This equates to the following minimal expenditure:

$$e = \sum_{i=1}^{M} \left[\sum_{j=1}^{M} \beta_j G(z_j \times y_i \pm a_j) - T_i \right]^2 \qquad (40)$$

If the gradient-based learning approach does not know the value of H, the algorithm will normally start looking for the $\|h\beta - t\|$ smallest value. In the gradient-based minimization process, the weights (z_j, β_j) are expressed. The above equation is applied for the minimization process.

$$Z_K = Z_{K-1} - m \frac{\partial e(Z)}{\partial Z} \qquad (41)$$

The set of weights (z_j, β_j) is represented as Z vector. To avoid these issues, EL is employed, and it is implemented as follows. In a particular training set,

$$\mathrm{N} = \left\{ (y_j, T_j) \| \, y_j \in r^m, T_j \in r^m, j = 1,....,M \right\} \qquad (42)$$

Then, the activation function $f(y)$ and the number of hidden nodes M are determined as follows and make a random assignment,

$$z_j, a_j = (j = 1,...,M) \qquad (43)$$

Estimate the output matrix hidden layer, which gives an output using the equation,

$$\beta = h^* \times t\left(t = (T_1,...,T_M)^t\right) \qquad (44)$$

Here, h^* is represented the Moore-Penrose inversion. When the hidden layer property mapping is unknown, the kernel matrix for the EL can be defined using the equation below.

$$\delta_{EL} = hh^t : \delta_{EL_{j,i}} = H(y_j) \times H(y_i) = k_{(y_j, y_i)} \qquad (45)$$

When the kernel is applied to the EL, the hidden layer mappings $H(y)$ are known to the practitioner, that is, the operator knows $H(y)$ instead of $k(v,u)$. The number of hidden nodes must also be specified in L. The output function of EL is then given by the following equation:

$$g(y) = H(y) h^t \left(\frac{1}{C} + hh^t \right)^{-1} t = \begin{bmatrix} k(y, y_1) \\ \vdots \\ k(y, y_M) \end{bmatrix}^t \left(\frac{1}{C} + \delta_{EL} \right)^{-1} t \qquad (46)$$

EL is implemented in a single learning step. If the value of $H(y)$ is known to the user, then according to Frénay and Verleysen, the extreme learning machine algorithm is defined by the following equation:

$$K(v,u) = \lim_{l \to +\infty} \left[\frac{1}{l} H(v) \times H(u) \right] \quad (47)$$

Algorithm 3 represents the working function of the extreme learning-based artificial neural network (EL-ANN) technique.

Algorithm 3 Routing using EL-ANN technique

Input	:Neurons
Output	: Nodes
1	Initialize the values for input parameters
2	Estimate the basic neural network model by $(m)_i = \sum_{j=1}^{m} z_{ji} y_j + a$
3	Determine the sigmoid function using $g(m)_i = \frac{1}{\left(1 + E^{-\alpha (m)_i}\right)}$
4	Compute the minimum cost on $e = \sum_{i=1}^{M} \left[\sum_{j=1}^{M} \beta_j G\left(z_j \times y_i \pm a_j\right) - T_i \right]^2$
5	Apply the minimization process as $Z_K = Z_{K-1} - m \frac{\partial e(Z)}{\partial Z}$
6	Make a random assignment $z_j, a_j = (j = 1, \ldots, M)$
7	Estimate the output matrix hidden layer $\beta = h^* \times t\left(t = \left(T_1, \ldots, T_M\right)^t\right)$
8	Define the kernel matrix as $\delta_{EL} = hh^t : \delta_{EL_{j,i}} = H(y_j) \times H(y_i) = k_{(y_j, y_i)}$
9	Calculate the output function using $g(y) = H(y) h^t \left(\frac{1}{C} + hh^t \right)^{-1} t = \begin{bmatrix} k(y, y_1) \\ \vdots \\ k(y, y_M) \end{bmatrix}^t \left(\frac{1}{C} + \delta_{EL} \right)^{-1} t$
10	End

5. RESULTS AND DISCUSSION

The proposed HOQC-MAC protocol is tested in 55 network scenarios with network sizes ranging from 4000 to 4000 m2. There are 100, 200, 300, 400, and 500 automobiles in the specified network. We varied the vehicle's speed between 10 and 60 kilometers per hour. Only when there is no other vehicle in front of them may vehicles travel at this pace. The speed of movement of a car depends on the speed of the car in front, forcing the car to stand as close as possible to the car in front, not just moving forward. The proposed algorithm is implemented in the network simulator (NS-2), and the test conditions are generated by the urban mobility simulation (SUMO). The performance of our HOQC-MAC protocol is compared with the existing state of art protocols are, including TDMA-MAC [21], GAH-MAC [22], AMC-MAC [23], SCMAC [24], CCHI-MAC [25], DCI-MAC [26], SDN-MAC [27], MP-MAC [29], SOM-MAC [30], OEC-MAC [31], CB-MAC [32] and AHT-MAC [33] in terms of carrier collisions, latency, packet delivery ratio, routing overhead, energy consumption, and throughput. The summary of simulation parameters is given in Table 1.

Table 1 Simulation parameters

Parameters	Values
Number of vehicles	100-500
Road length	2000m
Vehicle speed	10-60 kmph
Simulation area	500m X 4
Topology model	Intersection scenario
Bidirectional model	Yes
Number of intersections	25
Control channel	
Frame duration	4ms
Frame	100
Slot duration	0.4ms
Data rate	12mbps
Service channel	
Slot duration	1ms
Data rate	12mbps
Traffic source	Constant bit rate (CBR)
Simulation time	500 s

5.1 Impact of node density

In this section, we vary the number of nodes from 100 to 500 with the fixed simulation time of 500 seconds in Intersection scenario. Table 3 compares the proposed HOQC-MAC protocol to existing state-of-the-art protocols in terms of performance are TDMA-MAC [21], GAH-MAC [22], AMC-MAC [23], SCMAC [24], CCHI-MAC [25], DCI-MAC [26], SDN-MAC [27], MP-MAC [29], SOM-MAC [30], OEC-MAC [31], CB-MAC [32] and AHT-MAC [33] in terms of carrier collisions, latency, packet delivery ratio, routing overhead, energy consumption and throughput. The carrier collisions of proposed HOQC-MAC protocol is 76.60%, 73.36%, 73.618%, 76.103%, 75.368%, 76.177%, 76.7668%, 68.051%, 75.622%, 74.58%, 69.599% and 61.296% lower than the existing state of art protocols TDMA-MAC [21], GAH-MAC [22], AMC-MAC [23], SCMAC [24], CCHI-MAC [25], DCI-MAC [26], SDN-MAC [27], MP-MAC [29], SOM-MAC [30], OEC-MAC [31], CB-MAC [32] and AHT-MAC [33]. The comparative analysis of carrier collision is given in Fig. 2. The latency of proposed HOQC-MAC protocol is 41.346%, 40.377%, 39.5329%, 37.37%, 37.0178%, 35.2005%, 32.932%, 30.498%, 26.057%, 24.5%, 18.32% and 15.89% lower than the existing state of art protocols TDMA-MAC [21], GAH-MAC [22], AMC-MAC [23], SCMAC [24], CCHI-MAC [25], DCI-MAC [26], SDN-MAC [27], MP-MAC [29], SOM-MAC [30], OEC-MAC [31], CB-MAC [32] and AHT-MAC [33]. The comparative analysis of latency is given in Fig. 3.The packet delivery ratio of proposed HOQC-MAC protocol is 4.290%, 3.938%, 3.585%, 3.19%, 2.818%, 2.466%, 2.134%, 1.823%, 1.511%, 1.18%, 0.828% and 0.35% higher than the existing state of art protocols TDMA-MAC [21], GAH-MAC [22], AMC-MAC [23], SCMAC [24], CCHI-MAC [25], DCI-MAC [26], SDN-MAC [27], MP-MAC [29], SOM-MAC [30], OEC-MAC [31], CB-MAC [32] and AHT-MAC [33]. The comparative analysis of packet delivery ratio is given in Fig. 4.

Table 3 Comparative analysis of proposed and existing routing scheme with node density

Routing scheme	Carrier collisions (%)					Latency (s)					PDR (%)				
	100	200	300	400	500	100	200	300	400	500	100	200	300	400	500
TDMA-MAC	29	33	35	41	51	0.78	0.92	0.94	0.96	0.97	93.1	92.7	92.2	92.0	91.7
GAH-MAC	25	32	31	34	45	0.74	0.91	0.93	0.95	0.96	93.4	93.1	92.7	92.2	92.0
AMC-MAC	26	28	30	36	48	0.71	0.89	0.92	0.94	0.96	93.7	93.4	93.1	92.7	92.2
SCMAC	27	29	35	42	52	0.62	0.85	0.91	0.93	0.95	94.1	93.7	93.4	93.1	92.7
CCHI-MAC	24	31	38	40	47	0.67	0.81	0.89	0.92	0.94	94.5	94.1	93.7	93.4	93.1
DCI-MAC	26	34	38	41	47	0.64	0.78	0.85	0.91	0.93	94.8	94.5	94.1	93.7	93.4
SDN-MAC	31	34	39	41	46	0.61	0.74	0.81	0.89	0.92	95	94.8	94.5	94.1	93.7
MP-MAC	15	19	30	38	41	0.58	0.71	0.78	0.85	0.91	95.2	95	94.8	94.5	94.1
SOM-MAC	27	35	39	40	42	0.54	0.62	0.74	0.81	0.89	95.6	95.2	95	94.8	94.5
OEC-MAC	26	31	35	39	43	0.52	0.67	0.71	0.78	0.85	96.1	95.6	95.2	95	94.8
CB-MAC	17	24	31	35	40	0.47	0.64	0.62	0.74	0.81	96.5	96.1	95.6	95.2	95
AHT-MAC	10	18	25	31	38	0.41	0.61	0.67	0.71	0.78	96.9	96.9	96.1	95.6	95.2
HOQC-MAC	5	6	8	12	15	0.31	0.41	0.64	0.62	0.74	97.2	97.0	96.5	96.1	95.6

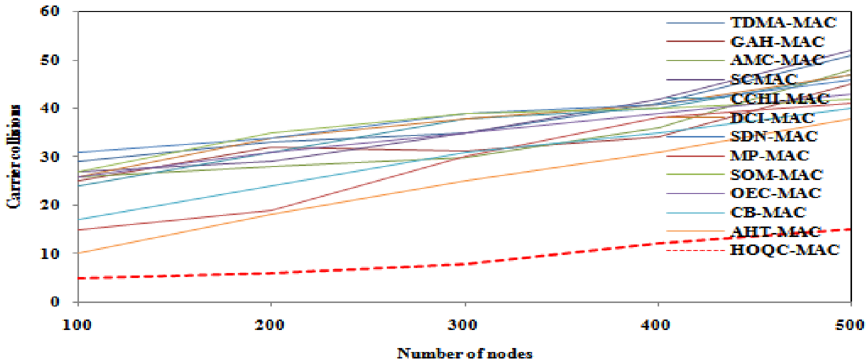

Fig. 2 Carrier collision comparison with the impact of nodes

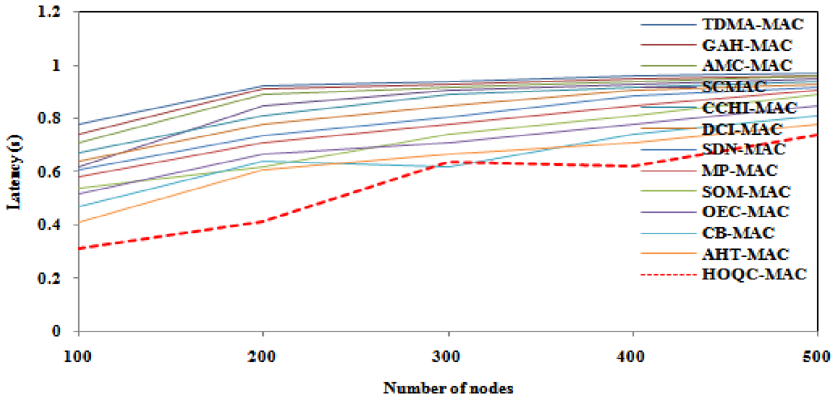

Fig. 3 Latency comparison with the impact of nodes

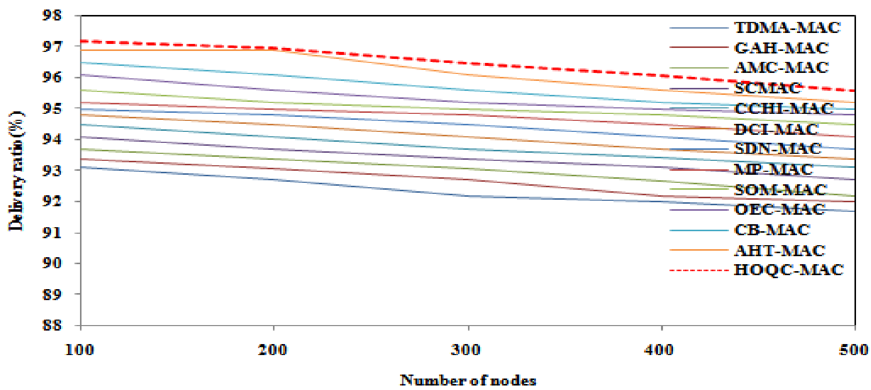

Fig. 4 Packet delivery comparison with the impact of nodes

The routing overhead of proposed HOQC-MAC protocol is 54.71%, 51.33%, 48.17%, 44.42%, 41.285%, 38.45%, 35.458%, 32.147%, 27.09%, 21.28%, 14.64% and 7.64% lower than the existing state of art protocols TDMA-MAC [21], GAH-MAC [22], AMC-MAC [23], SCMAC [24], CCHI-MAC [25], DCI-MAC [26], SDN-MAC [27], MP-MAC [29], SOM-MAC [30], OEC-MAC [31], CB-MAC [32] and AHT-MAC [33]. The comparative analysis of routing overhead is given in Fig. 5. The energy consumption of proposed HOQC-MAC protocol is 54.71%, 51.33%, 48.17%, 44.42%, 41.285%, 38.45%, 35.458%, 32.147%, 27.09%, 21.28%, 14.64% and 7.64% lower than the existing state of art protocols TDMA-MAC [21], GAH-MAC [22], AMC-MAC [23], SCMAC [24], CCHI-MAC [25], DCI-MAC [26], SDN-MAC [27], MP-MAC [29], SOM-MAC [30], OEC-MAC [31], CB-MAC [32] and AHT-MAC [33]. The comparative analysis of energy consumption is given in Fig. 6. The throughput of proposed HOQC-MAC protocol is 54.71%, 51.33%, 48.17%, 44.42%, 41.285%, 38.45%, 35.458%, 32.147%, 27.09%, 21.28%, 14.64% and 7.64% lower than the existing state of art protocols TDMA-MAC [21], GAH-MAC [22], AMC-MAC [23], SCMAC [24], CCHI-MAC [25], DCI-MAC [26], SDN-MAC [27], MP-MAC [29], SOM-MAC [30], OEC-MAC [31], CB-MAC [32] and AHT-MAC [33]. The comparative analysis of throughput is given in Fig. 7.

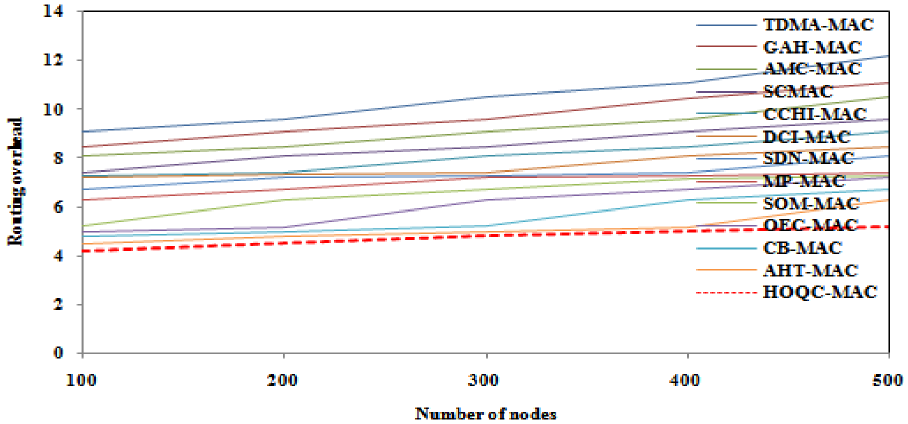

Fig. 5 Routing overhead comparison with the impact of nodes

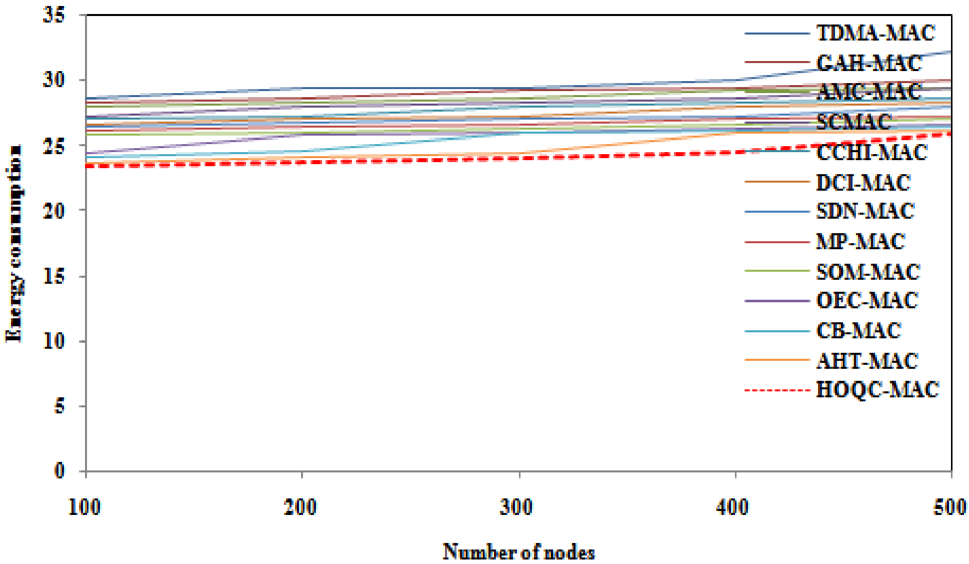

Fig. 6 Energy consumption comparison with the impact of nodes

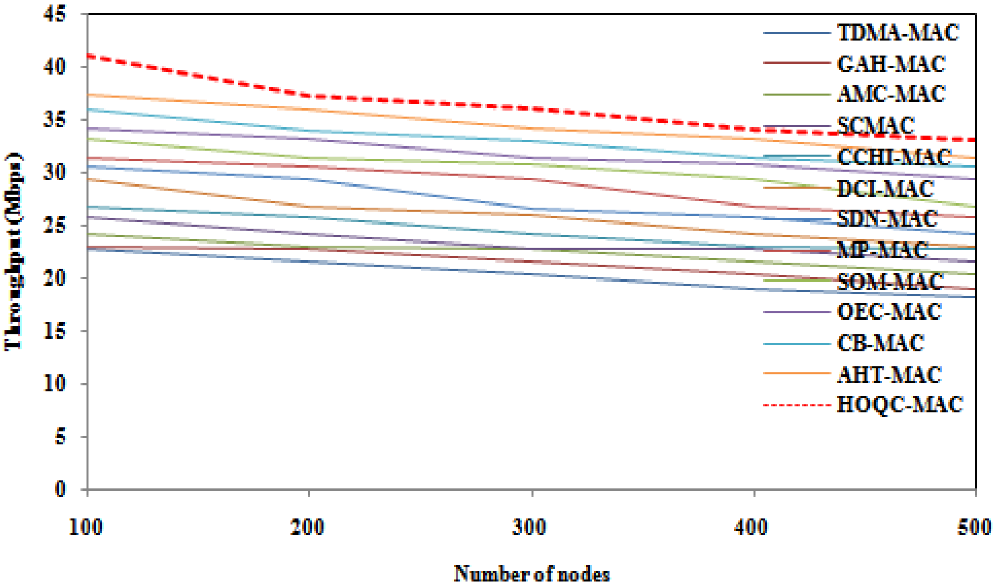

Fig. 7 Throughput comparison with the impact of nodes

Table 3 Cont….

Routing scheme	Routing overhead					Energy consumption (mJ)					Throughput (Mbps)				
	100	200	300	400	500	100	200	300	400	500	100	200	300	400	500
TDMA-MAC	9.1	9.6	10.5	11.1	12.2	28.7	29.4	29.5	30.1	32.2	22.9	21.7	20.4	19.1	18.3
GAH-MAC	8.5	9.1	9.6	10.5	11.1	28.4	28.7	29.4	29.5	30.1	23.0	22.9	21.7	20.4	19.1

AMC-MAC	8.1	8.5	9.1	9.6	10.5	28.1	28.4	28.7	29.4	29.5	24.3	23.0	22.9	21.7	20.4
SCMAC	7.4	8.1	8.5	9.1	9.6	27.3	28.1	28.4	28.7	29.4	25.9	24.3	23.0	22.9	21.7
CCHI-MAC	7.3	7.4	8.1	8.5	9.1	27.1	27.3	28.1	28.4	28.7	26.8	25.9	24.3	23.0	22.9
DCI-MAC	7.2	7.3	7.4	8.1	8.5	26.7	27.1	27.3	28.1	28.4	29.4	26.8	25.9	24.3	23.0
SDN-MAC	6.7	7.2	7.3	7.4	8.1	26.4	26.7	27.1	27.3	28.1	30.7	29.4	26.8	25.9	24.3
MP-MAC	6.3	6.7	7.2	7.3	7.4	26.1	26.4	26.7	27.1	27.3	31.4	30.7	29.4	26.8	25.9
SOM-MAC	5.2	6.3	6.7	7.2	7.3	25.9	26.1	26.4	26.7	27.1	33.2	31.4	30.7	29.4	26.8
OEC-MAC	5.0	5.2	6.3	6.7	7.2	24.5	25.9	26.1	26.4	26.7	34.2	33.2	31.4	30.7	29.4
CB-MAC	4.8	5.0	5.2	6.3	6.7	24.1	24.5	25.9	26.1	26.4	36.1	34.2	33.2	31.4	30.7
AHT-MAC	4.5	4.8	5.0	5.2	6.3	23.7	24.1	24.5	25.9	26.1	37.5	36.1	34.2	33.2	31.4
HOQC-MAC	4.2	4.5	4.8	5.0	5.2	23.4	23.7	24.1	24.5	25.9	41.2	37.5	36.1	34.2	33.2

Table 4 Comparative analysis of proposed and existing routing scheme with vehicle speed

Routing scheme	Carrier collisions (%)					Latency (s)					PDR (%)				
	10	20	30	40	50	10	20	30	40	50	10	20	30	40	50
TDMA-MAC	33	35	41	51	59	0.92	0.94	0.96	0.97	0.99	92.7	92.2	92.0	91.7	91.5
GAH-MAC	32	31	34	45	48	0.91	0.93	0.95	0.96	0.98	93.1	92.7	92.2	92.0	91.8
AMC-MAC	28	30	36	48	49	0.89	0.92	0.94	0.96	0.97	93.4	93.1	92.7	92.2	92.0
SCMAC	29	35	42	52	54	0.85	0.91	0.93	0.95	0.96	93.7	93.4	93.1	92.7	92.5
CCHI-MAC	31	38	40	47	48	0.81	0.89	0.92	0.94	0.95	94.1	93.7	93.4	93.1	92.9
DCI-MAC	34	38	41	47	49	0.78	0.85	0.91	0.93	0.94	94.5	94.1	93.7	93.4	93.0
SDN-MAC	34	39	41	46	47	0.74	0.81	0.89	0.92	0.93	94.8	94.5	94.1	93.7	93.4
MP-MAC	19	30	38	41	46	0.71	0.78	0.85	0.91	0.92	95	94.8	94.5	94.1	93.9
SOM-MAC	35	39	40	42	47	0.62	0.74	0.81	0.89	0.91	95.2	95	94.8	94.5	94.0
OEC-MAC	31	35	39	43	47	0.67	0.71	0.78	0.85	0.90	95.6	95.2	95	94.8	94.4
CB-MAC	24	31	35	40	42	0.64	0.62	0.74	0.81	0.87	96.1	95.6	95.2	95	94.7
AHT-MAC	18	25	31	38	40	0.61	0.67	0.71	0.78	0.85	96.9	96.1	95.6	95.2	94.9
HOQC-MAC	6	8	12	15	18	0.41	0.64	0.62	0.74	0.80	97.0	96.5	96.1	95.6	95.2

5.2 Impact of vehicle speed

In this section, we alter the number of vehicle speeds from 10 to 60 m/s in an Intersection scenario with a fixed vehicle node of 500. Table 4 describes the performance comparison of proposed HOQC-MAC protocol with the existing state of art protocols are TDMA-MAC [21], GAH-MAC [22], AMC-MAC [23], SCMAC [24], CCHI-MAC [25], DCI-MAC [26], SDN-MAC [27], MP-MAC [29], SOM-MAC [30], OEC-MAC [31], CB-MAC [32] and AHT-MAC [33] in terms of carrier collisions, latency, packet delivery ratio, routing overhead, energy consumption and throughput. The carrier collisions of proposed HOQC-MAC protocol is 73.95%, 69.86%, 70.117%, 73.14%, 72.03%, 72.67%, 72.33%, 66.89%, 71.666%, 70.76%, 66.91% and 62.296% lower than the existing state of art protocols TDMA-MAC [21], GAH-MAC [22], AMC-MAC [23], SCMAC [24], CCHI-MAC [25], DCI-MAC [26], SDN-MAC [27], MP-MAC [29], SOM-MAC [30], OEC-MAC [31], CB-MAC [32] and AHT-MAC [33]. The comparative analysis of carrier collision is given in Fig. 8. The latency of proposed HOQC-MAC protocol is 33.133%, 32.429%, 31.77%, 30.70%, 29.42%, 27.86%, 25.89%, 23.79%, 19.95%, 18.64%, 13.12% and 12.19% lower than the existing state of art protocols TDMA-MAC [21], GAH-MAC [22], AMC-MAC [23], SCMAC [24], CCHI-MAC [25], DCI-MAC [26], SDN-MAC [27], MP-MAC [29], SOM-MAC [30], OEC-MAC [31], CB-MAC [32] and AHT-MAC [33]. The comparative analysis of latency is given in Fig. 9. The packet delivery ratio of proposed HOQC-MAC protocol is 4.432%, 4.02%, 3.71%, 3.40%, 2.98%, 2.57%, 2.268%, 2.06%, 1.85%, 1.44%, 0.92% and 0.103% higher than the existing state of art protocols TDMA-MAC [21], GAH-MAC [22], AMC-MAC [23], SCMAC [24], CCHI-MAC [25], DCI-MAC [26], SDN-MAC [27], MP-MAC [29], SOM-MAC [30], OEC-MAC [31], CB-MAC [32] and AHT-MAC [33]. The comparative analysis of packet delivery ratio is given in Fig. 10.

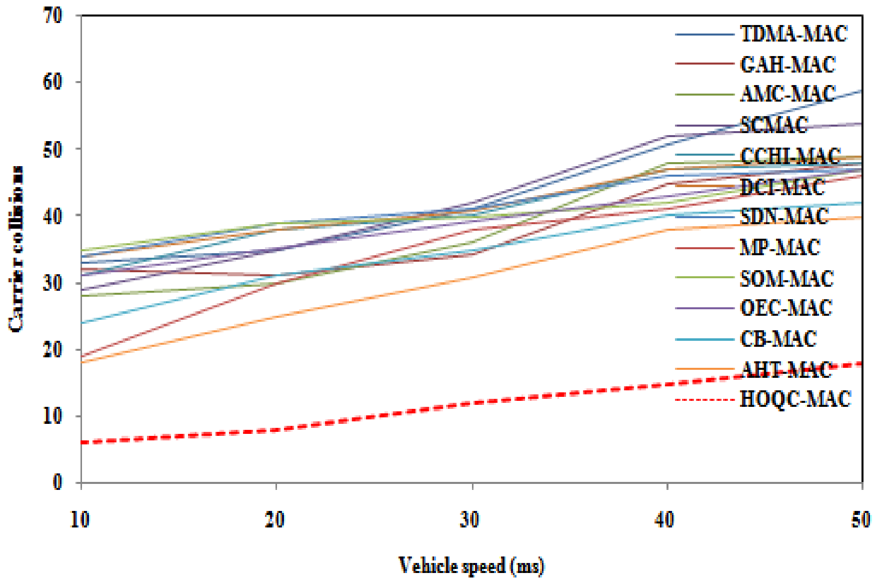

Fig. 8 Carrier collision comparison with the impact of vehicle speed

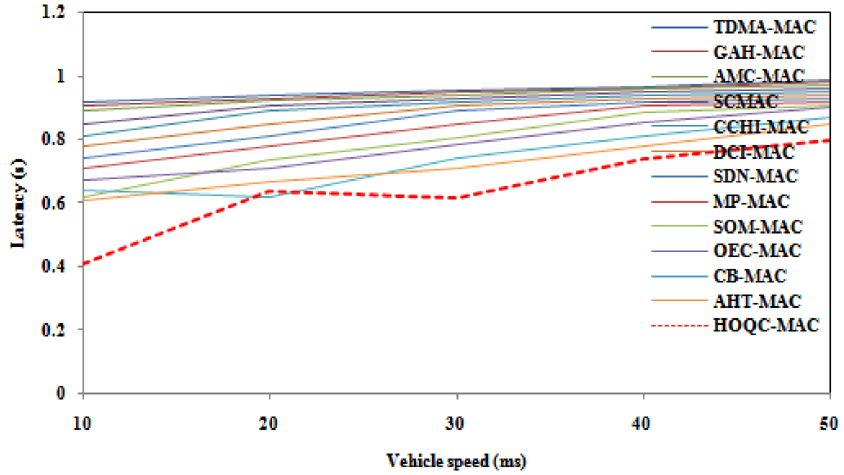

Fig. 9 Latency comparison with the impact of vehicle speed

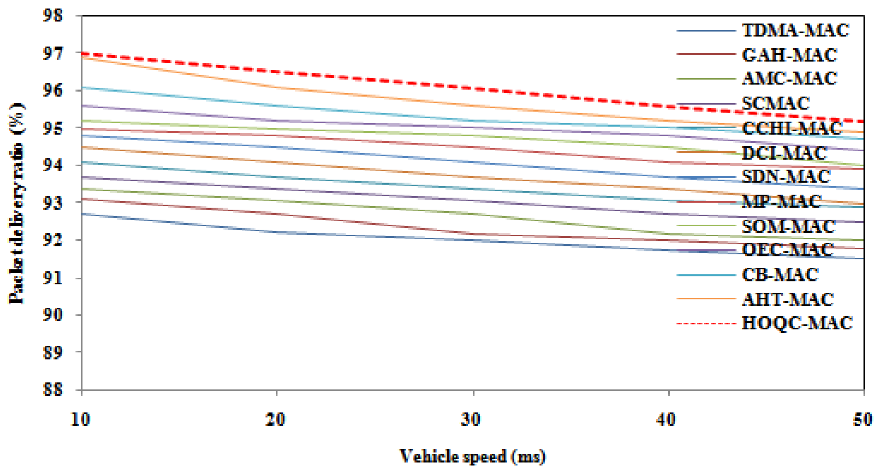

Fig. 10 Packet delivery ratio comparison with the impact of vehicle speed

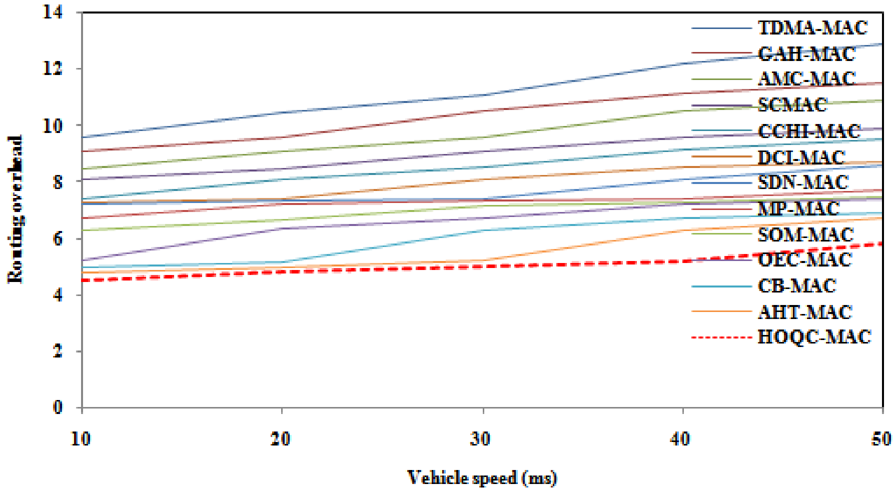

Fig. 11 Routing overhead comparison with the impact of vehicle speed

The routing overhead of proposed HOQC-MAC protocol is 54.95%, 51.129%, 47.89%, 44.05%, 40.58%, 36.78%, 34.507%, 30.416%, 27.78%, 22.408%, 15.33% and 8.99% lower than the existing state of art protocols TDMA-MAC [21], GAH-MAC [22], AMC-MAC [23], SCMAC [24], CCHI-MAC [25], DCI-MAC [26], SDN-MAC [27], MP-MAC [29], SOM-MAC [30], OEC-MAC [31], CB-MAC [32] and AHT-MAC [33]. The comparative analysis of routing overhead is given in Fig. 11. The energy consumption of proposed HOQC-MAC protocol is 19.063%, 16.00%, 14.44%, 13.50%, 11.84%, 10.77%, 9.611%, 7.87%, 6.84%, 5.56%, 3.79% and 2.11% lower than the existing state of art protocols TDMA-MAC [21], GAH-MAC [22], AMC-MAC [23], SCMAC [24], CCHI-MAC [25], DCI-MAC [26], SDN-MAC [27], MP-MAC [29], SOM-MAC [30], OEC-MAC [31], CB-MAC [32] and AHT-MAC [33]. The comparative analysis of energy consumption is given in Fig. 12. The throughput of proposed HOQC-MAC protocol is 19.06%, 16.00%, 14.44%, 13.50%, 11.84%, 10.77%, 9.61%, 7.87%, 6.84%, 5.56%, 3.79% and 2.11% lower than the existing state of art protocols TDMA-MAC [21], GAH-MAC [22], AMC-MAC [23], SCMAC [24], CCHI-MAC [25], DCI-MAC [26], SDN-MAC [27], MP-MAC [29], SOM-MAC [30], OEC-MAC [31], CB-MAC [32] and AHT-MAC [33]. The comparative analysis of throughput is given in Fig. 13.

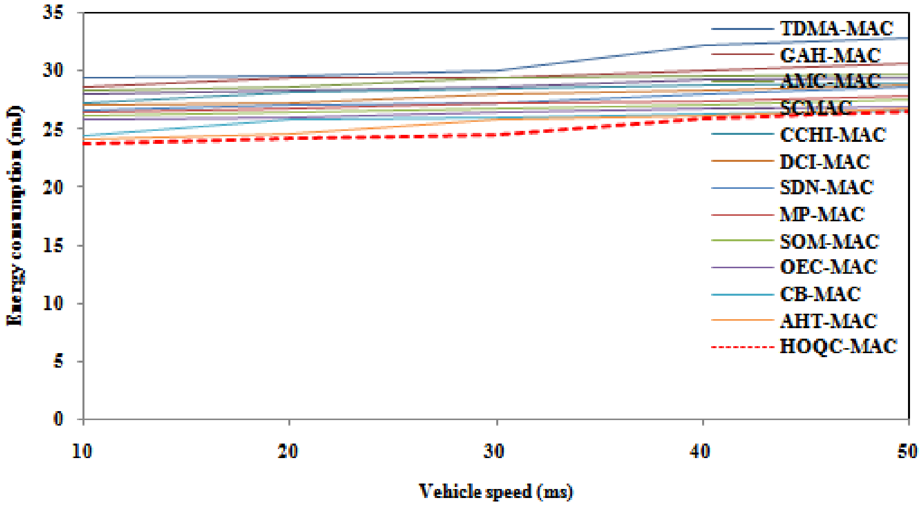

Fig. 12 Energy consumption comparison with the impact of vehicle speed

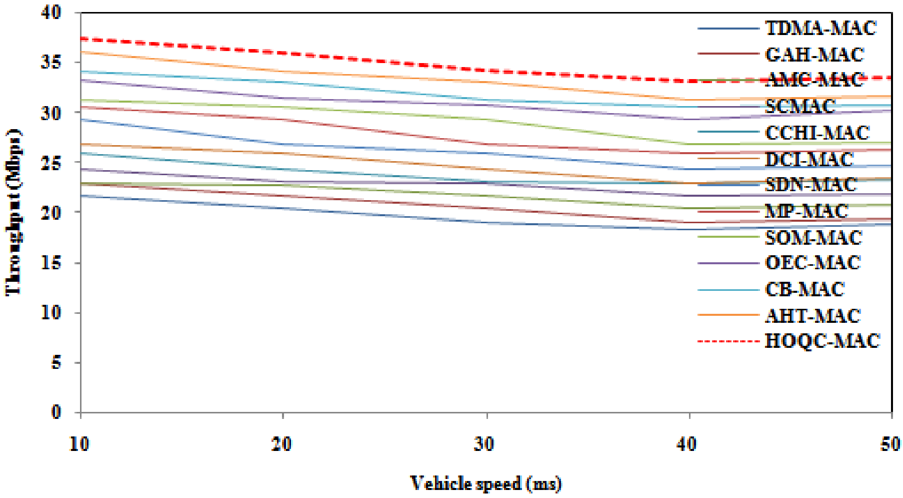

Fig. 13 Throughput comparison with the impact of vehicle speed

Table 4 Cont….

Routing scheme	Routing overhead					Energy consumption (mJ)					Throughput (Mbps)				
	10	20	30	40	50	10	20	30	40	50	10	20	30	40	50
TDMA-MAC	9.6	10.5	11.1	12.2	12.9	29.4	29.5	30.1	32.2	32.9	21.7	20.4	19.1	18.3	18.8
GAH-MAC	9.1	9.6	10.5	11.1	11.5	28.7	29.4	29.5	30.1	30.7	22.9	21.7	20.4	19.1	19.5
AMC-MAC	8.5	9.1	9.6	10.5	10.9	28.4	28.7	29.4	29.5	29.7	23.0	22.9	21.7	20.4	20.7
SCMAC	8.1	8.5	9.1	9.6	9.9	28.1	28.4	28.7	29.4	29.5	24.3	23.0	22.9	21.7	21.9
CCHI-MAC	7.4	8.1	8.5	9.1	9.5	27.3	28.1	28.4	28.7	28.9	25.9	24.3	23.0	22.9	23.2
DCI-MAC	7.3	7.4	8.1	8.5	8.7	27.1	27.3	28.1	28.4	28.8	26.8	25.9	24.3	23.0	23.6
SDN-MAC	7.2	7.3	7.4	8.1	8.6	26.7	27.1	27.3	28.1	28.7	29.4	26.8	25.9	24.3	24.7
MP-MAC	6.7	7.2	7.3	7.4	7.7	26.4	26.7	27.1	27.3	27.8	30.7	29.4	26.8	25.9	26.2
SOM-MAC	6.3	6.7	7.2	7.3	7.5	26.1	26.4	26.7	27.1	27.5	31.4	30.7	29.4	26.8	26.9
OEC-MAC	5.2	6.3	6.7	7.2	7.4	25.9	26.1	26.4	26.7	26.9	33.2	31.4	30.7	29.4	30.2
CB-MAC	5.0	5.2	6.3	6.7	6.9	24.5	25.9	26.1	26.4	26.7	34.2	33.2	31.4	30.7	30.9
AHT-MAC	4.8	5.0	5.2	6.3	6.7	24.1	24.5	25.9	26.1	26.8	36.1	34.2	33.2	31.4	31.7
HOQC-MAC	4.5	4.8	5.0	5.2	5.8	23.7	24.1	24.5	25.9	26.5	37.5	36.1	34.2	33.2	33.6

6. CONCLUSION

Objective: Using a hybrid optimization algorithm, we have proposed a QoS aware cluster-based MAC protocol (HOQC-MAC) for VANET.

Contributions: A tree-seed induced coyote optimization (TSCO) algorithm is proposed for clustering to group the vehicles, improving energy efficiency. A chaotic transient search optimization (CTSO) algorithm monitors the channels and guides the RSU to enhance channel utilization and subcarrier collision problem. Extreme learning-based artificial neural network (EL-ANN) decision-making technique is used to compute the proper communication candidates, which minimizes the lossless data transfer.

Findings: From the comparative analysis, we conclude that the proposed HOQC-MAC protocol's performance performs very effectively in high-density and high-speed vehicles. Finally, implementing a particular protocol is very effective compared to today's latest protocols regarding carrier competition, latency, package delivery factor, and throughput.

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