Journal of Information Systems Engineering and Management
2025, 10(26s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

Implementation of Optimized OLSR in 5G based VANETs to Improve QoS

M. Shoukath Ali[1], Sandeep P[2], M A Khadar Baba[3]
[1]*Associate Professor, ECE Department, Geethanjali College of Engineering and Technology; drshoukathali.ece@gcet.edu.in*
[2]*Associate Professor, ECE Department, Guru Nanak Institutions Technical Campus; sandeep.ecegnitc@gniindia.org*
[3]*Professor, ECE Department, N S Raju Institute of Engineering and Technology; abdul2805@gmail.com*

ARTICLEINFO

Received: 25 Dec 2024

Revised: 18 Feb 2025

Accepted: 04 Mar 2025

ABSTRACT

5G-based Vehicular Ad-Hoc Networks (5G-VANETs) combine the advancements of 5G wireless communication technology with the capabilities of VANETs. These networks leverage the high data rates, low latency, and massive device connectivity provided by 5G to enable efficient and reliable communication among vehicles and infrastructure. Implementing a VANET environment in real-world scenarios poses significant challenges. This paper focuses on improving the Quality of Service (QoS) in 5G-based VANETs through the implementation of an optimized approach to the routing protocol. The chosen routing protocol for this study is Optimized Link State Routing (OLSR). To optimize the protocol, Cuckoo Search Optimization (CSO) and Simulated Annealing (SA) techniques are applied. The simulation is conducted using the ManhattanGrid mobility model, which provides a realistic representation of the vehicular environment. Various test scenarios are created by varying the vehicular density and vehicle speeds. The performance evaluation of the suggested optimized techniques is carried out using three key metrics: Packet Delivery Ratio (PDR), throughput, and End-to-End Delay (E2ED). The results of the simulation demonstrate that the CSO technique outperforms other optimization techniques in terms of enhancing QoS in 5G-based VANETs.

Keywords: *VANET, Quality of Service, OLSR, Vehicle Density, Speed and PDR*

INTRODUCTION

A push towards "smart cities" has just been initiated by the Indian government. The smart city relies heavily on ITSs, or Intelligent Transportation Systems. Furthermore, the automotive industry is investing heavily in the deployment of real-time network infrastructure for vehicles. For instance, by 2020, all newly manufactured vehicles in the United States will be required by law to have internet connectivity. The primary purpose of ITS is to enhance the efficiency and effectiveness of transportation systems while also protecting and enhancing the environment [1]. It functions as a data processor, data transmitter, and sensor in vehicles that are always on the move, such as trains, trucks, cars, and airplanes. From about 0.3 million in 1951 to 230 million in 2016 [2], the number of registered automobiles in India has increased drastically. Indian cities are struggling to accommodate the rising number of cars on the road. Therefore, many cities face a significant difficulty with traffic management, which requires additional attention. One person in India dies every four minutes as a result of a traffic-related incident, and this has serious effects on human health and the natural world. The purpose of the VANET is to make roads safer for motorists and to offer useful commercial services. Accurate information is also disseminated to drivers and transportation authorities in a timely manner [3]. The VANET can facilitate the unprompted sharing of information between vehicles. This means that travellers can stay in touch with one another via VANET. How to accomplish this, though, is the question. The answer is to share traffic data using VANET or a similar infrastructure-free wireless ad-hoc network. The vehicular network is a specific type of mobile ad hoc network (MANET) that allows for two-way communication between automobiles and other roadside wireless sensors. This enables the sharing of data for the purpose of driver safety [4].

It's crucial that the various vehicle nodes be able to communicate with one another. The VANET has traditionally focused on these two forms of communication [5]. Communication between vehicles is one type, while communication with roadside infrastructure is another. VANET allows for both direct and multi-hop communication. Multi-hop packet transmission is used by VANET components like automobiles and roadside units (RSUs). As a result of the limited transmission range, communication is established via intermediate nodes via a series of hops. Short-range wireless Vehicle-to-Vehicle (V2V) communication or Vehicle-to-Roadside (V2R) communication, as well as location services like GPS, are made possible by the vehicle's On-Board Unit (OBUs). A roadside unit (RSU) is the basic communication building block for roadways. There is coordination between the various OBUs and RSUs. The operation of a VANET is shown in Figure 1.

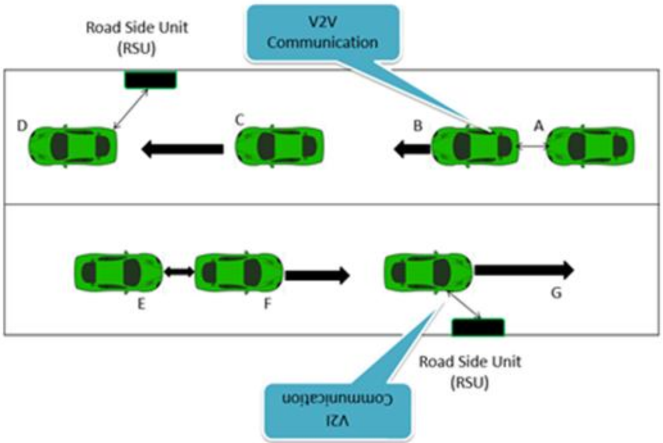

Fig. 1. VANET architecture

Together, the capabilities of 5G cellular networks and the unique demands of vehicular communication form a 5G-VANET, an advanced communication system. To improve road safety, traffic management, and the provision of value-added services, VANETs allow vehicles to interact with each other and with infrastructure components, thereby forming a dynamic network. There are many benefits to using 5G technology with VANETs instead of older vehicle communication methods. Because of its increased capacity and decreased latency, it enables applications like collision avoidance and traffic congestion detection in real-time [6]. With 5G networks, even when there is a lot of traffic, your connection won't drop, no matter how many devices you have. To guarantee dependability, low latency, and effective resource utilization, network slicing techniques are used to allocate specialized slices for vehicular communication. With the use of edge computing, traffic management, and network efficiency can be enhanced through the use of distributed decision-making and real-time processing. By centralizing control and allowing for the virtualization of network operations, NFV and SDN increase adaptability and scalability. Transformative uses for 5G-VANETs include supporting the rollout of autonomous vehicles through dependable and low-latency communication links, intelligent traffic lights that communicate with vehicles to optimize signal timings, and cooperative collision warning systems that exchange information to predict potential collisions. Overall, 5G-VANETs are a promising technology for the future of connected and autonomous vehicles since they improve road safety, facilitate effective traffic management, and have the ability to provide a wide range of value-added services.

The OLSR protocol's success in 5G-VANETs [7] has brought it a lot of attention as a proactive routing mechanism. Since VANETs are inherently dynamic and highly mobile, OLSR is well-suited to facilitating efficient and reliable communication in this setting. To function, the protocol keeps a decentralized database of network topology that details the nearby vehicles and the connections between them. Vehicles are able to detect and maintain contact with one another through the periodic broadcast of control messages known as "Hello" messages. The OLSR protocol establishes and maintains routing tables that identify the best paths for data transfer within the VANET through the exchange of topology control messages.Improving the OLSR protocol's functionality in 5G- VANETs can be achieved by fine-tuning it with optimization methods [8-10]. Network topology, MPR selection, routing metric, and parameter optimization are all examples of areas that can be optimized. By optimizing it for the VANET deployment, the OLSR protocol can be fine-tuned to improve routing efficiency, decrease latency, increase network stability, and yield overall superior performance. Effective data forwarding is made possible by optimization methods that determine which MPRs are most suited for a given set of conditions, such as connection quality and network connectivity. The protocol can be adapted to various VANET circumstances and optimal route calculation can be attained by selecting appropriate routing metrics and adjusting parameter values. Network connection and performance can benefit from the strategic placement of infrastructure components to optimize the network layout. The OLSR protocol can be adapted for use in 5G-VANETs, allowing for more effective and dependable communication in the ever-changing conditions of the road.

The paper is organized as follows:Section I provides an introduction to Vehicular Ad-Hoc Networks (VANETs), specifically focusing on 5G-based VANETs, and discusses the routing protocol OLSR (Optimized Link State Routing) commonly used in VANETs.Section II presents a literature survey, summarizing the existing research and studies related to QoS enhancement in 5G-based VANETs.Section III delves into the theoretical concepts of OLSR, as well as the proposed optimization techniques, namely CSO (Constrained Swarm Optimization) and SA (Simulated Annealing).Section IV presents the results of the research, analysing the QoS factors for the different routing protocols. The performance of the optimized techniques is evaluated and compared.Section V concludes the research by suggesting the most effective optimized technique for OLSR to enhance QoS in 5G-based VANETs

LITERATURE

The research [11] describes a novel dynamic multi-clustering technique that may adapt to the dynamics of the platoon in the face of traffic disruption. The nodes in the context of V2V communications are arranged into a single, hierarchical cluster. However, the commonly used vehicle disturbance adaptive techniques only cluster mobile vehicle nodes into a single cluster, resulting in poor service quality. It also lacks flexibility when it comes to rerouting automobiles inside a Platoon. To improve reliability, they employ a hierarchical clustering-based clustering strategy to establish several clusters of soldiers inside a platoon. The optimal number of clusters can be established by basing the decision on the RMDA value of the nodes. The behaviour of vehicles that do not belong to a platoon determines the establishment of these separate clusters. The analysis of the proposed method for cluster building takes into account both stable and unstable relative mobility of non-platoon vehicles in relation to their platoon vehicles. The approach improves QoS measures. In simulations, the suggested method outperforms the present vehicle disturbance adaption technique.Researchers [12] describe a VANET clustering technique based on an intelligent energy-aware oppositional chaos game optimization (IEAOCGO-C). The suggested IEAOCGO-C method is intended to be an efficient method of selecting network cluster heads (CH). The suggested model builds clusters utilizing oppositional-based learning (OBL) and the chaos game optimization (CGO) approach. A fitness function with five parameters is also calculated. The proposed model has been empirically validated, and its results have been thoroughly examined alongside those of other models for a variety of vehicles and metrics. In simulations, the proposed method outperformed state-of-the-art technology. According to the journal [13], implementing a more efficient routing scheme could improve VANET QoS. This study builds and deploys a novel routing system to improve VANET'sQoS. Multiple OBUs from various vehicles and an RSU are utilized in this arrangement to transfer the VANET packet to its final destination. They can show from simulation in MATLAB 2022a that the suggested solution outperforms the prior routing protocol in terms of performance as assessed by the QoS parameters.

The research [14] suggests an improved cluster-based lifetime protocol that prioritizes network routing stability and average performance. A fuzzy inference method based on the Sugeno model is used to evaluate the CH using input parameters like local distance, residual energy, concentration, node degree, and distance from the base station. By integrating an appropriate channel model with an efficient routing protocol, the new routing system shows that increasing the link throughput of a VANET for a given network size is possible. The research demonstrates how to make an informed decision when selecting CH using the fuzzy system, which extends the life of the network by 10%. The performance analysis also shows how various network sizes and routing strategies influence the whole.The article [15] describes in detail the suggested VANET system, which is based on a game-theoretic approach to automate vehicle grouping and CH nomination. As a result, no routine cluster reformation will be required. Furthermore, they will use each car's social behaviour to build clusters on the road. A machine learning technology (the K-means algorithm) is used to create clusters of social behaviour in autos. The proposed system has been validated and tested over a wide range of criteria, and the results reveal that the VANET performed admirably and accurately.The research [16] intends to improve the connection of autonomous firefighting Unmanned Ground Vehicles (FUGV) by selecting the most efficient way to the target fire zone. The purpose of the suggested cutting-edge model is to improve RS for the best tracking path for FUGV through the use of ant colony optimization. Swarm theory includes this-optimization method, which sees use in both VANETs and social networks. The results show that the suggested strategy can enhance the navigation of automated FUGVstoward the fire region by allowing them to take the shortest paths possible while avoiding congested roads and other obstacles. The research results can be utilized to enhance current methods used to keep tabs on the Internet of Things (IoT) and ad hoc vehicle networks.In the journal [17], the author examines the efficiency of Ad-hoc On-demand Distance Vector (AODV) routing, a prominent reactive routing protocol, in two different situations. The first example compares V2V and V2I communication. The second is a real-time V2V connection between Basrah and the Manhattan grid using OMNeT++ and SUMO. The utilization of QoS variables such as packet delivery ratio, packet drop rate, and network throughput by AODV allows for a comparison of results. The simulation data can be used by researchers to assess the protocol's success and enhance it for future use.

BACK GROUND

Theoretical concepts of the OLSR routing protocol and the optimization techniques employed in this research are elaborated and provided in detail.

A. OLSR

The OLSR protocol is a proactive routing protocol commonly used in VANETs, including 5G-VANETs. OLSR aims to establish and maintain routes in a distributed manner by exchanging control messages among network nodes [18]. Here is an overview of the OLSR routing protocol and its working, along with a mathematical equation used in its operation:

1.Topology Control and Multipoint Relays ($MPRs$): Each node in the network maintains a selected set of nodes, known as its neighborhood, for which it maintains routing information.OLSR employs $MPRs$to optimize the flooding of control messages. $MPRs$ are a subset of a node's neighbors selected to act as relays for broadcasting control messages to their respective neighbors.

2.Hello Messages and Neighbor Detection:Nodes periodically exchange control messages called "Hello" messages to detect their neighbors and establish links.Each node maintains a list of its neighbors based on the information received in Hello messages.

3. Link State Information and Topology Control (TC) Messages:OLSR nodes periodically broadcast TC messages, which contain information about their links and the links of their selected MPRs.These TC messages enable other nodes to build and maintain their routing tables and topology information.
4. Multipoint Relay Selector Set ($MPRS_{set}$) Calculation:The $MPRS_{set}$is the set of nodes that each node considers as its $MPRs$.The $MPRS_{set}$selection process aims to minimize message flooding while providing sufficient coverage for link state dissemination.The $MPRS_{set}$calculation involves the following steps:
   - Each node identifies its 1-hop neighbor coverage, i.e., the number of 2-hop neighbors that can only be reached through that node.
   - Nodes with the highest 1-hop neighbor coverage are selected as $MPRs$.
   - The $MPRS_{set}$ is periodically recalculated to adapt to changes in the network topology.
5. Route Calculation and Maintenance:Using the information obtained from the TC messages, each node builds and maintains its routing table, which includes routes to other nodes in the network.OLSR supports multiple routes between source and destination nodes, allowing for load balancing and fault tolerance.The routing table is updated based on changes in the network topology, such as link failures or new connections.

OLSR utilizes various algorithms and metrics for its operation, but there isn't a single mathematical equation that defines the entire protocol [19]. However, one notable aspect is the calculation of the $MPRS_{set}$, which involves a metric called "2-hop neighbor coverage." The 2-hop neighbor coverage ($C(v)$) for a node v is calculated using the following equation:

$$C(v) = \Sigma w \in N(v)\ Coverage(w) \qquad [1]$$

where$N(v)$ is the set of 1-hop neighbors of v, and Coverage(w) represents the number of 2-hop neighbors of node w that can only be reached through node v.

The $MPRS_{set}$calculation involves selecting nodes with the highest 2-hop neighbour coverage to act as MPRs, optimizing the routing information dissemination in the network.It's important to note that the OLSR protocol involves more complex algorithms and considerations beyond a single equation, and the specific details may vary depending on the implementation and research advancements. To enhance the QoS factor, we try to optimize the OLSR parameter selection. The steps involved in optimization are detailed [20].

1. Define the Objective Function: The first step is to define an objective function that evaluates the QoS of the OLSR protocol in a 5G-VANET environment. The objective function can consider various QoS metrics such as packet delivery ratio, end-to-end delay (E2ED), throughput, or energy efficiency. The objective function quantifies the performance of the OLSR protocol based on the selected QoS metrics.

2. Parameter Optimization: The OLSR protocol has various tunable parameters that affect its behavior and performance. Select the parameters that are relevant for QoS improvement in 5G-VANETs. These parameters can include timers, thresholds, weights, or other configuration values. Define the range or constraints for each parameter that should be considered during optimization.

   For optimization, we used two techniques like CSO, and SA. Both algorithms are detailed in the upcoming sections.

B. Cuckoo Search Optimization

The CSO is an optimization algorithm that takes inspiration from the breeding habits of cuckoos [21]. It can be applied to parameter tuning in the context of the OLSR routing protocol for 5G-VANETs to improve QoS. Here's an overview of how the Cuckoo Search algorithm can be used for OLSR parameter tuning [22]:

1. Initialize Cuckoo Population: Initialize a population of cuckoo nests, where each nest represents a potential solution (a set of parameter values). Generate an initial set of random parameter values for each nest within the defined range or constraints.
2. Evaluate Nest Quality: Evaluate the quality of each nest (solution) by applying the objective function to the OLSR protocol with the corresponding parameter values. Measure the QoS performance for each solution and assign a fitness value to each nest based on the objective function evaluation.
3. Cuckoo Breeding and Nest Selection: Perform breeding operations such as crossover or mutation to generate new solutions (parameter sets) based on the existing nests. Apply the objective function to evaluate the quality of the newly generated solutions.
4. Nest Replacement: Replace poorly performing nests (solutions) with new nests that have better fitness values. This step ensures that the population maintains high-quality solutions and allows for exploration and exploitation of the search space [23].

5. Iteration and Termination: Repeat steps 2–4 until a termination criterion is reached. The algorithm can be terminated after a set number of iterations, once an acceptable QoS threshold is reached, or after satisfying some other condition relating to convergence.

6. Output and Parameter Selection: After the termination of the Cuckoo Search algorithm, select the nest (solution) with the best fitness value as the optimized parameter set for the OLSR protocol. Use the selected parameter set in the OLSR implementation to improve the QoS performance in the 5G-VANET.

C. Simulated Annealing

The SA algorithm is a meta-heuristic optimization algorithm that mimics the annealing process in metallurgy [24]. It can be utilized for parameter tuning in the context of the OLSR routing protocol for 5G-VANETs to improve QoS. Here's an overview of how the Simulated Annealing algorithm can be applied to OLSR parameter tuning [25]:Initialization:Initialize the Simulated Annealing algorithm with initial parameter values.Set the initial temperature and cooling schedule, which controls the exploration and exploitation trade-off.

Iterative Optimization:Begin the iterative process of parameter optimization using the Simulated Annealing algorithm.Randomly perturb the current parameter values to generate a neighboring solution.Evaluate the QoS performance of the neighboring solution using the objective function. Determine whether to accept or reject the neighboring solution based on the acceptance probability, which depends on the current temperature and the change in the objective function value. If the neighboring solution is accepted, update the current parameter values [26].

1. Cooling Schedule:Reduce the temperature gradually in accordance with a predetermined cooling schedule. The search space is explored and an ideal solution is converged at a rate set by the cooling schedule. Typically, the temperature is reduced gradually over the iterations until a specified termination condition is met.
2. Termination: Define a termination condition, such as reaching a specified iteration or achieving a satisfactory QoS level.Once the termination condition is met, the optimization process concludes.
3. Output and Parameter Selection:Output the parameter set that achieved the best QoS performance during the optimization process.Use the selected parameter set in the OLSR implementation to enhance QoS in the 5G-VANET.

RESULTS AND DISCUSSION

The objective of the simulation was to analyse the quantitative QoS factors, including Packet Delivery Ratio (PDR), Average Throughput, and E2ED, in 5G-based VANETs by implementing an optimization technique. The simulation utilized the NS-2.35 simulator and employed the ManhattanGrid mobility model for scenario generation.The simulation aimed to evaluate the QoS of routing protocols in VANETs under various conditions, such as varying vehicular density and vehicular speed. The suggested optimized OLSR protocol was evaluated and compared against the traditional OLSR protocol.

A. *Case 1: Vehicular Density*

In the first case, the simulation focused on various vehicle densities. The vehicle densities considered were 20, 40, 60, 80, and 100. The performance measureswere analysed and compared between the three routing protocols (OLSR, CSO-OLSR, and SA-OLSR). The performance measures of the OLSR and suggested optimized OLSR were recorded and tabulated in Table 1 to Table 3 to analyse their performance under different vehicle densities.

Regarding PDR, for a vehicle count of 20, OLSR achieved a PDR of 58.42%, CSO-OLSR achieved 82.5%, and SA-OLSR achieved 80.57%. For a vehicle count of 100, OLSR achieved a PDR of 38.75%, CSO-OLSR achieved 71.02%, and SA-OLSR achieved 65.88%. The results indicate that both CSO-OLSR and SA-OLSR outperformed the traditional OLSR in terms of PDR.

Table 1: PDR (%)measures for various vehicle densities

Vehicle Count	OLSR	CSO-OLSR	SA-OLSR
20	58.42	82.5	80.57
40	52.47	78.96	76.11
60	49.17	75.88	71.99
80	46.55	73.72	70.45
100	38.75	71.02	65.88

Table 2: Throughput (kbps)measures for various vehicle densities

Vehicle Count	OLSR	CSO-OLSR	SA-OLSR
20	80.57	97.8	96.77
40	78.01	95.23	93.88
60	73.81	90.58	87.03
80	69.72	85.57	82.77
100	62.55	81.72	78.88

Average Throughput was the next parameter analysed. For a vehicle count of 20, OLSR achieved an average throughput of 80.57 kbps, CSO-OLSR achieved 97.8 kbps, and SA-OLSR achieved 96.77 kbps. For a vehicle count of 100, OLSR achieved an average throughput of 62.55 kbps, CSO-OLSR achieved 81.72 kbps, and SA-OLSR achieved 78.88 kbps. Similar to PDR, both CSO-OLSR and SA-OLSR demonstrated improved average throughput compared to OLSR.

Lastly, the E2ED was analysed. For a vehicle count of 20, OLSR resulted in an E2ED of 60.5 ms, CSO-OLSR achieved 42.56 ms, and SA-OLSR achieved 40.85 ms. For a vehicle count of 100, OLSR resulted in an E2ED of 258 ms, CSO-OLSR achieved 88.12 ms, and SA-OLSR achieved 105.7 ms. Once again, both CSO-OLSR and SA-OLSR showcased reduced E2ED compared to OLSR.

Table 3: E2ED (ms)measures for various vehicle densities

Vehicle Count	OLSR	CSO-OLSR	SA-OLSR
20	60.5	42.56	40.85
40	105.32	58.23	65.87
60	128.8	79.65	90.55
80	189.5	83.33	95.87
100	258	88.12	105.7

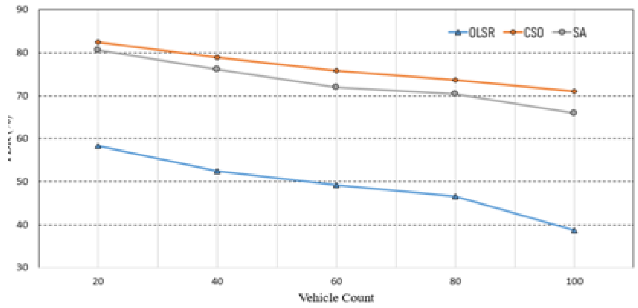

Fig. 2. PDR measure for different vehicle count

To present the findings visually, Figure 2 displays the plot of PDR in percentage for various vehicle densities, Figure 3 depicts the plot of average throughput in kbps, and Figure 4 illustrates the plot of E2ED in ms for various vehicle densities.

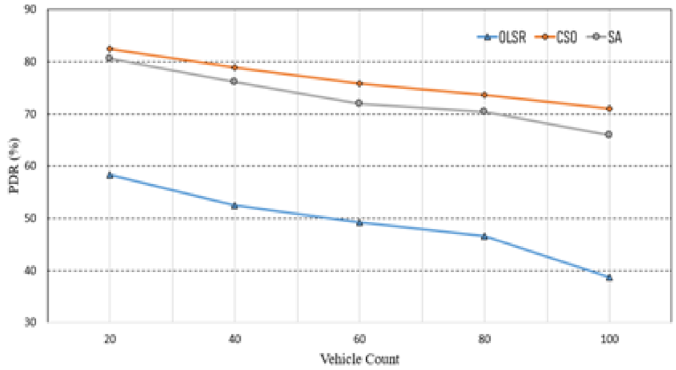

Fig. 2. PDR measure for different vehicle count

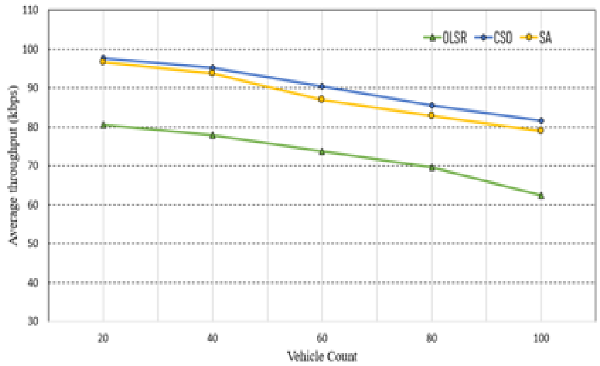

Fig. 3. Throughput measure for different vehicle count

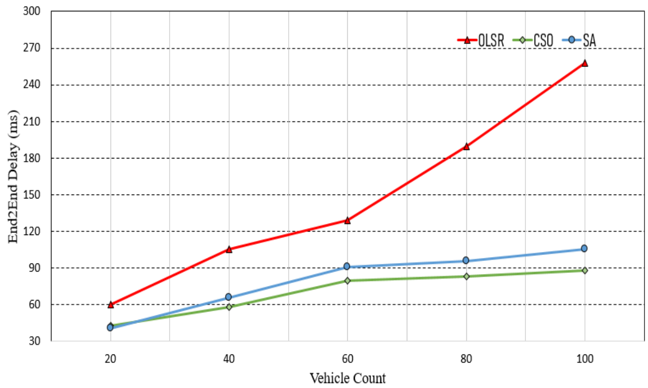

Fig. 4. E2ED measure for different vehicle count

B. *Case 2: Vehicular Speed*

Moving on to the second case, the simulation focused on various vehicle speeds. The vehicle speeds considered were 20 and 100. Similar to the first case, the performance measures were analysed for the three routing protocols under these different speeds. The performance measures of the OLSR and suggested optimized OLSR were recorded and tabulated in Table 4 to Table 6 to analyse their performance under different vehicle speeds.

For PDR, at a vehicle speed of 20, OLSR achieved a PDR of 70.85%, CSO-OLSR achieved 95.78%, and SA-OLSR achieved 93.57%. At a vehicle speed of 100, OLSR achieved a PDR of 49.52%, CSO-OLSR achieved 85.78%, and SA-OLSR achieved 78.55%. The results suggest that both CSO-OLSR and SA-OLSR performed better in terms of PDR compared to OLSR at different vehicle speeds.

Table 4: PDR (%)measures for various vehicle speed

Vehicle Speed	OLSR	CSO-OLSR	SA- OLSR
20	70.85	95.78	93.57
40	65.78	93.12	90.45
60	58.22	90.01	85.78
80	55.88	86.02	81.52
100	49.52	85.78	78.55

Table 5: Throughput (kbps)measures for various vehicle speed

Vehicle Speed	OLSR	CSO-OLSR	SA-OLSR
20	85.42	115.26	111.58
40	82.788	108.36	102.82
60	78.58	101.03	98.50
80	71.68	94.56	95.667
100	65.25	90.99	89.65

Regarding Average Throughput, at a vehicle speed of 20, OLSR achieved an average throughput of 85.2 kbps, CSO-OLSR achieved 115.26 kbps, and SA-OLSR achieved 111.58 kbps. At a vehicle speed of 100, OLSR achieved an average throughput of 65.25 kbps, CSO-OLSR achieved 90.99 kbps, and SA-OLSR achieved 89.65 kbps. Once again, both CSO-OLSR and SA-OLSR exhibited improved average throughput compared to OLSR.

Lastly, for E2ED, at a vehicle speed of 20, OLSR resulted in an E2ED of 58.56 ms, CSO-OLSR achieved 30.45 ms, and SA-OLSR achieved 37.14 ms. At a vehicle speed of 100, OLSR resulted in an E2ED of 286.9 ms, CSO-OLSR achieved 185 ms, and SA-OLSR achieved 196.56 ms. Similar to the first case, both CSO-OLSR and SA-OLSR showcased reduced E2ED compared to OLSR.

Table 6: E2ED (ms)measures for various vehicle speed

Vehicle Speed	OLSR	CSO-OLSR	SA-OLSR
20	58.56	30.45	37.14
40	98.56	56.87	70.258
60	143.56	62.578	91.58
80	207.05	102.59	138.76
100	286.9	185	196.56

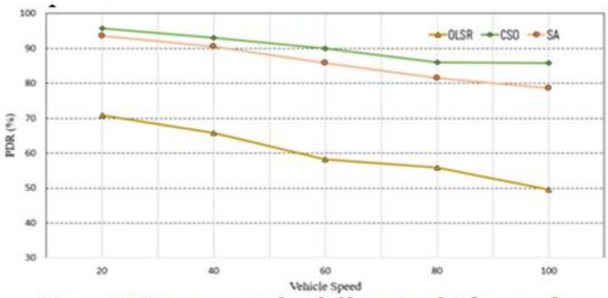

Fig. 5. PDR measure for different vehicle speed

For the visual representation of the second case's findings, Figure 5 displays the plot of PDR in percentage for various vehicle speeds, Figure 6 depicts the plot of average throughput in kbps, and Figure 7 illustrates the plot of E2ED in ms for different vehicle speeds.

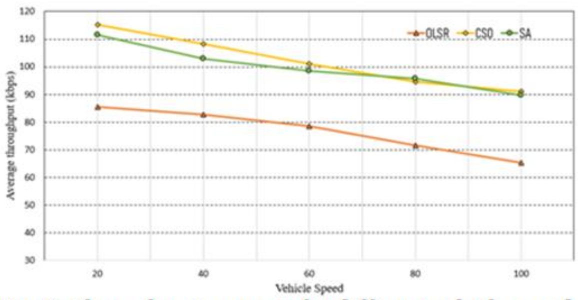

Fig. 6. Throughput measure for different vehicle speed

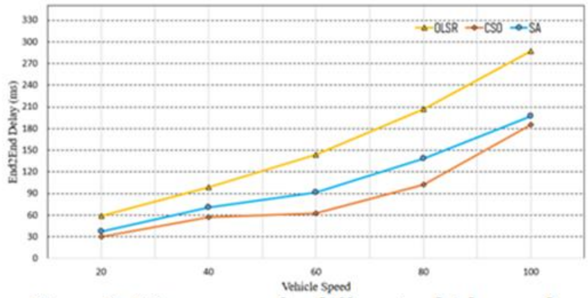

Fig. 7. E2EDmeasures for different vehicle speed

In conclusion, the simulation results demonstrated that the suggested optimized OLSR (CSO-OLSR and SA-OLSR) outperformed the traditional OLSR in terms of PDR, Average Throughput, and *E2ED* under various vehicular densities and speeds. The optimization techniques applied to the OLSR protocol showed improvements in the QoS factors, indicating their effectiveness in enhancing the performance of 5G-based VANETs.

CONCLUSION

In this research, we proposed introducing an optimization strategy into 5G-based VANETs to enhance QoS. Our primary goal was to use CSO and SA methods to make the routing protocol OLSR more efficient. Using the ManhattanGrid mobility model, we ran extensive simulations to assess how well the proposed optimization strategies performed over a range of test scenarios with varying vehicle densities and speeds. According to the findings, the CSO method considerably improved the QoS in 5G-based VANETs. When compared to the classic OLSR protocol and SA-OLSR, it improved on all three measures (PDR, throughput, and E2ED). The use of optimization approaches to improve QoS in 5G-based VANETs offers up various opportunities for future study and development. Here are some ideas on where research could go next: Potential future research should focus on improving the accuracy of performance evaluation in VANETs, for example, creating unique QoS-aware routing metrics that take into account elements beyond existing measures. Metrics such aschannel quality, network load, and energy usage can all be factored into the optimization process. Exploring the integration of optimization approaches with upcoming technologies such as edge computing, blockchain, or the IoT can increase QoS in 5G-based VANETs even further. Investigating how these technologies may complement and improve the process would be a worthwhile research endeavour.

REFRENCES

[1] Rawal, Tejas, and V. Devadas. "Intelligent transportation system in india-a review." Journal of Development Management and Communication 2, no. 3 (2015): 299-308.

[2] www.statistica.com/statistics/664729/total-number-of-vehicles-india last accessed on 18 Feb.2019.

[3] S. K. Bhoi and P. M. Khilar, "Vehicular communication: a survey," in IET Networks, vol. 3, no.3, pp. 204-217, September 2014

[4] Li, Fan, and Yu Wang. "Routing in vehicular ad hoc networks: A survey." IEEE Vehicular technology magazine 2, no. 2 (2007): 12-22.

[5] Rasheed, Asim, SairaGillani, Sana Ajmal, and Amir Qayyum. "Vehicular ad hoc network (VANET): A survey, challenges, and applications." In Vehicular Ad-Hoc Networks for Smart Cities: Second International Workshop, 2016, pp. 39-51. Springer Singapore, 2017.

[6] Sharma, Sachin, Piyush Agarwal, and Seshadri Mohan. "Security challenges and future aspects of fifth generation vehicular adhoc networking (5g-vanet) in connected vehicles." In 2020 3rd International Conference on Intelligent Sustainable Systems (ICISS), pp. 1376-1380. IEEE, 2020.

[7] Toutouh, Jamal, José García-Nieto, and Enrique Alba. "Intelligent OLSR routing protocol optimization for VANETs." IEEE transactions on vehicular technology 61, no. 4 (2012): 1884-1894.

[8] Chauhan, Radhika, NitinGoyal, and Rakesh Kumar. "A review on tuning of OLSR routing protocol in VANET." International Journal of Advanced Research and Innovative Ideas in Education 2, no. 2 (2016): 508-512.

[9] Bandi, Anusha. "Parameters tuning of OLSR routing protocol with metaheuristic algorithm for VANET." In 2015 IEEE International Advance Computing Conference (IACC), pp. 1207-1212. IEEE, 2015.

[10] Gupta, Kanika, and A. P. S. Kohli. "Optimizing OLSR protocol for VANET." Asian Journal of Technology and Management Research (AJTMR) 6, no. 2 (2016).

[11] Padmanabhan, Kaushik, IlangoJeyasubramanian, JagadishSaravananPandian, and Jai VigneshRajendran. "Improving QoS in VANET using dynamic clustering technique." International Journal of Networks and Communications 6, no. 4 (2016): 72-79.

[12] Elhoseny, Mohamed, Ibrahim M. El-Hasnony, and ZahraaTarek. "Intelligent energy aware optimization protocol for vehicular adhoc networks." Scientific Reports 13, no. 1 (2023): 9019.

[13] S. Ali, K. Baba, S. P and P. B. L, "Dynamic Short Range Mobility Patterns based Vehicular Communications for 5G-VANET," *2023 International Conference on Distributed Computing and Electrical Circuits and Electronics (ICDCECE)*, Ballar, India, 2023, pp. 1-6, doi: 10.1109/ICDCECE57866.2023.10151271.

[14] Naeem, Afia, Muhammad Rizwan, ShtwaiAlsubai, Ahmad Almadhor, MdAkhtaruzzaman, Shayla Islam, and Hameedur Rahman. "Enhanced clustering based routing protocol in vehicular ad-hoc networks." IET Electrical Systems in Transportation 13, no. 1 (2023): e12069.

[15] Phull, Nitika, Parminder Singh, Mohammad Shabaz, and F. Sammy. "Enhancing vehicular ad hoc networks' dynamic behavior by integrating game theory and machine learning techniques for reliable and stable routing." Security and Communication Networks 2022 (2022).

[16] Ali, Ali M., MdAsriNgadi, Rohana Sham, and IsraaIbraheemAl_Barazanchi. "Enhanced QoS Routing Protocol for an Unmanned Ground Vehicle, Based on the ACO Approach." sensors 23, no. 3 (2023): 1431.

[17] Aljabry, Israa A., and Ghaida A. Al-Suhail. "A QoS Evaluation of AODV Topology-Based Routing Protocol in VANETs." In 2022 International Conference on Engineering & MIS (ICEMIS), pp. 1-6. IEEE, 2022.

[18] Clausen, Thomas, and Philippe Jacquet. Optimized link state routing protocol (OLSR). No. rfc3626. 2003.

[19] Haerri, Jerome, FethiFilali, and Christian Bonnet. "Performance comparison of AODV and OLSR in VANETs urban environments under realistic mobility patterns." In Proceedings of the 5th IFIP mediterranean ad-hoc networking workshop, no. i, pp. 14-17. 2006.
[20] Dong, Si Yu. "Optimization of OLSR routing protocol in UAV ad HOC network." In 2016 13th International Computer Conference on Wavelet Active Media Technology and Information Processing (ICCWAMTIP), pp. 90-94. IEEE, 2016.
[21] Joshi, Akshata S., Omkar Kulkarni, Ganesh M. Kakandikar, and Vilas M. Nandedkar. "Cuckoo search optimization-a review." Materials Today: Proceedings 4, no. 8 (2017): 7262-7269.