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OCI-OLSR: An Optimized Control Interval-Optimized Link State Routing-Based Efficient Routing Mechanism for Ad-Hoc Networks

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Abstract: MANET (Mobile Ad hoc Networks) functionality is determined by routing protocols' ability to adjust to atypical changes in information and communication technologies, topological systems, and connection status. Due to interference, node migration, the growth of several pathways, security, and propagation loss, MANET network configurations are dynamic. The proactive routing protocol enhances the message flow utilized in the neighborhood discovery process by using the multipoint relays (MPR) approach. In order to increase the protocol's effectiveness and efficiency while maintaining the OLSR protocol's reliability, the research presented in this paper proposed an improved OCI-OLSR (Optimized Control Interval-Optimized Link State Routing) that focuses on better control interval management, an advanced MPR selection process, reducing neighbor hold time as well as decreasing flooding. The suggested proposed protocol was examined using the NS3 simulator, and it was compared to the standard OLSR version and AODV(Ad-hoc On-Demand Routing) routing protocol. According to the analysis's findings, the suggested system has a lot of promise in terms of a variety of performance metrics under diverse conditions. Overall, the article makes the case that the OCI-OLSR protocol may enhance the performance of the regular OLSR protocol in wireless ad hoc networks by addressing a number of the protocol's flaws.

Keywords: Optimized Control Interval OLSR; OLSR Routing; MANETs; Network Infrastructure; Enhanced OLSR Routing Protocol

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1. Introduction

Mobile Ad hoc Networks (MANETs) possess notable properties such as multi-hop routing, self-configuration, self-healing, self-managing, reliability, and scalability that have drawn the interest of networking sectors [1]. It's a self-configuring wireless network made up of mobile wireless devices. MANET has the advantage of requiring minimal configuration and deploying quickly, making it ideal for emergency situations. Even when nodes are static, routing across wireless mobile networks is a vital issue because of the dynamic behavior of wireless mobile networks' quality. In MANETs, the routing issue is principally concerned with finding an optimal way between the source and the destination node [2,3]. Without a backbone or fixed infrastructure, MANET instantaneously incorporates a network [4]. Three distinct kinds of routing protocols are widely employed in MANETs: reactive, proactive, and hybrid. Reactive routing protocols don't operate until the source advises for a channel to a destination node. AODV protocol and Dynamic Source

Routing (DSR) are major protocols for this category. Table-driven protocols are employed by proactive routing protocols to maintain accurate route information for each node in the network. The examples include the Destination Sequenced Distance Vector (DSDV) and OLSR [5,6]. To connect network nodes, the algorithm from the proactive routing protocol class which is recognized as OLSR is utilized. These protocols rely on a routing method that chooses the MPR (Multi Points Relay) technology primarily in order to diminish network traffic load and the route to the objective [7]. Neighborhood sensing, message flooding, topological information, and path computation are the four core OLSR principles. It preserves a topological description of the network for each node and presents a route when applicable. Subsequently, it adopts the MPR solution to minimize control traffic and create the shortest paths (in terms of hops) across all network destinations. Consequently, an MPR set is coupled to each node because each node chooses a subset of the nodes in its neighborhood as its MPR and observes the operations of the neighbors who have labeled themselves as an MPR [8]. Figure 1 depicts the numerous application of OLSR in Wireless Ad-Hoc Networks. The keyword 'OLSR' and 'MANET' when taken into consideration using Vos Viewer software on the Web of Science database, outputs 1147 results which means this number of articles has been available in conjugation with these keywords. The main contributions of this paper are summarized as follows:

(i) The work highlights the role of OLSR in the MANET environment and depicts the research trends of OLSR routing protocol in the MANET environment.
(ii) The proposed model, namely OCI-OLSR, which operates on principals by lowering the interval value to one second, maximizes packet exchange. Since messages choose more MPR nodes to which control topology packets are relayed, more fresh routes are consequently periodically available in the network. Additionally, the neighbor hold duration is lowered to one sec to intensify overall performance.
(iii) The execution finding of the proposed scheme OCI-OLSR successfully strengthens the routing mechanism in Ad-hoc Networks when tested and validated on numerous parameters.

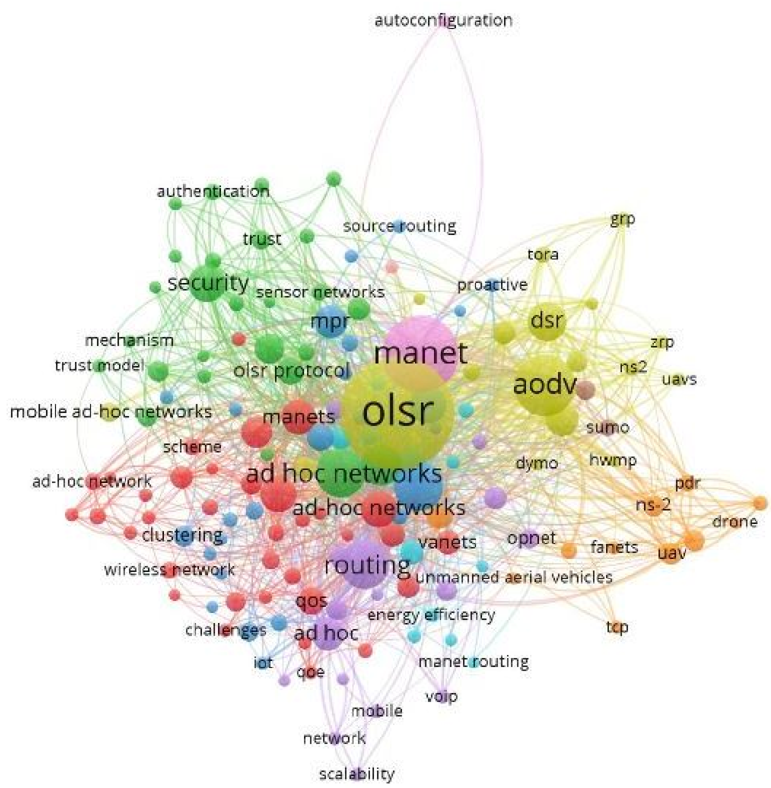

Figure 1. OLSR Protocol in Ad Hoc Networks: Web of Science Core Collection. Data were obtained from www.webofscience.com/wos/woscc accessed on 25 February 2023.

The structure of the whole work accomplishment is specified as follows. Section 2 reviews the literature and recent trends regarding the role of the OLSR protocol in the MANET environment. Section 3 elaborates on the workflow of the proposed model. Section 4 outlines experimental findings and offers an extensive comparative analysis of the proposed scheme with the existing ones on several parameters. At last, the Conclusion is covered in Section 5.

2. The Proactive Routing Protocol

2.1. Optimized Link State Routing (OLSR) Protocol

The main function of the OLSR is to store and up-to-date its routes in the table so that whenever a route is needed, it presents the route instantly at a time. The primary control messages are employed by OLSR: Hello and Topology Control (TC). The information about the adjacent nodes and the link status is obtained using hello messages. Information about one's own advertised neighbors, at the very least the MPR Selector list, is broadcast through TC messages. By diminishing the greatest possible time frame for the transfer of periodic control messages, the OLSR may strengthen the responsiveness to topological changes [9]. Moreover, OLSR supports Several Interface Design (MID) features that allow the usage of distinct OLSR interface addresses and the relaying of external routing updates by nodes, facilitating routing to external addresses. Relying on this data, nodes in the ad hoc network potentially function as gateways toward other networks. As OLSR consistently refreshes routes to entire network destinations, the protocol is well-suited for traffic designs where a substantial chunk of nodes interacts with another group of nodes in which the source and destination pairings are progressively changing. In order to manage its routing mechanism, OLSR does not require a centralized administrative system. OLSR interpretation has been analyzed using the Web of Science Core Collection database and implemented in the VOS viewer tool as depicted in Figure 1. The figure clearly shows that the OLSR protocol in Ad Hoc Networks is diverse and ongoing, with a focus on improving the protocol's performance, reliability, and scalability in different scenarios and applications.

2.2. Research Trends of OLSR Routing Protocol in MANETS

Owing to the routing table, OLSR has a significantly smaller latency. It has the potential to simultaneously upgrade the routing table, on the other side [10]. Since the control messages are transmitted on a regular basis and do not need to be delivered in order, the link is dependable. Collecting data from Web of Science databases, a scientific metric assessment of research trends pertaining to the OLSR Routing Protocol and MANETS is shown in Figure 2, where it is clear that OLSR possesses far better performance than other protocols. High-density networks are best suited for OLSR since it prohibits packet transmission delays from lasting too long. Figure 3 demonstrates the fact that OLSR in MANETS is closely used for optimization and effective routing. The experiment is performed using the VOSviewer tool for empirical evidence landscaping adopting the OLSR and MANET keywords' epicenters from the WoS database having started in 2002 to 2022.

According to Figure 3, research papers have steadily expanded every year since 2002. The total publications have risen dramatically from years 2007 to 2016, affirming that a lot of work is being accomplished in this discipline. The year 2013 achieved the highest publication rate among all years.

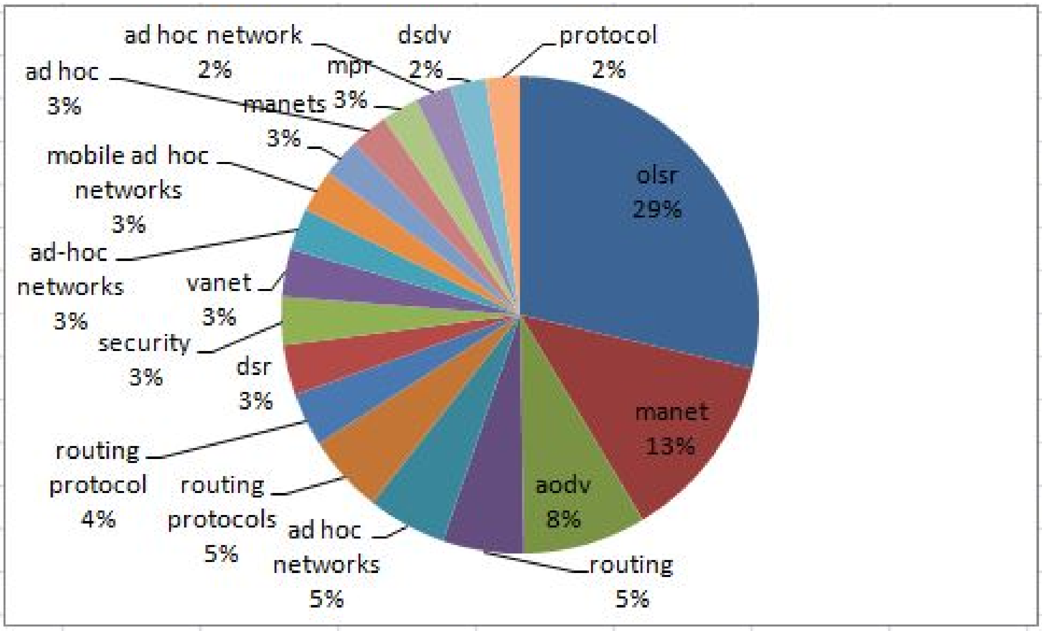

Figure 2. Performance of OLSR Protocol: Web of Science Core Collection. Data were obtained from www.webofscience.com/wos/woscc accessed on 25 February 2023.

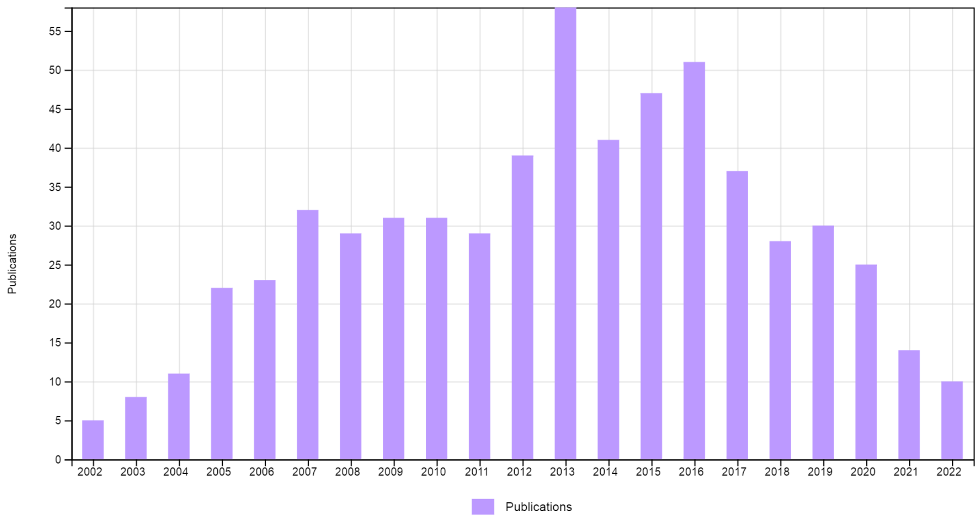

Figure 3. Year-wise Analysis of Publication: Web of Science Core Collection. Data were obtained from www.webofscience.com/wos/woscc accessed on 25 February 2023.

3. Related Work

Wireless technologies can be used for the conscience-recognition of autonomous Ad-hoc Networks i.e., MANETS [11]. The enforcement among several small UAVs, AODV, and OLSR protocols is researched using the NS3 simulation tool to pursue the potential of ad hoc environments that are joined by mini-UAVs. The protocols are researched with different operations such as UAV mass, nodes, stability, and range of transmission. Such criteria affect the evaluation and quality assessments. Packets and local delivery differentials are the performance metrics under consideration. There are approximations that are seen in the diversification of the transmission range and density [12,13].

The authors examine the weaknesses of the proactive routing scheme optimal link state routing (OLSR) against the node isolation attack sort denial-of-service (DOS) exploit. After examining the attack, the authors suggest an extended OLSR (EOLSR) protocol, a trust-based security measure, to protect OLSR nodes from it. The chosen strategy can identify node isolation threats by ascertaining from a node's Hello packets whether or not it is advertising accurate topology information. When compared to normal OLSR, the experiment outcomes demonstrated that the suggested protocol is capable of achieving routing security rapidly growing the ratio of delivered packets, and declining the proportion of lost packets [14].

By applying extensive dynamic updates for the routing parameters, the authors of [15] suggested a unique cross-layer performance enhancement strategy that is implemented and tested in order to optimize the performance of the SIP signaling system over an OLSR-based MANET. The SIP performance metrics aim to reflect the routing parameters' necessary actions and the SIP signaling condition as accurately as possible. The total QoS of SIP-based VoIP apps over MANET is greatly impacted by the SIP signaling performance. The Cross-Layer OLSR approach has been implemented successfully in reducing the overall delays in SIP procedures, improving signaling performance, and raising the level of system bandwidth and routing process effectiveness.

The testing of the proactive and as well as reactive protocols has been the authors' prime focus. An adaptable network architecture using MANET could be set up in disaster zones with little to no infrastructure. Each protocol's performance is evaluated according to QoS, the simulation results show that for every QoS parameter, OLSR surpasses AODV and DSDV. This highlights that OLSR can pick the MPR to raise the PDR and throughput as the number of nodes, simulation regions, and simulation speed advance [16]. The authors compared CBR and TCP traffic and evaluated the effectiveness of several MANET routing protocols. According to the authors' findings, OLSR considerably and consistently improves normalized routing load, proving MANET environment using OLSR is more suitable for handling TCP traffic [17].

In an investigation done by the authors in their work, they differentiated OLSR along with MHAR-OLSR (multipath heterogeneous ad hoc network) scheme [18]. They invented an expansion to OLSR that incorporates new features such as node identification, pathways calculation, path categorization, and path selection. It signifies open lines of communication between these various parts. With diverse numbers of nodes in a heterogeneous scenario, assessment is done on QoS dimensions using the simulation toolkits NS-3 and BonnMotion. According to the findings obtained, MHAR-OLSR exhibits far better performance than the traditional routing protocol [18].

MANET already has mobile nodes that have no other infrastructures, without active directories or centralized materials such as points of everything from access. That requires extensive route definition that connects mobile contexts dynamically and competently in energy and bandwidth exemplified by changing network topology. The threat of malicious node attacks tends to affect these protocols [19].

The throughput of information dissemination in Adhoc networks has differed to be reinforced by multipath routing [20]. On the basis of the OLSR protocol, they also presented the multipath routing system NC-OLSR for FANETS. In order to establish a hybrid multipath selection model based on the connection quality of neighbor's nodes, NC-OLSR leverages OLSR. local limitations cannot be avoided in a single OLSR. According to experimental testing, the proposed scheme may substantially enhance the data delivery ratio and transmission efficiency.

The authors in [21], by assessing standard OLSR current energy and overhead challenges, recommended a new workable OLSR methodology and named it Disaster Scenario Optimized Link State Routing (DS-OLSR) Protocol that is energy and overhead-friendly. Time Slices (TSs), a new message type designed exclusively for DS-OLSR, are a notion presented by DS-OLSR that connects OLSR communications and of necessity alert messages into their corresponding TSs. DS-OLSR, a suggested routing protocol, was put into operation in NS-3 and contrasted with OLSRv1. The simulation results revealed that DS-OLSR outperforms OLSRv1 because it greatly reduces routing overhead, optimizes packet delivery, and saves immense energy in both sparse and dense network simulation settings.

The WSN system's potential to transmit sensor data is widely dominated by the OLSR. Using NS-3, authors simulated and tested protocols on parameters packet delivery ratio, data throughput, delay, and packet loss percentage [22]. The simulation's findings indicate that OLSR performs more effectively with the aforementioned parameters.

The extended MPR (EMPR) approach has been used to study MPR choice in wireless OLSR ad-hoc networks by authors of [23]. The cost's value is a new factor that EMPR considers when examining MPR elections. With respect to the MPR-based OLSR heuristic, the intended EMPR specification offers a wider coverage area for the MPR ensemble.

Based on optimal link state routing, the authors suggested a straightforward integration strategy for a MANET based on OLSR. The discovered scheme provides incorporation without requiring new routing messages for gateway discovery, OLSR routing messages are re-engineered and streamlined. The suggested solution does not mandate the mandatory compulsory of a MANET node with a gateway node as is necessary for integration, allowing nodes to move around freely inside the local MANET without losing connectivity to other nodes in the external network. The simulation's performance standards showed the proposed system operates well at various mobility speeds [24].

Authors in [25] indicated that the inter-process communication foundation is the routing protocol. Optimizing broadcast message flooding is a concern in an OLSR-based mobile wireless network related to mobility and bandwidth availability. The authors employed a more accurate technique of assessing MPR which is Wingsuit Flying Search (WS) which improves the working of OLSR. The authors proposed revamped version of the OLSR protocol and named it WS-OLSR. Based on the number of parameters, the execution for both Novel WS-OLSR and standard OLSR has been investigated. According to the simulation results, compared to standard OLSR, the Novel WS-OLSR protocol can elevate throughput, decrease TC, and minimize the MPR count needed to cover 95% of mobile nodes, which mitigates the broadcasting storm phenomenon.

Based upon the study of authors in the past, as presented above, there are some of the limitations and open issues that exist in OLSR are enlisted below:

1. Scalability: OLSR can become inefficient and slow down as the network size increases. This is because OLSR floods topology information throughout the network, which can lead to excessive overhead and congestion.
2. Route Stability: OLSR's routing stability can be affected by link fluctuations and topology changes. If a link fails or becomes unstable, OLSR may take some time to re-calculate the new route, leading to packet loss.
3. Quality of Service (QoS): OLSR does not support QoS requirements. It cannot differentiate between different types of traffic, leading to possible congestion and delay.
4. Network Partitioning: OLSR cannot handle network partitioning effectively. If a network splits into two parts, OLSR may not be able to route packets between the two parts.
5. Multi-path Routing: OLSR does not provide efficient support for multi-path routing. It may not always be able to find and utilize multiple paths to a destination, which can limit its ability to provide reliable communication.
6. Mobility: OLSR's performance can be affected by the mobility of nodes in the network. As nodes move, the network topology changes, which can lead to route instability and overhead.

4. Proposed Model

Numerous authors have specifically attempted to expand the workflow of the standard OLSR routing protocol by varying throughput and also clustering of nodes which help to enhance performance. The performance of OLSR depends upon the lost link the packets are not forwarded to the lost link but packets are forwarded along the fresh shortest way, and the neighbors hold time is the maximum amount of time a node waits for a link to respond for symmetric in the event of a broken link. Standard OLSR has some limitations and problems, such as:

1. Scalability: OLSR suffers from scalability issues in large networks due to its flooding mechanism, which can result in a significant increase in control traffic overhead.
2. Mobility and Poor MPR Selection: The OLSR protocol does not handle high node mobility very well, and frequent topology changes can cause instability and packet loss. Due to the control traffic overhead, it leverages a poor Multi-point Relay (MPR) selection mechanism.
3. Congestion: OLSR assumes that the network is always underutilized, which can result in congestion and poor performance in high-traffic situations.
4. Energy efficiency: OLSR may not be energy-efficient, especially in mobile ad hoc networks where nodes have limited battery power. The frequent exchange of control packets can drain the battery of nodes quickly.
5. Quality of Service (QoS): OLSR does not provide any QoS guarantees, and the routing decisions are based solely on the hop count metric, which may not always result in the best path for real-time applications.

To address the above concerns the proposed enhanced OCI-OLSR scheme is presented which will overcome the above said issues. To strengthen the OLSR scheme as depicted in Figure 4 an optimized OCI-OLSR algorithm is formulated to get coupled in standard OLSR in which the neighbor hold time is the maximum waiting period for which a node waits for a hello packet. After the expiry of the waiting period, the link is declared to be lost. The neighbor hold-time in the proposed scheme is reduced to 1 s to minimize the delay which results in packet loss. The neighbor hold-time decreases the delay for nodes as instead of waiting for a link to respond, the node is free to route alternative packets. Secondly, the control intervals are optimally used for optimal performance. As a result, more fresh routes are constantly present in the network to choose for routing.

Lastly, in the event of both mobility and failures, there is a repeated exchange of messages including the network state for the existing network. In order to lessen control traffic overhead, it leverages the Multi-point Relay (MPR) technology. The following two messages are continuously issued in a network with n nodes and k average neighbors.

- Hello Messages: Every node is able to gain information about its neighbors up to two hops away according to these messages. Each node selects its multi-point relay nodes using this information.
- Topology Control Messages: Every node broadcasts control messages defined as topology control messages across the whole system to maintain a database essential for packet routing. To assess its MPR selector set, diverse nodes broadcast a TC message on a regular basis.

The MPR selection process is modified by the proposed OLSR, and its algorithm is shown in Algorithm 1. This algorithm's direction calculation is based on the idea of cross and dot products. A third vector is produced by taking the cross-product of two distinct vectors. The two input vectors will be parallel to each other in the final vector. Here, the availability or insufficiency of a target node in the right or left direction of the sender node is confirmed by employing the dot product of two vectors. Each node will upgrade its MPR set each time the topology changes. Take into consideration the fact whenever source node E intends to send packets of data to receiving node Q. E will first specify whether node Q is on the right or left side of the channel by examining its positioning.

Second, if it is on the right-hand (RH) side, it will choose the RHS's adjacent nodes; for example, let's say it selects the L and M nodes as its right-side MPR. However, L is not related to target Q any further. Therefore, there will only be one MPR, node M. For the intention of sending data packets to Q, in the MPR set of E. The data will be relayed to node M by node E. Thirdly, the right-hand side MPRs of node M shall now be discovered. Let's assume that these are nodes I and Q, but Q has not subsequently been associated with node Z. Accordingly, the MPR set of node M will only contain node I.

Algorithm 1 Proposed OCI-OLSR Algorithm

```
if Broadcast then
    Node sends a signal to find other nodes within range
else
    Updating routing table and synchronization between nodes
end if
MPR selection with cross and dot product
if Node is ready then
    Route reply message within = 1 s.
else
    Update neighbor hold duration = 1 s.
end if
if destination node then
    Transmission begin
    Successful Transmission
else
    Check for the readiness of the destination node
end if
```

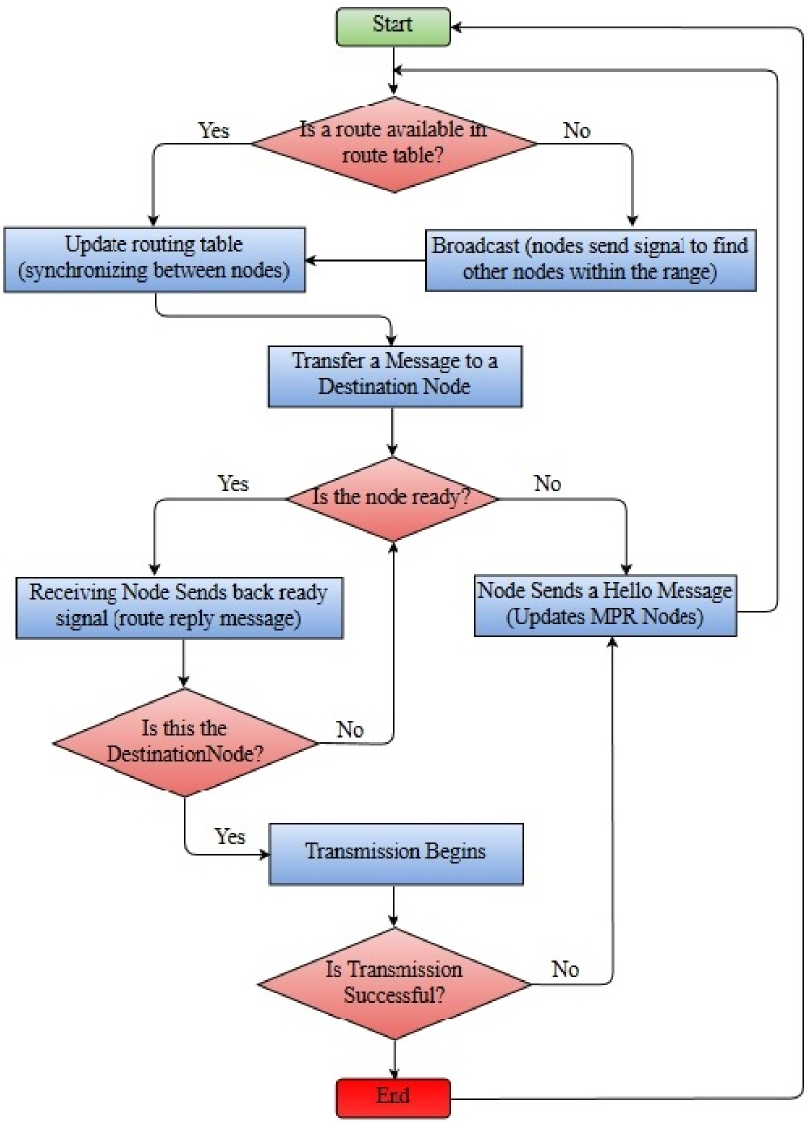

Figure 4. OLSR Working Mechanism—Flowchart.

The data packet will then be routed by node M to node I, who will then deliver it yet another time to node Q. Therefore, the route taken will be E, M, I, and Q. The step-by-step working of the proposed OCI-OLSR is discussed below:

- Step1: Select a new scenario of 100 × 100 m scale.
- Step2: Then create a network by placing nodes from the object.
- Step3: Synchronizing all network nodes and modifying the routing table periodically.
- Step4: MPR selection with cross and dot product.
- Step5: Run the simulation for the desired time to collect the results
- Step6: Exchange of message through chosen route from source to destination
- Step7: Receiving node sens back ready signal route reply message.
- Step8: Finally, transmission begins successfully.

5. Result and Discussion

The MANET network and simulations were analyzed using the Network Simulator 3 simulator. NS-3 is an open-source discrete-event network simulator that is widely used for network research and education (https://www.nsnam.org/ accessed on 25 February 2023). The study done in this article employed NS-3 to investigate and assess the performance of several networking protocols, notably, OLSR, proposed OLSR, and AODV. NS-3 provides a complete collection of network simulation frameworks and tools. Using NS3, the simulation process entails defining the network topology, configuring the network parameters, and running the simulation using a simulation script. The NS3 simulation has been executed in the following steps: Installing NS3 on the system, writing a simulation script using the NS3 API, compiling and executing the simulation script using the NS3 build system, and at last analyzing the simulation results using NS3 tools, and scripts.

Modules and header files are presented at the beginning of the code. Throughout the simulation run on the NS3 simulator, these modules are employed. After that, nodes in the network are created using the Create method and accessed using a NodeContainer in the NS-3 simulator. Nodes require a predetermined grid structure. Nodes are deployed using MobilityHelper and the SetPositionAllocator method in the NS-3 simulator. Initial coordinates (MinX, MinY), node distance represented by (DeltaX, DeltaY), number of nodes placed in the network shown by (GridWidth), and node layout approach (RowFirst or ColumnFirst) are all depicted.

The nodes in this network are aligned in a row and are 50 m apart. There are 70 nodes used, and since their mobility is constant, they do not move. The WifiMacHelper, YansWifiPhyHelper, and YansWifiChannelHelper helpers are employed to make sure that the nodes can communicate with one another via the wireless channel. The parameters, such as physical and line addresses, are then assigned to specific nodes using the Install technique. The production of pcap files is then enabled, which Wireshark will display. All nodes in the developed network's communication are preserved in the files.

These are some of the key parameters that need to be considered when deploying OLSR. It's important to select appropriate values for these parameters based on the specific requirements of the network (the simulation environment is represented in Table 1) and to monitor their performance over time to ensure optimal operation. Like other routing protocols, OLSR relies on a number of parameters to operate correctly. The selection of these parameters can affect the performance and stability of the protocol. Based upon the Table 1 setup network proposed optimized OLSR scheme is investigated on the parameters such as delay, load, packet delivery, TC message sent, and Throughput. To examine how the optimized OLSR protocol performs as compared with traditional OLSR in various scenarios, numerous in-depth simulations were run using the NS3 tool.

Table 1. Configuration Setup.

Parameters	**Values**
Simulator	NS-3
Routing Protocol	Existing OLSR, Proposed OLSR
Simulation Area	1000 m × 1000 m
No. Of Nodes	70
Node Speed	5 m/s
No. of Sources	All nodes
Simulation Repetition's	3
Topology Control	1 s
Methodology	Routing with Clustering
MAC Layer	IEEE 802.11
No. of packet send	5 packets/s
Packet length	512 bytes
Simulation Time	30, 80, 120, 180
Node Speed	1, 2, 3, 4, 5

5.1. Protocol Comparison: Delay Metric

Delay in a network refers to the amount of time it takes for data packets to travel from the source node to the destination node. High delay in a network can lead to poor performance. The entire network is influenced by each node's estimation of the average latency for its neighbor. For 70 nodes, the delay for conventional, proposed optimized OLSR and AODV (Ad-hoc On-Demand Distance Vector) technique is evaluated. While enhanced OLSR experiences less delay than standard OLSR [16] and AODV [26], flooding causes the delay to rise. The clustering in enhanced optimized OLSR selects a cluster head for each round, lessening the time spent in transit from source to destination. In each round, the cluster head is selected with probability p, which is the same for all nodes, indicating that every node has an equal chance of becoming a forwarder node. The strategy used greatly reduces the delay. The value of delay obtained is highlighted in Table 2 and the delay comparison graph of all three techniques considered is shown in Figure 5.

Table 2. OLSR vs. Proposed OLSR vs. AODV—Average End to End delay.

	Delay	
Standard OLSR	Proposed OLSR	AODV
37.5	17.0	38.5

Per round, the cluster head is determined with probability p, which is identical for every node, implying that each node has an equal chance of being nominated as the forwarder node. The strengthening approach reduces the delay in the proposed OLSR.

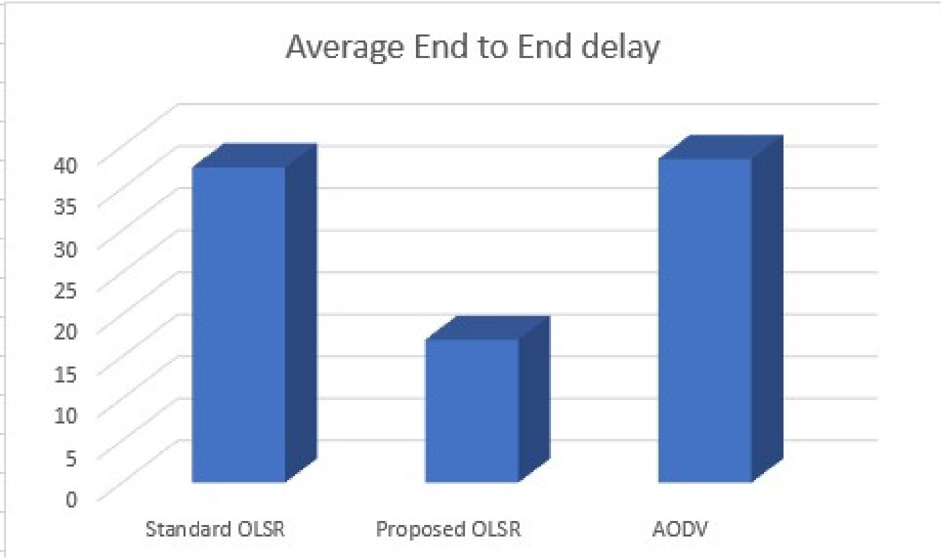

Figure 5. Comparison of Standard OLSR vs. Proposed OLSR vs. AODV Protocol: Delay.

5.2. Protocol Comparison: Load Metric

Load parameter in routing protocols is an important metric used to calculate the best path for network traffic. It is used to avoid congested links and balance the traffic load across the network. It refers to the current level of traffic or utilization on a particular link or network path. It is typically expressed as a percentage of the link's capacity such as 25 percent load. In comparison to the default OLSR [16] and AODV [26], the proposed OLSR has demonstrated a decrease in load. The value of delay obtained is highlighted in Table 3 and the comparison graph for all three techniques observed is highlighted in Figure 6.

Table 3. OLSR vs. Proposed OLSR vs. AODV—Average Load.

	Load	
Standard OLSR	Proposed OLSR	AODV
39	37	40

5.3. Protocol Comparison: Packet Delivery Metric

Information correctly transmitted via a network is referred to as packet delivery. Packet Delivery is a sampling measure of the number of IP packets successfully received on a specific node, expressed as a percentage ratio. The graph represented in Figure 7 shows the comparison of existing OLSR [16] with the proposed OLSR technique and AODV [26] the results show that Packet Delivery is maximum in the proposed technique as compared to the existing techniques considered. The obtained result values are shown in Table 4 and a graph is depicted in Figure 7.

Table 4. OLSR vs. Proposed OLSR vs. AODV—Average Packet Delivery.

	Packet Delivery	
Standard OLSR	Proposed OLSR	AODV
85.2	94.5	83.7

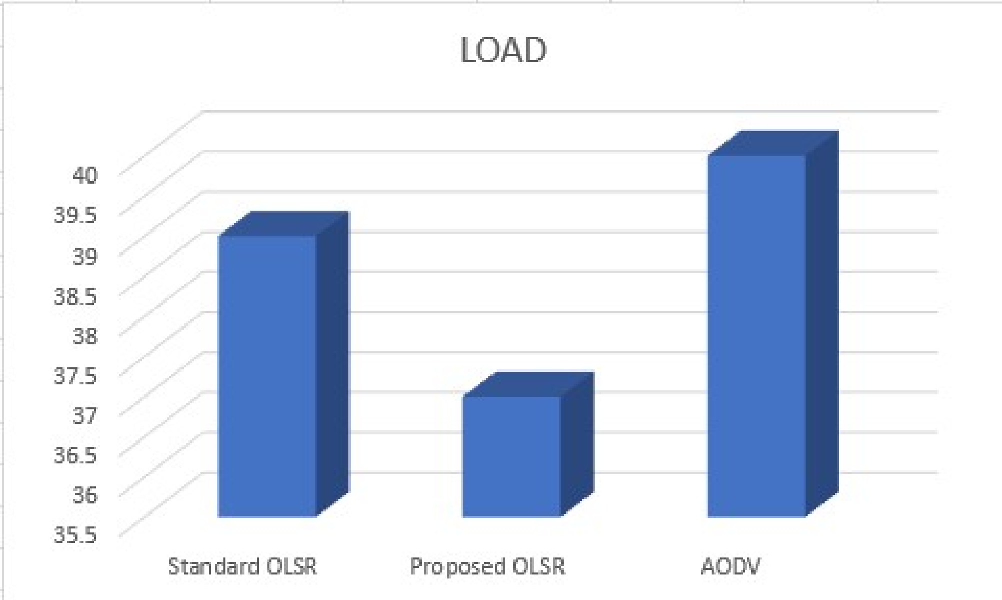

Figure 6. Comparison of Standard OLSR vs. Proposed OLSR vs. AODV Protocol: Load.

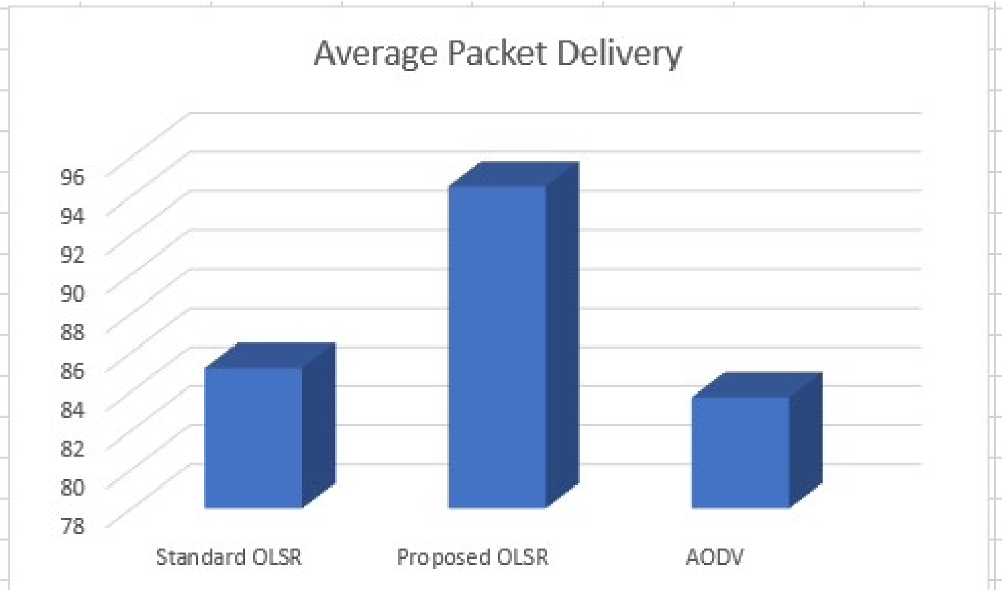

Figure 7. Comparison of Standard OLSR vs. Proposed OLSR vs. AODV Protocol: Packet Delivery.

5.4. Protocol Comparisons: Topology Control (TC) Messages Sent Metric

The topology control message contains a portrait of the quantity of TC messages transmitted by all of the network's nodes. The topology control (TC) messages are forwarded by the MPR nodes, changing the topology to the one that is best for routing at that precise moment. The more MPR nodes chosen by the network, the more topology control messages are forwarded by those nodes. The TC messages for standard OLSR, the proposed OLSR, and AODV are portrayed in Figure 8 and values are shown in Table 5. Compared to standard OLSR of [16] and AODV [26], the proposed OLSR sends a significantly higher number of TC messages which yields better performance.

Table 5. OLSR vs. Proposed OLSR vs. AODV—Topology Control (TC) Message Sent.

(TC) Messages Sent		
Standard OLSR	Proposed OLSR	AODV
49	56	40

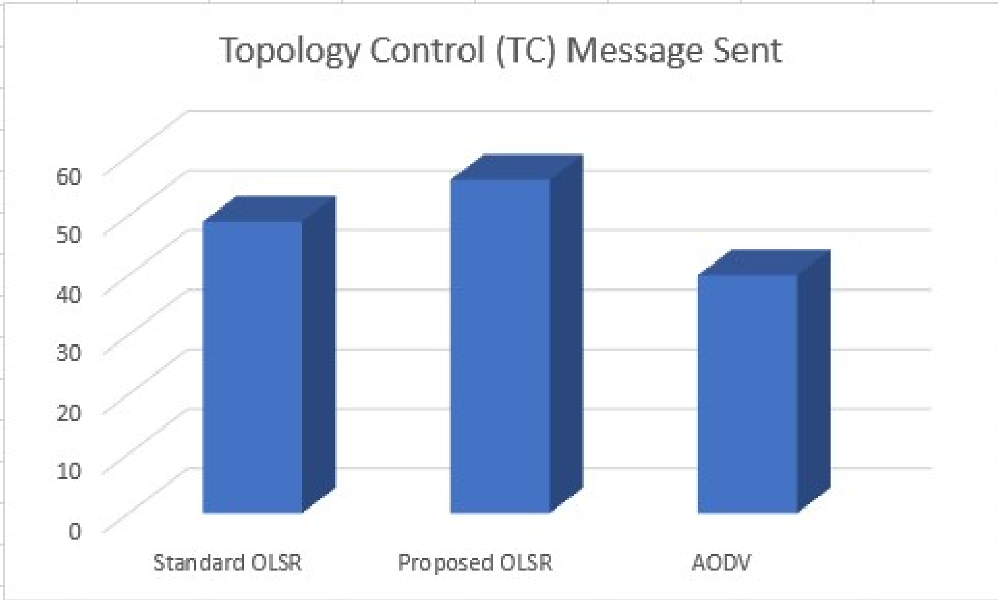

Figure 8. Comparison of Standard OLSR vs. Proposed OLSR vs. AODV Protocol: Topology Control (TC) Messages.

5.5. Protocol Comparison: Throughput Metric

The total number of bits delivered from a network to the nodes in its higher layer is known as throughput. The proposed OLSR has a higher throughput since it benefits from MPR nodes, hello message exchange, and TC messages. Through improved routing efficiency and a decrease in OLSR time, clustering increases throughput. Each cluster's cluster head serves as the forwarder node, and the source is aware of the cluster that contains the destination node. As a result, sending a packet to the target node without having to explore the entire network is made simple for the forwarder node. The improved OLSR illustrates significantly excessive throughput in contrast to standard OLSR utilized in [16] and AODV used in [26]. The value of throughput obtained is highlighted in Table 6 and the delay comparison graph is highlighted in Figure 9.

Table 6. OLSR vs. Proposed OLSR vs. AODV—Average Throughput.

Average Throughput		
Standard OLSR	Proposed OLSR	AODV
58	67	51

5.6. Contract of QoS Parameters with Simulation Time

Table 7, corresponding to Figures 10 and 11 while Table 8, corresponding to Figures 12 and 13 clearly outlined the performance for considered QoS parameters on the Simulation Time and Node Speed. The observation achieved has been portrayed using the comparison graphs. The accomplished proposed OLSR is shown quite better than the existing OLSR [16] under multiple scenarios.

Table 7. Simulation Time vs. QoS Parameters.

End to End Delay			Throughput (bps)		
Simulation Time	**Standard OLSR**	**Proposed OLSR**	**Simulation Time**	**Standard OLSR**	**Proposed OLSR**
30	37.5	17	30	50	150
80	32.3	15.5	80	45	132
120	29.4	14.2	120	41.5	122
180	26	13	180	36	111

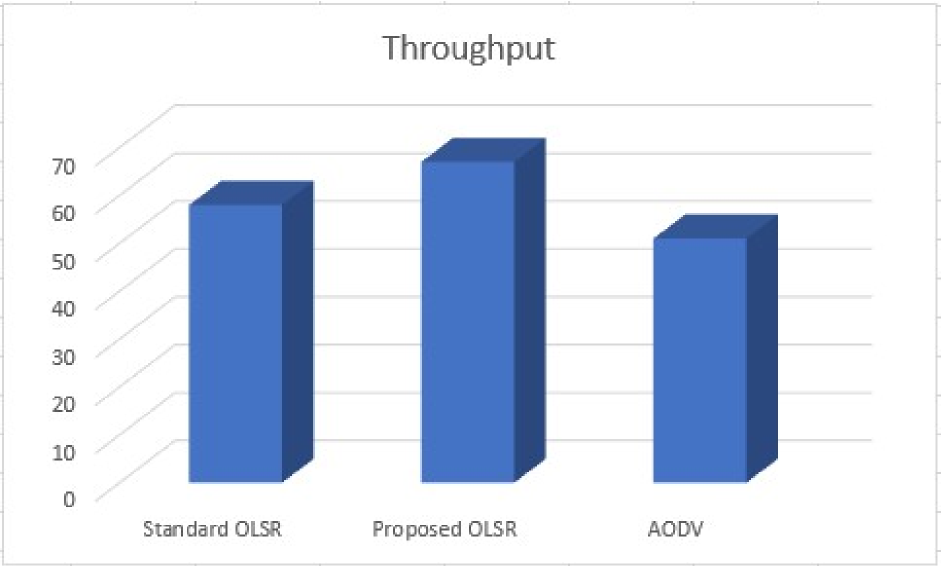

Figure 9. Comparison of Standard OLSR vs. Proposed OLSR vs. AODV Protocol: Throughput.

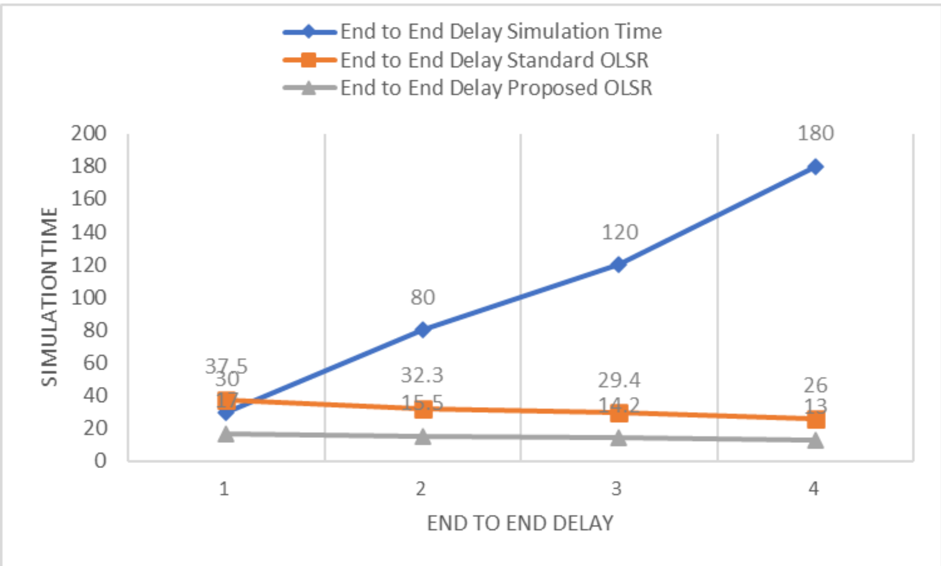

Figure 10. Contrast of QoS Parameter (End to End Delay) vs. Simulation Time.

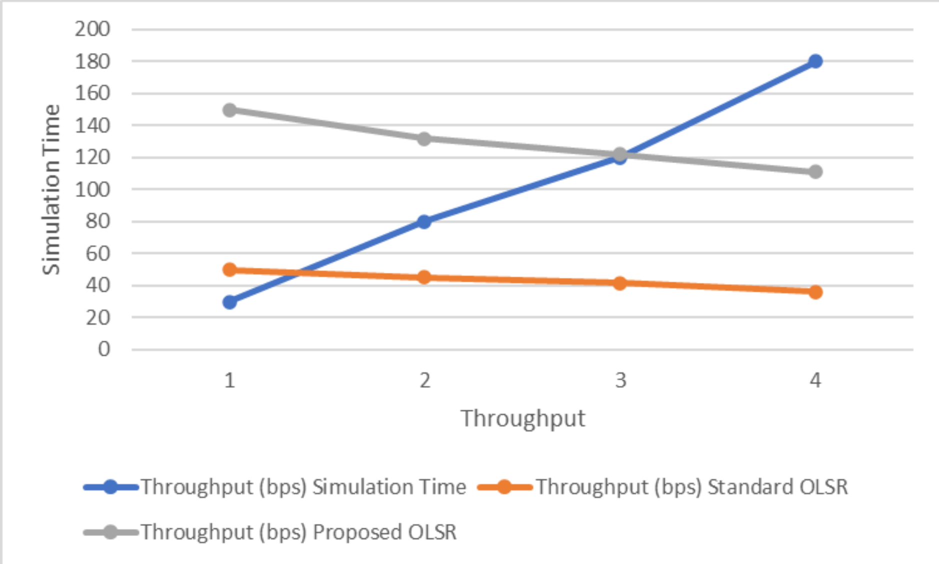

Figure 11. Contrast of QoS Parameter (Throughput) vs. Simulation Time.

Table 8. Node Speed vs. QoS Parameters.

Packet Delivery			TC Message Sent		
Node Speed	**Standard OLSR**	**Proposed OLSR**	**Node Speed**	**Standard OLSR**	**Proposed OLSR**
1	85.2	94.5	1	40	160
2	81.4	90.2	2	35	151
3	75.6	86.8	3	32.5	143
4	71.7	80.9	4	29	132
5	70.3	79.4	5	26	121

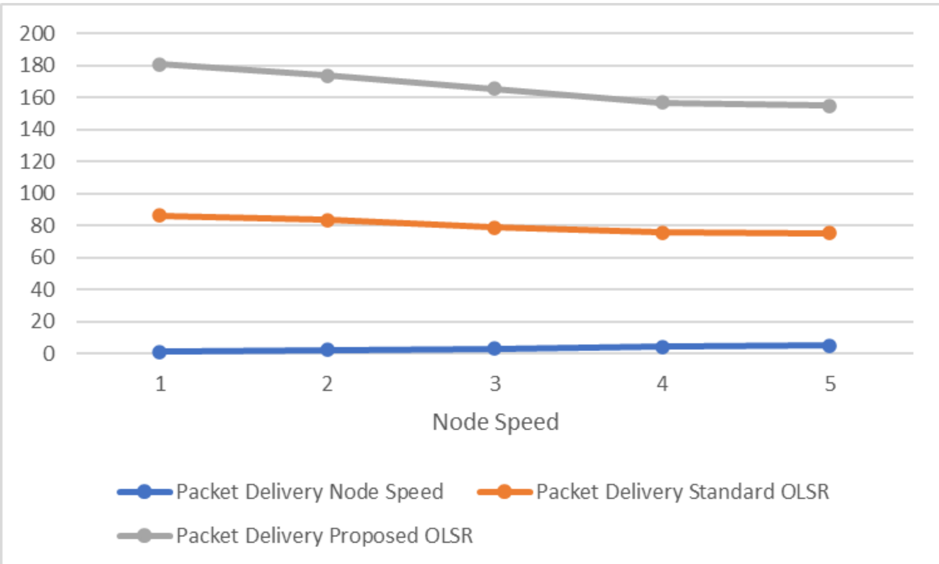

Figure 12. Contrast of QoS Parameter (Packet Delivery) vs. Node Speed.

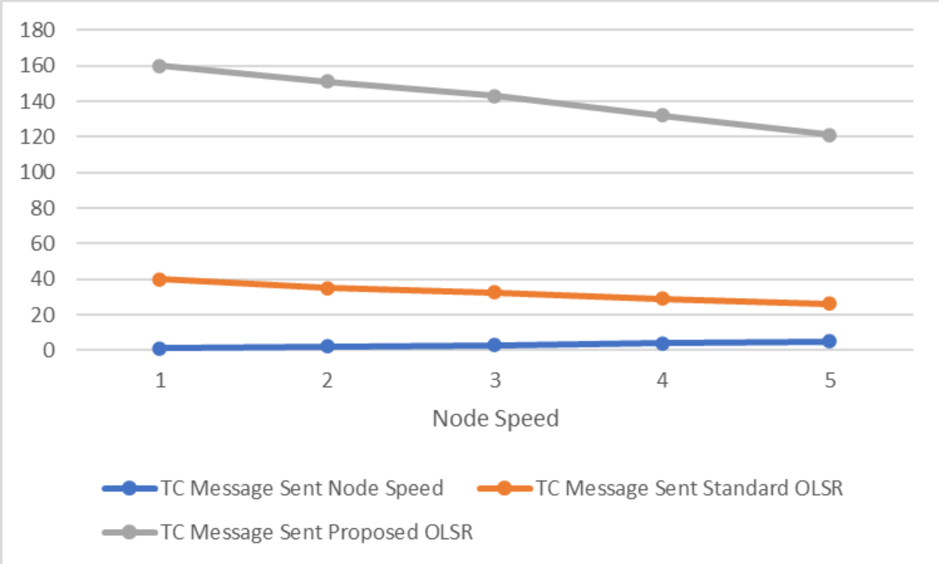

Figure 13. Contrast of QoS Parameter (TC Message) vs. Node Speed.

6. Conclusions

MANET routing protocols are a prominent topic, and numerous approaches have been made to monitor and manage topological information, facilitate network scalability, and extend network lifetime. Routing protocols assist communication in the MANET environment. How well these routing protocols operate is in influenced by various factors. The paper highlighted and formulated a refined OCI-OLSR protocol by varying all the control intervals in OLSR and using an optimal value for all intervals that are influential for offering distinguished network performance. The clustering aspect was consolidated into the proposed enhanced OLSR strategy, which is a notable technique to improve the performance of routing because it brings down flooding and further selects a cluster head based on an equipped factor, diminishing overall network costs. The computation of the proposed OCI-OLSR scheme is carried out on the NS-3 simulator. The findings revealed that the optimized OLSR variant delivers better execution results than the standard OLSR and AODV mechanism over various parameters thereby reshaping the network's overall performance and trustworthiness.

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