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COMPARATIVE EVALUATION OF AODV, OLSR, AND DSDV ROUTING PROTOCOL PERFORMANCE IN MANET USING NS-3

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Abstract: Performance comparisons were conducted between three widely used routing protocols in mobile ad hoc networks (MANETs): destination sequenced distance vector (DSDV), optimized link state routing (OLSR), and ad hoc on-demand distance vector (AODV). We evaluate the protocols using the NS 3 simulation environment by looking at important "metrics for performance such as throughput, end to end latency, and packet delivery ratio (PDR)" under different network conditions like node density and mobility. The results reveal that AODV consistently achieves the highest PDR and throughput, particularly in dynamic environments, while maintaining a lower end to end delay compared to DSDV and OLSR. OLSR, with its proactive approach, demonstrates robust performance in high density scenarios, although it incurs higher overhead. DSDV, while straightforward in its operation, struggles with scalability and adaptability, leading to suboptimal performance in highly mobile networks. This analysis provides essential insights into the operational characteristics of these protocols, aiding in the selection of appropriate routing strategies for diverse MANET applications.

Keywords: AODV, OLSR, DSDV, MANET, NS-3, Throughput.

I. INTRODUCTION

Mobile Ad hoc Networks (MANETs) are characterized by their self-configuring nature, allowing mobile devices to communicate directly without the necessity of a permanent infrastructure [1]. MANETs are especially well-suited for a range of applications due to their versatility, such as military communications, emergency response, and vehicular networks [2]. However, there are many difficulties because these networks are dynamic and unpredictable for routing protocols, which must efficiently manage regular changes in network topology due to node mobility. As a result, the choice of routing protocol is critical for ensuring reliable communication and optimal network performance [3]. Among the most popular routing protocols designed for MANETs are "Optimized Link State Routing (OLSR), Destination-Sequenced Distance Vector (DSDV), and Adhoc On-Demand Distance Vector (AODV)" [4]. As a reactive protocol, AODV only creates routes when necessary, making it bandwidth-efficient, especially in sparse networks [5]. In contrast, OLSR operates proactively, maintaining up-to-date routing information, which can facilitate quicker route discovery in dense networks [6]. "DSDV a table-driven protocol", relies on periodic updates to keep up with routing tables, which in highly mobile environments may result in higher overhead and latency. Understanding the performance implications of these protocols is essential for optimizing network operations in various scenarios [7].

Using the NS-3 simulation framework, this study attempts to perform a thorough performance evaluation of AODV, OLSR, and DSDV with an emphasis on important metrics for performance such as throughput, end-to-end latency, and packet delivery ratio (PDR). By simulating different network conditions, including variations in node mobility and density, we seek to uncover the strengths and weaknesses of each protocol. The findings from this research will not only contribute to the existing literature on MANET routing protocols but also provide practical insights for network designers and engineers in deciding which routing technique is best for a given application. Ultimately, this comparative analysis aims to enhance the understanding of how different routing protocols can impact the "efficiency and reliability of MANETs in real-world scenarios" [8].

II. RELATED WORK

This paper shows how well four routing protocols AODV, DSR, OLSR, and DSDV perform. And assessed the routing protocols according to network density and pause time using the most recent simulation environment, NS3. In a fixed topography of 500x2000 meters, the number of nodes varies from 20 to 100, and the pause time varies from 0 to 100 seconds. For evaluating any routing protocol, the performance metrics employed in this paper packet delivery ratio, throughput, and end-to-end average delay are essential. Because the "end-to-end average delay" was substantially lower than that of other protocols and the throughput did not drop as the "number of nodes" increased, according to the simulations, networks with low latency and high density are the ideal candidates for OLSR and DSDV. AODV performed the best overall, and it performs best in networks with more nodes. On the other hand, DSR works well with networks that have lower traffic densities and low mobility rates [9].

Performance evaluations AODV, DSDV, DSR, and OLSR were carried out by Sampad Mohapatra and Priyadarshi Kanungo using the NS2 simulator in this paper. "The performance of the aforementioned protocols is compared using four standard metrics: packet delivery ratio, control overhead, throughput, and delay" [10].

This paper compares the AODV, OLSR, and DSDV routing protocols' power-constrained performance. When a desired source node wishes to send a packet to the destination, only the route to the destination is determined by the on-demand reactive routing protocol, or AODV. A table containing details about the destination packet is retained by the packet. Although they were initially developed for MANETs, It is also possible to extend the table-driven proactive routing protocols DSDV and OLSR for VANETs. Lastly, a comparison of these three routing protocols is made using NS-3 and SUMO using quantitative measures like overhead, packet delivery ratio, and average throughput. According to simulation results, AODV adapts well to extremely dense vehicular networks and provides a realistic performance in contrast to OLSR and DSDV [11].

This study provides “a detailed analysis of the many routing protocols that have been proposed for mobile ad hoc networks,” as well as a classification of these protocols. [12] According to their routing strategies. Additionally, AODV, CBRP, DSR, and DSDV were presented in this paper along with an analysis of their features, distinctions, and traits. The NS2 simulator is used to analyze the performance of these routing protocols in a five-node scenario. Variations in network mobility are used to make the observations. According to the results of numerous network analyses conducted under various conditions, “AODV outperforms DSR, DSDV, and CBRP in terms of throughput and average delay, while CBRP outperforms them in terms of packet delivery ratio” [13]. After examining every parameter, it is determined that the AODV routing protocol is preferable [14].

The three routing protocols DSDV, AODV, and DSR [20] are realistically compared in this paper. The important finding is that the results of the simulation match the predictions made by theoretical analysis. The best performance is expected from AODV due to its ability to maintain a connection through periodic information exchange, which is required for TCP-based traffic reactive routing protocol. AODV operates in a predictable way [15].

AODV, DSR, DSDV, OLSR, and DYMO are among the MANET routing protocols that are examined in this paper. In order to compare these protocols under various network conditions, NS-2 simulation is used. The performance matrices for Average Throughput, Changing the number of nodes displays the packet delivery ratio, normalized routing load, and average end-to-end delay. The packet delivery ratios of AODV and DSR are higher than those of DSDV, OLSR, and DYMO protocols. The protocols that are driven by tables Comparing on-demand protocols (AODV, DSR, and DYMO), DSDV and OLSR have the lowest Average End-to-End delay. Among the protocols, DSR exhibits the lowest Normalized Routing Load. When it comes to Average Throughput, “AODV and DSR perform better than other protocols (DSDV, OLSR, and DYMO)” in practically every scenario [16].

This study assesses the performance of AODV, OLSR and DSDV are three widely used MANET routing protocols. Because of the network's dynamic and decentralized nature, reliable communication in MANETs depends on effective routing protocols. AODV belongs to the reactive protocol category that creates routes on demand; OLSR and DSDV belong to the proactive protocol category that updates routing tables constantly. The protocols are assessed in terms of some critical metrics, such as PDR, throughput, and latency, considering different network conditions like changes in node density and simulation area. The research is beneficial in picking the correct routing protocols to go within particular MANET configurations. This will help optimize wireless communication in scenarios such as emergency response, military operations, or even mobile sensor networks [17].

To assess the “performance of all six protocols (DSDV, OLSR, AODV, DSR, ZRP, and FSR), a comparative analysis of the reactive, proactive, and hybrid protocols has been conducted” based on their advantages and disadvantages, in order to make selecting an effective routing protocol based on network complexity simple [18].

III. OVERVIEW OF AD-HOC ROUTING PROTOCOLS

Proactive Routing

Proactive routing protocols are designed to continuously update and maintain routes within a network, even before any data transmission occurs. These protocols operate on a table-driven model where each node in the network maintains an up-to-date routing table, containing routes to all other nodes. As the network topology changes, these protocols send out control messages on a regular basis [19] to update all the nodes. The benefit of proactive routing is that it ensures fast delivery of data packets since the route is already known and ready when needed. However, it can be inefficient in terms of bandwidth and power consumption, as the network continuously exchanges control messages, even when there is little or no data traffic. An example of a proactive routing protocol is Optimized Link State Routing (OLSR), Destination Sequenced Distance Vector (DSDV) commonly used in mobile ad hoc networks (MANETs).

Reactive Routing

Reactive routing protocols don't keep continuous route tables like proactive ones do. Instead, these protocols discover routes only when needed, which leads to a more efficient use of network resources, especially in environments with sparse traffic. A route request (RREQ) is typically broadcast throughout the network to start the process of finding a route when a node needs to communicate with another node. The route reply (RREP) is returned if the destination node is located, establishing the route. Reactive protocols are more energy-efficient and bandwidth-efficient in scenarios where routes are infrequently needed. However, they introduce a delay in the data transmission process due to the route discovery phase. Ad hoc On-Demand Distance Vector (AODV), a popular reactive routing protocol in ad hoc networks is one example.

Hybrid Routing

The goal of hybrid routing protocols is to integrate the benefits of proactive and reactive routing techniques, addressing their individual limitations. In hybrid protocols, the network is typically divided into two regions: one that uses proactive routing and one that uses reactive routing. In the proactive region, routes are pre-established and updated continuously, while in the reactive region, routes are discovered only when needed. This hybrid approach can reduce the overhead associated with frequent control message exchanges, while still providing low-latency routes when necessary. By using both proactive and reactive strategies, hybrid protocols aim to balance efficiency, scalability, and responsiveness. A well-known example of a hybrid routing protocol is the networks are divided into zones by the Zone Routing Protocol (ZRP), which employs reactive routing for communication between zones and proactive routing within each zone.

Ad hoc On-Demand Distance Vector (AODV)

The reactive routing system known as Adhoc On-Demand Distance Vector (AODV) was created mainly for Mobile Adhoc Networks (MANETs), which are networks where devices can join or leave dynamically. AODV is reactive, meaning it discovers routes only when they are required, unlike proactive protocols that maintain routes constantly. It relies on a distance vector routing mechanism, where each node keeps a routing table that stores information like the destination address, next hop, and the number of hops required to reach the destination.

A route discovery procedure is started in AODV when a source node needs to communicate data but does not yet have an active route to the destination. A Route Request (RREQ) packet including the source and destination addresses, sequence numbers, and hop count is first broadcast by the node. If intermediate nodes have a route, they respond with a Route Reply (RREP); if not, they forward the RREQ. After receiving the RREQ, the destination node (or an intermediary node with a valid route) sends back to the source an RREP, which is then sent back along the RREQ's reverse path. This creates a path from the starting point to the final destination.

Once a route is established, AODV ensures it is maintained as long as it is in use. If a node moves or a link fails, the protocol sends a Route Error (RERR) message to inform affected nodes. This prevents the use of broken routes. AODV uses sequence numbers to ensure that only the most recent and valid routes are used and helps prevent routing loops. Additionally, routes are removed from the routing table if they are not used for a certain period to avoid unnecessary memory consumption.

The protocol's key features include its low overhead, since routes are only discovered on demand, and its ability to adapt to the dynamic nature of mobile networks. However, AODV also has some limitations. The process of discovering routes can introduce delays, particularly if the network is large and the route discovery process is time-consuming. Moreover, in large networks, the broadcast of RREQ packets can result in considerable network traffic, potentially degrading performance. Despite these drawbacks, AODV is well-suited for environments with high mobility and frequent topology changes, such as military operations, disaster recovery scenarios, and vehicular ad hoc networks (VANETs). It offers an efficient and scalable solution for dynamic wireless networks, but careful consideration is needed to manage its overhead and delays, especially in larger or highly dynamic networks.

Optimized Link State Routing (OLSR)

A proactive routing system called Optimized Link State Routing (OLSR) was created for Mobile Ad hoc Networks (MANETs), in which nodes are free to join and exit the network at any time. Unlike reactive protocols that discover routes only when needed, OLSR maintains up-to-date routes at all times. It is based on a link-state routing mechanism, where each node periodically exchanges information with other nodes to build and update a global network topology. OLSR is specifically optimized to work efficiently in mobile and dynamic networks by using Multipoint Relays (MPRs). These MPRs are selected nodes that help forward routing information, minimizing the overhead caused by broadcast flooding and improving scalability.

In OLSR, nodes periodically send Hello messages to discover their neighbors and to maintain a list of directly connected nodes. These messages help identify potential MPRs, which are then responsible for forwarding Topology Control (TC) messages. These TC messages allow nodes to share their topology information, ensuring that all nodes in the network have an up-to-date view of the network's structure. Using this information, nodes calculate the most efficient routes to other nodes, keeping their routing tables updated at all times. Since OLSR is a proactive protocol, it ensures that routes are always available when needed, resulting in low latency for data transmission.

One of the main advantages of OLSR is its ability to minimize network overhead compared to traditional link-state protocols. By using MPRs to reduce redundant control message flooding, OLSR optimizes the use of network resources, especially in dense networks. This also makes OLSR scalable and well-suited for environments where mobility is high, like in vehicular ad hoc networks (VANETs), military networks, and disaster recovery situations. However, there are some disadvantages, such as the continuous exchange of control messages, which can lead to high overhead, especially in highly dynamic networks. The protocol also requires more memory to store the network topology and routing tables. Additionally, OLSR may not be as efficient in sparse networks where the proactive nature of the protocol may lead to unnecessary control traffic.

Destination Sequenced Distance Vector (DSDV)

For mobile ad hoc networks (MANETs), the Destination-Sequenced Distance-Vector (DSDV) protocol is a proactive, table-driven routing mechanism, where nodes function both as hosts and routers. Every node in this protocol keeps a routing table with entries for every potential network destination. These entries include the destination, the next hop to reach that destination, and a sequence number that helps ensure the freshness and accuracy of the route. The sequence number also helps prevent routing loops, as nodes will only accept a route with a higher sequence number than their current route. DSDV operates by periodically exchanging these routing tables with neighboring nodes. Whenever there is a change in the network, such as a topology update, the sequence number is incremented, and the new route information is broadcasted to neighbors.

DSDV uses the principle of distance-vector routing, where nodes select the shortest path to each destination based on the number of hops and the freshness of the route (indicated by the sequence number). This proactive approach ensures that routes are always available, reducing delay when sending data. However, it comes with some downsides, including periodic route updates that lead to increased overhead, particularly in larger networks. In such cases, the protocol can become less efficient due to the constant need to send out updates, even if the network topology hasn't changed. Furthermore, in highly dynamic environments, stale routes may exist temporarily until updated information propagates through the network. Although DSDV performs well in small, stable networks, its scalability issues can be a limitation in larger, more mobile networks.

While DSDV ensures low latency and up-to-date routes in smaller networks, its high overhead and bandwidth consumption in large, dynamic environments limit its scalability. It is particularly useful in applications such as military networks, sensor networks, and personal area networks, where network mobility is limited, and routing consistency is crucial. Compared to other protocols like AODV, which operates reactively, DSDV's proactive nature allows for faster route availability but at the cost of higher control message overhead.

IV. PERFORMANCE EVALUATION METRICS AND SCENARIOS

Performance Metrics

Packet Delivery Ratio (PDR): PDR is defined as the proportion of the total number of messages sent by the source that are successfully delivered to the destination. It displays how well the routing protocol distributes data throughout the network.

$$PDR = \frac{\text{Total Received Packets} \times 100}{\text{Total Sent Packets}} \quad (1)$$

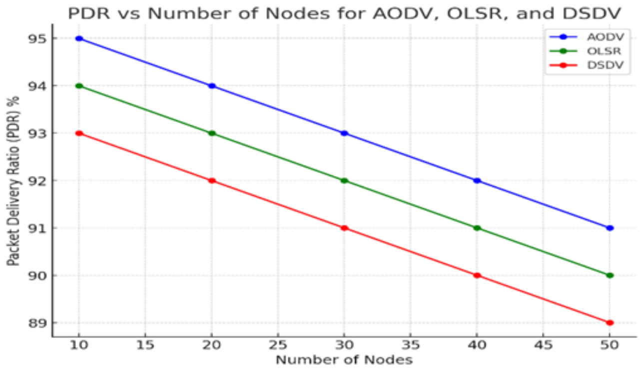

Fig. 1 The line graph that contrasts the DSDV, OLSR, and AODV packet delivery ratios (PDR) with 10,000 sent packets across 10, 20, 30, 40, and 50 communicating nodes. The PDR trends indicate that the PDR for each of the three protocols somewhat declines as the number of nodes rises, with AODV maintaining the highest PDR, followed by OLSR and DSDV.

End-to-End Delay: The average time it takes for a data packet to move from its starting point to its destination is measured by the end-to-end delay. It encompasses all delays brought on by aligning, transmission, communication and route discovery.

$$\text{End-to-End Delay} = \frac{\sum_{i=1}^{N}\left(t_{received} - t_{sent}\right)}{N} \qquad (2)$$

- N = total number of successfully received packets.
- treceived = the time the packet reaches its destination.
- tsent = the time the packet leaves the source.
- ∑ represents the sum of all packets that were reached at the destination.

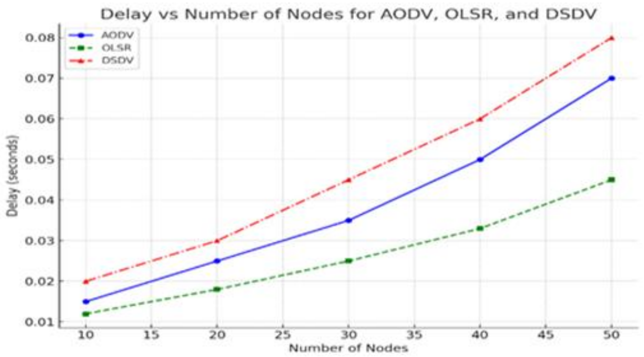

Fig. 2 Based on the hypothetical data, the graph shows how the AODV, OLSR, and DSDV routing protocols' delays (Seconds) relate to their node counts. You can see how the delay varies for each protocol as the nodes increases.

- AODV: AODV generally shows a steady increase in delay as the network size grows.
- OLSR: OLSR tends to have lower delays in contrast to the two other protocols.
- DSDV: DSDV shows the highest delay, especially as the quantity of nodes rises.

Throughput: A crucial performance indicator that shows the success rate of data transfer over the network is throughput. Bits per second (bps) is used to measure and indicates how effectively a routing protocol manages dynamic topology and node mobility to transfer packets from one location to another. Throughput is influenced by factors like network size, node mobility, routing overhead, link failures, and interference.

$$\text{Throughput (bps)} = \frac{\text{Total Data Received (in bits)}}{\text{Total Simulation Time (in seconds)}} \qquad (3)$$

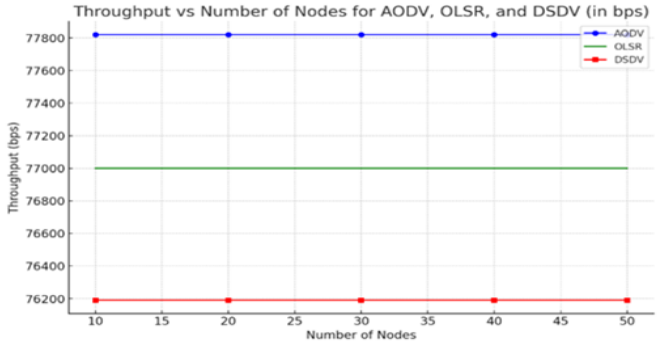

Fig. 3 The line graph comparing the throughput of AODV, OLSR, and DSDV (in bits per second) against the number of nodes (10, 20, 30, 40, and 50). The throughput is represented as constant values for every protocol, while the x-axis shows the number of nodes.

TABLE I. PERFORMANCE METRICS OF AODV, OLSR, DSDV IN MANET SIMULATION.

Parameters	Value & Results
Network Simulator	NS-3.38
Routing Protocols	AODV, OLSR, DSDV
Wireless Protocol	IEEE 802.11
Mobility	Random
Area	800 x 800 m
Nodes	10-50.
Simulation Seconds	500s
Pause Time	20ms
Energy Consumption	WifiRadioEnergyModel

V. CONCLUSION

In conclusion, this paper offers a comprehensive comparative analysis of the AODV, OLSR, and DSDV protocols within a MANET environment using NS-3. The simulation results show that AODV excels in packet delivery but at the cost of increased delay as the network scales, making it suitable for networks where delivery success is prioritized over latency. OLSR maintains a balance between packet delivery and delay, making it ideal for highly dynamic environments. DSDV, though exhibiting higher delays, proves effective in scenarios where network stability is more important than speed. Overall, the network's unique requirements have a significant influence on the protocol selection, with AODV being better for high-delivery applications, OLSR for mobile environments, and DSDV for stable, low-mobility networks. Future work could explore protocol optimizations and extensions to improve performance under more challenging conditions, such as highly dense or highly mobile networks.

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VII. REFERENCES

[1] D. Kanellopoulos, Congestion control for MANETs: An overview, ICT Express, Volume 5, Issue 2, 2019, Pages 77-83, ISSN 2405-9595, https://doi.org/10.1016/j.icte.2018.06.001.

[2] M. Al-Absi, A. Al-Absi, M. Sain, and H. Lee, "Moving ad hoc Networks-A comparative study," Sustainability, vol. 13, no. 11, p. 6187, 2021, doi: 10.3390/su13116187.

[3] S. Singh and S. Agrawal, "VANET routing protocols: Issues and challenges," 2014 Recent Advances in Engineering and Computational Sciences (RAECS), Chandigarh, India, 2014, pp. 1-5, doi: 10.1109/RAECS.2014.6799625.

[4] B. Paul, S. Konwar, U. Gogoi, A. Chakraborty, N. Yeshmin and S. Nandi, "Implementation and performance evaluation of AODV in Wireless Mesh Networks using NS-3," (2010) 2nd International Conference on Education Technology and Computer, Shanghai, China, 2010, pp. V5-298-V5-303, doi: 10.1109/ICETC.2010.5530060.

[5] F. De Rango, M. Fotino and S. Marano, "EE-OLSR: Energy Efficient OLSR routing protocol for Mobile ad-hoc Networks," MILCOM 2008 - 2008 IEEE Military Communications Conference, San Diego, CA, USA, 2008, pp. 1-7, doi: 10.1109/MILCOM.2008.4753611.

[6] G. F. Ahmed, R. Barskar, and N. Barskar, "An improved DSDV routing protocol for wireless ad hoc networks," Procedia Technology, vol. 6, pp. 822-831, 2012, doi: 10.1016/j.protcy.2012.10.100.

[7] P. G. Lye and J. C. McEachen, "A Comparison of Optimized Link State Routing with Traditional Routing Protocols in Marine Wireless Ad-hoc and Sensor Networks," 2007 40th Annual Hawaii International Conference on System Sciences (HICSS'07), Waikoloa, HI, USA, 2007, pp. 293b-293b, doi: 10.1109/HICSS.2007.8.

[8] K. Vimala and Dr. D. Maruthanayagam, "Comparative analysis of routing algorithms to enhance the quality of service in MANET," Int. J. Recent Technol. Eng. (IJRTE), vol. 11, no. 1, pp. 108–115, 2022, doi: 10.35940/ijrte.a6949.0511122.

[9] A. Shankar and L. Chelle, "Performance comparison of AODV, DSR, DSDV and OLSR MANET routing protocols," Int. J. Eng. Res. Technol. (IJERT), vol. 5, no. 10, pp. 1-6, Oct. 2016.

[10] S. Mohapatra and P. Kanungo, "Performance analysis of AODV, DSR, OLSR and DSDV routing protocols using NS2 simulator," Procedia Eng., vol. 30, pp. 69-76, 2012, doi: 10.1016/j.proeng.2012.01.835.

[11] A. Choksi and M. Shah, "Machine learning based centralized dynamic clustering algorithm for energy efficient routing in vehicular ad hoc networks," Trans. Emerg. Telecommun. Technol., vol. 35, no. 1, Jan. 2024, doi: 10.1002/ett.4914.

[12] P. Parvathi, "Comparative analysis of CBRP, AODV, DSDV routing protocols in mobile Ad-hoc networks," 2012 International Conference on Computing, Communication and Applications, Dindigul, India, 2012, pp. 1-4, doi: 10.1109/ICCCA.2012.6179145.

[13] T. Bhatia, A.K. Verma, "QoS Comparison of MANET Routing Protocols", International Journal of Computer Network and Information Security(IJCNIS), vol.7, no.9, pp. 64-73, 2015. DOI:10.5815/ijcnis.2015.09.08

[14] A. Kumar, P. Singh, V. Kumar, and N. Tyagi, "Performance analysis of AODV, CBRP, DSDV and DSR MANET routing protocol using NS2 simulation," Int. J. Comput. Netw. Inf. Secur., vol. 5, no. 9, pp. 45-50, 2013.

[15] S. A. Ade., P.A.Tijare. Performance Comparison of AODV, DSDV, OLSR and DSR Routing Protocols in Mobile Ad Hoc Networks. International Journal of Information Technology and Knowledge Management, July-December 2010, Volume 2, No. 2, pp. 545-548.

[16] M. Elboukhari, M. Azizi, and A. Azizi, "Performance comparison of routing protocols in mobile ad hoc networks," Int. J. UbiComp (IJU), vol. 6, no. 2, Apr. 2015, doi: 10.5121/iju.2015.6201.

[17] D. Thakre and S. Awaya, "Performance study of AODV, OLSR, and DSDV routing protocols in mobile ad hoc networks," Int. J. Microwave Eng. Technol. (IJMET), vol. 10, no. 3, 2024.

[18] D. Aggarwal and S. Gaba, "A comparative study: Reviewing performance of routing protocols in mobile ad-hoc network," Int. J. Sci. Res. Sci., Eng. Technol. (IJSRSET), vol. 4, no. 8, pp. 528-532, May-June 2018.

[19] A. Shabani Baghani, S. Rahimpour and M. Khabbazian, "The DAO Induction Attack: Analysis and Countermeasure," in IEEE Internet of Things Journal, vol. 9, no. 7, pp. 4875-4887, 1 April1, 2022, doi: 10.1109/JIOT.2021.3108154.

[20] B. K. Saraswat, M. Bhardwaj, and A. Pathak, "Optimum experimental results of AODV, DSDV & DSR routing protocol in grid environment," Procedia Comput. Sci., vol. 57, pp. 1359–1366, 2015, doi: 10.1016/j.procs.2015.07.451.