Optimizing MANET Network Performance through Routing Protocol

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Abstract

The proper configurations must be utilised in order for Mobile Ad Hoc Network (MANET) protocols to operate as efficiently as feasible. The only approaches to resolve this problem are to select the proper routing protocol and use its default parameter settings. Performance was evaluated using the following performance indicators: packet delivery ratio (PDR), throughput, latency, packet loss, energy consumption, and routing overhead. The results show that while the AODV protocol outperforms the OLSR approach in some parameters, the OLSR methodology has a lower delay than the AODV protocol. By adjusting the combo values of RREQ_RETRIES, MAX_RREQ_TIMEOUT in AODV routing to (2, 10 s) and (3, 5 s), the protocol's performance can be improved. 3.09% in throughput performance, 17.7% in latency reduction, 27.15% in packet loss reduction, and 4.8% in PDR are the average advantages from the two combinations. When it comes to node movement speed variations, 20 m/s is the best performance and 5 m/s is the worst.

Keywords: Mobile Ad Hoc Network, Optimised Link State Routing, Packet Delivery Ratio, Routing Protocol.
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1. Introduction

In a network, routing is the process of sending data from a source to a destination via transitional nodes. Because of its limited resources, designing an effective routing mechanism is one of the most challenging problems in MANETs. A routing process needs to be comparatively sufficient to handle variations in the network's size, traffic intensity, and network segmentation. In wired networks, two popular algorithms known as link state and distance vector were typically employed.Link state employs a flooding stratagem to periodically broadcast link state outlays of each node's neighbouring nodes, providing the most recent network aspect. Every node receives an update and uses the shortest path method to select the next hop for each destination based on its own view of the network and link state outlays. By using all of its neighbours, a distance vector practise keeps track of a set of distances to every destination at every node. To find the shortest path, a node choose its neighbour who is the closest to its destination.

A dissemination of the current approximation of the shortest distance at each node periodically

represents the distance vector information for every node in the network. The outdated link status and distance vector methods are ineffective in MANETs due to their frequent route modifications, which consume a significant portion of available bandwidth.For wired networks, there are numerous routing methods available. Nearly all of them may be categorised as using either the link-state algorithms or the distance vector.

Every router in the network transmits its view of its distance from every other node on a regular basis while using distance vector routing to the surrounding areas. Using this data, every router determines its next-hop neighbours at each node along the shortest path. Each router in link-state routing communicates to all the routers in its network the status of its neighbouring network links on a regular basis the system. After then, each router can decide what to forward based on a comprehensive a network image created by aggregating the most recent router updates.

[1] The aforementioned methods were created for usage in static wired networks with bi-directional links and rare topology changes. Additionally, they need a lot of processing, which makes them challenging to employ with limited resources.

[2] These issues necessitate the development of novel routing algorithms that take MANET characteristics into consideration.

[3] Finding routes between nodes that are a part of a constantly changing topology with potentially unidirectional links while consuming the fewest resources is the problem of routing in MANETs.

[4] Nodes in a wireless network with a dynamic topology, such as a mobile ad hoc network, are free to move anywhere inside the boundary.

[5] It is challenging to analyse MANET analytically because of these characteristics. Therefore, investigations are centred on simulation of the to examine and comprehend these properties.

2. Materials and Methods

The current study's technique involved simulating using the NS2 simulator. The first step was to create a simulation.

[6] The design of the simulation was completed in order to identify real-world case studies that would serve as models for the simulation's parameters.

[7] The procedure then moved on to designing the network traffic and node placements for the scenarios' test design related to the routing protocol's performance test. Figure 1 provides a broad overview of the research process.

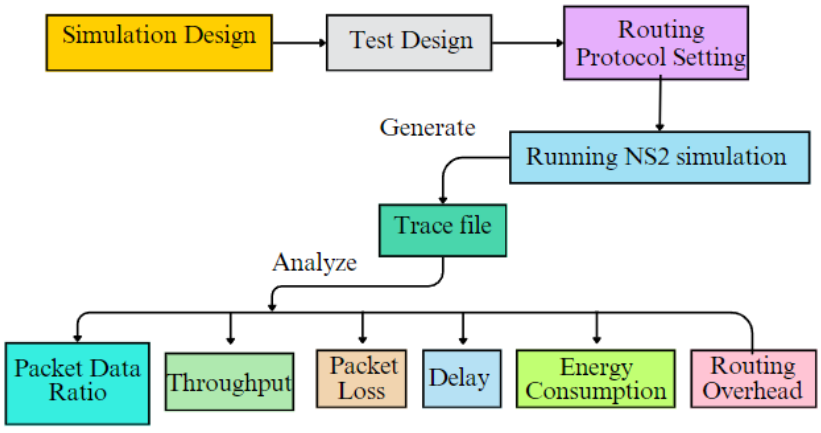

Figure1. Researchsteps.

Simulation Design

The current study's case selection was

important since it had an impact on how the simulation scenarios were created. [8] On mobile communication devices like notebooks, cellphones, and data sharing sensors, MANET can be employed in practical applications. [9] Because the selected example for this study comprised a smartphone or sensor mounted on a car, it was able to transmit packet data to base stations or other devices. [10] In order to facilitate this situation, we employed a 1000 x 1000 m simulation area, the UDP transport protocol, and 512-byte packets with a maximum of 1000 packets per connection, sent ten times each minute. [11] The parameters and values used in the research are displayed in Table 1.

Table1. Simulationparameter.

Parameter	Value
Area of simulation	1000x1000 m
Idle power	0.6W
Initial energy	1000J
Maximum packets	1000 packets
Packet size	512 bytes
Packet type	CBR
Propagation model	Two Ray Ground
Rate of packets	20 packets/second
Rx Power	1.3W
Simulation time	100 s
Sleep power	0.04W
Transportation protocol	UDP
Tx Power	1.7W

Test Design

In this case, the five nodes in the scenario were made up of one moving node and four stationary nodes. Table 2 illustrates the amount of network traffic for a single connection with a single source and destination node.[12]

Table2. Scenariodetails.

Parameter	Value
Number of nodes	5
Amount of traffic	1

Configuring the Routing Protocol

Table 3 displays a list of the combinations of the two values. After that, a test design was used to simulate the values. [13] Comparing the change in the RREQ_RETRIES value to the MAX_RREQ_TIMEOUT value and vice versa was the goal of the value selection.

Table3.RREQ_RETRIESandMAX_RREQ_TIMEOUTvariationofAODVprotocol.

RREQ_RETRIES Value	MAX_RREQ_TIMEOUT Value
3 (default)	10 (default)
3	20
5	20

4	6
4	7
4	8
4	9
4	10

Performance Metrics

PDR

The network performs better the higher the PDR value. One of the QoS parameters is PDR. It may be computed using Equation (1) and shows the routing protocol's success rate.

$$\text{PDR} = \frac{\sum_{i=0}^{N} \text{Rn}_i}{\sum_{i=0}^{N} \text{Sn}_i} \qquad (1)$$

Throughput

Understanding whether there is enough bandwidth available for the application is the key to throughput. [14] This establishes the maximum amount of network traffic that an application is permitted to receive. Equation (2) can be used to calculate this throughput, which can be measured after the data transfer has completed.

$$\text{Throughput} = \frac{\text{total of the packet sent}}{\text{total data sending time}} \qquad (2)$$

Loss of Packets

Packet loss occurs, however, because the UDP protocol does not resend a lost packet. Network overload, packet corruption, physical media faults, and receiver transmission failure (also known as buffer overload) are some of the factors that lead to packet loss on a network. Equation (3) can be used to compute packet loss.

$$\text{Packet loss} = \frac{\text{total of packet sent - total of the packet received}}{\text{total of packet sent}} \qquad (3)$$

Delay

The time it takes to move a packet from its source via a network of nodes to its destination is known as the delay [15]. The delay is expressed in milliseconds since it has a temporal component. This delay is caused by a number of causes, including network congestion, overloaded servers, and network connection point distance. A higher delay value is possible when a network is under more stress and the link is further away. One parameter used to evaluate QoS is delay. The higher the network quality, the lower the delay value. Equation (4) can be used to find the average delay.

$$\text{Delay} = \frac{\text{time packet received} - \text{time packet sent}}{\text{total package received}}. \qquad (4)$$

Average Energy Consumption

It is possible to compute the energy consumption of MANET by utilising Equation (5). Each node's energy consumption is calculated by deducting its beginning energy value (i) from its remaining energy value (r); the result is then divided by the total number of nodes (N).

$$\text{Average Energy Consumption} = \frac{i-r}{N}. \qquad (5)$$

Routing Overhead

The amount of routing packets transmitted during a simulation is displayed by routing overhead.

Equation (6) illustrates the routing packages used in the AODV protocol: Route Request (RREQ), Route Reply (RREP), and Route Error (RRER). Equation (7) illustrates the presence of Topology Control (TC) and HELLO routing packages in OLSR. Generally speaking, an increase of TC messages can result in collisions, congestion, and higher energy usage, all of which can impair network performance:

AODV Routing Overhead = RREQ + RREP + RRER (6)

OLSR Routing Overhead = HELLO + TC. (7)

Results

The study findings on PDR, throughput, packet loss, latency, energy usage, and routing overhead are presented in this section. We compare the AODV and OLSR protocols with a default setting for every outcome. Next, we examine how the AODV protocol is affected by RREQ_RETRIES and MAX_RREQ_TIMEOUT.Figure 2 displays the PDR results of the AODV and OLSR methods.

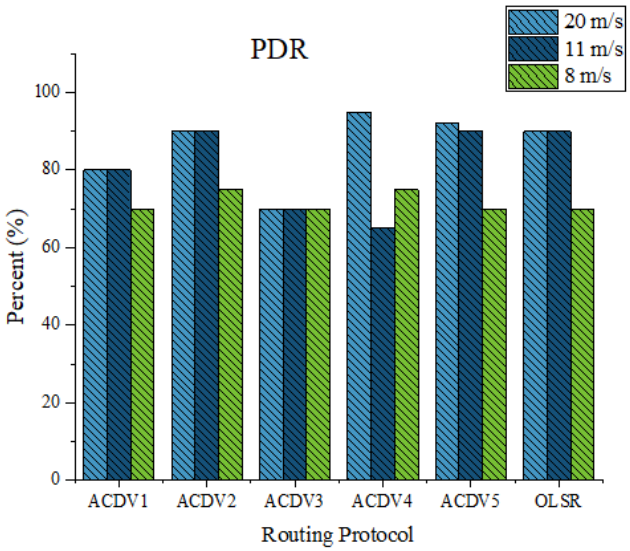

Figure2.PDRresults.

Throughput

Figure 3 displays the throughput outcomes of the AODV and OLSR methods. As can be seen in the graphic, Next, throughput is reduced to 2.6% when RREQ_RETRIES is increased to 4 (AODV 3). These findings also hold when MAX_RREQ_TIMEOUT is decreased, improving throughput performance.

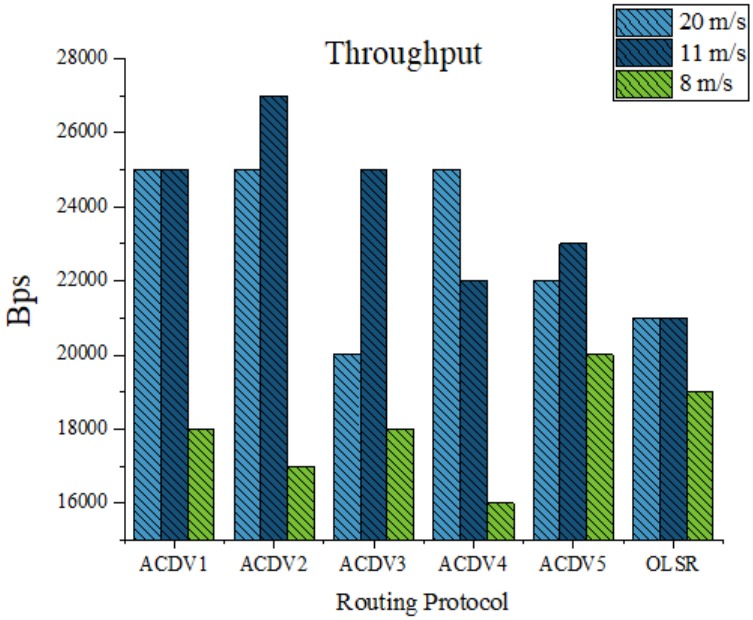

Figure3. Throughput results.

Figure 4 displays the packet loss results for the AODV and OLSR protocols.

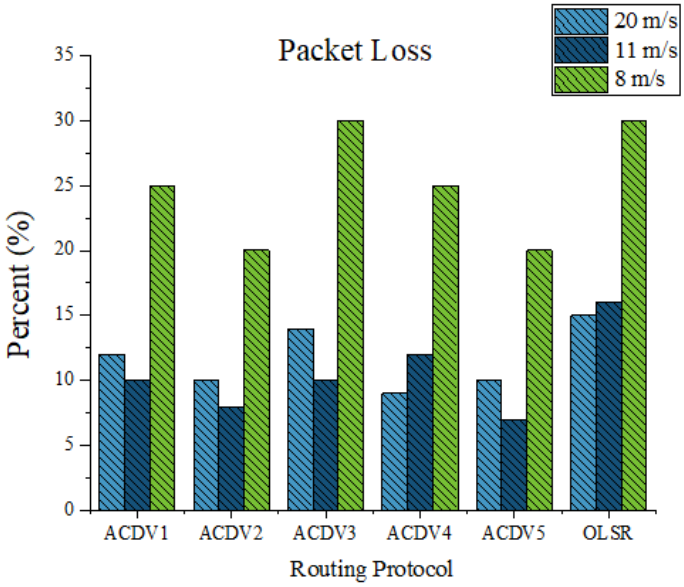

Figure4. Packet loss results.

Delay

Figure 5 displays the delay findings from both the AODV and OLSR methods. The findings indicate that OLSR outperforms AODV in terms of delay. The average latency of the OLSR protocol is 0.022 ms, whereas the default AODV protocol delay is 0.1722 ms.

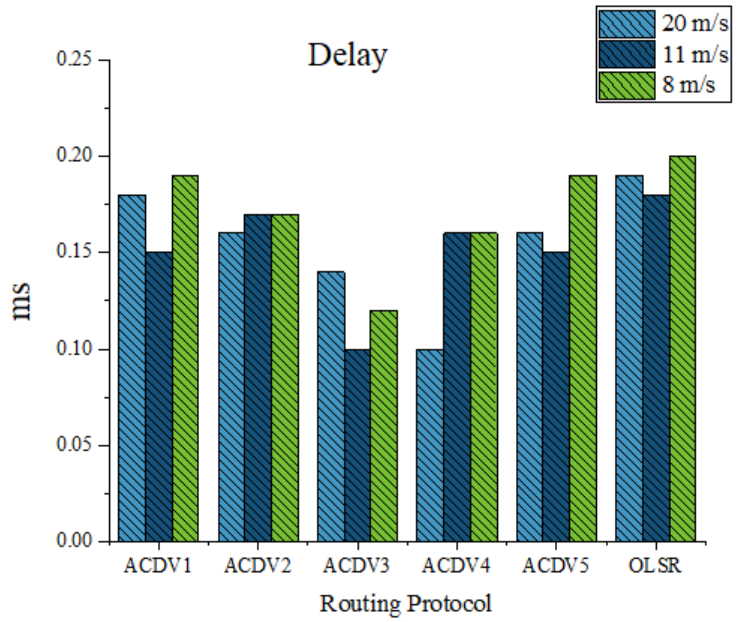

Figure5. Delay Results.

Average Energy Consumption

Figure 6 displays the average energy usage from the AODV and OLSR protocols. The findings indicate that OLSR uses more energy on average than AODV. The average energy usage of the OLSR protocol is 145.82 joules, compared to 78.38 J for the baseline AODV protocol. The average energy usage so rises by 0.83% when RREQ_RETRIES is set to 4 (AODV 3). When it comes to subtracting and increasing the value, MAX_RREQ_TIMEOUT occasionally raises the average energy consumption.

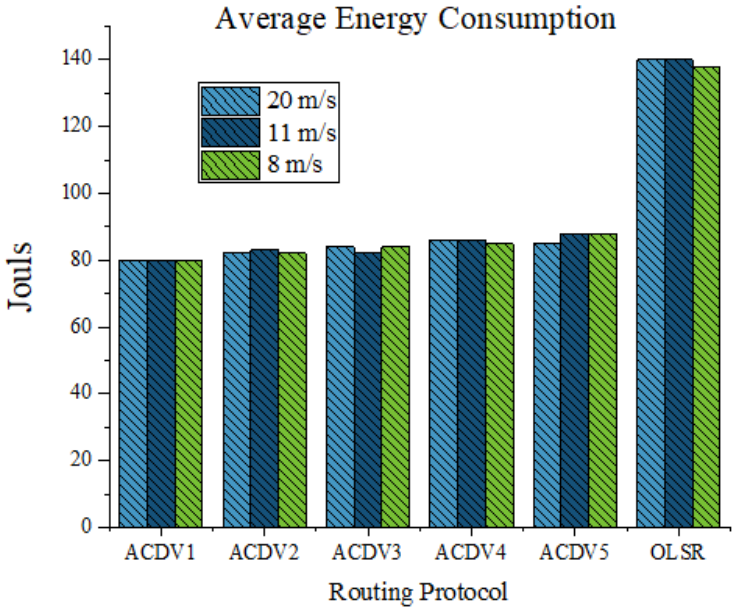

Figure6. Average Energy Consumption Results.

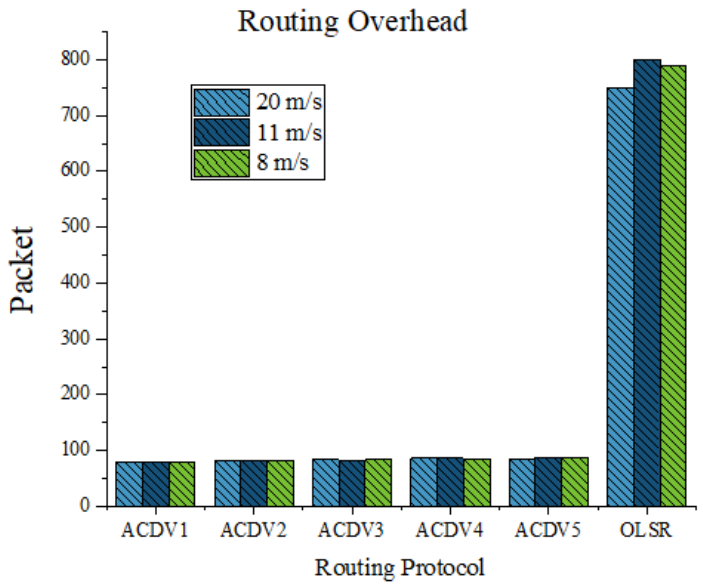

Figure 7. Routing overhead results.

Routing Overhead

Figure 7 displays the routing overhead findings from the AODV and OLSR protocols. The outcomes demonstrate that OLSR's routing overhead is greater than that of the AODV protocol by default. The average overhead routing value for the OLSR protocol is 774, whereas the AODV protocol is 41.

Discussion

Due to the fact that OLSR keeps routing information on each node, packets are sent more quickly than they would be using the AODV protocol, which has a higher delay. The results at a velocity of 20 m/s, which exhibits the best results, are referred to in this section of the discussion. Poor performance is seen at other speeds.Packets cannot be sent during node 3's movement since previously created routes cannot be used. Once node 3 is within reach of node 2, the path is reconfigured. The RREQ must be sent again in order to create the new route. The parameters of MAX_RREQ_TIMEOUT and RREQ_RETRIES determine how long an RREQ packet lasts. The routing table formation time at node 0 is displayed in Table 5 based on the settings of RREQ_RETRIES and MAX_RREQ_TIMEOUT.

This is a result of the delay value that was generated at the time the packet was sent following the formation of the route. The average energy consumption demonstrates that energy consumption decreases as MAX_RREQ_TIMEOUT is increased. This is due to the fact that route changes result in a significant packet delivery delay when the MAX_RREQ_TIMEOUT setting is larger. As a result, fewer packets are sent. The MAX_RREQ_TIMEOUT value of 11 s produces the lowest average use. It reduces energy usage by 0.399%. Performance is unaffected by changes in MAX_RREQ_TIMEOUT, according to the routing overhead. This is so because MAX_RREQ_TIMEOUT does not actually lower the amount of RREQ packets delivered; rather, it just delays the sending of RREQ packets.

Conclusion

The results of this experiment show that the OLSR protocol is less latency-prone than the AODV protocol. All other performance metrics show that the AODV protocol performs better than the OLSR protocol, yet the OLSR protocol has a delay of 0.02 seconds whereas the AODV protocol has a latency of 0.156 seconds. OLSR results in 11% less PDR, 8% less throughput, 46% more packet loss, 49% higher energy

usage, and 94% more routing overhead. This result indicates that AODV is more robust against topology changes than OLSR protocol.The two combinations led to an average gain of 3.09% in throughput performance, a decrease of 17.7% in delay, a drop of 27.15% in packet loss, a decrease of 19% in energy consumption, a decrease of 4.8% in routing overhead, and an increase of 4.8% in PDR. These findings suggest that the AODV protocol works better than OLSR because fewer routing packets are created, and that the protocol may be made to function better by lowering the combined value of RREQ_RETRIES and MAX_RREQ_TIMEOUT.

Abbreviation

MANET - Mobile Ad Hoc Network
RRER - Route Error
RREP - Route Reply
RREQ - Route Request
TC - Topology Control

Competing interests

The authors declare that they have no competing interests.

Consent for publication

Not applicable

Ethics approval and consent to participate

Not applicable

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Availability of data and materials

Not applicable

Authors' contribution

Author A supports to find materials and results part in this manuscript. Author B helps to develop literature part.

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References

1. Abdali, Taj-AldeenNaser, et al. "Optimized particle swarm optimization algorithm for the realization of an enhanced energy-aware location-aided routing protocol in manet." *Information* 11.11 (2020): 529.
2. Alameri, Ibrahim Ahmed. "A novel approach to comparative analysis of legacy and nature inspired ant colony optimization based routing protocol in MANET." *Journal of Southwest Jiaotong University* 54.4 (2019).
3. Alameri, Ibrahim Ahmed, and JitkaKomarkova. "A multi-parameter comparative study of manet routing protocols." *2020 15th Iberian Conference on Information Systems and Technologies (CISTI)*. IEEE, 2020.
4. Anand, M., and T. Sasikala. "Efficient energy optimization in mobile ad hoc network (MANET) using better-quality

AODV protocol." *Cluster Computing* 22 (2019): 12681-12687.

5. Haglan, Hussein M., et al. "Analyzing the impact of the number of nodes on the performance of the routing protocols in manet environment." *Bulletin of Electrical Engineering and Informatics* 10.1 (2021): 434-440.
6. Hassan, Mustafa Hamid, et al. "A general framework of genetic multi-agent routing protocol for improving the performance of MANET environment." *IAES International Journal of Artificial Intelligence* 9.2 (2020): 310.
7. Karthick, K., and R. Asokan. "Mobility aware quality enhanced cluster based routing protocol for mobile ad-hoc networks using hybrid optimization algorithm." *Wireless Personal Communications* 119.4 (2021): 3063-3087.
8. Kurniawan, Ashadi, Prima Kristalina, and Moch Zen SamsonoHadi. "Performance analysis of routing protocols AODV, OLSR and DSDV on MANET using NS3." *2020 international electronics symposium (IES)*. IEEE, 2020.
9. Mohsin, AhlamHashim. "Optimize routing protocol overheads in MANETs: Challenges and solutions: A review paper." *Wireless Personal Communications* 126.4 (2022): 2871-2910.
10. Nisar, Kashif, Ibrahim A. Lawal, Usman Ismail Abdulmalik, AbubakarAminuMu'azu, B. S. Chowdhry, Sohrab Khan, and ShuaibMemon. "QoS Analysis of the MANET Routing Protocols with Respect to Delay, Throughput, & Network Load: Challenges and Open Issues." In *2020 IEEE 14th International Conference on Application of Information and Communication Technologies (AICT)*,(2020), 1–8. IEEE.
11. Prasath, N., and J. Sreemathy. "Optimized dynamic source routing protocol for MANETs." *Cluster Computing* 22.Suppl 5 (2019): 12397-12409.
12. Priyambodo, Tri Kuntoro, DanurWijayanto, and Made Santo Gitakarma. "Performance optimization of MANET networks through routing protocol analysis." *Computers* 10.1 (2020): 2.
13. Rath, Mamata, and Binod Kumar Pattanayak. "Performance evaluation of optimised protocol in MANET." *International Journal of Information and Computer Security* 14.3-4 (2021): 318-326.
14. Sathyaraj, P., and D. Rukmani Devi. "Designing the routing protocol with secured IoT devices and QoS over Manet using trust-based performance evaluation method." *Journal of Ambient Intelligence and Humanized Computing* 12 (2021): 6987-6995.
15. Srilakshmi, Uppalapati, et al. "A secure optimization routing algorithm for mobile ad hoc networks." *IEEE Access* 10 (2022): 14260-14269.