



Performance Evaluation of DSR, AODV and MP-OLSR Routing Protocols Using NS-2 Simulator in MANETs

Hameed Khan¹(✉), Kamal Kumar Kushwah², Jitendra Singh Thakur¹,
Gireesh Gaurav Soni³, Abhishek Tripathi¹, and Sandeep Rao¹

¹ Department of Computer Science and Engineering, Jabalpur Engineering College, Jabalpur, M.P., India

hameed.khan20@gmail.com

² Department of Applied Physics, Jabalpur Engineering College, Jabalpur, M.P., India

³ Department of Applied Physics and Optoelectronics, SGSITS, Indore, M.P., India

Abstract. MANET (Ad-Hoc Mobile Network) is a systematic aggregation of identical types and varieties of nodes. These nodes are dynamically created as desirable and capable of communicating, barring a primary infrastructure-based system. As these nodes connect devices such as mobiles, tablets, etc., they can develop a range of provider delivery with an appreciation for network performance. Network traffic is an essential assignment in the ad-hoc mobile area network. Route agreements efficiently enhance carrier exceptionality in better access, partial delivery of packets, and minimal storage delays. The predominant motive of this analysis is to evaluate the legal method concerning the parameters of the various quality of service enhancement services. The simulation outcomes affirm that the proposed scenario affords a better dimension of the exceptional testing of the compliance offerings at MANET.

Keywords: MANET · AODV · DSR · MP-OLSR · NS-2 · Routing Protocols

1 Introduction

The well-known problems associated with wireless and mobile communications, such as bandwidth maximizing efficiency, strength control, and enhancing transmission quality, are carried over by mobile ad hoc networks (MANET). The multi-hop nature and lack of installed infrastructure have given rise to new research concerns such as ad hoc addressing, self-routing, configurations advertising, discovery, and preservation. Mobile ad hoc network architecture is very uncertain and dynamic. The nodes' distribution and ability to self-organize also have a significant impact. Except for a consistent architecture, MANET is a dynamic environment where numerous nodes may be freely distributed and connected to other nodes. Figure 1's representation of the basic architecture of a mobile ad-hoc network illustrates how various networking elements, such as a server, access point, GPS satellite, etc., interact with one another.

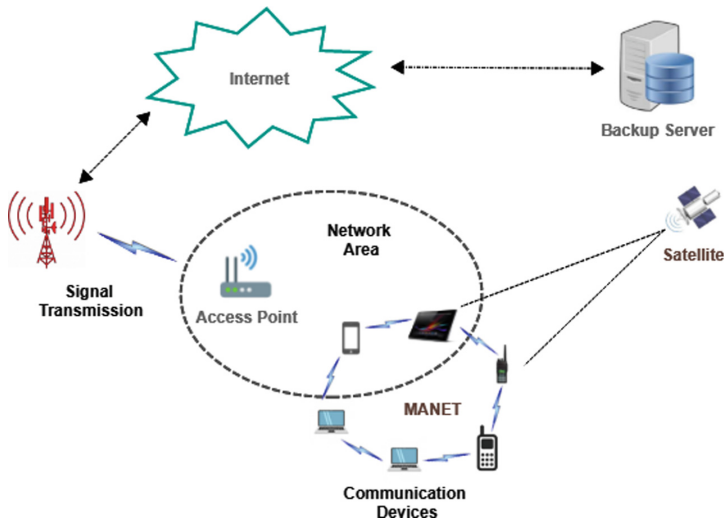


Fig. 1. Architecture of MANET

In MANET, the motive of this routing protocol is to decide how the nodes themselves determine how they can locate, connect, and transmit packets to different nodes [1]. These route strategies are divided primarily into functional and hybrid contracts. Active protocols preserve all the viable pathways between all current nodes equally. In inactive protocols, only the contact nodes related to the assisting nodes have required to switch packets. Hybrid Agreements comprise negotiating strategies to discover an excellent way to change packets to an ad-hoc cellular network. In MANET, nodes can regularly alternate locations with complete instructions to produce specific route issues [2]. The most challenging problem is finding an efficient way between two nodes with multiple hops in the network based on the quality of service parameters for proactive and reactive protocols such as throughput and partial delivery packages by altering the MANET's network load and dimension [3]. Figure 2 shows the essential characteristics of a mobile ad-hoc network.

2 Literature Survey

When more extensive networks are taken into consideration, tests on the Network Simulator (NS-2) have demonstrated that the Dynamic Source Routing protocol (DSR) is only slightly less efficient than the Ad-hoc On-demand Distance Vector (AODV). However, since AODV affects several networking websites, it is more prone to assault than DSR [4]. Additionally, it has been shown that the (DSR) increases the overall performance of vehicular ad hoc networks (VANET) in comparison to AODV protocols in terms of high power consumption, low packet loss, increased delivery rate, and decreased latency even in a wide variety of vehicular networks. However, primarily based on the simulation results of NS-2, it examines four quality parameters, end delays, termination, packet loss, and energy consumption [5]. The DSR agreements with the AODV under ego-centric and

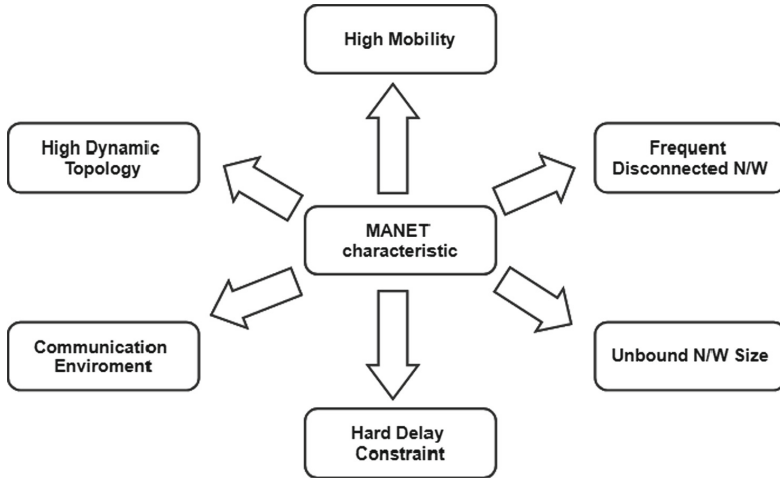


Fig. 2. Characteristics of MANET

dark attacks additionally produced comprehensive tests and outcomes that showed DSR used to be more affected by egocentric node attacks than AODV.

On the other hand, DSR performed better than AODV under black hole attacks. Depending on the individual parameters, such as widespread packing and installation, AODV has higher performance and much less packet delay than the more significant packet delay in DSR [6]. Similarly to other parameters like energy consumption per byte under the attack of egocentric nodes, DSR consumes less energy than AODV. However, the DSR consumes more energy under the black hole attack than the AODV. In short, each DSR and AODV technique is affected by this attack, and performance varies under different parameters [7]. Also, selecting the proper routes according to the network finally impacts the implementation of this network in secure and efficient ways.

In contrast, the protocol (MP-OLSR) hybrid segment was analyzed higher than AODV and DSR. However, its performance will affect trade with an exclusive community and variability in mobility [8]. Due to its potential to keep a connection through periodic information exchange, AODV performance is most desirable to DSR. AODV demonstrates its most influential and overall performance under greater mobility than DSR for real-time functions. To check product accuracy using the Analysis of Variance check (1-way ANOVA), AODV indicates better route overall performance (security and power optimization) than the preferred routing method, DSR [9]. AODV ensures an excessive packet delivery ratio (PDR) and several installations. During the simulation experiments in the MATLAB 2018a simulator, many amendments to network topology extend the computational complexity of current MP-OLSR routing processes as calculating new routes becomes more complicated [10]. With its extensive range of nodes and network statistics, DSR exceeds AODV in terms of performance, PDR, and packet loss ratio using the Netsim 10.2 simulator.

The Riverbed Simulator Modeler examined AODV, MP-OLSR, and DSR. Regarding E2E delays, records lowered and surpassed, and the MP-OLSR protocol fared better than

the other agreements, AODV and DSR [11]. Analyze performance for all performance metrics utilizing Riverbed Simulator Modeler, AODV, DSR, OLSR, and GRP. In terms of stop delays, termination, and packet disposal, it has been shown that the OLSR protocol performs better than the other three agreements (AODV, GRP, and DSR) [12]. It has already been proven that when we amplify the wide-area network of nodes in the MP-OLSR protocol network technique phase, there are more significant delays than other AOMDV techniques and AOMDV work for the wider community. To analyze the number of processes of the range of routes, the authors reviewed each of the following guidelines with an exceptional feature, and the only way to decide the route is to make them different [13]. Table 1 compares the many sorts of work done by scholars on various platforms.

Table 1. Summary of current studies and applications that is pertinent.

Study	Approach and Application	Findings
Parissidis, [14]	Quantitative comparison of routing protocols	Node Density
Yang J, [15]	Particle swarm optimization	Energy consumption
Alturfi, [16]	Performance of heterogeneous nodes	Optimize N/W Load
J. Deepika, [17]	Energy Efficient Routing	Power optimization
Mohapatra, S., [18]	Routing strategic approach	NS-2 Simulation
L, Yun-kyung, [19]	Correlation Analysis of Performance Metrics	NS and QualNet 5.0
Abdulleh,M., [20]	Performance Analysis of Protocol	N/W Size and Density
Sharma, A., [21]	QoS improving methods	Overhead minimization
Jiazi Yi, [22]	Hybrid Protocol routing technique	Scalability and Security
A Mouiz [23]	Performance evaluation in MANET	Energy conservation

3 Methodology

This literature assessment is accomplished on separate route contracts at MANET. We took the other three routing processes, DSR, AODV, and MP-OLSR protocol, and discussed the overall performance and the impact on various ever-changing performance parameters. A DSR is a required protocol that uses an activation mechanism. AODV is a wonderful mechanism by which it finds a route wherever it is needed, and finally, MP-OLSR is a hybrid multipath routing protocol [18]. It combines repetitive and intermittent material to hold network topology. The performance of the routing protocols is measured based on the measurement of the navigation network, and the result validates the feasibility of the routing protocol. The proposed quality of service simulation mode has extraordinary parameters for evaluating and comparing the performances of DSR, AODV, and MP-OLSR through NS2 simulations. Instead of maximizing the interpretation of one family of protocols, our focus is on demonstrating the various behaviors of multiple families of protocols. They are classified as efficient, effective, and hybrid

approaches. A comparative evaluation of these methods provided an overall performance evaluation of various route problems. This literature learns about objectives to advance a high-quality regulation enforcement framework with multiple parameters to improve the quality of services at MANET [19].

4 Routing Protocol in MANET

4.1 Routing Protocol Classification

In MANET, Fig. 3 displays several routing protocols used in routing. Proactive, reactive, and hybrid systems are the three categories of routing protocols. The MANET routing protocols are intended to support many nodes with few resources. In routing systems, the disappearance and reappearance of nodes at various places is a serious issue. Message routing overhead must be reduced despite the growing number of mobile nodes. As the size of the routing protocol may affect the control packets transmitted inside the network, it is also crucial to keep the routing table small. Although they choose the fastest route to the goal, routing protocols are categorized depending on how and when routes are identified.

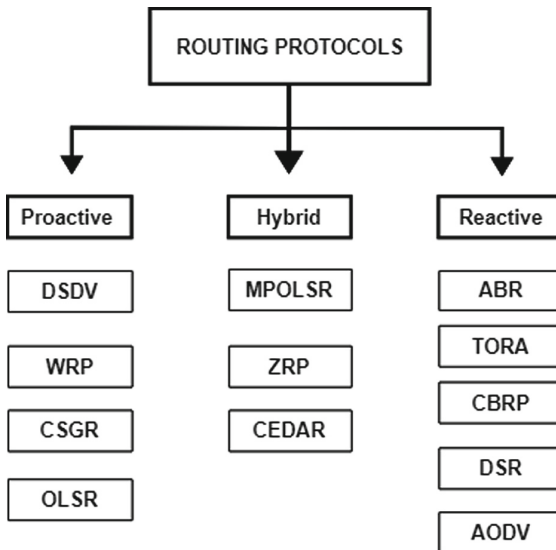


Fig. 3. Classification of routing protocol in MANET

4.2 Proactive Routing Protocols

A proactive routing system employs link-state routing algorithms that often saturate nearby connections with data. The proactive routing system preserves and maintains routing information by commuting control packets with their neighbors. Proactive routing techniques include DSDV, WRP, and OLSR [19].

4.3 Reactive Routing Protocols

Reactive routing approaches need to have the overheads that proactive routing strategies have. It uses a distance-vector routing method and builds a route only when a receiving node requests it, initiating the route discovery process. Only a handful of the reactive routing protocols available in MANET include DSR, AODV, TORA, and LMR [20].

4.4 Hybrid Protocol

It uses both proactive and reactive routing strategies. Several hybrid routing protocols include ZRP, BGP, and EIGRP. In this paper, we compare the effectiveness of the MANET DSR, AODV, and MP-OLSR routing protocols using a variety of factors.

4.5 DSR Protocol

When a data packet travels from the source to a location to discover the source route, the device's address between the source and destination ought to be accrued through the vicinity of the route it splits to pass the packets. It can result in excessive throughput of IPV6 address types. To avoid using the source route, a new protocol known as Dynamic Source Routing (DSR) has been developed, which no longer depends on the routing table for each central device. However, instead, it defines a flow-id alternative that a permit packet has transferred to a hop-by-hop base. Its much-needed feature prevents the package from overloading by control packs by deleting periodic beacon messages (Hello messages), which is required in any other case. On the other hand, like all other procedures, it has drawbacks. It does not restore a damaged link due to a route correction method. Also, connection setup extends greater than table-driven protocols. Its overall performance decreases unexpectedly with increasing nodes.

4.6 AODV Protocol

Ad hoc on Demand Vector (AODV) is a routing protocol in MANET. It is an on-demand protocol that does not depend on pre-maintained routes but builds their preferred routes depending on needs. The protocol has been designed to overcome the impairment troubles of the DSR protocol, with many nodes inside the source and destination [21]. Also, it overcomes some barriers of the DSR protocol, i.e., it has a couple of packet transfer routes between the source and your destination, which requires the preservation of multiple router tables. Two other counters have been saved in AODV protocols and route tables, which assist in determining the updated route between the source and destination.

4.7 MP-OLSR Protocol

The MP-OLSR, or Multipath Optimized Link Source Routing Protocol for MANET, is a hybrid protocol that uses the Dijkstra algorithm to achieve multiple travel packages; its identity suggests this protocol to alternate information except going via a single primary channel [22]. It affords dynamic route tables as per the need to produce transfer information packets in various feasible ways. Apart from this, some critical aspects of

this protocol work inexpensively as route restoration methods and discover limitations in the proposed loop [23]. Sometimes it needs to be more adequate to estimate information loading in distinct approaches due to the selected algorithm (Round Robin). Also, a pre-determined amount is provided for the duly carried out cost when a network does not comply with the conditions.

5 Study Matrix

Some essential overall performance matrices can be explored:

5.1 Packet Delivery Ratio (PDR)

It allows the percentage-based disclosure of a protocol's capacity to transmit all emitted data. By dividing the number of packets sent by the source node SN_p by the total number of packets received by the destination node DN_p , Eq. (1) calculates the number of packets lost. Higher PDR values indicate better performance. PDR of 100% means excellent availability and dependability of the network. An average packet of statistics delivered to destinations is produced through constant bit rate (CBR) sources.

$$PDR = \frac{DN_p_received}{SN_p_transmitted} \times 100 \quad (1)$$

5.2 Throughput

The number of packets/bytes acquired by the source at each time. It is an essential parameter for inspecting network agreements. The magnitude of successful data transmission sent from one location to another at a specific time is measured in bits per second. The throughput may be evaluated by using Eq. (2):

$$\text{Throughput} = \frac{(L - C)}{L} \times R \times F(\gamma) \quad (2)$$

Where the following parameters:

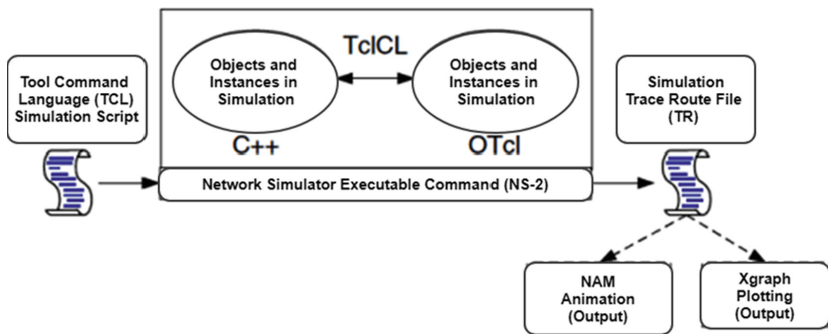
- L: Packet length.
- C: Cyclic Redundancy Check.
- R (b/s): Binary transmission rate.
- $F(\gamma)$ Packet success rate.

6 Performance Analysis of Multicast Protocols

The simulation time is regarded as 20 s in the state, and the number of nodes varies from 10, 30, 50, 100, and 150 nodes. The grid (network size) region has been viewed to be 2000 X 2000 rectangular meters. The architecture of NS-2, which stands for Network Simulator Version 2, is seen in Fig. 4. It's a free, open-source, event-driven simulator for computer communication network research (Table 2).

Table 2. Simulation Parameters.

Parameters	Simulation Matrix	Values
Configuration	Network Size	2000 × 2000 m
	Number of Nodes	10, 30, 50, 100 and 150
Run	Simulation time	20 s
Mobility	Model	Random Way Point
	Maximum Speed	5 to 10 m/s
	Pause Time	10 s
PHY	Propagation Model	Two-ray ground
	Transmission range	300 m
Traffic	Traffic Types	CBR (Constant Bit Rate)
	Packet Size	1200 Byte
	Packet Rate	10 packets/s
Platform	Simulator	NS-2.29

**Fig. 4.** Architecture of Network Simulator -2

7 Results

Three critical overall performance metrics have been identified for assessing these route processes. The simulation results with parameters are listed in Table 3:

Table 3. Summary of Simulation Results.

Parameters/ Protocols	AODV	DSR	MP-OLSR
Throughput	Low	High	Average
Packet Delivery Ratio	Average	Low	High

7.1 Throughput

The large number of packets transmitted to the recipient provides network benefits. The comparison of three techniques for throughput measures is shown in Fig. 5. The chart shows AODV protocols present slightly lower throughput than MP-OLSR protocols. Furthermore, the DSR protocol had a higher throughput than the AODV and MP-OLSR protocols. With additional traffic sources, congestion, obscured terminals, and network disruption become more common. Due to these problems, protocols respond to changing circumstances differently, and latency plays a crucial role in determining network speed. Finally, the throughput of AODV and MP-OLSR is less worrying than DSR; the throughput drops with a smaller node and improves when the network's nodes are expanded.

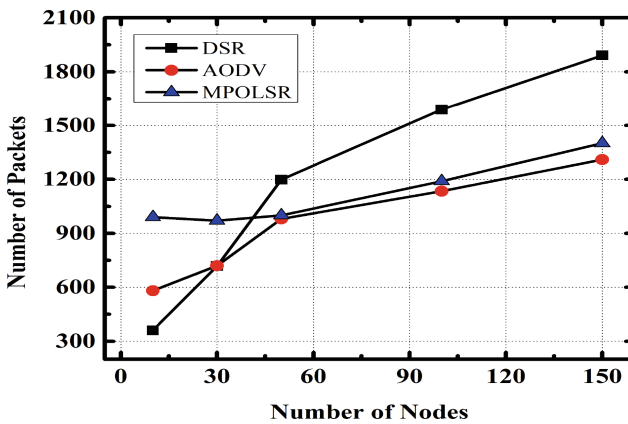


Fig. 5. Throughput

7.2 Packet Delivery Ratio

The throughput metric and the packet delivery ratio (PDR) are intimately related. The destination keeps track of how many data packets it gets and uses that data to determine the network's PDR delivery ratio. Figure 6 illustrates how the MP-OLSR protocols have a higher packet delivery ratio than the other AODV and DSR protocols. The DSR has a lower packet delivery ratio than AODV and MP-OLSR regarding the proportion of data packets drawn into their source. Reactive protocols gradually increased their packet delivery ratio from 0.8 for 10 numbers to unity for higher node densities. As the number of nodes increased, so did the values of MP-OLSR and AODV. Additionally, the MP-OLSR and AODV protocols outperformed the DSR protocol by a small margin.

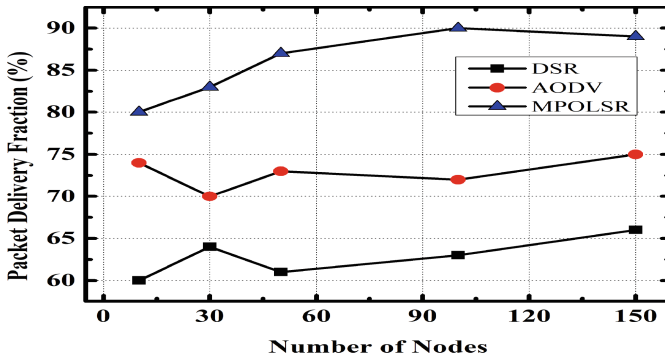


Fig. 6. Packet Delivery Ratio

8 Conclusion

The DSR routing protocol has higher performance than the proposed parameters. However, it will grant less overall latency to the wider network area than other routing protocols. MP-OLSR works better than DSR and AODV in general community delays and common network approaches. In the simulation and subsequent analysis, the overall performance routing protocols' are extended with the network's resolution and the suitable routes under the network. The authors analyzed the package delivery charge on the scale of the DSR, AODV, and MP-OLSR.

In the proposed investigation, two distinctive route strategies confirmed that the MP-OLSR protocol works exceptionally well for MANET in simulation results. However, it is no longer usually better for the entire network. Its performance and functionality have been modified with various networks and versions regarding durability and mobility. Finally, deciding on the proper network protocol gives a better understanding of efficiency. Our future work focuses on extending the set of experiments by considering other simulation parameters. Our future simulation will be elaborated in NS-3.

Acknowledgement. The authors would like to acknowledge the TEQIP-3 CRS lab (ID 1-5726249571) of Jabalpur Engineering College, Jabalpur, MP, India, for the progress of the research work.

References

1. Chang, S., Ting, W., Chen, J.: Method for reducing routing overhead for mobile Ad Hoc network. Int. Conf. on Wireless Communications & Signal Processing (WCSP), pp. 1-6, MECS press (2010)
2. Al-khatib, A., Hassan, R.: Performance evaluation of AODV, DSDV, and DSR routing protocols in MANET using NS-2 simulator. International Conference of Reliable Information and Communication Technology, pp. 276-284. Malaysia (2018)
3. Adeyemi, A.A., et al.: A comprehensive analysis of proactive and reactive manet routing protocols using Ns3. Journal of Engineering and Applied Sciences Technology. SRC/JEAS-130 (2021). [https://doi.org/10.47363/JEAS\(3\)120](https://doi.org/10.47363/JEAS(3)120)

4. Fauzia, S., Fatima, K.: Performance evaluation of AODV routing protocol for free space optical mobile ad-hoc networks. *The International Symposium on Intelligent Systems Technologies and Applications*, pp. 74–83, Springer International Publishing (2018)
5. Khosa, T., Mathonsi, T.E., Plessis, D.: A model to prevent gray hole attack in mobile ad-hoc networks. *Ad Hoc & Sensor Wireless Networks* **14**, 532–542 (2023). <https://doi.org/10.12720/jait.14.3.532-542>
6. Bello, A., Akpofure, O.: Mobile adhoc network routing protocols: Performance evaluation & assessment. *An International Multidisciplinary Research Journal* **11**, 1266–1273 (2021). <https://doi.org/10.5958/2249-7137.2021.01550.0>
7. Saudi, N.A., Mohamad, B., Alya, G.F., Ahmad, S.R.: Mobile Ad-Hoc network (MANET) routing protocols: a performance assessment. *Proceedings of the Third International Conference on Computing, Mathematics and Statistics (iCMS2017)*, pp.53–59, Malaysia (2019)
8. Gupta, C., Singh, L., Tiwari, R.: Wormhole attack detection techniques in ad-hoc network: a systematic review. *Open Computer Science* **12**(1), 260–288 (2022). <https://doi.org/10.1515/comp-2022-0245>
9. Marina, M.K., Das, S.R.: Routing in mobile ad hoc networks. In: Mohapatra, P., Krishnamurthy, S.V. (eds) *Ad Hoc Networks*. Springer, Boston, MA. (2005) https://doi.org/10.1007/0-387-22690-7_3
10. Sandhu, D.S., Sharma, S.: Performance evaluation of DSDV, DSR, OLSR, TORA routing protocols – a review. In: Das, V.V., Chaba, Y. (eds) *Mobile Communication and Power Engineering*. AIM 2012. *Communications in Computer and Information Science*, vol 296. Springer, Berlin, Heidelberg. (2013) https://doi.org/10.1007/978-3-642-35864-7_77
11. Wang, H.-M., Zhang, Y., Ng, D.W.K., Lee, M.H.: Secure routing with power optimization for ad-hoc networks. *IEEE Transactions on Communications* **66**(10), 4666–4679, IEEE (2018). <https://doi.org/10.1109/TCOMM.2018.2835478>
12. Boushaba, A., Benabbou, A., Benabbou, R., et al.: An intelligent multipath optimized link state routing protocol for QoS and QoE enhancement of video transmission in MANETs. *Computing* **98**, 803–825 (2016). <https://doi.org/10.1007/s00607-015-0450-0>
13. Guaya-Delgado, L., Pallarès-Segarra, E., Mezher, A.M., et al.: A novel dynamic reputation-based source routing protocol for mobile ad hoc networks. *J Wireless Com Network* **77** (2019). <https://doi.org/10.1186/s13638-019-1375-7>
14. Parissidis, G., Lenders, V., May, M., Plattner, B.: Multi-path routing protocols in wireless mobile ad hoc networks: a quantitative comparison. In: Koucheryavy, Y., Harju, J., Iversen, V.B. (eds) *Next Generation Teletraffic and Wired/Wireless Advanced Networking*. NEW2AN . *Lecture Notes in Computer Science*, vol 4003. Springer, Berlin, Heidelberg. (2006). https://doi.org/10.1007/11759355_30
15. Yang, J., Liu, F., Cao, J., Wang, L.: Discrete particle swarm optimization routing protocol for wireless sensor networks with multiple mobile sinks. *Sensors* **16**(7), 1081 (2016). <https://doi.org/10.3390/s16071081>
16. Alturfí, S., Kadhim, D., Mohammed, M.: Network performance evaluation of different manet routing protocols configured on heterogeneous nodes. *Journal of Physics: Conference Series*. 1804. 012124. Babylon-Hilla City, Iraq (2021). <https://doi.org/10.1088/1742-6596/1804/1/012124>
17. Deepika, J., Rangaiah, L., Jeyabalan, S.: A novel approach to AODV for energy efficient routing mechanism to control power consumption in MANET. *International Journal of Engineering Trends and Technology* **69**(8), 206–210 (2021). <https://doi.org/10.14445/22315381/IJETT-V69I8P225>
18. Mohapatra, S., Kanungo, P.: Comparative performance analysis of MANET routing protocols using NS2 simulator. In: Das, V.V., Thankachan, N. (eds) *Computational Intelligence and Information Technology*. CIIT. *Communications in Computer and Information Science*, vol 250. Springer, Berlin, Heidelberg (2011). https://doi.org/10.1007/978-3-642-25734-6_127

19. Lee, Y.-K., Kim, J.-G.: Performance comparison between routing protocols based on the correlation analysis of performance metrics for AODV routing protocol. *Journal of Information Technology Services* **12**(4), 349–367 (2013). <https://doi.org/10.9716/KITS.2013.12.4.349>
20. Abdulleh, M., Yussof, S.: Performance analysis of AODV, OLSR and GPSR MANET routing protocols with respect to network size and density. *Research Journal of Applied Sciences, Engineering and Technology* **11**, 400–406 (2015). <https://doi.org/10.19026/rjaset.11.1794>
21. Sharma, A., Vashistha, S.: Improving the QOS in MANET by enhancing the routing technique of AOMDV protocol. In: Satapathy, S., Avadhani, P., Udgata, S., Lakshminarayana, S. (eds) *ICT and Critical Infrastructure: Proceedings of the 48th Annual Convention of Computer Society of India- Vol I. Advances in Intelligent Systems and Computing*, **248**. Springer, Cham (2014). https://doi.org/10.1007/978-3-319-03107-1_41
22. Yi, J., Adnane, A., David, S., Parrein, B.: Multipath optimized link state routing for mobile ad hoc networks. *Ad Hoc Netw.* **9**, 28–47 (2011). <https://doi.org/10.1016/j.adhoc.2010.04.007>
23. Mouiz, A., Badri, A., Baghdad, A., Sahel, A.: Performance evaluation of OLSR and AODV routing protocols with different parameters in mobile ad-hoc networks using NS2 simulator. In *Proceedings of the 2019, 5th International Conference on Computer and Technology Applications (ICCTA'19)*. Association for Computing Machinery, New York, NY, USA, pp.134–139 (2019). <https://doi.org/10.1145/3323933.3324065>