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Performance Analysis of AODV and DSDV Routing Protocol in MANET

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ABSTRACT
This research focuses on a performance analysis of two prominent routing protocols in Mobile Ad-Hoc Networks (MANETs): Ad-Hoc On-Demand Distance Vector (AODV) and Destination-Sequenced Distance Vector (DSDV). The study utilizes the NS-2.35 simulation tool to evaluate these protocols under various network conditions using three key performance metrics: Packet Delivery Ratio (PDR), End-to-End Delay, and Routing Overhead. Simulations were conducted with node counts of 10, 20, 30, and 40 in a 500m x 500m area, operating under a random waypoint mobility model. The findings reveal that AODV outperforms DSDV in terms of PDR and Routing Overhead, showing significant improvements, such as an 88.58% decrease in routing overhead at 10 nodes. However, DSDV shows a better performance in terms of End-to-End Delay, especially in stable environments with fewer nodes. The results suggest that AODV is more suitable for dynamic and larger networks, while DSDV is better for smaller, less mobile networks. This comparative analysis highlights the importance of selecting an appropriate protocol depending on specific network conditions and application needs. The implications of these findings extend to optimizing routing protocols for various real-time applications in MANETs, offering a valuable contribution to enhancing the efficiency and reliability of wireless communication systems.

Keywords:
AODV Protocol,
DSDV Protocol,
MANETs (Mobile Ad-hoc Networks),
Packet Delivery Ratio (PDR),
Routing Overhead

INTRODUCTION

Mobile Ad-hoc Networks (MANETs) comprise wireless devices capable of intercommunication without reliance on a central router or fixed infrastructure (Džubur et al., 2021). These networks are distinguished by their capacity to dynamically form and reconfigure in response to node movement. The lack of centralised control and the dynamic topology render the design of routing protocols in MANETs a challenging endeavour (Džubur et al., 2021; Mane, S. 2022). Efficient routing protocols are essential for ensuring reliable communication in the face of the dynamic nature of these networks, addressing issues such as topology changes, network congestion, and fluctuating mobility patterns (Džubur et al., 2021; Mane, S. 2022; Khudayer et al., 2023).

Routing mechanisms in MANETs are based on criteria such as routing information exchange, update timing, and route maintenance techniques. In table-driven protocols like DSDV, each node stores routing tables for all network nodes. These protocols are useful in large networks as they continuously update routing information to adapt to changing topologies (Surajo et al., 2023). However, constant updates can lead to high bandwidth consumption, especially in networks with many nodes. (Brito, I. V. 2021; Bansal, S. 2023). DSDV, a notable instance of a table-driven protocol, mitigates challenges like routing loops by employing sequence numbers to indicate the validity of route entries (Skaggs-Schellenberg et al., 2020).

In reactive protocols like AODV, routes are created only when needed, reducing overhead and enhancing scalability. AODV uses route request (RREQ) and route reply (RREP) messages to establish and maintain routes, which are stored in the routing table (Saini et al., 2020; Madhanmohan, 2019). The route is maintained until no longer needed, adapting to topology changes.

The paper by (Alasadi et al., 2021) discusses the implementation of both types using various protocols including DSDV (Destination-Sequenced Distance Vector) and AODV (Ad Hoc On-Demand Distance Vector). It focuses on their performance in terms of metrics like throughput, packet delivery ratio, and end-to-end delay. The study found that while DSDV showed stable performance in less dynamic conditions, AODV outperformed in highly mobile scenarios, providing insights for optimizing MANETs in different contexts.

This study evaluates the performance of DSDV and AODV routing protocols in the context of e-health monitoring systems. The authors analyze both protocols under various network conditions and provide performance metrics. The results indicate that AODV outperforms DSDV in dynamic environments, providing better routing efficiency, which is crucial for real-time e-health data transfer (Al-Abadi et al., 2023).

A study carried out by (Ardiani et al., 2023) proposes a modification to the DSDV routing protocol using the Dynamic-power Transmission (DPT) algorithm to reduce signal interference. The modification aims to optimize the quality of service (QoS) by adjusting the communication range based on node density. The modified DPT-DSDV protocol demonstrated improvements in throughput, packet delivery ratio (PDR), and reduced end-to-end delay when compared to standard DSDV and AODV protocols, suggesting its potential in scenarios with varying node densities.

This research by (Chandra et al., 2022) compares the performance of AODV, DSDV, and DSR routing protocols in MANETs under CBR traffic using the NS-2.35 simulator. It evaluates these protocols with varying node densities and traffic conditions. The results indicate that while AODV and DSR are more reliable under dynamic conditions, DSDV performs better with low node density and stable traffic patterns.

Another paper by (Leenas et al., 2022) presents an approach to improve the AODV routing protocol by considering both time and hop-count factors, addressing performance issues in mobile ad hoc networks. The modifications aim to optimize route discovery and maintenance, ultimately enhancing the reliability and efficiency of AODV under dynamic network conditions.

Razouqi et al. (2024) This comparative analysis evaluates the performance of MANET routing protocols—DSDV, DSR, and AODV—under varying traffic loads and network conditions. The study reveals that DSR and AODV outperform DSDV in terms of throughput and packet delivery ratio, particularly under higher node mobility and packet rate variations. DSDV, however, performs optimally in low-density networks with regular traffic.

Krishnanet al. (2025) presents an energy-efficient routing algorithm for MANETs using AODV and its modified version, DE-AODV. The proposed algorithm focuses on reducing energy consumption while maintaining network reliability. The results suggest that DE-AODV offers significant improvements in energy efficiency compared to traditional AODV, making it more suitable for applications where energy conservation is critical.

This paper seeks to fill this gap by conducting a comparative analysis of AODV and DSDV based on essential performance metrics, including Packet Delivery Ratio (PDR), routing overhead, and end-to-end delay (Zimbeleet al., 2024). This study will compare AODV and DSDV based on routing overhead, packet delivery ratio (PDR), and end-to-end delay. The comparison will show the pros and cons of these protocols in different network conditions and help choose the best protocol for MANET applications.

MATERIALS AND METHODS

Simulation Setup

The efficacy of AODV and DSDVwas assessedutilising the NS-2.35 simulation tool, which is widely employed for simulating MANETs (Zimbeleet al., 2024). The simulation comprised 10, 20, 30, and 40 nodes randomly distributed within a 500 square metre area. The nodes operated based on the random waypoint mobility model, with a simulation duration of 50 seconds. Figures 1 through 9 illustrate the creation of nodes within the scenario. Consequently, the nodes have been established within the scenario, and transmission has occurred between them. The two protocols were subsequently compared using three performance metrics.

Performance Metrics

The efficacy of the two protocols was assessed through three principal metrics: Packet Delivery Ratio (PDR), indicating the proportion of successfully delivered packets relative to the total packets dispatched by the source node; End-to-End Delay, denoting the average duration required for a packet to traverse from the source to the destination, encompassing queuing, transmission, and processing delays; and Routing Overhead, which pertains to the supplementary control packet traffic produced for Network simulations were performed utilising NS-2, and AWK scripts were used to analyse the results and compute the performance metrics.

Packet Delivery Ratio (PDR)

Packet Delivery Ratio (PDR) is defined as the ratio of how much of packets sent by the source to the how much of packets received by the destination. The measurement of loss rate is done here. For good network connectivity, a great packet delivery ratio is needed.

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

End-to-End Delay

The end-to-end delay refers to the average time taken by the network to transmit a packet from its source to its destination. This encompasses all the delays present in the network, such as queuing, transmission, and processing delays.

End-to-End Delay

$$= \frac{\sum_{i=1}^{n} T_{(received,i-Tsent,i)}}{n} \quad (2)$$

Routing Overhead

Routing Overhead is defined as the total amount of control packets exchanged among nodes to establish and maintain routing paths, normalized by the number of nodes in the network.

$$Routing\ Overhead = \frac{Total\ Control\ Packets\ Sent}{Number\ of\ Nodes} \quad (3)$$

Figure 1: Proposed Simulation Method

The flowchart shown in Figure 1 delineates a systematic procedure for simulating and evaluating the performance of MANET protocols utilizing NS-2. First, we set up the simulation environment by installing NS-2.35 on Ubuntu 20. Secondly, we created different variable nodes using NSG 2.1 for both protocols, we applied a random way mobility model for the moment of nodes. Thirdly, we used the NS-2 Simulation tool to create TCL and Trace files. Then we created an AWK Script for the comparison metrics. We generated X-graph files from trace files by applying the AWK scripts. Finally, we used X-graph to plot the comparison graph.

RESULTS AND DISCUSSION

Simulation

The parameters for the simulation assessing AODV and DSDV consist of a simulation area measuring 500 m x 500 m, along with node counts of 10, 20, 30, and 40 nodes. The nodes operate under a Random Waypoint Mobility Model, with the simulation conducted over a period of 50 seconds. The traffic type is Constant Bit Rate (CBR), featuring a packet size of 512 bytes and a transmission range of 250 meters, establishing a thorough configuration to evaluate the performance of the protocols across different network conditions.

As shown in a sample Figure 2, we created a model for different variable nodes using NSG 2.1 for both protocols, and we generated basic codes for TCL files.

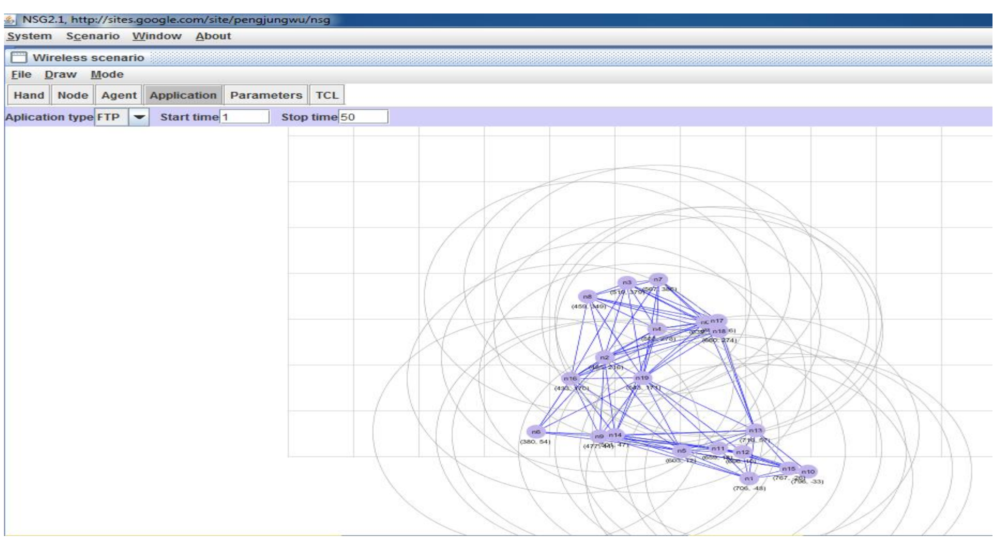

Figure 2: MANET NW design using NSG2 to generate TCL files.

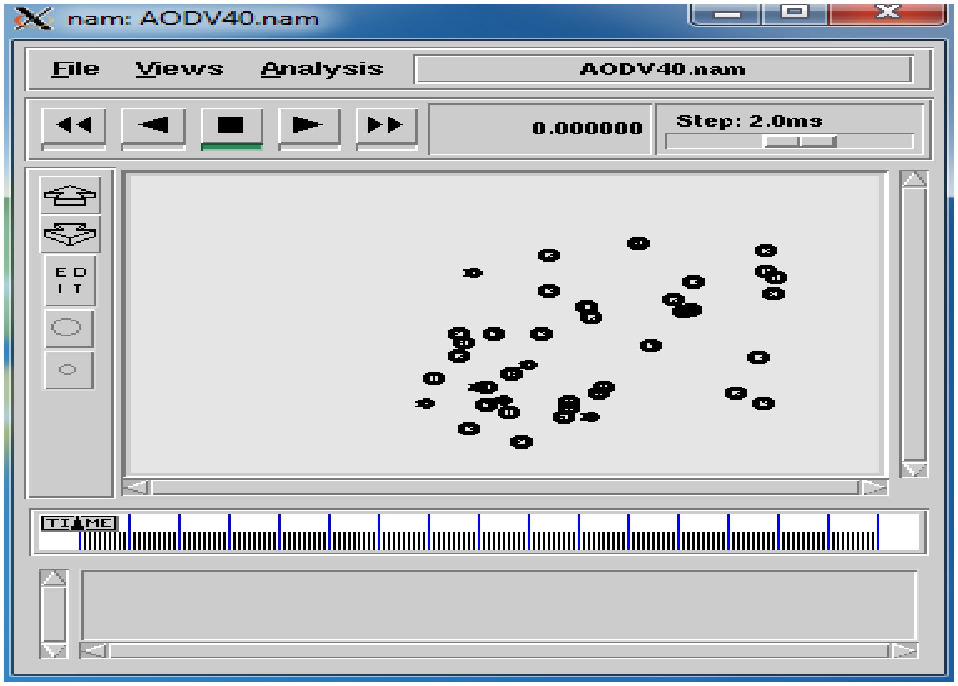

Figure 3: nam for 40 nodes

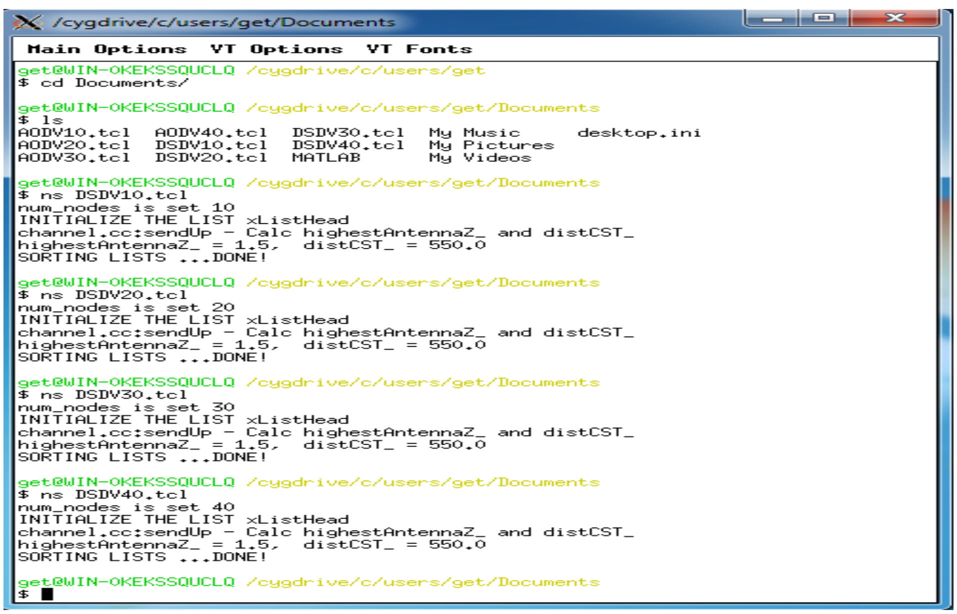

Figure 4: NS2 codes to generate nam files

Figure 3is a sample of one of our NAM outputs based on the code shown in Figure 4, whichvisualizes a MANET in the NAManimation tool. It shows the network topology where mobile nodes are connected, and their movement over time influences the communication paths. The nodes' locations are determined by a mobility model, likely the Random Waypoint Mobility Model, which simulates real-world mobility, such as that of mobile phones or vehicles (Akpaneno et al., 2024).The simulation evaluates network protocols (e.g., AODV or DSDV) in different mobility and traffic conditions. The simulation runs from time 1 to 50, allowing observation of how connectivity and protocol behavior evolve during this period.

Figure 4, shows ns2 commands to execute our TCL files to display the behavior of the protocols on NAM.

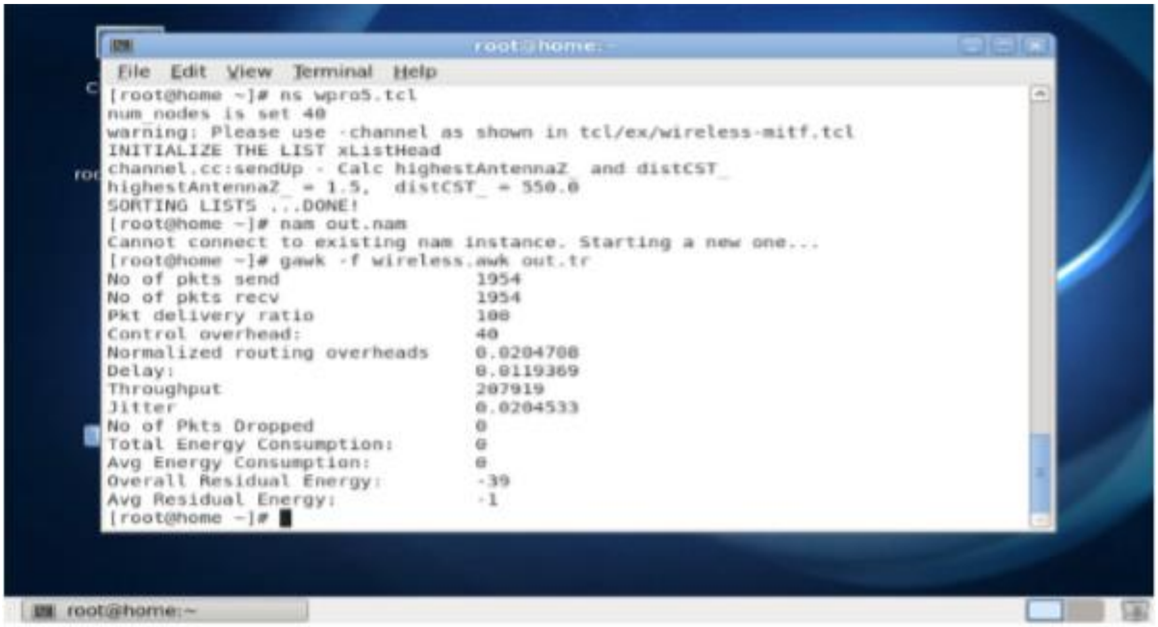

Figure 5: Performance metrics of AODV protocol when the number of nodes is 40.

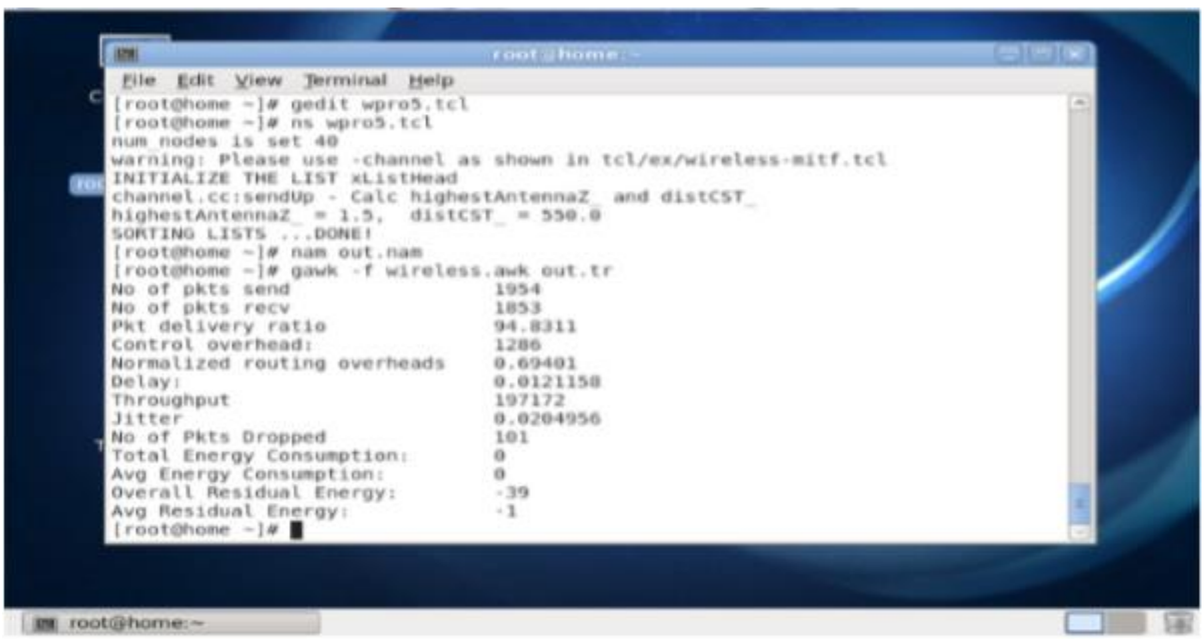

Figure 6: Performance metrics of DSDV protocol when the number of nodes is 40.

We depicted the sample simulated performance metrics for the two protocols to the scenariohaving a different number of nodes in a samplein Figure 5 and Figure 6.At first, AODV protocol is used in the changing scenario, and the performance metrics are simulated similarly, as shown in Figure 4, by changing the number of nodes in the scenario. Secondly, by using the DSDV protocol in the changing scenario, the performance metrics results are given inas shown in Figure 6.

Table 1: AODV and DSDV Protocols in terms of End-to-End Delay

No. of Nodes	End-T0-End Delay	
	AODV	DSDV
10	0.027915	0.011007
20	0.00701998	0.00581059
30	0.0655349	0.00786292
40	0.0119369	0.0121158

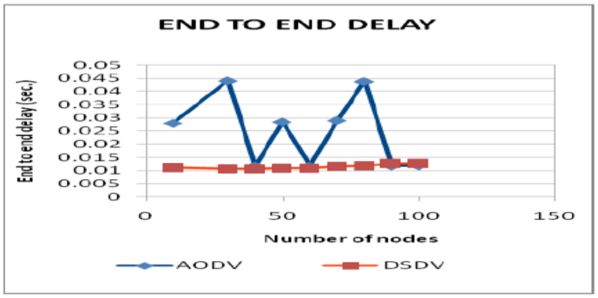

Figure 7: End to end delay of AODV and DSDV

Based on the analysis from Table 1 and Figure 7, it is evident that for 10 nodes, AODV exhibits a greater end-to-end delay in comparison to DSDV, showing a percentage difference of 10.50%. In the case of 20 nodes, AODV exhibits a delay that is 24.49% greater compared to DSDV. The delay for AODV with 30 nodes is 23.09% greater compared to DSDV. In the case of 40 nodes, the delay experienced by AODV is 20.98% greater compared to DSDV.

Table 2: AODV and DSDV Protocols in terms of Routing Overhead

No. of Nodes	Routing Overhead	
	AODV	DSDV
10	0.000536	0.004697
20	0.003400	0.005480
30	0.003281	0.015131
40	0.001071	0.02025

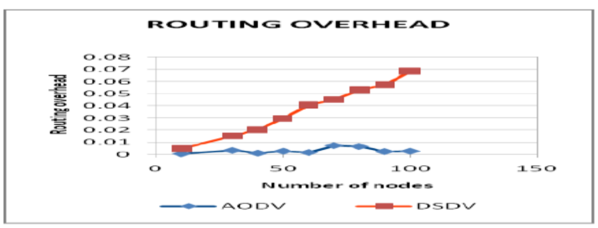

Figure 8: Routing Overhead of AODV and DSDV

Analysis of Table 2 and Figure 8 reveals that with 10 nodes, AODV demonstrates an 88.58% decrease in routing overhead when compared to DSDV. The routing overhead for AODV is 38.87% lower than that of DSDV when considering 20 nodes. In the case of 30 nodes, the routing overhead of AODV is significantly reduced, showing a decrease of 78.34% compared to DSDV. The routing overhead for AODV is 94.71% lower than that of DSDV when considering 40 nodes.

Table 3: AODV and DSDV Protocolsin terms of PDR

No. of Nodes	Packet Delivery Ratio	
	AODV	DSDV
10	1	0.904966
20	0.998976	0.802456
30	0.980403	0.79651
40	1	0.826577

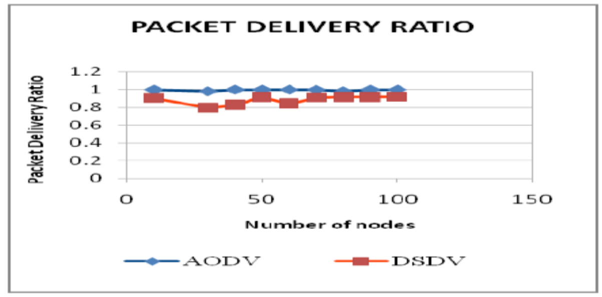

Figure 9: Packet delivery ratio of AODV and DSDV

Analysis of Table 3 and Figure 9 indicates that for 10 nodes, AODV exhibits a 10.50% higher packet delivery ratio compared to DSDV. In a scenario with 20 nodes, the performance of AODV surpasses that of DSDV, achieving a 24.49% higher packet delivery ratio. In the case of 30 nodes, the Packet Delivery Ratio (PDR) of AODV exceeds that of DSDV by 23.09%. In the case of 40 nodes, the performance of AODV surpasses that of DSDV by 20.98% in terms of packet delivery ratio.

CONCLUSION

In conclusion, AODV demonstrates superior performance compared to DSDV regarding packet delivery ratio and routing overhead, rendering it more appropriate for extensive and dynamic networks. DSDV demonstrates reduced end-to-end delay and operates more effectively in stable, low-mobility settings. This paper offers a detailed comparison of the two protocols, assisting network designers in selecting the most suitable protocol according to the specific application needs.

FUTURE WORK

Future investigations might delve into hybrid protocols that combine the advantages of both AODV and DSDV, with the goal of minimising routing overhead while maintaining effective route discovery. Furthermore, it is essential to examine the effects of different security threats, including Denial of Service (DoS) and Sybil attacks, on these protocols and to create secure routing mechanisms to address these vulnerabilities. Additionally, broadening the analysis to include Quality of Service (QoS) parameters such as jitter, throughput, and packet loss is crucial for enhancing the performance of real-time applications in MANETs, thereby ensuring improved reliability and user experience in dynamic network settings.

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