International Journal of Soft Computing and Engineering (IJSCE)
ISSN: 2231-2307 (Online), Volume-15 Issue-5, November 2025

Assessing the Impact of Node Density on MANET Routing: A Comparative Study of NTSM, AODV, and DSDV Using NS2 Simulation

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Abstract: ***MANETs provide a dynamic, decentralised communication architecture that enables nodes to form spontaneous networks. They are, therefore, best suited for situations where fixed infrastructure does not exist. However, performance in MANETs depends heavily on the routing protocol used and the node density. This paper describes the performance evaluation of three necessary routing protocols, NTSM, AODV, and DSDV, with respect to different node density conditions. We use extensive simulations on the NS2 simulation framework to analyses the performance of these protocols at several node densities. The critical performance metrics under study include packet delivery ratio, end-to-end delay, network throughput, and routing overhead. The systematic comparative study aims to identify the strengths and weaknesses of the protocols and their adaptability to dynamic variations within the network. This study explains in detail how NTSM, AODV, and DSDV respond to changes in node density in simulated MANET environments. They could serve as valuable guidelines for selecting the best routing protocol for different deployment types. Furthermore, these results highlight that, when designing and optimising MANETs, network dynamics and node density variations should also be considered, particularly through simulation tools such as NS2 for performance evaluation.***

Keywords: MANETs, Routing Protocols, Node Density Variations, Network Efficiency, NS2 Simulator

Nomenclature:
MANETs: Mobile Ad-Hoc Networks
NTSM: Ad-Hoc On-Demand Distance Vector
AODV: Node-Based Traffic Sharing
DSDV: Destination-Sequenced Distance Vector
DSR: Dynamic Source Routing
RREQ: Route Discovery Relies on Request
RREP: Route Discovery Relies on Reply
QoS: Quality of Service
PDR: Packet Delivery Ratio

I. INTRODUCTION

Due to the tremendous advancement in communication technology, MANETs [1] have emerged as a flexible and A Reliable communication method in many scenarios where conventional infrastructure is unavailable or infeasible. These networks enable devices to connect and communicate autonomously, eliminating the need for fixed routers or access points. This adaptability makes MANETs ideal for applications such as disaster recovery, remote outdoor regions, and dynamic settings with mobile devices [2]. Figure 1 shows the ad-hoc mobile structure and functionality of the MANET.

[Fig.1: Mobile Ad-Hoc Network (MANET) [1]]

While MANETs offer excellent flexibility, they pose significant challenges [3], especially in the efficient exchange of data among nodes. The performance of such networks is highly dependent on the choice of routing protocol, which may vary with node density.

This paper thoroughly analyses three widely adopted routing protocols for MANETs: NTSM, AODV, and DSDV. The NTSM, AODV [4], and DSDV [5] protocols are evaluated at different node densities using the NS2 simulation framework [6] to analyse adaptability and protocol performance optimizing.

We performed extensive simulations in NS2 to address that, simulating sparse to dense node distributions. Some of the key performance metrics include packet delivery ratio, end-to-end delay, network throughput, and routing overhead.

The findings from this research aim to provide valuable insights for engineers, researchers, and practitioners into the design and deployment optimisation of MANETs. By learning about the performance differences among NTSM, AODV, and DSDV across different node densities, participants will have a solid foundation for informed decision-making to achieve higher reliability and efficiency in their networks across different dynamic environment setups.

This research contributes to the development of MANET technology, equipping it with enhanced capabilities to meet communication demands in challenging, ever-changing scenarios.

Manuscript Received on 25 October 2025 | Revised Manuscript Received on 06 November 2025 | Manuscript Accepted on 15 November 2025 | Manuscript published on 30 November 2025.
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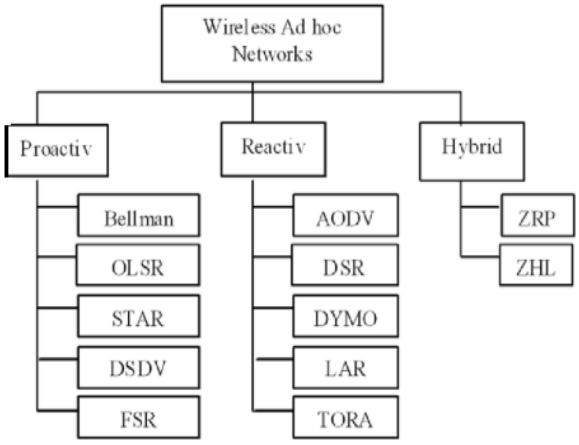
A. Types of Routing Protocols

Routing protocols play a significant role in determining optimal paths for packet transmission among nodes in a mobile network. There are two broad categories of routing protocols: topology-based and position-based. For the discussion of unicast routing protocols in MANETs, we refer readers to our earlier research. Figure 2 is the classification of routing protocols.



[Fig.2: Routing Protocols Classification]

This paper focuses on the performance simulation of two widely used on-demand routing protocols: Ad-hoc On-demand Distance Vector (AODV) and Dynamic Source Routing (DSR) [7]. These protocols are well established and extensively studied within the context of MANETs. Our choice of AODV and DSR for simulation is to provide a comparative evaluation of our proposed Node-Based Traffic Sharing Model (NTSM) against these standard protocols under different traffic conditions.

i. AODV

The Ad Hoc On-Demand Distance Vector (AODV) routing protocol [8] is a reactive protocol that only initiates route discovery when a node wants to send data packets. It supports both unicast and multicast routing and is very adaptive. AODV uses a unique DestSeqNum for each destination to ensure that routes remain fresh and accurate. It maintains a routing table that stores active routes and automatically deletes unused entries after a predefined timeout period. Route discovery relies on request (RREQ) and reply (RREP) messages, while route errors trigger the generation of error messages and the initiation of new route discovery processes.

ii. DSDV

Destination-Sequenced Distance Vector (DSDV) is a proactive routing protocol specifically designed for wireless networks and particularly well-suited to dynamic environments such as mobile ad hoc networks. It maintains a routing table with sequence numbers that ensure loop-free, up-to-date route information. By continuously updating the routing table, DSDV ensures reliable communication even in networks with frequent topology changes.

II. LITERATURE SURVEY

This paper [7] presents a new load-balancing method for ad hoc networks. It suggests a dynamic algorithm that evenly distributes network traffic across available nodes, thereby improving resource utilisation and overall network performance. The main goals are to reduce congestion, improve throughput, and enhance Quality of Service (QoS). Comparative analyses show that the proposed method outperforms other load-balancing methods in optimising network efficiency.

The paper [8] surveys key topics identified for energy-efficient load-balancing strategies to improve the AOMDV routing protocol in MANETs and explores mechanisms for data security. This provides an in-depth review of numerous energy-saving techniques, explaining their advantages and disadvantages, and evaluating protocols related to the confidentiality, integrity, and availability of data. This is a valuable contribution to research on energy efficiency, AOMDV, and MANET data security.

This paper [9] describes a routing protocol that balances traffic loads among nodes. The protocol improves resource utilisation and network performance. It chooses routes based on each node's load. Less congested paths are given priority to avoid congestion, minimise delay, reduce packet loss, and improve QoS. This method greatly enhances load balancing, network efficiency, and its lifetime.

Paper [10] Load balancing techniques for shortest-path routing protocols in MANETs are investigated in this paper. It discusses various approaches, including multipath routing, load-aware metrics, and proactive balancing. It highlights the need for even traffic distribution and resource optimisation, demonstrating how these approaches improve traffic management and network performance.

Paper [11] In MANET, a novel approach in a multipath-based Fibonacci sequence technique will be used for load balancing. Since the number of paths can be determined and this number of paths determines which part of the traffic goes which way, the intention was to increase utilisation, remove congestion, and optimise networking.

This paper [12] provided an overview of energy-efficient techniques and load balancing in MANETs. Energy-aware routing, sleep scheduling, and adaptive protocols were considered. It assesses the approaches based on the Routing Overhead, network lifetime, and throughput. This is a comprehensive survey to help increase energy efficiency and balanced resource use in MANETs.

The review paper [13] presents the various load-balancing routing protocols in MANETs, their advantages and limitations, and the performance metrics. It provides insight into the state of the art in load-balancing strategies, helping researchers identify gaps and future directions for innovation.

Paper [14] This paper focuses on load balancing and congestion control techniques in MANETs. It reviews and evaluates the mechanisms from the existing literature, highlighting their potential to improve network performance. Emphasis is placed on the interplay between load balancing and congestion control to improve resource utilisation while reducing delays.

This paper [15] reviews load-balancing and congestion-control techniques in MANETs and discusses their effectiveness in improving network performance. This paper analyses the metrics of throughput, delay, packet loss,

and Routing Overhead, thus providing an in-depth assessment of these techniques for efficient resource management.

This paper proposes a routing protocol [16] that combines load balancing and link break prediction in MANETs. The distribution of traffic and the protocol's ability to predict link failures enhance network reliability and performance. It has been proven, through comparative studies, to be more effective than existing protocols in ensuring robust data delivery.

The present paper [17] proposes LAPU, a load-balancing technique for geographic routing in MANETs that adjusts position update frequencies based on network load. Besides improving load distribution, LAPU also reduces control overhead and improves routing efficiency. The performance comparisons show LAPU's gains in throughput, delay, packet loss, and control overhead.

This paper [18] proposes an ant colony optimisation-based routing protocol with a cross-layer load-balancing technique for ad hoc networks. The approach integrates information from multiple network layers by exploiting ant-colony optimisation to balance traffic and reduce congestion, thereby improving performance. The study includes comparative evaluations that highlight efficiency.

This paper [19] introduces a framework implemented in NS-2 for controlling the topology of wireless ad hoc networks. Given the framework, various tools are provided for node placement, power management, and link scheduling, thereby optimising network performance through effective topology control. Performance evaluations using NS-2 simulations validate the design's functionality and effectiveness.

III. NODE-BASED TRAFFIC SHARING MODEL (NTSM) TECHNOLOGY

The Node-Based Traffic Sharing Model (NTSM) proposes a new approach toward optimising traffic distribution for load balancing in MANETs. NTSM achieves better network performance by efficiently utilising resources and leveraging intermediate nodes to handle traffic actively.

A. Essential Elements of NTSM

i. Active Load Monitoring

Intermediate nodes constantly monitor the load and status of neighbouring nodes. That also involves tracking metrics such as the number of packets processed and node flag statuses to understand network conditions.

ii. Dynamic Information Exchange

Intermediate nodes share load and status updates via periodic hello messages. These updates enable the routing tables to change dynamically in real time as the network state changes.

iii. Load Analysis

The NTSM works by evaluating network traffic flow and node load to determine which nodes are under- or overutilized. This analysis is crucial to ensuring load balance across the network.

iv. Traffic Redistribution

NTSM uses a traffic-diversion mechanism to balance loads. Nodes with too much traffic offload part of the data to less congested nodes, thereby reducing congestion and bottlenecks and improving traffic flow.

v. Optimized Route Discovery

If a source node wants to send data, it sends a route request message containing load metrics and the path it will take. The destination node will calculate the load along the proposed path and send a route reply, designating the most efficient route for data transfer.

vi. Reliable Data Transmission

Once the best route has been determined, data packets are efficiently transmitted along it. This minimises delay and thus provides stable communication over the network.

vii. Collision Reduction

NTSM reduces data collisions by monitoring network activity, further streamlining transmission and enhancing overall efficiency.

The Node-Based Traffic Sharing Model is a robust framework that combines traffic management, load balancing, and route optimisation for MANETs. NTSM actively involves intermediate nodes in traffic handling to address uneven load distribution and congestion, boosting the network's reliability and performance. It provides a scalable, practical approach to improving communication in dynamic, decentralised mobile networks.

B. NTSM Protocol Algorithm

The NTSM protocol is optimised for traffic distribution and load balancing in MANETs. It systematically coordinates information sharing, traffic analysis, and load management to transmit data efficiently. Network initialisation, exchange of load/status information, traffic analysis, route discovery, and continuous performance monitoring are significant steps involved. Since the algorithm is complex, here is a step-by-step breakdown:

Algorithm: NTSM Protocol
Start
Step 1: Initialization
Initialize network parameters
Initialize data structures for the nodes:
Set all nodes to "underutilized" status
Set all the nodes' load to 0
Step 2: Information Exchange
For every node in the network:
Exchange hello messages with the neighbor nodes
Share the load and status information
Categorize nodes according to current load as "underutilized" or "over-loaded"
Step 3: Traffic Analysis and Load Balancing
For each node in the network:
If node's load is > threshold:
Set node status to "overloaded"
Else:
Set node status to "underutilized"
For each overloaded node:
Find underutilized node(s) to balance the load
Divert traffic from the overloaded node to the underutilized node
Adjust load values to reflect a balanced load
Step 4: Route Discovery and

Published By:
Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP)

Data Transmission
The source node broadcasts a Route Request (RREQ) message with load information
While Route Reply (RREP) is not received:
If the node is an intermediate node:
Forward RREQ and update the routing table
If the node is the destination node:
Calculate the load of the path
Send Route Reply (RREP) with load details back to the source node
Set flag status for the path
If the node is an intermediate node:
Forward RREP and update flag status
If the node is the source node:
Initiate data transmission along the optimal route
Step 5: Network Monitoring
Continuously monitor the network for:
Efficient data transmission
Minimal collisions during transmission
End Algorithm

IV. RESULTS AND DISCUSSION

A. Simulation Settings

The performance of the protocol is evaluated through simulations conducted with the event-driven ns-2.35 simulator [11]. For the simulations, a random mobility model is used, in which nodes are randomly distributed within a rectangular area of 1000 m x 1000 m. The protocol is then modelled by configuring and testing various parameters within the network's TCL script. A detailed list of the simulation parameters used in the experiments is provided in Table 1 below.

Table I. Parameters Used in the Simulation

Scenario Elements	Values
Number of nodes	60, 80, 100 Nodes
Node speed	5 meters/second
Queue size	40 packets
Simulation area	1000 * 1000 Meter^2
Routing protocols	AODV, DSR, NTSM Protocol
Mobility model	Random way point
Packet size	512 Bytes
Traffic type	CBR
Transmission power consumption	0.034 Joules
Receive power consumption	0.034 Joules
Idle Power	0.100 Joules
Sense Power	0.0175 Joules
Simulation time	300 seconds

The simulation parameters used in our experiments are summarised in detail in Table 2. These parameters define the simulation environment and conditions required for comprehensive testing of a protocol's performance across various scenarios.

B. Performance Evaluation Metrics

To analyse the behaviour of the protocol with respect to different simulation durations, we can compute some performance metrics that provide insight into the effectiveness of the protocol:

i. *Packet Delivery Ratio (PDR):* This metric calculates the percentage of successfully delivered data packets from the source node to the destination. PDR is determined by the ratio of received packets to sent packets, multiplied by 100.

PDR = (Number of packets received / Number of packets sent) * 100

ii. *Throughput*: Throughput measures the rate of data transmission and reception within the network. It represents the total number of bits successfully received by the destination node.

Throughput = (Number of bits received / Time taken for reception)

iii. *End-to-End Delay*: This metric tracks the time required for a data packet to travel from the source node to the destination node, accounting for all delays during transmission, such as propagation delay, queuing delay, and processing delay.

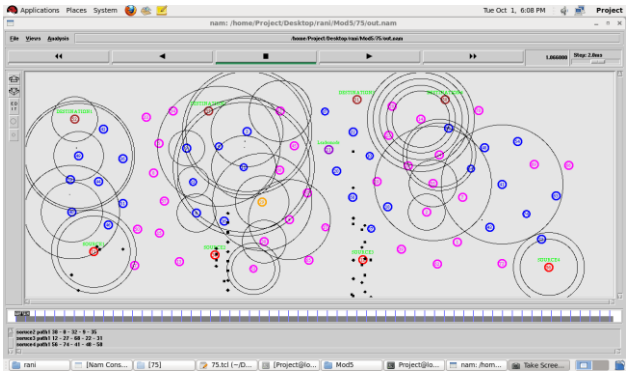
End-to-End Delay = Time taken for a packet to reach the destination - Time at which the packet was sent.

iv. *Routing Overhead*: Routing overhead measures the additional control messages and signalling needed for routing operations. It includes extra network traffic generated by routing protocols to establish and maintain paths.

Routing Overhead = (Number of routing control messages / Number of data packets sent) * 100

C. Results and Analysis of the Simulation

We will present the results of our NS2.35 simulation work in this section. We have implemented the protocols that we will investigate and evaluate their performance. To better clarify the network topology for the reader, we have provided a couple of screenshots in Figure 3 to accompany this result, which provide substantial insight into how protocols behave and perform in this simulation environment.



[Fig.3: Network Simulator Interface]

i. *Execution of the NTSM Algorithm and Simulation Results*

In this section, we provide a detailed description of the implementation of the proposed NTSM algorithm and present simulation results based on different node configurations. We carefully selected and calibrated all simulation parameters to conduct a thorough, comprehensive analysis, thereby making the study robust for evaluating the algorithm's performance.

ii. *Packet Delivery Ratio (PDR)*

Table 2 compares the PDR of the AODV, DSR, and NTSM protocols at different node densities (60, 80, and 100 nodes). PDR is a metric that measures the percentage of

data packets delivered from source to destination. For example, AODV at 60 nodes achieves a PDR of 12.41%, while DSR at 80 nodes achieves a PDR of 28.12%. This comparison provides valuable insight into the performance of each protocol under different network conditions, helping select the most suitable protocol for specific scenarios. Although route instability challenges arise, the results show appreciable differences in PDR values across the three protocols. The NTSM protocol consistently outperforms AODV and DSR, ensuring reliable packet delivery even under varying node densities.

Table II. PDR Comparison

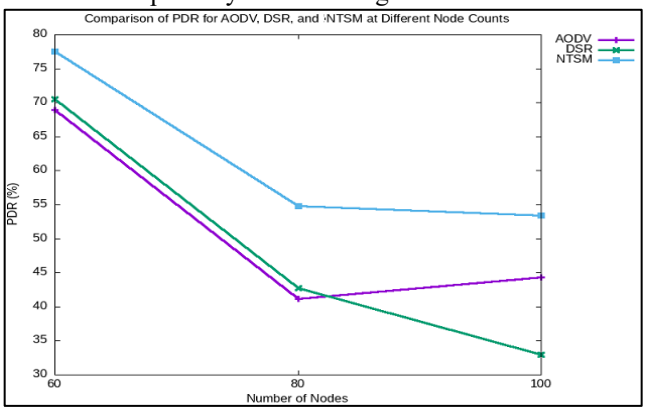
Protocols	60	80	100
AODV	68.9717	41.2145	44.3759
DSR	70.5444	42.7877	32.9614
NTSM	77.5252	54.81134	53.4431

Table III. Compares the Packet Delivery Ratio (PDR) of NTSM with AODV and DSR Protocols Across Different Node Densities

Number of Nodes	60	80	100	Average/Overall
NTSM compared to AODV	12.41%	32.98%	20.42%	21.94%
NTSM compared to DSR	9.90%	28.12%	62.18%	33.40%

Table 3 shows the average percentage differences in PDR, indicating that NTSM outperforms AODV by 21.94% and DSR by 33.40% across different node configurations. The results suggest that NTSM is more efficient at delivering data packets than AODV and DSR.

Figure 4 also shows that the PDR of the NTSM protocol consistently exceeds those of AODV and DSR, regardless of node density. This performance benefit can be attributed to the Intermediate Node Traffic Sharing Model supported by NTSM, which provides efficient load balancing and congestion reduction. It reduces packet loss by redistributing traffic from overloaded nodes to underutilised nodes, thereby significantly enhancing packet delivery. On the other hand, AODV can maintain a high PDR only with difficulty due to its limited adaptability to fluctuating network conditions.



[Fig.4: Packet Delivery Ratio for Different Node Densities]

iii. Throughput

Throughput is another performance metric that counts the number of bits received at the destination node and indicates the data transmission rate within the network.

Table 4 shows that, across all cases, NTSM outperforms AODV and DSR in terms of throughput as node density varies. This performance benefit is evident in NTSM's efficient distribution of traffic between nodes and its ability to maintain balanced loads, thereby optimising data transmission and overall network capacity. NTSM significantly improves throughput by identifying underutilised nodes and offloading traffic from overloaded ones. On the other hand, AODV and DSR struggle to cope with increased traffic as the node count increases, resulting in lower throughput than NTSM.

Table IV. Throughput Comparison

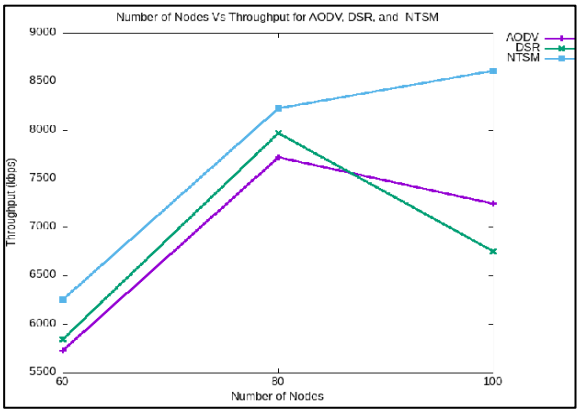
Protocols	Number of Nodes Vs Throughput		
	60	80	100
AODV	5728.65	7718.62	7239.72
DSR	5842.43	7969.58	6748.91
NTSM	6256.84	8226.38	8615.04

Table V. Compares the Throughput of NTSM with AODV and DSR Across Varying Node Densities

Number of Nodes	60	80	100	Average/Overall
NTSM compared to AODV	9.23 %	6.57%	19.02%	11.61%
NTSM compared to DSR	7.09 %	3.23%	27.67%	12.00%

Table 5 compares throughput among the NTSM protocol, AODV, and DSR for 50, 75, and 100 nodes. From this table, it is evident that NTSM has the highest Throughput percentage compared with AODV and DSR. It follows that NTSM outperforms AODV by an average of 11.61% and DSR by an average of 12.00% in Throughput across the three node densities, indicating its efficiency in data transfer.

Figure 5 visually corroborates the results, showing that the NTSM protocol achieves much higher throughput than AODV and DSR across all node combinations. Although NTSM's Routing Overhead was slightly higher, its effective traffic management made it the preferred protocol for dynamic MANETs. The adaptability and reliability of NTSM make it a good candidate for practical deployment in real-world environments. This therefore provides valuable research on protocol selection across diverse network scenarios. Thus, NTSM is an efficient and reliable choice in MANET communication in today's increasingly connected world.



[Fig.5. Throughput for Different Node Densities]

iv. End-to-End Delay

The Average End-to-End Delay is the average time it takes for a data packet generated by the source to reach the destination. These include various delays encountered as a packet travels, such as interface

queueing, routing latency, buffering, transfer time, packet queuing, and propagation.

Table 6. From this table, it is clear that the Average End-to-End Delay of the NTSM protocol is always lower than those of AODV and DSR across all node scenarios. NTSM manages traffic flow and load balancing, resulting in less congestion and reduced delay time. NTSM identifies nodes with less utilization and routes traffic through them, thereby alleviating network congestion. Additionally, NTSM predicts link failures in advance and finds alternative routes beforehand, minimising the delay caused by route rediscovery. On the other hand, AODV experiences higher delays when the number of nodes is high, mainly because of its limited adaptability to changing network conditions.

Table VI. End-to-End Delay Comparison

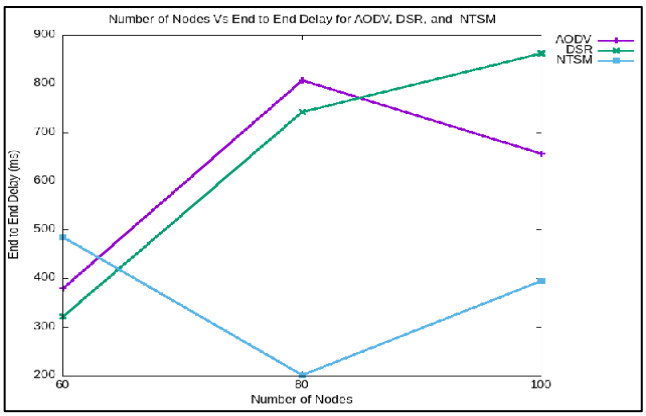
Protocols	Number of Nodes vs. End-to-End Delay		
	60	80	100
AODV	379.34	807.363	657.179
DSR	321.678	741.836	862.546
NTSM	485.426	201.701	395.29

Table VII. Compares the End-to-End Delay of NTSM with AODV and DSR Across Varying Node Densities

Number of Nodes	60	80	100	Average/ Overall
Absolute Reduction: NTSM vs. AODV	28.00%	75.02%	39.84%	47.62%
Absolute Reduction: NTSM vs. DSR	50.91%	72.81%	54.19%	59.30%

Table 7 Comparison of End-to-End Delay of NTSM Protocol, AODV and DSR for varied Node Scenarios (50, 75, and 100 nodes). NTSM, across all given node scenarios, has consistently shown delay values that are 47.62% lower than AODV and 59.30% lower than DSR. These variations in the delay indicate that NTSM achieves lower data transmission delays.

Figure 6 shows the End-to-End Delay visualisations for the three protocols. From the graph, it is clear that the NTSM protocol delivers better End-to-End Delay results than AODV and DSR across various node densities, further emphasising its ability to reduce delays and optimise data communication within the network.



[Fig.6: End-to-End Delay for Different Node Densities]

v. Routing Overhead

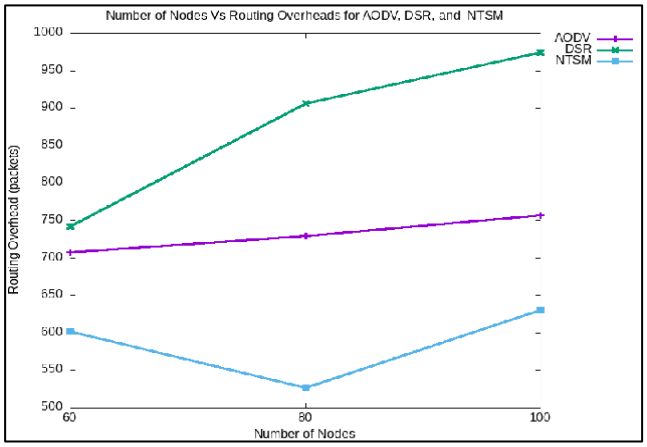
Table 8 compares routing overhead among NTSM, AODV, and DSR for various node counts. NTSM is seen to generate slightly more overhead than AODV and DSR, as more routing information must be exchanged to maintain the Intermediate Node Traffic Sharing Model. It enables load balancing and congestion avoidance by improving network performance. AODV performs well in terms of routing overhead at low node density, but it struggles as the number of nodes increases, as it cannot efficiently handle the overhead. The overhead added to NTSM is a trade-off with network efficiency and its better performance.

Table VIII. Routing Overhead Comparison.

Protocols	Number of Nodes Vs Routing Overheads		
	60	80	100
AODV	707.463	729.471	756.597
DSR	741.936	905.9	974.45
NTSM	601.801	527.055	630.007

Table IX. Compares the Routing Overhead of NTSM with AODV and DSR Across Varying Node Densities

Number of Nodes	60	80	100	Average/Overall
Reduction in Overhead: NTSM vs. AODV	14.91 %	27.76 %	16.75 %	19.81%
Reduction in Overhead: NTSM vs. DSR	18.91 %	41.81 %	35.34 %	32.02%



[Fig.7: Routing Overhead for Different Node Densities]

Figure 7 shows an obvious comparison in routing overhead among the three. NTSM exhibits slightly higher overhead than AODV and DSR, yet it is highly efficient overall. The protocol benefits from its ability to spread traffic and avoid congestion, resulting in better overall performance at the expense of higher routing overhead. On the contrary, AODV and DSR cannot tolerate significant overhead as the number of nodes increases. Hence, in larger network scenarios, NTSM can be a better choice.

vi. Analysis

- *Packet Delivery Ratio (PDR)*: NTSM has outperformed the compared AODV and DSR protocols in each trial in terms of Packet Delivery Ratio. This illustrates how it ensures the reliable forwarding of data packets even across challenging network conditions. A robust load-balancing strategy that effectively avoids congestion to maintain high delivery success is another main reason for this advance in PDR.

When network conditions become highly dynamic, AODV cannot maintain higher packet delivery ratios.

- *Throughput*: NTSM protocol outperforms the AODV and DSR protocols in terms of throughput. Its better performance is therefore due to efficient traffic distribution, load balancing, and optimised data transmission, resulting in increased overall network capacity. In other words, NTSM successfully minimises data transmission delay, making it highly efficient for applications in dynamic networks.
- *Routing Overhead*: While NTSM shows a slightly higher routing overhead than AODV and DSR due to additional routing information exchange, it still performs better in terms of network efficiency. The overhead incurred is justified by the protocol's enhanced network performance, thanks to its traffic redistribution and congestion management capabilities.

Overall, the critical performance comparison confirms that the NTSM protocol indeed outperforms AODV and DSR across all relevant performance metrics, making it well-suited for optimising ad hoc wireless networks, especially in sparse and very dense environments.

V. CONCLUSION

This paper evaluated the performance of three MANET routing protocols, namely NTSM, AODV, and DSR, for various node densities through ns2.35 simulations. The results showed that NTSM outperformed both AODV and DSR in terms of Packet Delivery Ratios, Throughput, and End-to-End Delays. Although NTSM's Routing Overhead was slightly higher, its effective traffic management made it the preferred protocol for dynamic MANETs. The adaptability and reliability of NTSM make it a good candidate for practical deployment in real-world environments. This therefore provides valuable research on protocol selection across diverse network scenarios. Thus, NTSM is an efficient and reliable choice in MANET communication in today's increasingly connected world. Practical Implications and Future Directions: This work provides valuable insights for network administrators, researchers, and professionals involved in the design, deployment, and optimisation of MANETs. The results can help inform appropriate routing protocol choices in dynamic node populations. Besides, it underscores the need to consider network dynamics when designing and optimising mobile ad hoc communication systems. Simulation tools like NS2 play an essential role in testing the performance of protocols under different conditions.

DECLARATION STATEMENT

After aggregating input from all authors, I must verify the accuracy of the following information as the article's author.

- **Conflicts of Interest/ Competing Interests:** Based on my understanding, this article has no conflicts of interest.
- **Funding Support:** This article has not been funded by any organizations or agencies. This independence ensures that the research is conducted with objectivity and without any external influence.
- **Ethical Approval and Consent to Participate:** The content of this article does not necessitate ethical approval or consent to participate with supporting documentation.
- **Data Access Statement and Material Availability:** The adequate resources of this article are publicly accessible.
- **Author's Contributions:** The authorship of this article is contributed equally to all participating individuals.

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