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Original Article

Novel Routing Protocol Reduce End to End Delay by Introducing the Delay Computation Table Mobile Adhoc Network

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Abstract *- In the Mobile Adhoc Network, the most predominant parameter is End to End Delay which supports the network performance as well as efficiency of the communication. Many studies have been conducted to overcome packet delay in nodes by designing routing protocols using cutting-edge approaches, but the research has not progressed. Existing routing strategies select paths by dynamically manipulating various parameters, which adds overhead to the routing protocol. This article focuses on developing a new strategy for overcoming packet delay in Mobile Adhoc Networks with the use of a delay table and delay calculation nodes. The simulation was performed using NS2.34, and the results were compared to AODV in terms of performance metrics such as PDR, END and throughput, revealing that the proposed work achieved a PDR of 90% to 98%. In contrast, normal AODV had a packet delivery ratio of 70% to 90%. End-to-end delay was 0.083 to 0.77%, compared to the old routing protocol AODV's delay of 0.186 to 1.08ms, and throughput was 94 to 99% higher.*

Keywords *- Delay table, Delay computation nodes, Delay rectification, End to End delay, MANET.*

1. Introduction

The various research contributions in the field of Mobile Adhoc Networks (MANETs) routing protocols for achieving better End to End delay. It introduces several novel algorithms and protocols proposed by different researchers to address the challenges in MANETs, including routing efficiency, energy consumption, security, and Quality of Service (QoS). The major role of wireless based communication of Mobile Adhoc Network (MANET) [1] is providing the best routing strategy in the Network layer functionality.

Since the best packet delivery to the destination produces an improvement in the performance factor. Packet performance variables are altered by forwarding delays or the presence of an attacker [2] in the communication network. Many external influences are attempting to undermine the MANET [2] application utilization by mitigating the MANET performance factor. One of the famous mitigation innovations is done when the transmission of the packets by delay or dropping the packets. Traditional routing protocols are not supported to overcome the delay of the packet as well as dropping packet issues. The research needs to provide an efficient packet delivery routing protocol to support packet delivery without insisting on the additional overhead to the network layers.

The introduction highlights the significance of routing protocols in MANETs for facilitating efficient data communication among nodes in a dynamic and self-organizing network environment. It emphasizes the need for innovative routing solutions to overcome inherent challenges such as network dynamics, limited resources, security threats, and unpredictable node behaviours. Several researchers have proposed new algorithms and protocols to enhance various aspects of MANET routing.

These include the FPSOR Algorithm [3], A routing algorithm utilizing Fuzzified Particle Swarm Optimization to reduce overhead and data loss in MANETs. It aims to find optimal paths while considering energy consumption, although energy prediction for all nodes remains a challenge.GA-AOMDV Protocol [4]: This protocol employs a genetic algorithm to calculate energy-based routes, focusing on shortest distance, congestion, and minimal energy consumption.

However, parameter estimation for route optimization may overload source nodes. Node Capability Based Routing [5]: A secure routing approach detecting attacks like black holes, wormholes, and DoS flooding. Although it enhances packet delivery ratio and throughput, predicting secure routes based on energy, buffer length, and mobility requires frequent updates.

Routing with Artificial Neural Network [6]: Utilizing artificial neural networks to optimize energy consumption based on node mobility, traffic, and transmission power. While it improves energy utilization and network lifetime, predicting metric values is challenging due to MANET's dynamic nature.ML-AODV Protocol [7]: This protocol integrates machine learning to enhance QoS and detect attacks. However, classifying attackers using machine learning can be complex, especially with new attack types.

Crypto-based AODV Protocol [8]: Enhances security using cryptographic hash functions and Dijkstra's algorithm, ensuring data transfer success despite attackers. However, computation complexity arises from hash function and route calculations.

Trust-Aware On-Demand Distance Vector (TAODV) Protocol [9]: Focuses on network efficiency and security through trust metrics. While it improves security and network efficiency, selecting routes involves complex metric calculations. Fuzzy C-Means Clustering-based Energy [10] - Efficient Protected Optimal Path-Routing Protocol: Combines fuzzy logic and cryptography to achieve energy-efficient and secure routing.

However, the protocol incurs high operating costs. Hybrid Routing Protocol [11]: Incorporates digital certificate authority and SHA-3 for robust route failure detection. Despite reducing failed nodes, security concerns arise from secret key usage.

Improved Hybrid Routing Protocol [12]: Utilizes a combination of existing routing protocols to create routes based on the situation, improving performance but adding complexity to route selection. Reputation Based Routing Protocol [13]: Uses Q-learning and reinforcement learning to overcome attacks and improve network efficiency. However, predicting new attacker nodes poses a challenge. In summary, the introduction chapter provides an overview of various routing protocols proposed by researchers to address the challenges in MANETs, including efficiency, energy consumption, security, and QoS. These protocols aim to enhance different aspects of routing in MANETs, although each comes with its own set of advantages and challenges.

This research article is organized as follows: survey related to delay computation research work discussed in Chapter 2, proposed delay table and delay computation nodes Algorithm and delay rectification techniques discussed in Chapter 3 studies, proposed research work simulation work mentioned in Chapter 4, and conclusion in Chapter 5.

2. Literature Survey

In this chapter, the different routing protocols were supported for the End-to-end delay improvement in the MANET communication with the limitations and advantages.

From the literature survey, the prediction of route discovery for routing protocol with secure communication uses modern techniques like fuzzy based methods, genetic algorithms, artificial neural networks, machine learning, and traditional techniques, cryptographic, hybrid routing, Situation routing; all these use some metric to evaluate the route decision, but the evaluation of these metric is a fruitless to the route strategy in network layers functionality which consumes MANET energy to process the metrics.

This article focuses on the simple table named as delay table and delay computation node. This work will achieve the best end to end delay the MANET.

3. Designing Delay Node Computation Process

From the Literature survey, several methods were used to improve the delay in MANET communication. However, all the methods are not preventing the delay; they will be overcome after the delay is encountered in the communication. This article proposed a novel method to overcome the delay in MANET communication, which is accompanied by the monitoring of the node's packet communication.

If any node is delayed in forwarding the packet, the alert message is sent to the node to carry out the necessary action to overcome the delay. The reason for the delay could be the congestion, buffer overflow, or any intruder activities. To achieve the delay computation, the nodes could carry out the additional responsibility of maintaining the details about the incoming packets and outgoing packets in the form of the table as shown in the format as, called the delay table.

Table 1. Literature survey

S.NO	Authors & Invention	Methodology	Advantages	Disadvantages
1	FPSOR Algorithm (Harihara Gopalan et al [3]):	Fuzzified Particle Swarm Optimization oriented Routing algorithm for reducing overhead and data loss in MANET.	It uses a Fuzzy method for finding fresh routes, potentially optimizing energy consumption.	Energy consumption prediction is not perfect for all nodes.
2	GA-AOMDV (Rao et al [4]):	Energy-based route calculation protocol using optimized genetic algorithm for finding optimal paths.	Considers shortest distance, congestion, and energy consumption for route optimization.	Parameter estimation for an optimal route is cumbersome and can overload the source node.
3	Node Capability Based Routing (Patsariya & Rajavat [5]):	Secure MANET routing using node capability and trusted node capability based routing for attack detection.	It improves packet delivery ratio and throughput enhances security against attacks.	Requires prediction based on varying factors like energy, buffer length, mobility, and bandwidth, needing frequent updates.
4	Routing with Artificial Neural Network (Jayant & Ritesh Sadiwala 6]):	Routing based on artificial neural network considering node mobility, traffic, and transmission power.	Optimizes energy utilization and prolongs network lifetime.	Prediction of metric values is challenging due to the dynamic nature of MANET, which requires dynamic computation of metric values.
5	ML-AODV Protocol (Sivapriya et al. [7]):	Machine learning-based routing protocol for improving QoS and detecting attacks.	Better results in QoS and attack detection compared to other protocols.	Complex classification technique for predicting attackers, challenging when facing new kinds of attack nodes.
6	Crypto-based AODV Protocol (Majumder et al. [8]):	Crypto-based AODV protocol using a cryptographic hash function and Dijkstra algorithm for security in MANET.	Improves throughput, reduces END, enhances data transfer	Computationally complex due to hash function and shortest path calculation.
7	TAODV Protocol (Matre & Vikhar [9]):	Trust-aware routing protocol for MANET focusing on network efficiency and security.	Improves network efficiency and security and manages dynamic network structures and traffic.	The selection of a route involves many metric calculations, which are time-consuming in dynamic environments.
8	Fuzzy C-Means Clustering-based (Purushothaman et al. [10]):	Secured routing protocol using fuzzy logic and cryptographic techniques for energy-efficient routing.	Provides better performance compared to other routing protocols in terms of security and efficiency.	The high operating cost for providing a secured protocol.

9	Hybrid Routing Protocol (Sangeetha et al. [11]):	Digital certificate authority and SHA-3	Reduces the number of failed nodes in communications.	Security concerns with secret key usage
10	Improved Hybrid Routing Protocol (Advin Manhar and Dr. Deepak Dembla [12]):	Combines different routing protocols for route path creation based on the situation.	Shows better performance compared to existing routing protocols.	The selection of routing protocol for route selection and packet forwarding is complex for nodes.
11	Reputation Based Routing Protocol (Ryu et al. [13]):	Reinforcement learning in game theory.	Overcomes black hole and gray hole attacks, improves PDR, END.	Adaptation of game theory and reinforcement learning requires trained datasets inability to predict new attacker nodes.

This format helps to determine the node delay in the communication. This article introduces a special agent named a delay computing agent to monitor all the node's activities. If the node is found to be delayed in the packet forwarding then the message will be sent to the node to initiate the necessary action like checking the reason for the delay due to buffer overflow or congestion, etc. Let us assume the MANET nodes are N1, N2, and Nn, and each node is connected to the edges E. Among the N number of nodes in the MAENT, one node will act as a delay computing agent by monitoring the delay table.

Delay Node Prediction Algorithm : I

The delay node prediction algorithm has been established to predict the delay node before making the communication; the Algorithm works as follows. A routing algorithm for selecting the route path from the Source node S to the Destination node D is working based on the internal node forward time. The algorithm steps for selecting the route from the source to the destination nodes are as follows.

1. Collect N number of MANET nodes.
2. One node takes the responsibility of the Delay computation process of other nodes.
3. All the nodes send the delay table to the Delay computation nodes that monitor the node's delay table.
4. The sender node can get the transmission path to the receiver node using the AODV algorithm.
5. Receiving the RREP path has passed to the delay computation node, Delay computation nodes verifies all the intermediate nodes are not having the delay in forwarding the packets.
6. A delay computation node responds to the sender if all the nodes are efficient in communicating. Otherwise the delay computation node responds to the node which does not forward the packet without delay.
7. If any node is delayed in forwarding the packet, a warning message will be sent to the node.
8. Delay node will call the delay rectification process to overcome the issue.

```
Delay Rectification (Delay node, Delay table)
{
//node check itself for solving the delay issue
If (There is congestion in the buffer)
{
Keep only the data packet and drop RREQ, RREP, SYN packets in the buffer
}
Else if (there buffer overflow)
{
Respond the sender to follow slow start
}
Else if
{
Call the routing there is any intruder or attacker
}
Return node status
}
```

The working of the proposed delay computation is explained in Figures 1 to 3. Figure 1 shows that all the nodes share the delay table with the delay computation node. Sender S is the source node and wants to communicate with the receiver node R to send an RREQ signal by stating the destination R address.

All the nodes send the route reply; this route replay is forwarded to the delay computation node to confirm the selected path, as shown in Figure 2, and the delay computation nodes verify all the intermediate nodes in the delay table and respond route confirmed to the sender only all the intermediate nodes are forwarding the packet without delay as shown in Figure 3.

Table 2. Delay table

Timing	Packet Seq. No	Incoming	Outgoing	Difference

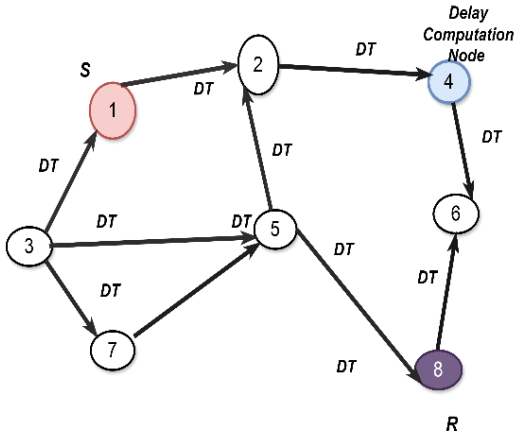

Fig. 1 Delay table forward to the delay computation node

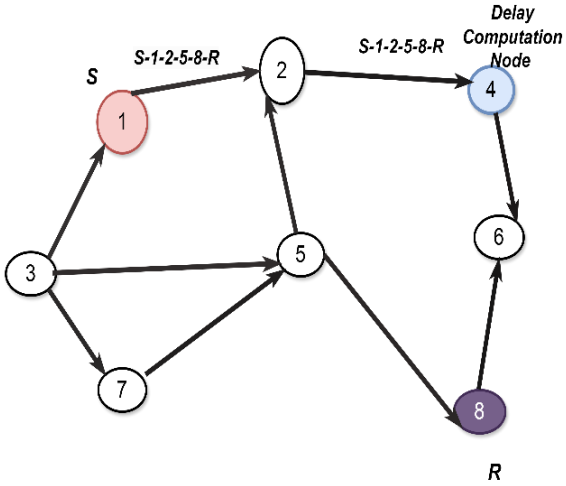

Fig. 2 Route confirmed request

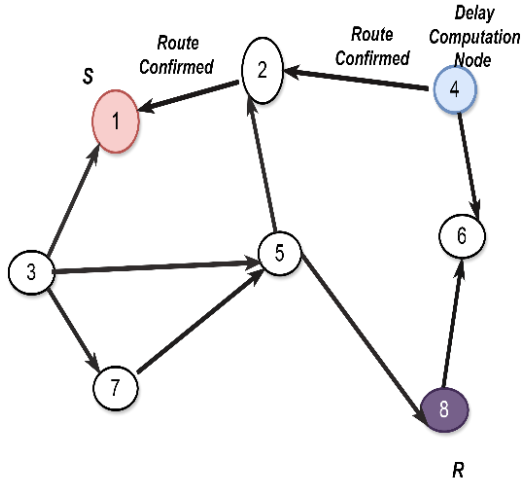

Fig. 3 Route confirmed

The process of the new Delay approach process of the new delay approach is shown in the flowchart in Figure 4. The route node selects the delay computation node, and other nodes share the delay table with the delay computation node. The sender node defined the way to the receiver node and sent the collected route information to the delay computation node to confirm the route. The delay computation node confirms the intermediate delay table and responds that the route path has no delay in forwarding. While collecting the delay table, the node has a delay in forwarding the packet the message sends to the delaying node. The delayed node calls the delay rectification process to rectify the node that has congestion or buffer overflow or intruder and attacker.

4. Simulation Result

Simulation of proposed work for reducing the packet delay was simulated using the network simulator and the parameter defined in the TABLE II. The normal AODV protocol was taken for the simulation since it is on demand and does not require a predefined routing table. The total number of node are 200 numbers in the simulation area of 300.*300m, the simulation time is 150 seconds and the number of packets defined for the transmission is 10 to 50 Packets.

The delay computation algorithm is defined in the node and named as Delay computation node AODV protocol, which is compared with the on-demand AODV protocol. The three performance comparisons are packet delivery ratio, End-to-end delay and Throughput.

Table 3. Metric value used for simulation

Parameter	Value
Network simulator	NS 2.34
Protocol selected	AODV
Number of nodes	50,100,150,200
Simulation time	150 sec
Model of mobility	Random
Speed of node	0-25 m/s
Network area	300m * 300 m
Initial sending Data packets	10,20,30,40,50
Traffic	Constant Bit rate

4.1. Packet Delivery Ratio

The Packet Delivery Ratio is the ratio between the number of packets received from the sender and with number of packets sent, as shown in Equation 1,

PDR = (Total number of Data Packet Received /Total number of Data packets sent) * 100 (1)

Table 4. Packet delivery ratio

NODES	AODV	DCN-AODV
50	75	90
100	78	95
150	82	97
200	90	98

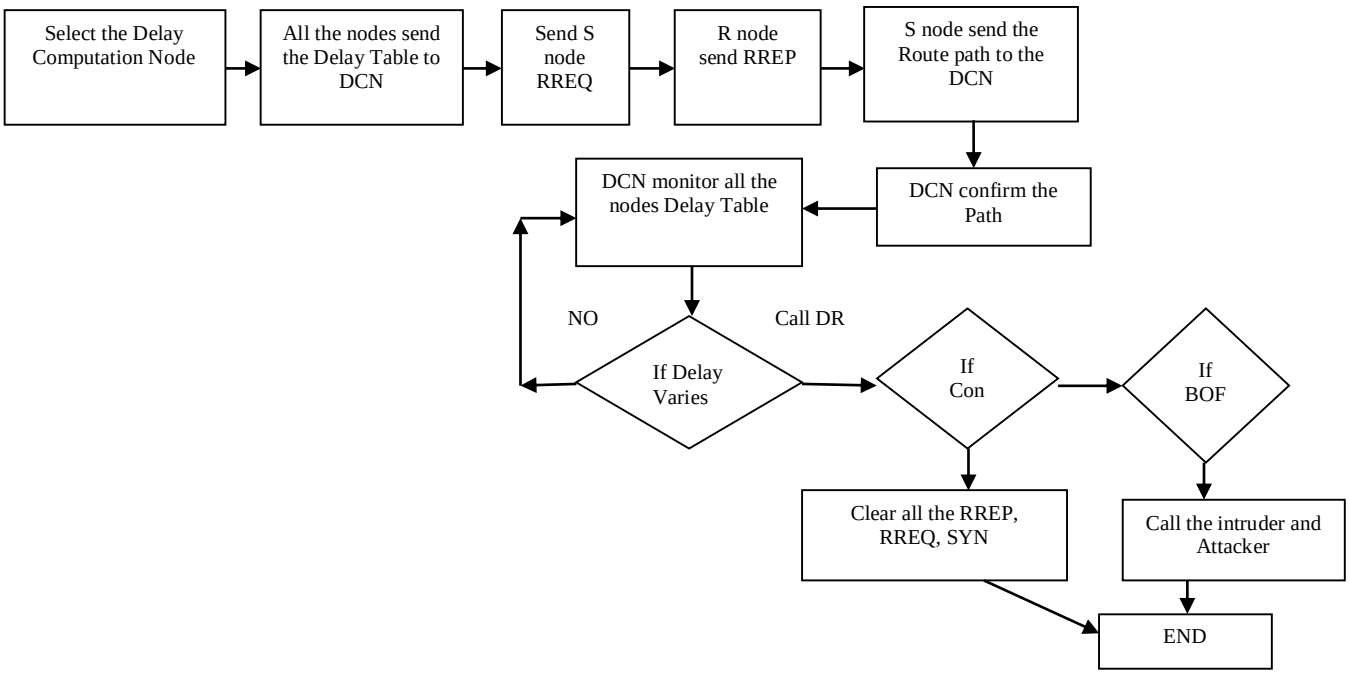

Fig. 4 Route selection based on forward time with classification technique

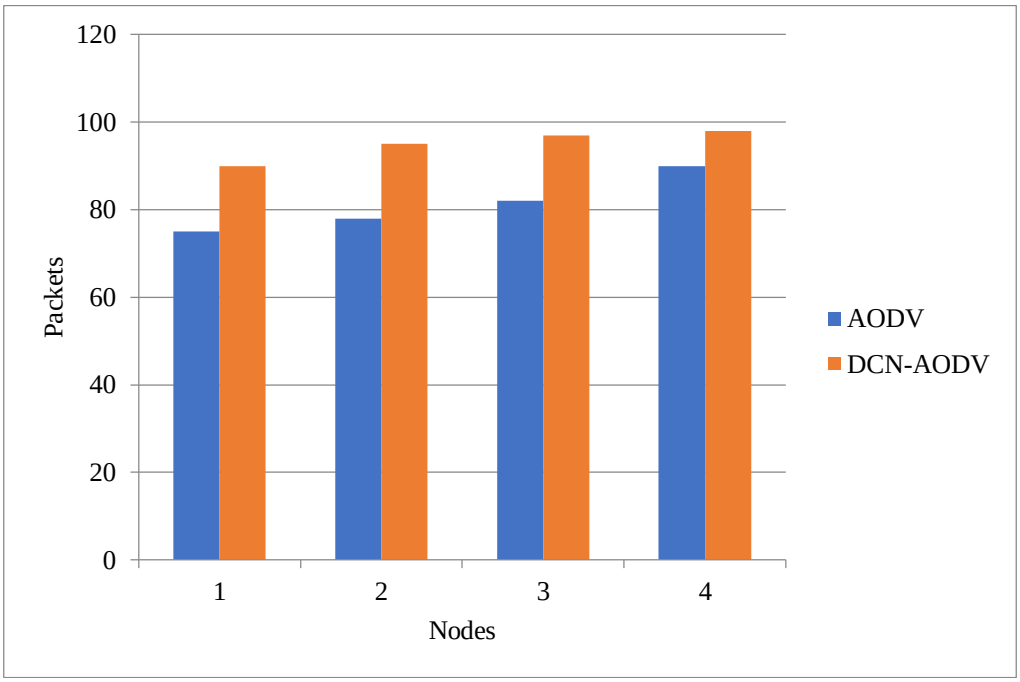

Fig. 5 Packet delivery ratio

Initially, the packets are sent with a value of 10, gradually increasing to 20, 30, 40, and 50. The dropped packets are displayed in the comparison table in TABLE IV and in Figure 5, where the suggested DCN-AODV model packet delivery ratio is high, ranging from 90% to 98%.

In contrast, standard AODV has a packet delivery ratio of 70% to 90%.

4.2. End to End Delay

Table 5. End to end delay

NODES	AODV	DCN-AODV
50	0.186	0.083
100	1.01	0.65
150	1.06	0.53
200	1.08	0.77

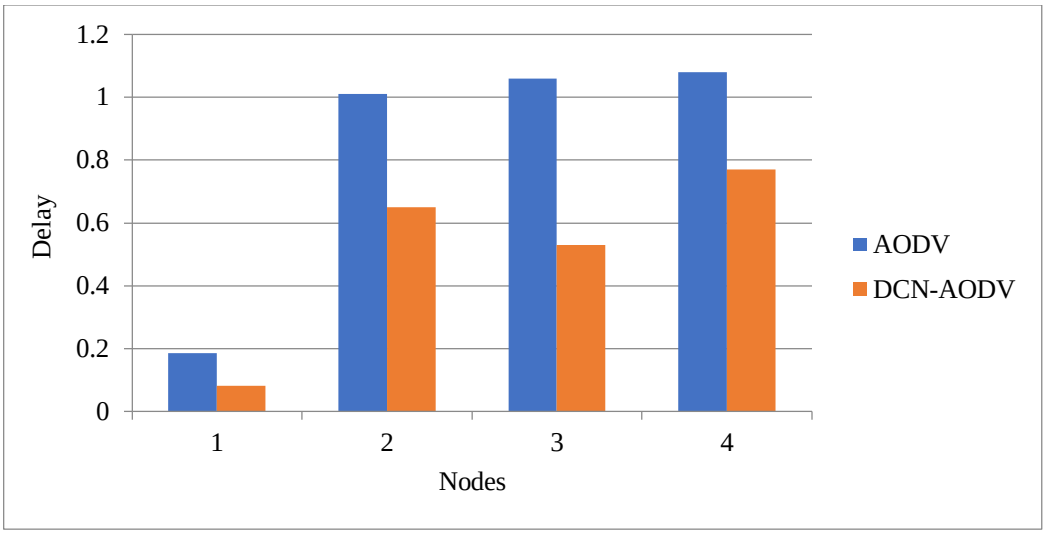

Fig. 6 End to end delay

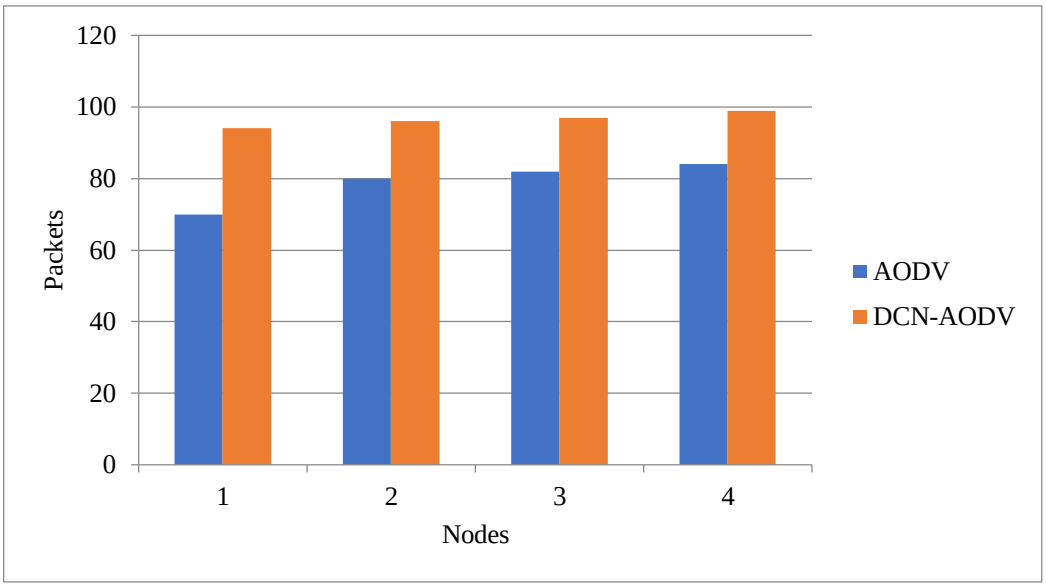

Fig. 7 Throughput

End-to-end latency is calculated as the time differences between packets transmitted from the source and packet arrival at the destination. The packet send delay from the sender side is 0ms. However, there is varying delay at the destination node, as shown in Table 5. The comparison chart in Figure 6 shows the comparison chart of delay between the traditional AODV and the proposed DCN-AODV model, where the proposed model delay is less, ranging from 0.083 to 0.77%, when compared to the existing routing protocol AODV delay of 0.186 to 1.08ms.

4.2. Throughput

Throughput is defined as the successful transmission of a packet from the sender to the receiver and is measured in bits per second (bps). The DCN-AODV protocol achieves 94 to 99% greater throughput than the existing routing protocol AODV, as shown in Table 6 and the comparison chart in Figure 7.

Table 6. Throughput

NODES	AODV	DCN-AODV
50	70	94
100	80	96
150	82	97
200	84	99

5. Conclusion

This article proposed a novel method to predict the packet delaying node and improve the End to End delay in the MANET communication by introducing the Delay calculation table and delay computation table incorporated with the

AODV protocol. The simulation was done by using the NS2.34, and the result was compared with AODV along the performance metric of packet delivery ratio, End-to-end delay and throughput which shows the proposed work produced PDR 90% to 98%. In contrast, standard AODV has a packet delivery ratio of 70% to 90%., 0.083 to 0.77%, when compared to the existing routing protocol AODV delay of 0.186 to 1.08ms and 94 to 99% greater throughput than the existing routing protocol AODV. In the feature, this work could be carried out with the table driven protocol to improve the delay in MANET communication.

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