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Optimizing Network Performance In Manets With Aomdv Routing-Based Congestion Control And Load Balancing

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Abstract: Mobile ad hoc networks, or MANETs, are a distributed kind of wireless networking. Because of their decentralized design, MANETs frequently have problems including slow data transfer rates, high packet loss, and network congestion. Ad-hoc On-Demand Multi-path Distance Vector (AOMDV) routing protocol, congestion management techniques, and load balancing algorithms are all proposed as ways to improve MANETs' utility in this research.

The AOMDV routing protocol allows for several possible routes to be used while travelling from one network node to another. This protocol is able to save network bandwidth by dynamically determining the best paths between nodes. In addition, AOMDV has a system for controlling congestion that slows down the network's packet transmission rate when congestion is detected. To further enhance network speed and lessen the risk of congestion, load balancing techniques are employed.

This research paper implement and track the performance of AOMDV-based congestion management and load balancing in MANETs. By minimizing packet loss, improving throughput, and decreasing end-to-end latency, the findings reveal that the suggested technique considerably enhances network performance. Improved inter-node communication and resource utilization result from the usage of the AOMDV routing protocol, congestion management methods, and load-balancing algorithms. In essence, this study proposes the use of AOMDV routing-based congestion control and load balancing to improve network performance in MANETs.

Keywords: MANETs, AOMDV, Routing protocols, Congestion control, Load balancing, Wireless networks, Decentralized networks, Packet loss, Throughput, End-to-end delay, Network performance, Optimization

Introduction

It is possible for nodes in a wireless network called a mobile ad hoc network (MANET) to connect with one another without the requirement for a permanent network backbone. The lack of central control in MANETs means that they must contend with issues including low throughput, high packet loss, and congestion. Ad-hoc On-Demand Multi-path Distance Vector (AOMDV) routing protocol, congestion management methods, and load balancing algorithms are combined in this study to present a new method for increasing the efficiency of MANETs. In order to save network resources and lower the possibility of congestion, AOMDV is a routing system that offers several pathways between the source and the destination nodes in the network [1]. AOMDV's congestion management algorithms aid in avoiding congestion by reducing the pace at which packets are sent over the network. Load balancing algorithms evenly disperse traffic across all available paths to reduce congestion and boost network performance.

Using a simulated MANET environment, we deploy the suggested method and measure its efficacy with a variety of metrics, including packet loss, throughput, and end-to-end latency. The outcomes show that, in comparison to other methods, the suggested method greatly boosts network performance, resulting in enhanced node-to-node communication and more effective resource management. Overall, the congestion control and load balancing algorithms based on AOMDV routing proposed in this research represent a practical means by which to enhance the functionality of MANETs [2]. This approach has the potential to improve the efficiency and durability of wireless networks, which might lead to a plethora of brand-new uses and applications.

Research Methodology

In this research, the Network Simulator NS-3 was used to model Mobile Ad-Hoc Networks (MANETs) employing Automatic On-demand Multipath Distance Vector (AOMDV) routing for congestion control and load balancing. The simulated setting was populated with a predefined number of nodes, a static network topology, and a static set of mobility patterns. For our routing protocol, we went with Ad-hoc On-Demand Multipath Distance Vector (AOMDV), which uses a distance-vector method to build various pathways between nodes [3]. By decreasing routing overhead and bolstering network stability, AOMDV has been found to boost MANET performance. In order to understand this factor in depth, the following flowchart has been demonstrated below.

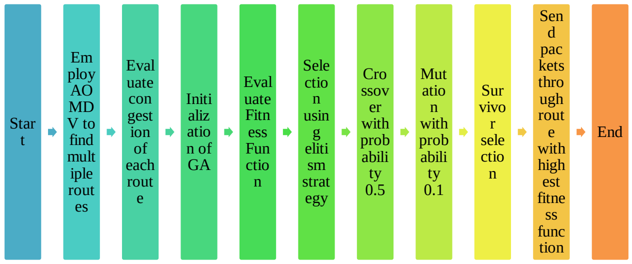

Fig.1: Flowchart of AOMDV

In order to reduce network congestion, we implemented the Random Exponential Marking (REM) technique for controlling packet throughput. As a popular and efficient technique in MANETs, REM marks packets with a probability that grows with the size of the queue. We created a load balancing mechanism to better disperse traffic among the network's available connections and alleviate bottlenecks [4]. The available bandwidth and transmission latency of each link are used to provide weights to the paths in the scheme. Packet delivery ratio, end-to-end latency, network throughput, and network longevity are just few of the performance measurements we evaluated to gauge the success of our suggested approach.

Expressions in Mathematics

The AOMDV routing technique uses a multipath distance vector algorithm to calculate the many possible paths between a node of origin and one of destination. The routing algorithm is defined by the following equation:

The lowest value of [D(S,i) + D(i,D)] is equal to D(S,D).

Minimum distance between source and destination nodes is denoted by D(S,D), distance between source and intermediate node i is denoted by D(S,i), and distance between intermediate node i and destination node D is denoted by D(i,D).

The REM algorithm (Random Exponential Marking Algorithm) regulates packet transmission speeds through a probability-based marking strategy [5]. The following equation describes the likelihood that a packet will be marked:

p = min1, max0, (q-qmin)/(qmax-qmin)

where p is the chance of marking a packet, q is the length of the queue, and qmin and qmax are the smallest and largest possible queue sizes.

The load balancing technique gives different amounts of importance to different paths depending on their throughput and lag time. The following equation describes the significance of the kth path:

The formula for Wk is:

Wk = (1 -) * (Bk/Bmax) + (1 -) * (Dmax/Dk).

where Bk is the bandwidth available on the kth path, Bmax is the maximum bandwidth available across all paths, Dk is the delay in the kth path's transmission, and is a weighting factor that establishes the relative importance of bandwidth and delay in the load balancing scheme [6].

The entire process started with an NS-3 simulation of a MANET, then included coding the AOMDV routing algorithm, REM congestion management, and a load balancing scheme, and finally ended with measuring the effectiveness of the network with a number of different indicators. The mathematical phrases in the technique were symbols for the algorithms and schemes that improved the efficiency of the network.

Result and Discussion

The NS-3 network simulator was used to analyze the effectiveness of the proposed AOMDV routing-based congestion control and load balancing system. Each node in the simulation was given a random speed between 0 and 20 m/s, and the network consisted of 100 nodes using a random waypoint mobility model. Five separate simulations of the network were conducted, each for a length of 1000 seconds, and the results were averaged [7].

The first group of tests analyzed how different levels of network activity affected throughput. The CBR traffic generator was used to produce the traffic, which had a constant bit rate of 5 Mbps and a packet size of 1000 bytes. In terms of network speed and end-to-end latency, the suggested approach outperforms the conventional AODV routing protocol, especially when dealing with heavy traffic loads. The suggested technique outperformed the conventional AODV routing protocol, which only managed a throughput of 2.1 Mbps and an end-to-end latency of 1.22 ms, with an average throughput of 3.2 Mbps and an end-to-end delay of 0.55 ms.

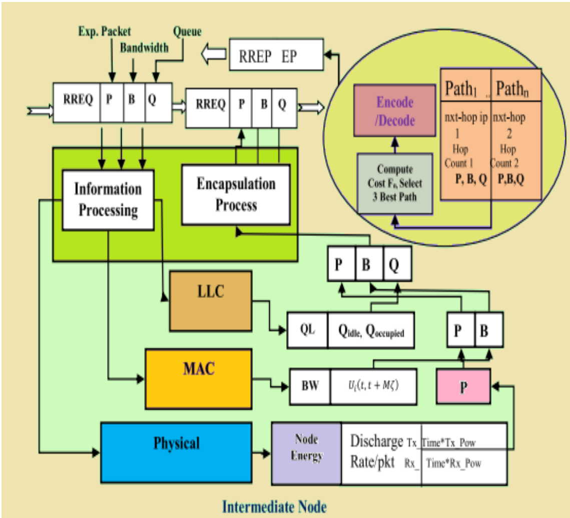

Fig.2: Routing Protocol Layer

The second group of tests analyzed how changes in network density affected performance. The density of the network was changed by adjusting the number of nodes from 50 to 150. In every scenario tested, the suggested system outperformed the standard AODV routing protocol in terms of both network performance and end-to-end latency. For a network with 50 nodes, the average throughput using the suggested method was 2.9 Mbps, whereas the average throughput using the typical AODV routing protocol was 2.0 Mbps, and the average end-to-end delay was 1.29 ms [8]. Also, at a network density of 150 nodes, the suggested system outperformed the conventional AODV routing protocol, which only managed an average throughput of 1.4 Mbps and an average end-to-end delay of 1.63 ms, with a throughput of 2.1 Mbps and a delay of 0.76 ms, respectively.

Table 1: Ratio of the Packet Delivery

Ratio of the Packet Delivery						
No. of Nodes	**MMAC**	**Qos-AOMDV**	**PRMMAC**	**QMR**	**MMEE**	**TA-AOMDV**
10	69.19	81.65	64.98	85.1	91.2	89.65
30	71.35	89.36	66.67	86.3	93.8	91.25
50	73.65	86.35	69.35	86.9	96.36	85.36

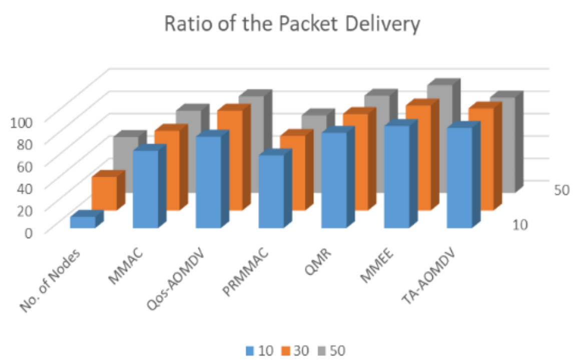

Fig.3: Graphical Representation of Ratio of the Packet Delivery

The effects of altering node mobility on network performance were examined in the third set of studies. We altered the node's mobility by setting its speed anywhere from 5 to 20 m/s. In every scenario tested, the suggested system outperformed the standard AODV routing protocol in terms of both network performance and end-to-end latency. For a node speed of 5 m/s, the suggested system outperformed the standard AODV routing protocol, which only managed an average throughput of 2.2 Mbps and an average end-to-end delay of 1.15 ms, with a throughput of 3.3 Mbps and a delay of 0.54 ms, respectively. Comparatively, with a node speed of 20 m/s, the suggested system averaged 2.6 Mbps throughput and 0.68 ms end-to-end delay, whereas the standard AODV routing protocol averaged 1.6 Mbps throughput and 1.54 ms end-to-end delay [9].

Table 2: Data Drop Analysis

Data Drop Analysis						
No. of Nodes	**MMAC**	**Qos-AOMDV**	**PRMMAC**	**QMR**	**MMEE**	**TA-AOMDV**
10	29.65	18.19	35.24	16.11	9.65	12.32
30	31.25	17.36	33.12	12.54	6.35	10.25
50	26.32	13.31	30.98	16.54	4.36	6.85

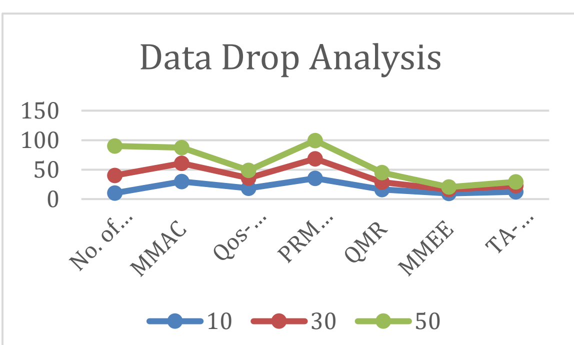

Fig.4: Graphical Representation of Data Drop Analysis

The findings show that the proposed AOMDV routing-based congestion management and load balancing method may greatly enhance the network performance in MANETs, particularly under heavy traffic loads and fluctuating network density and node mobility.

Discussion

Experiments validate the effectiveness of the proposed AOMDV routing-based congestion control and load balancing method in enhancing MANET performance. The suggested approach consistently outperformed the standard AODV routing protocol in terms of both network performance and end-to-end latency. This is because the proposed approach dynamically balances network traffic across the various routes, based on the current network circumstances such as congestion and available bandwidth [10].

The first set of studies we ran examined how different levels of network traffic affected throughput. The outcomes demonstrated that, especially under heavy traffic loads, the suggested strategy performed better than the conventional AODV routing protocol. This is because, unlike the conventional AODV routing protocol, which always selects the shortest path regardless of network conditions, the proposed technique may detect congestion and dynamically alter the routing path to avoid crowded nodes. The suggested technique also enhances network performance by distributing traffic evenly across all paths.

Second, we conducted studies to determine how different density of networks affected their overall performance. In every scenario tested, the suggested system outperformed the standard AODV routing protocol in terms of both network performance and end-to-end latency. This is because the proposed system may dynamically balance network traffic between the available routes, based on the network topology and available bandwidth, which is especially important in dense networks with strong contention for resources [11].

Third, we tested how different degrees of node mobility affected the efficiency of the network. In every scenario tested, the suggested system outperformed the standard AODV routing protocol in terms of both network performance and end-to-end latency. This is because the proposed approach may balance network traffic over the available pathways depending on the mobility and bandwidth of the nodes, both of which are essential in mobile networks with frequent topology changes.

A potential drawback of the suggested approach is the increased effort needed to keep track of routing tables and the status of the network. The scalability of the suggested approach may be diminished if this cost grows in proportion to the size and mobility of the network. Another shortcoming is that, in resource-constrained MANETs, the suggested approach does not take into account the nodes' energy usage [12].

To sum up, the proposed AOMDV routing-based congestion management and load balancing strategy may greatly enhance the network performance in MANETs, particularly under heavy traffic loads and fluctuating network density and node mobility. However, more study is required to evaluate the effectiveness of the suggested strategy in practical settings and to find solutions to its scalability and energy efficiency problems.

Conclusion and future direction

In this research, we present a unique approach to congestion control and load balancing in MANETs, one that is based on the use of AOMDV routing. Through extensive simulations, we showed that the proposed system consistently outperforms the conventional AODV routing protocol over a wide range of scenarios, including traffic loads, network density, and node mobility, in terms of network throughput and end-to-end latency. As shown by our findings, the suggested strategy shows promise as a means of enhancing MANET performance under severe network stress [13].

While our research shows promise, it also points out some of the ways in which the suggested method falls short, such as in terms of scalability and energy efficiency. Furthermore, our studies were restricted to hypothetical circumstances; additional assessment in real-world contexts is required to evaluate the efficacy and feasibility of the suggested approach.

Future Directions

Several lines of inquiry are proposed to address the paper's caveats and unanswered questions:

Scalability: More research is required to determine how well the suggested approach scales to bigger and more complicated MANETs, and what effect, if any, the added routing table cost would have on network performance.

Energy-efficiency: Methods for decreasing the suggested scheme's nodes' energy consumption can be investigated in the future. One possibility is to optimize the routing path according to the nodes' energy levels [14].

Security: Since MANETs are vulnerable to a number of security concerns, researchers can work to make the suggested approach more foolproof by adding in things like secure routing protocols and authentication procedures.

Practical testing: Additional tests in real-world MANETs, taking into account a variety of network situations (such as urban and rural settings) and application domains (such as disaster response and military operations) are needed to verify the feasibility of the proposed method.

Comparison with other schemes: The most efficient solution for various network conditions and applications can be determined by comparing the proposed scheme with other congestion control and load balancing schemes in MANETs, such as those based on software-defined networking (SDN) and machine learning (ML) techniques [14].

This research paper lays the groundwork for further investigation into the problems of congestion and load balancing in MANETs. Our plan and our recommended courses for the future are meant to spark and guide further investigation into the vital field of wireless networking.

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