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Light Load Path Selection Techniques for Control Congestion in MANET (ENBA)

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Abstract— *The nodes have limited bandwidth and processing capability. The routing protocols cannot handle the congestion due to heavy load in mobile ad hoc networks. Several routes are established in the network, and some intermediate nodes are common. The dynamic behaviour of the network creates problems for strong link establishment. The routing protocol establishes the connection between the sender and receiver. The efficient routing approach uses the concept of load balancing to reduce packet loss in a network. The heavy load on the network affects the node's buffer capacity and link capacity. The research proposed the Effective Network Behavior Analyze (ENBA) for route sections to control congestion in MANET. This paper's effort is driven by the idea of considering several aspects of the routing design of Mobile Ad hoc Networks (MANETs) in a unified manner. ENBA is a routing strategy that uses the shortest path for routing and balances the load by managing incoming and outgoing packets on links and nodes. In this routing scheme, the shortest path measures the buffer capacity of the nodes with higher TTL values selected for sending the data packets in the network.*

The link capacity is based on the flow of packets in the network. Queue optimisation is a continuous optimisation in which we count the number of packets incoming and decide the link reliability in a dynamic network. The performance of ENBA is compared with the Ad hoc On-demand Multipath Distance Vector - Modified (AOMDV-M) routing protocol. The ENDA strategy outperforms the competition in terms of performance over a shorter period. In the proposed technique, performance matrices like PDR, overhead, and delay provide better results than the previous AOMDV-M routing approach.

Keywords:- AODV-M, ENBA, Congestion, Load, MANET, TTL, AOMDV

I. INTRODUCTION

Mobile Ad-hoc Networks Mobile (MANETs) are incredibly appealing for cutting-edge applications. There are numerous problems and challenges in coming up with a MANET network. At the transport layer, end-systems will gather info regarding every used path: congestion state, capability, and latency. This info will then react to congestion events within the network by moving the traffic away from engorged methods [12]. Mobile Ad-hoc Networks (MANETs) are offensively beautiful components for up-to-date applications. There are many problems and challenges in coming up with a MANET network. Congestion is one of the live challenges in MANET because of the active topology structure and node amendment each second on its position. In MANET, if a sender node needs to send knowledge to the thus specific receiver, it must transmit an initial broadcast routing packet onto the network and obtain the destination through the shortest path (if we use AODV) or minimum intermediate hop (if we use DSR). Various scientists' works filed for a step-down of congestion from the network. During this outline, we tend to focus on congestion step-down minimisation multi-path routing in ad-hoc networks and the Transport layer base congestion management or rate analysis base congestion management in MANET. In the multi-path technique, the sender sends info through more than one path to the receiver node, which will increase the performance of the network unit management. The one shared path congestion means that we have bent on analysing the info rate of the sender if the sender rate is larger than the receiver node. Thus, we bent on reducing the exploit rate based on the transport layer technique. The method of discovering multiple routes among the distinct providers and a single destination at the time of single route discovery corresponds to multi-path routing [12]. In MANET, the prevailing problems like quantification ability, security, and network period, will be handled by the multi-path routing protocols [13]. This protocol enhances end-to-end turnout and offers load reconciliation in MANETs.

II. LITERATURE SURVEY

This section describes related research in the field of congestion control and reliable route discovery with different methods. These works are unique, which helps to develop a new module for congestion control in MANET. Gagandeep Singh et al. [1] "Effective Congestion Control in MANET" This title presents the updated approach to Ad-hoc On-Demand Multipath Distance Vector Routing in MANET for congestion management. In the suggested solution, the source selects a better neighbour node from several neighbours with enough queue size to participate in the routing process. In addition to efficiently monitoring congestion, the congested node initiates a warning message to the source of the route reply queue. Compared with the current research, the proposed solution offers a better quality of service (QoS). Dimitris Kanellopoulos [2] “Congestion control for MANETs: An overview” This title discusses TCP enhancements for wireless links. It analyses design challenges for an enhanced transport protocol and presents congestion control schemes for MANETs. In a MANET, there is no need to deploy any infrastructure to allow nodes to communicate with each other. MANETs have unique characteristics that complicate congestion control. The standard TCP congestion control mechanism cannot handle the unique properties of a shared wireless multi-hop channel well. The frequent changes in the network topology and the shared nature of the wireless channel pose significant challenges. Geetika Maheshwari et al. [3] “A Survey on Congestion Control in MANET” In this title, we overview existing methods. This title aims to discuss and compare different proposed congestion control mechanisms. A mobile ad hoc network is a type of ad hoc network that can change locations and configure itself on the fly. MANETs use wireless connections to connect various networks. There are several issues and challenges in mobile ad hoc networks.

Congestion control is a challenging task in mobile ad hoc networks. Congestion occurs when the demand is greater than the available resources. Different mechanisms have been proposed to overcome the congestion in the mobile ad hoc network. Congestion control mechanisms control congestion either before or after it has occurred. Shaik Arshiya Anjum et al. [4] “Congestion Avoidance Methods Using Caching Information Techniques in IoT and Manets” This title reviews different techniques used for congestion control in the MANET. It can cause congestion that results in increasing transmission delay and packet loss. This problem is more severe in more extensive networks with more traffic and high mobility that enforces dynamic topology. To resolve these issues, they propose a bandwidth-aware routing scheme (BARS) that can avoid congestion by monitoring residual bandwidth capacity in network paths and available space in queues to cache the information. The amount of available and consumed bandwidth and residual cache must be worked out before transmitting messages. The BARS utilise the feedback mechanism to intimate the traffic source for adjusting the data rate according to the availability of bandwidth and queue in the routing path. S.Sheeja et al. [5] “Effective Congestion Avoidance Scheme for Mobile Ad Hoc Networks” In this research work, we proposed to develop the Effective Congestion Avoidance Scheme (ECAS), which consists of congestion monitoring, effective route establishment, and congestion-less based routing. The overall congestion status is measured through congestion monitoring. In establishing the particular channel, we propose the contention metric in terms of queue length of the packet, overall congestion standard, packet loss rate, and packet dropping ratio to monitor the congestion status. Based on the congestion standard, congestion-less-based routing is established to reduce packet loss, high overhead, and long delays in the network. Harsh Pratap Singh et al. [6] “Congestion Control in Mobile Ad Hoc Networks: A Literature Survey” Congestion is a severe problem in mobile ad hoc networks. In such a network, every node behaves as the router and can convey the packet from correspondent to respondent. Because of the limited capacity of the bandwidth, every node may transmit the packet at the same time. Due to this, congestion arises, which incurs long delays and high packet loss, degrading the network’s performance. This network has a dynamic topology and has shared behaviour; it automatically forms the network temporarily, which helps in transmission efficiency. To overcome these difficulties, many approaches have been suggested earlier. This title presents an overview of the existing approaches and discusses the differences between these congestion control techniques. Khalid A. Alattas [7] “A Novel Method for Avoiding Congestion in a Mobile Ad Hoc Network for Maintaining Service Quality in a Network” In this title, under the mobile ad-hoc network system, the main reason for causing congestion is the limited availability of resources. On the other hand, the standardised TCP-based congestion control mechanism cannot control and handle the significant properties associated with the shared system of wireless channels. It affects the design associated with suitable protocols and protocol stacks through the process of determining the mechanisms of congestion on a complete basis. Moreover, compared with standard TCP systems, the primary environment associated with mobile ad hoc networks is regarded to be more problematic on a complete basis. On the other hand, an agent-based mobile technique for congestion is designed and developed to avoid any congestion mode within the ad-hoc network systems. Shanthini [8] “Red Congestion Control with Energy Aware Auction Based Route Selection in MANET” Congestion is a massive issue in mobile ad hoc networks. MANET has various congestion control algorithms to solve this issue. The RED algorithm is one of the congestion control algorithms. It increases the queue’s buffer space, reduces packet loss, and controls transmission delay. The proposed technique first refined the energy-aware auction-based route selection and then used the red algorithm to control the congestion. Veguru Gayatri [9] “A Study on Congestion Control in

Mobile Ad-Hoc Networks" In this title, we consider the problem of congestion control in mobile ad-hoc networks (MANETs). TCP does not work correctly for the different structures with the specific effects occurring in MANETs. This is because TCP was initially designed for the Internet, a network with different properties. Because of this, many people think that MANETs' most significant problem is how to keep traffic from getting too bad. S.TamilSelvi, et.al.[10] "A Novel Scheme for Congestion Control in Mobile Ad Hoc Networks" In this work, we developed an Energy Efficient Scheme for Congestion Control (EESCC) to improve the energy efficiency of the nodes. Multi-path routing is needed to control congestion. Retransmission of packets is minimised by calculating the data energy level and acknowledgement packets. With the help of extensive simulation, this scheme provides minimum energy consumption, a high packet delivery ratio, and low delay. Remya A et al. [11] "A Review on Congestion Control Methods in Mobile Ad-hoc Networks" This title reviews different congestion control techniques in the MANET. MANET (Mobile Ad hoc Network) is a type of ad hoc network consisting of mobile devices as the nodes in the network. There will not be any centralised infrastructure. It has many features like multi-hop communication and dynamic topology. But it has limited resources and limited security. The limitations in resources may cause congestion in the network.

III. EFFECTIVE NETWORK BEHAVIOR ANALYSIS FOR THE ENBA

There is a limit to the channel bandwidth available on the networks, and it takes multiple hops to exchange information with any other node on the network. It is also possible that packets travelling across wireless lines will be affected by radio interference from surrounding nodes. Managing topological change caused by node mobility and limited battery power must be done so that link break periods do not become excessively prolonged. Congestion is one of the most common causes of link failure. The increased load placed on the nodes causes a buffer overflow, resulting in the packets being discarded due to the overflow. Due to this, the MANET protocol has packet delays and harms the packet delivery ratio. Load balancing is a technique for preventing congestion in a computer network. Because a balanced load makes efficient use of the network, packet latency and packet delivery ratio are reduced, and the network's overall efficiency is improved. The existing protocols give us various paths but cannot avoid congestion and provide load balancing because of their design. After presenting numerous routes to a destination, DSR-PM selects a single route with a low hop count while discarding routes with a higher hop count. In the event of a link failure, these routes could be used as backup routes. The load must be moved to these pathways to maximise the network's use.

This research proposed an Effective Network Behavior Analyse for route selection to control congestion (ENBA) approach for load balancing and rate base congestion control in a MANET environment that ensures reliable and efficient communication while also being cost-effective. The network implements the rate control and route selection routing algorithm through the DSR protocol described below. Following a route discovery procedure, the ENBA routing system establishes a multi-path between the sender and the recipient. The sender uses these various channels to convey data to the recipient, which helps keep the network's load balanced. Now, anytime a sender wishes to transfer data, it employs numerous paths, and at each step, it measures the end-to-end latency and the standard time (without congestion) acknowledgement delays difference, which it then stores in memory.

As a result, we create the second scenario, in which many senders and receivers share a single mobile node, causing unavoidable congestion in the network. In this scenario, each sender compares the new acknowledgement delay difference with the previous acknowledgement delay difference. The number of nodes participating in routing has sufficient energy for forwarding or sending data packets in the network. Here now, three routes are available, and which route select routing depends on the less acknowledgement (ACK) delay and light load, but the minor hop count on the same ranking is preferred first. This bandwidth estimation technique is achieved using the acknowledgement delay difference. Another strategy for congestion control is the use of dynamic queue management techniques. In this technique, a dynamic queue is implemented at each network node to reduce congestion caused by queue overflows as much as possible. By utilising these techniques as a foundation, we may reduce congestion, raise the percentage of receiving data in the network, and decrease the average end-to-end delay in general.

Congestion occurs in MANETs that have a limited number of resources. Interference and fading are experienced during packet transmission in these networks because of the shared wireless channel and dynamic topology. Congestion results in packet victims and bandwidth degradation; as a result, time and energy are wasted while recovering from it. When using a congestion-aware protocol, it is possible to avoid congested areas by bypassing the affected links. Congestion-related problems such as severe throughput degradation and massive fairness issues have been identified, among other things. These issues arise at the MAC, protocol routing, and transport layers, among other levels of the protocol stack.

There is a clear explanation of how the proposed load balancing scheme operates within the proposed algorithm. In this paper, the first sender has established the route to the receiver based on the standard AOMDV protocol described below. It means that more than one path is established between the sender and receiver and that the data is delivered through the shortest path selected at any given time. The link expiration time (TTL) value and the nodes' buffering capacity are now fixed. As soon as the sender fails to deliver the data within a specified time frame, the AOMDV will provide an alternative path equal to or less reliable than the current path, whichever is greater. Therefore, increasing the TTL value eliminates the possibility of a link failure due to a time limit. The concept of queue length variation is introduced to control the possibility of congestion and the link expiration time limit when the load on any link or node increases. The variable queue length scheme increases nodes' storing and forwarding capacity in the network and the processing speed of those nodes. The combination of these two different methods improves the performance of AOMDV routing while also ensuring proper load balancing in the network environment.

IV. ENBA ALGORITHM AND SIMULATION PARAMETERS

4.1 ENBA Algorithm

(1) S = sender //sender nodes
(2) R = Receiver/ Receiver nodes
(3) M = Mobile Node's
(4) AOMDV// Multipath routing protocol
(5) B_RREQ// Broadcast Route request
(6) Time to Live (TTL_START) initial= 5 //time to live 5 ms
(7) THRESHOLD in TTL; //Set for handle load on nodes or links
(8) Consider Increment by 2 // after estimate queue length
{If (S B_RREQ &&R found)&& (Selected _Routes => 1) //means alternative route exist in network
{
If (next-hop!=R)
Continue to flood the RREQ packets for search the receiver;
Else
{ Receiver found;
Establish multiple routes;
Start data sending after receiving successful RREP;
}
Else
Route Error (RERR)
}
If (start == Data send (S, R, data)&&If (Q_Limit == Full)) // sending case drop minimization and queue length estimation
{
The sender starts sending data through the selected path;
Continuously check the load on each node;
Queue size of Intermediate (I) nodes; //variate Q scheme at intermediate node
increment queue by 2;
Store incoming data;
Rreceives data from I node; }
If (TTL value ==5) // The Queue length full condition
Increment the threshold value by 2;
Else
Continue sending of data and use alternative path for failure old route;
}}

According to the AOMDV protocol, each RREQ and RREP arriving at a node has the potential to define an alternate path to either the source or target. Accepting all of these copies will result in routing loops in the network. The TTL provide the extra time to handle the load in the network. The "advertised hop-count" is introduced to eliminate the possibility of loops occurring in the network. In the case of a node advertising a hop count for a destination, the advertised hop count represents the maximum hop count of all the multiple destination paths available at the intermediate node. Alternatively, the protocol only accepts routed traffic with a hop count lower than the advertised hop count. Alternative routes with a higher or the exact hop count are discarded in favour of the original route. The advertised hop-count mechanism establishes multiple loop-free paths at each node, allowing for a more efficient network. These paths still need to be separated from one another. This is used at the intermediate nodes in the AOMDV network. It is not immediately removed from the system if there are duplicate copies of an RREQ. A node-disjoint path to the source is determined for each packet by examining the packet's header.

For node-disjoint paths to be valid, all RREQs must arrive at the source via different neighbours from the source. We can verify this is the case using the first-hop field in the RREQ packet and the first-hop list for the RREQ packets at the node. A slightly different approach is taken at the destination, and the paths determined there are link-disjoint rather than node-disjoint in character. To accomplish the destination responds with up to k copies of the RREQ, regardless of the number of hops between it and the source. The only requirement is that the RREQs arrive via unique neighbours.

4.2 Simulation Parameters

The NS instructions can specify a network's topology structure and the nodes' motion mode and configure the service provider and recipient, among other things. Simulation parameters to make the scenario of AOMDV-V and ENDA are mentioned in Table 1. The detailed simulation model is based on network simulator-2 (ver-2.31), which is used in the evaluation.

Parameters	Configuration Value
Simulation Tool	NS-2.31
Routing Protocol	AOMDV-M, ENBA
Simulation Area	1000m*1000m
Network Type	MANET
Number of Nodes	100
Physical Medium	Wireless, 802.11
Simulation Time (Sec)	550Sec
MAC Layer	802.11
Antenna Model	Omni Antenna
Traffic Type	CBR, FTP
Propagation radio model	Two ray ground
Energy (Initial)/J	Random

V. SIMULATION RESULT

5.1 PDR Analysis

The Packet Delivery Ratio (PDR) is the number of packets received to the number of packets sent in a specific period in a network. This performance metric is critical for determining the percentage of packets received successfully in a network.

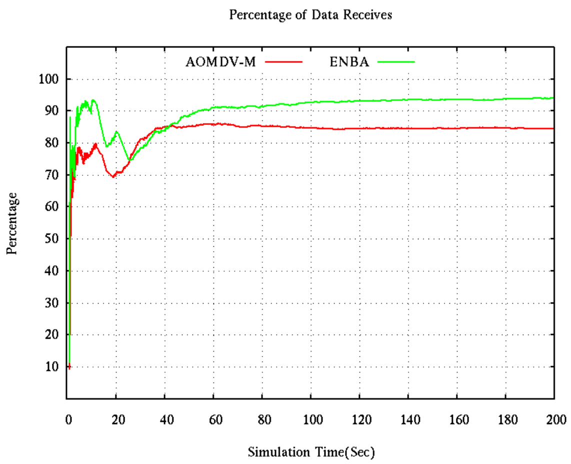

Figure 1: PDR Performance Analysis

The performance of the proposed ENBA routing protocol is shown to be superior to that of the previous AOMDV-M routing protocol in this graph. Here, the packet delivery ratio of AOMDV-M is approximately 85%in 20m/s nodes velocity, whereas the PDR value is approximately 94% in the case of the proposed ENBA method in 100m/s node velocity. The packet transmission differences between the previous and proposed schemes are nearly identical, but the receiving differences between the previous and proposed schemes are more significant because the PDR arises and shows better performance.

5.2 Throughput Analysis

Throughput represents the number of packets transmitted and received at a time. In this graph, the throughput of AODV-M is lowered than the throughput of the proposed ENBA protocol. The ENBA technique utilises the node's buffer capacity, which improves link quality to balance the network load. The queue optimisation improved the performance of the routing protocol with a higher TTL value. The throughput of the AOMDV-M routing protocol is 2400 kbps, showing degradation in all scenarios, but the throughput of the proposed ENBA routing protocol is about 2800 Kbps, continuously showing enhancement until the end of the experiment. The previous routing method provides an alternative path, but the load distribution does not occur, resulting in a reduction in routing efficiency. On the other hand, the proposed method ensures that the load distribution occurs appropriately, increasing the network's efficiency.

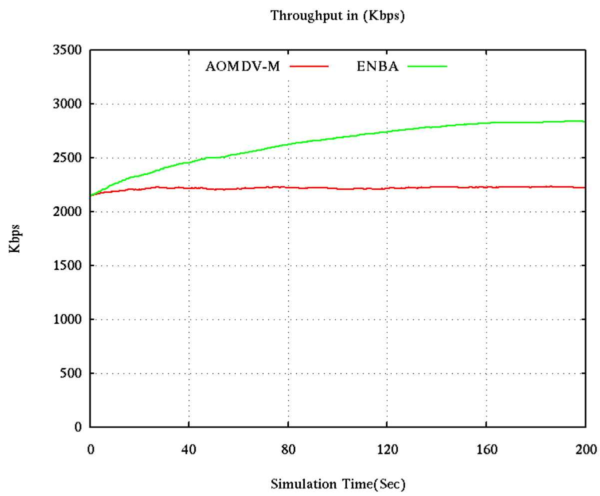

Figure 2: Throughput Analysis

5.3 Normal Routing Load Analysis

The routing load is described in terms of the number of packets delivered in the network to establish a connection with the receiver (or the destination). Hello, packets are often referred to as routing packets or overhead packets. In this graph, the routing load in the case of the proposed scheme is lower than the routing load in the prior scheme, and the lower value of the routing load improves the network's performance. In this scenario, the proposed system delivers around 0.4overhead means fewer routing packets in the network, whereas the old scheme overhead is about1 in the network. The routing performance of the ENBA protocol gives better performance than others.

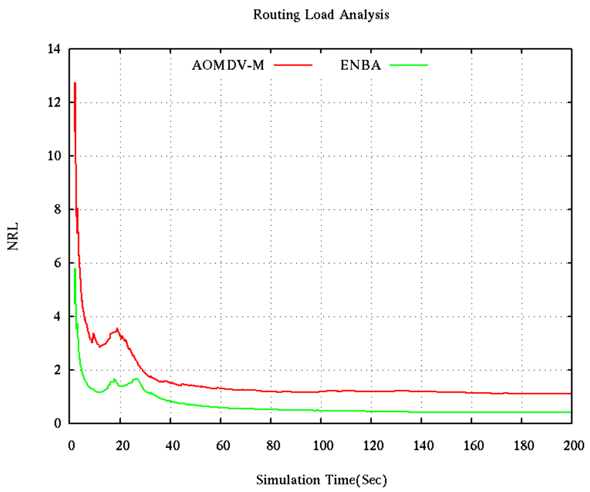

Figure 3: Routing Load Analysis

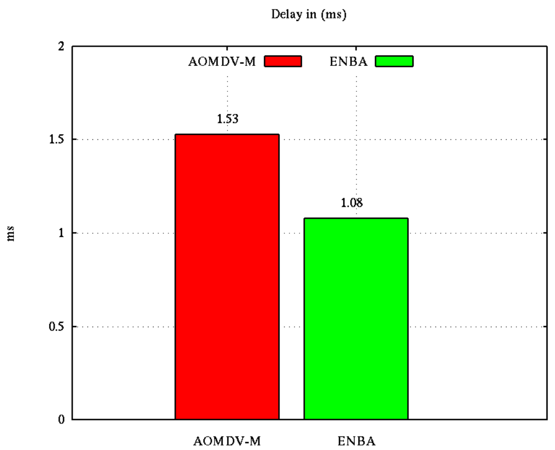

Figure 4: Delay Performance Analysis

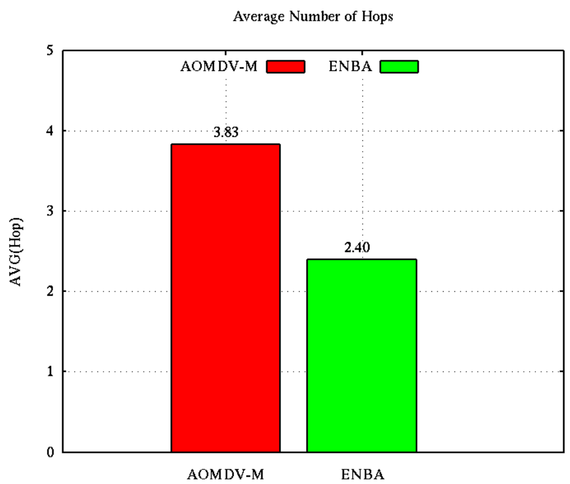

Figure 5: Hop Count Analysis

5.4 Delay Analysis

The delay is directly related to the poor performance of routing—the delay in the network measured in milliseconds (ms). The more delay in the network shows degradation in the performance of protocols. It is the extra time required for received the data successfully at the destination. This graph measured the delay performance of previous AOMDV-M and ENBA in different node density scenarios. The load and queue optimisation in the proposed ENBA protocol has been determined to evaluate its performance. Although in the previous scheme, the load distribution is not balanced, this does not necessarily indicate whether the load on the system is manageable or not. In this case, fewer packets are received compared to the previous scheme and show a higher delay in the network. However, the proposed scheme balances load with the proper distribution.

5.5 Hop Count Analysis

In a normal routine, the least number of hops possible is selected for data transmission between the sender and receiver. The shortest route selection means a minor hop count and more traffic on the route. The hop count analysis of the previous AOMDV-M and ENBA is mentioned in this graph. The average hop count analysis of AOMDV-M is about 4, and of ENBA is 2.5. The difference of 1.5 hop counts means that the network can provide better reception of packets after modifying the route selection with the minimum hop count.

5.6 Overall Analysis

The complete analysis of previous AOMDV-M and ENBA is mentioned in table 2. In the given analysis, the performance parameters show the AOMDV-M and ENBA approach performance in MANET. The performance of ENBA is better than that of AOMDV-M and shows improvement in all parameters. The ENBA approach shows a 10% improvement in PDR, about 5000 packets more received, reducing delay and overhead in the network.

Table 2 Summarized Performance Analysis

Parameters	**AOMDV-M**	**ENBA (Proposed)**
Total Data Sends	28392	31319
Total Data Receives	24015	29470
Percentage of Data Receives	84.58	94.1
Average Delay (ms)	1.53	1.08
Average Hop Count	3.83	2.4
Average NRL	1.1	0.41

VI. CONCLUSION AND FUTURE WORK

Several routes are established in the network, and some intermediate nodes are common. The MANET is a group of mobile hosts outfitted with wireless communication devices to communicate with one another. The primary characteristic of MANET is that it operates without the assistance of a central coordinator. Rapidly deployable, self-configuring, and extensible multi-hop radio communication, frequent connection breaking owing to mobile nodes, resource constraints (bandwidth, processing power, battery lifetime), and all nodes are movable means that the topology might be highly volatile. The higher TTL value gives sufficient time to handle the link load. In this work, we proposed the Effective Network Behavior Analyze (ENBA) to balance the load and control the congestion. The heavy load in the network affects the nodes' buffer capacity and link capacity. So that the routing protocol in MANET can achieve the primary challenges of being fully distributed, adaptable to frequent topology changes, and scalable, among other things, to achieve better performance. The most efficient use of available resources like bandwidth and node processing capability is simple computation and maintenance, an optimal and loop-free route.

The performance of previous AOMDV-M shows better results, but the utilisation of resources is poor. The proposed ENBA shows the performance improvement and efficiently utilises the resources with the help of TTL. The PDR shows an improvement of 10%, and the throughput shows an improvement of 400Kbps (minimum). The delay and overhead performance show better results in the ENBA protocol. The performance of ENBA is better compared to AOMDV-M in all performance metrics. Congestion problems are crucial in wireless networks because bandwidth enhancement is impossible. Many factors affect the performance of the network. The low data rate is one of the significant constraints in the network. In the future, we proposed the high data rate technology 6G and compared the performance with the current approach.

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