ENHANCING LINK STABILITY OF MULTICAST ROUTING PROTOCOL (ELSMRP) IN WIRELESS MESH NETWORKS

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ABSTRACT
The objective of this work is to increase the lifetime of the route and to reduce the need for route maintenance. Therefore in this paper, an algorithm titled "Enhancing Link Stability of Multicast Routing Protocol (ELSMRP) in Wireless Mesh Networks", based on On-demand Multicast Routing Protocol (ODMRP) is proposed. . The proposed method modifies the route discovery process and data packets multicasting in original ODMRP to discover the most stable route against route failure and movement of mobility node. Simulation results show that the proposed system improves the lifetime and reduces the routing overhead using ns2.

KEYWORDS: *Wireless Mesh Network, Link Stability, Multicast Routing Protocol.*

I. INTRODUCTION

Mobile Ad-hoc Networks are dynamic networks which are totally independent from fixed infrastructure. Such types of networks are self-created; self-organized; highly dynamic and capable to reconfigure. These networks are distinguished by other networks due to many of their constraints like low channel bandwidth; high node mobility and limited battery power. The tasks of mobile nodes include generation of flows; receive flows from other nodes and forward flows to other nodes. In any mobile ad-hoc network, the communication range of mobile devices connected to the network is the main restriction. The mobile nodes which are in direct communication range can communicate immediately; otherwise they need to depend on intermediate nodes to forward flows.

Multicast routing is used in group-oriented video streaming data transmission, but there should be a strong routing protocol that can discover, sustain and reconfigure links in a network whose topology changes dynamically due to mobility of nodes.

Major challenges to WMNs are embedding Quality of Services (QoS), prevention of attacks, reducing energy consumption; incorporating fault-tolerance and delay of nodes in the network. The main intention of this paper is to improve QoS by improving route stability through selection of links that are likely to be more stable (i.e.) do not break frequently owing to node mobility. Mesh networks may involve in fixed or mobile devices. The solutions are as diverse as communication needs, for example in difficult environments such as emergency situations, tunnels, oil rigs, battlefield surveillance, high-speed mobile-video applications on board public transport or real-time racing-car telemetry.

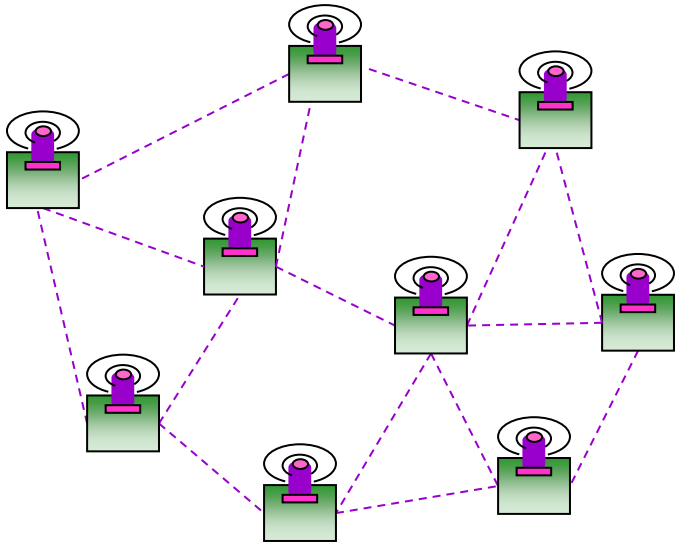

Figure 1: Wireless Mesh Network

The objective is to determine a stable link from available links for a reliable route in a multicast routing protocol. In existing schemes, route was established on the basis of minimum hop count without any consideration of link quality. The link that is likely to be disconnected soon could be part of the route. Therefore the link is not in good quality as network connection is disrupted at short interval(s). Limited bandwidth, resource constraints and dynamic topology necessitates development of a simple; scalable; robust and energy efficient routing protocol for multicast environment.
The rest of this paper is organized as follows. The section II described the related works. In Section III, the proposed method Enhancing Link Stability of Multicast Routing Protocol (ELSMRP) in Wireless Mesh Networks is presented. The section IV describes the simulation results and comparative performance analysis. Conclusion and future work are presented in section V and VI.

II. RELATED WORKS

During past research, lots of multicast path finding algorithms have been suggested by researchers for mobile ad-hoc networks. Most of them are already covered in few surveys in the area and some of them are out of date. The proposed research paper incorporates only recent path finding algorithms based on specialized learning techniques like agent based, position based, bio inspired, energy efficient multicast path finding etc.
Rajendiran and Srivatsa [1] proposed an energy efficient algorithm with the plan to find a stable energy multicast host against host mobility. This can be achieved by initially identifying the energy level of individual host in MANET and then transmitting the data packets. The purpose of this transmission is to define some factors that are necessary for increasing reliability and to choose secure route direction. The proposed algorithm uses adaptive function for improving reliability and choosing a secure route. The algorithm then uses a power function for growing reliability.
Kai-Jie and Yuh-Ren [2] proposed a link stability prediction method based on current link-related or user-related information. A realistic user mobility model and a realistic propagation model are taken into concern. Through the numerical and simulation results, the proposed method can exactly predict the link stability for different environment and mobility conditions. The results predicted can be regarded as a link stability measure and can be applied to the applications such as link performance prediction; system performance analysis; service quality prediction and route search. In addition, the impact of different mobility information on the accuracy of link stability prediction is evaluated to review the importance of the knowledge of mobility information.
Krunal and Tejas [3] evaluated the performance of stable and normal AODV routing under different mobility models like Random Way Point; Manhattan Model; Reference Point Group Mobility and Gauss Markov Model. Performance measures were Packet Delivery Ratio (PDR) and routing overhead. The outcome shows that RPGM results in improved PDR and lowest routing overhead

compared to other existing models in the network whereas the Manhattan model results in lower PDR and higher routing overhead.

Suman et.al [4] introduced the mobility-aware routing protocol based on the Ad-hoc On demand Distance Vector (AODV) routing protocol called MA-AODV (Mobility Aware Ad-hoc On demand Distance Vector) in an effort to improve the handling of high mobility factor in ad-hoc networks. MA-AODV protocols performed periodic quantification of nodes mobility for the sake of establishing more stable paths between source/destination pairs. Therefore avoiding the frequent link breakages associated with unstable paths contains high mobile nodes. The topological changes are therefore reduced and it will minimize the overhead of broadcasting messages. MA-AODV can be efficient at the time of sending the large data where continuous connection between the source and destination is more preferable.

Rajendiran and Srivatsa [5] developed a multicast routing protocol that finds stable multicast path from source to destination in the network. The nodes that perform the delay requirements can only flood the JOIN-QUERY messages in the network. The contributing nodes are assumed to follow M/M/1 queuing systems. This system contains maximum value for queuing and contention delay which can be evaluated as the ratio of maximum queue size over the service time in a node. The stable routes are found based on selection of stable forwarding nodes that have high stability of link connectivity. The stability of the link is calculated by using parameters link received power; distance between neighboring nodes and quality of the link. The proposed model's performance is simulated over MANET nodes with wide range of mobility with two mesh based multicast routing protocol. The proposed model has better throughput and reduced overheads.

Ramalakshmi and Radhakrishnan [6] proposed a distributed algorithm for energy efficient stable Multi Point Relay (MPR) based Connected Domain Set (CDS) construction to extend the lifetime of ad hoc wireless networks by considering energy and velocity of nodes in the network. The authors also implemented route discovery protocol to make use of the CDS nodes to relay route request messages. They proposed two rules to reduce the connected dominating size and to prolong the life span of the nodes with residual energy level and velocity.

Rajashekhar and Sunilkumar [7] proposed a system for information priority based multiple path multicast routing in MANETs that used reliable neighbor node selection mechanism. The selection of neighbor nodes would satisfy certain threshold of reliability pair factor to find non-pruned neighbors. Those neighbors were used to establish reliable multipath multicast routes with assigned priority levels using request and reply control packets along with node database comprising of neighbor and routing information in the network. Prioritized multi paths carry various priority data to multicast destinations. The selection of the neighbor node was realized with the help of node power model and mobility model. The mechanism of route maintenance was provided to handle link and node failure situations.

Jenifus et.al [8] proposed the performance of Hydra and Link stability based multicast routing protocol. This paper compares both the protocols with some performance metrics. Hydra elects a core for the mesh of a multicast group among the sources of the group so that only control packets from the core are disseminated towards the receivers of a group. Therefore Hydra accomplishes this by dynamically electing a core for the mesh of a multicast group among the sources of the group so that only control packets from the core are disseminated towards the receivers of a group. Data packets are forwarded through the stable paths in a mesh which are found based on selection of stable forwarding nodes that have high stability of link connectivity.

Akbari and Meybodi [9] proposed an algorithm called weighted multicast routing algorithm for MANET in which the mobility parameters are believed to be random variable with unknown distribution. The multicast routing problem is transformed into an equivalent stochastic Steiner tree problem in which the random weight associated with a communication link is its expected duration time. The plan of the proposed algorithm is to find the most stable multicast route against the host mobility. The multicast routes having longer expected duration time are more stable against the host mobility. For each iteration, a multicast route is constructed by finding a random solution of the stochastic Steiner tree problem in the network topology graph. The constructed multicast route is rewarded, if its expected duration time is longer than those of the previous iterations and it is penalized otherwise.

Floriano et.al [10] proposed a Link-Stability and Energy aware Routing protocol (LAER) to make a acceptable balance between link stability and energy efficiency. Each node broadcasts HELLO packets to all its neighbors that are in its communication range. Each node in LAER maintains the table of its direct neighbors. When a node receives the HELLO packet, it updates the information of the neighbor, if neighbor ID is already present in table or adds neighbor information, if it is a new neighbor node in the network.

Sunil and Ashwani [11] made an effort that has been made to perform analysis using random way point mobility model. The metrics used for the performance evaluation are packet delivery ratio; average end to end delay; throughput; normalized routing load and packet loss. The energy efficient routing is provided over mobile ad hoc networks in an efficient way in the proposed method. This method assumes that all nodes are capable of dynamically adjusting the transmission power used to communicate with other nodes in the network. The stable path can be selected using routing table entries and making choice between active and week nodes. Thus the optimality of the protocol can be proved.

Chauhan and Nandi [12] introduced a QoS aware on demand routing protocol that uses signal stability as the routing criteria along with other QoS metrics. The proposed QoS Aware Stable path Routing is designed over Signal Stability based Adaptive routing and aims to select stable QoS routes that can survive for longer period of time. An extensive set of simulations is conducted to verify the effectiveness of QASR with a wide variety of mobility patterns and network loads using the NS-2 simulator. A comprehensive performance analysis of QASR and comparison with other QoS aware routing for MANET is also presented in the paper.

Kant and Awasthi [13] presented a Scheme based on stable link which contains a process of node selection based on mobility prediction and battery power ratio to construct a more stable route for performing packet transmission, message flooding, routing discovery and maintenance in multicast routing of data in MANET. The mechanisms proposed in this paper can deliver data packets to larger mobile user groups within MANET in a high efficient way.

Valantina , GM; and Jayashri, S [14] proposed link stability based hop by hop multicast routing scheme that finds stable multicast path from source to receivers. The multicast path is constructed by using route request and route reply packets with the help of multicast routing information cache and link stability database maintained at every node. A multicast routing protocol implements multicast distribution through recursive unicast trees. The main goals of LSHBH are to support unicast clouds, allowing incremental deployment to have a stable tree structure, by minimizing the impact of receiver departures, and to construct low-cost trees, to reduce administrative costs and to lower error rate. The proposed scheme is simulated over a large number of VANET nodes with wide range of mobility and the performance is evaluated. It is observed that proposed scheme produces better packet delivery ratio, less control overheads and reduced packet delay compared to on-demand multicast routing protocol.

ODMRP is mesh based and on-demand protocol that uses forwarding group to communicate a mesh for each multicasting group. The aim of this algorithm [15] is to find the stable path selection in ODMRP for forwarding packets. The basic on demand multicast routing protocol path selection uses minimum delay principle. The algorithm considers node energy in path selection from source to destination. This article discusses the studies on output parameters such as control overhead and end to end delay by varying the input parameters viz., multicast groups size and mobility in the developed algorithm. Experimental results confirm that this approach can improve stability of path due to node energy consumption.

III. PROPOSED SYSTEM

In [16] the forwarding group is selected on the basis of link with maximum SINR value. Link stability provides stable route for longer connectivity duration. This protocol shows improved Packet Delivery Ratio and Average End-to End delay with respect of different number of receivers with varying mobility. Effect of increasing multicast group size i.e. number of receivers improves PDR even when mobility is varied. However, this protocol does not consider inclusion of other metrics such as node energy; bandwidth and distance improve link stability.

In this section, a stable multicast routing protocol for MANET is proposed. The proposed algorithm modifies the mechanism of route discovery and transmission of data to enhance the use of routes that consists of stable mobile nodes. The objective of this algorithm is to improve the stability of the route by increasing the route lifetime and to reduce the need of route maintenance mechanism. This algorithm finds the most stable route from multiple routes to decrease the control overhead and end to end delay between the source and destination. The important parameters in our proposed algorithm for improving stability are the coverage area and the distance between mobile nodes.

3.1. Mobile Coverage Area

Let us consider n number of nodes is present in the network. Imagine two mobile nodes M1 and M2 within the transmission range R. Let the current coordinate for M1 is (a1, b1) and for M2 is (a2, b2). The distance between the mobile node M1 and mobile node M2 is given by equation 1.

$$D(\mathrm{M}_1, \mathrm{M}_2) = \sqrt{(\mathrm{a}_1 - a_2)^2 + (\mathrm{b}_1 - b_2)^2} \qquad (1)$$

Suppose M1 move in direction with v1 velocity and M2 move in direction with v2 velocity. After T period of time, M1 and M2 move a distance d1 and d2, the new coordinate will be (a1new, b1new) and (a2new, b2new) respectively. The value of distance d is given by equations 2.

$$d = V * T = \frac{V_I + V_F * T}{2} \qquad (2)$$

where V_{iI} and V_{IF} represent the initial and final velocities of mobile nodes. The value of the new coordinates a_{inew} and b_{inew} are given by equations 3 and 4 respectively.

$$a_{new} = a + d * \cos\phi = a + T(\mathrm{V}_I * \cos\phi) \qquad (3)$$

$$b_{new} = b + d * \sin\phi = b + T(V_F * \sin\phi) \qquad (4)$$

The distance between the mobile node M_1 and mobile node M_2 in the new coordinate is given by equation 5.

$$D(\mathrm{M}_1, \mathrm{M}_2)_{new} = \sqrt{(\mathrm{a}_{1new} - a_{2new})^2 + (\mathrm{b}_{1new} - b_{2new})^2}$$

$$= \sqrt{[(\mathrm{a}_1 - a_2) + \mathrm{T}(\mathrm{V}_1 \cos\phi_1 - V_2 \cos\phi_2)] + [(\mathrm{b}_1 - b_2) + \mathrm{T}(\mathrm{v}_{iF} \sin\phi_1 - V_{2F} \sin\phi_2)]^2} \qquad (5)$$

The required condition for connection between M_1 andM_2 is

$$Transmission\,range\,(\mathrm{R}) \geq \text{distance between } M_1 and\ M_2\ (D(\mathrm{M}_1, \mathrm{M}_2))$$

So, depending on coverage area by each mobile node, the link stability between M_1 and M_2 after T time period can be calculated by the equation

$$L.S(\mathrm{M}_1, \mathrm{M}_2) = \frac{R}{D(\mathrm{M}_1, \mathrm{M}_2)_{new}} \qquad (6)$$

3.2 Mobile Distance

Link stability between any neighboring nodes can be calculated by the equation 7.

$$L.S(\mathrm{M}_i, \mathrm{M}_j) = \frac{R}{D(\mathrm{M}_i, \mathrm{M}_j)} \qquad (7)$$

According to coverage area and the distance between neighboring nodes, the route stability from source to receiver will be calculated through the following steps

1. Find the minimum link stability (L.S) between neighboring nodes along the certain route.
2. Repeat the step 1 over all available routes from source to destination.
3. Compare between all the selected values (minimum L.S) in each route, and the maximum value will be the most stable route (R.S) value.
4. The route from the source to the destination, which has this value, will be selected as the best stable route.

3.3 Route stability function

To meet the requirements of proposed algorithm target by increasing the route lifetime and reducing the need for route maintenance mechanism, the overall route stability between source and destination will be calculated through equation

$$R.S = Min\, L.\mathrm{S}(\mathrm{i}) \quad (8)$$

where, hc represents the maximum value of hope counts in the selected route. The route that has the maximum R.S value will be chosen as the most stable route to carry the data packets from a source. The pseudocode for ELSMRP Algorithm is described below.

1: Input Multicast mobile nodes(S: source, R: Destination).

2: Auxiliary variables: Maximum transmission rang (R), Link stability between neighbors nodes (L.S), Hop count (h.c),

3. Assumption Trans Range R ≥ D(M1,M2).

4: Output Stable multicast route between source and destination (R.S)

5: Begin procedure

6: when (DataPkt.Src) do

7: lookup for minimum (L.S);

8:L.S (M1 , M2) = R/(D(N1,N2)new

9: R.S= Min L.S (i)

10: Max (L.S (S-R))

11: Send through Max RS;

12: End

IV. PERFORMANCE EVALUATION

The performance of the proposed scheme is analyzed by using the Network simulator (NS2). The NS2 is an open source programming language written in C++ and OTCL (Object Oriented Tool Command Language). NS2 is a discrete event time driven simulator which is used to mainly model the network protocols. The nodes are distributed in the simulation environment. The nodes have to be configured as mobile nodes by using the node-config command in NS2. The parameters used for the simulation of the proposed scheme are tabulated below.

The simulation of the proposed scheme has 30 nodes deployed in the simulation area 1500×1000. The nodes are moved randomly within the simulation area by using the mobility model Random waypoint as shown in Table 1. The nodes are communicated with each other by using the communication protocol User Datagram Protocol (UDP). The traffic is handled using the traffic model CBR. The radio waves are propagated by using the propagation model two ray ground. All the nodes receive the signal from all direction by using the Omni directional antenna. The performance of the proposed scheme is evaluated by the parameters packet delivery ratio, packet loss ratio, delay and throughput.

Table 1: Simulation Parameters

Parameter	**Value**
Simulation Area	1500x1000s.m
Simulation Time	30ms
Channel Type	WirelessPhy
Radio Model	TwoRayGroundModel
MAC Type	IEEE 802.11

Antenna Type	Omni Antenna
Mobility Model	Random Way Point
Number of Nodes	38
Transmission Range	250m
Traffic Model	CBR

4.1. Packet Delivery Rate

Packet delivery rate is the ratio of number of packets delivered to all receivers to the number of data packets sent by the source node. The packet delivery rate is calculated by the following formula.

$$PDR = \frac{Total\ Packets\ Received}{Total\ Packets\ Send} \quad (9)$$

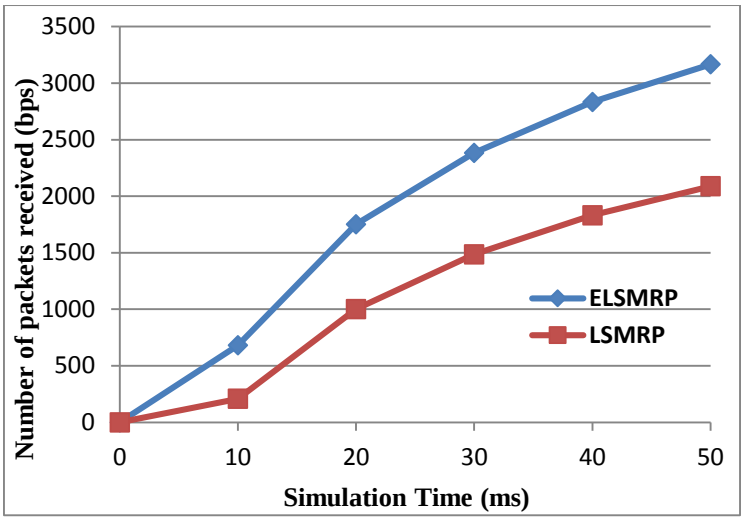

Figure 2: Packet Delivery Rate

The packet delivery rate of the proposed scheme is higher than the packet delivery rate of the existing method. The greater value of packet delivery rate means the better performance of the protocol.

4.2. Packet Loss Rate

The packet loss rate is the ratio of the number of packets dropped to the number of data packets sent. The formula used to calculate the packet loss rate is as follows

$$PLR = \frac{Total\ Packets\ Dropped}{Total\ Packets\ Send} \quad (10)$$

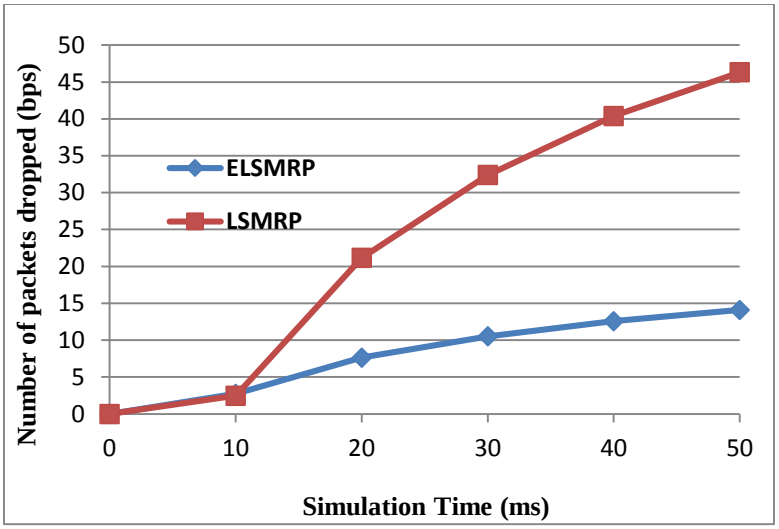

Figure 3: Packet Loss Rate

The packet loss rate of the proposed scheme is lower than the existing scheme. Lower the packet loss rate indicates that higher performance of the network.

4.3. Average Delay

The average delay is defined as the time difference between the current packets received and the previous packet received. It is measured by the equation.

$$Delay = \frac{\sum_{0}^{n} Pkt\ Send\ Time - Pkt\ \mathrm{Re}cvd\ Time}{n} \qquad (11)$$

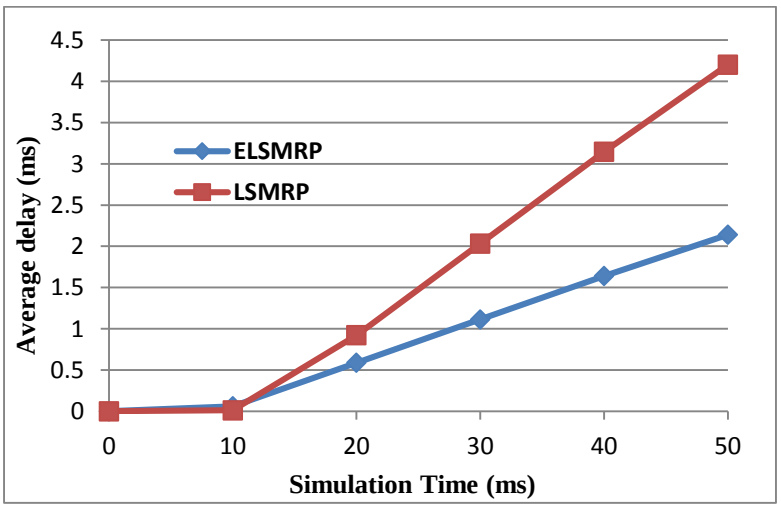

Figure 4: Delay Rate

The figure 4 shows that, the delay value is low for the proposed scheme than the existing scheme. The minimum value of delay means that higher value of the throughput of the network.

4.4. Throughput

Throughput is the average of successful messages delivered to the destination. The average throughput is estimated using the equation.

$$Throughput = \frac{\sum_0^n Pkts\ Received\ (n) * Pkt\ Size}{1000} \quad (12)$$

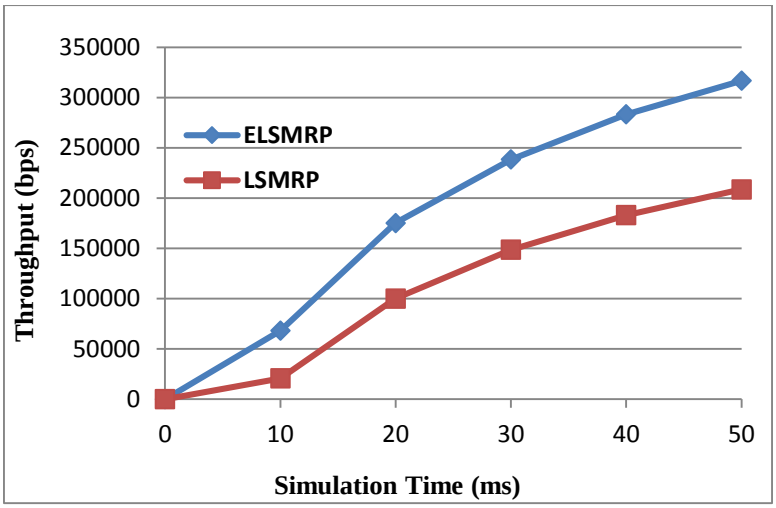

Figure 5: Throughput

The figure shows that the proposed scheme has greater average throughput when compared to the existing scheme.

V. CONCLUSION

The proposed multicast routing mechanism described various challenges in a WMN environment due to arbitrary movement of mobile nodes. In this paper, a new stable multicast routing mechanism, Enhancing Link Stability of Multicast Routing Protocol (ELSMRP) in WMN, based on On-Demand Multicast Routing Protocol (ODMRP) is proposed. The proposed mechanism finds the stable route against route failure and movement of mobile node by altering the mechanism of both route discovery and data multicasting. The proposed routing protocol extends the route lifetime; decrease the use of route maintenance mechanism; reduces end to end delay and control overhead.

VI. FUTURE WORK

Future work is to differentiate the inclusion of other metrics such as bandwidth, node energy and congestion to improve link stability in wireless mesh networks. Also to present a mathematical model and analyze it using simulation results.

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