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Network Path Stability Based Routing Protocol for MANET

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Abstract - An ad hoc network is a mobile wireless network that has no centralized infrastructure and not has fixed access point. Each node in the network also functions as a mobile router of data packets for other nodes. However, due to node mobility, link failures in such networks are very frequent and render certain standard protocols inefficient resulting in wastage of power and loss in throughput. Due to high node mobility the neighbor list of a node might change more often, thereby raising the need for predicting link lifetime for improving reliability in communication. The cases when network size is large or traffic rate is very high, often leads to frequent congestion in the network. In this paper we propose Link Breakage prediction i.e. LBP based on signal strength, energy and position of the dispersed node randomly in network using Ad-hoc on demand Distance Vector routing protocol modification. In this context targeted QoS parameters are selected for performance measurement. So the results demonstrated that proposed mechanism is very effective for ad-hoc network.

Keywords: MANET, AODV, NS-2, Link Prediction, Link Breakage, Routing Protocol, Network Node

I. INTRODUCTION

In the recent years, wireless technology has enjoyed a tremendous rise in popularity and usage, thus opening new fields of applications in the domain of networking. Without using any fixed structural support the information is exchanging in the network of mobile devices. Such networks are termed as ad –hoc network. Communication protocols will have to deal with a frequently changing network topology. However, many applications require stable connections to guarantee a certain degree of QoS (Quality of service). In access networks, access point handovers may disrupt the data transfer. In addition, service contexts may need to be transferred to the new access points, introducing additional overhead and delays to the connection [1, 2].

A. MANET Overview

An ad hoc network is a collection of nodes that do not need to rely on a predefined infrastructure to keep the network connected.

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Ad hoc networks can be formed, merged together or partitioned into separate networks on the fly, without necessarily relying on a fixed infrastructure to manage the operation. Nodes of ad hoc networks are often mobile, which also implicates that they apply wireless communication to maintain the connectivity, In which case the networks are called as mobile ad hoc networks (MANET). Mobility is not, however, a requirement for nodes in ad hoc networks, in ad hoc networks there may exists static and wired nodes, which may make use of services offered by fixed infrastructure [3, 4]. Figure 1 is the depiction of example of mobile ad hoc structure:

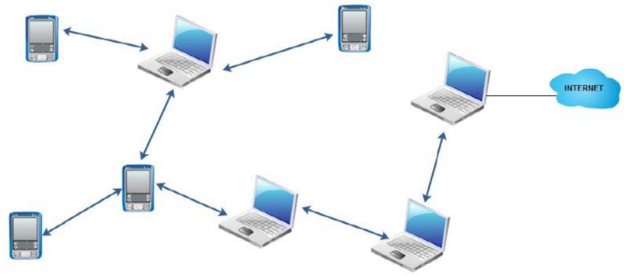

Figure 1: Example of MANET

A Mobile Ad hoc Network (MANET) is an arrangement of remote portable hubs that powerfully self-sort out in discretionary and brief system topologies. Individuals and vehicles can subsequently be internet worked in regions without a previous correspondence foundation or when the utilization of such framework requires remote augmentation. In the versatile specially appointed system, hubs can straightforwardly speak with the various hubs inside their radio reaches; while hubs that not in the immediate correspondence go utilize halfway hub (s) to speak with each other

B. Prediction of Link Availability

In link breakage prediction, a link breakage can be predicted before its real occurring so route maintenance can start before the occurring of the problem avoiding the problems that come with a link breakage. In the link breakage prediction, a node in an active route can predict if the link between it and its previous hop will break soon. In this case it can inform the source node about the problem and the source node, if still needs the route, will be able to construct a new route which avoids this soon to be broken link. It has been found that this procedure has made a good improvement in the performance of the mobile ad hoc network's protocols, but the problem is that the focusing during constructing a new route was only on excluding the link that was predicted to have a link breakage [5].

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This mechanism may cause constructing a new route with some or all bad links from the current used route which are weak but did not predicted to be broken yet.

These links may break during or directly after the constructing of the new route which will cause a high decrease in the packet delivery ratio and a high increase in the packet loss and delay. In order to improve the idea of link breakage prediction, this research work has proposed a new approach for link breakage prediction in MANETs [6].

C. Fundamental aspects of Route Stability in MANET

To meet the quality of service requirements of mobile users, several metrics can be considered for selecting a source destination routing path. The fundamental aspects of Route stability are determined as follows [7, 8]:

Stable Routes: To maximize throughput and reduce traffic latency, it is essential to ensure reliable source-destination connections over time. A route should therefore be selected based on some knowledge of the nodes motion and on a probability model of the path future availability.

Efficient Route Repair: If an estimate of the path duration is available, service disruption due to route failure can be avoided by creating an alternative path before the current one breaks. Note that having some information on the path duration avoids waste of radio resources due to pre-allocation of backup paths.

Network Connectivity: Connectivity and topology characteristics of a MANET are determined by the link dynamics. These are fundamental issues to network design, since they determine the system capability to support user communications and their reliability level.

II. LITERATURE SURVEY

Several researchers have investigated the area of link breakage prediction in mobile ad hoc networks. In this section, some examples of their works are discussed.

In this paper, ***K´aroly Farkas et al. [9]*** propose an approach called XCoPred to predict link quality variations based on pattern matching which can be exploited for mobility prediction. XCoPred doesn't require the use of any external hardware or reference point. Each MANET node monitors the Signal to Noise Ratio (SNR) of its links to obtain a time series of SNR measurements. When a prediction is required, the node tries to detect patterns similar to the current situation in the history of the SNR values of its links by applying the normalized cross-correlation function. The found matches are then used as the base of the prediction. Simulations have shown that fairly accurate predictions around 2 dB of absolute average prediction error can be achieved with XCoPred in case of appropriate parameter settings and scenarios showing clear node mobility patterns.

With more and more wireless devices being mobile, there is a constant challenge to provide reliable and high quality communication services among these devices. In this paper, ***Ming Yu et al. [10]*** propose a link availability-based QoS-aware (LABQ) routing protocol for mobile ad hoc networks based on mobility prediction and link quality measurement, in addition to energy consumption estimate. The goal is to provide highly reliable and better communication links with energy-efficiency. The proposed routing algorithm has been verified by NS-2 simulations. The results have shown that LABQ outperforms existing algorithms by significantly reducing link breakages and thereby reducing the overheads in reconnection and retransmission. It also reduces the average end-to-end delay for data transfer and enhances the lifetime of nodes by making energy-efficient routing decisions. In this paper, ***Zhinan Li et al. [11]*** investigate the residual link lifetime (RLL) in a mobile ad hoc network, such as a vehicular network. Although, owing to the underlying mobility of the network nodes, the RLLs of adjacent links are highly correlated, yet previous works typically neglected such correlation. In contrast, this study is based on an accurate modeling of the relative distances and speeds between neighboring mobile nodes. Firstly, a scenario is presented that demonstrates the dependence of RLLs of two adjacent links. Authors then derive the joint probability distribution of the RLLs of two adjacent links in terms of their parameters. This model shows that neglecting the correlation between adjacent links results in serious overestimation of the path's lifetime. Simulation is used to verify our model. Mobile Ad hoc Network (MANET) consists of a group of mobile nodes that can communicate with each other without the need of infrastructure. The movement of nodes in MANET is random; therefore MANETs have a dynamic topology. Because of this dynamic topology, the link breakages in these networks are something common. This problem causes high data loss and delay. In order to decrease these problems, the idea of link breakage prediction has appeared. In link breakage prediction, the availability of a link is evaluated, and a warning is issued if there is a possibility of soon link breakage. In this paper ***Khalid Zahedi et al. [12]*** propose a new approach of link breakage prediction in MANETs. This approach has been implemented on the well-known Dynamic Source Routing protocol (DSR). This new mechanism was able to decrease the packet loss and delay that occur in the original protocol. In this paper, ***N. Lalitha et al. [13]*** add a link breakage prediction algorithm to the Dynamic Source Routing (DSR) protocol. The mobile node uses signal power strength from the received packets to predict the link breakage time, and sends a warning to the source node of the packet if the link is soon-to-be-broken. The source node can perform a pro-active route rebuild to avoid disconnection. Intermediate nodes in the route continuously monitor the signal strength at the time of communication, based on a predefined threshold signal value. Intermediate node sends a message to the source node that the route is likely to be disconnected, if signal strength falls below the threshold value. If source receive this message it starts using backup route and if back route also fails then it finds alternative route. The backup route will minimize the time consuming process of finding an alternative route to some extent. Addition of link breakage prediction to DSR can significantly reduce the total number of dropped data packets (by at least 25%). Security to the packets in the MANET is provided by employing a message encryption technique using the concept of deceptive text which ensures confidentiality and authentication to the data.

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III. PROPOSED SYSTEM

The given solution is based on the predictive methodology, which includes the mathematical formulation to resolve overcome of the frequent link breakage via finding appropriate node location in MANET for improving the performance of the mobile network. Methodology comprises with different perspective where we can summarize overall solution with following points. In this section, we introduced model to estimate the future status of link availability using estimated node location and energy status of every nodes A link is composed of the two nodes in a connection and the connection itself. The making concept is broadcast to the entire network preceded by node route discovery i.e. a path have to be developed between intended sources to sink. Therefore RREQ and RREP route discovery is captured with routing information packet. Whenever route is established, means that node are initiated the communication to each other. So that, here, we need to build the terminology which is concentrate on mobility of node. The assessment of the future position of a node is called its Mobility Prediction. The meaning of 'position' varies with the kind of wireless network being used. Therefore, in this concern we mean the mobility of the node by location.

Initially, in idle network we assign various nodes in network which is dispersed randomly and moving rapidly. Here we assume there are N number of node $N = 1, 2, 3, \ldots\ldots, n$. For a particular instance let us process a node n_1 and find a node location in network. Similarly we can find other node location. n_1 Moving in randomly which is assumed by x and y co-ordinate. Therefore the co-ordinate in network is assigned for all nodes, n_1 direction in(x_1, y_1), n_2 direction in(x_2, y_2), similarly find all node direction using these co-ordinate. These nodes can move to their maximum range. For this R_{max} is the maximum range for all nodes.

$$R_{max} = \{n_1(x_1, y_1), n_2(x_2, y_2), \ldots\ n_n(x_n, y_n)\}$$

Theoretically, we generalize the node (n) position at time$t$, for finding the position of the node projection the node direction using (x, y) co-ordinate. Therefore estimate the time difference from evaluate node direction:

$$\boxed{\begin{array}{l} \mathbf{\Delta t_1 = (t_2 - t_1)}, \text{ at } (x_1, y_1) \\ \mathbf{\Delta t_2 = (t_3 - t_2)}, \text{ at } (x_2, y_2) \end{array}}$$

We have to find three different locations D_1, D_2, D_3 at time t_1, t_2, t_3 respectively of the node n_1

$$\boxed{\begin{array}{l} Location\ (D_1) ------at\ time\ (t_1) \\ Location\ (D_2) ------at\ time\ (t_2) \\ Location\ (D_3) ------at\ time\ (t_3) \end{array}}$$

For the node position find location difference in above indicated line. The differences predict the mobility of the node representing by$d\Delta$:

$$\mathbf{D_2 - D_1 = \Delta d_1}, \text{ and}$$

$$\mathbf{D_3 - D_2 = \Delta d_2}$$

Successfully finding the difference between the nodes incurred formula for velocity of this node. Node is a basic entity of the network, on which all process is dependent besides of input and output. For calculating velocity of node respective of the time movement:

$$\mathbf{V_1 = \frac{\Delta d_1}{\Delta t_1}}$$

$$\mathbf{V_2 = \frac{\Delta d_2}{\Delta t_2}}$$

$$\boldsymbol{\delta} = \mathbf{(d_2 d_3 - d_1 d_2)}$$

$$\mathbf{t_p = \frac{\boldsymbol{\delta}}{V_1 - V_2}}$$

Clearly, show that t_p is the time after which an active link will break. Therefore, t_p is the link break time that indicates the time on which we should switch the path and select alternate path. In this manner, we set up a time t_s time just smaller time than link break timet_p. Hence need to assign a constant time 0.5 to reduce from link break time i.e.

$$t_s = (t_p - 0.5)$$

$t_s = Critical\ Path$, where, the node enters into critical state and node should find an alternate route.

After finding the link breakage time we formulate the energy consumption for 25, 50, 75, 100 and 125 nodes in the simulation. This is cause due to assumption of energy scenario at different time.

Assume a node n_1 which has different energy status e_1, e_2, e_3 at different timet_1, t_2, t_3. To combine the time and energy by demonstrating following pair:

$$(e_1, t_1), (e_2, t_2), (e_3, t_3)$$

Furthermore, to find the difference between the time values form the energy status. Given equation is checking the difference of time i.e. ΔT_1andΔT_2:

$$\Delta T_1 = t_2 - t_1$$

$$\Delta T_2 = t_3 - t_2$$

For making accurate link breakage prediction, to obtain signal strength of the node n_1 at different timet_1, t_2, t_3 of signal strengthP_1, P_2, P_3Finally, we compare the time values to each other along with packet signal strength. Checks the time difference and signal strength of the node and we get the prediction which link will be break in future aspects.

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The entire process of the Link Breakage approach can be summarized as the algorithm the table 1 shows the process of the proposed algorithm:

Table 1: Link Breakage Prediction

Input: Number of Node

Output: Predicted Breakage Link

Process:

1: For each neighboring of all node in network

2: To Find the location of a random node

- Assume Node e.g. n_1
- Location of node D_1, D_2, D_3 at time t_1, t_2, t_3
- Find the difference of location at Δt

3: Using the node location calculate velocity of the node respective Δt

4: Calculate the δ i.e. multiplicative difference of location

5: Update the information using these constraints

6: estimate and update the time t_p after an active link will break

7: Similarly Find t_s, time t_s just smaller time than link break timet_p

- Less the constant time 0.5 from the t_p, $t_s = (t_p - 0.5)$
- Check the constraints
- $if\ (current\ time \geq t_s)$
- Switch the path to alternate path
- $\boldsymbol{endif}$

8: By using Energy Consumption for a link breakage time

- Find different energy status e_1, e_2, e_3 at different timet_1, t_2, t_3.
- find the difference between the time values form the energy status i.e. $\Delta T_1\ and \Delta T_2$
- Obtain a signal strength of node n_1
- Compute difference at t_1, t_2, t_3 of signal strengthP_1, P_2, P_3.

9: Update the information and checks the constraints

10: $\boldsymbol{if}\ (\Delta T_1 > \Delta T_2)||[(P_1 > P_2)\&\&(P_2 > P_3)]$

Choose alternate path

11: $\boldsymbol{endif}$

12: end Process

IV. IMPLEMENTATION

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 1100×1000. The nodes are moved randomly within the simulation area by using the mobility model Random waypoint as shown in Table 2.

Table 2: Simulation Scenarios

Parameters	Values
Antenna Model	Omni Antenna
Dimension	1000 X 1000
Radio-Propagation	Two Ray Ground
Channel Type	Wireless Channel
Traffic Model	CBR
Routing Protocol	AODV
Mobility Model	Random Waypoint
Number of Nodes	25, 50, 75, 100, 125

A. Simulation Scenario

This section provides the understanding about the simulation scenarios under which the experiments are performed. To demonstrate the security technique their two key simulation scenarios are proposed in this section. Both the simulation scenarios are conducted with different number of nodes that are 25, 50, 75, 100 and 125 nodes.

In order to perform the experiments the following investigational scenarios are demonstrated in this section.

1. Simulation of existing Link Prediction based on AODV: In this phase the network is configured with the help of AODV of base approach for link prediction using AODV routing protocol and with the different number of nodes the experiments are performed. During the experiments different performance parameters are computed and their comparative study is performed with proposed approach. The traditional network is demonstrated using figure 2. In this simulation process,

Node 0 and node 7 indicating source and destination node respectively with blue colour.

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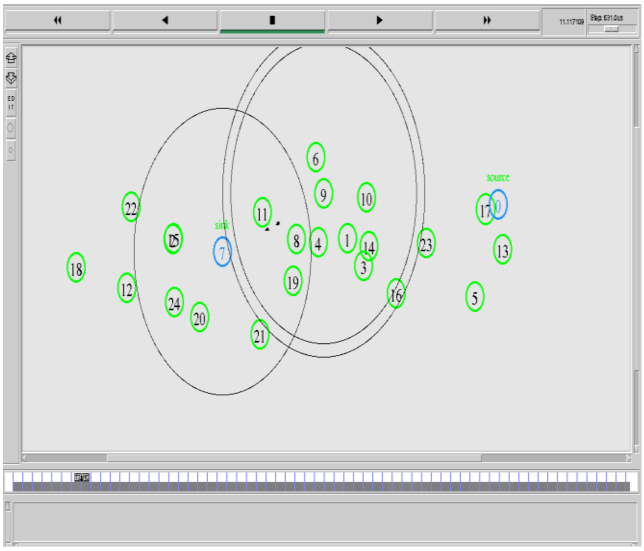

Figure 2: Base Approach of Link Prediction

2. Simulation of Proposed Link Breakage Prediction under AODV Routing: In this phase the network is configured with the help of proposed LBP technique and their performance is projected for comparative performance study. The required network is demonstrated using figure 3. If there is availability of multiple links and routing is performing through desired path then there is a case of link breakage due to overload of link. This simulation screen shows that we switch the routed path if we successfully predicted failure of path. Simulation is processed over 25 nodes.

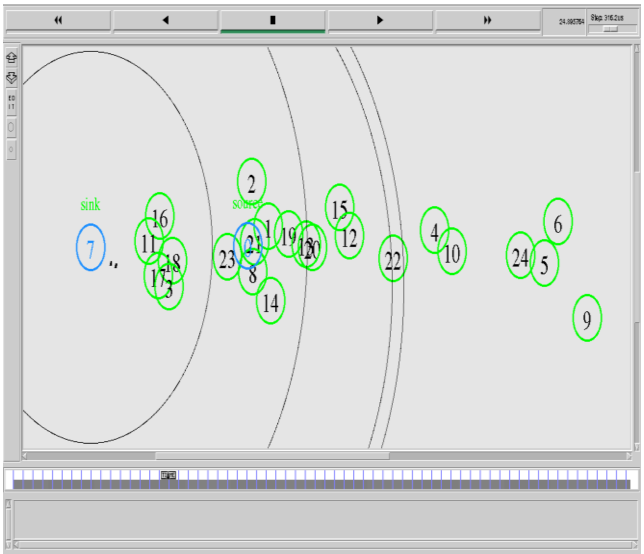

Figure 3: Proposed Link Breakage Prediction Approach

V. RESULT ANALYSIS

A. End to End Delay

End to end delay is the time taken by a packet to travel from source to destination. Delay depends on number of hops and congestion on the network. End-to-end delay of data packets includes all possible delays caused by buffering during route discovery, queuing at interface queue, retransmission delays at MAC layer, propagation and transfer time

$$\text{E2E Delay} = \text{Receiving Time } (R_t) - \text{ Sending Time}(S_t)$$

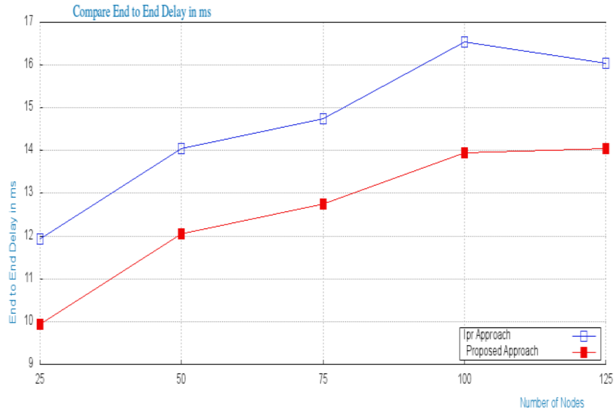

Figure 4: End to End Delay Comparisons

The end to end delay of the proposed approach and existing link prediction routing approach is reported in figure 4. In this diagram the X axis shows the number of network nodes in the experiments and the Y axis shows the amount of end to end delay in terms of milliseconds. The results show the end to end delay of the network in previous approach is higher as compared to the proposed LBP approach. Therefore the proposed technique is much adoptable as compared to the traditional one. Additionally the increasing amount of network nodes is impact on end to end delay. End-to-end delay increases with increase in the network size in AODV with LBP and AODV with existing because high node density increases collisions.

B. Remain Energy

During the communication and network events the nodes consumes a part of energy from its initial amount of energy. Remain energy of network nodes are recorded and reported here as the performance parameter of network.

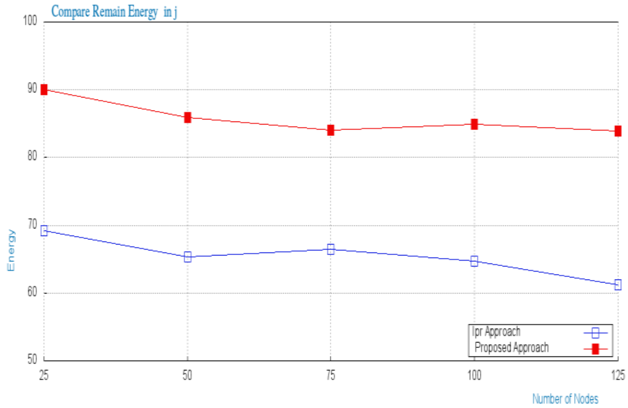

Figure 5: Remain Energy

The figure 5 shows the amount of energy consumed in network nodes during the different experiments. The experiments are performed over 25, 50, 75, 100 and 125 numbers of nodes. In order to demonstrate the performance of networks the X axis contains the number of nodes in experimental network and the Y axis shows the amount of energy consumed after experiments. The measurement of energy is given here in terms of Jules.

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According to the experimental results the proposed LBP technique consumes less amount of energy as compared to the traditional approach. Therefore the proposed approach of route prediction is energy efficient as compared to normal network configurations with base method under AODV for both simulations. Therefore, AODV of base and AODV with LBP give increasing average energy consumption as network load increases, since more packets are generated in the network and thus these packets are send to the destinations therefore, more energy is consumed in successful communication of these packets.

C. Packet Delivery Ratio

Packet delivery ratio is defined as the ratio of data packets received by the destinations to those generated by the sources. Mathematically, it can be defined as:

$$\text{Packet Delivery Ratio (PDR)} = \frac{S_1}{S_2} \text{X100}$$

Here, S_1 is the sum of data packets received by the each destination and S_2 is the sum of data packets generated by the source node. Graphs show the fraction of data packets that are successfully delivered during PDR versus the number of nodes. The comparative packet delivery ratio of traditional AODV/LP routing and LBP based technique is described using figure 6. In this diagram the different number of nodes are given in X axis and the Y axis includes the percentage amount of packets successfully delivered. According to the obtained results the proposed technique able to deliver more packets effectively as compared to the AODV/LP method. Additionally that shows 89-94% percentage amount of successfully delivered packets in our LBP method. Therefore the proposed technique is more effective as compared to the traditional method. On the other hand the traditional approach shows the 85-88% of successfully delivered packets. Thus the proposed approach is more efficient than the traditional routing technique.

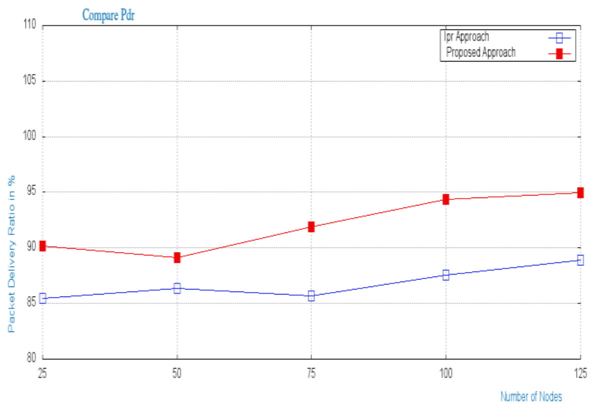

Figure 6: Packet Delivery Ratios

B. Routing Overhead

Due to high mobility of node in MANET there is no static topology, which leads to the frequent link breakage while route discovery. Thus, link breakage problem cause an interruption in data transmission that raises routing overhead problems. The amount of routing overhead for both the network routing techniques is given using figure 7 In this diagram the amount of nodes in network is given using X axis and the Y axis contains the routing overhead of the network. According to the experimental results the proposed LBP routing technique produces less overhead as compared to the base method thus proposed technique much suitable for improving other network performance parameters. The main reason behind less routing overhead is the additional control messages is forwarded when new route is establish to know participating all nodes.

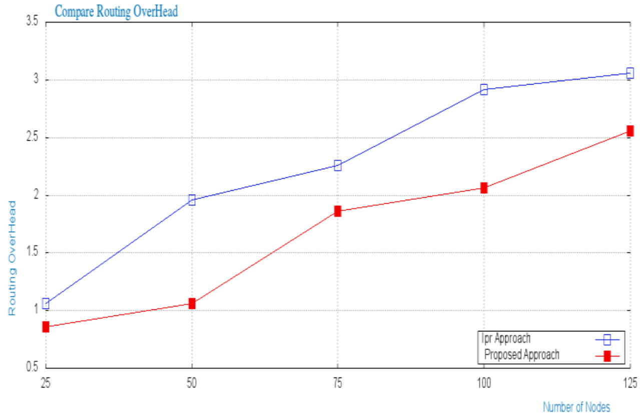

Figure 7: Routing Overhead

C. Throughput

It is defined as the total number of packets delivered over the total simulation. This data might be delivered above a physical or logical link, or pass during a certain network node. Throughput is the number of messages successfully delivered per unit time. Throughput is controlled by available bandwidth, as well as the available signal-to-noise ratio and hardware limitations. The throughput is regularly considered in bits per second (bit/s or bps), and sometimes in data packets per second or data packets per time slot. The comparative performance of the traditional AODV/LP routing and proposed Link Breakage Prediction with AODV routing technique is demonstrated using figure 8. In this diagram the amount of experimental nodes are given in X axis and the Y axis contains the amount of throughput achieved in the network. The computed throughput of network is reported here in terms of KBPS (kilobyte per seconds). According to the obtained performance results the proposed technique enable higher throughput as compared to the traditional routing technique thus proposed technique.

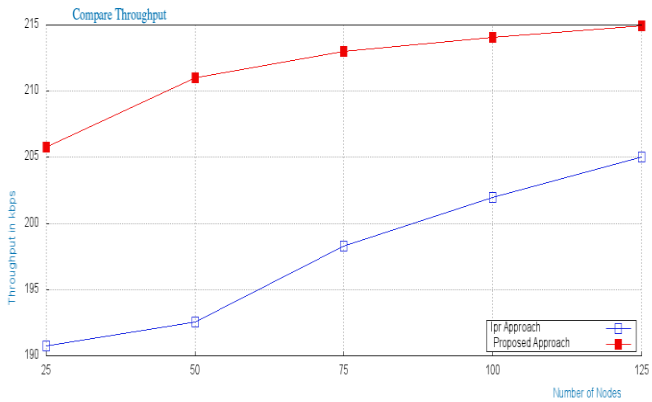

Figure 8: Throughput

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VI. CONCLUSION

The standard IEEE 802.11 and ordinary routing protocols are preferred for applications where the reliable and quick delivery of data is important. But in some applications, the requirement is of improved performance of the network to support mobility and hence incorporation of link prediction in routing is very important. The lifetime of a mobile node and hence energy conservation is also very important. They lead to increase in packet delivery ratio and the network lifetime so that the performance of the network does not degrade too soon. In this research we present Link Breakage Prediction i.e. *LBP* with modified AODV routing protocol which received signal strength based link prediction to increase the availability of the links. The goal of the present work is to minimize packets drops by switching to alternate path even before links fail with the help of link prediction and to reduce energy consumption in an ad-hoc network while maximizing the network throughput, PDR. Results show that the proposed approach perform better than the already existing schemes (AODV/LP) in terms of increase in throughput, packet delivery ratio and decrease in end to end delay, routing overheads and energy consumption.

REFERENCE

1. Xin Ming Zhang, Feng Fu Zou, En Bo Wang, and Dan Keun Sung "Exploring the Dynamic Nature of Mobile Nodes for Predicting Route Lifetime in Mobile Ad Hoc Networks" IEEE Transactions on Vehicular Technology, vol. 59, no. 3, March 2010.
2. Taneja,S., & Kush, A.,"A Survey of routing protocols in mobile ad hoc networks", International Journal of Innovation Management and Technology, vol. 1, no. 3, pp. 2010 - 0248, 2010.
3. Mäki, Silja, "Security Fundamentals in Ad Hoc Networking", Proceedings of the Helsinki University of Technology, Seminar on Internetworking-Ad Hoc Networks. 2000.
4. Amitabh Mishra and Ketan M. Nadkarni, Security in Wireless Ad Hoc Networks, in Book the Handbook of Ad Hoc Wireless Networks (Chapter 30), CRC Press LLC, 2003
5. Zayani, Mohamed-Haykel, Link prediction in dynamic and human-centered mobile wireless networks, Diss. Institute National des Telecommunications, 2012.
6. Gautam S. Thakur, Ahmed Helmy and Wei-Jen Hsu, "Similarity analysis and modeling in mobile societies: the missing link" In Proc. of the 5th ACM workshop on Challenged networks (CHANTS '10), pages 13-20, 2010.
7. Ajay Kumar Singh Kushwah and Amit Kumar Manjhvar, "A Review on Link Prediction in Social Network", International Journal of Grid and Distributed Computing Vol. 9, No. 2, pp.43-50, 2016
8. Geetha Nair and Dr. N. J. R. Muniraj, "Prediction based Link Stability Scheme for Mobile Ad Hoc Networks", IJCSI International Journal of Computer Science Issues, Vol. 9, Issue 6, No 3, November 2012
9. Farkas, Károly, et al. "Pattern matching based link quality prediction in wireless mobile ad hoc networks", Proceedings of the 9th ACM international symposium on Modeling analysis and simulation of wireless and mobile systems, ACM, 2006.
10. Yu, Ming, et al. "A link availability-based QoS-aware route protocol Computer Communications 30.18 (2007): 3823-3831
11. Li, Zhinan, and Zygmunt J. Haas, "On residual path lifetime in mobile networks." IEEE Communications Letters 20.3 (2016): pp. 582-585.
12. Khalid Zahedi and Abdul Samad Ismail, "Route Maintenance Approach for Link Breakage Predicttion in Mobile Ad Hoc Networks", (IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 2, No. 10, 2011
13. N. Lalitha and L Surya Prasanthi Latike, "MDSR to Reduce Link Breakage Routing Overhead in MANET Using PRM", IOSR Journal of Computer Engineering (IOSR-JCE), Volume 11, Issue 1 (May. - Jun. 2013), PP 79-86

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