A Route Stability Routing Protocol for Improving the Performance of AODV Routing

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***Abstract:*-Mobile ad hoc network is a collection of network devices which free from any infrastructure and can behave independent for communication. The independence of the node is comes from their freedom of mobility and dynamic topology creation ability. Additionally that enables the new directions of applications for the technology and application advancements. On the other hand the mobility or independence of nodes creates some network performance issues such as link break, network partitions, data loss, communication overheads and others. Therefore the stable route is the key area of investigation and routing protocol design. In this presented work the key intension is to find some solution for link stability of routing protocol. The proposed technique of routing is works on the basis of two stages route establishment and route management. During the route establishment that acts as the AODV routing protocol and after establishment of connection that implements the node tracking concept. Using the tracking concept the node mobility is predicted additionally that helps to estimate the new possible node position in network. In addition of that for more accurate location estimation the velocity and direction of node movement is also associated. Once the direction and velocity of node is obtained the time estimation is performed when the node leave the current or existing path. This presented technique is implemented on NS2 network simulator and their comparative study with the AODV routing protocol is performed. The obtained performance shows the proposed protocol improves the performance of the traditionally used AODV routing protocol.**

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

I. INTRODUCTION

In mobile ad hoc network the mobility is an advantage of network. Additionally that property makes more valuable for different applications i.e. army movements, disaster management and others. Due to the network devices dynamicity the network topologies are rapidly developed and destroyed. That processes affect the performance of network in terms of packet delivery ratio and the routing overheads. Therefore the network mobility can also create some issues in network performance. In this context some improvements are required in the existing routing protocols by which the stability of current routes or topology can be estimated. And before destroying any route the alternative paths are developed for effective end to end communication.

Basically in the traditional AODV routing technique the network is enabled for both the task route discovery and route maintenance. But if the route is not feasible for recovery then the route discovery again initiated this process takes additional effort and network resources in order to computed new paths. In order to optimize the existing routing protocols for improving the routing strategy a new prediction based data model is proposed. The proposed technique first estimate the routes among the source and destination which are going to communicate as usually defined in AODV routing but after route establishment the current node's position or coordinates are continuously observed and the it is estimated how long time a particular node available in the maximum defined network range. By this manner the link stability time is approximated and if that is observed the route going to abandoned then new route discovery initiated before broken the exiting link.

II. PROPOSED WORK

This chapter provides the complete understanding about the proposed concept of routing protocol improvement on the basis of link stability. Thus the chapter includes the overview of the routing protocol, additionally the implemented methodology of the system. Finally the proposed algorithm is also explained.

2.1. Routing Overview

The mobile ad hoc network is one of the most popular network technologies in wireless networks. In this network the term ad hoc is used because of their dynamicity and their rapid installation and their removal. In addition of that this technique supports the mobility in network devices due to the independent nature of network nodes. This independent nature is obtained because the network nodes are works on Wi-Fi technology and they are staying connected using the wireless links. The dynamicity of network creates various different performance issues in network such as loss of packets, frequent path breaks, re-establishment of routes and others. In this context the improvement on the existing routing protocol in order to maintain the routes more effectively is required. By which various losses in network can be reduced.

In order to perform this task a new technique of route stability measurement is proposed. That indicate how long a route is available. Here the availability term is used for the time of a node exist in the network path after that the network path breaks. In order to estimate this amount of time a predictive scheme is proposed for implementation. That technique first obtains the node location or coordinates of the current and previous location between a time differences. Using this velocity and direction of the node is measured. If the node moves out from the current nodes scenario the time is obtained when the route broken. In addition of that the parallel path discovery for the alternative route is also initiated to continuous flow of communication in network. This technique helps to improve the network stability or communication life time. This section provides the basic understanding about the proposed approach. In further the detailed methodology is described.

2.2. Methodology

The proposed routing technique is working in two major parts first the route establishment and secondly the route maintenance phase. Therefore during the route establishment phase the proposed work is works as the traditional AODV routing protocol. According to the traditional AODV routing protocol the source node who initiate the communication send the RREQ (route request) message towards the destination node. The RREQ packet sent by the source node is received through the one hop neighbour node. The neighbour node validates the destination address from the RREQ message. If the destination is same as the received host packet is accepted otherwise it is again broadcasted to the neighbour nodes. In this manner when the RREQ message received by the destination node the RREP (route replay) message is transmitted towards the source node. After receiving the RREP packet from the destination node the reverse path is constructed and communication is enabled.

After establishment of the route the current position of the node in terms of their coordinates are estimated. Thus let the current position of node is (x, y) at a timet_1. It is assumed that there three neighbour node which is having the positions as $(x_1, y_1), (x_2, y_2)$ *and* (x_3, y_3) at the same timet_1. Therefore the distance from each node from the routed node is computed as:

$$\sqrt{(x - x_1)^2 + (y - y_1)^2} = r_1$$

$$\sqrt{(x - x_2)^2 + (y - y_2)^2} = r_2$$

$$\sqrt{(x - x_3)^2 + (y - y_3)^2} = r_3$$

Where r_1, r_2 *and* r_3 is the distance between the node and the assumed nodes. It is also considerable here the distance of nodes and not greater than the maximum radio range of the nodes. The maximum radio range of nodes are given usingr_{max}.

In addition of that by using these three nodes the current node position can be computed using the following equations as:

$$x = \frac{(y_1 - y_2)X_x - (y_1 - y_3)X_y}{[(x_1 - x_3)(y_1 - y_2) - (x_1 - x_2)(y_1 - y_3)]}$$

$$y = \frac{(x_1 - x_2)X_x - (x_1 - x_3)X_y}{[(x_1 - x_2)(y_1 - y_3) - (x_1 - x_3)(y_1 - y_2)]}$$

Where,

$$X_x = (x_1^2 - x_3^2) + (y_1^2 - y_3^2) + (r_3^2 - r_1^2)$$

Now let after a small time the node is moved from its position, thus at the time t_2 the position of node is (x_{t+1}, y_{t+1}). Therefore the velocity of node is given by:

$$V = \frac{\sqrt{(x - x_1)^2 + (y - y_1)^2}}{t_2 - t_1}$$

$$V = \frac{D}{\Delta t}$$

Therefore the node is moving in network by the velocity V. then two estimated the new location we need to find the direction of movement too. For finding the angle of movement the following equation is used.

$$\theta = cos^{-1}\frac{x_i - x_{i-1}}{\sqrt{(x_i - x_{i-1})^2 + (y_i - y_{i-1})^2}}$$

Now we can predict the next possible location of the node by using the following equations:

$$x_{i+1} = x_i + vt\cos\theta$$

$$y_{i+1} = y_i + vt\sin\theta$$

Now we can find the distance of the node which is travelled by the node using the following equation:

$$R = \sqrt{(x_i - x_{i+1})^2 + (y_i - y_{i+1})^2}$$

And if the $R > r_{max}$ then node can leave the current route and route becomes abundant. Thus for finding the time after how many time this link is broken then we estimate the time as:

$$\delta t = \frac{R < r_{max}}{V}$$

III. NETWORK SIMULATION SETUP

This section includes the network parameters and the simulation scenarios on which the experimentations are performed.

3.1 Network Simulation Setup

To prepare and design the desired simulation model of communication the below given Network parameters are consumed which are listed in the below given table.

Table 3.1 Network Simulation Setup

Simulation properties	Values
Antenna model	Omni Antenna
Simulation area	1000X1000
Radio-Propagation Model	Two Ray Ground
Channel Type	Wireless Channel
No of Mobile Nodes	20, 30, 50, 80 and 100
Routing Protocol	AODV

3.2 Simulation Scenario

This section provides the understanding about the simulation scenarios under which the experiments are performed. To demonstrate the link breakage technique of two key simulation scenarios are proposed in this part. Both the simulation scenarios are conducted with different number of nodes that are 20, 30, 50, 80 and 100 nodes for both attacks.

In order to perform the experiments here we show simulation scenario of 20 node script of proposed and normal approach with their description in given figure 3.1 and 3.2.

3.2.1. Simulation of Traditional Link Prediction based on AODV: In this demonstration, we simulate the network on the basis of the different number of node. These mobile nodes are moving in MANET network and communication to each other while established route. Figure 3.1 show the normal AODV scenario for link breakage prediction. In this green nodes are depict the normal node and blue nodes are source and destination nodes.

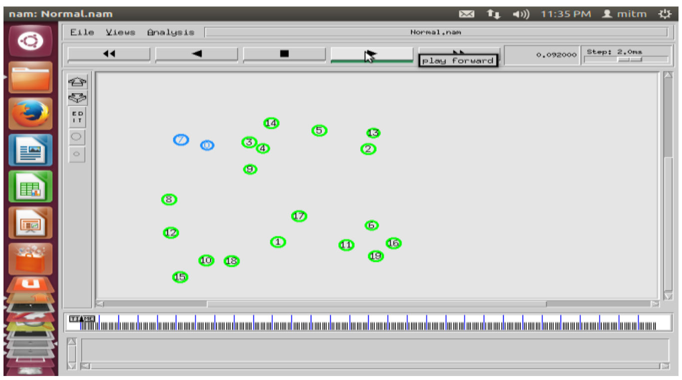

Figure 3.1 Normal AODV Approach

3.2.2. Simulation of Proposed Link Breakage Prediction under AODV Routing: In this phase the network is configured with the help of proposed link prediction technique using AODV and their performance is projected for comparative performance study. The required network is demonstrated using figure 3.2. This simulation screen shows that we switch the routed path if we successfully predicted failure of path. Simulation is processed over 20 nodes. Similar as above here also green nodes are normal nodes and blue nodes as source and destination nodes.

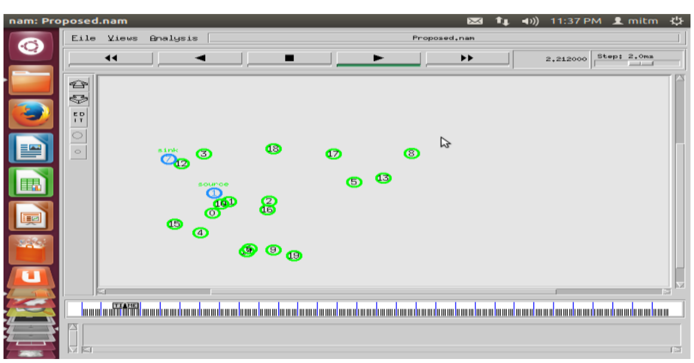

Figure 3.2 Proposed Link Prediction Approach

IV. RESULT ANALYSIS

This chapter provides the detailed discussion about the experiments performed with the AODV routing for both existing normal approach and the proposed LBP approach. The comparative study among both the techniques is also reported in this chapter.

4.1 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

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

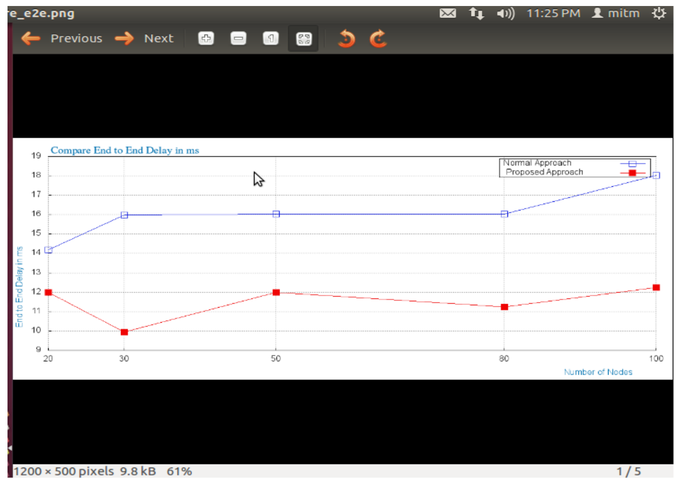

Figure 4.1 End to End Delay Comparisons

The end to end delay of the proposed approach and normal AODV based routing is reported in figure 4.1. In this diagram the X axis contains different nodes in the experiments and the Y axis shows the amount of end to end delay in terms of milliseconds for performance depiction. The results demonstrate the end to end delay of the network in normal AODV is higher as compared to the proposed approach. Therefore the proposed technique is much flexible as compared to the existing 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 normal and AODV with proposed concept because high node density increases collisions.

4.2. Consumed 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.

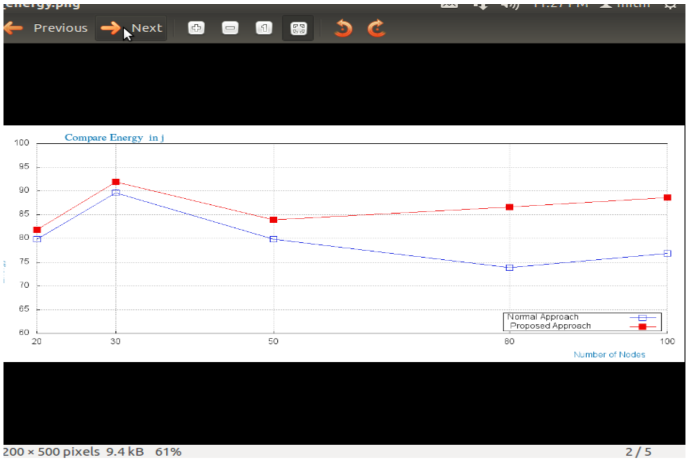

Figure 4.2: Consumed Energy

The figure 4.2 shows the amount of energy consumed in network nodes during the different experiments. The experiments are performed over 20, 30, 50, 80 and 100 numbers of nodes. In order to demonstrate the performance of networks the X axis shows the number of nodes and the Y axis shows the energy consumed after simulation. The measurement of energy is given here in terms of Joule. According to the generated results the proposed technique consumes minimum energy as compared to the normal AODV approach. Therefore the proposed approach of route prediction is energy efficient as compared to normal network configurations which is based on normal AODV routing protocol. Therefore, normal AODV and AODV with proposed gives the increasing average energy consumption as network load increases, since more packets are generated in the network and these packets are send to the destinations therefore, more energy is consumed in successful communication of these packets.

4.3 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 normal AODV routing and Link breakage prediction based technique is described using figure 4.3. In this diagram the different number of nodes are given in X axis and the Y axis illustrate the number of packet delivery ratio in percentage. According to the generated results the proposed technique able to deliver more packets effectively as compared to the normal AODV method. Therefore the proposed technique is more effective as compared to the traditional method. Thus the proposed approach is more efficient than the traditional AODV routing approach.

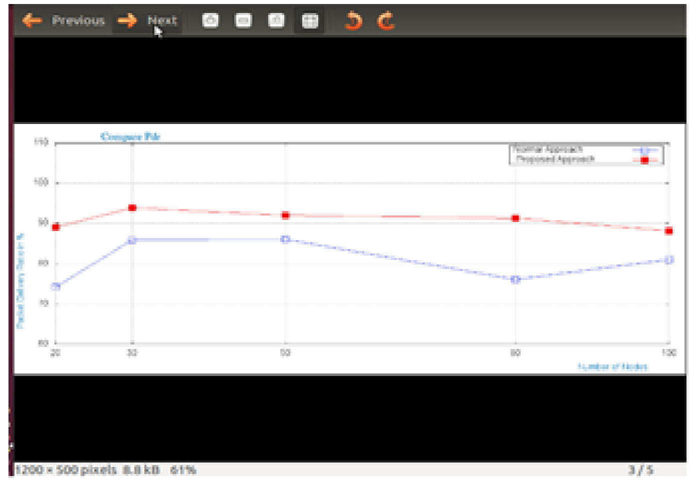

Figure 4.3 Packet Delivery Ratios

4.4 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 rises routing overhead problems. The amount of routing overhead for both the network routing scenario is given using figure 4.4.

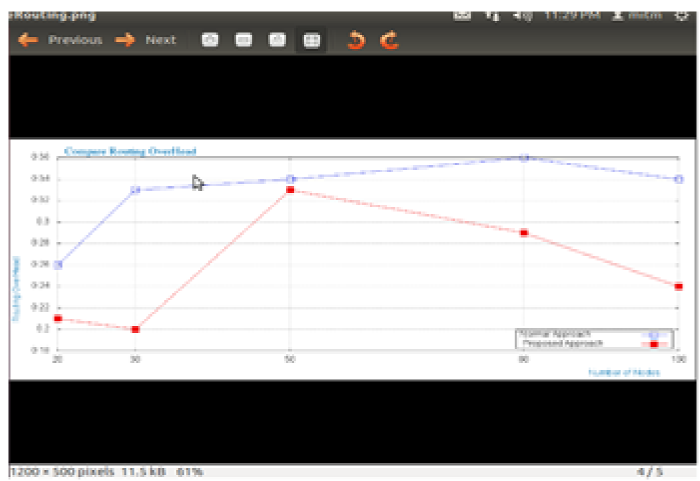

Figure 4.4 Routing Overhead

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 in per unit of time. According to the experimental results the proposed link prediction technique produces less overhead as compared to the AODV, thus proposed technique much suitable for improving other network performance parameters. The main reason behind generating routing overhead is the additional control messages is forwarded when new route is establish to know participating all nodes..

4.5 Throughput

It is defined as the total number of packets delivered over the total simulation time. 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 AODV routing and proposed Link Breakage Prediction with AODV routing technique is demonstrated using figure 4.5. 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 AODV approach.

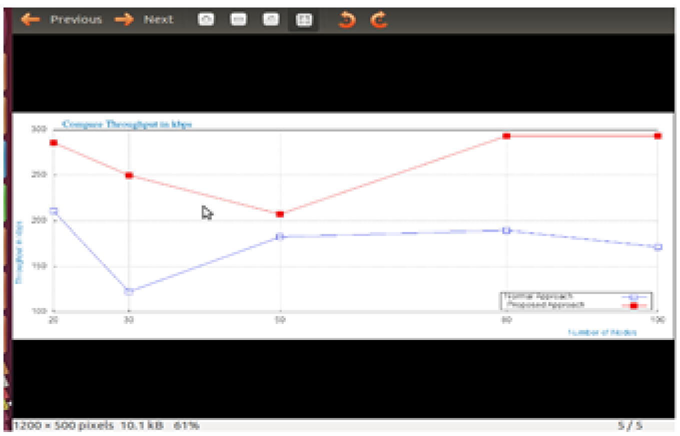

Figure 4.5 Throughput.

V. CONCLUSIONS AND FUTURE WORK

This chapter provides the summary of the proposed formulation of the link stability prediction. That solution is helpful to know about the time when the link is broken. In addition of that the future improvement of the work is also reported in this work.

5.1 Conclusion

Wireless communication is keeps attracted researchers to deploy more and more efficient networks. Therefore a continuous work is observed in this domain. In different popular network technologies the MANET has its own importance and their applications. The network is becomes popular due to their ability and challenges because that supports mobility, independence of devices, wirelessly communication, dynamicity and less use of infrastructure. Due to this the performance achievement is a much challenging task. In this presented work the mobility is the key area of investigation and protocol design. Among various mobility based issues this work is intended to improve the traditional routing protocol for their link stability. Behind this concept the main aim is to find out the amount of time on which a route or link broken. Therefore if we correctly estimate this time we can manage the new route for continuous flow of current or ongoing communication.

The proposed route stability prediction technique is based on location tracking technique. In this approach the node's coordinates are approximated and their correlation is established for finding the new position of the node. In this context two parameters are helpful first direction of node movement and velocity of the node movement. That helps to impure the prediction accuracy of the node. But in the current issue the aim is to estimate time when the node leave the route and it broken. Therefore the distance among the initial position and last predicted position is estimated. If the distance among predicted node location and initial location is greater than the radio range of two nodes by which the route is formed then the link broken. Thus finally the distance among both the location (i.e. predicted position and initial position) and the velocity is again used for computing the time when the node leaves the route. In order to place the concept the AODV routing protocol is modified.

The implementation of the proposed improved AODV routing protocol for finding the stable route is performed using the NS2 network simulator. In addition of that their comparative performance study is performed with the traditional technique namely AODV routing protocol. The obtained performance is summarized in table 5.1.

S. No.	Parameters	Proposed AODV	Traditional AODV
1	Throughput	High	Low
2	End to end delay	Low	High
3	Packet delivery ratio	High	Low
4	Energy remain	High	Low
5	Routing overhead	Low	High

Table 5.1 performance summary

According to the obtained performance the proposed AODV perform much effectively for the issues of network performance. Additionally help to improve the packet delivery ratio, bandwidth utilization and other expensive resource parameters. Thus the proposed technique is helpful for network performance improvement.

5.2 Future Work

The proposed technique of the ad hoc network route stability prediction is implemented successfully and demonstrated their effective performance. In near future the following extensions are feasible for the work.

1. In this current solution a node is placed with assumption to find accurate outcome. In near future

using only two nodes the prediction of the node is proposed.

2. The work is also extended and simulated for the real world applications such as VANET and other similar technologies where mobility is a key issue of communication
3. In near future the work is also included for optimization based techniques such as hill climbing approach

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