International Journal of Scientific & Engineering Research, Volume 4, Issue 9, September-2013 679
ISSN 2229-5518

Mobility Assisted Routing In MANET Using AODV

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Abstract—One of the major challenges in mobile ad hoc networks (MANETs) is link failures due to mobility. In order to reduce packet loss due to link failures, an algorithm that takes care of mobility needs to be integrated in routing protocols. The proposed algorithm estimates the route's Route Life Time (RLT), and allows routing protocol to send maximum number of packets that can traverse the route successfully during this RLT period. It also increases the network throughput and packet delivery ratio of MANETs by estimating the maximum number of packets that can traverse through the route before it breaks because of mobility. The algorithm includes mobility information and is combined with the existing AODV (Ad hoc On demand Distance Vector) routing protocol to reduce packet loss in MANETs.

Index Terms—Link life time, route life time, mobility, threshold link life time, minimum threshold link life time ,MANET,AODV

1 Introduction

Mobile ad hoc network (MANET) is a collection of independent mobile nodes that can communicate to each other through radio waves. The mobile nodes can directly communicate to those nodes that are in radio range of each other whereas other nodes need help of intermediate nodes to route their packets. In MANETs, nodes are free to move and organize without involving any infrastructure or centralized administration. There may be a need for intermediate nodes, working as relays, to establish a communication path between source-destination pairs in the network because of the limited transmission range of wireless radio transceivers.

One of the major challenges in MANETs is link failures due to mobility. In a MANET nodes act as routers for any ongoing packet communication and have limited transmission range. When the communication links are broken the packet loss occurs. If we can predict how long a link can be operational then, the routing protocol can use this to its advantage. The duration of connectivity of two neighboring nodes in a route is called LLT(Link Life Time).The RLT(Route Life Time) is a measure of how much time the route will be alive. The RLT depends on the LLTs of links, and can be taken as the lowest LLT in the route. When degree of mobility increases, LLTs and eventually RLTs decrease. That contributes to increase in packet loss and low throughputs in a MANET. In order to reduce packet loss due to link failures, mobility needs to be integrated in routing protocols. The proposed algorithm estimates the route's RLT, and allows routing protocol to send number of packets that can traverse the route successfully during the RLT period. An algorithm that includes mobility information is combined with the existing AODV routing protocol to reduce packet loss in MANETs.

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2 Related work

R.S. Chang and W.W. Chen proposed a mobility assessment on-demand (MAOD) routing protocol to select a stable route in order to enhance system throughput and performance [1]. MAOD is an on-demand routing protocol similar to dynamic source routing (DSR) protocol .The difference between MAOD and DSR is in the path selection method. As MAOD takes the mobility of the hosts into consideration, it selects a more stable route than DSR. In MAOD, an error count parameter is used to measure mobility of a host. However, the error count method has problems in judging the mobility of the nodes because it does not indicate which node is mobile, the node itself or the nodes around it

M. Pascoe, J. Gomez, V. Rangel, and M. Lopez-Guerrero, proposed a model to determine the upper bound on the maximum network size of wireless Adhoc networks [2]. The upper bound on the maximum network size is found by determining the maximum feasible number of intermediate nodes, in any route of the network. The maximum number of intermediate nodes is inversely proportional to the packet size and speed of nodes. This model can be used to scale up/down the network size as to meet minimum route duration requirements to guarantee a communication path for any source-destination pair in ad-hoc networks.

S. Basagni, D. Turgut, and S.K. Das proposed a protocol for managing mobile ad hoc networks [3]. In this protocol, a small subset of the network nodes, called backbone network, is selected based on the nodes' status. The protocol operates in two phases: first the "most suitable" nodes are selected to serve as backbone nodes, and then a backbone network is formed by using these nodes.

After a certain number of hops a route would die due to mobility. When there is an increase in mobility the expected link life time decreases exponentially. MAOD routing protocol select a stable route to increase system throughput and performance. On-demand multicast routing protocol (ODMRP) is a reactive (on-demand) protocol that delivers packets to a destination in a mesh topology using scoped flooding of data.

ODMRP proposes a method to predict the link expiration time, which is based on a more realistic propagation model.

M. Zhao and W. Wang investigated topology dynamics based on the smooth mobility model [4]. The smooth model generates smooth and microscopic nodal movements, and maintains a uniform spatial node distribution. The model predicts link existence based on the present distance between a pair of nodes and their relative speeds. The analysis reveals that the expected link life time decreases exponentially with increasing mobility.

N. Enneya K. Oudidi and M. Elkoutbi proposed a new measure of mobility in which each node estimates at regular time intervals its relative mobility with respect to its neighbors [6].

Vincent Lenders, Martin M, proposed the impact of mobility on the link and route lifetimes in ad hoc networks is of major importance for the design of efficient MAC and network layer protocols [8]. Till now, no real-life measurements were used to study the effect of node mobility on link and route lifetime distributions. They presented data gathered from a real network of 20 test users and analyzed it with regard to link and route lifetime distributions. Link breakage can happen due to node mobility and also due to diverse sources of interference or packet collisions. They develop a statistical framework to distinguish between the mobility and interference or collision errors. With this framework, they are able to determine and analyze the lifetime distributions for both error types separately. They use this framework together with our measurements to validate two commonly used stochastic mobility models including the random waypoint and the random reference group mobility model.

K. A. Rahman and M. Lott presented neighborhood capture problem in ad hoc networks [9]. A possible way to solve this problem was provided with theoretical and experimental analysis. Extended Reservation ALOHA is very good for solving neighborhood capture when the number of nodes in ad hoc networks is higher.

The main advantage of AODV over DSR is that the packet header overhead in DSR is larger than AODV because data and control packets in DSR typically carry complete route information. The scalability of DSR is restricted by the header overhead in DSR. Compared to DSR, AODV is able to run on larger networks.

3 Proposed Algorithm

The duration of connectivity between two nodes changes with mobility in MANETs where as it is unlimited for static ad hoc networks. Link failures are inevitable if the nodes are mobile. When degree of mobility increases, LLTs and eventually RLTs decrease. This contributes to increase in packet loss and low throughputs in a MANET. In order to reduce packet loss due to link failures, mobility needs to be integrated in routing protocols. This integration can be done with any on-demand routing protocols (i.e. DSR, AODV). But we choose AODV as our candidate key because of its better performance compared to DSR

3.1 Calculation Of LLT

S.J. Lee, W. Su, and M. Gerla, proposed a method to calculate LLT [7]. This method is utilized for the calculation of LLT. Figure1 shows two mobile nodes P and Q with their radio range r. The present location of P and Q are P (X_{a1}, Y_{a1}) and Q (X_{b1}, Y_{b1}) respectively. P and Q are moving with a velocity V_p and V_q, and angles θ_p and θ_q respectively. Their future locations are P (X_{a2}, Y_{a2}) and Q(X_{b2},Y_{b2}) after some time t. The next location is calculated using all the information related to their current location, by following two functions.

$$P (X_{a2}, Y_{a2}) = f(t, V_p, \theta_p, X_{a1}, Y_{a1}) \quad (1)$$

$$Q (X_{b2}, Y_{b2}) = f(t, V_q, \theta_q, X_{b1}, Y_{b1}) \quad (2)$$

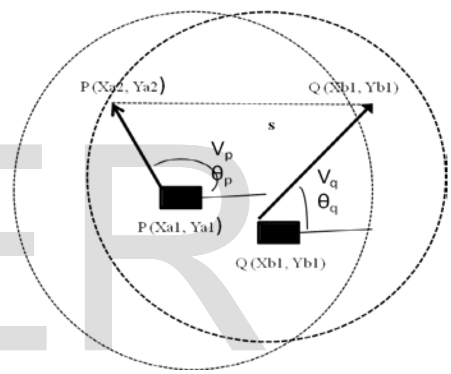

Fig1. A scenario for calculating LLT

If the distance between P and Q after time t is s then

$$S^2 = (X_{a2} - X_{b2})^2 + (Y_{a2} - Y_{b2})^2 \quad (3)$$

P and Q will be able to communicate with each other as long as they will remain within their transmission range, r. So, t = LLT if S ≤ r. After solving (3) with S≤ r and considering t = LLT, we get

$$LLT = \frac{-(ab+cd)+\sqrt{(a^2+c^2)r^2-(ad-bc)^2}}{a^2+c^2} \quad (4)$$

Where $a = V_p \cos\theta_p - V_q \cos\theta_q$, $b = (X_{a2} - X_{b2})$ $c = V_P \sin\theta_p - V_q \sin\theta_q$, and $d = (Y_{a2} - Y_{b2})$

3.2. Mobility Model

Kazi Atiqur Rahman and Kemal E. Tepe proposed a mobility model [5]. This model has been implemented to treat the mobility related issues in the ad hoc network. In MANETs the movement of node is unpredictable and the time they are in range holds key for packet transmission. Hence calculation of link life time is carried with respect to the mobility of nodes, as there is increase in mobility, LLT between the nodes decreases. This breaks the routes, and packet loss occurs due to link failure which significantly affects the packet delivery ratio, throughput and delay. Hence this model has been proposed with other routing protocol to increase its efficiency. After calculating the LLT and RLT, AODV protocol comes in picture in finding the path among all the available routes calculated using RLT. The proposed algorithm solves the path finding and mobility related problem as explained in four steps.

Step 1: Estimation of minimum threshold LLT initiated by source

In the proposed algorithm source uses minimum threshold link life time (TLLT) to find more stable link and route to the destination. Upon estimating the TLLT based on the nature of mobility, which is random mobility in some area and stable in places where mobility is least. As per two aspects of mobility, the TLLT has to be set accordingly. In random mobility the TLLT can be set higher for low speeds compared to high speed and in stable aspect the TLLT can be set higher [8].

Step 2: Route discovery using TLLT

In a reactive protocol, whenever there is a packet to be transmitted, the source itself will search for the route in the route cache. If no route is present in the cache then with the help of RREQ message AODV protocol will start the path finding process. Each node along the path towards destination calculates its own LLT with the previous nodes, and compares the calculation with TLLT in the packet. If the LLT calculated is greater than the TLLT of the packet, then this node becomes part of the route. This will help to find out routes that have less stable links.

Step 3: Route life time determination

The liveliness of the route is called the route life time (RLT), that is all the nodes in the networks have their own link life time, and the node with lowest LLT has high probability of breaking the route. So, the link with lowest LLT in any route is considered as RLT. Here if any node is a part of the route, it compares its own LLT with the RLT in the route discovery packet sent by the source. If the LLT is less than the RLT, it replaces the RLT in the discovery packet with its own LLT. Or if LLT is more or equal, it forwards the route discovery packet without changing RLT field. The source receives the route reply packet; calculate the net RLT i.e. RLT_{net}, which is difference between RLT of the packet and the time taken by the route reply packet to arrive at the source, t_{route}. RLT_{net} and t_{route} are stored in route cache by source. t_{route} is average latency between source and destination. Then, RLT_{net} is given by

$$RLT_{net} = RLT - t_{route} \quad (5)$$

Step 4: Algorithm for packet loss reduction

Whenever there is a packet to send, the source searches for route from route cache, and estimates the number of packet that route is able to deliver without loss. Latency between source and destination, t_{route}, is important. Let us consider N_{est} be estimated number of packets to be sent through that route, and calculated by

$$N_{est} = RLT_{net}/t_{route} \quad (6)$$

The selected route will be alive during RLT_{net}, and within RLT_{net}, the source will be able to send the N_{est} number of packets. If more than N_{est} numbers of packets are sent they have high probability of getting lost due to broken route. If there are many packets to be sent then the source has to find an alternative route from route cache, if there is no such route is present again the route discovery process is re initiated again.

4 System Model and Implementation

The proposed algorithm is implemented in Mobile ad hoc networks with 25, 50 and 100 nodes. The scenarios were tested with Network Simulator version 2.34 (ns2) [10] in Linux. Each node is using an Omni-directional antenna with a height of 1.5 meters. Two ray ground reflected propagation model is chosen for radio propagation. Constant bit rate (CBR) traffic is used as the traffic mode at the source, and it is producing 512 byte data packets. User datagram protocol (UDP) is used in transport layer. Loss monitor is used at the destinations to monitor and measure the observed parameters at the end of each transmission. The simulations were run for 10 seconds. We have used AODV with mobility to obtain the result.

5 Results

Three metrics packet delivery ratio, packet loss and average packet delay are considered in measuring and comparing the performance of the proposed algorithm with existing solutions. Packet delivery ratio is the ratio between the number of received packets by the destination and the total number of packets sent by the source at the end of each simulation. Packet loss is defined as the total number of lost packets during the simulation. Average packet delay is defined as the span of time required by a packet to reach from source to destination. The proposed algorithm is compared with our implementation with original AODV and simulated for 100 nodes. The results are shown in Fig 2, Fig 3 and Fig 4.

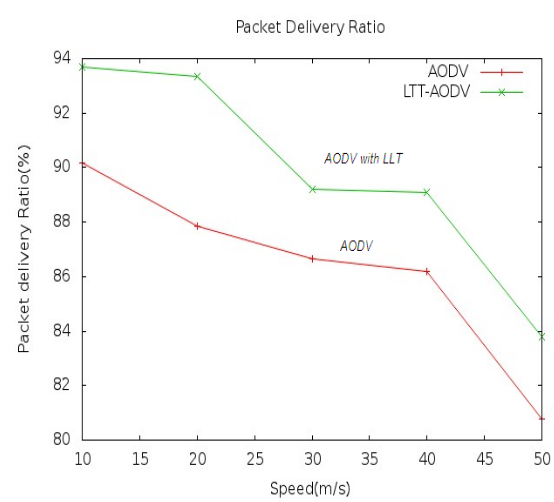

Fig 2 Packet delivery ratio versus speed

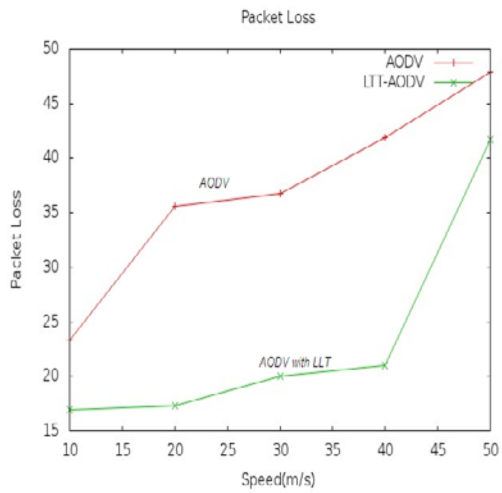

Fig 3 Packet loss ratio versus speed

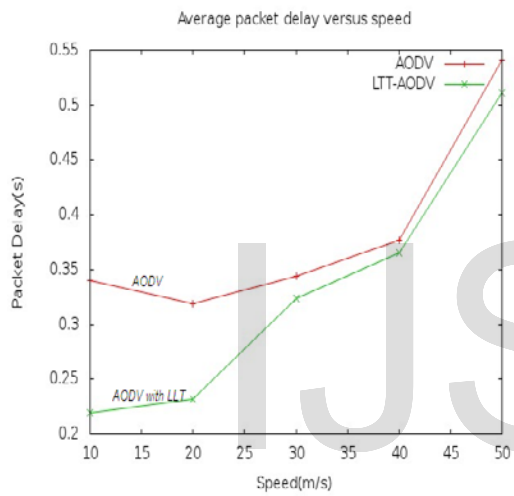

Fig 4 Packet delay ratio versus speed

The proposed algorithm is simulated with different number of nodes (i.e., 10, 25, 30 and 100 nodes) to see the impact of the size of a MANET on the mobility assisted algorithm. The results are shown in figure 5. The number of link failures is increasing with increasing number of nodes.

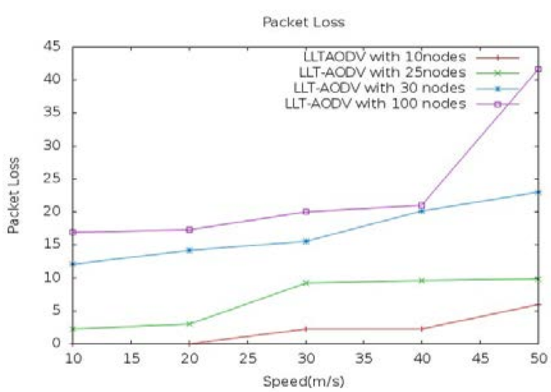

Figure 5 Effect of number of nodes on packet loss

6 Conclusion

A new approach to reduce packet loss due to inevitable link failures in MANET is presented. The proposed changes to the routing algorithm are implemented in AODV but this approach is independent of the choice of any on-demand routing protocol. RLT is estimated using the route discovery mechanism. Using RLT and latency, the number of packets that can traverse a route is estimated, and only this number of packets is sent through that route. The simulation results show that packet loss decreases and packet delivery ratio increases significantly compared to the conventional AODV and AODV with LLT. Packet loss is reduced by 52 percent when speed is 20 m/s and 50 percent when speed is 40 m/s.

Acknowledgment

We would like to express our profound sense of gratitude to the Management of M. S. Ramaiah Institute of technology, Bangalore who has provided us with all the resources to carry out our work. We would also like to thank all faculty members and HOD of department of CSE MSRIT for their valuable suggestion.

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