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Efficient Beaconing and Mobility Prediction for GPSR Protocol in MANETs

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ABSTRACT: In Mobile ad hoc networks, each node is needed to maintain its location information with the neighbor nodes. For this purpose they transmit the beacon packet periodically, which is not fair in terms of update cost and performances in term of routing decision. Further the inaccuracy in local topology has its impact on the performance geographic routing. To overcome this we introduce the Efficient Beacon Scheme and a prediction Scheme for Link Expiration Time. For geographic routing we use Greedy Perimeter Stateless Routing (GRPS) Protocol with greedy techniques. When greedy fails in selecting the next node nearest to destination we use perimeter rule which search over the perimeter for the destination. Using the Efficient Beacon technique in GPSR we try to decrease the update cost and increase accuracy of local topology.

I. INTRODUCTION

In MANET there is no fixed communication infrastructure. Each node is free to move in an arbitrary manner. Hence it's necessary for nodes to maintain updated position information with the immediate neighbor. Also there will be frequent changes in the topology of the mobile nodes. In geographic routing, the destination node and the node in the forwarding path can be mobile. In such case it is necessary to reduce the effects caused by the changing topology, which is a difficult task in geographic routing to reconstruct the network topology in presences of changing topology. Various routing schemes have been proposed which uses the location information such as LAR.

To obtain the location of node's neighbor, each node exchanges its location information (Using GPS) with its neighbor by periodic broadcast of beacons. This periodic beaconing is not fair in terms of update cost and for the possible for collision. To overcome this drawback, in this paper we propose an efficient beacon scheme, which dynamically adjust the frequency for beacon update based on nodes mobility. Also we enhance the location information to estimate the expiration time of the link between two nodes.

II. LITERATURE SURVEY

Greedy Perimeter Stateless Routing (GPSR) [2] uses the neighbor list of node and destination location for forwarding decision. In Greedy forwarding strategy the next hop is selected based on the optimal path that is it always selects a node which is closest to the destination. Nodes broadcast beacon to immediate neighbors periodically for maintaining local topology.

In [4] showed that the inaccuracy of location information has a significant impact on the performance of geographic routing protocols. They applied a mobility prediction scheme as [3] to GPSR and studied its impact of on the performance. However, they only use the prediction scheme to compute current position of neighbors and still employed periodic beacon updates.

Heissenbuttel et al[5]. have shown that periodic beaconing can cause the inaccurate local topologies in highly mobile ad-hoc networks, which leads to performances degradation. They proposed several simple optimizations that adapt beacon interval to node mobility or traffic load, including distance-based beaconing (DB), speed-based beaconing.

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In the distance-based beaconing, a node transmits a beacon when it has moved a given distance d. The node removes an outdated neighbor if the node does not hear any beacons from the neighbor after a maximum time out. However, this approach has two problems. First, a slow node may have many outdated neighbors in its neighbor list since the neighbor time-out interval at the slow node is longer[6]. Second, when a fast moved node passes by a slow node, the fast node may not detect the slow node due the infrequent beaconing of the slow node, which reduces the perceived network connectivity.

In the speed-based beaconing, the beacon interval is dependent on the node speed. A node determines its beacon interval which is inversely proportional to its speed. Nodes piggyback their neighbor time-out interval in the beacons. A receiving node compares the piggybacked time-out interval with its own time-out interval, and selects the smaller one as the time-out interval for this neighbor. In this way, a slow node can have short time-out interval, which eliminate first problem. But it still suffer from the second problem i.e. a fast node may not detect the slow node existences.

III. EXISTING METHODS

3.1 Adaptive Position Update (APU)

Initially, each node broadcasts a beacon to its neighbors to inform its presences stating its current location and velocity. Following this each node periodically broadcasts its current location information. This position information of beacons is stored at each node[7]. Each node continuously updates its neighbor list based on its transmission range, current location and the position updates received from its neighbors. Neighbors which are outside the nodes communication range are not considered for data forwarding. Hence beacon is very important in building the local topology.

Instead of periodic beaconing, APU adapts the beacon update intervals to the mobility of the nodes and the amount of data being forwarded in the neighborhood of the nodes. APU uses two principles 1) nodes that are frequently changing its position are updated frequently 2) nodes which are in forwarding path are updated.

Mobility Prediction (MP) Rule

This rule adapts the beacon generation rate to the mobility of the nodes. Nodes that are highly mobile need to frequently update their neighbors since their locations are changing dynamically. On the contrary, nodes which move slowly do not need to send frequent updates. A periodic beacon update policy cannot satisfy both these requirements simultaneously, since a small update interval will be wasteful for slow nodes, whereas a larger update interval will lead to inaccurate position information for the highly mobile nodes.

In our scheme, upon receiving a beacon update from a node *i*, each of its neighbors, denoted by the set *N(i),* records its current position and velocity and continues to track node *i's* location using a simple prediction scheme (discussed below). Based on this position estimate the neighbors *N(i)*, check whether node *i* is still within their transmission range and update their neighbor list accordingly[8]. The goal of the MP rule is to send the next beacon update from *i* when the error between the predicted location in *N(i)* and *i's* actual location is greater than an acceptable value. To achieve this, node *i*, must track its own predicted location in its neighbors, *N(i).*

We use a simple location prediction scheme based on the physics of motion to track a nodes current location. Note that, in our discussion we assume that the nodes are located in a two-dimensional coordinate system with the location indicated by the x and y coordinates. However, this scheme can be easily extended to a three dimensional system.

Let (X_a, Y_a), denote the actual location of node i, obtained via GPS or other localization techniques. (X_p, Y_p) denotes the predicated position of the node I at current time. Node i then computes the deviation D^idevi as follows:

$$D^i_{devi}=\sqrt{((X^i_a - X^i_p)^2 + (X^i_a - X^i_p)^2)} \qquad (1)$$

If the deviation (Obtained in Eqn(1)) is greater than a certain threshold, known as the *Acceptable Error Range (AER)*, it acts as a trigger for node i to broadcast its current location and velocity as a new beacon. The AER threshold is an important parameter that can affect the performance of the APU scheme. A large value of AER will minimize the

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beacon updates but will result in a larger error in the estimated location of the node at its neighbors. On the contrary, a smaller value guarantees accuracy of location information amongst the neighbors but increases the beacon overheads.

The MP rule, tries to maximize the effective duration of each beacon, by broadcasting a beacon only when the position information in the previous beacon becomes inaccurate. This extends the effective duration of the beacon for nodes with low mobility, thus reducing the number of beacons. Further, highly mobile nodes can broadcast frequent beacons to ensure that their neighbors are aware of the rapidly changing topology.

On-Demand Learning (ODL) Rule

The MP rule solely may not be sufficient for maintaining an accurate local topology. Consider the example illustrated in Fig. 1, where node 1 moves from P1 to P2 at a constant velocity. Now, assume that node 1 has just sent a beacon while at P1. Since node 2 did not receive this packet, it is unaware of the existence of node 1. Further, assume that the AER is sufficiently large such that the MP rule is never triggered. However, as seen in Fig. 1 node 1 is within the communication range of 2 for a significant portion of its motion. If either 1 or 2 was transmitting data packets, then their local topology will not be updated and they will exclude each other while selecting the next hop node. In the worst-case, assuming no other nodes were in the vicinity, the data packets would not be transmitted at all.

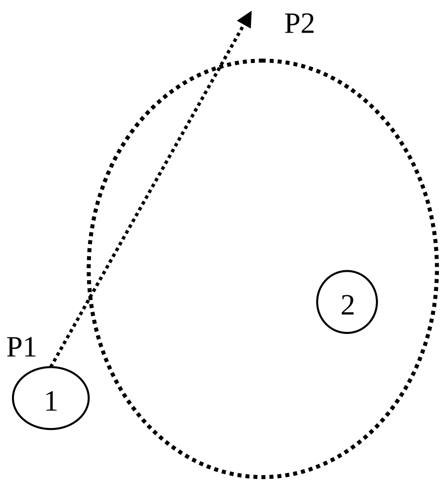

Fig 1. An example illustrating a drawback of the MP rule

Hence, it is necessary to devise a mechanism which will maintain a more accurate local topology in those regions of the network where significant data forwarding activities are on-going. This is precisely what the *On-Demand Learning (ODL)* rule aims to achieve. As the name suggests, a node broadcasts beacons *on-demand*, i.e. in response to data forwarding activities that occur in the vicinity of that node. According to this rule, whenever a node overhears a data transmission from a *new* neighbor, it broadcasts a beacon as a response.

The ODL rule allows active nodes that are involved in data forwarding to enrich their local topology beyond this basic set. In other words, a *rich* neighbor list is maintained at the nodes located in the regions of high traffic load[9]. Thus the rich list is maintained only at the active nodes and is built reactively in response to the network traffic. All inactive nodes simply maintain the basic neighbor list. By maintaining a rich neighbor list along the forwarding path, ODL ensures that in situations where the nodes involved in data forwarding are highly mobile, alternate routes can be easily established without incurring additional delays.

Fig. 2(a) illustrates the network topology before node 1 starts sending data to node P. The solid lines in the figure denote that both ends of the link are aware of each other. The initial possible routing path from 1 to P is 1-2-P. Now, when source 1 send a data packet to node 2, both 3 and 4 receive the data packet from 1. As 1 is a new neighbor of 3 and 4, according to the ODL rule, both 3 and 4 will send back beacons to 1. As a result, the links 1-3 and 1-4 will be discovered. Further, based on the location of the destination and their current locations, 3 and 4 discover that the

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destination P is within their one-hop neighborhood. Similarly when 2 forwards the data packet to P, the links 2-3 and 2-4 are discovered. Fig. 2(b) reflects the enriched topology along the routing path from 1 to P.

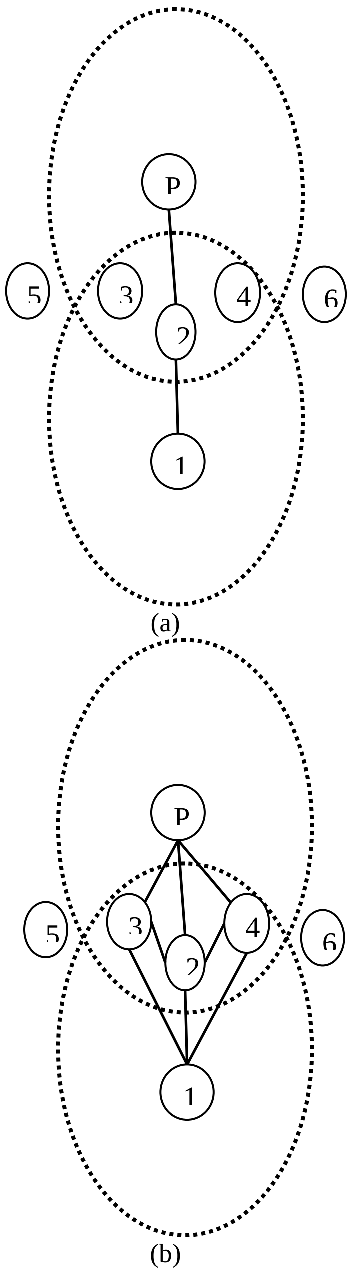

Fig 2. An example illustrating the ODL rule

3.2 Estimation of Link Expiration Time

We introduce our mobility prediction method utilizing the location and mobility information provided by GPS. We assume a free space propagation model, where the received signal strength solely depends on its distance to the transmitter. We also assume that all nodes in the network have their clock synchronized (e.g., the GPS clock itself).

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Therefore, if the motion parameters of two neighbors (e.g., speed, direction, radio propagation range, etc.) are known, we can determine the duration of time these two nodes will remain connected. Assume two nodes *i* and *j* are within the transmission range *r* of each other. The predicted time is the link expiration time (LET) between the two nodes. Let (X_i,Y_i)be the coordinate of mobile host *i* and (X_j,Y_j) be that of mobile host *j*. Also Let V_i and V_j be the speeds, and θ_i and θ_j be the moving directions of nodes *i* and *j* respectively. Then, the amount of time two mobile hosts will stay connected, D_t is predicted by:

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

Where,
a= $V_i \cos\theta_i - V_j \cos\theta_j$,
b=$Xi - Xj$.
c= $V_i \sin\theta_i - V_j \sin\theta_j$, and
d=$Yi - Yj$. (2)

Using Eqn(2), the routing protocol always selects routes with the largest LET for data forwarding. However they used this scheme only for link expiration by implementing periodic beacons.

IV. PROPOSED METHOD

In [1], they used the Adaptive Position Update Scheme for dynamically adjust the frequency for beacon update by using GPSR protocol for geographic routing[10]. However in GPSR, the selected next node for forwarding the packet may get lost in the forwarding path due to the mobility of node out of the range, which decreases the performances of routing protocols. In this paper we propose our work by using the dynamic adjustment of the frequency for beacon update interval and estimation of the expiration time of the link between the mobile nodes. Based on the link expiration time the next hop is selected for forwarding the packets.

V. CONCLUSIONS

In this paper, we proposed the Efficient beaconing scheme and the mobility prediction rule to estimate the link expiration time of the nodes to increase the performances of geographic routing protocol. Future work includes the analysis of various geographic routing protocols using the above prediction scheme for beaconing and routing in Mobile Ad hoc Networks.

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