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Framework for Location Based Power Aware Routing in MANET

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Abstract

With the rapid growth in the area of wireless networks and mobile applications, Quality of Service (QoS) provision has received the attention of researchers. But unpredictable nature of Mobile Adhoc Networks makes it a very difficult task. Various QoS based protocols have been proposed by the researchers. These protocols make use of either proactive (table-driven) or reactive (on-demand) approach. Table driven approach requires a large amount of storage space to store the information regarding whole of the network which is not possible in case of small mobile devices. On the other hand, due to flooding of RREQ packets, on-demand routing protocols consumes a large amount of bandwidth and thus increases the network load. Also, there is a transmission delay for the first data packet. This paper presents an optimized approach for providing QoS in a location aware environment.

Keywords: *Bandwidth, Battery Power, GPS, MANET, routing .*

1. Introduction

A mobile Ad hoc network is network of mobile nodes which are able to create dynamic topology without any central administration. Thus, the task of efficient routing the data packets in terms of QoS and energy consumption becomes very important. Many routing protocols have been proposed for efficient routing [1,2,3,4,5,6,7,8].

Earlier on-demand routing protocols[3,4,5,6,7] were based on flooding the routing packets in all directions irrespective of the location of the destination node, resulting in increase in bandwidth consumption where as table driven protocol [2] maintains large amount of information as well as they perform large computations in order to select the best node which results in premature loss of battery life. This bandwidth consumption was reduced by the Location Aided Routing Protocols [9,10,11,12,13]. These location based protocols uses the Global Positioning System (GPS) [14] to find the direction of propagation of the packets. By finding the direction of propagation we can decrease the bandwidth consumption.

In this paper, we are proposing a power aware routing approach which helps in decreasing the routing overhead by utilizing the concept of global location information of mobile nodes. The proposed protocol Location Based Power Aware Routing (LBPAR) protocols use location information to minimize the Request Zone to reach the destination node. LBPAR will also help in reducing the overheads at each node by decreasing the number of calculations performed at each node, which in turn increased the battery life of node.

Rest of the paper is organized into following sections. Section II gives an overview of the existing work in the area of location aided routing. Section III describes the proposed protocol. Section IV gives the evaluation of proposed work. Section V presents conclusion.

2. Related Work

Nodes in the ad hoc network are dependent on the batteries for the power supply. As batteries have limited life, it becomes imperative to find the routing protocols which require less number of calculations.

In recent times, many routing protocols have been proposed which uses the Global Positioning System (GPS). The GPS Scheme uses the concept of forwarding region. An intermediate node forwards the data packets to the next intermediate node only if it lies in with in the forwarding region. Node using GPS needs to obtain the various co-ordinates such as latitude, longitude and altitude co-ordinates. This kind of geocasting is helpful in sending emergency messages to the small area. The GPS plays the most vital role in all the location based routing protocols like DREAM, LAR, LARDAR, ILAR etc.

LAR (Location Aided Routing in Mobile Adhoc Networks) [9] is an on demand routing protocol which uses the location information to identify the request zone and expected zone. Request zone in this protocol is the rectangular area including both sender as well as receiver. By decreasing the search area, this protocol leads to the decrease in routing over heads.

DREAM (A Distance Routing Effect Algorithm for Mobility) [10] is a table driven protocol which maintains each node's location information in routing tables. Data packet is send by using this location information. To maintain the location table accurately, each node periodically broadcasts a control packet containing its own coordinates.

ILAR (Improved Location Aided Routing) [11] is another location based technique which uses the concept of base line lying in between the source and destination node. Node which is closest to this line of sight will be chosen as the next intermediate node. As the transmitting node check the distance of every neighboring node from base line and find the closest neighbor for further transmission. This process will increase the delay in data transmission and also increases the nodal overhead and in turn decreases the battery life.

LARDAR (Location Aware Routing Protocol with Dynamic Adaptation of Request Zone for Mobile Ad hoc Networks) [12] is an on demand routing protocol which decreases the search area given by LAR. In LAR the search area is the smallest rectangle containing both sender as well as receiver. LARDAR reduces this rectangle to triangular zone, which helps in reducing the routing overheads. But the calculations done to find whether the node lie in the forwarding zone or not increases the overhead on the node. This results in decrease in battery of the node.

The proposed protocol (LBPAR) tries to remove the above cited problems. LBPAR uses the concept of slope of line to minimize the search area and also the number of calculations which in turn increases the battery life and route life.

3. LBPAR The proposed protocol

3.1 Terminology Used

In order to understand the proposed protocol we first need to understand the concept of expected zone and request zone.

Expected Zone: Consider, source node S wants to send the data packet to destination node D at time T. Assume that S knows the location of D at time Ti. Also it also knows velocity (VD) of D with which D is traveling. Maximum distance traveled by D in any direction can be calculated as:

$$\mathbf{r = V_D\,(T - T_i)} \qquad \textbf{(1)}$$

As node is free to move in any direction, so the expected region will be a circular area of radius D shown in Fig. 1.

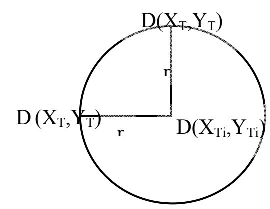

Fig. 1 Expected Zone

Request Zone: Request zone is the area where the request packets are sent or broadcast to find a path from source to destination. In the traditional routing algorithms it is the complete network. For eg. In AODV, DSR, etc. RREQ packet is broadcasted in all directions to find the optimal path from source to the destination node. LAR tries to minimize the request zone by confining it to the smallest rectangular area containing both sender as well as receiver (Fig. 2). Whereas, LARDAR uses the concept of Triangle zone and the angles α and β (Fig. 3).

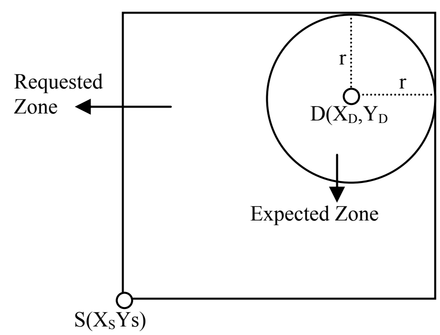

Fig. 2. Request zone and Expected zone in LAR

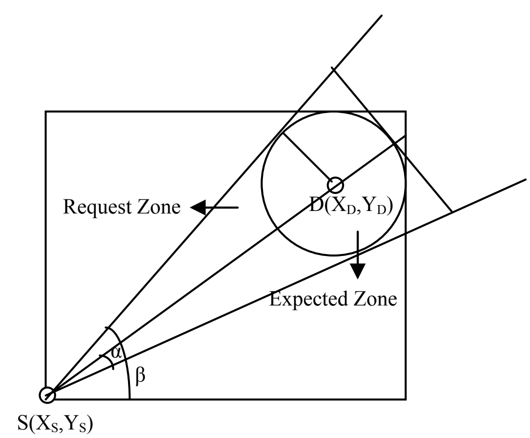

Fig. 3. Request zone and Expected zone in LARDAR

The proposed protocol LBPAR uses the concept of triangle zone. But instead of using the angular values in route request packet as in LARDAR we are using the concept of slopes of line (Fig. 4) which can be calculated using the following formula:

$$\mathbf{M_p = (X_P - X_S) / (Y_P - Y_S)} \quad \textbf{(2)}$$

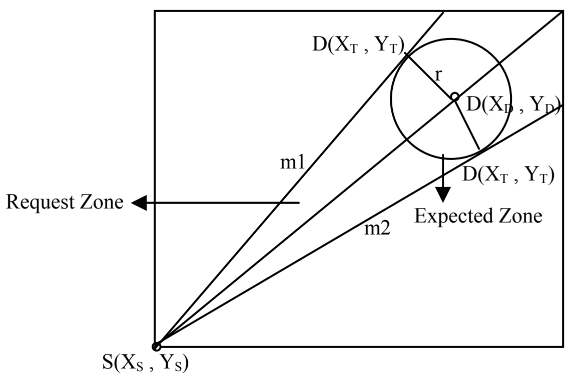

Fig. 4. Request zone and Expected Zone in LBPAR

Where,
M_P is the slope of a line drawn between point P and S
X_S is the X co-ordinate of S
X_P is the X co-ordinate of P
Y_S is the Y co-ordinate of S
Y_P is the Y co-ordinate of P

Route Zone: The Base objective of LBPAR is to find an optimal path in terms of bandwidth consumption along with the reduction in power loss of a node. Here, the route discovery process starts when source node S initiates a request to send the data packet to destination node D. m1 and m2 are the slopes of the line. $D(X_T,Y_T)$ are the points where the tangents drawn from source to the expected zone touches the expected zone. From the mathematical equations it is clear that m1 and m2 will be the maximum and minimum slopes for any line drawn between the source and any point in between these two tangents. These two slopes can be calculated from the following quadratic equation:

$$mX_D - mX_S - Y_D + Y_S = r \times \sqrt{1+m^2} \quad \textbf{(3)}$$

Source node S broadcast a route request packet to find the path. Format of RREQ packet is shown in Fig. 5.

On receiving the RREQ packet node 'N' calculates the slope m_N using its own location co-ordinates and source location co-ordinates. If its slope lies between the max and min slope i.e. ($\mathbf{m_1} \geq \mathbf{m_N} \geq \mathbf{m_2}$) then node will again broadcast the packet otherwise node drops the packet.

0	8	12	16 32
TOP	Max Slope	Min Slope	TTL
Broadcast Id			
Source Address			
Source location(X_S, Y_S)			
Destination Address			
Address 1			
|			
Address n			

Fig. 5. Format of Route Request Packet

Bandwidth consumption is reduced by decreasing the forwarding zone to a triangular zone. As all the devices used in MANET are battery aware. Power consumption is proportional to the number of computations done at the device. Calculation of slope for a single line will be less which will help in decreasing the power consumption. Loops are also avoided by using the Broadcast Id. If a node receives RREQ packet with same Broadcast Id, it will not consider this request. Algorithm and steps followed by LBPAR are explained in Fig. 6 and Fig. 7

```
LBPAR(RREQ Packet)
if (TTL ≤count(address in List of visited nodes))
{
  if (Destination ID == Node ID)
  {
    Consume RREQ;
    Revert RREP;
  }
  else if (TTL ==count(address in List of visited nodes))
  {
    Drop RREQ packet;
  }
```

```
  else
  {
     Calculate mN;
      if (m1 ≥ mN ≥m2)
      {
         Attach own address to list of visited node;
         Broadcast RREQ packet;
      }
      else
      {
         Drop RREQ packet;
      }
   }
}
```

Fig. 6. Algorithm for LBPAR

Step 1: Source node 'S' initiates route request to destination node 'D'.

Step 2: S calculates the expected zone and slope of tangent rawn from source to expected zone.

Step 3: S broadcast RREQ packet with Source Id, Destination Id, Broadcast Id, m_1 (max. slope), m_2 (min slope) values.

Step 4: At the receiving node N, N will check whether it has already received RREQ packet with the same broadcast Id. If yes, then drop RREQ packet else check whether Destination Id matches with its own Id. If N is the destination node then consume RREQ and revert back RREP packet.

Step 5: If N is not the destination node, then N will check whether number of addresses in list of visited nodes is less than TTL. If number is equal to TTL then drop the RREQ packet.

Step 6: If number is less than TTL then N will calculate 'm_N' (slope of line joining S and N). If m_N lies between m_1 and m_2 i.e. if $m_1 \geq m_N \geq m_2$ then N attach its own address to list of visited nodes and re-broadcast the RREQ packet else N drops the RREQ packet.

Fig. 7. Steps involved in LBPAR

3. Evaluation of LBPAR

In order to evaluate the proposed protocol let us compare the working of ILAR, LARDAR and LBPAR. Let us consider a network Fig. 8 having source node S having co-ordinates XS and YS. Let S knows location of Destination node D (XD,YD)at any instance of time TI. After time T if S wants to send the data to D, it can calculate the expected zone by eq (1).

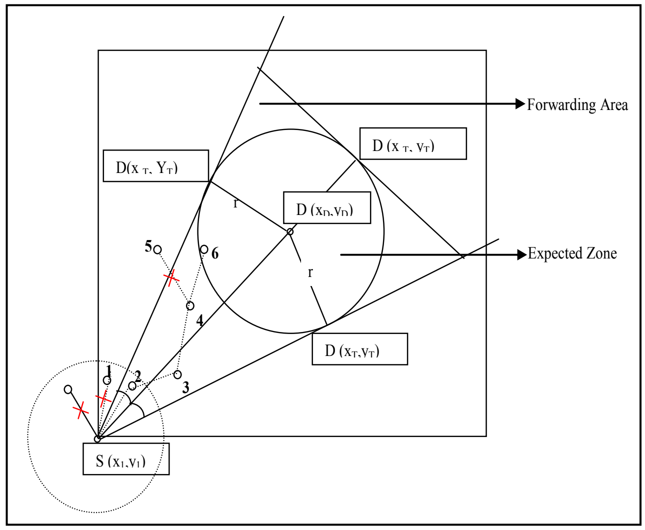

Fig. 8. packet communication in LBPAR

In LAR, forwarding zone is the rectangle containing both S and D. Here, the route is discovered by forwarding data packet to a node which is near to the base line SD. Here the source/forwarding node finds the best node by comparing the distance of all neighboring node to base line. Here, the RREQ packet is heavier as it contains large amount of information, which in turn consumes large amount of bandwidth. As the forwarding node takes the decision by comparing the distance, its battery get consumed at much higher rate at compare to other location base routing protocols. This in turn results in early route failure.

In LARDAR, the forwarding zone is reduced to a triangular zone. This result in decrease in bandwidth consumption as the RREQ packet will not be broadcasted to the whole network. Also in LARDAR, the forwarding node does not compare the values of all neighboring node. It checks whether the node N lies between the search angle α (Fig. 3) or not. Here, also the calculations at N are complex which results in early battery loss.

LBPAR, proposed a solution for the above cited problems. The packet size of RREQ is small in case of LBPAR which helps in less bandwidth consumption during broadcasting. Also, as compare to the calculation done at the node source node or an intermediate node N are less complex and simple which can be calculated by consuming small power. This will help in long battery life and in turn increases the route life. In the above cited example (Fig. 9), S will broadcast RREQ packet along with the min. and max. slope values to all the neighboring nodes. On receiving the RREQ packet node number 1 and 2 calculates their slope with respect to S. Slope of node 2 lies between the given slopes, thus it will again broadcast RREQ to next neighboring node. Whereas, slope of node 1 does not lie with in the given range, it will drop the RREQ packet. Thus, LBPAR helps in decreasing the bandwidth consumption and also helps in maintaining the routing path by increasing the network life.

4. Conclusion

This paper has presented a protocol (LBPAR) for routing packets between mobile nodes in an ad hoc network using the Global Positioning System. Unlike routing protocols like LAR, ILAR, LARDAR our protocol considers various parameters like bandwidth requirement and battery life of all the intermediate nodes on a path to destination. Increase in the battery life tends to high probability of routing path. Based on evaluation of LBPAR is proved to be a better protocol as it helps in lowering the bandwidth consumption of the network and also helps in increasing the battery life by decreasing the number and complexity of calculations.

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