Performance Evaluation of Mesh and Position Based Hybrid Routing In MANETs

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Abstract: A new routing algorithm called position based hybrid routing algorithm (PBHRA) was developed to optimize bandwidth usage of ad hoc networks. The main goal of PBHRA is effective use of bandwidth by reducing the routing overload. Additionally, the other goals of the algorithm are to extend battery life and signal strength or power level of the mobile devices by reducing the required number of operations for route determination and to reduce the amount of memory used. Although in the PBHRA, some features of both table driven and on-demand algorithms were used to achieve these goals at some stages, PBHRA algorithm is a completely different approach in terms of position information usage and global positioning system (GPS).

Key words: Hybrid routing, Extended battery life, Signal strength, Power level, global positioning system.

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1 INTRODUCTION

Wireless networks have been quite popular since they appeared in 1970. The popularity of wireless networks arises from supplying data access opportunity to the users anywhere. The technological tendency of users is to communicate with wireless and mobile devices. The wide spread usage of cellular phones, portable computers and palmtop computers (PDA – personal digital assistant) with WLAN (wireless local area network) is the greatest indicator of this. Wireless networks can be classified into two categories: with infrastructure and without infrastructure networks. Wireless networks with infrastructure, also known as cellular networks, have permanent base stations, which are used to connect each other through links. Mobile nodes communicate with each other as through these base stations.

Wireless networks without infrastructure also known as MANET (mobile *ad hoc* network) are composed of random moving mobile nodes without central controls such as a predefined infrastructure or base station. Nowadays, these mobile nodes that can take place on airports, ships, trucks, automobiles and people in very small devices are widely used in many industrial and commercial applications. The usage areas given above make mobility of the nodes compulsory.

The characteristic of mobile ad hoc networks (MANETs) is that they do not have fixed network infrastructure, nodes can act as both host and router, nodes may be mobile, nodes may have limited resources, limited battery life and they have capability of self organization. MANETs require

fundamental changes to conventional routing protocols for both unicast and multicast communication owing to its unique features.

2 PROPOSED WORK

In this paper, we propose a link stability based multicast routing scheme that establishes a route from source to multicast destinations in MANET. A multicast mesh is created with stable links when a source node needs to send data to receiver nodes. The scheme consists of following phases.
1) Mesh creation through the route request (RR) packets and route reply (RP) packets, 2) finding stable routes between source to destination by selecting SFNs using link stability metric, 3) mesh maintenance and handling link failures, Selecting stable forwarding node for multicast paths based on link stability computed using the parameters such as received power, distance between the nodes and link quality. 4) Attempts to select different stable forwarding node in a mesh during link failures rather than immediately going in for route discovery.
5) Comparing the performance of the proposed scheme with ODMRP.
• Power: This is the power at which a node has transmitted the packet to neighbor.
• Next hop stability: This defines stability factor of a link connecting next hop (taken from link stability database).

3 POSITION BASED HYBRID ROUTING ALGORITHM

The proposed algorithm, PBHRA takes place in position based algorithm class in hybrid main category. The

working principle of infrastructured wireless networks is also benefited in the proposal.

3.1 Working steps of algorithm

The detailed working steps of the algorithm are these: (a) The first node that stands up, while network is firstly started is assigned as master node. If two nodes are opened at the same time and two master nodes form, these nodes compare MAC addresses in the first packets that they took from each other and the node whose MAC address has higher value decides not to be the master node. The details of master determining process are given in the following section. (b) Master node broadcasts packets in regular intervals and declares to the other nodes in the network that it is the master node. These packets are called "master node announcement packet (map)".(c) The nodes excluding master node send "update packets (up)" to master node. In these packets there is information about the geographical position of nodes (as x, y, z coordinates), rest of battery life as percentage and node density. There are destination address, source address and id area in the update packet. Id area is used for in order to update the related line of position information matrix that master node will form.

The receiver address is the current address of the node that sent updating data. Sender node increases id area in the packet each update. In this format of updating information is processed as a row element in P matrix kept on master node. If updating information is taken from the same node formerly id values are compared. The packet that has higher id value is recorded and follow former record is changed.

$$P = \begin{pmatrix} x_1 & y_1 & z_1 & b_1 & d_1 & id_1 \\ x_2 & y_2 & z_2 & b_2 & d_2 & id_2 \\ \ldots & \ldots & \ldots & \ldots & \ldots \\ \ldots & \ldots & \ldots & \ldots & \ldots \\ x_k & y_k & z_k & b_k & d_k & id_k \end{pmatrix} \ldots(1)$$

(d) Master node forms position information matrix by using packets that come from other nodes. There are position information as (x_i, y_i, z_i), battery life as b_i, density d_i and node update sequence number id_i in the columns of this matrix called P matrix. The row numbers of the matrix are equal to number of nodes. This matrix for k-node network is given in (1).

$$l_{i,j} = \sqrt{(x_j - x_i)^2 + (y_j - y_i)^2 + (\dot{z}_j - z_i)^2} \ldots (2)$$

(e) Master node calculates the distance of each node to each other by using the first, second and third columns of P matrix that is given in (1). It makes this process by using the

(2). In the result of this, q square matrix that's dimension is equal to number of nodes in the network. M distance matrix for k-node network is obtained as given (3).

$$M = \begin{pmatrix} l_{1.1} & l_{1.2} & \ldots & l_{1.k} \\ l_{2.1} & l_{2.2} & \ldots & l_{2.k} \\ \ldots & \ldots & \ldots & \ldots \\ l_{k.1} & l_{k.2} & \ldots & l_{k.k} \end{pmatrix} \ldots \ldots \ldots (3)$$

The diagonal of M will be zero as the distance of every node to itself is zero. Also with a condition i _ j, the distance between i and j and the distance between j and i are the same, thus the matrix M will be symmetrical matrix. Therefore the upper triangular part of matrix M will only be calculated. The lower triangular part of M will be filled by upper triangle. As a result of this, the computational time, which is an important factor for battery life of a node, is reduced. (f) The node in the center of the network is determined. The total of row elements of M distance matrix given in (3). are derived and transferred to column matrix T that is given in (4). The number of the row that has the smallest element of T matrix is equal to the number of the node that is in the center of the network.

$$T = [\, t_1 \ t_2 \ t_3 \ \ldots \ t_k \,] \ldots\ldots\ldots\ldots(4)$$

Where

$$t1 = \sum_{n=1}^{k} l_{n.1} \ldots\ldots\ldots\ldots\ldots(5)$$

(g) New master node candidate is the node that is in the center of the network. Master node asks candidate master node if it can be the new master node. If the answer is positive, it sends the whole routing information that it keeps on itself to the new master node and also it declares new master and its position information to the other nodes. If the answer is negative, the second central node for the T matrix is the new master candidate. The same processes are realized for this node. Candidate node can refuse to be the master node because of low battery life or high density.

(h) New master node sends broadcast packets to the network relating to being master node. The updating packets that will come from other nodes are collected in P matrix as the former master node did. New master node repeats the steps between a to h.

(i) The other nodes send event based updating packets to the master node when they changed their position, their battery life got under threshold level and their density increased. Thanks to id value sent in P matrix related to that node. Because other nodes send id value that is one bigger than the former in the update packet they sent.

(j) According to this algorithm, normal nodes requisition from master node path information to destination node when they want to send a data to any destination.

Master node assigns a cost value to the intermodal borders with fuzzy logic by using M matrix and P matrix when a request relating to a destination comes to itself. In this way a graph consisted of nodes and borders forms. G matrix is formed in order to keep the cost values of graph. The forming of G matrix will be handled in the next section. (k) Master node supplies an optimization in order to found the path between source and destination with the least cost over the formed graph. The shortest path, in other words the path has lowest cost is determined by using Dijkstra or Bellman Ford algorithm.

(l) Master node declares the result got from j and k steps to the node which requested path and related node send its data using this path. When any node will demand routing path from master node, it sends a "route request packet (rqp)" to the master node. Master node sends "route reply packet (rrp)" to the node which requested a route. Master node answers to the node that is the owner of request by determining most optimum path to the destination node from the source node and replacing an optimization on graph structure that is formed when master node received route request packet.

(m) If master node goes far from central position or battery life falls down a threshold, it transfers the mastership to other node, which has minimum row total value in M. Nodes decide to be a master node or not in accordance with battery lives and densities. In the case of master node's closure with any reason, a "secondary master" node is assigned in order not to make network stay without a master. This assignment process is made by the master node. Master node selects the nearest node to itself as the secondary master. It sends the routing information that it holds on itself to the secondary node in certain periods. The frequency of data sending to the secondary master is four times of the interval of master node broadcast packet sending

(n) The other nodes do not hold information belonging to whole nodes and do not make any process related to routing. But they hold "master node packet" that comes from master node in their memories.

Figure 1 shows the flow chart of the algorithm whose detailed steps were given.

3.2 Determining role of master node

According to PBHRA algorithm, there are three roles for a node in the network. These are master, secondary master

and normal node. The process of determining secondary master's role is determined by master node. For this reason, a node has to know whether it is a master node or a normal node. Determining of being a master is realized

Figure 1. Flow chart of PBHRA algorithm
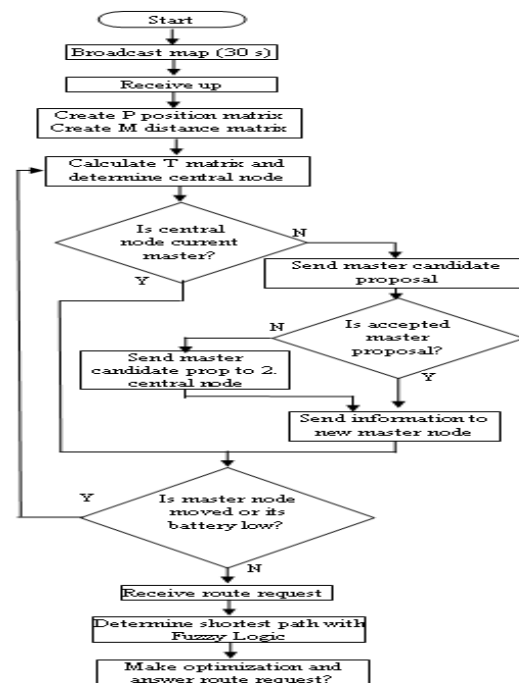
with following steps: (a) A node in the network waits for 30 second after it stands up.

(b) Did the node receive master node announcement packet (map) in this period?

c) If the answer step b is yes; (c1) Did it receive one map, or more maps than once? (c1a) If it receives one map, it records at its memory the address and position of node from which it receives a packet as master node. Thus, it decides itself that it is a Signal .normal node. c1b) If it receives maps more than once, it compares the address in the packets received. It records the one with low address and its position into its memory as master node. It decides that it is a normal node itself. (c2) It sends an update packet (up) containing its position to master node whose address is stored in memory.

(d) If the answer of 2nd step is No; (d1) There is no master node in the network. It decides that it is a master node itself; (d2) It broadcasts maps for period of 30 seconds.

e) Finish.

3.3 Distribution of master node announcement packets in the network

Master node announcement packets (map) are the most priority packets in the network. When any node receives a map in order to transmit to another node, firstly transmits this packet. After the map is left from the master node, it is sent to the nodes, which e in the broadcast distance of master node. If a node receives a map from other nodes

more than once, it retransmits only once. Nodes do not send map to the sender node. In other words, map packets are send in single direction in the network. Consequently, network is protected to be intensively busy with map packets.

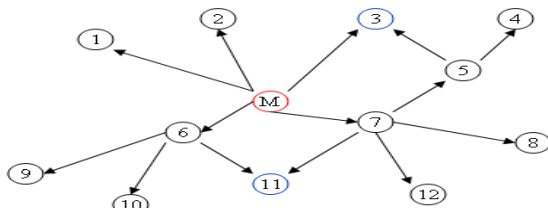The distribution of map packets that were sent by M master node is shown in Figure 2.

Figure 2. Distribution of master node announcement packets in the network.

Data packets are transmitted in the network according to source routing method. When a node receives a data packet in order to transmit, it extracts the address information belonging to destination part of the packet's heading and transmits the packet to the owner of next address.

4   PERFORMANCE EVALUATION

- Mobility: A medium where nodes move in different velocities from 0 to 20 m/s.
- Simulation time: 100 s.
- Pause time of nodes: The simulation process was made in immobility simulations that change in 0-10-20- 50-100 second's periods. The value 0 shows that nodes are fully mobile while the value 100 means that nodes are completely stable.
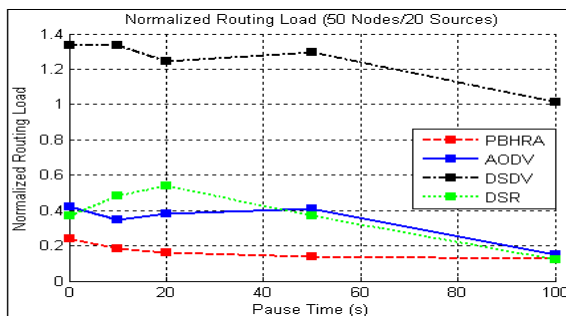

Figure 3. Normalized routing load for 20 sourced / 50 noded network.

One of the criteria used for the performance evolution is normalized routing load. Normalized routing load is the number of control packets per data packets transmitted in the network. Normalized load value has to be low in order to make algorithm performance value high. Normalized

routing load graph for PBHRA, AODV, DSDV and DSR algorithms for a 50 noded and 20-sourced network are given in Figure 7. As it can be seen in Figure 3, normalized routing load value of PBHRA is lower than other algorithms. As a result, routing overload is reduced with the proposed algorithm especially in case of high mobility. Reducing routing overload in network will supply effective usage of bandwidth and energy consumption.

5   CONCLUSION

In this study, we proposed a routing algorithm for optimizing bandwidth usage and decreasing energy consumption, power level by reducing routing overload for wireless ad-hoc networks were developed. The proposed PBHRA algorithm is compared with table driven, on demand and position based algorithms in terms of normalized routing load, packet delivery fraction and end-to-end packet delay. It was observed from performance values that the PBHRA gives better results others, on demand and position based algorithms especially in the case of high mobility.

As the continuation of this study, we are going to emphasize on classification of nodes, energy efficiency of the nodes and signal strength and power level between the nodes.

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