ROUTING MANAGEMENT FOR MOBILE AD-HOC NETWORKS

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ABSTRACT

A mobile ad hoc network (MANETs) is a collection of distributed nodes which communicate using multi-hop wireless links with frequent node mobility. The frequent mobility of nodes leads network partition and futile communication. To alleviate various network connectivity and routing issues, we have proposed Cluster Based Distributed Spanning Tree (CBDST) interconnection would be the better solution. CBDST structure is organized into a hierarchy of groups. The nodes are put together in groups and groups are gathered in groups of higher level, recursively. This organization, built on top of routing tables allows the instantaneous creation of spanning trees rooted by any nodes and keeps the load balanced between the nodes.

KEYWORDS: CBDST, MANET, Cluster Head, Mobile Node, NS-2

1. INTRODUCTION

A Mobile Ad-Hoc Network (MANET) is an autonomous collection of distributed mobile users. Every host in a MANET works as a source and a sink, and also relays packets for other hosts and is thus a router as well. This type of network can be used in fire, safety, rescue, disaster recovery operations, conference and campus settings, car networks, personal area networking, etc. MANETs have similar characteristics to other wireless communication networks, which are mainly attributed to the wireless channel’s properties.

2. CLUSTER BASED DISTRIBUTED SPANNING TREE (CBDST)

CBDST structure is organized into a hierarchy of groups. The nodes are put together in groups and groups are gathered in groups of higher level, recursively. This organization, built on top of routing tables allows the instantaneous creation of spanning trees rooted by any nodes and keeps the load balanced between the nodes.
2.1 Formation of Cluster

Initially each node is assigned a unique ID value. It broadcasts its ID value to its neighbors and builds its neighborhood table. Each node calculates its own weight based on the following factors:

i) **Node connectivity**: The number of nodes that can communicate directly with the given node i.e. that are in its transmission range.

ii) **Battery Power**: The power currently left in each node. The energy is consumed by sending and receiving of messages.

iii) **Mobility**: Running average of speed of each node. If mobility is less, the node is more suitable to become cluster head CH.

iv) **Distance**: Sum of distance of the node from all its neighbors.

Each node broadcasts a beacon message to notify its presence to the neighbors. A beacon message contains the state of the node. Each node builds its neighbor list based on the beacon messages received. The cluster-heads election is based on the weight values of the nodes and the node having the lowest weight is chosen as CH. Each node computes its weight value based on the following algorithm:

2.2 Node Weight Computational Algorithm

Step 1: The coefficients used in weight calculation are assumed the following values \( w_1=0.7, \ w_2=0.2, \ w_3=0.05, \ w_4=0.05; \) The sum of these co-efficient is 1. This is actually used to normalize the factors such as spreading degree, distance with its neighbors, mobility of the node, and power consumed used in the calculation of weight of a node. The factors node connectivity and distance with its neighbors are given more importance and assumed higher co-efficient values 0.7 and 0.2 respectively.

Step 2: Compute the difference between the optimal cluster’s size ‘\( \alpha \)’ and the real number of neighbors ‘\( R(V) \)’ as node connectivity .nc= 1-(|\( \alpha \)-\( R(V) \)|/\( \alpha \))

Step 3: For every node the sum of the distances, \( D_v \), with all its neighbors is calculated.

\[
D_v = \sum \text{dist}(v,v') \text{ where } v' \in N(v)
\]

Step 4: Calculate the average speed for every node until the current time \( T \). This gives the measure of the mobility \( M_v \) based on the X co-ordinate and Y co-ordinate i.e. position of the node \( v \) at all previous time instance \( t \).

Step 5: Determine how much battery power has been consumed as \( P_v \). This is assumed to be more for a Cluster-Head when compared to an ordinary node. Because Cluster-Head has taken care of all the members of the cluster by continuously sending the signal.

Step 6: The weight \( W_v \) for each node is calculated based on

\[
W_v = (w_1 \times \text{nc}) + (w_2 \times D_v) + (w_3 \times M_v) + (w_4 \times P_v)
\]

Where \( \text{nc} \) is the node connectivity, \( D_v \) is the distance with its neighbors, \( M_v \) is the mobility of the node, and power consumed is represented by, \( P_v \)

Step 7: The node with the smallest \( W_v \) is elected as a cluster-head. All the neighbors of the chosen cluster-head are no more allowed to participate in the election procedure.

Step 8: All the above steps are repeated for remaining nodes which is not yet elected as a cluster-head or assigned to a cluster.

2.3 Cluster Maintenance

The second phase is the clustering maintenance. There are defined two distinct types of operations for cluster maintenance: the battery power threshold property and the node movement to the outside of its cluster boundary.
2.3.1 Node Movements
The node movements can be in the form of node joining or node leaving a cluster. These operations will have only local effects on the clustered topology if the moving node is a MN node. If the leaving node is CH node, the cluster reorganization has to be performed for the nodes in the cluster by evoking the clustering algorithm.

Step 1: Broadcast a beacon signal to all its neighbor nodes in the transmission range;
Step 2: Process the signals received from the neighbor nodes in the network and form the connection matrix, A;
Step 3: Calculate the Degree \( R(U) \) using A, Spreading degree, \( \Delta sp \), Sum of the distances, \( Du \), with all its neighbors, Average speed, \( Mu \), Amount of battery power that has been consumed, \( Pu \), and Weight of node \( U \) as \( Wu \);
Step 4: If (A Cluster head already exist in the neighborhood)
Send request to join the Cluster;
Else
Form a new cluster and declare itself as the cluster-head;

2.3.2 Battery Power Threshold
The battery power of the nodes participating in the Clustering changes continuously. The Cluster-Heads Power decreases more rapidly when compared to the Cluster Members. When the Cluster-Heads Battery Power falls below a threshold then the node is no longer able to perform its activates and a New Head from the members available need to be chosen.

Step 1: Verify the threshold on the Cluster-Head’s Battery power;
If (Battery power < Threshold)
Cluster-Head sends a LIFE_DOWN message to all its Neighbors;
All the Member nodes participate in the Re-Election Procedure using Modified Weighted Clustering Algorithm and the Node with least weight is selected as the New Cluster-Head;
Else
Re-election is not needed;

3. RESULTS AND DISCUSSION

The mobile network model assumed in this project consists of random number of mobile nodes with each node having fixed energy and random mobility. Further each node starts with some energy and its energy decreases each time it passes a message. A node fails if its whole energy has been consumed. A failed node is represented as a black node. The measured performance of the proposed algorithm was compared with AODV using NS2 simulation tool.

3.1 Packet Delivery Ratio (PDR)
The Packet Delivery ratio is based on the number of packets delivered and number of packets sent. Higher the pause time better is the performance of the Cluster. The CBDST technique approaches a ratio of one or 100% delivery as the network becomes more static in figure 1. Only under dynamic conditions the packets collide or the packets are lost. As the pause time increases the static nature is enhanced. CBDST also delivered good PDR against the scalability.
3.2 Connectivity

The connectivity of nodes gives path for data packets to be forwarded without loss and comparison results are shown in the above graph. NS2 simulation with varying node count ranging from 10 to 100 is used to study the percentage of connectivity in wireless environment. Maximum possible connectivity is 100% where each node is connected with every other node. CBDST perform well over AODV while increasing number of nodes and pause time as shown in figure 2. CBDST has good scalability and robustness.

4. CONCLUSION

We have proposed new routing management for better connectivity, network lifetime, less energy consumption and equally load balancing of the cluster head by re-elected the cluster head after a threshold. The CBDST perform well over AODV for packet delivery ratio and scalability.
REFERENCES


