A PACKET BASED RECONFIGURABLE VIRTUAL BACKBONE TO SUPPORT MOBILITY IN MANET

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ABSTRACT

Construction of Virtual Backbone (VB) in Mobile Ad-Hoc Network (MANET) is a very familiar method to avoid broadcast storm problem. Most of the routing protocols in wireless domain based on flooding information and the result will be performance degradation. Existing research works concentrate on construction of Virtual Backbone, no work give the effective solution for Reconfiguration virtual backbone (R-VB) during mobility. If a node in movement topology maintenance is a difficult process. In this paper we propose a packet based solution for Reconfigurable virtual backbone (R-VB) to support mobility in MANET. The R-VB in MANET is achieved by exchange of ten bit control packet between backbone nodes and non backbone nodes. The fields in the packet indicate movement and battery power of the node. Exchange of packet between backbones and nodes locally, in the way every update support to maintain topology during the mobility. Exchange of small control packet between nodes, control overhead will be minimized, which will give the extra life time to the network, because to process the tiny packet less power required for each node. We present the performance of R-VB in terms of backbone size, delay and packet transmitted per each node. The performance of our algorithm is witnessed by simulation results.

Key Words: *Virtual Backbone (VB); Reconfigurable Networks (RN); Mobile Ad-Hoc Networks (MANET); Packet Based Approach (PBA).*

1. INTRODUCTION:

As there is no fixed infrastructure ad-hoc network share the same wireless communication interface. A MANET is self organizing and the nodes are autonomous. Terminals are move anywhere at any time. It is mainly useful in emergency operations such as rescue and military applications. However, the properties of frequently route breakage and unpredictable topology changes in MANET still make most of these traditional routing protocols inherently not scalable with respect to number of nodes, control overhead, and degree of mobility. A common source of overhead in a MANET comes from blind flooding/broadcasting, where a broadcast message is forwarded by every node exactly once. Broadcasting is used in the route discovery process in several reactive routing protocols. Due to the broadcast nature of wireless communication (i.e., when a source sends a message, all its neighbors will hear it), blind flooding/broadcasting may generate excessive redundant transmission. Redundant transmission may cause a serious problem, referred to as the broadcast storm problem [1], in which redundant messages cause communication contention and collision. To overcome this problem virtual backbone routing is proposed, where set of nodes act as a backbone which makes the routing decision. A connected dominating set (CDS) [2] can form an interesting virtual backbone. A dominating set (DS) of a graph is a subset of nodes such that each node in the graph is either in the subset or adjacent to at least one node in that subset. A connected DS (CDS) is a DS in which all nodes are connected to at least one other node.

To design a routing protocol in MANET [3] to converge quickly, protocols relay on localized algorithm and make the local decision. The localized algorithm [4] used in the following applications:

- Construction of VB
- Reconfiguration of VB(based on mobile VB, Non VB nodes)

To construct virtual backbone Greedy algorithms are used. Normally Dijsktra algorithm used to find the shortest path between nodes and kruskal algorithms used to find the minimum spanning tree (MST). Reconfiguration virtual backbone (R-VB) is formed and maintained by packet based approach [5], [6]. In order to maintain the connectivity control packets [7] are exchanged between VB to VB and VB to NON VB nodes. Node mobility and battery power is indicated with control packets.

The rest of the paper is organized as follows: In section 2, we briefly present network model, notation and control messages of R-VB, section 3, describe the formation VB in detail. In section 4, packet based R-VB formation and connectivity maintenance. In section 5, simulation results show the performance of MANET in dynamic environment. Finally section 6, conclude the paper.

2. NETWORK MODEL, NOTATION AND CONTROL MESSAGES OF R-VB:

In this section we describe the network model; notation used throughout the paper and explains the control messages used by R-VB.

Network model: we assume that each node has a same transmission power and know about 1-hop information (between VB to non VB).The medium access method is random and full duplex links between nodes. If VB node enters a new area will act as a non VB node and it will attach with non VB node. At this movement non VB which connect the new node, act as a new VB node.

We also assume that if VB in movement handover the connectivity information to one hop Eligible Virtual Backbone (E-VB) node.

A. Notation: The following notations are used for reconfiguration of virtual backbone maintenance. During the mobility node may follow any one of the following :

- VB: The Virtual Backbone
- Non-VB: Non member of VB
- R-VB: Reconfigurable virtual backbone
- E- VB: Eligible virtual backbone. (The node identified by the following parameters: non member of CDS, one hop distance from VB node, more than 25% of battery power)-we set the threshold value for battery power is 25%.
- New-VB: New virtual backbone (After the addition of VB or N-VB to the edge node)

B. Control messages of R-VB:

We use a single control message packet with minimum fields to achieve R-VB.This packet is named as State Change Packet.

State Change Packet (SCP): State is mentioned above. Each node transmits this 1-hop control message at the time of change their state, settled in new state and battery power below 25%.

Dead node packet (DNP): The nodes with battery power between 1-5% are indicated by DNP. VB receive this packet and update the routing table.

3. VB FORMATION:

If a graph say G= (V, E), finding the dominating set can be formulated using linear programming approach.

A variable d_i is a non-dominating variable,

d_i ={1 if the node i is an non- dominator (edge nodes in the graph)
0 otherwise

Minimize the number of dominating set:

$$G - \max \sum_{i \in V} d_i$$

Subtract the edge nodes from the actual graph minimum dominating set was obtained.

We use the Greedy algorithm for virtual backbone construction. Normally Dijsktra algorithm used to find the shortest path between nodes and kruskal algorithms used to find the minimum spanning tree (MST).The following steps are used to construct virtual backbone

i) Calculate the spanning tree of the network.
ii) Non selection of edge node, Subtract the edge nodes from the actual graph.

In this way only half of the nodes will act as a virtual backbone node, which will give extra life time for the network.

4. RECONFIGURATION OF VB:

In this section figure 1, give the state diagram model, to indicate the function of each node during the movement. And also describe the algorithm for R-VB and control packet format for updating the virtual backbone.

All the nodes follow the any one of the following four states;
1. VB Stable
2. VB Mobile
3. Non VB stable
4. Non VB Mobile

All the mobile and stable nodes follow the state diagram given below; during the movement VB and Non-VB nodes exchange the eligible VB (E-VB) and battery power information to one hop neighbor.

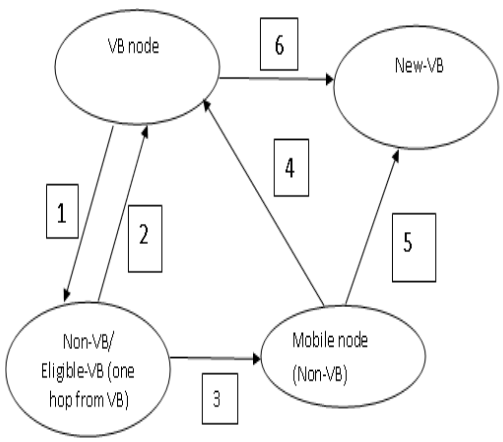

Figure.1 State Diagram

Functions:

1. Exchange hand over information
2. Inform Eligible-VB/battery power to VB
3. Change the state(stable to mobile)
4. Movement indication to VB
5. E-VB indication to New-VB
6. Change state indication to New-VB

During the state change VB node exchange the routing table information to one hop nearby node, similarly Non VB node indicate the routing information to one hop VB. Assume the following situation, if the Non-VB node say C, change their state (moved from one place to another), it attach with a new node say B (Non-VB node).Node C exchange all the control information to node B and node B become a New-VB node. In this way local updates used to maintain MANET topology. This function indicated by functions 3, 4, and 5. At the same time service provider VB of node C, say node A, delete the routing table information about node C and this information share between one hop neighbors.

Algorithm for R-VB:

On receiving 10 bit control message, VB functions

VB stable

Step 1 if (non VB in movement)
{
Send Non VB in movement nearby VB
VB update one hop neighbor
Return
}

Non VB Stable (one hop E-VB)

Step 2 if (VB in movement)
{
State change process
Handover routing information to one hop
E-VB become new VB
Return
}

New VB Stable

Step 3 if (non VB enter a new state)
{
Exchange the power and E-VB information to new VB
Return
}

Non VB mobile

Step 4 if (VB enter a new state)
{
Change to Non VB and Attach to Non VB
Attached a Non VB will become a New VB
}
else if
{
New VB satisfy E-VB criteria (or)
Joint to one hop VB of Non VB
}
}
}

Our objective is to concentrate on reconfigurable backbone with minimum overheads. To maintain a dominating set a 10 bit control packet as shown in fig.2 is used. This packet used for local updating between VB and other nodes.

0/1	0/1	POWER

Figure.2 Control packet format.

Packet fields used for reconfiguration is shown in table.1

Table.1Packet field details:

0	0	VB Stable(enter a new state, stop travelling)
0	1	VB Mobile(movement)
1	0	Non-VB Stable(enter a new state, stop travelling)
1	1	Non-VB Mobile(movement)

During the movement of mobile nodes topology and backbone maintenance are the important issues. When the VB node in movement, CDS maintained by send the ten bit control information to the nearby one hop eligible neighbor, in this way distributed pruning will be achieved. The following example shows control information transfer between on VB and Non VB to achieve R-VB in wireless networks.

Example: 1

Assume VB and non VB nodes are having 64% of battery power and the first two bits indicate the state of the nodes, last six bit indicates the battery power. Control packet formats:
VB stable – 0000111111
VB in movement – 0100111111
Non-VB stable – 1000111111
VB movement – 1100111111

First two bits **– 01** for VB start movement**,** Next eight bits **– 00111111** for indicating **-** 64% of battery power available in this node.

5. SIMULATION RESULTS:

All the simulations are conducted using ns-2 with 50 nodes initially, a 900x900 m^2 deployment area, with transmission range 250 m,0.90s hello interval and random way point model. We would like to observe the number of VB and network size, control message transmitted per nodes for updating and maintain virtual backbone and delay of each node.

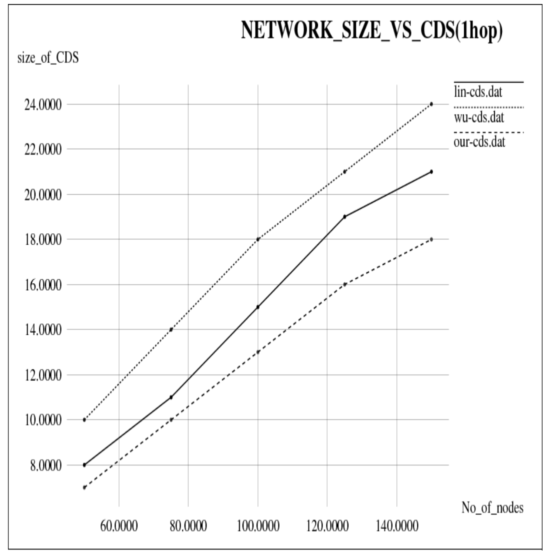

Figure.3 Network size vs. CDS (1 hop)

The proposed method was compared with Dai and Wu's method (Restricted Rule K) [2], and yang and Lin's method (D_1) [3], because this methods efficient and required minimum control overheads to maintain the backbone. Comparison is based on one hop and two hop neighbor information. The other methods like 3-hop connected dominating sets of yang and Lin's and Dai and Wu's method (Non-Restricted Rule K) are not compared here because it require more message overhead. Three set of simulations have been produced. The first one, we vary speed of each node from10 m/s to 20 m/s for a network size equal to 50 nodes. The second set we vary the network size 50 to 100 nodes and the average speed is constant and equal to10m/s. Third set we vary the network size from 100 to 150 with the speed of10m/s. In all three cases we follow the movement of Non VB.

Result shows if the Non-VB changes their state, it is not affect the overall network performance. VB movement and all node movement (both VB and Non-VB) produce the same result in all the simulations. And also shows network density i.e. increased number of nodes and mobility still the network gives the excellent response in terms of routing and data transfer.Figure 3 and 4 give the comparison of our results with [2], [3]. It show the performance of R-VB with network size with 15m/s, 10m/s, 10 m/s as a increase number in nodes 50,100,150 respectively. We observe that all in movement and VB movement have the same performance to network size. From the results our algorithm performs better than other algorithms compared in section1.

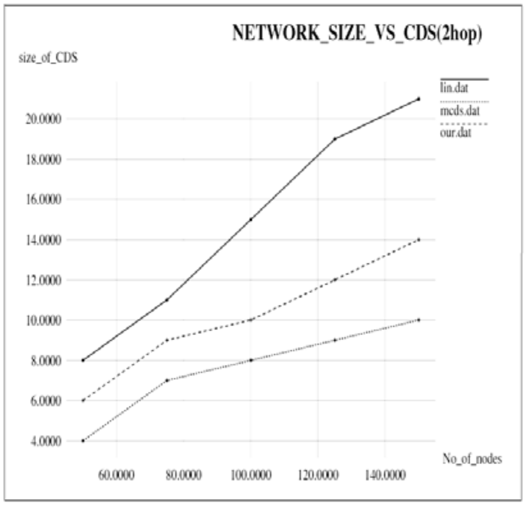

Figure. 4 network size vs. CDS (2 hop)

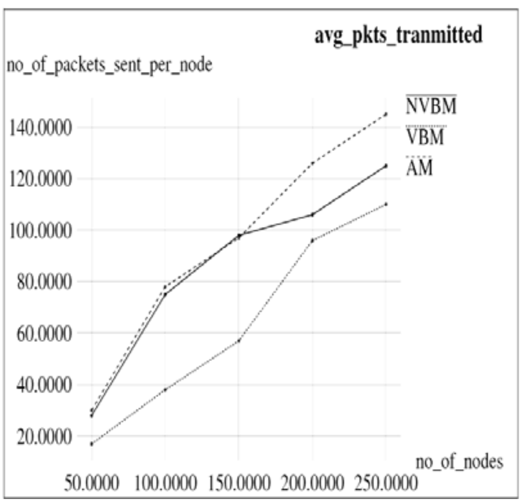

Figure.5 Average packet transmitted per node

Legends:
NVBM - Non VB movement, VBM – VB in movement, AM-all node in movement.

In figure 5, each node transmits the packet for updating R-VB, as a function of packet per each node is displayed. Here also VB and AM follow the same result. From this point of view we prove that maintain VB only required achieving efficient communication in MANET.

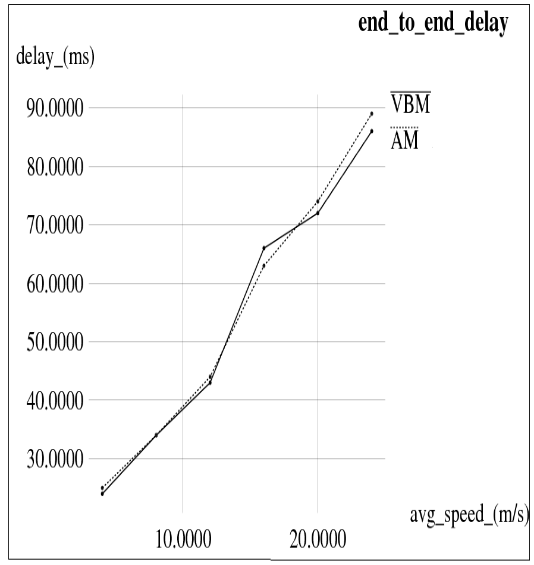

Figure.6 Delay vs. Speed

Based on our algorithm the end delay also same for both virtual backbone and all node movement. In this case we increase the speed 10m/s, 20m/s and delay is calculated as shown in figure 6. From our results we show that two hop virtual backbone is more efficient compare to one hop virtual backbone, but it requires some extra overhead.

6. CONCLUSION:

In this paper we discussed the problem of reconfiguration of virtual backbone during mobile condition. Although there exist a large number of algorithms to construct a VB, there is no work on how to reconfigure a VB in case of all nodes in movement. Due to the dynamic nature of MANET, caused by terminals movement, we designed a packet based approach for reconfiguration of VB nodes and non vb nodes. The main problem of the MANET is absence of fixed infrastructure, a large number of control message generated. To overcome this only ten bit packet solution for update the entire network locally. The advantage of packet based solution gives a clear picture about updating and reconfiguration VB during node movement, because of each node process the tiny 10 bit packet efficiently. In future, we intend to extend this algorithm for wireless routing and implement this concept in demand routing protocols.

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