Demand Based Energy Efficient Topology for Manets

Yogesh P Ramteke
M.Tech (Electronics)
Department of Electrical Engineering,
Veermata Jijabai Technological Institute, Matunga, Mumbai, India

ABSTRACT

This paper proposes a Demand based energy efficient topology to reduce energy consumption for mobile ad hoc network by adjusting the topology for various network traffic conditions. In mobile ad hoc network Energy efficient topology can be achieved by two different ways. In first method the energy efficiency is achieved by power efficient topology for high traffic conditions and in second method for low traffic condition the network maintains a set of nodes while remaining nodes go to sleep to conserve energy. With this process used in reactive routing protocol like AODV, efficient energy, delay and delivery ratio can be achieved. .

KEYWORDS: *Mobile ah-hoc network, ad hoc distance vector routing, route request, route update control message.*

I. INTRODUCTION

Energy conserving is one of the challenges because of limited battery resource. The techniques which are used to reduce the initial topology of network to save the energy and increase the lifetime of network, with the preference of network connectivity, called topology control techniques. Various techniques, in network layer, are proposed in the literature to conserve energy. These techniques can be classified mainly into two categories: by controlling the number of nodes with the smaller link cost. In the first method a small number of nodes awake to maintain the network connectivity and remaining nodes go into sleep state to conserve energy. This method is effective in low traffic conditions, because the power consumption to keep nodes awake dominates the power consumption in data transfer. In the second method, topology is controlled by keeping lesser cost links in the network. This method is effective in high data traffic because power consumption in data transfer dominates the power required to keep nodes awake. We combine the advantages of these two techniques to dynamically adjust network topology for various network traffic conditions.

In this paper, we present a demand based energy efficient topology (DBET) that dynamically adjust network topology for various network traffic conditions. We have simulated our proposed protocol DBET by using AODV as routing protocol using network simulator NS2 and compared with AODV. The simulation studies revealed that the proposed scheme perform better in terms of energy, delay, and delivery ratio. In general network topology is controlled by keeping small number of nodes awake as in the first technique. The proposed DBET keeps more number of nodes along the bulk data transfer path to conserve energy by keeping low link cost as in the second technique.

1.1. Introduction to MANETS

A MANET is an autonomous collection of mobile users that communicate over relatively bandwidth constrained wireless links. Since the nodes are mobile, the network topology may change rapidly and unpredictably over time. The network is decentralized, where all network activity including discovering the topology and delivering messages must be executed by the nodes themselves, i.e., routing functionality will be incorporated into mobile nodes.

The set of applications for MANETs is diverse, ranging from small, static networks that are constrained by power sources, to large-scale, mobile, highly dynamic networks. The design of network protocols for these networks is a complex issue. Regardless of the application, MANETs need efficient distributed algorithms to determine network organization, link scheduling, and routing.

However, determining viable routing paths and delivering messages in a decentralized environment where network topology fluctuates is not a well-defined problem. While the shortest path (based on a given cost function) from a source to a destination in a static network is usually the optimal route, this idea is not easily extended to MANETs. Factors such as variable wireless link quality, propagation path loss, fading, multiuser interference, power expended, and topological changes, become relevant issues.

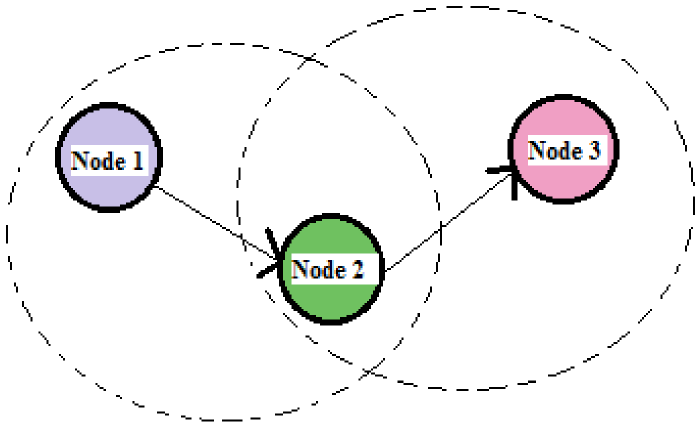

Figure 1 . mobile adhoc network

1.2 MANET Characteristics

1) Distributed operation: There is no background network for the central control of the network operations, the control of the network is distributed among the nodes. The nodes involved in a MANET should cooperate with each other and communicate among themselves and each node acts as a relay as needed, to implement specific functions such as routing and security.
2) Multi hop routing: When a node tries to send information to other nodes which is out of its communication range, the packet should be forwarded via one or more intermediate nodes.
3) Autonomous terminal: In MANET, each mobile node is an independent node, which could function as both a host and a router.
4) Dynamic topology: Nodes are free to move arbitrarily with different speeds; thus, the network topology may change randomly and at unpredictable time. The nodes in the MANET dynamically establish routing among themselves as they travel around, establishing their own network.
5) Light-weight terminals: In maximum cases, the nodes at MANET are mobile with less CPU capability, low power storage and small memory size.

1.3 DBET Demand Based Energy Efficient Topology

In this section, we present a demand based energy efficient topology (DBET) for mobile ad hoc network, which dynamically changes the topology according to the network traffic requirements. Initially we compute a small set of nodes, which form a connected backbone, while the other nodes are put off to conserve energy. These connected backbone is used for routing the packets under low network load. When there is a bulk data transfer between a pair of nodes, the topology dynamically changes along the path between these nodes by power control and route optimize technique to minimize the power consumption. The proposed DBET can be divided into four phases.

The first phase selects a small set of nodes that constitutes a independent set of the network. The second phase is responsible for electing more nodes to ensure that the selected nodes form a connected backbone. Remaining nodes go to sleep to conserve energy. Active node withdraw process is implement in the third phase to remove redundant nodes in each region. To improve the performance along the high traffic path we use the route optimization with power control technique in the fourth phase. In this technique, we change topology dynamically to connect more nodes, around the routing path to minimize the total power consumption.

1.4 Independent set formation

The first phase selects a minimal set of nodes that constitute a minimal independent set of a connected backbone of the network. This selection is done in a distributed and localized manner using neighbour information available with the network layer. Let n_i be the total number of nodes surrounding a node i and let n_{ai} be the number of additional nodes among these neighbours, which are connected, if node i becomes a coordinator to the forward packets. The following heuristic is used in this phase:

• Stability factor (denoted by S): Nodes that are relatively more stable as compared to the others in the localities are given more preference. The node's stability is measured as the ratio of number of link failures (f_i) and new connection established (c_i) per unit time to the total number of nodes surrounding that node (n_i). Therefore, stability of a node i is $c_i+f_i\ n_i$. As the values of c_i and f_i increase, the stability of the node decreases.

• Utility factor (denoted by U): Nodes that have higher number of neighbours without an active neighbour are given more preference. This heuristic is derived from the fact that such nodes, if elected, can help a larger number of other nodes, which can then be put to sleep state. Thus, the utility factor U_i of a node i is calculate as $n_i - n_{ai}\ n_i$

• Energy factor (denoted by E): Nodes that have higher amounts of percentage remaining power are given more preference over others to be elected as active nodes. This introduces fairness in the protocol by ensuring proper rotation in the selection of active nodes. Let E_{0i} denote the initial node's energy and E_{ti} be the amount of energy of a node at time t. So the energy factor E_i of the node i is calculate as($E_{0i} - E_{ti}$)/E_{0i} Thus, the above discussion suggests that the coordinator selection factor for $phase - I$ can be the sum of all these factors

$$C_i = S_i + U_i + E_i = \frac{c_i + f_i}{n_i} + \frac{n_i - n_{a_i}}{n_i} + \frac{E_{0_i} - E_{t_i}}{E_{0_i}}$$

Only nodes that do not have an active node in their neighbourhood are allowed to participate in the election. Announcement contention occurs when multiple nodes discover the lack of an active node, and all decide to become active nodes. We resolve the contention by delaying the announcement with randomized back off delay, which is proportional to the extent to which the node satisfies the heuristics. The selected nodes forms an independent set of a connecting backbone of the network. Selected active nodes go back to sleep after they have used up a fixed percentage of their power to ensure fairness and allow other nodes to become active.

Nodes selected in the first phase are not connected. This is because there is only one active node in a given locality. In this phase more nodes are elected to ensure that the selected nodes form a connected network. All nodes that have two or more active nodes as neighbours, which are not connected directly or through one or two active nodes, are eligible to become active in this phase. Preference is given to the nodes satisfying the following criteria:

• Nodes having higher amount of remaining energy.

• Nodes having higher stability. This can be measured similar to the one used in the first phase.

• Nodes having more number of active nodes in the 1-hop Neighbourhood.

The stability and energy factors of this phase is very much similar with 1st *phase*. But the utility factor is depends upon the 1st *phase*'s black active nodes. Let n_{bi} be the number of active nodes of the 1st *phase* in $1 - hop$ neighbourhood of a node i. If nodes with high n_{bi} become the coordinators in this phase, fewer coordinators in total may be needed in order to make sure every node can talk to a coordinator. Thus a node with a high n_{bi} should volunteer more quickly than one with smaller value. Thus, the coordinator selection factor for 2nd *phase* is the sum of all these factors The contention if any is also resolved using the back off mechanism like in the first phase.

II. INTEGRATING DBET WITH ROUTING PROTOCOL

The minimum required energy for the data transmission can be calculated as follow: each node in the network has fixed default full transmission power *Pt*, when a node *I* receives control message from node *J* with power *Pr* it calculates the distance between nodes *I* and *J* then node *I* can find minimum energy *Pt*(*d*) required for transmitting the data to node *J*. Let consider the nodes *B* and node *C* which are in the transmission range of a node *A* as shown in the Fig. . If $\xi A,B + \xi B,C < \xi A,C$ then sending data packet from node *A* to the node *C* via intermediate node *B* consume less energy.

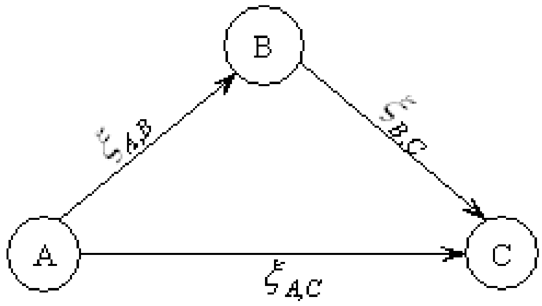

Figure 2. Minimizing transmission power

Our proposed . DBET uses this power optimization technique locally along the routing path to minimize the energy consumption during the transmission. Whenever a new node satisfies the above criteria it remains awake to participate in the high traffic flow path. Please note that a new node can come either a sleeping node wakes up near high traffic flow path or awake node moves closer to high traffic flow path. The proposed DBET can be integrated with any routing protocol. In this section, we discusses the process of integration with AODV. In our approach all control packets and data packets are transmit on low traffic path with full transmission power and data packets on high traffic path with minimum required energy.

Route discovery: Route discovery uses route cost in place of hop count as route metric. We use the notation *δI,J* denotes the cost of least cost path from the node *I* to the node *J*. When a source node *S* wants to find a route to a destination *D*, it broadcasts the route request packet (RREQ) to its neighbours.

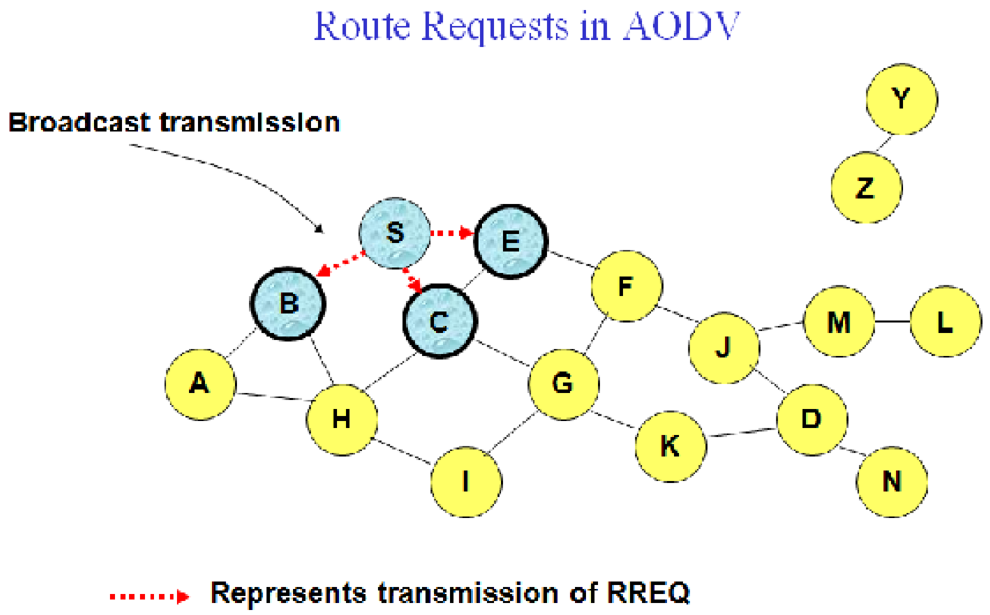

Figure 3.: RREQ in AODV Transmission

The route request packet contains the least route cost from source node *S*, which is initially zero. An intermediate node *J* receiving the route request packet from another intermediate node *I*, it calculates the cost of the path form node *S* to nodes *J* as *δS,I* + *ξI,J*. The node *J* update its routing table if the calculated cost is less than the cost in its routing table and forward the route request packet to its neighbours with updated cost. In order to avoid another cost update, node *J* waits for the time (propositional to the cost to *δS,J*) before forwarding. When a destination node *D* receives first route request packet (RREQ), it calculates the route cost and update its routing table. It waits for a fixed time interval to receive more route request packets and find the least cost route among them. The node *D* unicast a route reply packet (RREP) back to its neighbor from which it received the least cost route. The neighbour nodes unicast RREP towards the source node *S*.

Local route customization: As we discussed earlier due to the dynamic nature of the network new node may come closer to existing path, which may reduce the existing route cost, if it participates in forwarding the data.

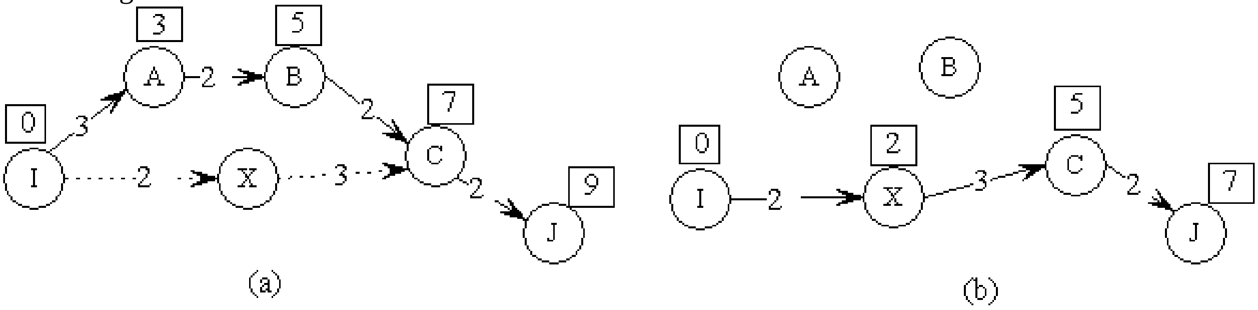

Figure 4: Local Path Customization

Let consider the example network given in the Fig. (a) with the existing path cost from the node *I* to the node *J* is 9 units. If a node is in data transmission path, it sends the
< *Source address, Destination address, Route cost from source to itself*> as a piggyback with periodic hello messages in full transmission path. After receive the hello messages from the node *I* and the node *C*, along with piggyback information, node *X* calculate the link cost $\xi_{I,X}$ and $\xi_{C,X}$ and checks whether it can participate in the ongoing data transfer. The node *X* can participate in data forwarding, if it reduces the cost of the path from the node *I* to the node *C*. That is, if $\xi_{I,X} + \xi_{C,X} < \delta_{I,C}$ then the new node *X* participate in the routing by sending route update control message (RUP) to the
node *I* and the node *C* with route cost $\delta_{I,C.}$ When the node *I* and the node *C* receive (RUP) messages and then update their routing tables.
Every active node periodically checks if it should go to sleep state or not. The need for a node to be an active may also cease to exist due to the dynamics of the system. More explicitly, this may happen due to one of the following reasons. If first phase active nodes may move into a region that already has another first phase active node so that the region now has more than one first phase active nodes. These active nodes recognize this situation and one of them withdraws.

III. CONCLUSIONS

This paper describes how energy of the nodes can be used to provide the efficient routing path for energy conservation in terms of each node .It presents how the topology can be adjusted based on the traffic conditions to reduce energy required for routing information from node to node .It assists in finding more energy aware paths in the network with reduced routing overheads .

REFERENCES

[1]. H. P. Gupta and S. V. Rao. “Power control-based locally customize routing for manet.” I. *IEEE International Conference on RF and Signal Processing Systems*, ppl 632–637, 2010 Lee, S.hyun. & Kim Mi Na, (2008) “This is my paper”, ABC *Transactions on ECE*, Vol. 10, No. 5, pp120-122.

[2]. C.E. Perkins and E.M. Royer, “Ad hoc on demand distance vector (AODV) routing”, Internet-draft, in: *Mobile Ad-hoc Network(MANET) Working Group, IETF* ,1998.

[3]. Feng Xue and P. R. Kumar. “The number of neighbours needed for connectivity of wireless networks”. *Wireless Networks*, 10 ppl 169–181,

AUTHORS

NAME : Yogesh P Ramteke Qualification : BE EXTC VCET Mumbai Mtech electronics VJTI Mumbai (final year)