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Optimal Energy Efficient Multicast Algorithm for MANETs

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***Abstract*— A Mobile Ad Hoc Network (MANET) is a self-organizing, dynamically reconfigurable wireless network that has no fixed infrastructure or central authority. Two nodes can communicate directly if they are within transmission range of each other. Due to their limited radio propagation range of wireless devices, routes are often "multi-hopped." Every node in a MANET must be able to function as a router which can forward the data packets to other nodes. Recently, multicasting has emerged as one of the most focused areas in the field of networking- video conference, distance learning and video on-demand. Many different multicast protocols have been proposed in mobile ad-hoc networks, but most of them do not take the power consumption into account . Design objective of power aware multicast protocols is to select the energy efficient routes and simultaneously minimizing the overhead incurred in the selection of the routes. This paper proposes an optimal energy efficient multicast algorithm for MANETs. It reduces the power consumption as well selecting optimal paths for packet transmission.**

***Keywords*— MANET, Multicasting, Node, Routing, Threshold.**

I. INTRODUCTION

Mobile Ad Hoc Network (MANET) consists of a collection of mobile nodes which are not bounded to any infrastructure. MANET nodes can communicate with each other directly or indirectly through the intermediate nodes. Non-restricted mobility and easy deployments characteristics of MANETs make them very popular and highly suitable for applications like natural disasters, emergencies, and military operations [1]. As MANETs are infrastructure free and highly dynamic in the nature, routing in MANET becomes one of the major issues. Figure 1 shows an example MANET.

Routing protocols generally establishes a shortest path based on the number of hops between the source and the destination. In MANETs, the routing protocols have to route the packets depending on the MANET constraints such as battery power in addition to the shortest path. Energy efficient routing has a significant impact on the MANETs due to their limitation of mobile node's battery power. These batteries cannot be replaced and recharged in the complex scenarios, such as, battlefields and emergency relief scenarios. To this end, nodes in MANET networks should be enabled to manage efficiently their energy consumption to prolong the network lifetime. The energy consumption of each node varies according to its communication state- transmitting, receiving, listening or sleeping state [2]. Any power failure of a MANET node will affect the overall network lifetime. As a result, energy efficiency should be taken into consideration as it is a critical and very extensive research issue.

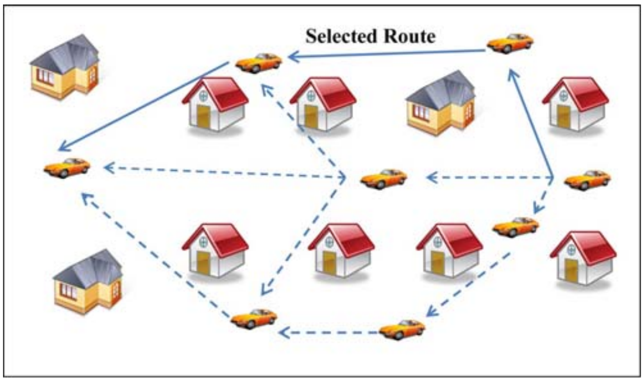

Figure 1: An example MANET

II. MULTICASTING IN MANETS

Multicasting is the transmission of packets to a group of one or more hosts identified by a single destination address [3]. Multicasting is intended for group-oriented computing, where the membership of a host group is typically dynamic i.e., hosts may join and leave groups at any time. There is no restriction on the location or number of members in the host group. A host can be a member of more than one group at a time. Also, a host does not have to be the member of a group to send packets to the members in the group.

In the wired networks, there are two popular network multicast approaches, namely, shortest path multicast tree and core-based tree [4]. The shortest path multicast tree guarantees that the shortest path to each destination. But each source needs to build a tree. Usually, there exist too many trees in the network, so the overhead tends to be very large. In contrast, the core-based tree constructs only one tree for each of the group and the number of trees is greatly reduced. Unlike typical wired multicast routing protocols, multicast routing for MANETs[5][6] must address a diverse range of issues due to the characteristics of MANETs, such as low bandwidth, mobility and low power. There are three basic categories of multicast methods [4] in MANETs:

1. A basic method is to simply flood the network. Every node receiving a message floods it to a list of neighbors. Flooding a network acts like a chain reaction that can result in the exponential growth.
2. The proactive approach pre-computes paths to all the possible destinations and stores this information in the

routing table. To maintain an up- to- date database, routing information is periodically distributed through the entire network.

3. The final method is to create the paths to other nodes on demand. The idea is based on the query response mechanism or reactive multicast. In the query phase, the node explores the environment. Once the query reaches the destination the response phase starts and then establishes the path.

Recently, many multicast routing protocols have been newly proposed to performthe multicasting in MANETs. These include ad-hoc multicast routing protocol utilizing increasing Id numbers (AMRIS) [7], multicast ad-hoc on-demand vector (MAODV) [8], core assisted mesh protocol (CAMP) [9],etc.., However, many multicast routing protocols do not perform well in MANETs because in a highly dynamic environment, nodes move arbitrarily, thus network topology changes frequently and battery power is also limited.

III. Energy efficient routing in MANETs

The Power Aware Ad hoc routing protocol enables dynamic, multi hop routing between the participating nodes wishing to establish and maintain an ad hoc network. They allows mobile nodes to maintain routes to destinations with more stable route selection but designing the power aware routing protocols has attracted a lot of attention for prolonged network operational time. Design objective of power aware protocols is to select the energy efficient routes and simultaneously minimizing the overhead incurred in the selection of the routes.

Many routing protocols [10][11] for ad hoc networks select the routes under the metric of the minimum hop count. Such min-hop routing protocols can use energy unevenly among the nodes and thus it can cause some nodes to spend their whole energy. MTPR (Minimum Total Transmission Power Routing) sets up the route that needs the lowest transmission power among all possible routes. This scheme may be applied in the environment where transmission power adjustment is available. However, MTPR has some basic problems. It turns out that the adaptation of transmission power can bring a new hidden terminal problem [12]. MBCR (Minimum Battery Cost Routing) tries to use the battery power evenly by using a cost function which is inversely proportional to residual battery power. The total cost for the route is defined as the sum of costs of the nodes that are the components of the route, and MBCR selects a route with the minimum total cost. This method seems to extend the network lifetime because it chooses the route composed of the nodes whose remaining battery power is very high. However, because it considers only the total cost, the remaining energy level of the individual node may hardly be accounted for. CMMBCR (Conditional Max-Min Battery Capacity Routing) [13] tries to balance the total transmission power consumption and the individual node power consumption. This algorithm operates in 2 modes according to the residual battery power. If there are nodes that have more battery power than the threshold power, it applies MTPR to the nodes. Otherwise, it resembles MMBCR.

IV. Proposed Method

The main goal of the proposed algorithm is to increase the life time of the network and make the network power aware. In this algorithm, the power capacities of intermediate node are checked with a threshold value and the distance is also checked so that we can make the protocol very efficient. It also checks the shortest distance. This algorithm has mainly two steps. First step is the route discovery phase, in this step the source node sends the RREQ to all neighbours and waits for their reply. In the second step, power and distance are checked or calculated and then route is decided according to threshold value of the power and shortest distance. If the value of the power capacity is lower than the threshold value then algorithm takes another route or path.

The steps of the algorithm are as follows:-

Algorithm:

Step 1. Whenever any node in network wants to send any data, first it generates a RREQ and sends it to all its neighbors in its transmission range.

Step 2. Route reply are stored at the sender end, in route reply (RREP) intermediate nodes send their information like their distance, power capacity.

Step 3. The sender waits until all the route reply (RREP) not arrives.

Step 4. After all the reply comes the power capacity of nodes and distance are compared with the threshold value and each other.

Step 5. Now, the route whose minimum distance and the power capacity is greater than threshold value is selected.

Step 6. While shortest path nodes not having power capacity greater than the threshold value are ignored and then the next shortest path is considered.

Step 7. If the route breaks in between, then repeat from step 1 to step 6.

Figure 2 shows the proposed algorithm:

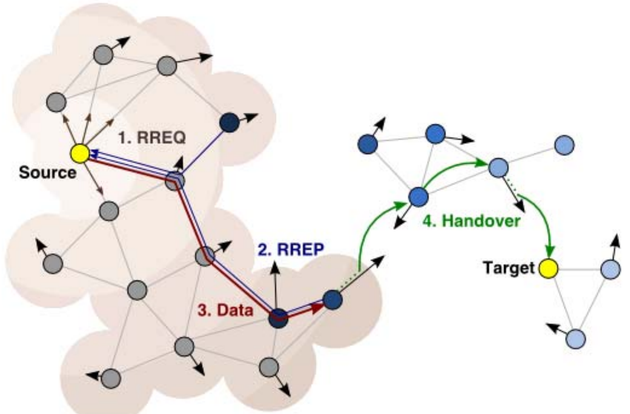

Figure 2: Proposed algorithm

The following pseudo code explains the proposed algorithm:

Threshold = 50%; success = 0; cutoff = 10%
A := S;
Repeat
If g(A) >= threshold then
B := A;

Let A be neighbor of B that minimizes
pc(B,A) = power-cost(B,A) + v(s)f‘(A);
Send message to A;
success = 1;
Until A = D (* Destination reached *)
or if success <> 1 then
if threshold > cutoff then
threshold = threshold /2;
or A = B (* Delivery failed *);

V. CONCLUSIONS

In MANETs, nodes drastically require battery energy in order to make relation with each other and compute data to be transmitted or received and also to handle routing computations. Nowadays, wide researches are being carried out by the object of minimizing the energy usage of CPU and also other data saving devices and node-related hard wares of these networks. The results of studies have revealed that the maximum energy consumption in MANETs is related to transmitting route discovery packets and data packets. In this paper, the power capacities of intermediate node are checked with a threshold value and the distance is also checked so that we can make the protocol very efficient. It also checks the shortest distance. Traffic jamming is a main problem in MANETs. In future work, we consider the problem of jamming-aware source routing in which the source node performs traffic allocation based on empirical jamming statistics at individual network nodes.

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