CONTROLLING THE ENERGY STATE OF MANET THROUGH ENERGY ANTS

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Abstract

Multipath routing in MANET is a way of utilizing multiple alternative paths in the network, which can provide a variety of benefits like preventing delays due to stale routes, increased available bandwidth on different links etc. as compared to the protocols like DSR and AODV. But Energy is an important factor in these networks. The Energy failure of a node may lead to the development of stale route in the network. In the present paper, the various existing multipath routing techniques for MANETs which consider energy as the contributing factor have been elaborated along with their weak zones. It is observed that none of the existing protocols analyzed the energy of neighbor intermediate nodes used for forwarding the packets. An ant based scheme has been proposed in this paper that makes an attempt in the direction of overcoming the above problem. An illustration of the observed shortcoming and the proposition has been outlined in the paper.

Keywords: Energy efficient, Multipath, On-demand, Proactive, Routing.

1. Introduction

Routing in MANETs can be proactive or reactive [1] [2]. Route length has always been an important factor while deciding the path for routing. But one factor which is equally important in MANETs is Energy. If the energy of the participating nodes in the MANET is not up to the desired level then this may lead to the node failure. This will result in link failure or path failure. The major issue with such a path failure is that it also leads to the wastage of energy in the participating nodes. This paper focuses on this issue so that the energy of these intermediate nodes can be preserved. In order to achieve this goal the concept of Energy ants has also been proposed.

Section 2 provides an insight to existing protocols that focus on the concept of energy along with their limitations. Section 3 proposes the concept of energy ants along with its role in controlling the energy state of the network. Finally section 4 concludes by giving the direction of the work in progress.

2. Survey of Energy Efficient Multipath Routing

Multipath routing in MANETs uses multiple paths for sending data packet from source node

to the destination node. The existing multipath routing protocols which utilize the concept of Energy include Modified AOMDV and Ant-Based Energy-Aware Routing Protocol (ABEAR).

The Modified AOMDV [3], modified the AOMDV protocol by utilizing the concept of residual energy of node for selecting the path. It finds the path according to energy of a node and then the routes are sorted in descending order on the basis of residual energy. The data packets are forwarded using the route with the maximum residual energy of nodes. In this way the overall energy state of the network can be improved and it also increases the lifetime of the network. The steps involved are:

1. Compute the nodal residual energy of every route discovered during the route discovery process.
2. Finding out the route having the minimum nodal residual energy.
3. Sort all the routes in the descending order of the nodal residual energy.
4. The route with maximum nodal residual energy is selected for forwarding the data packets.

EM-AODV [4] calculated the route establishment cost based on the residual energy of node but it does not involve any procedure to modify the values of routing table based on the current state of network.

In another variant of AODV protocol [4] the protocol is modified and converted to work on multiple paths to send data in such a way that it is much energy friendly. A new parameter named as RATE_LIMIT parameter has been introduced. The RATE_LIMIT computes the number of route requests that can be accepted and can be processed normally by a node for a unit time. During the discovery process of protocol [5] when a destination receives a RREQ packet a check is performed. If the rate of the route request originator is below the RATE_LIMIT, the RREQ packet is processed as normal. Otherwise the RREQ originator is blacklisted.

The Ant-Based Energy-Aware Routing Protocol (ABEAR) is based on the Ant Colony Optimization (ACO) [6] [7]. It combines the benefit of route setting up procedure of reactive routing approach with the table driven neighbor maintenance process. ABEAR also utilizes route maintenance procedure for repairing the route. Among existing routing protocols most of the protocols do not consider aspect of increasing the life-time of a network. Moreover, network congestion in the ad hoc networks may cause retransmissions of the packet and it may also lead to dropping of data packets. Both the retransmissions as well as the dropping of packets lead to waste of energy. The process of designing an energy-efficient routing protocol involves considering the parameters like congestion metric, pheromone value, the quality

of link and the residual energy of the next node. This information is used for insuring that selected the neighbor is not the one with less residual energy and thus increases the energy efficiency by reducing the loss of energy caused by retransmission of packets or packets being dropped. ABEAR with the energy-efficiency property contributes to increasing lifetime of the network.

The above approaches do suffer from few limitations. Energy is a vital resource and hence needs to be taken into consideration. The Modified AODV although considers the nodal residual energy but it alone cannot be the sole criteria for designing the efficient routing protocol. Another variant of AODV provided a way of blacklisting the requesting nodes for a particular node on the basis of number of packets it has received from them. But this approach is not suitable as merely the number of request packets cannot decide the criteria for black listing a particular node. ABEAR [8] has an energy efficient property and perform better than AODV but it does not support multipath routing. Above all none of these strategies predict the future state of the network i.e. whether the packet routed through a particular node will result into a useful transmission. In order to predict about Energy state of the network the concept of energy ants has been proposed in the next section.

3. Controlling The Energy of Nodes With Energy Ants

3.1 Energy Ants

The energy Ants are used to update the pheromone tables which are being maintained by each node. The energy Ant packets are broadcasted by each node with hop limit set to 1. These packets carry the information regarding the residual energy stored in the node. These energy ants can also be used to control the energy state of the network. The Energy ants can be represented as follows:

Source id
Energy stored in the node(RE_i)
Hop limit

Figure 1 ENERGY ANT

The overhead in updating the pheromone probability table can be minimized based on the threshold limit which can be decided for a particular node in form of energy factor. The threshold limit determines the energy level of a node up to which the node may participate in the MANET.

3.2 Preventing the energy of the nodes from getting exhausted.

The Energy packets are broadcasted regularly by a node after the threshold limit is reached. The energy packets are broadcasted based on the **Energy factor (Ø).**

If (Current energy < Threshold limit)

{

Energy factor (Ø) = (Initial energy - Current energy level)/number of uses Count

IF (Ø < Current energy level)

{

Broadcast the energy ant with current energy level;

}

Else

{

Broad cast the energy Ant with current energy level set to 0;

}

}

When the current energy levels gets lower than the energy factors the energy ants are broadcasted by setting the value of RE=0. This leads to zero probability of the node in the pheromone probability table.

3.3 Control The Routing Decision By Predicting The State of The Network.

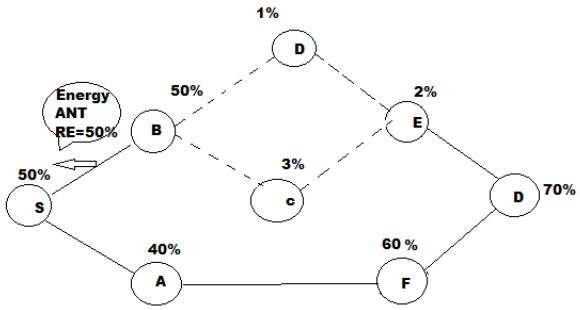

Figure 2 MANET showing the blocked links in form of dashed lines

The problem represented in the above scenario is that if we will consider the Residual energy of the node as the only factor to modify the pheromone probably table than in case of the above network. The Path through node B will have a greater probability to get selected as it has more residual energy as compared to the node A. But the problem is that the Energy ants arrived at Node B show that all its neighbors are low in energy and hence cannot be used for further data transmission.

3.4 The Proposed Solution

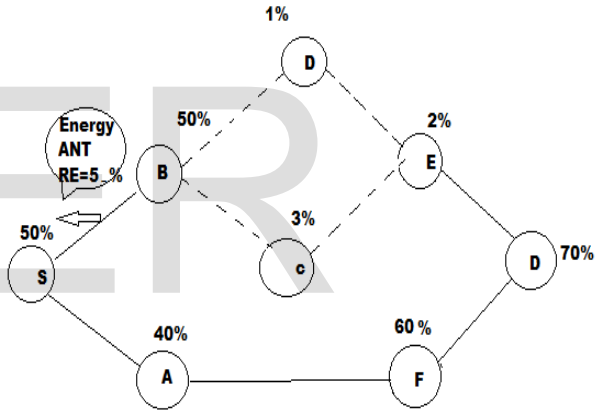

Figure 3: MANET showing the transmission of modified energy ant from node b

The solution to above problem must be designed in such way that the node B may not be used to transmit the data packets which are directed toward other nodes. But at the same time it can be used for the packets which are directed toward it. Now this can be achieved if the Residual energy value in the energy ants generated at node B can be set equal to energy

factor value which is 5 % in above case. This will limit the use of node B as the intermediate node. This can be generalized to whole network. Hence it will also control the overall energy state of the network. The Complete procedure to control the energy state of the network is as follows:

The Energy packets are broadcasted regularly by a node after the threshold limit is reached. The energy packets are broadcasted based on the **Energy factor (Ø).**

If(Current energy < Threshold limit)
{
Energy factor (Ø) = (Initial energy - Current energy level)/number of uses Count
IF (Ø < Current energy level)
{
Broadcast the energy ant with current energy level;
}
Else if (The Current Energy level in all the Energy Ants Received at the Node is 0)
{
Broad cast the energy Ant with current energy level set to Ø ;
}
Else
{
Broad cast the energy Ant with current energy level set to 0 ;
}
}

4. Conclusion

The paper proposed the concept of Energy ants. It significantly proved that the energy ants can be easily used to control the energy state of the MANETs. The energy ants also help in predicting the future state of the routes through residual energy value they carry between the neighbors. The work is in progress to design the routing strategy based on the Energy ants. The resultant routing strategy will be able to modify the value of probability of the route selection and hence help in taking the routing decision dynamically based on the residual energy and the route length.

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