Energy Efficient Routing In MANET Using OLSR

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Abstract

Energy-efficient MANET routing protocol OSLR is widely used for routing in ad hoc networks. Residual energy of nodes play a vital role in route discovery in MANET. To support energy-efficient routing, accurate state information about energy levels of nodes should be available. But due to bandwidth constraints, communication costs, high loss rate and the dynamic topology of MANET, collecting and maintaining up-to-date state information is a very complex task. We focus on the inaccuracy of state information, more specifically the residual energy level of nodes that is collected by the control messages of OLSR. Inaccurate information effect the efficiency of OLSR protocol. We study some parameters of OLSR that forces the inaccuracies in the energy level information of neighboring nodes and show the comparison between ideal and realistic version of OLSR. Our study concluded that tuning of OLSR does not really improve the residual energy information of nodes. And finally try to suggest some techniques to reduce inaccuracies.

1 Introduction to OLSR

Optimized Link State Routing (OLSR) is a table driven proactive routing protocol for MANET . A mobile ad-hoc network (MANET) is a self-configuring wireless network of mobile hosts connected through arbitrary topology without the aid of any centralized administration. It is an optimization of link-state routing. In a classic link-state algorithm, link-state information is flooded throughout the network. OLSR uses this approach as well, but since the protocol runs in wireless multi-hop scenarios the message flooding in OLSR is optimized to preserve bandwidth. The optimization is based on a technique called Multipoint Relaying. The nodes are free to move randomly and organize themselves arbitrarily and treating each mobile host as a router. In this all the nodes contain pre-computed routes information about all the other nodes in network. This information is exchanged by protocol messages after periodic time. OLSR performs hop-by-hop routing, where each node uses its most recent topology information for routing.

Each node selects a set of its neighbor nodes as MPRs (Multi point relays).Only nodes selected as MPRs are responsible for forwarding control traffic. MPRs are selected such that 2-hop neighbors must be reachable through at least one MPR node and OLSR provide shortest path routes to all destinations by providing link-state information for their MPR selectors. Nodes which have been selected as MPRs by some neighbor nodes announce this information periodically in their control messages. MPRs are used to form the route from starting node to destination node in MANET. All this information is announces to neighboring MPRs through control messages. The purpose of selecting MPR is to reduce flooding overhead and provide optimal flooding distance. The diagram 1 shows nodes and selection of MPRs for flooding control messages.

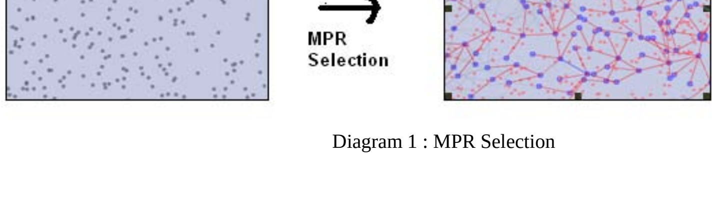

Diagram 1 : MPR Selection

The key messages in OLSR are Hello and TC messages. Hello messages are periodically exchanged to inform nodes about their neighbors and their neighbors' neighbors and are 1-hop broadcast messages. The 2-hop neighborhood information is then used locally by each node to determine MPRs. In contrast, TC messages are flooded through the network to inform all nodes about the (partial) network topology. At a minimum, TC messages contain information about MPRs and their MPR selectors. There are few parameters in OLSR which can control the efficiency of OLSR. The Hello-interval parameter represents the frequency of generating a Hello message. Increasing the frequency of generating Hello messages leads to more frequent updates about the neighborhood and hence a more accurate view of the network and result in overhead. The TC-interval parameter represents the frequency of generating a TC message and are used for topology discovery. If frequency of TC messages is increased then nodes are having more resent information about topology, as nodes leaves and enter in the network very frequently. The MPR-coverage parameter allows a node to select redundant MPRs. No of MPRs should be minimum as it introduce overhead in the network. But more the MPRs more is the reach ability. The TC-redundancy parameter specifies, for the local node, the amount of information that may be included in the TC message. The TC-redundancy parameter affects the overhead through affecting the amount of links being advertised as well as the amount of nodes advertising links.

Through the exchange of OLSR control messages, each node accumulates information about the network. This information is stored according to the OLSR specifications. Timestamp with each data point and modify the control messages and local repositories accordingly. For better efficiency of OLSR state information such as residual energy level of each node, bandwidth, queue length etc should be available while making routing decisions. Incorrect information may lead to degradation in efficiency of OLSR. As state information in OLSR is collected by Periodic exchange of above mentioned messages . This information may not be up to date as topology changes very fast. Residual energy level of nodes are changes rapidly and the node with less energy levels must not be selected in route. We are mainly interested in studying the effect of residual energy levels on protocol efficiency. Main thing is how nodes can collect accurate energy level information about other nodes by OLSR control messages. Traffic load can be one factor that can affect the inaccuracy of energy level information.

2 Factors Effecting OLSR Efficiency & Energy Level Accuracy

We can tune the OLSR protocol and see the performance changes in OLSR and how performance depend on residual energy of nodes. Some of the factors on which OLSR efficiency vary are discussed in this section. We have various MPR selection techniques and path determination algorithms available. In Modified Routing original MPR selection criteria is combined with new path determination algorithm. And in a other variation Modified MPR/Routing new MPR selection and the new path determination algorithm are combined. These variations effect performance of OLSR a lot. Also we can vary the protocol on the basis of " How old the information about Residual energy" is. In one we use the residual energy at that time when MPR was selected , is Ideal version. In realistic version data about residual energy collected by protocol message exchange . Also change in topology impact number of packets delivered and accuracy of the residual energy level. Packect latenct also effect accuracy of data collected.

In the diagram 2 given below we are comparing the performance of ideal and realistic version of OLSR under different traffic rate. We are comparing the performance of network in terms of packet delivered with respect to variation in packet interval time. As Packet interval time decreases (X-Axis) , more no packets are delivered and more resent information about residual energy is collected by nodes in MANET. So inaccuracy is less and system performance increases. This is true in both ideal and realistic approach , as packet interval time decreases performances increases. But when we compare ideal with realistic, Ideal outperforms realistic for every piece of data. It means it is sufficient to collect residual energy information at the time when MPR was selected.

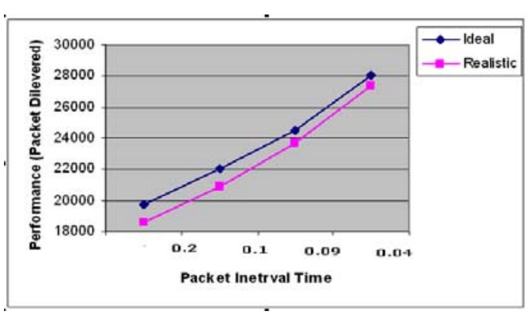

Diagram 2 : Performance Comparison of Ideal and Realistic approach

In Energy efficient variation of OLSR we select MPRs on the basis of residual energy levels of nodes. Path determination algorithm is modified, selecting paths based on the residual energy level of intermediate nodes. Nodes with low residual energy are avoided. The route & MPR selection is such that to maximize bottleneck residual energy level. That will increase the efficiency of network. If wrong or old information is collected by nodes then efficiency is degraded as route may vanish. But the main issue is how to collect the correct residual energy information. One solution is use of EOLSR that select route and MPRs on basis of residual energy of nodes and number of neighbors.

Ideal approach is sending more packets than realistic approach in above diagram. As the traffic rate increases from low to high the the Ideal approach send more and more packets. Omniscient knowledge of a node's energy level delivers more packets than the realistic version. As Choosing very small values for Hello and TC intervals will significantly increase the protocol overheads. So realistic in approach with decrease in packet interval time more and more TC and Hello messages are send in the network which increase in network overhead. That is the reason Realistic approach is little less efficient then Ideal as shown in diagram 2. These results are a direct consequence of the increased level of congestion in the network which results in high message loss and delay and hence less accurate state information.

In diagram 3 we compare OLSR and EOLSR and see how energy vary with network life.As time passes energy of nodes decay very fast. In OLSR MPRs are not frequently changed & efficiency degrade. But in EOLSR MPRs selection depends on residual energy level of nodes. So EOLSR performs better then OLSR.

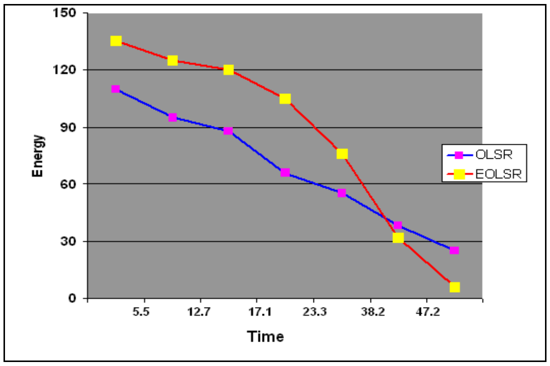

Diagram 3 : Comparison of OLSR and EOLSR Residual Energy Levels

Our studies so far show that nodes have inaccurate information about the actual residual energy levels when making routing decisions. Modifying the OLSR protocol parameters (such as increasing the Hello or TC message rates) has very limited impact on this inaccuracy. This means if we increase the frequency of TC and Hello messages improve residual energy information of neighboring nodes a little but increase the traffic overhead.

So we need some other method to improve the accuracy of energy state information. In the next section we suggest predictive technique to increase energy level accuracy above and beyond modifying the protocol parameters.

3 Method to Reduce Inaccuracies of Residual Energy

In the above section we conclude that increase in frequency of packet does not improve inaccurate energy information. So we need some other technique to compute residual energy information of nodes. Here in this section we suggest Prediction mechanism to compute residual energy information that is more accurate then previous method. Our idea is therefore to have every node locally adjust nodes' old energy levels based on their past energy consumption rate. In this mechanism each node locally extrapolates the expected energy level based on old (reported) energy levels and the energy consumption rate for that node based on the most recent two reported values.

A drawback of the Prediction algorithm is the need to wait for two different perceived value readings, so a consumption rate can be calculated and used to adjust the perceived values. For predicting at least two previous values are required. If a new MPR is selected then it is not possible to predict residual energy as no previous data is available. Under high traffic loads, adjustments happen less rarely. Protocol control messages are lost/delayed, and as a result nodes will not "hear" other nodes. After a node is deemed unreachable, we go through the startup phase again, where we need at least two successive reports to be able to calculate a consumption rate.

To overcome the drawbacks of prediction technique we use smart prediction technique in which adjustments take place almost all the time. The number of time adjustment take place depend on packet interval times. In the Smart Prediction algorithm, for every pair of nodes (p,q), if q's consumption rate is not yet known, p adjusts the perceived value of q's residual energy level based on the average of all known consumption rates for other nodes. If p knows not a single consumption rate for other nodes, it adjusts q's perceived energy level based on its (p's) consumption rate. Using all known nodes' consumption rates eliminates the domination of outliers and ensures closeness to the actual consumption rate, assuming that nodes are somewhat homogeneous in the energy characteristics of their wireless cards. The Prediction algorithms improve the overall inaccuracy level under different traffic rates. The improvement under higher traffic rates is not as high as it is under lower traffic rates. For an adjustment to take place, a node must have received two different reported values. But under high traffic rates, due to message loss and delays, the percentage of times adjustments take place decreases. Since the Smart Prediction algorithm addresses the problem of not being able to adjust the perceived energy level value all the time, it achieves much better performance in terms of overall inaccuracy level, especially under higher traffic rates. Both the Prediction and the Smart Prediction algorithms outperform the Default OLSR protocol.

4 Conclusion

In MANET state information such as residual energy level plays an important role in route selection. If latest information is not collected by nodes then performance may degrade. We also evaluated the effect of time at which state information was collected in ideal and realistic approach. And concluded that although ideal approach is better than realistic but increase in frequency of packets improve the performance very little and also increase traffic overhead. As a solution we used prediction mechanism and smart prediction mechanism which performs better than EOLSR protocol and reduce traffic load. Also we can not calculate 100 % accurate state information as topology changes very frequently but we can maximize it by using some other technique also that may be even better than prediction mechanism. So in future some other methods may be suggested that calculate more accurate state information.

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