Adaptative Algorithm based on Heuristic Approach for Optimal Battery Threshold

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1. INTRODUCTION

In Mobile Adhoc Networks, the major limiting resource for the nodes is the amount of battery power. Researchers have been consistently doing work to optimize its utilization. We know that prolonged battery use during the communication will lead to early disconnections and degrades network performance.

A Mobile Ad Hoc network is a collection of wireless mobile nodes that gather to form a temporary network without any predefined infrastructure or centralized administration [1].Such an environment makes it different from other wireless LAN's .In MANET, each node may act as a router, source or destination, and forwards packets to the next hop in order to make them reach to the final destination through multiple hops. Since nodes or computing devices in MANET are mobile and battery operated, and battery power is consumed in receiving or transmitting data, one of the major reason of the node failure in MANET is the battery exhaustion. Once the node failure occurs, it may disrupt the communication of data, thereby affecting network performance. Therefore it is important to manage the battery consumption or utilization in order to improve the overall performance of the network.

In this chapter we propose an effective battery utilization algorithm, which is applied during the active data transmission phase of the network. We implement this algorithm on the DSR protocol, which is considered to be an efficient reactive routing protocol. The chapter is also trying to find out the value of threshold which give the best results for network performance and accept that threshold value as optimum. We performed simulation using ns-2 to study the effect of our algorithm by varying energy levels of the battery and compare it with standard DSR protocol. Finally analyze the results to carry out important deductions.

2. RELATED STUDY

Dynamic Source Routing protocol is an easy and proficient reactive routing protocol for multi-hop wireless Ad Hoc network. From the literature it is clear that DSR allows network to be completely self-organizing and self- configuring, without the need for any existing infrastructure or administration [2].An efficient energy management scheme is a crucial requirement for the better operation of the limited battery powered MANETs. Authors in [3] proposed an on-demand power management framework for Ad Hoc networks in which is extensible and acclimatizes to traffic loads. The essential features of an on-demand minimum energy routing protocol are recognized and also the methods for such implementation is given by researchers in [4]. [5] Elaborates various distributed power aware routing protocols in MANET. Algorithms for energy efficient routing in ad hoc networks based on iteration are taken into account in [6]. The objective of the problem that is taken as an any cast routing problem here,is to maximize the time until the first battery drains out. An entropy inhibited routing algorithm for power conservation is introduced by [7]. This paper makes use of information theoretic concept of the entropy for the purpose of progressively trimming down the uncertainty coupled with route discovery by a deterministic annealing process. [8]emphasizes that even if setting up acceptable and competent routes is a vital design concern in MANETs, a more demanding objective is to offer energy proficient routes. In this regard authors have taken into consideration the efficient energy aspect of one-to-all and all-to-all broadcast operations of ad hoc network in [8]. The proposal of minimizing the active communication energy requisite for transmitting or receiving packets or else energy taken by the idle nodes is submitted in [9]. [10] Integrate the current approximations of battery levels into routing metrics. This lessens the burden on nodes with little residual energy and it becomes feasible for such nodes to take part in the network for a longer time. In order to enhance the lifetime of MANET [11] proposes the Energy Saving Dynamic Source Routing (ESDSR).

Distributed power control is used as a mechanism to enhance energy efficiency of routing algorithms in ad hoc networks in [12]. A table-driven protocol called BEST and an on demand routing protocol called DST are introduced and compared with DSR in [13]. Numerous protocols including protocols particularly designed for Ad hoc networks are given by making use of traditional protocols for instance link state and distance vector in [14]. The Analysis suggest that the new generation of on-demand routing protocols employ a great deal of lesser routing load whereas the traditional link state and distance vector protocols offer improved packet delivery and delay performance. The authors in [15] have evaluated DSR, DSDV and AODV with the use of three diverse realistic situations. The deduction reflects that the reactive protocols (AODV and DSR) perform considerably superior than DSDV. AODV performs better than DSR at higher traffic loads although DSR execute better than AODV at moderate traffic load.

The above discussed works so far are mainly concerned with the route discovery phase of DSR. It means some efficient energy mechanism is introduced in route discovery process so that we can have a low energy consumption route or optimized energy path.

Instead, this chapter has proposed an efficient energy utilization algorithm, which takes care of energy utilization at each node during the data communication i.e. after the route discovery. Although much work have been done on this threshold value, but exact value of the threshold is not given by any one. We have chosen a threshold value of the battery below which the nodes takes some precautionary actions to increase the connectivity of the network. The detailed algorithm and discussion related with the threshold value of the battery is described in the next section.

3. PROPOSED WORK

Once the route is established in DSR and data transfer starts from source to destination, each node keeps a check on its battery level before sending or forwarding the packet. We have defined a threshold value as said before, if the battery level falls down the threshold value of initial battery level, the following action takes place:

1. If the node is only forwarding the packet and its residual battery level falls below the threshold value of initial battery level, it will send a low energy broadcast message to the neighboring nodes.
2. Upon receiving the low energy broadcast message, the nodes starts to search an alternate route for that node and after waiting for some time to find the alternate route, delete that node from its route cache.
3. If the node is the source node means the battery level of the source node falls below the threshold value of initial battery level, it will send a message to the application layer to stop generating packets after a short duration of time.

This work is different from the earlier work done by researchers in the respect of handling of source node battery depletion. There is no description of what would happen if the source node exhausts itself of its battery life. In this respect the proposed work interact with the application layer to stop the application immediately. Moreover, a timer is used in order to provide neighboring nodes with some time before deleting the route involving low battery node which has not been done by earlier work. In addition to this, the work also recognize that 0.45 is the optimum threshold value by thorough simulations, which has not been identified exactly in any previous work already done

We know that when there is no way to find the exact optimal solution of any problem, we can apply some heuristic approach to find the optimal solution of that problem. The definition of heuristics is “A Trial –and-error procedure for solving problems through incremental exploration, and by employing known criteria to unknown factors". The solution provided by the heuristic approach is not always optimal but close to optimal. Now we can consider our problem of finding the optimal value of the battery threshold as a problem for which exact optimal solution is not possible because of rapidly changing behavior of the mobile ad hoc networks. Therefore we applied a simple heuristic to consider different threshold values and apply them on the simulated network and choose one of them as optimal depending upon their behavior. We performed several simulations to find out the optimal value of this battery threshold. The above algorithm is implemented in DSR with different values of threshold varies from .2 to .6.The values above .6 are not considered as .6 of initial battery level will be more towards the initial energy.

Performance Metrics

- **Throughput:** It is defined as the total no. of data packet per unit time received at the destination. It is also measured as bits/sec or bytes/sec.
- **Packet Delivery Fraction**: It is defined as the ratio of total no. of packets received at the destination and total no. of packets generated at the source.
- **Average Delay:** It is measured as time a packet takes to travel from the source to destination. In other words it is average delay of one packet to reach at destination.
- **Network Life Time**: the network life time is found by calculating the difference of times at which the first tcp packet send by any source and time at which last acknowledgement is received by any source during the simulation in the network.

4. SIMULATION AND RESULTS

We use network simulator ns-2.34 for the simulation. Initially, the total number of nodes participate in the network is taken as 40 for the simulation. The nodes move inside a simulation area of (500×500) m2.The simulation time is kept at 100 seconds. The nodes move with a maximum velocity of 10m/s and in accordance with the random waypoint mobility model. In this model, a node randomly chooses a speed and a point in the simulation area for the next move. For the above comparison of routing protocols TCP traffic patterns are used. The network contains variable TCP traffic connections and packet size of 512 bytes.We consider energy model. Transmit power consumption is kept at 1.43 J. Receiving and sleep power consumptions are taken as 0.925 J and .045 J respectively. The simulation is performed for different runs with different initial energies ranging from 5J up to 70J.

here we compared results obtain from modified DSR or m-DSR (with threshold 0.45)with standard DSR.

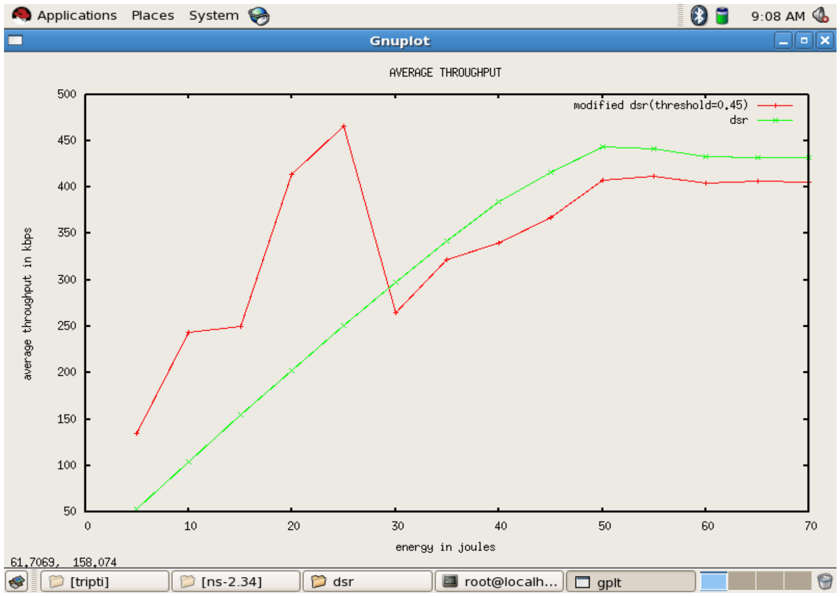

Fig.1 : Average Throughput Vs Energy

Figure 1 depicts the throughput comparison of m-DSR and DSR. It is clear from the figure that m-DSR outperforms standard DSR up to 28 J. It is good to observe that our modification shows better performance with critical or low energy values. This gives weight to our algorithm.

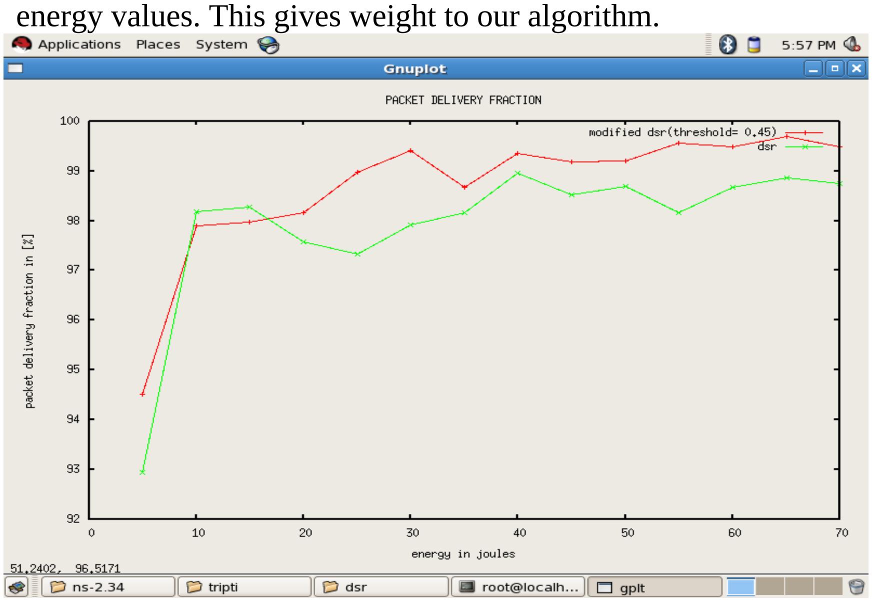

Fig.2 :Packet Delivery FractionVs Energy

The PDF of m-DSR as shown in figure 2 also depicts that m-DSR performs well almost at all energy levels in comparison to DSR. Packet Delivery Fraction or

PDF in m-DSR is steadily increasing and more than normal or standard DSR almost at each energy level.

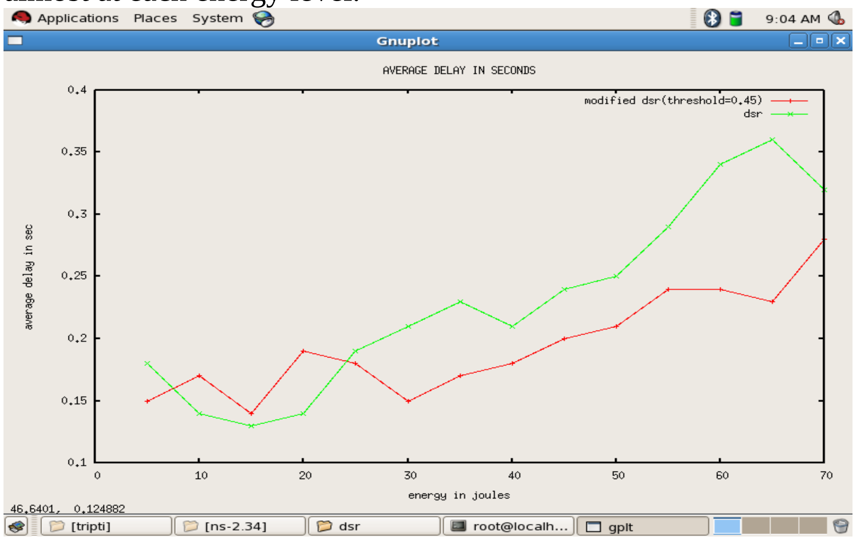

Fig.3 : Average Delay Vs Energy

Figure 3 represent the delay which is also less in m-dsr in higher energy levels in comparison to DSR as 0.45 times of the initial energy in case of higher energies will not be reduced so much. Therefore the nodes can work faster and for longer time. In case of low energies, 0.45 times of the initial energy is reduced early, and the nodes are mobile, so the neighboring nodes can take much time to find the alternate routes.

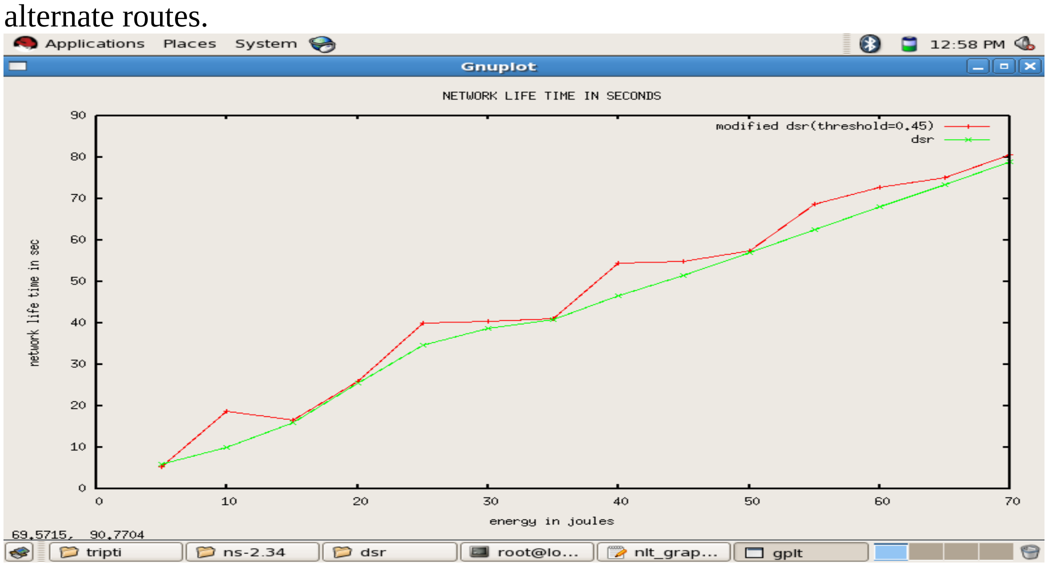

Fig.4 : Network Lifetime Vs Energy

Figure 4 describe the most important aspect of network connectivity. It shows that the network life time is equal to or more in m-dsr as compared to DSR in all energy levels.

After comparing m-DSR with DSR at different energy levels, we extend our analysis by keeping energy level fixed at 25 J and vary traffic or number of connections means source-destination pairs from 4 connections to 16 connections taken at an interval of 4. We analyzenetwork connectivity, PDF, average throughput, and finally the average delay against node density or number of nodes ranging from 20 to 120. The results are discussed as follow:

5. ANALYSIS AND DISCUSSION

We get an optimal value of battery threshold which is 0.45, as at this threshold the average throughput ,PDF , average delay and network lifetime is consistent and better as compared to other considered threshold value .From the above results we can also conclude that the modified DSR or m-DSR performs better than DSR in terms of throughput, PDF, delay and above all network life time. Moreover m-DSR is performing well in the condition of more traffic as well as with high node density, which is a general scenario of the ad hoc network. Better the network life time more will be the network connectivity. We can see from the above results that as we increase the connections, performance metrics like throughput , PDF , network lifetime shows tendency to improve , while delay reduces. In this way m-DSR improves the overall performance of the network. Since all the performance metrics we evaluate shows the consistent behavior, we can use our proposed work in the application where the consistency of the data transfer is to be maintained at consistent rate. One of the advantage of m-DSR is that it is an adaptive algorithm, as it automatically adapts to the changing parameters like energy, numbers of connections, number of nodes etc. We will not have to change the threshold value according to the changing conditions.

6. CONCLUSION

In this chapter we dealt with problem of finding the optimal value of the battery threshold, which provides us optimal network performance with in the given conditions. The proposed work implements some modifications in the existing DSR and give adaptive m-DSR. It is also recognized that 0.45 is the optimum threshold value by thorough simulations, which has not been identified exactly in any previous work already done. It is observed from the above results that the given threshold value of 0.45 is optimal, as it provides better results than DSR.The future work will try to evaluate m-DSR with other parameters also and try to modify it give better results. It will also try some probabilistic optimization methods to prove that our identified threshold value is optimal.

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