Comparative Analysis of Various Energy Efficient Routing Protocols in Adhoc Networks

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***Abstract*—Mobile Adhoc Network(MANET) are infrastructureless dynamic network with different topologies at different times. Power conservation is a crucial issue in wireless networks, as nodes are unattented and battery operated in the network. Various power aware routing approaches have been introduced in literature which save energy of the nodes in network using Minimum total power transmission , remaining residual energy capacity of the node and the hybrid approach using the combination of above two stated approaches. The objective cannot be satisfied by using existing power aware routing algorithm. So a new routing metric, drain rate , is proposed in the literature which predicts the lifespan of a node depending upon the current traffic load on that path. In this paper various power aware routing algorithms have been studied and compared the performance based on the simulations results in various research paper.**

***Keywords*— MANET, MDR, MTPR, MPR, MMBCR, CMDR.**

I. INTRODUCTION

An adhoc network is a dynamically reconfigurable wireless network with no fixed infrastructure or central administration. A mobile ad hoc network (MANET) is formed by randomly moving nodes that use the wireless medium to cooperatively forward data packets for nodes that are not within direct transmission range. Unlike routing in wired networks, ad hoc routing protocols cater for node mobility and quickly adapt to dynamically changing network topology. MANETs thus possess features like adaptivity, auto-configuration and the ability to operate in an environment where no previous infrastructure exists for communication. This allows the MANETs to meet communication needs in situations like military operations, disaster relief, emergency rescue, etc, by providing rapidly installable, cost effective and easily reusable solution. Several routing protocols have been designed for MANETs each aimed at optimizing network routing performance. The development of efficient routing protocols is a non trivial and challenging task because of the specific characteristics of a MANET environment[13]:

Due to node movements, the network topology may protocols change randomly and rapidly at unpredicted times.

The available bandwidth is limited and can vary due to fading, noise, interference.

Most mobile devices are battery powered; therefore energy consumption plays an important role.

However, wireless MANET is particularly vulnerable due to its fundamental characteristics, such as open medium, dynamic topology, distributed cooperation, and constrained capability. Routing plays an important role in the security of the entire network

II. POWER CONSCIOUS ROUTING METRICS

To minimize the total transmission power and maximize the network life time, several energy efficient routing protocols have been proposed in the literature[4]. Some power aware routing metrics used are as follows:

- Minimum transmission power
- Remaining energy capacity
- Hybrid approach
- Drain rate

2.1 Minimized Transmission Power Technique

In order to save power senders dynamically adjust the transmission power proportional to the transmission distance [3] . As the transmitted signal propagates to the receiver, it is subject to the effects of shadowing and multipath fading, and its power decays with distance [2]. Main objective of this routing metric is to minimize the average energy consumed per packet which lead to the reduction in total energy expended for a particular path.

Minimum Total Transmission Power Routing (MTPR) proposed in [4] uses the transmission power as the cost metric. The cost function is defined as

$$C(r) = \sum_{i=0}^{k-1} \left(PT(i) + PR(i+1) \right)$$

Where PT(i) is power expended of i-th node and is proportional to |ni, ni+1|, |ni, ni+1|,is the distance between ni and ni+1. PR(i+1) is the power expended in receiving the packets. MTPR method choose the path with minimum cost value.

One serious problem of this metric is that nodes in the network have differing energy expenditure profiles resulting in early death of several nodes. Second, MPTR may select the path with more hops, which result in increased end to end delay.

Minimum Power Routing (MPR) protocol in [2] uses the combination of physical and data link layer to conserve power. This aims to select a path which requires least amount of required power along with maintaining an acceptable level of signal to noise ratio at receiver site. Here a cost function is used that tells about how much transmission power is required to communicate on that link. Required transmission power from node a to node b [3]:

PT = ε / Sab rab-α

Received power at node b due to node a:

PR = K Fab PT rab-α

Where Sab= scale factor,Rab= distance from node I to node j

Fab = random attenuation to show the effects of shadowing and fading

K = constant factor, α= propagation path loss exponent

MPR more accurately estimate the total power required for the transmission.

2.2 Remaining Energy Capacity

The network lifetime is described as the whole period at which setup of network originates upto the time at which initial depletion of node starts in a network. If same node is present in a number of minimum cost paths then that node will be depleted fast and the network will tend to end. A number of routing protocols use remaining battery capacity as metric cost function of node ni as fi(t)= 1/ci(t) where ci(t) is the battery capacity of a node ni at time t. If total remaining battery of a route is considered , nodes with little remaining battery may be selected.

Min- Max Battery Cost Routing (MMBCR) in [4] defines the route cost as

$R_j = \max_{n \in r_j} f(t)$

The desired route ro is obtained so that

$R(r_o) = \min_{r_j \in r^*} R(r_j)$

Where r* is the set of all possible routes.

Since MMBCR considers the weakest and crucial node over the path, so a route with best condition among paths impacted by each crucial node over each path is selected. MMBCR technique does not guarantee that the total transmission energy consumed per packet is minimized.

2.3 Hybrid Approach

Conditional Max-Min Battery Capacity Routing (CMMBCR) in [6] used a hybrid approach . It uses combination of MTPR and MMBCR techniques which consider both the total transmission power consumption of path and remaining power of nodes. When all the nodes in all possible routes have sufficient remaining battery capacity(i,e above threshold ϒ), a path with minimum total transmission power is chosen among possible ones. The relaying load for most nodes must be reduced , because less total power is required to forward packets for each connection, and their lifetime is extended. The battery capacity of a route rj at time t is defined as[6]

$R_j(t) = \min_{n \in r_j} c(t)$

Major problem of CMMBCR is selection of threshold ϒ. It either needs centralized server to keep track of power status of all nodes.

III. THE MINIMUM DRAIN RATE MECHANISM

Energy saving mechanisms based only on metrics related to the remaining energy, minimum total transmission power approach cannot be used to establish the best route between source and destination nodes. If a node is willing to accept all route requests only because it currently has enough residual battery capacity, much traffic load will be injected through that node. In this sense, the actual drain rate of energy consumption of the node will tend to be high, resulting in a sharp reduction of battery energy. As a consequence, it could exhaust the node's energy supply very quickly, causing the node to halt soon.

To resolve this problem , a new metric , minimum drain rate(MDR) [7] is used that measures the energy dissipation rate in a given node. Each node ni monitors its energy consumption caused by the transmission, reception, and overhearing activities and computes the energy drain rate, denoted by DRi, for every T seconds sampling interval by averaging the amount of energy consumption and estimating the energy dissipation per second during the past T seconds. T is set to 6 seconds.

DRi = α * DRold + (1 – α) * † DRsample

The corresponding cost function can bedefined as:

Ci = RBPi / DRi

RBP denotes residual battery power and DR is drain rate

The maximum lifetime of a given path rp is determined[7]

$L_p = \min_{n_i \in r_p} C_i$

Protocols	Objective	Cost Function	Drawback
MTPR	Minimize total energy consumption of a selected route	$C(r) = \sum_{i=0}^{k-1} PT(i) + PR(i+1)$	May cause early depletion of nodes
MPR	Minimize total energy consumption of a selected route	$P_T = \varepsilon / S_{ab}\, r_{ab}^{-\alpha}$ $P_R = K\, F_{ab}\, P_T\, r_{ab}^{-\alpha}$	May cause early depletion of nodes
MMBCR	Evenly distribute energy depletion	$f_i(t) = 1/c_i(t)$ $R_j = \max_{n \in r_j} f(t)$	Does not ensure least power cost route
CMMBCR	Minimize total power and even distribution of energy among nodes	$R_j(t) = \min_{n \in r_j} c(t)$	Major problem of CMMBCR is selection of threshold ϒ
MDR	Minimum drain rate and fair energy distribution	$C_i = \sum_{n=0}^{n=i} \frac{RBPi}{DRi}$ $L_p = \min_{n_i \in r_p} C_i$	Total power consumption is not minimized

Table1: Performance Comparison of power aware routing protocols in MANET

MDR mechanism is based on selecting the route rm, contained in set of all possible routes r* between source and destination nodes. Highest lifetime route is represented as

Rm= rp= maxri€r* Li

The status of selected path can change over time due to the variation in energy drain rate at nodes. The conditional Minimum Drain rate Mechanism (CMDR) [8] ensure that the total transmission energy is minimized for the selected route. The lifetime of nodes in the selected route is higher than a given threshold i,e RBPi/DRi >= δ. If no path verifies this condition CMDR switches to MDR mechanism

IV. Conclusion

In this paper, we surveyed and classified a number of energy aware routing schemes. In many cases, it is difficult to compare them directly since each method has a different goal with different assumptions and employs different means to achieve the goal. Various energy related metrics viz. minimum total power consumption , remaining battery capacity, drain rate and hybrid approach is studied in detail . From the survey and comparative analysis we have found that MDR metric is good at reflecting the current dissipation of energy using the current traffic load on that path. Performance of the protocol varies greatly according to the variation in the network parameters.

V. References

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