Performance Exploration of Energy Proficient Routing Protocol in Wireless Adhoc Network

Sonam
M.tech student
Amity University, Haryana

VivekJaglan,PhD
Assistant Professor
Amity University, Haryana

MeenuVijarania
Assistant Professor
Amity University, Haryana

ABSTRACT
Today, all of the ad-hoc portable devices operate on their limited battery hence, lifetime of the network is restricted. Energy proficient routing protocols are considered as better solution to provide stability and portability in a network. Here the main issue is how to maximize the lifetime of a network. To maximize the lifetime and to achieve stability in a network, the power consumption rate of all the nodes should be evenly distributed and overall transmission power required to route a packet should also be minimized. Wireless networks are power constrained and power can also be used as cost metric. In this paper, an analysisto compare the performance of various power conscious routing protocols has been done which are based on adhoc routing. This paper also delivers a survey and analysis of power associatedcost metrics used for routing in a wireless network.

1. INTRODUCTION
The MANET (Portableadhoc network) is a group of portable nodes that roam independently within a network and all the nodes communicate with another one in freely manner. Each portable node has limited battery energy and main objective is to extend their lifetime to overall extend the network`s lifetime. When comparingadhoc networks with fixed network, special features make it more adaptable like dynamic topology, unstable links, and no any need of centralized controller. Due to these special features, design of wireless network is becoming a great challenge for us. Everyportable node in a network implementsrouting function among all of the nodes and even decease of a little nodes may cause disturbance of service in the whole network.

Adhoc routing protocols goal to find out the direct path routing while discovering a path from source to destination. But it is not always true later direct path routing easily origins power deletion of nodes by using the same node repeatedly. To solve this problem of battery exhaustion, a number of energy efficient routing protocols are examined. They mainly consider cost metric in terms of power. These power proficient routing protocols are divided and established on their power selection criteria.

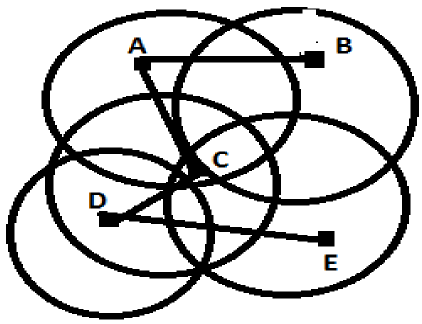

Fig1: Portable nodes in MANET

The main issue is how the network lifetime can be prolonged while each node has limited battery capacity. This limited energy is easily lost when same node is overused in all the discovered paths. Energy exhaustion of the node may interrupt the communication or cause network partitioning. Recently after discussing different energy aware routing protocols and energy related cost metrics an idea is given about how to achieve balanced energy consumption and prolong network lifetime.

2. PARAMETERS USED FOR CLASSIFICATION OF ENERGY EFFICIENT ROUTING PROTOCOLS

1. Transmission power
2. Remaining energy capacity
3. Combined energy metrics

In adhoc network, each metric consider a route from source node to destination node.

2.1 Transmission power
It is preferred condition to always adapt the path or neighbor node with least transmission power consumption in order to extend lifetime of network. Wireless network is considered as a pool of communicating nodes which has a property of sensing, data processing and communicating with each other as well as they have power supply and battery. If nodes have limited battery life power consumption becoming a most important issue. When a node transmit the data at high power then not only lifetime of a network will be reduced it will also introduces excessive interference.

There is also present a transmission power self-optimization technique that automatically updates the power of all the nodes in a network. This technique also guarantees that the lowest possible transmission power is responsible for maintaining connectivity as well as reliability in a network.

By increasing the transmission distance, transmission power required to route a packet will also increased. Transmission power should be adjusted dynamically to achieve conservation of energy.

2.2 Remaining energy capacity

The network lifetime is described as the whole period at which setup of network originatesupto 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.

2.3 Combined Energy Metrics

A no. of protocols come under this category which concentrates on minimizing the battery capacity as well as maximizing network lifetime. These both goals can`t be achieved easily.

3. ENERGY AWARE ROUTING PROTOCOLS (EARP)

3.1 Minimum transmission power routing (MTPR)

The scheme MTPR in [1] always chooses the path that has minimum cost as well as energy consumption for transmission of a packet should also be minimum. In MTPR, the cost function is:

$$C(r) = \sum_{i=0}^{k-1} p(i)$$

But MTPR may also select the route which has maximum hop or a larger delay. To more accurately representing the energy cost, the cost of receiving a packet at a node is also added to above function. So it is represented as :

$$C(r) = \sum_{i=0}^{k-1}(p(i) + p(i+1))$$

Where `i` is the transmitting node and `i+1` is the receiving node. The metric used in [1] for the performance evaluation are as follows:

MTPR_Hop Count: Defined as total number of hops in a route from source to destination for successful transmissions.

MTPR_Throughput: Ratio of total number of successful data packets received at receiver to the total no of data packet sent.If throughput is higher, that means route will be stable for a longer time.

3.2 Minimum power routing protocol (MPR)

The protocol MPR 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:

$$P_T = \varepsilon / S_{ab} r_{ab}^{-\alpha}$$

Received power[2] at node b due to node a:

$$P_R = KF_{ab}P_T r_{ab}^{-\alpha}$$

S_{ab} = scale factor

R_{ab} = distance from node I to node j

F_{ab} = random attenuation to show the effects of shadowing and fading

K = constant factor

α= propagation path loss exponent

3.3 Minimum battery cost routing(MBCR)

In MBCR protocol in [7], the cost function is defined as:

$$C(r) = \sum_{i=1}^{k-1} f(E(t))$$

Where f(E(t)) = 1/E(t)

It will always choose the path which contains maximum remaining energy capacity of nodes. It considers summation of remaining energy capacity that’s why the nodes in a route which has lower energy ability can even be selected.

3.4 Min-max battery cost routing (MMBCR)

The difficulty occurred in MBCR protocol is overcome in MMBCR in [7]. It guarantees that any of the node willnot beoverworked. The battery value for any route is:

$$R = \max f(c^t)$$

This metric always try to choose the node which have higher battery capacity among all the nodes in a network. But there is also a problem that it will not always choose the path which contains minimum transmission power. A no. of paths can use a larger power to transfer information from one node to another one.

3.5 Energy Aware probability routing (EAPR)

In EAPR[4], the remaining energy level of node is used for corresponding energy depletionamongst nodes. EARP uses a probability model to check that the node will forward or drop a route request packet. EAPR protocol has modification in route discovery phase as compare to DSR protocol. The intermediate node cannot forward a received packet until residual energy of another node is unknown. In route discovery phase, any of the nodes will send the RREQ message according to REONN (Remaining energy of next node). The REONN of a node `a` is defined as:

$$P_a = \begin{cases} 1, & E \geq Thr \\ \alpha * \left(\frac{E}{Thr}\right), & E < Thr \end{cases}$$

$P_a$is the probability[4] to check whether the packet will be forwarded or not.

Thr is the predefined threshold rate that is similar for all of the nodes in a network.

α is the coefficient.

E is the remaining energy level of a node.

3.6 Time delay on-demand routing(TDOD)

TDOD (time delay on demand) routing protocol[5]converts lasting battery capability into delay. Then route request messages are forwarded with that delay. The delay function is:

$D(t_i) = 1/E(t_i)$

$D(t_i)$ is the delay occurred when a node transfers the packet from node i1 to i2. Which nodes have lesser energy proficiency that are allocated with higher delay. The packet forwarded from these higher delay nodes are likely to be dropped.

3.6Conditional max-min battery capacity routing(CMMBCR)

The proposed CMMBCR [7] has resolved this problem. The goals(extend lifetime of anetwork and use the battery in an equally manner) cannot be accomplishedconcurrently by any of previous protocols like MTPR,MBCR, MMBCR. This algorithm uses battery capacity as a route selection metrics and uses a battery capacity to choose the route. This protocol each timeproceeds a waythroughleast transmission power when there are a no. of paths which contains sufficient remaining battery capacity. Less power is used for transmission of packets, load of the node is mostly reduced that’s why network lifetime will be increased. In a path, a large no of nodes which have low battery capacity then avoid that path which have lowest battery to maintain the network stability. Here, the battery ability for a path at a time $t_0$is :

$$P_j = \text{minimum } c_t^i$$

Suppose X is a collection of all the probable paths between any of the two different nodes at time t_0 and it satisfies a condition:

$P_j >= ¥$ for a route ¥ € X

¥ is a threshold value which ranges from 0 to 100.

3.7 Power aware source routing(PSR)

This protocol PSR[3] goals to prolongvaluable service existence of a wireless ad-hoc network. In a network, decease of little nodes may be a cause to the partitioning of network due to which some active nodes become unreachable. The PSR protocol has found a solution to this problem of finding a route `r` at time t_1 by minimizing this cost function:

$$C(r,t_1) = \sum_{i \in r} c(t)$$

In PSR[3] protocol, detection of a direct path and maintenance of that path are more complicated as compared to DSR. Because in DSR only node mobility is a reason of path invalidation while in PSR both flexibility of node as well as node energy lessening may cause path invalidation.

3.8 Power aware on-demand routing (PAOD)

In PAOD[6] protocol, each node maintains an energy arrangement table (EAT) instead of route collectionallowing to which route request packet is forwarded. Route collection is mainly used in on – demand routing protocols. The entry in EAT table is mapped with the route passing through that node and maintains a record of how much energy is conserved.

Path cost function cost(p) = $A_1 * n - B_1 * \min\{E_i \mid i = n_1 \ldots\ldots n_m\}$, when n> 0;
A_1 and B_1 are positive constants.

4. PERFORMANCE ANALYSIS

Table1:comparison of “adhoc routing protocols”

Protocols	**Objective**	**Cost function**	**Metric**	**Cost/Packet**	**Degree of Hop Count**
TDOD	evenly distribute energy exhaustion	$D(t) = 1/E(t)$	Remaining energy capacity	Maximum	High
MBCR	evenly distribute energy exhaustion	$C(r)= \sum_{i=1}^{k-1} f(E(t))$	Remaining energy capacity	Maximum	High
MMBCR	evenly distribute energy exhaustion	$R=\max f(c^t)$	Remaining energy capacity	Maximum	High
EAPR	evenly distribute energy exhaustion	$P_i = \begin{cases} 1, & E \geq Thr \\ \alpha * \left(\frac{E}{Thr}\right), & E < Thr \end{cases}$	Remaining energy capacity	Maximum	High
CMMBCR	minimize power consumption and fairness	$R_j^c = \min\ c_i^t$	Combination	Moderate	Moderate

PAOD	Minimize power consumption and fairness	cost(p) = A*m-B*min{E_i ! i=n_1……..n_m }, when m > 0;	Combination	Moderate	Moderate
PSR	Minimize power consumption and fairness	C(r,t) = $\sum_{i\in r} c(t)$	Combination	Moderate	Moderate
MPR	Minimize energy consumption	$P_T = \varepsilon / S_{ij} r_{ij}^{-\alpha}$ $P_R = K F_{ij} P_T r_{ij}^{-\alpha}$	Total transmission power	Minimum	Low
MTPR	Minimize energy consumption	C(r) = $\sum_{i=0}^{k-1} p(i)$	Total transmission power	Minimum	Low

5. CONCLUSION

We studied energy proficient routing protocols for ad-hoc networks and categorized them according to their metric used in cost evaluation. The protocols come under the category transmission power only aims to minimize required transmission power and conserve energy but may select the path which may have a large no of hops. Protocols in remaining energy capacity checks for evenly distribution of energy among nodes which extends network lifetime but they choose the path which consumes a large transmission power. And the combined energy metrics combine both the metrics minimum transmission power as well as maximum remaining battery capacity for fairness of service in network.

6. REFERENCES

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