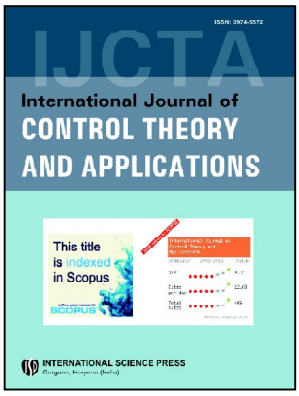

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A Study on Energy Aware Routing Protocols for Mobile Ad Hoc Networks

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Abstract: As the technology emerges the MANETs plays a prominent role in almost all fields. The MANET consist of nodes which are having mobility. These are infrastructure less networks so the nodes are all operated with the help of battery. Due to mobility the nodes tend to move from one place to other places easily and battery drains fastly. Any failure of the nodes causes the effect on network performance and lifetime. Sometimes it may not be possible to replace the battery in remote locations, so maintaining the optimal power during data transferring and receiving is a major issue. Therefore energy saving is an important thing; the energy aware routing protocols provide the solution to maximize the lifetime of the network. In this paper we are going to describe some of the energy efficient protocols namely MTPR, EPAR, EEAODV. These protocols provides the more efficient path to the users. MTPR (Minimum Transmission Power Routing) monitors the total transmission power of all possible routes and sends the data along the route with minimum transmission power. Instead of monitoring the paths, EPAR (Efficient Power Aware Routing) forwards the data based on energy with maximum lowest hop energy. EEAODV (Energy Efficient Adhoc Distance Vector protocol) checks energy to distance ratio for each path and selects the path with maximum energy and minimum distance.

Keywords: *MANETS*, EEAODV, EPAR, MTPR, battery power.

1. INTRODUCTION

The communication is very important for interchanging of data. The wireless networks widely distributed and become popular during past decades. MANETs are a kind of wireless Adhoc networks. These are self configuring networks and formed dynamically. The network consists of limited energy and bandwidth. The nodes communicate directly with other nodes if they are in same radio range otherwise they need the cooperation of other nodes to communicate. As the MANET is a network with mobile devices they can change links easily and frequently changes its position. MANETs are far away from centralization mechanism and doesn't need any system for guiding. For establishing these networks includes very low cost since there is no fixed infrastructure.

To exchange the data in MANETs routing protocols are required. Routing means providing the finest path to data to reach its destination.

The activities of routing are 1.determining optimal paths 2.transferring the data through the network. In general, the shortest path is considered as the optimal path but it is not always true. These energy aware routing protocols provides the path based on energy metric.

The major challenges of MANETs are: dynamic topology, limited bandwidth, routing overhead, constraint on battery power, security threats. The applications of MANETs include: military environment, disaster recovery, rescue operations, sensor networks.

2. ENERGY AWARE ROUTING PROTOCOLS

(A) Minimum Total Power Routing (MTPR)

The MANETs are operated on battery power so the energy efficiency is a major issue. To enhance the lifetime of the network the energy consumed by each node must be minimized. The MTPR algorithm provides the solution to minimize the energy consumption.

The MTPR selects the path with minimum total transmission power. When a node requires a route to transmit data then it broadcasts the route request (RREQ) to its neighbors. The RREQ is broadcasted into the network continuously by intermediate nodes upto it reaches its destination. The destination nodes may receive multiple RREQs but it selects the path with minimum total transmission power. In this way the energy consumption is reduced.

Algorithm

The algorithm of MTPR is as follows

1. Broadcasts RREQ to reach its destination.
2. Calculate the transmission power of all possible routes from source to destination.
3. Selects the path with total minimum transmission power.

This protocol selects the path with more number of nodes. This is due to the statement that power is inversely proportional to the distance. The drawback of this protocol is it may consume more time (while satisfying minimum transmission power path) to send data due to this the end to end delay increases.

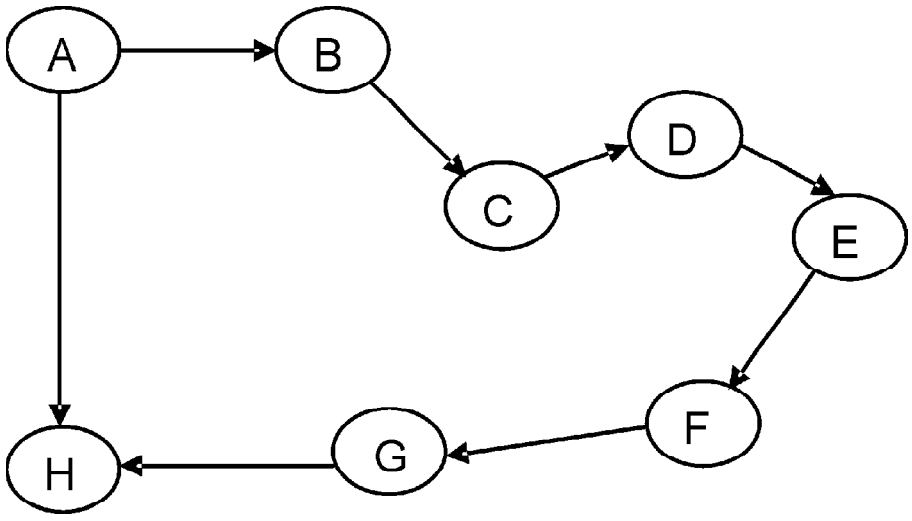

Figure 1: Route discovery in MTPR

The figure 1. Shows the nodes in a network which starts the route discovery process with RREQ packets. The nodes send the reply back by calculating the transmission power between the nodes in that particular path. The distance between the nodes is provided in the following table. Based on the distance, the path having the minimum transmission power and minimum loss is selected for routing.

Table 1
Distance between the nodes

Node	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*
A	0	5	7	10	-	-	-	-
B	5	0	4	7	-	-	-	-
C	-	-	0	4	-	-	-	-
D	-	-	-	0	-	6	-	-
E	-	-	-	-	-	-	-	-
F	-	-	-	-	-	-	-	-
G	-	-	-	-	-	-	-	-
H	-	-	-	-	-	-	-	4

In this, the available paths for transmission are ABCDFH, ACDFH, and ADFH. The transmission power loss for those paths are as follows:

1. For the path ABCDFH, the transmission loss is 5*5+4*4+4*4+6*6+4*4=109 units.
2. ACDFH path has 117 units transmission loss (7*7+4*4+6*6+4*4).
3. ADFH has 10*10+6*6+4*4=152 units of transmission loss.

Out of these paths ABCDFH has low transmission loss. So this path is selected to transmit data. The same is shown in fig. 2 i.e., the path from source to destination node.

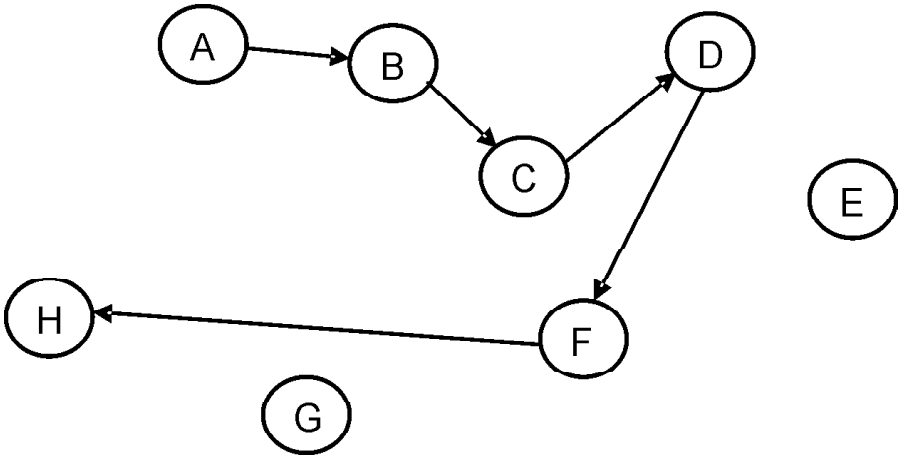

Figure 2: Path from source to destination using MTPR

(B) Efficient power aware routing (EPAR)

In the reactive protocols, the optimum path is chosen for communication and route is maintained with the help of route error (RERR) packets. But there is no indication for link changes. As MANETs are having mobility nature,

if one node changes its position then energy of the node vary according with the position of node with respect to other nodes (node may move far away or it side by) it shows effect on energy. Due to this the lifetime of the network varies. The information about the link changes is conveyed to source node is possible with this protocol (it uses backup node).

EPAR is an on demand protocol. Unlike MTPR, EPAR considers the energy of each node. It not only considers the residual power but also the predicted energy over the path. The path is chosen based on maximum lowest hop energy. This extends the lifetime of the network.

Route discovery and establishment

First it sends the data regarding the route request to all the nodes. It continuously broadcast that data packet through other nodes throughout the network until it reaches the terminus node. It follows the max-min strategy.

The algorithm is

1. Determine the minimum hop energy of all available paths.
2. Consider the maximum of all minimum hop energies and exchange the data.

Route maintenance in EPAR

In any network the flattening will happen if there is any failure. This is indicated with RERR packets (or with acknowledgement in some protocols). The failure of the link is mainly due to

1. Node moves to out of range.
2. Energy fatigue of the dropped node.

This will overcome with the help of backup node. The backup node acts as substitute node for the dropped node and immediately updates its location in the network.

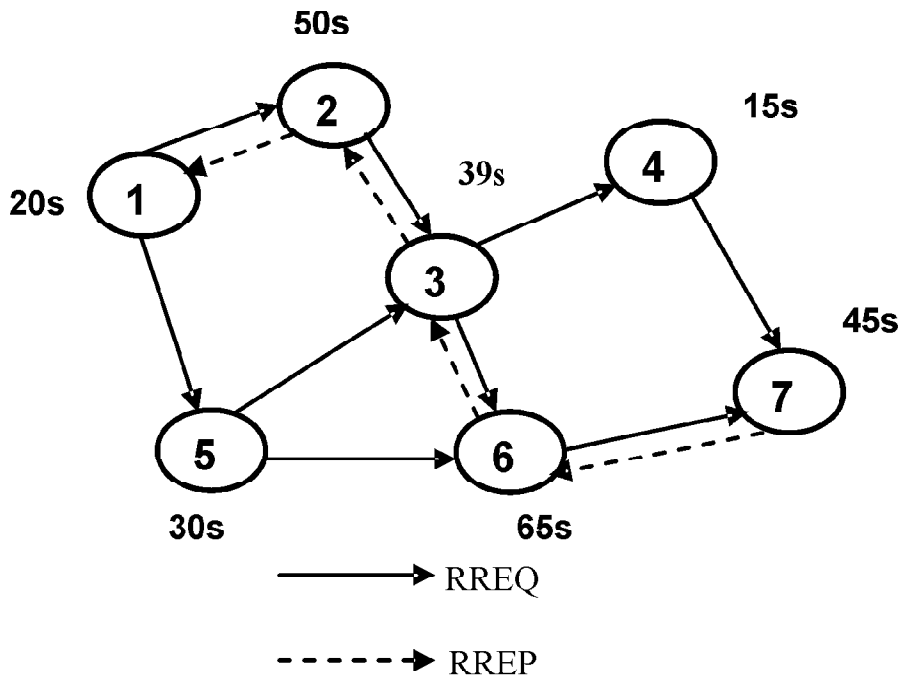

Figure 3: Route discovery and establishment in EPAR

The figure shows the nodes of a network with energy, route discovery process and route establishment using EPAR. The possible paths are 1-5-6-7, 1-2-3-6-7, 1-5-3-4,7. Now the path is selected based on the maximum of minimum transmission power of all the paths. It is as follows

T (1, 5, 6, 7) = min (20, 30, 65, 45) =20

T (1, 2, 3, 6, 7) = min (20, 50, 39, 65, 45) =20

T (1, 5, 3, 4, 7) = min (20, 30, 39, 15, 45) =15

T_{max} = max (20, 20, 15) = 20

The lifetime of these paths are 160 (20+30+65+45), 219 (20+50+39+65+45), 149 (20+30+39+15+45) respectively. So the path 1-2-3-6-7 is selected for communication. The data packets are transmitted via the path to its destination. In this way the route is remained for maximum time.

(C) Energy efficient AODV (EEAODV)

In AODV the route selected is shortest path but it doesn't consider the energy metric. If the same shortest path is selected frequently then the battery power of the common nodes drains fastly. To avoid these EEAODV is proposed. EEAODV is an on demand protocol. It is same as AODV but the main difference is EEAODV selects the minimum residual energy path.

Every node maintains the information of available path to other nodes and energy consumption of that route in its routing table. EEAODV consist of route discovery phase, route maintenance. The protocol maintains a threshold level to forward the data.

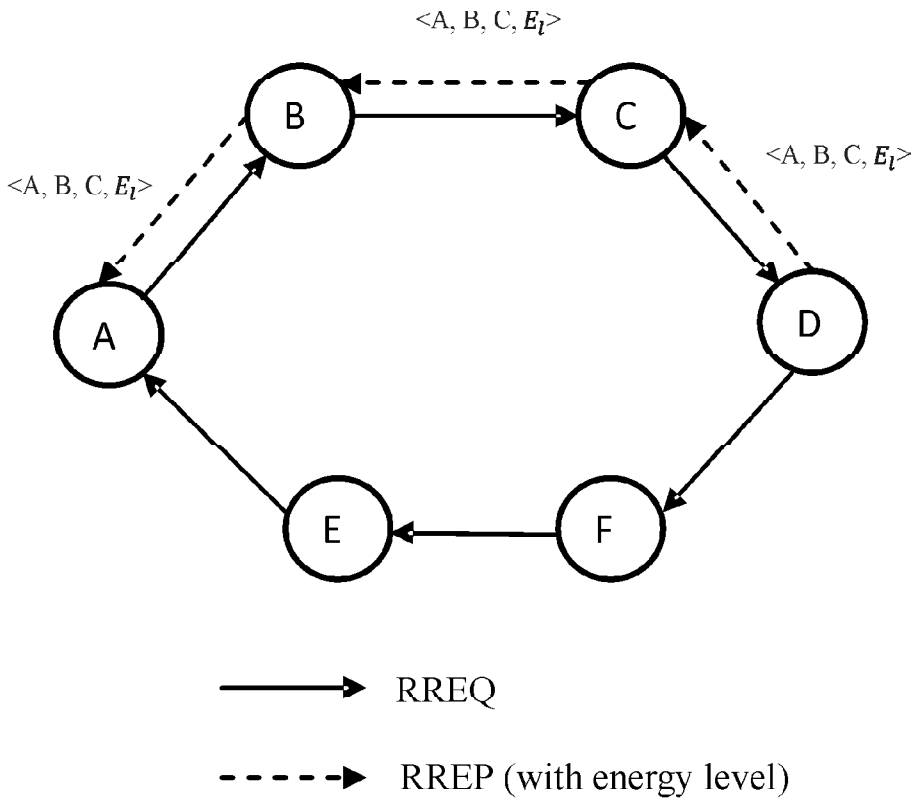

Figure 4: Routing in EEAODV

The figure represents the EEAODV with route discovery and maintenance. The node first broadcasts the request and gets the reply back with energy level represented as.

1. **Route discovery:** Like in a normal AODV, the route is discovered by broadcasting RREQ's (route request) throughout the network. This protocol checks the energy at each node and compare the energy level with the threshold level. If the level is less than the threshold then it is discarded. After broadcasting RREQ the destination node reply back with RREP (route reply) along the reverse path in response to route request. The energy level also appends with the RREP.
2. **Route maintenance:** As an Adhoc network, the nodes will move from one place to another. So path may not exist all the time. While exchanging the data the route may disrupt this will be indicated with the help of RERR packets (route error). The node which receives RERR packet will discard that route from its routing table and selects the alternate path for transmission.

3. CONCLUSION

In this paper we discussed various protocols like MTPR, EPAR, and EEAODV. Each of the routing protocol acts differently. Mainly in this we present the protocols to maximize he network lifetime. EEAODV provides an optimal path by considering the energy consumption. Through this the optimal path with maximum lifetime is to be achieved. MTPR provides the route by computing the energy of different paths. But EPAR provides the path by considering every node energy. EPAR is an extension to DSR but it provides more lifetime to the network and it gives better performance than MTPR and DSR.

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