A Study of Energy Efficient Routing Protocols in Mobile Ad hoc Networks (MANETs)

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***Abstract*- Mobile Ad Hoc network is abbreviated as MANET which consists of large number of nodes which are moving arbitrarily in any direction in which nodes allow to exchange information without any special infrastructure. There are many research issues in MANET and one of the most important issues is the efficient utilization of battery power or energy during routing process. There are lot of work has been done in this field and some of them are proposed with good approaches. In this paper, a study is presented regarding energy efficient routing protocols which reduces the energy consumption of mobile nodes and increases the life time of battery and thereby enhance the life of network.**

***Index Terms* - Mobile Ad hoc Networks, Routing Protocols, Energy Efficiency, Review ,Survey .**

I. INTRODUCTION

A Recently extensive work has been done in integrating mobile hosts and mobile networking hardware and they are used into traditional networks such as Internet [1, 2]. Sometimes, mobile users will want to communicate in situations in which no fixed wired infrastructure such as this is available, either because it may not be economically practical or physically possible. For these purposes , a mobile user needs wireless infrastructure less ad hoc networks in particular wireless applications like military operation, emergency operations etc..

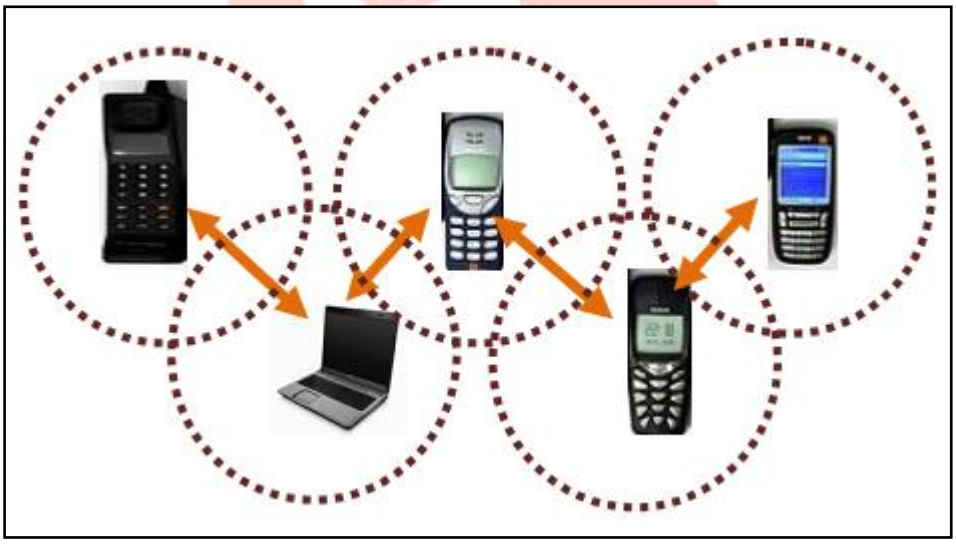

Figure 1: Typical Mobile Ad Hoc Networks

The Figure 1 depicts the overview of the mobile ad hoc network. The nodes involved in ad hoc networks have a limited lifetime, so power availability is one of the important constraints for the operation of the ad hoc network. There are different sources of power or energy [2, 3, 4] consumption in a mobile ad hoc network.

The environment of an ad hoc network is characterized by unpredictable connectivity changes, unreliable wireless medium, resource-constrained nodes, and dynamic topology. These features make a MANET prone to numerous types of failures including: transmission errors, node failures, link failures, route breakages, and congestions. The environment of ad hoc network can be categorized into three main states: an ideal state, wherein the network is relatively stable with sufficient resources; a congested state, wherein some nodes, regions or the whole network is experiencing congestion; and an energy critical state, wherein the energy capacity of nodes in the network is critically low. Under these conditions, designing an efficient and reliable routing protocol that adapts to the current state of the network is an important and challenging task. To our knowledge none of the current routing protocols designed and evaluated for ad hoc networks in literatures has demonstrated effective operation in a wide range of network dynamics or states.

II. CHALLENGES IN MANETS

Although MANET is applicable in many areas, but researchers need to study their challenges carefully before its wide commercial deployment. Following are the challenges involved in MANETs [5,6]:

A. Routing:

The issue of routing packets among any source destination pair of nodes in ad hoc network becomes challenges task due to constant changes in network topology. MANET follows mainly reactive and proactive type of routing protocols. Another issue may be with multi-cast routing protocols because multi-cast tree is no longer static due to the random movement of nodes within the network.

B. Security and Reliability:

Security is another issue with such kind of networks due to nasty neighbor relaying packets. Furthermore wireless link distinctiveness commence also reliability problems due to the restricted wireless transmission range, hidden terminal problem, mobility-induced packet losses, and data transmission errors.

C. Quality of Service (QoS):

Due to constantly changing environment quality of service (QoS) is also the challenging issue. The inherent stochastic feature of communications quality in a MANET makes it difficult to offer fixed guarantees on the services offered to a device. A flexible QoS issue must be resolved over the traditional resource reservation to support the multimedia services.

D. Inter-networking:

Inter-networking issue between MANET and fixed networks (mainly IP based) is often expected in many cases. The coexistence of routing protocols in such a mobile network is a challenge for the harmonious mobility supervision.

E. Power Consumption:

Power consumption issue must be considered for the mobile nodes participating in a network which do communication related functions. The routing must be power aware routing and mobile nodes must conserve the power.

F. Energy Efficiency

Mobile Ad hoc networks are energy constrained since nodes operate with limited energy or battery. There may be a condition that some nodes may die due to lack of energy and then they cannot communicate with each other. Some of the reasons for energy efficient routing in MANET are difficulties in replacing the batteries, limited energy of the nodes, lack of central coordination, constraints on the battery source, selection of optimum transmission power and channel utilization.

III. RELATED WORK

One important aim of routing protocol is to keep the network functioning as long as possible along with establishing correct and efficient routes between a pair of nodes [7]. This aim can be accomplished by minimizing mobile nodes' energy not only during active communication, but also when they are inactive mode. There are many approaches to minimize the energy in inactive or active mode.

1. EPAR

This stands for Efficient Power Aware Routing Protocol. This is on demand routing protocol based on minimizing the power consumption per packet. EPAR identifies the capacity of a node in both residual battery power and the expected energy spent in constantly forwarding data packets over a particular link. Using a mini-max formulation, EPAR selects the path that has the largest packet capacity at the smallest residual packet transmission capacity. EPAR is to minimize the variance in the remaining energies of all the nodes and thereby prolong the network lifetime. Reduces total energy consumption, Decreases the mean delay, and extend the network lifetime [8]. But in which some node operates on limited battery resource & a multi hop routing path and also it does not contain the alternate path in case of link failure.

2. Modified EPAR

This protocol reduces the energy consumption using the link cost to transmit power control in EPAR in four modes (transmit, receiving, idle & sleep) and residual energy. They added two power value like to set power and max value for packet transmission. In which the cost value depend on packet size or adjustable for small packet choose the short path and for large packet use the long path [9]. But for the large packet this protocol is not efficient chooses the longer path so network lifetime will be reduced.

3. EPRDSR

This stands for Efficient Power Routing DSR Protocol. EPRDSR selects the bandwidth and a power constraint path is built in to the DSR route discovery process. This is not only extending the lifetime of each node, but also to improve the lifetime of each connection [10].

4. Novel PER

This stands for Novel Power Efficient Routing Protocol. This protocol minimizes the power consumption for operation so that transmission power can be saved. In which instead of reinitializing route discovery process periodically; route discovery is initialized only after transmission of an optimum number of data packets. Hence the optimum value of this number must be chosen carefully depending on the size of the network [11] and the energy level of nodes to avoid routing overhead and maximize the lifetime of the network.

5. EDSR

This stands for Efficient DSR Protocol. In this protocol minimize the energy consumption per packet, minimize maximize the node cost, find the intermediate selfish nodes whose drop the packets and maximize the network lifetime through the route discovery process, in EDSR route discovery, Set and start the timer and destination waits for a specific time after receiving the RREQ packet [12]. It then replies the best path in that timer period and ignore another. According to this protocol destination will wait for the specific time after that RREP packet will send so process will be run for longer time means it is a time consuming process.

6. MBCR

It minimizes the total cost of the route. This algorithm minimizes the summation of inverse of remaining battery capacity for all nodes on the routing path. However, since it just minimizes the sum, some nodes may still be overused because a route containing nodes with little remaining battery may still be selected. Since MBCR uses the remaining battery of the nodes as for selecting the route which is quite a good method for selecting the route.[13]

Disadvantage-Since battery capacity is directly incorporated into the routing protocol, this metric prevents nodes from being overused; thereby increasing node lifetime and the time until the network is partitioned. If all nodes have similar battery power, this metric will select a minimum-hop route. However, because only the sum of values of battery cost is considered, route nodes with little remaining battery capacity may still be selected.

7. MMBCR

This stands for Min-Max battery Cost Routing Protocol. It is a modification of the MBCR [13]. It attempts to avoid the route with nodes having the minimum battery capacity among all nodes in all possible routes. MMBCR [13] treats nodes more fairly from the standpoint of their remaining battery capacity. Minimum remaining battery capacity nodes are avoided and ones with superior battery capacity are favored when selecting a route. However, more overall energy will be consumed throughout the network since minimum total transmission power routes are no longer favored.

8. CMMBR

This stands for Conditional Min-Max battery Capacity Routing Protocol. This chooses the route with minimal total transmission power if all nodes in the route have remaining battery capacities higher than a threshold; else the routes that consist of nodes with the lowest remaining power are avoided.

9. MPRC

It identifies the capacity of the node not just by the residual battery capacity, but also by the expected energy spent in reliably forwarding a packet over a specific link.

10. PSR

It is an on-demand source routing that uses an accumulative graded cost function. It also uses state of the charge of battery to maximize the lifetime of the MANET.

11. MTPR

This stands for Minimum Total Power Routing Protocol. In MTPR, energy metric [14] is represented by the total energy consumed to forward the packets along the route. In this way, MTPR reduces the overall transmission energy consumed per packet, but it does not directly affect the lifetime of each node. Each node learns the routing paths not only as a source or an intermediate node, but also as an overhearing neighbor node.

Disadvantage –The more nodes involved in routing packets, the larger end-to-end delay. In addition, a route consisting of more nodes is possible to be unstable, because the chances of that intermediate nodes will move away is higher. Hence, from the standpoint of minimum hops, large numbers of nodes are remains in active mode. The route obtained from this algorithm is not attractive.

Following table 1 shows the comparison of several energy efficient routing protocols against appropriate parameters.

Table 1: Comparison Chart

Protocols	Max. Lifetime	Min. Energy Consumption	Overhead Ratio and End to End Delay
EPAR	YES	YES	Moderate
Modified EPAR	YES	YES	Low
EPRDSR	YES	YES	Moderate
Novel PER	YES	YES	Low
EDSR	YES	YES	Low
MBCR	YES	NO	Moderate
MMBCR	YES	NO	Moderate
CMMBR	YES	YES	Moderate
MPRC	YES	YES	Low
PSR	YES	YES	Low
MTPR	NO	NO	High

IV. CONCLUSION

We observe that the existing routing protocols suffered from several problems like network congestion, network wide flooding, bandwidth constraints, delay, greater load on radios, processing overheads, busy network, selection of route containing nodes with little remaining battery capacity etc. In the existing power aware protocols longer path is selected whereby maximum number of node participates for packet transmission from source node to destination node with minimum number of nodes in the idle mode and maximum number of nodes in the active mode. This will ensure higher energy consumption; while some of the nodes operate on limited energy resources and multipath routing.

An energy efficient routing protocol is required to choose the energy efficient route from source to destination. Energy efficiency is the main problem of the network. In this paper, we have undergone the survey and classified the energy efficient routing protocols with their methods, benefits and limitations. It is difficult to compare them directly because each method is distinct with different underlying assumptions. In future we try to design a new procedure that reduces the energy consumption and increases the energy utilization of nodes in network.

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