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Energy Efficient Routing Protocols in MANET - An Overview

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***Abstract*: Advances in wireless communication make the researchers to show their interest in various fields under mobile ad hoc network (MANET).It consists of devices that are autonomously self-organizing, self-configuring in networks. MANETs are very important in situation like disaster, search & rescue operations, in battle field for communication, military environment etc. In a MANET, the energy consumption has always been an issue. Since the mobile nodes are assumed to be dead when they are running out of battery, it is imperative to optimize the battery consumption at the nodes. The maximum energy consumption may cause early unavailability of nodes and thus failure of node links in the network due to running out of energy. To prevent network failure, many protocols have been designed for efficient energy consumption with minimizing the delay. In Past research many energy efficient routing techniques has been introduced but they have certain limitation. In our work we are trying to do a research in the same field which will help in increasing the energy efficiency with minimizing end to end delay, increase network lifetime, and PDR**

***Keywords*: MANET, MTPR, EPAR, EEAODV, EELAR**

1. Introduction

MANET is a special type of network which is infrastructure less or footing its establishment in all fields due to high efficiency of their autonomous and self-governing mobile nodes. Mobile ad hoc networks are also called de-centralized networks because there is no central device which controls the network, such as router or switch. All devices have same status and free to create link with other ad hoc networks where link is available. The devices in this type of network are free in moving and also provide the services of host and router forwards the packet to destination. During data communication from sender to receiver, there are many constraints in the path finding, node selecting, and detection of link failures, route maintenance, route repair, retaining routing tables and to take correct decision of packet forwarding towards the direction of exact destination. MANET consists of number of mobile nodes which operates on battery. A mobile node has a finite energy which is degrading soon when use in continuous communication. Therefore, these nodes must to be conserved energy to maximize the life time of the network. Energy management is the task of MAC (Medium Access Control) layer while the network layer can take decisions based on topology or traffic characteristics. In sleeping state, energy consumed by the node is significantly less than the transmit/receive/idle state node. For this, Selection of path in such a way that it consumes less power & minimize energy consumption .Various type of routing protocols are designed which have very low power consumption in different scenarios.

Energy Efficiency: The energy efficiency of the routing protocol depends upon various factors such as routing process & route discovery .The route discovery process in MANET involves the frequent broadcasts of route request packets to the neighboring nodes. So these will results into maximum energy consumption. An energy efficient protocol algorithm can be applied to any one of the existing reactive routing protocols and make the protocol more efficient. In this research we are trying to find a method that will definitely help to improve the energy efficiency of network. The main purpose of routing protocol is to find suitable routes between two communicating nodes in a mobile ad hoc network. There is different way to communicate with a node in mobile ad hoc network and for this their routing protocols are responsible to create a finest path between these nodes. The classification of Protocols is as follows in fig 1:

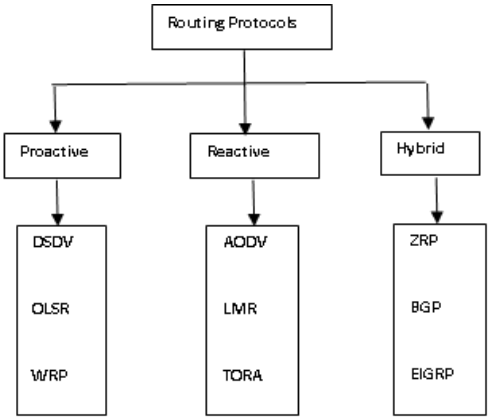

Fig. 1. Classification of routing protocols

A. Proactive routing protocols

Table Driven routing protocol named as proactive routing protocol. Every node maintain a routing table which contains information about the network topology even without requiring it .This feature although useful for datagram traffic, incurs substantial signaling traffic and power consumption . Its routing

table updated automatically as per the network topology varies due to this they have very low latency Examples of various well known routing protocols are DSDV, OLSR,WRP, and CGSR etc.

B. Reactive routing protocols

Reactive Routing Protocol named as on demand Routing Protocol. In this protocol the routes are discovered only when the source needs to transmit data packets. Thus, the control packets are broadcasted only just when the data is to be transmitted. So, the broadcast overhead is reduced. In these protocols, there are two parts to establish a route from source to destination. These two parts are route discovery and route maintenance. The topology of the network is changed often since the nature of the ad hoc network is mobile. When the path between routes to destination is broken, the route maintenance phase is started to keep route available. As a result a large end to end delay is present in this Protocol. An example of reactive routing protocol is Dynamic source routing (DSR), Ad0hoc on demand (AODV) etc.[3]

C. Hybrid routing protocol

Hybrid routing protocols are the combination of table- driven and On-demand routing protocols. Zone Routing Protocol (ZRP), is one of the examples of Hybrid routing protocols. In ZRP, internally we use proactive routing, but outside the zone, we use reactive routing. Other examples of Hybrid routing protocols are, Cluster-Based Routing Protocol (CBRP), Border Gateway Protocol (BGP), Enhanced Interior Gateway Routing Protocol (EIGRP).[3]

2. Literature survey

The major challenge in MANET is to increase the lifetime of the network keeping the network energy efficient. As the network nodes have very limited battery power. Due to this, the most critical problem is node link failure. With the help of the conservation of energy, the battery life span can be maximize. The broad and large routes in the network use more battery energy, so that sudden depletion of energy will occur. For the conservation of energy of mobile nodes within the network, there are different types of power aware routing algorithms and mechanisms exist. Alaa Muqattash et.al (2004) [1] proposed a power controlled dual channel MAC protocol for wireless ad hoc networks. To produce power-efficient routes. Bulent Tavli et.al (2006) [2] proposed an energy and spatial reuse efficient network-wide broadcasting architecture which was a completely distributed algorithm, and targeted to reduce the total energy dissipation, which consists not only of transmit energy dissipation, but receive, carrier sense, idle, and sleep energy dissipation terms as well. Jihui Zhang et.al (2006) [3] investigated the energy-efficient packet routing in a multi-hop wireless network, where mobility is taken into account by adopting a deterministic model.Author considered the objective of minimizing the energy consumption for packet delivery, subject to the packet delay constraint and SINR requirement among concurrent transmissions. This can be formulated and solved by a dynamic programming algorithm. Song Guo et.al (2007) [4] presented a framework for the design of a distributed minimum energy multicast algorithm for wireless ad hoc networks, covering topics from the discrete power level management, energy efficient tree construction process, and tree flood mechanism, to localized operations for energy saving and tree maintenance. Floriano De Rango et.al (2008) [5] proposed a novel energy aware multi point relay (MPR) election policy which allows energy node to be kept preserved for longer time. Ting Lu et.al (2013) [7] proposed an energy-efficient delay-constrained multicast routing algorithm. The proposed algorithm was a source-based algorithm which takes into account energy consumption as well as end-to-end delay in route selection. Wei Wang et.al (2013) [8] proposed a unified framework for the design of an energy aware & self-adaptive anomaly detection scheme based on network tomography.

Sajal Sarkara et.al (2016) [12] proposed a secure and energy efficient stochastic multipath data routing scheme for mobile ad hoc networks. Author considered packet forwarding energy consumption as the value function of a Markov chain to determine the optimal routing policy. Nikolaos Papanikos et.al (2016) [13] proposed XOR-based coding that is used to enhance energy efficiency of broadcasting in MANET. Aqeel Taha et.al (2017) [14] proposed a new energy efficient multipath routing algorithm called FF-AOMDV(Fitness Function- ad hoc on demand multipath distance vector) which is a combination of Fitness Function and the AOMDV's protocol. Mahendra Maiti et.al (2018) [20] proposed an energy efficient common content distribution approach based on teaching learning based optimization technique Based on bit rate, remaining energy & maximum fitness values are selected as cluster heads. Reducing this idle time can lead to increase energy efficiency of the network.

3. Problem statement

Till date there are various routing protocols that focus on various problems including energy minimization and routing overhead. All the studies have acted as a good guideline to carry out future research work towards further enhancement in communication performance, but still, there are some facts which are found to be not addressed in the prior literatures. Therefore, the biggest challenged for the researcher is to design a MANET's routing protocol with efficient energy consumption. Due to limited energy resources of mobile nodes battery it is a challenging task .Power or energy aware routing is the most popular approach to improve energy efficiency. Stabilized routes are termed as those routes established between nodes with higher signal strength and unstabilized routes are established between the nodes with weaker signal strength. Till date, there is no such study to define such parameter and associate with the energy to combinely solve energy and routing overhead issues in mobile adhoc network.

Table 1
Various energy efficient techniques

	Types of Energy conservation	Description	Advantages	Limitation
1	On the basis of Power/Energy Aware	It increase energy Storage in each node& calculate the amount of energy used for the hop transmission with respect to cost	Having energy efficient Routing Path	Due to unbalance Energy consumption in nodes results into overuse of some nodes (Multi Hop Relay)
2	On the Basis of Load Distribution	To avoid overuse of Mobile nodes, it uses Multipath routing techniques.	Avoid Network Failure or Very short duration of network Failure	Affects Routing Performance & increase loop in multi path relay
3	On the basis of Sleep /Power Mode	In this sleep mode mechanism is used to reduce the power consumption	It can be implemented with some energy conservation approaches	End to end delay increases.
4	On the basis of Cross layer optimization	In this technique energy consumption is reduced with the help of interaction between TCP/IP layer	It improves energy efficiency in Practical situation	Some unknown effect due to cross layering
5	On the basis of Transmission Power Control	In this unnecessary power transmission is control which helps in reducing power consumption.	Energy consumption Reduces significantly	Loss of information is there due to increments in Hops.

4. Proposed work

In various research, different type of algorithm has been presented for minimizing the energy efficiency .Still realizing a true energy efficient MANET solution is still impossible. Here we proposed an energy efficient method for common content distribution in which the communication takes place between the networks with the help of two way approach.

A. First approach

First the data packets are to be sent with the help of base station to node having maximum value of fitness function. Fitness function is calculated for each node present in the network. After that nodes are arranged in increasing order of their fitness function values. The node having maximum fitness value are elected as cluster head among all nodes. After that distance between the nodes is calculated and arrange them in their respective nearest cluster head.

B. Second approach

The communication between the nodes and cluster head is type of short range communication, between cluster head to base station is via means of long range communication. If this approach is not used then there is always a long range communication present then the energy consumption is maximum at each time and then network lifetime is decreases continuously. So this method can prevent the network failure since this approach used both type of communication as per the energy level.

5. Classification of energy efficient techniques in MANET

Classification of energy efficient routing protocols is as follows:

A. Energy efficient location aided routing (EELAR)-

It is a modification to the ad hoc routing protocol LAR. In EELAR, location information of mobile nodes uses to minimize routing-related overhead. It uses location information to search for a new route which results in a significant reduction in the number of routing messages and therefore the energy consumption in the batteries of the mobile nodes is decreases significantly. Results showed that we can decreasing control overhead by increasing number of areas and increasing route loss by increasing the number of network areas.

B. Optimized AODV routing

In O-AODV, Each node has a limited battery life and node density in its surrounding environment This Process works in two parameters such as:

- *First Parameter:* The RREQ message was not forwarded by intermediate node, if there is a route to destination. First it will check its lifetime and calculate the node density of its surrounding.
- *Second parameter:* There should be sufficient number of nodes to forward RREQ. Hello messages are a signaling message used to determine neighbour connectivity. Two thresholds value are introduced for RREQ rebroadcasting and for node density of the environment. The battery life and node density of the intermediate node, who receives the RREQ is greater than two threshold values, then it can be concluded that, the broadcast of RREQ is successful when it reached the destination node & then intermediate node rebroadcast RREQ message. If the ratio is less than Broadcast threshold and node density threshold, the intermediate node buffers the packets and repeats the above process until either the broadcast is successful or the number of attempts exceeds a threshold. As a result unnecessary packet rebroadcasting decreases and the throughput increase. Successful delivery of RREP is important in MANET. In this the node does not broadcast the routing request (RREQ) if it does not have sufficient energy (battery lifetime), and until the node density in its surrounding exceeds a particular threshold. After comparing AODV with OAODV in terms of battery lifetime and throughput, it is observed that the new protocol is much better than AODV and lengthens the battery lifetime.

C. Energy efficient AODV routing (EEAODV)

Energy efficient AODV is an improved AODV routing

protocol. In this energy model network lifetime is considered for n number of nodes. For energy factor of a node they consider residual energy of the nodes at a particular instance. During packet transmission, consumption of energy takes place during transmitting, receive, sleep, idle and transition mode of a node. The process of Route discovery in EE- AODV is initiated by the source node when it wants to send a packet to the destination. RREQ and RREP are used to find the route to the destination is vice versa. At the source node when it wants to communicate to destination, it checks the route cache. As the intermediate node receives the RREQ packet, it calculates the remaining energy level, which is compared to the threshold value. As the RREQ packets are received by the destination node, it selects the path that has good energy levels. The destination node selects the path on the basis of hop count value. The path with less hop count would be selected. The RREP is replied by the destination to the source node.

D. Efficient Power Aware Routing (EPAR)

EPAR is a reactive routing protocol that utilizes battery lifetime properly and thereby increase the MANET lifespan. EPAR identifies the node capacity with the help of its battery power & energy lost over a specific link. EPAR used the concept of the traffic density factor, for which the improvement of the packet delivery ratio is calculated. This reduces the total variance in the residual battery power of each node as the topology varies. The total power is calculated in terms of mini-max formulation. For the large size mobile ad hoc networks, the network topology dynamically changes thus it will increase the overload message within network due to increase in routing overhead. As a result end-to-end delay increases and takes greater number of hops within the network.

E. High traffic rate optimized link state Routing (HTR-OLSR)

Is an improved version of OLSR, lead improvement in network lifetime performance & minimized the inaccuracy in energy level by reducing the interval between hello & TC.

F. Ant colony optimization (ACO) based Backbone Routing

This technique is based on load balancing. The selection of node based on probability of path preference which is based on availability of next node, delay and its bandwidth. During route discovery, the nodes which are subjected to faults are detected and that path is skipped.

G. Hybrid ACO-firefly routing

This technique focuses on selecting the optimal path using the factor of the nodes found by applying firefly algorithm. Since firefly would result in single path, so to have multiple paths (in case the node in the first path goes out of the network) ACO is applied.

H. Energy aware load balancing multipath routing protocol EALBM

The energy efficiency of a node is achieved by transferring the load from lower energy to high energy node which leads to increase in the network lifetime.

I. Enhanced Ad Hoc on demand multipath distance vector (E-AODMV)

This approach tends to maximize the lifetime of the network by selecting the nodes having highest residual energy and lowest load over it. This also improves the throughput of the network.

6. Performance Parameters

In MANET, the calculation of the energy efficiency of routing protocol depends on the various network performance metrics.

A. Power consumption

In MANET, battery power consumption occurs because of sending or forwarding of data packets and receiving of same. If a node keeps on active then it use power in the network. If the node is in sleepy mode or idle mode in network then the battery power starts decreasing.

B. Network lifetime

If the residual battery power is long in all mobile nodes then the network lifespan will increase. The MANET should not perform properly if the single mobile node battery dead or a group of mobile nodes are destroyed. It will suffer the total network efficiency.

C. Throughput

Network throughput is measured as the average rate of successful delivery of data packets in communication channel across the network. The throughput can be calculated in terms of bits per second or data packets per second. Value of throughput indicates that how much data can be transferred successfully from one location to another location in a particular duration.

D. Packet delivery ratio

It is the ratio of information received to information sent in the network.

E. Energy efficiency

It is defined as the ratio of number of packets transmitted to the total energy consumed. The higher the packet transmission with respect to low energy consumption the better the energy efficiency will be considered.

7. Conclusion

In MANET, design of energy efficient routing protocols is very necessary. In case if we have not considered a careful design, an energy-efficient routing protocol could have much poor performance than a normal routing protocol. This paper, basically focuses with the issue of improving network lifespan by reducing power & Energy of the system. And most of them are the part of reactive routing protocol. All protocols behave differently in different situation. In proposed work aim is to

implement a method that will definitely consume less power & energy by considering the above mentioned protocols as well as network condition. The lifetime of a mobile node and hence energy conservation is also very important. They lead to increase in packet delivery ratio and the network lifetime so that the performance of the network does not degrade too soon. This research considers the existing literature in MANET, and then proposed energy efficient techniques for the improvement of energy efficiency along with quality of services.

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