ISSN 2348 – 9928
IJAICT Volume 5, Issue 1, January 2018 Doi:01.0401/ijaict.2015.10.05 Published on 05 (1) 2018

A SURVEY OF ENERGY EFFICIENT ROUTING PROTOCOLS IN MANET

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Abstract*— *Mobile Adhoc Networks (MANET) are self-configured infrastructure less network which has many issues like scalability, node mobility, Qos, network life time etc. Among these the network lifetime is considered to be an important issue to improve the communication energy efficiency at individual nodes. Since every node in MANET is performing the routing function, the death of even a few nodes will cause the network failure. To increase the lifetime of the network many energy efficient routing protocols were proposed. In this paper many energy efficient protocols are surveyed and analysed based on their working.

***Keywords*— MANET, Lifetime, Routing, Energy Efficiency.**

I. INTRODUCTION

Mobile Adhoc Network (MANET) is a self-configuring network which does not have an infrastructure. Nodes in MANET are communicates with each other directly or indirectly with the help of other nodes. Every node in the network is act as a router by participating in the routing process. An example of MANET is shown in figure 1. The network contains three nodes where node 1 and node 3 are not within the range of each other's, however the node 2 is used to forward the packets from node 1 to node 3 and vice versa. MANET has become popular over the past decade since it can be deployed quickly in a given area. It has many applications such as emergency services, disaster recovery, military applications etc., and every node in MANET has in-built battery in it. This battery will lose energy whenever the node is participating in the routing process. And the replacement of these batteries is difficult in the complex scenario like battle field. Since every node in the network is being a part in the routing process, a death of even a few nodes will become a disaster for the whole network. So the batteries should be handled efficiently by the use of energy routing protocols.

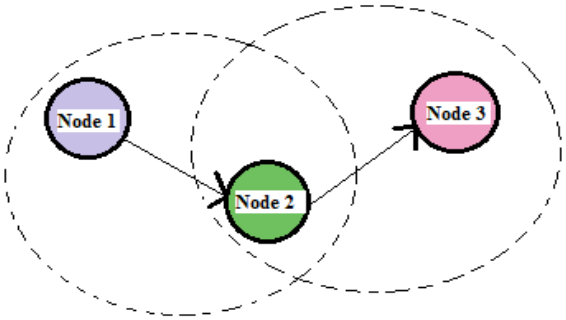

Fig 1 : Example of Adhoc Network

II. ROUTING PROTOCOLS FOR MANET

Protocol is defined as "a set of rules". Here the routing protocol in the sense, it controls the routing process of the network. Routing protocols for MANET are classified as three groups: proactive protocols, Reactive protocols and Hybrid protocols.

2.1 Proactive Routing Protocols

Proactive routing protocols are also known as table driven routing protocols. In this protocols the nodes have maintain the routing table which has the information of the routes and the latest neighbour node information. These tables are updated periodically or whenever the changes occur in the routing information. This group contains the protocols such as "Destination Sequence Distance Vector" (DSDV), Link State Routing (LSR), and "Optimized Link State Routing" (OLSR).

2.2 Reactive Routing Protocols

Reactive routing protocols are also known as "On Demand Routing Protocols". The routing paths are being searched only when the route to destination is required. There are two main procedures in this group of protocols. That is 1) Route discovery 2) Route maintenance procedures. When a source node wants to send a packet to a destination the route to the destination is discovered if the route is not available. It is started with the Route Request (RREQ) packet and the destination is replying to the request by the Route Reply (RREP) packet. These reactive protocols reduce the routing overhead. Dynamic Source Routing (DSR), Adhoc On-demand Distance Vector (AODV) are the examples of this type of protocols.

2.3 Hybrid Routing Protocols

The advantages of both proactive and reactive routing protocols are combined in this hybrid routing protocol. These types of protocols are suits for the large network. The examples are Zone

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Routing Protocol (ZRP), Temporally Ordered Routing Algorithm (TORA) etc.

III. ENERGY SAVING ROUTING PROTOCOLS FOR MANET

Energy efficient routing protocols can be classified as two categories. That is the Protocols which consider about the total energy consumption of a node and the protocols which consider about the network lifetime. In the first category the protocols are minimized the total power that has been used to transmit the packet from source to destination. In the other category the protocols try to increase the network lifetime by providing the energy efficient way of routing between sources to destination. Few algorithms are discussed in the following section.

In [1] the authors have proposed the QoS Power Aware Routing (QPAR) protocol to establish the energy stable route. This protocol contains route discovery and route maintenance process. In the route discovery process the protocol calculates the lifetime of nodes whose residual energy is minimum. It uses the health metric to calculate the lifetime of the network. In route maintenance process whenever a link failure occur, a new link would be established. Also whenever the energy of a node becomes less than a threshold value, it informs this to its neighbour node and the route maintenance process starts. The advantage of this algorithm is the overall packet delivery is high. The disadvantage is the priori estimation of bandwidth is required to provide bandwidth availability.

In [2] they have proposed a Modified Weighted Clustering Algorithm (MWCA) which includes the process of cluster formation and cluster maintenance. In cluster formation, each node identifies its neighbour nodes by sending and receiving the beacon messages. Nodes in a cluster are controlled by the Cluster Head (CH). The node which has the minimum weight is chosen as a cluster head. The factors included in calculating the weight factor is node degree, distance summation to all its neighbour, node mobility and remaining battery power. Two types of cluster maintenance are available. Node movement cluster maintenance and battery power threshold property. In the first type the node joining or leaving a cluster due to its mobility can send the request to join the cluster or made itself as a cluster head and forms a new cluster. In the second type, a new cluster head from the members should be identified since the CH node energy becomes less than a threshold value. The advantage of this method is it shows better performance in case of throughput. The limit of this method is the cluster maintenance is difficult for large network.

In [3] the authors have proposed the new route selection mechanisms, Conditional Minimum Drain Rate (CMDR) protocol, and compared with the existing Minimum Drain Rate (MDR) protocol. MDR maximizes the nodal battery lifetime. It uses a metric called drain rate to forecast the path which has maximum lifetime. But it does not guarantee about the total transmission power is minimized. Hence the modified version of MDR is known as CMDR also minimizes the total transmission power consumed per packet. The merit of this method is the total transmission power is minimised and the demerit is its throughput is low.

In [4] the authors have proposed a new route discovery algorithm called threshold based algorithm. It uses the threshold value of each node in the network. The algorithm selects the node which consumes less energy to transmit the packet but the node should satisfy the threshold value. If the threshold value becomes less then another node is taken for transmission of packet. Based on the equations the residual battery power and the consumed energy are calculated. The advantage is it provides robustness to mobility. The disadvantage of this threshold method is its delay is high because of the initial calculations.

In [5] they have proposed an algorithm called Minimum Total Power Routing (MTPR) which considers the path which consumes minimum total power to transmit the packet from source to destination. After receiving number of RREQ from different nodes the destination node selects the path which consumes minimum energy among those. This protocol always selects the path which has maximum number of hop count to minimize the total energy. This protocol produces the significant impact on the nodes with less energy. Its advantage is the total transmission power is minimized. But it has the limits of low throughput and high packet drop.

In [6] the proposed algorithm called Energy Efficient Adhoc On-demand Routing (EEAODR) discovers all the available paths. When the first RREQ is arrived at the destination, it waits for‘t’ time to get all the RREQ. After‘t’ time it selects the best suited path considering the individual battery power of node. If a path contains the node which has minimum residual battery then that path has been rejected. It increases the network lifetime and minimize the energy consumption comparing to AODV. Its throughput is not considerably high.

In [7] the authors proposed the Effective Power Aware Routing (EPAR) protocol which minimizes the total power consumed to transmit the packet and also it increases the network lifetime by using min-max formula. It calculates the energy value of each node and it discovers the paths which have minimum lowest

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energy values and selects the path which has maximum lowest energy value. Suppose if the two paths contain the same lowest energy value then it select the path in which highest energy node is present. The advantage is it achieves high throughput comparing the previous algorithms but its delay is slightly increased when number of nodes are increased.

In [8] the authors have proposed a routing protocol called Efficient Power Aware and Life aware Routing (EPALR) protocol to increase the network lifetime in MANET. This protocol is a source routing protocol which uses battery lifetime and mobility prediction. The protocol selects the path in which the maximum lifetime node is present. The nodes in the network are formed as clusters and the battery power of the nodes in the clusters are calculated. Therefore the route which is discovered includes the maximum lifetime nodes. Alternate route will be established in case the discovered route is failed. The advantages of this method are it provides link stability and black hole prevention.

In [9] the authors have proposed Exploring Dynamic Based Routing (EDBR) protocol which uses the network parameters energy drain rate, relative mobility estimation rate to calculate node lifetime and link lifetime. This algorithm selects the path which is least dynamic. This protocol outperforms the existing Lifetime Prediction Routing (LPR) and Dynamic Source Routing (DSR). The advantage of this algorithm is it outperforms the LPR and DSR protocols. Disadvantage of this method is it gives the problem of network congestion and delay.

IV. CONCLUSION

Since MANET does not have any fixed infrastructure the routing becomes challenging when the nodes are moving. Every node is power constrained and efficient use of battery is important to increase the lifetime in the network. Many energy aware routing protocols were proposed. Here the survey of few papers and each and every algorithm is performing better in their own assumptions and metric used. Although the performance of these protocols is good in terms of energy efficiency, further research is needed to ensure the QoS and required bandwidth.

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