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A Survey on Energy Aware Dynamic Source Routing Protocol in Mobile Ad Hoc Network

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***Abstract*— Mobile ad hoc network (MANET) is inferior framework system of communication. Most of the devices in MANETs are battery powered. Therefore, power saving is an important component in MANETs. Power consumption is a crucial design concern in Wireless ad hoc networks since wireless nodes are typically battery limited. Power consumption can occur due to receiving the data, transmitting the data traffic, mobility etc. Power failure of mobile node not only affects the node itself but also its ability to forward packets on behalf of others and hence overall network lifetime. We need to reduce the power consumption of every node. MANETs use several protocols but the most widely used protocol is Dynamic source Routing (DSR) Protocol. Although establishing correct and efficient routes is an important design issue in mobile ad hoc networks (MANETs), a more challenging goal is to provide power efficient routes because mobile nodes operation time is the most critical limiting factor. This paper surveys and classifies the energy aware routing protocols proposed for MANETs. They minimize either the active communication energy required to transmit or receive packets or the inactive energy consumed when a mobile node stays idle but listens to the wireless medium for any possible communication requests from other nodes**

***Index Terms*— MANET, DSR, Energy Aware DSR, Hop-by-Hop Routing, Multihop routing**

I. INTRODUCTION

Power failure of a mobile node not only affects the node itself but also its ability to forward packets on behalf of others and thus the overall network lifetime. A mobile node consumes its battery energy not only when it actively sends or receives packets, but also when it stays idle listening to the wireless medium for any possible communication requests from other nodes. Thus, energy-efficient routing protocols minimize either the active communication energy required to transmit and receive data packets or the energy during inactive periods. The transmission power control approach can be extended to determine the optimal routing path that minimizes the total transmission energy required to deliver data packets to the destination. For protocols that belong to the latter category, each node can save the inactivity energy by switching its mode of operation. The main goal is to balance the energy usage among the nodes and to maximize the network lifetime by avoiding over-utilized nodes when selecting a routing path [2].

DSR has been found to be very useful especially in developing new power aware routing protocols. However, the continuous flooding of route request (RREQ), route reply (RREP) and route error (RERR) packets by the DSR algorithm brings with it high routing overhead that causes substantial energy exhaustion of the nodes. While previous research has looked at minimizing routing overhead as a means to saving node energy in DSR, few if any have looked at controlling the frequency of flooding the RREQ packets. This paper proposes an extension of DSR that looks at controlled and periodic flooding of RREQ packets as opposed to that in the original DSR algorithm based on energy of the node. Two modifications have been done to implement the algorithm in traditional DSR. Firstly, Change the routing algorithm of DSR so that given two nodes between which it necessarily establishes a multi hop path. Statistically you choose, among all the possible ones that passing through the nodes at a given moment have a higher level of energy. Secondly, modify the algorithm so that when the energy of a node that is forwarding data within multi hop path reaches a level less than or equal to a certain threshold percentage of initial energy. The node will ask the neighbors to look for another path for such data to avoid consuming the residual energy in a short time [2].

II. MANET:

A MANET consists of a set of mobile hosts that carry out basic networking functions like packet forwarding, routing, and service discovery without the help of an established infrastructure. Nodes of an ad hoc network rely on one another in forwarding a packet to its destination, due to the limited range of each mobile host's wireless transmissions. An ad hoc network uses no centralized administration. This ensures that the network will not cease functioning just because one of the mobile nodes moves out of the range of the others. Nodes should be able to enter and leave the network as they wish. Because of the limited transition range of the nodes, hops are generally needed to reach other nodes. The topology of ad hoc networks varies with time as nodes move, join or leave the network. This topological instability requires a routing protocol to run on each node to create and maintain routes among the nodes.

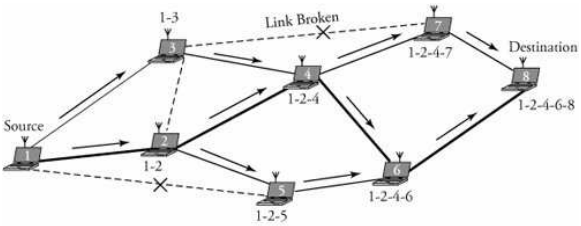


Fig 1 :Message transmission hop by hop in MANET[2]

Mobile nodes in MANETs are battery driven and hence they have limited energy level to transmit the data packets. Also the topology of the network is dynamic i.e. nodes in the network are moving. If a node moves out of the radio range of the other node, then the link between them is broken. There are two major causes for a link breakage in MANET:

When nodes die because of energy exhaustion

When node(s) move out of the radio range of its neighboring node(s) [1].

III. DYNAMIC SOURCE ROUTING:

DYNAMIC SOURCE ROUTING Mobile networks have attracted significant interest in recent years because of their improved flexibility and reduced costs. Compared to wired networks, mobile networks have unique characteristics like frequent network topology changes, varying link capacity because of the impacts from transmission power, receiver sensitivity, noise, fading, and interference. Additionally, wireless mobile networks have a high error rate, power restrictions, and bandwidth limitations. Routing is the process of selecting paths in a network along which network traffic can be sent. In a mobile ad hoc network arbitrarily motion of nodes results in unpredictable and frequent topology changes. Additionally, since nodes in a mobile ad hoc network normally have limited transmission ranges, nodes cannot communicate directly with each other. Hence, routing paths in mobile ad hoc networks contain multiple hops, and each node in mobile ad hoc networks has the responsibility to act as a router. Because of the importance of routing protocols in dynamic multi-hop networks, a lot of mobile ad hoc network routing protocols have been proposed in the last few years [3].

IV. ENERGY SAVING DYNAMIC SOURCE ROUTING:

ESDSR is a modified version of dynamic source routing (DSR) that integrates the advantages of a transmission power control approach and a load sharing approach to save energy and increases the lifespan of a mobile ad hoc network (MANET). ESDSR combines two approaches that try to minimize the amount of energy consumed during routing. The transmit power control approach minimizes total transmission energy. The disadvantage of this approach is that it always chooses the same least-transmission power path, which causes this path to be overused and hence 'die' faster than other paths. The load sharing approach focuses on balancing energy usage among nodes by avoiding over-utilized nodes. The disadvantage of this approach is that it assumes transmission power is the same for all nodes. Energy can actually be saved by transmitting at a lower power for closer nodes.

For example, ESDSR chooses a path. First, it gives a score to each path. The ratio of the remaining battery energy and the current transmit power of each node in the path is calculated. The minimum ratio along the path is considered the score. The path with the highest score is then chosen to be the one used for routing. ESDSR still performs route discovery and route maintenance in the same manner as DSR except that it stores the extra energy and power information in its route reply packets. Hence, shows results of this protocol from a simulation using ns-2. Compared to DSR, ESDSR can save energy up to 40% per packet and can send 20% more packets with the same battery power. We used the idea of selecting a path based on the remaining battery energy and implemented it on a real platform. We then compared this with the performance of DSR [7].

V. BACKGROUND:

Unlike fixed networks, routing in an ad hoc wireless environment must account for nodes that arrive and leave the network. In order to be scalable, ad hoc network routing protocols should avoid active probing to maintain awareness of the network topology. A common approach is to utilize a source-path routing approach where the entire forwarding path is included in the network packet. This is in contrast to normal IP routing, where packets are forwarded hop-by-hop [7].

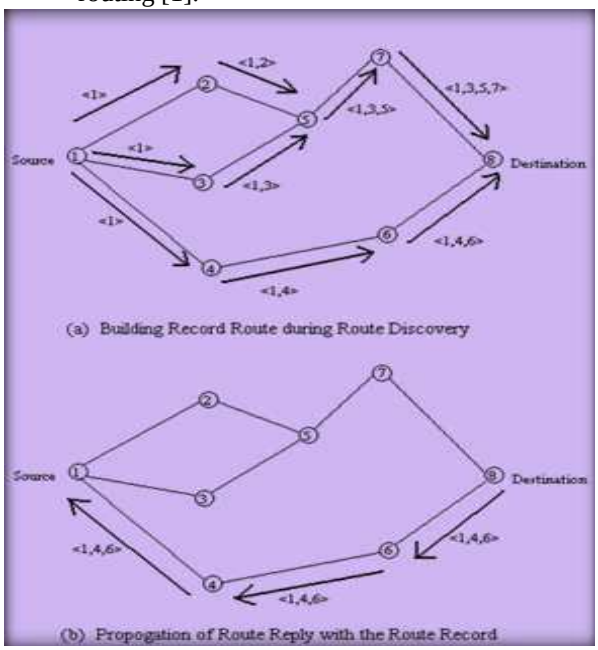
We assume that mobile nodes employ the IEEE 802.11 PSM for energy efficient use of the shared medium and DSR for discovering and maintaining routing paths. Section A summarizes the DSR routing protocol. It also discusses the effect of overhearing in DSR and argues that unconditional overhearing and rebroadcast is the main reason behind energy inefficiency. Section B explains 802.11 PSM and previous research work on its use in single-hop and multi-hop networks [6].

A. DSR Routing Protocol:

The Dynamic Source Routing is an on-demand protocol based on source routing. Basically the protocol is composed of two mechanisms, Rote Discover and Route Maintenance and these two mechanisms work together to allow nodes to discover and maintain the source route to any destination node in the a hoc networks [2] [5].

- Route Discovery: Route discovery is done with two sub steps that is Route request and Route Reply [5]. It is the method in which the source node receives the end node source destination path. In DSR to further reduce the cost of route discovery, the RREQs are initially broadcasted to neighbors only by zero-ring search, and then to the entire network if no reply are received. When an intermediate node forwarding a packet detects through Route Maintenance that the next hop along the route for that packet is broken, if the node has another route to the packet destination it uses it to send the packet rather than discard it [1].
- Route Maintenance: Route maintenance is a process of identifying link whether it is reliable and capable of carrying packet on it or not [5]. In route

maintenance a routing entry contains all the intermediate nodes information not only the next node information. The source node has entire routing path, and the packet is sent through that routing path. If the source node does not have entire routing [1].



Dynamic Source Routing

1) Route discovery and maintenance: When a node has a data packet to send but does not know the routing path to the destination, it initiates the route discovery procedure by broadcasting a control packet, called route request (RREQ). When an RREQ reaches the destination, it prepares another control packet, called route reply (RREP), and replies back to the source with the complete route information. Upon receiving an RREP, the source saves the route information in its local memory, called route cache, for later uses. Since nodes move randomly in a MANET, link errors occur and route information that includes a broken link becomes obsolete. When a node detects a link error during its data transmission, it sends another control packet, called route error (RERR), to the source and deletes the stale route from its route cache. Overhearing improves the network performance by allowing nodes to collect more route information. Nodes in the vicinity of a transmitter would learn about the path to the destination via overhearing [2] [6].

2) Effect of overhearing*:* To better understand the effect of overhearing in terms of routing performance and its implication on energy consumption. We compare 802.11 with and without over-hearing1 under the simulation scenario. We compare the two in terms of packet delivery ratio (PDR) and packet delay, respectively. As can be inferred from the figure, overhearing improves the network performance, pronounced more at higher traffic condition. To identify the cause of the performance difference, the number of packets transmitted and that received/overheard is compared respectively. We observe data packets are dominant. However, the number of control packets (RREQ, RREP, and RERR) increases when packet rate increases 802.11 without overhearing results in more control packets and a slightly larger number of data packets than with overhearing. Total traffic in the network is not significantly different [6].

In short, overhearing increases traffic (and energy consumption) but improves network performance. It is therefore important to know how to make a prudent tradeoff between the two and how to control the level of overhearing [6].

B. IEEE 802.11 Power Saving Mechanism (PSM)

According to the IEEE 802.11 standard, there are two medium access methods depending on the existence of an *accesspoint* (AP). They are referred to as *Distributed CoordinationFunction* (DCF) and *Point Coordination Function* (PCF). The PCF is an optional access method implemented on top of DCF and provides a contention-free service coordinated by an AP [6].

VI. RELATED WORK

A number of routing protocols have been projected and implemented for wireless ad hoc Network in order to enhance the bandwidth utilization, higher throughputs, lesser overheads per packet, minimum consumption of energy and others. All these protocols have their own advantages and disadvantages under certain situations. The major requirements of a routing protocol was proposed (ZuraidaBintiet al., 2003) that includes minimum route getting hold of delay, quick routing reconfiguration, loop-free routing, distributed routing approach, minimum control overhead and scalability. Wireless ad hoc network Routing Protocols possess two properties such as Qualitative properties (distributed operation, loop freedom, demand based routing & security) and Quantitative properties (end-to-end throughput, delay, route discovery time, memory byte requirement &network recovery time). Clearly, most of the routing protocols are qualitatively permitted. A simulation studies were carried out in the paper (Mohammed Bouhorma et al., 2009) to review the quantitative properties of routing protocols. A number of general simulation studies on various routing protocols have been performed in terms of control overhead, memory overhead, time complexity, communication complexity, route discovery and route maintenance (ZuraidaBinti et al., 2003). Though, there is a severe lacking in implementation and operational experiences with existing Wireless ad hoc network Routing Protocols. The various types of mobility models were recognized and assessed by (D. Johnson et al., 2001) because the mobility of a node will also affect the overall performance of the routing protocols [2].

Since last 10 years many energy efficient routing protocols have been proposed and wondering the best solution out of all. As it is very difficult to restrict technologies and research digging for optimal solution, many noticeable enhancement and modifications have been done to convert DSR as an energy efficient routing protocol and serve it as efficient routing protocols like other protocols. So in the next session here are few important routing protocols which are made after doing some modification in traditional DSR protocol [5].

Many research efforts have been devoted for developing energy efficient routing algorithms. Node's energy is minimized not only during active communication but also

when they are in inactive state. Transmission power control and load distribution are two approaches used to minimize the active communication energy of individual nodes and sleep/power-down mode to minimize energy of nodes during inactivity. In transmission power control approach choosing a high transmission power reduces the number of forwarding nodes needed to reach the required destination, but creates excessive interference in a medium that is commonly shared whereas, choosing a lower transmission power reduces the interference seen by potential transmitters but packets require more forwarding nodes to reach their required destination. The specific goal of the load distribution approach is to balance the energy usage of all mobile nodes by selecting a route with underutilized nodes rather than selecting the shortest route [4].

The main goal of Minimum Energy Routing (MER**)** is not to provide energy efficient paths but to make the given path energy efficient by adjusting the transmission power just enough to reach to the next hop node. The authors investigates the impact of variable range power control on physical layer and network layer connectivity and shows that variable range increases network lifetime over common range transmission [4].

VII. ENERGY AWARE DSR (EADSR) PROTOCOL

The EADSR is a modified DSR protocol with power awareness using the Location Aided Power Aware Routing (LAPAR) algorithm. The Location Aided Power Aware Routing (LAPAR)[8] algorithm can be implemented over any existing routing protocol. This protocol discovers the optimum route between a source destination pair in such cases the total power essential for the transmission of data packets is minimized. This algorithm presents that for any node belonging to a set V, there exists a group of nodes to which direct transmission results in the least power. The algorithm requires the determination of planar graph for each node and determining the path between a source destination pair by using greedy algorithm on these Planar graphs.

The EADSR protocol was implemented by using the DSR protocol as the basis with power awareness derived from LAPAR algorithm; The following steps are identified after extensive mathematical and logical analysis and by the construction of flow diagrams to carry out the implementation:

a. Initialization of nodes with location information.

b. Primary broadcasting to know the relative position of neighbours.

c. Secondary broadcasting and formation of planar graph.

d. Route request packet from source node to the nodes in its planar graph.

e. Route request processing & forwarding by intermediate nodes till the destination is reached.

f. Route reply packet from destination to source along the path traversed by route request.

g. Multiple route processing and selection of minimum power route.

h. Path setting and transmission of data packets.

i. Imparting mobility to nodes.

j. Link failure processing.

k. Performing repeated transmissions and Calculation of the average power and no. of hops.

1. Analysis and comparison with conventional DSR protocol.

Here the EADSR protocol was first implemented based on the steps mentioned above and then the conventional DSR protocol was implemented using the same steps except for a few modifications like identification of routes based on the number of hops and elimination of periodic broadcasting etc. Simulation result shows that average power in DSR is almost constant for different velocities but in EADSR the power is inversely proportional to velocity. The reduction in average power is 31.65% in comparison with DSR.

VIII. CONCLUSION:

In this research paper, we conducted research on various energy aware routing protocols and identified the limitations and how those protocol organized routing based on energy parameters. In this article we have discussed, one of the important issue that is energy consumption problem in MANET. This research presents the importance of energy or power in MANET and how efficient routing will impact on the energy utilizations. We organized this research by describing DSR routing protocol and the limitation of DSR protocol. In related work we presented various routing protocols and limitations to illustrate importance of energy balancing in MANET. As there are many energy efficient routing protocols exist, it is very difficult to compare them directly since each method has different assumptions and has different means to achieve the goals.

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