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## A Survey on Energy Efficient Dynamic Source Routing Protocol for Manets

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**ABSTRACT:** Although establishing correct and efficient routes is an important design issue in mobile ad hoc networks (MANETs), a more challenging goal is to provide energy efficient routes because mobile nodes' operation time is the most critical limiting factor. In order to maximize the lifetime of ad hoc networks traffic should be sent via a route that can avoid nodes with low energy while minimizing the total transmission power. In a MANET, the energy depletion of a node does not affect the node itself only but the overall network lifetime. This paper presents a comprehensive summary of different energy efficient protocols that are based on the basic Mechanism of DSR.

**KEYWORDS:** Mobile Ad-hoc Networks, Dynamic Source Routing Protocol, Route discovery, Route maintenance

### I.INTRODUCTION

The mobile hosts in an ad hoc network are constrained by battery power for their operations. To route a packet from a source to a destination involves a sufficient number of intermediate nodes. Hence, battery power of a node is a precious resource that must be used efficiently in order to avoid early termination of a node or a network. Hence, power consumption and clock frequency are important criteria in designing these hosts. Apart from static design optimizations of the hosts, it is possible to improve the performance and lifetime of the network of such hosts by employing dynamic resource and power management. It is evident that minimizing the power consumption or maximizing the service speed of any given node may not be sufficient to achieve the lowest latency and longest lifetime of the network. The key factor is that in the network of nodes, power consumption should be uniformly distributed among all the nodes to increase the network lifetime.

Various energy efficient routing protocols have been proposed to increase the lifetime of the nodes as well as lifetime of the networks, so that communication can be carried out without any interruption. This article provides as well as analyses different energy efficient routing protocols designed for ad hoc wireless networks which are only based on the mechanism of traditional DSR routing protocol. Protocol

#### Power Consumption Modes

The mobile nodes in wireless mobile ad hoc network are connected to other mobile nodes. These nodes are free to transmit and receive the data packet to or from other nodes and require energy to such activity. The total energy [4], [5], [6], of nodes is spent in following modes:

(a) Transmission Mode (b) Reception Mode (c) Idle Mode and (d) Overhearing Mode. These modes of power consumption are described as:-

**a) Transmission Mode:** A node is said in transmission mode when it sends data packet to other nodes in network. These nodes require energy to transmit data packet, such energy is called Transmission Energy (Tx) [1], [2], of that nodes. Transmission energy is depended on size of data packet (in Bits), means when the size of a data packet is increased the required transmission energy is also increased. The transmission energy can be formulated as:

$$T_x = (330 * P_{length}) / 2 * 10^6 \quad (1)$$

$$P_T = T_x / T_t \quad (2)$$

Where  $T_x$  is transmission Energy,  $P_T$  is Transmission Power,  $T_t$  is time taken to transmit data packet and  $P_{length}$  is length of data packet in Bits.



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**b) Reception Mode:** When a node receives a data packet from other nodes then it said to be in Reception Mode and the energy taken to receive packet is called Reception Energy ( $R_x$ ), [1]. Then Reception Energy can be given as:

$$R_x = (230 * Plength) / 2 * 10^6 \quad (3)$$

$$P_R = R_x / T_r \quad (4)$$

Where  $R_x$  is a Reception Energy,  $P_R$  is a Reception Power,  $T_r$  is a time taken to receive data packet, and  $Plength$  is length of data packet in Bits.

**(c) Idle Mode:** In this mode, [4], generally the node is neither transmitting nor receiving any data packets. But this mode consumes power because the nodes have to listen to the wireless medium continuously in order to detect a packet that it should receive, so that the node can then switch into receive mode from idle mode.

Despite the fact that while in idle mode the node does not actually handle data communication operations, [3], it was found that the wireless interface consumes a considerable amount of energy nevertheless. This amount approaches the amount that is consumed in the receive operation. Idle energy is a wasted energy that should be eliminated or reduced. Then power consumed in Idle Mode is:

$$P_I = P_R \quad (5)$$

Where  $P_I$  is power consumed in Idle Mode and  $P_R$  is power consumed in Reception Mode.

**d) Overhearing Mode:** When a node receives data packets that are not destined for it, then it said to be in over-hearing mode [7], and it may consume the energy used in receiving mode. Unnecessarily receiving such packets will cause energy consumption. Then power consumed in overhearing mode is:

$$P_{over} = P_R \quad (6)$$

Where  $P_{over}$  is power consumed in Overhearing Mode and  $P_R$  is power consumed in Reception Mode.

## Power-Aware Metrics

**Minimize Energy consumed/packet:** This is one of the more obvious metrics. To conserve energy, we want to minimize the amount of energy consumed by all packets traversing from the source node to the destination node. That is, we want to know the total amount of energy the packets consumed when it travels from each and every node on the route to the next node. The energy consumed for one packet is thus given by the equation:

$$\sum E = \sum_{i=1}^{k-1} T(n_i, n_{i+1}) \quad (7)$$

where  $n_1$  to  $n_k$  are nodes in the route while  $T$  denotes the energy consumed in transmitting and receiving a packet over one hop. Then we find the minimum  $E$  for all packets.

**Minimize Maximum Node Cost:** The idea here is to find the minimum value from a list of costs of routing a packet through a node. The costs themselves are maximized value of the costs of routing a packet at a specific time. The equation for this metric is:

$$\text{Minimize } \hat{C}(t), \text{ for all } t > 0, \quad (8)$$

Where  $\hat{C}(t)$  denote the maximum of the  $C_i(t)$ s and  $C_i(t)$  is the cost of routing a packet through node  $i$  at time  $t$ .

**Maximize Time to Network Partition:** For this metric, the basic criterion is that given a network topology, we can find a minimal set of nodes whereby the removal of it will cause the network to partition. A routing procedure must therefore divide the work among nodes to maximize the life of the network

**Minimize Variance in node power levels:** This metric ensures that all the nodes in the network remain up and running together for as long as possible. It achieves the objective by using a routing procedure where each node sends packets through a neighbor with the least amount of packets waiting to be transmitted. In this way, the traffic load of the network is shared among the nodes with each node relaying about equal number of packets. Therefore, each node spends about the same amount of power in transmission



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## II.RELATED WORK

In MANET routing is a process of establishing a route and then forwarding packets from source to destination through some intermediate nodes if the destination node is not directly within the range of sender node. The route establishment itself is a two steps process. First one is the Route Discovery where it finds the different routes from same source to destination. Second, the Route Selection, where it selects a particular route among all routes found for the same source to destination. In ad hoc network routing protocols fall into three categories.

**Table Driven Routing Protocols:** The Table Driven Routing Protocol, also known as Proactive Protocols, work out routes in the background independent of traffic demands. Each node uses routing information to store the location information of other nodes in the network and this information is then used to move data among different nodes in the network. These protocols keep a constant overview of the network and this can be a disadvantage as they may react to change in the network topology even if no traffic is affected by the topology modification which could create unnecessary overhead. Even in a network with little data traffic, Table Driven Protocols will use limited resources such as power and link bandwidth therefore they might not be considered an effective routing solution for Ad hoc Networks. Fisheye State Routing and DSDV are the examples of a Table Driven Protocol.

**On Demand Routing Protocols:** On Demand Routing Protocol, also known as Reactive Protocols establish routes between nodes only when they are required to route data packets. There is no updating of every possible route in the network instead it focuses on routes that are being used or being set up. When a route is required by a source node to a destination for which it does not have route information, it starts a route discovery process which goes from one node to the other until it arrives at the destination or a node in between has a route to the destination. On Demand protocols are generally considered efficient when the route discovery is less frequent than the data transfer because the network traffic caused by the route discovery step is low compared to the total communication bandwidth. This makes On Demand Protocols more suited to large networks with light traffic and low mobility. Examples are: AODV and DSR.

**Hybrid Routing Protocols:** Hybrid routing protocol combine Table Based Routing Protocols with On Demand Routing Protocols. They use distance vectors for more precise metrics to establish the best paths to destination networks and report routing information only when there is a change in the topology of the network. Each node in the network has its own routing zone, the size of which is defined by a zone radius, which is defined by a metric such as the number of hops. Each node keeps a record of routing information for its own zone.

### Dynamic Source Routing Protocol

Dynamic Source Routing (DSR) [9, 10] is a simple and efficient routing protocol designed specification for use in multi-hop wireless ad hoc mobile networks. DSR is one of the important routing protocols that are used for mobile ad hoc networks as much energy efficient routing protocols are designed based on its mechanism. It finds the route from source to destination only when the source initiates route discovery process. All aspects of protocol operate entirely on demand. This protocol also makes the network self-organizing and self configuring. Basically the protocol is composed of two mechanisms, Route 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 ad hoc networks.

**Route discovery:** Route discovery is done with two sub steps that is Route request and Route Reply.

**Route request:** The route discovery comes in play when a mobile node has some data/packet to send to any destination and it does not have any route to the destination in its route cache. Then it initiates route discovery by broadcasting a route request (RREQ) packet. This route request contains address of the destination, address of the source and a unique identification number that is generated by the source node only. Each node receives the packet and checks whether the packet is meant for it or not. If it is not the destination node then it simply forwards the packet to the outgoing links adding its own address in the packet. To avoid duplicate route request which is generated from the same source, a node only forwards the route request that has not yet been seen appear in the route request with the same identification number.



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Route reply: As soon as the packet arrives at the destination node or arrives at a node that contains in its route cache an unexpired route to the destination, then a route reply is generated. Not only the packet contains all the address of the intermediate node it has come across but the sequences of hops are also stored in it. The Route reply is generated by the destination placing the route record contained in the route request into route reply. During the route reply if the destination node has the route to the initiator in its route cache, It may use that route for route reply. Otherwise destination node may reverse the route in the route record if the link is symmetric. If the symmetric links are not supported then the node may initiate its own route discovery piggybacking the route reply on the new route request. When any intermediate node receives any route reply from destination node or any other node then they append their route record and forwards it to its neighbor nodes.

**Route maintenance:** Route maintenance is a process of identifying link whether it is reliable and capable of carrying packet on it or not. This process is executed by the use of route error packets and acknowledgements. When the data link layer encounters a fatal transmission problem then a route error message is generated. Suppose a packet is retransmitted (up to a maximum number of attempts) by some hop the maximum number of times and number of receipt conformation in received, then this node returns a packet error message to the original sender of the packet, identifying the link over which the packet could not be forwarded.

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.

## 1) Power Aware DSR (PADSR) protocol

The PADSR 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..It identifies the optimum route between a source destination pair such that the total power required for the transmission of data packets is minimized. This algorithm states that for any node belonging to a set  $V$ , there exists a set 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 PADSR 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.
- l. Analysis and comparison with conventional DSR protocol.

Here the PADSR 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



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almost constant for different velocities but in PADSRR the power is inversely proportional to velocity. The reduction in average power is 31.65% in comparison with DSR.

## 2) Modified Energy Saving Dynamic Source Routing in MANETs (MESDSR)

A Modified Energy Saving Dynamic Source Routing in MANETs (MESDSR) has been designed which will efficiently utilize the battery power of the mobile nodes in such a way that the network will get more life time.

### Algorithm for Modified Energy Saving Dynamic Source Routing

**Step 1** If the Source node S wants to send data to the destination node D, it will first send REQ message to all its neighbour nodes.

**Step 2** When neighbour nodes receive REQ message they will check their Route Cache, if this packet's ID is already in their Route Cache then packet will be discarded.

**Step 3** Otherwise, node will calculate its power by using:

$$P_{new} = P_{tx} - P_r + P_{th} + P_m + P_{over} \quad (9)$$

and send this value as a reply to source node.

**Step 4** Source node will calculate the mean value of all the values of  $P_{new}$  of all the nodes and send a RREQ message to the node whose  $P_{new}$  value is nearest to the mean value.

**Step 5** When the node receives a RREQ message it will send REQ message to its own neighbours and this process will be continued till the destination node reaches.

**Step 6** When destination node will receive the RREQ message it will send the RREP message back with the same route.

**Step 7** RREP process is same as in traditional DSR simulation results show that the performance of ESDSR is better than DSR according to packet delivery ratio, average energy consumption, throughput and end to end delay

## 3) Minimum Energy Dynamic Source Routing Protocol (MEDSR)

Minimum Energy Dynamic Source Routing Protocol (MEDSR) [9] has done one of the finest attempts to make DSR more as an energy aware routing protocol. The whole MEDSR approach is based on Route Discovery and Link Power Adjustment mechanism. The route Discovery process itself is classified into two sub processes.

Route Discovery mechanism using low power level: In this process of route discovery when source node S has some packets to send, then it sets a minimum level transmitting power for all the nodes. So the route packet will be broadcasted to only re within the range of the minimum level of transmitting power. Once the route request arrives at the destination, the destination node copies the power level information from the route request packet into the route reply. The route reply is sent back to the nodes that are within the small range of transmitting power level from the destination node. The moment, the intermediate node will receive the route reply, it will calculate the minimum power for itself. The minimum transmitting power level for any node can be calculated as

$$P_{min} = P_{tx} - P_{rec} + P_{th} \quad (10)$$

Where  $P_{tx}$ =Transmitting Power of Destination

$P_{rec}$ =Receiving Power of the node that has received route reply

$P_{th}$ = Threshold receive power for successful reception of the packet. And it will keep continuing at each node until the route reply is received by the source. Once the route reply reaches at the source, the source sets the transmitting power. And start sending with that transmitting power on the route that is been selected for data transmission.

Route Discovery mechanism using High Power Level: High power route discovery is just same as the low power route discovery. The only difference is that instead of setting up the low transmitting power, it sets high transmitting power while sending route request. This process is highly needed for route discovery, especially when no path is found due to unreachability by setting the transmitting power low. So to overcome this problem high power routing is also mandatory.

MEDSR uses two levels of powers; the network connectivity is highly maintained and results less network partition. The result also depicts that when the network size is small the energy saving per data is maximum in MEDSR as compared to DSR, almost 55% high which indeed turning out to be an efficient routing protocol





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## 4) Efficient Power Routing DSR (EPRDSR)

In this each node tracks its current power level by using the battery power. When a node receives a route reply or an acknowledgement (ACK), it updates its power field in the packet path. Once the source node receives either a route reply or an ACK, it updates its power table with the power values in the path. When choosing a path, the DSR implementation chooses the path with the minimum number of hops. For the EPRDSR, however, the path is chosen based on the power. First, we calculate the mobile node battery power for each path, that is, the lowest hop power of the path. The path is then selected by choosing the path with the maximum lowest hop power. For example, consider the following scenario, in which there are two paths to choose from. The first path contains three hops with energy values 22, 18 and 100, respectively and the second path contains four hops with energy values 20, 35, 25 and 80, respectively. The score for the first path is 18, whereas the score for the second path is 20. Hence, the second path would be chosen since it has a higher score.

**Power aware model in the EPRDSR :** This maximizes the network lifetime and minimizes the power consumption during the route establishment. This algorithm [11] takes special care to transfer both the real time and the non-real traffic by providing a power efficient and less congested path between a source and a destination pair. This model is discussed as follows.

The energy is calculated by using

$$\text{Energy} = \text{Power} * \text{Time} \quad (11)$$

The power consumption is measured by the transmitting power or the receiving power multiplied by the transmitted time

$$P_t = (8 * \text{Pocketsize}) / \text{Bandwidth} \quad (12)$$

The transmitting energy  $E_{tx}$  is defined as

$$E_{tx} = P_{tx} * P_t \quad (13)$$

The receiving energy  $E_{rx}$  is defined as

$$E_{rx} = P_{rx} * P_t \quad (14)$$

The energy consumption of a node after time  $t$  is calculated by using the following equation

$$E_{con}(t) = N_t * C_1 + N_r * C_2 \quad (15)$$

where  $E_{con}(t)$ , is the energy consumed by a node after time  $t$ ,  $N_t$ , is the number of packets transmitted by the node after time  $t$ .  $N_r$ , is the number of packets received by the node after time  $t$ ,  $C_1$  and  $C_2$  are constant factors having a value between 0 and 1.

Let  $E$  be the initial power of a node and the residual energy  $E_{Res}$  of a node at time  $t$ , can be calculated by using

$$E_{Res} = E - E_{con}(t) \quad (16)$$

where  $E_{Res}$  is the residual energy and  $E_{con}$  is the consumed energy. The total power consumption of all the nodes is measured as the summation of all the nodes' residual battery power plus the product of the initial power and the number of nodes

$$TE_{con} = N * \text{Initial energy} - E_{res} \quad (17)$$

where  $TE_{con}$  is the total consumed energy and  $N$  is the total number of mobile nodes in the MANETs.

## III.CONCLUSION

In this article we have discussed, one of the important issue that is energy consumption problem in MANET. As the traditional routing mechanisms like minimum hop count produces not only overheads in the networks but also consume more power in the networks during the communication..And hence it is required to have some any energy efficient routing protocols to be designed in order to overcome this problem. 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.

This paper has also expounded few energy efficient routing protocols which are explicitly based on the DSR routing protocol. These protocols have proved the traditional DSR can also be acted as an energy efficient routing protocol. Because DSR is considered as one of the unconventional routing protocol which does not concerned about energy consumption at all. This paper has also revealed that a single routing protocol cannot stand strongly against the major constraint of MANET that is power consumption until it is integrated with some other techniques like power



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consumption, load balancing, transmission control, multi path routing and many more. The combination of all these techniques can surely turning out be an efficient solution for energy constraint.

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