Power Aware Routing Protocol to Extend Life-Time of MANET

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Abstract—**Mobile Ad-Hoc Network (MANET) is a self-configuring network of mobile devices connected through wireless. Nowadays mobile devices in mobile Ad-hoc network are battery operated. Battery is an important factor in MANET. Dynamic topology of mobile ad-hoc network and limited battery capacity are constrained on network life time. AODV is one of the reactive routing protocols used for MANET but which is not power aware. Variants of Power aware AODV and DSR protocols are available. So we will focus on any one variant of that and we will incorporate some new mechanism which will select energy efficient route based on link stability, residual energy level.**

Keywords- power aware, MANET, network lifetime, residual energy.

I.   INTRODUCTION

A Mobile Ad-Hoc Network is a combination of self-configuring mobile routers(and associated hosts) interconnected by wireless links forming an arbitrary topology, where:

- The mobile routers are free to move randomly and organize themselves arbitrarily
- The network's wireless topology may change rapidly and unpredictably
- Such a network may operate in a standalone method, or a part of a larger network (i.e., internet)

MANET is network in which nodes are connected together by wireless links without any fixed infrastructure.

Mobile ad-hoc networks have few challenges like limited power constrained, limited security, bandwidth constrained, throughput, survivability of the nodes. Limited battery life is a very critical issue in MANET. So energy efficient protocol must to increase the lifetime of nodes and networks.

Main purpose of power aware routing protocols is to maximize the lifetime of network. It's nearly impossible to recharge or replace nodes batteries in network. So reducing power consumption is only way to extend lifetime of network.

Routing protocols are usually classified as table driven or on-demand routing protocols. Table driven routing protocols also called proactive protocols which maintain continuous view of the full topology of the network in each node. On-demand protocols also called reactive protocols which search for a route between source and destination.

II.   CLASSIFICATION OF MANET ROUTING PROTOCOLS

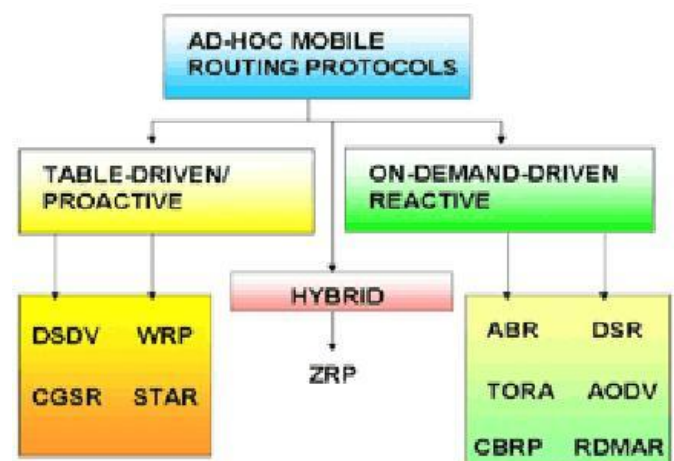There are different types of MANET routing protocols are there as classified in figure 1 as follows.

Fig 1: Classification of routing protocols

A. Proactive routing protocols

Proactive (table-driven) routing protocols in which every node maintains routing table which contains information about

the network topology even without requiring it. The routing tables are updated periodically whenever network topology changes. These types of protocols maintain different number of routing tables varying from protocol to protocol. So they are not suitable for large networks as they need to maintain node entries for each and every node in the routing table.

DSDV, WRP, STAR, CGSR etc. are various well known proactive routing protocols in MANET. Destination sequenced distance vector (DSDV) routing protocol is based on the Distributed Bellman Ford Algorithm. In this each node maintain routing table which contains next hop, number of hops to reach the destination, sequence number. So DSDV has large overhead due to routing information in table. Four different types of tables maintained in DSDV namely distance table, routing table, link cost table, message retransmission list.

B. Reactive Routing Protocols

Reactive (on demand) routing protocol does not maintain their route tables with the latest route topology. If a node wants to send any packet then protocol searches for the route and establishes the connection in order to transmit and receive the packet.

The on-demand routing protocols have two major components:

Route discovery: In this source node initiates route discovery on demand basis. Source node has the destination address of the node as well as address of the intermediate nodes to the destination. Source nodes consults its route cache for the available route from source to destination otherwise if the route is not present it initiates route discovery.

Route maintenance: Route maintenance is done because of dynamic topology of the network cases of the route failure between the nodes arises due to link breakage etc. Route maintenance is possible due to acknowledgement mechanism of reactive protocols.

Because of the route discovery mechanism, reactive protocols add latency to the network. Each intermediate node involved in the route discovery process adds latency. These protocols decrease the routing overhead but at the cost of increased latency in the network. So these protocols are suitable where low routing overhead is required.

There are various types of well known reactive routing protocols in MANET like AODV, DSR, TORA, ABR, RDMAR, and CBRP.

Dynamic Source Routing (DSR) protocol is based on the link state algorithm in which source initiates route discovery on demand basis. DSR was designed for multi hop networks for small diameters. Ad hoc on demand distance vector (AODV) protocol in which source node only includes the address of its neighbor in the packet so overhead in this protocol is less compare to DSR. Temporally ordered routing algorithm (TORA) protocol is based on link reversal algorithm.

C. Hybrid routing protocol

There is a trade-off between proactive and reactive protocols. Proactive protocols have large overhead and less latency while reactive protocols have less overhead and more latency. So hybrid protocol is presented to overcome the shortcomings of both proactive and reactive routing protocols. It uses the route discovery mechanism of reactive protocol and the table maintenance mechanism of proactive protocol so as to avoid latency and overhead problems in the network. It's suitable for large networks. ZRP is an example of hybrid protocol. Zone routing protocol (ZRP) in which zone are divided into peripheral nodes and interior nodes. Every node in the network has a zone associated to it. The zone of a node is defined as the collection of nodes whose minimum distance from the node is not greater than the radius of the node. The Minimum distance is defined in terms of number of hops from that node. The routing inside the zone i.e. intra-zone is done by using proactive approach. For intra-zone routing a node must know about its neighbors. The neighbors of nodes are defined as the nodes which are one hop away from particular node. The neighbor discovery is done by neighbor discovery protocol (NDP) so as to proactively monitor the network for intra-zone routing. The central node selects its zone by considering set of nodes whose distance from the central node is not greater than the radius of the zone. These set of nodes are known as peripheral nodes.

Protocol	Advantage	Disadvantage
Proactive	Latency is reduced. Information is always available.	Routing information is flooded in the network. Overhead is high.
Reactive	Path available when needed overhead is low and free from loops.	Latency is increased in the network.
Hybrid	Suitable for large networks and up to date information available.	Complexity increases.

III.   BACKGROUND

Our power-aware source routing algorithm belongs to reactive routing protocols. So in this section, we start with a general review of two on -demand routing protocols, Dynamic Source Routing (DSR) and Ad -hoc on -demand Distance Vector (AODV), in MANETs. These protocols Initiate route discovery only when a route is needed and maintains active routes only while they are in use.

A. DSR

DSR is an on-demand routing protocol for small-size ad-hoc networks. This protocol is source-initiated rather than hop-by-hop. This is particularly designed for use in multi hop wireless ad hoc networks of mobile nodes. Basically, DSR protocol

does not need any existing network infrastructure or administration and this allows the network to be completely self-organizing and self-configuring. In DSR, when a node wishes to establish a route, it issues a route request (RREQ) to all of its neighbors. Each neighbor broadcasts this RREQ, adding its own address in the header of the packet. When the RREQ is received by the destination or by a node with a route to the destination, a route reply (RREP) is generated and sent back to the sender along with the addresses accumulated in the RREQ header. Since this process may consume a lot of bandwidth, DSR provides each node with a route cache to be used aggressively to reduce the number of control messages that must be sent. If a node has a cache entry for the destination, when a route request for that destination is received at the node, it will use the cached copy rather than forwarding the request to the network. In addition, each node promiscuously listens to other control messages (RREQs and RREPs) for additional routing data to add to its cache.

B. AODV overview

Ad-Hoc On-Demand Distance Vector Routing Protocol (AODV) finds route between nodes only when it is necessary. It does not maintain topology information about all other nodes in the network. When a source has data to transmit to an unknown destination, it broadcasts a Route Request (RREQ) for that destination. At each intermediate node, when a RREQ is received a route to the source is created. If the receiving node has not received this RREQ before, is not the destination and does not have a current route to the destination, it rebroadcasts the RREQ. If the receiving node is the destination or has a current route to the destination, it generates a Route Reply (RREP). The RREP is unicast in a hop-by-hop fashion to the source. As the RREP propagates, each intermediate node creates a route to the destination. When the source receives the RREP, it records the route to the destination and can begin sending data. If multiple RREPs are received by the source, the route with the shortest hop count is chosen. As data flows from the source to the destination, each node along the route updates the timers associated with the routes to the source and destination, maintaining the routes in the routing table. If a route is not used for some period of time, a node cannot be sure whether the route is still valid; consequently, the node removes the route from its routing table. If data is flowing and a link break is detected, a Route Error (RERR) is sent to the source of the data in a hop-by-hop fashion. As the RERR propagates towards the source, each intermediate node invalidates routes to any unreachable destinations. When the source of the data receives the RERR, it invalidates the route and reinitiates route discovery if necessary.

IV. RELATED WORK

Network performance is key issue in MANET research. There has been some study on power aware routing protocols for MANET. Presented below is a brief review of them.

In [8, 9], a node holds the RREQ packet for some time, inversely proportional to its residual energy. Hence, paths with nodes that are poor in energy will have minimal chance to be chosen. In [10], the Residual Energy-aware Probability Model of Node (REPMN) is proposed. In this, on receiving a RREQ, if the residual energy Er of the current node is superior to a certain threshold THr than the RREQ is forwarded with a probability 1, else it's forwarded with a probability $\mu \times$ (Er/THr) where μ is a variable coefficient that should increase as the average energy of the network decreases.

In [9], a routing algorithm based on minimizing the amount of power required to get a packet from source to destination is proposed. The main disadvantage of [9] algorithm is that it always select the least-power cost routes. So as a result because of the battery energy exhaustion, nodes die soon. So it will be better to use a higher power cost route.

The previous observation rise to number of battery cost aware routing algorithms as described below.

1. Minimum battery cost routing algorithm which minimizes the total cost of the route by provides minimizing the summation of inverse of remaining battery capacity for all nodes on the routing path [10].

2. Min-Max battery cost routing algorithm is a modification of the minimum battery cost routing which attempts to avoid the route with nodes having the least battery capacity among all nodes in all possible routes. So it results in better use of the battery of each node [9] [10].

3. In [10], Conditional Max-Min battery capacity routing algorithm was proposed. In this algorithm the route with minimal total transmission power is selected if all nodes in the route have remaining battery capacities higher than a threshold; otherwise, routes that consist of nodes with the lowest remaining battery capacities are avoided. Some experiments have been performed in [10] to compare different battery cost aware routing. As per result of reports, the minimum battery cost routing exhibited superior results compared to the Min-Max battery cost routing. Results of Min-Max routing are depending on how threshold value was selected.

4. In [14], Maximum Residual Packet Capacity (MRPC) is proposed. MRPC is abstractly similar to the conditional Min-Max battery cost, but MEPC recognizes the capacity of node by the expected energy spent in reliably forwarding a packet over a specific link.

5. In [16], Power aware source routing (PSR) is proposed which uses state of the charge of battery to maximize the lifetime of MANET. This protocol adds a power aware routing metric into DSR. PSR try to find a route π such that properly defined route cost functions are minimized.

6. In [9], Location Aided Routing (LAR) algorithm is proposed. In this algorithm mobile nodes find out their route using location information obtained from global positioning system (GPS) receivers. Because of this number of broadcast packets reduced.

7. In [7], an adaptive gossip-based protocol is proposed which employs a predefined probability p to forward an RREQ packet if the node far from the source s hops; otherwise it will gossip with probability 1. Several schemes to optimize the basic gossiping scheme introduced to prevent broadcast

packets from rapidly dying out and prevent nodes from transmitting unnecessary packets.

8. In [13], the energy based gossip (EBG) routing algorithm is introduced in which the intermediate nodes forward the RREQ packets with a probability which considered on the basis of current energy status of that node, but in this algorithm, if probability is below pc then RREQ packets dying out.

9. In [10], a distributed power control has been designed to improve the power efficiency of routing algorithms. Every node in the networks calculates the power required to reach its own neighbors.

10. In [19], a life-time prediction-based routing (LPR) proposed which focused on the minimization of the variances of the nodes enduring energies in the network. In this protocol, each node tries to guess future energy costs, but its prediction depends on factors like node mobility, hop count, node distances, and remaining power.

11. In [7], clustering algorithm is proposed in that by using cluster coordinator to schedule sleeping /wakeup and forwarding/buffering packets for cluster members. Algorithm can be used to select a coordinator in a cluster for the connecting dominating set problem. In [9] a dual clustering mechanism proposed where the cluster coordinator first selects its members based on the received energy levels reported by the nodes.

V. PROPOSED SCHEME

Our main goal is to improve the performance of existing on-demand routing protocols. The basic idea behind our algorithm is to find nodes with dynamic route to the destination, having energy level above than threshold value. The two common on-demand routing protocols are dynamic source routing (DSR) protocol and ad-hoc on demand distance vector routing (AODV) protocol. So from them, we select AODV protocol to implement our proposed scheme because AODV is an efficient routing protocol which removes any unnecessary and outmoded information quickly, and does not create traffic unless necessary. So that's why AODV can react to topological changes that have an effect on active routes in a timely and quick manner. AODV performs better in scenarios with extra load and/or higher node mobility; as a result it's more scalable than DSR.

In our proposed algorithm, main goal is to find neighboring nodes with an active route to the destination. As shown in fig.2, first of all find energy status of all nodes in the network. Any node in the network wants to communicate with another node than source node broadcast message to know status of energy level of all other nodes. Based on threshold value which defines by default, energy levels of nodes are compared with threshold. Only those neighboring nodes that have energy levels higher than the threshold are eligible to participate in route discovery. Nodes having Energy level above than threshold are picked, from that node having maximum energy and less distance is selected and packet will send to that node. As the scheme has both distance and energy metrics. Local

repair of the active path is automatically built-in the scheme.

The proposed scheme is simulated using network simulator NS-2 with latest version and the performance is compared with well known on demand protocols AODV and advanced existing AODV protocols.
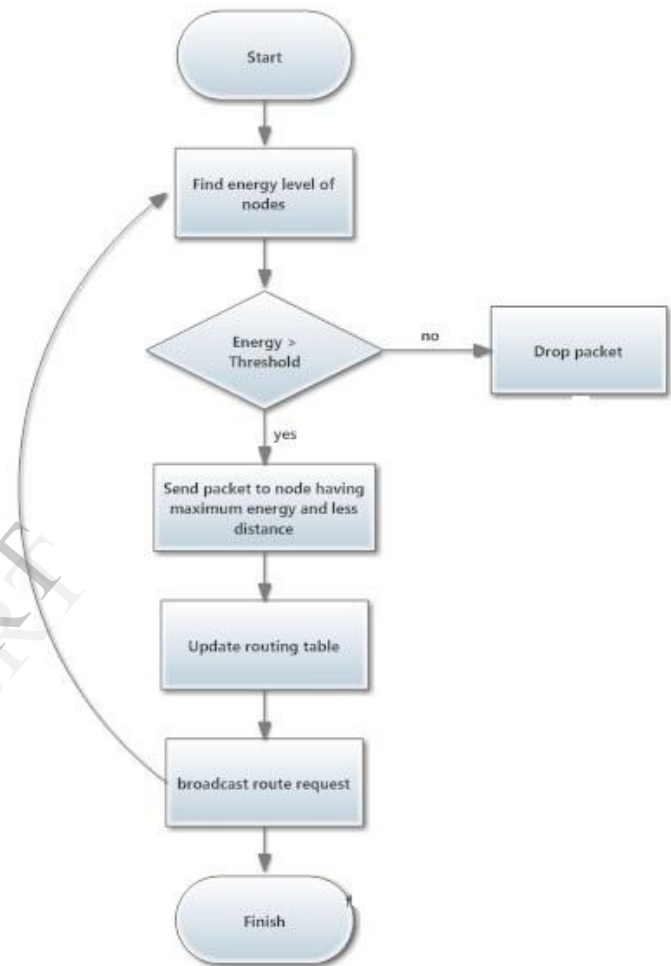

Fig 2: Proposed algorithm

VI. CONCLUSION

We will apply our proposed scheme to AODV that works on a reactive approach and make use of alternate paths by satisfying a set of energy and distance based threshold area. So we can achieve the following:

1. Improvement in the lifetime of the entire network
2. Raise the success rate of packet delivery by preventing nodes from dying out due to energy fatigue.

Our proposed scheme picks the nodes based on their energy level, which may also help in solving the problem of asymmetric links.

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