Energy Efficient Multipath Routing Protocol For Mobile Ad-Hoc Network Using The Fitness Function

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Abstract- *Mobile ad hoc network is a collection of wireless mobile node that connects mobiles to a network and it is forms a temporary network without the interdependence of any infrastructure. Energy utilization is considered as main confines in MANET. As the mobile nodes do not have permanent power supply and have to depend on batteries. So dropping network lifetime as batteries get drain quickly as nodes moves from on position to another position across the MANET. This paper focus on the energy consumption in MANET by applying the fitness function technique to optimize the energy consumption in ad hoc on demand multipath distance vector (AOMDV) routing protocol. The proposed protocol is called AOMDV with fitness function (FF-AOMDV).The fitness function is used to find the best path from source to destination node to reduce the energy consumption in multipath routing. The performance of the proposed FF-AOMDV protocol has been evaluated by using network simulator version2, where the performance was compared with AOMDV and AOMR-LM protocols, these are the two most protocols proposed in this area. The comparison was done based on the energy consumption, throughput, packet delivery ratio, end to end delay, network lifetime and routing overhead ratio performance metrics, varying the node speed, packet size and simulation time. The results clearly show that the proposed FF-AOMDV performed better than the AOMDV and AOMR-LM under the majority of the network performance metrics and parameters.*

Keywords- Energy efficient protocol, mobile ad hoc network, multipath routing, and fitness function

I. INTRODUCTION

The performance of computer and wireless communications technologies was advanced in recent years. As result, it is expected that the application of advanced mobile wireless computing use is rapidly increased. Much of this future development will involve the utilization of the Internet protocol (IP) suite. Mobile ad hoc networks(MANETs) are intended to support effective and robust mobile wireless network operation through the combination of routing functionality into mobile nodes. These networks are predicted to have topologies like multihop, dynamic, random and sometimes rapidly changing. These topologies will possibly be consisting of wireless links that are relatively bandwidth unnatural. Ad hoc networks are essential in the evolution of wireless networks as they consist of mobile nodes which communicate over wireless links without central control. The long established wireless and mobile communication problems like bandwidth optimization, transmission quality improvement and power control are directly inherited by ad hoc wireless networks. New research problems like configuration advertising, discovery and maintenance are brought by ad hoc networks because of their multihop nature, lack of infrastructure and ad hoc addressing and self-routing. There are numerous proposals on different approaches and protocols.

Engineering Task Force and even as academic and industrial ventures

In MANET's, due to the limit battery capacity of mobile node, it affects network survivability since links are disconnected when the battery is drained. Therefore, to guarantee the network connectivity and prolong the network lifetime a routing protocol is considered as the mobile nodes energy. Power-aware routing protocol deal with the techniques that reduce the energy consumption of batteries of the mobile nodes. Therefore, by using the power-aware routing protocols, various routing costs and path selection algorithms have been developed for the purpose of improving the energy efficiency in the MANET. Many routing protocols have been developed in recent years to increase the lifetime of the route. Multi routing protocols enable the source code to choose best route among the many routes when the route discovery is processed. Multipath routing protocols send a route request to more than one route so that the packet can be delivered to the destination and if any route fail to send the packet to the destination then automatically, it will find alternate route to deliver the packet to the destination. It is not necessary that the source will find the optimum or shortest path.

This paper presents the energy efficient multipath routing protocol called ad-hoc on demand multipath distance vector with fitness function(FF-AOMDV). The FF-AOMDV uses the optimization method and this method contains two parameters. These parameters are used to select the optimum route and other parameter is used as route distance, which is used to send the packet to the destination more efficiently. Based on the results, FF-AOMDV is better than the ad-hoc on demand distance vector (AOMDV) and ad-hoc on demand multipath routing with life maximization (AOMR-LM) in the terms of throughput, packet delivery ratio, end to end delay, energy consumption, network lifetime and routing overhead ratio.

II. BACKGROUND AND RELATED WORK

A. AOMDV routing protocol:

AOMDV have its root in the ad hoc on demand distance vector(AODV). AODV is a popular single path routing protocol but AOMDV creates broad AODV by discovering at every route discovery process. The AOMDV have two keys, they are route discovery and route maintenance. As AOMDV depends on AODV route information which is already available. But AOMDV experiences less than AODV through the discovery of multiple routes. When compared to AODV, AOMDV is additional with route request(RREPs) and route errors(RERRs) in addition with several extra ends to route control packets. By adding and changing, structure of AOMDV below figure represents the AODV and AOMDV routing table. Always the sequence number gets updated.

destination
sequence number
hopcount
nexthop
expiration_timeout

(a) AODV

destination
sequence number
advertised_hopcount
route_list $\{(nexthop_1, hopcount_1),$ $(nexthop_2, hopcount_2), ..\}$
expiration_timeout

(b) AOMDV

After performing the simulations using NS-2, AOMDV decreases the packet loss up to 40% and greatly improves the end to end delay and it also causes decreasing of routing overhead about 30% by decreasing route discovery operations frequency, which helps improving the overall performance of MANET when it is compared to AODV algorithm.

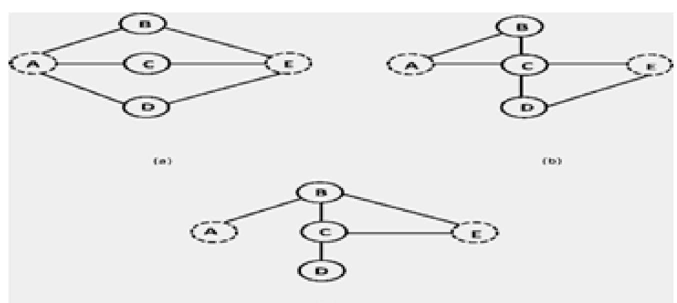
B. ROUTE DISCOVERY AND MAINTANANCE:

During sending the packets from source to destination, route discovery and route maintenance is involved. Multipath routing protocols will try to discover the link disjoint, node disjoint and non-disjoint routes. Here link disjoint have no common links but it may have nodes in common node disjoint does not have common nodes or links. Whereas Non-disjoint may have both nodes and links which are common. The AOMDV is designed in such a way that it may serve highly dynamic ad hoc networks. AOMDV uses three control packets, they are RREQ, RREP and RERR. the source node is required to transmit the data packets to specific destination the source node broadcast RREQ because RREQ is coded network wide but in AOMDV all the duplicate copies undergo an examination to determine the potential alternate reverse path. The receiving node checks whether the node which is sent i.e. RERR is its own or not. RERR continuous to be forwarded until the source receives. After it is happened, it still initiates the route discovery again if it still requires.

The RREQ not propagated by intermediate node. The receiving node initially checks if the code sent by the RRER is its own. The receiving node makes this route table as invalid.

C. DISJOINTPATH:

There are two types of disjoint path, they are the node-disjoint path and link-disjoint path. In a node-disjoint path, no common node exists in a specificpath rather than the source and destination nodes. In a link-disjoint path, there is no common link at all.



The routes ABCE and ABE, have both link AB and node B in common.It doesn’t have a disjoint path. The routes ABE, ACE, and ADE have no common node or link.

D. FITNESS FUNCTION:

Fitness function is the most important feature in the optimization process, which could be many factors depending on the aim of the research. In MANET, the fitness factor is usually energy, distance, delay, and bandwidth. This matches the reasons for designing any routing protocol, as they aim to enhance the network resources. It was used with wireless sensor networks to optimize the alternative route in case the primary route fails. The factors that affect the choice of the optimum route are:

The remaining energy functions for each node

The distance functions of the links connecting the neighboring nodes
Energy consumption of the nodes Communication delay of the nodes

The PSO algorithm is adjusted with a population of random candidate solutions, conceptualized as particles. Each particle is assigned a randomized velocity and iteratively moved through the problem space. This algorithm (PSO algorithm) consist of some tuning parameters that are in sequence, which is frequently indicated as exploration exploitation trade off.Exploration is the ability of testing various regions in problem space, in order to locate a good optimum, whereas exploitation is the ability to concentrate the search around promising candidate solution to locate optimum precisely. Here the particles are attracted with two fitness parameters. The two fitness parameters are energy level of the mobile nodes and the distance of the route. With the help of these two fitness parameters the optimization can be found by forwarding the route that has the highest level of energy and less distance in order to minimize the energy consumption.

AOMR-LM is the proposed energy efficient multipath routing protocol which conserves the energy of nodes and balances the energy which was consumed to increase the network lifetime. But they used the energy of nodes for calculating the node energy level. In this algorithm, the number of active neighbors are counted in each direction. The energy consumed in the process of route discovery, which consumes less energy could be possibly be

1)the route that has the shortest distance
2)the route with the highest level of energy
3) or both 1 &2

The source node will send the data packets via the route with highest energy level. The main advantage of this multipath routing protocol is that, this protocol will find new route when all routes to the destination are failed and even if the selected route fails, then the source node will select an alternate route form its routing table. The route with less distance which consumes less energy will be calculated as

Optimal route=∑v(n)∈rene(v(n))∑v∈Vene(v)(1)

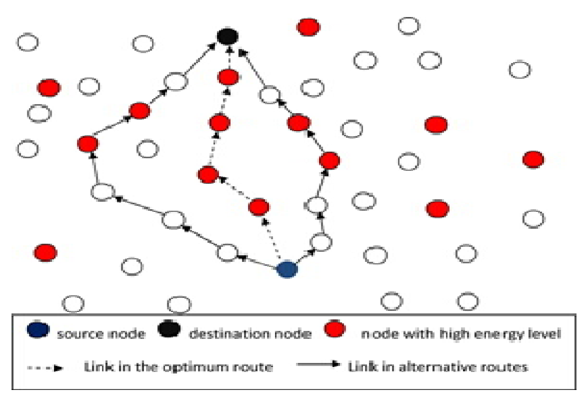
In the above equation, where v represents the nodes in optimal route. AOMDV maintain the route with least hop count and FF-AOMDV implement the same technique after selecting the route with highest energy level. And the routing table have the information about the route with least distance. The calculation for the shortest route can be done as follows:

Optimuroute2=∑e(n)∈rdist(e(n))∑e∈E(2)

In the above equation, e represents the links in the optimal route and E represents the edges in the network. The pseudo code for fitness function is:

1) Select the source and destination
2) Source initialize the route discovery
3) Broadcast the routing packet to direct nodes
4) Update the routing information in the source routing table
5) Source initialize the deacon
6) Broadcast the routing packet to direct nodes.
7) Update the energy, location information in the source energy table for all the nodes in the entire network
8) Check

To understand how the fitness function works better with AOMDV routing protocol, below figure represents the route selection of FF-AOMDV based specific parameters



The FF-AOMDV broadcast the RREQ in order to collect the information regarding the available routes towards the destination as it is shown in the above figure. Here fitness function performs the scan on the network in order to locate the nodes that have the higher level of energy.

In the above figure, the nodes with higher level of energy are represented as red nodes and the source will receive the RREP that consists information available routes towards the destination along with their energy level. After calculating each route energy level, the fitness function then compares the route with highest energy level and this distance route is considered

Here fitness function chooses the route with shortest distance available if the intermediate nodes located between source and destination with lesser energy compared to other nodes in the network.

III. RESULTS AND PERFORMANCE METRICS

To estimate the performance of our proposed FF-AOMDV protocol, there are three different types of scenarios selected and the scenarios are node speed, packet size and simulation time. Here in this simulation we used the constant bit rate (CBR) as source with 50 mobile nodes and they are distributed casually in a 1500m area network. And the network topology may undergo random change since the nodes distribution and movements are unplanned. Node speed, packet size and simulation time were chosen because to see how they are effecting the performance of the proposed FF-AOMDV protocol. The performance metrics that were used in the simulation experiments are PDR(Packet Delivery Ratio), Throughput, end to end delay, experiment consumption, network lifetime, routing overhead ratio.

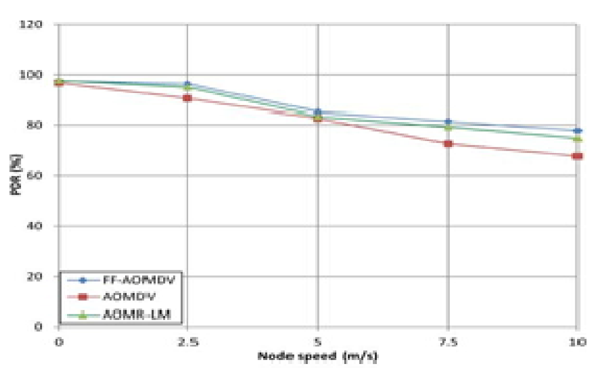
Now let us discuss each performance metrics briefly

PACKET DELIVERY RATIO:

Fig 1(a) shows the various packet delivery ratio for FF-AOMDV, AOMR-LM and AOMDV. When the node speed increases then eventually the packet delivery ratio decreases. For example

1) FF-AOMDV decreases from 97.55% to 77.8%
2) AOMR-LM decreases from 97.7% to 74.7%
3) AOMDV decreases from 96.79% to 67.355

We can observe that the FF-AOMDV have the higher packet delivery ratio when compared to AOMR-Lm and AOMDV.



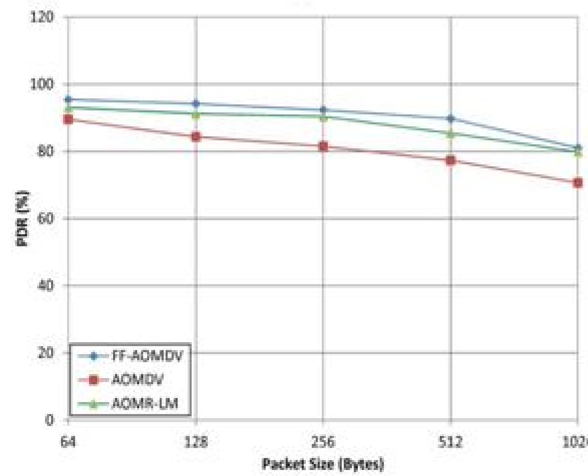
(a)

In Fig 1(b), it shows the variation of the packet delivery ratio for FF-AOMDV, AOMR-LM, AOMDV.

When the packet size increases then the packet delivery ratio decreases. For example

1)FF-AOMDV decreases from 95.45% to 81.06%
2) AOMR-LM decreases from 93.12% to 79.9%
3)AOMDV decreases from 89.56% to 70.67%

We can observe that FF-AOMDV performance was better than AOMR-Lm and AOMDV routing protocols in terms of packet deliver ratio. And FF-AOMDV minimizes the packet loss by selecting the reliable routes and routes with less distance.



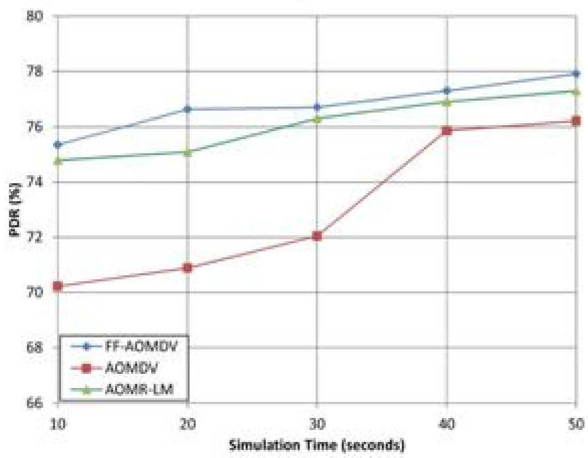
(b)

In Fig 1(c), it shows the effect of various simulation time on the packet delivery ratio for FF-AOMDV, AOMR-LM and AOMDV routing protocols. Simulation time is inseconds. When the simulation time increases, the packet delivery ratio also increases. For packet delivery ratio FF-AOMDV protocol is better than both AOMR-LM and AOMDV protocols.

For example

1) FF-AOMDV protocol attained 75.36% of packet delivery ratio in 10 seconds and 77.91% in 50 seconds.
2) AOMR-LM protocol attained 74.8% of packet delivery ratio in 10 seconds and 77.3% in 50 seconds.
3) AOMDV attained 70.23% in 10 seconds and 76.22% of 50 seconds.

Results clearly shows that FF-AOMDV protocol is better in performance because of its strong and short routes.



(c)

THROUGHPUT:

The results clearly show the various throughput for FF-AOMDV, AOMR-LM and human speed because FF-AOMDV protocol have better throughput as it selects the active route to send the data from source to destination and these routes will have less distance or more energy level when compared to other routes.

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