Implementing and Evaluating the Performance Metrics Using Energy Consumption Protocols in Manets Using Multi-Path Routing- Fitness Function

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Abstract:

The energy consumption plays a key role in Mobile Adhoc Networks in a day to day life. Mobile Ad Hoc Network (MANET) structure is a temporary network organized dynamically with a possible family of wireless mobiles independent of any extra infrastructural facilities and central administration requirements. Also, it provides solutions to overcome the minimal energy consumption issues. Nodes are battery operated temporarily does not operate on permanent batteries, so energy consumed by a battery depends on the lifetime of the battery, and its energy utilization dynamically decreases as the nodes change their position in MANETs. Multi-path routing algorithm in MANETs provides the best optimal; the solution to transmit the information in multiple paths to minimize the end to end delay, increases energy efficiency, and moderately enhances the life time of a network. The research mainly focused on minimum energy consumption techniques in MANET is of a great challenge in industries. In this paper, the author highlights a novel algorithmic approach Adhoc on Demand Multipath Distance Vector (AOMDV) routing protocol that increases the energy efficiency in MANET by incorporating the demand multipath distance and fitness function. The Adhoc on Demand Multipath Distance Vector-Fitness Function (AOMDV-FF) routing protocol short out minimum distance path that consumes minimum energy and the simulation performance is evaluated using network simulator-2 (NS2) tool. Two protocols are proposed in this work AOMDV and AOMDV-FF and compared some of the performance parameters like energy efficiency, network life time and routing overhead in terms of data transfer rate, data packet size and simulation time, etc. The overall simulation results of the proposed AOMDV-FF method is to be considered as a network with 49 nodesand the network performance factor-end to end delay 14.4358msec, energy consumption 18.3673 joules, packet delivery ratio 0.9911 and routing overhead ratio 4.68 are evaluated. The results show an enriched performance as compared to AOMDV and AOMR-LM methods.

Keywords: Energy Efficiency, MANET, Multipath Routing, Fitness Function, Packet Delivery Ratio, Throughput.

1. Introduction

As the scaling down technology is progressing tremendously in a day to day life, in turn, the growth of the computer performance, as well as the scope and applications of wireless technologies, is also drastically increasing. Withthe advent of new technologies, the research has been mainly focused on minimum power consumption protocol developments and its cost effective hardware architecture implementation. The awareness of power consumption, investigation on performance, effective routing protocols, and more efficient path selection algorithms are major concern to improve the performance of the metrics and also to acquire maximum energy efficiency in MANETs. The performance factors of MANET nodes have limitations in terms of speed and power, battery, storage, and transport mechanisms. Most critical and challenging issues in MANETs are the development of routing techniques and also the development of routing algorithms. Multipath routing protocols most reasonably and efficiently find the shortest path among the many identified paths to establish the link to transmit the packets information source nodes to destination nodes. It is not necessary that each time the source will relay on only shortest path available to improve the life time of the network performance but also other factors like power, battery life may also influence the performance of the networks. So the saving

the power consumed at the source is limited by the number of dependant mobile nodes, the researchers made attempts to provide the minimal power consumption at these nodes which in turn enhances the lifetime of MANETS. There are several critical issues, and facts exist in multipath routing protocols developing techniques. The researches focused on novel methodologies and algorithmic approaches that could able to identify the shortest path between the source nodes and the destination nodes. As the number of modes increases, this identity issue becomes much more complicated in MANETs to transfer the data/information in the form of packets. In most of the cases, a partial amount of energy is being spent on identifying the optimum path and this being one of the drawbacks or critical issue is trying either to minimize or eliminate during transmission of data. So the part of energy being wasted during identifying the shortest path is given major priority to resolve of this paper. The more energy is being wasted during the data transmission. In this paper, the author identifies the approach to incorporate some of these major issues and to develop an innovative idea Adhoc on Demand Multipath Distance Vector (AOMDV) routing protocol to minimize energy consumption algorithm in MANET with add on functions the demand multipath distance and fitness function too. Adhoc on Demand Multipath Distance Vector Fitness Function (AOMDV-FF) an efficient multipath routing protocol can detect the possibility of conceiving nominal power with minimum path distance. The AOMDV-FF uses the fitness function to obtain an optimized solution by considering six parameters to choose the best possible shortest route with the minimum energy level of the route and increasing the network lifetime of the path to transfer the packets from the source to the destination more efficiently. From the obtained simulation results as overall performance, AOMDV-FF routing protocol shows the better performance factors like throughput, packet delivery ratio, end-to-end delay, energy consumption, network lifetime and routing overhead ratio as compared to both AOMDV and Ad-Hoc On Demand Multipath Routing with Life Maximization (AOMR-LM) routing protocols.

The work of this paper is structured as follows: Section 2 elaborates the related literature survey of AOMDV with fitness function as major concern and critical issues involved in the current work; Section 3 explores with a novel AOMDV-FF method; Section 4 highlights some of the key factors based on the obtained results and evaluation process adopted; Section 5 performs the conclusion based on the obtained results and explores insights to further enhance as a future scope.

2. Background & Related Work

The literature survey explores the new developments and their tremendous utilization methods of internet protocols (IPs) in mobile Adhoc networks and wireless communications applications mainly depend on their band width limitations.

Aqeel Taha [1] and S Carson [11] proposed that the networks that utilized in MANETs mainly depend on routing protocols and topologies like; multi-hop, dynamic, and random types. Recent developments in many routing protocols have been made efforts by researchers to enhance the lifetime of all routes and in turn, made to select the best path to increase the network lifetime. J. Iswarya [2] and Mueen Uddin [3] both proposed similar multipath routing protocols provide best solutions to select the shortest path to transfer information (data) packets efficiently between the source nodes and destination nodes. The same is preserved and used asbackup data whenever the route failures occur and also provides better performance without degrading the performance factors.

Due to lack of non-availability of permanent power supplies in mobile energy consumption plays a vital role in the research area as to how to minimize power consumption during the transmission of data in MANETs. Ramya. V [4] proposed a model on how to minimize energy consumption with the routing protocol AOMDV using fitness function and that establishes the shortest route to transfer the data more efficiently between the source nodes and destination nodes. With the help of the performance parameters that are used to calculate the metrics using NS_2 tool and also compared with protocols AOMDV AOMR-LM for better performance. The protocol AOMDV-FF was able to establish an optimal link among the nodes in a network and also provides less energy consumption in multipath routing.

May Cho Aye [5] highlights the major issue in mobile Adhoc networks in energy consumption and provides a solution by which this issue is minimized through a more efficient multipath routing protocol that consumes less energy during the transmission of power, and residual energy is used to maximize the network life time.

M. Tekaya [6] and L. Gatani [7] elaborated what are the possible ways to increase the network performance from the literature survey and explains the two types of the routing protocols implemented for ad hoc networks: Table driven (proactive) based on consistency of updated information and on-demand reactive [8, 9]. At every instant of time, these routing protocols are shown more consistent and provide updated routing information efficiently at each mobile host. These protocols explain that each host mobile maintains with one or more tables regarding the routing information of all other host mobiles in the network. However, network topology changes at any instant of time, the mobile hosts transmit the relevant messages to be updated to all other nodes in the network to increase the performance efficiency in establishing the routing information.

A. Montazeri, [14] AOMDV protocol is an extension of AODV protocol in locating all possible routes or multipath solution and to identify the shortest path among the identified one between the source and a destination node in a given network frame. Hiremath, P. S [15] AOMDV's ideal goal is to identify multiple routes. The implementation of AOMDV is inbuilt to overcome the critical issues like; the link failure rate and route/path discontinuities in MANETS and WSNs that degrades the performance of the network [15].

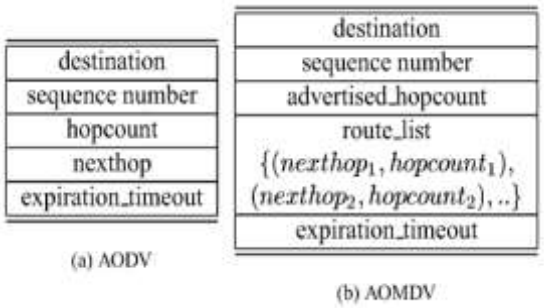

Fig.1 Structures of Routing Table

The disadvantage of AOMDV is it requires additional requests; extra route requests (RREPs) and route errors (RERRs) in a multiple path detection process, and to maintain with additional fields; route replies (RREPs) [14].

Identification of route and its route maintenance is an integral part of the route discovery process. To establish a possible set of routes between a source node and a destination node, first these multi path protocols need to identify the link-disjoints, node disjoints, or non-disjoint routes [16, 17]. The link-disjoint routes do not possess a common path; these nodes are referred to be in a common path. Node-disjoint routes- totally disjoint routes do not possess either common nodes or links. Non- disjoint routes possess both nodes and links that are in common [17]. AOMDV major role is to evaluate multiple additional routes during a route discovery process. The development of AOMDV routing protocol is focused on establishing highly dynamic ad-hoc networks that have more frequent of link failures occurrences as well as route breaks. A novel approach has been incorporated to identify the route path, which is applicable in this event process from all paths to the destination end.

3. Proposed Method

In this paper, the author incorporates an innovative idea by using Fitness Function (FF) to increase the efficiency of energy in the multipath routing protocol is known as Ad-hoc On Demand Multipath Distance Vector using the fitness function (AOMDV-FF) is of major concern. This system uses the fitness function to provide an optimized solution by highlighting one parameter out of two parameters as major concern in order to select the optimum shortest route/path; first is maximum energy absorbed at the route level and second is the route/path distance while transferring the data from source to the destination more efficiently with minimal

energy consumption and by prolonging the network lifetime. To improve the performance of MAC layers by adopting some of the parameters like; average energy consumption and network lifetime and also the maximum level of elimination of congestion by adopting variable contention window sizes.

This work focuses on energy consumption in MANET's by applying the fitness function technique to optimize the energy consumption in ad hoc on demand multipath distance vector (AOMDV) routing protocol. The modified protocol AOMDV is with the fitness function as major concern is AOMDV-FF. The main purpose of the fitness function is to identify an optimal solution among the multipath routing between source and destination nodes with minimum energy consumption. To evaluate the performance of the proposed AOMDV using FF protocol is being carried out using network simulator version 2 tools, simultaneously the results of it are being been made comparison with the results of AOMDV protocol and ad hoc on demand multipath routing with life maximization (AOMR-LM) protocols. From the simulated results of the following metrics like 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 are being compared to acquire an accurate solution for MANETs.

A fitness function is mainly an objective function to measure the metrics of design with the optimal solution in selecting a path among many paths. Fitness functions are incorporated in genetic programming as well as genetic algorithms to provide a suitable optimal solution for a particular design in MANET's. In particular, in the fields of genetic programming and genetic algorithms, each design solution is commonly represented as a string of numbers (referred to as a chromosome). In recursive testing operations using NS2 tool, fitness function provides the best possible round of testing among several worst design simulated solutions. Each solution/ round it provides the closest proximity that meets the required minimal solution with the help of fitness function. The fitness functions mainly classified into two based on:

i. stationary fitness function is a set of possible test solutions.

ii. Mutable fitness function based on niche differentiation with a set of test solutions.

In MANET's, the research mainly focuses on the fitness factor depending on the factors energy, distance, delay, bandwidth, etc. These overall performance factors have shown an opportunity to design a novel routing protocol to enrich that network performance and its resources. From the literature survey, an integral part of the fitness function is incorporated in particles warm optimization (PSO) algorithms [13]. It was used to find an optimized solution for the path/route if the primary path fails/route. Some of the factors that affect to select the best possible optimized route depend on:

- Utilization of energy functional properties at each node.
- The path distance identity function of all links connectivity of all adjacent nodes.
- Evaluation of energy efficiency at each node.
- Measure path delays between the adjacent nodes.

Here the author proposed a novel method by bringing the modifications required in AOMDV routing protocol and incorporating fitness function as major concerned. The message packets can transmit through these shortest routes depending upon the accuracy and quality; that is needed with the help of request handshake signals by the node to highlight the principle of increasing energy efficiency factor and network life time. The major concerns are to be made clear at the source node before broadcasting and receiving the data packets in terms of shortest optimized route, maximum energy efficiency. To avail, this minimum requirement of the nodes includes:

- Complete information of each node.

- The distances between the nodes.
- All possible energy consumptions of all the paths.

At each source node, the above two parameters are calculated by permitting highest energy levels at the source end and at receiving end the energy consumption is measured by route discovery recursive process. The advantage of the route discovery process is used when all the routes at the destination end are failed. In such a case, the source node will not select an alternate approach from the existing routing table by satisfying all parameters. Thus the optimal shortest route with lower energy utilization is identified by equation (1).

$$Optimumroute = \frac{\sum v(n) \in rene(v(n))}{\sum v \in Vene(v)} \quad (1)$$

v = No of nodes in the optimum route 'r.'

V= Maximum No of nodes in a given network.

From the obtained simulation results for the parametric of MANET using NS2 tool. The comparison is made for the shortest route and optimized, maximum energy efficiency. The alternative path is chosen based on its distance parameter. The AOMDV protocol effectively evaluates the route with the lowest hop count. The modified AOMDV-FF implements the same principles of AOMDV to evaluate the route with peak energy level, minimum energy consumption during transmitting, and the shortest possible route. The evaluation of the shortest route of AOMDV-FF technique is evaluated by equation (2):

$$Optimumroute = \frac{\sum e(n) \in rdist(e(n))}{\sum e \, \varepsilon \, E} \quad (2)$$

Where '*e*' indicates the edges/links formed in the optimum route 'r.'

E = sum of all the edges/links in a network.

A. Algorithm Implementation:

An algorithmic code for adapted fitness function is generated mentioned in the following steps:

- Choose the Source node and the Destination node.
- Set the parameters for the source node.
- Initialize the control message path request and broadcasting the data packets and updating the routing table.
- Update all possible routes information in terms of energy levels and keep sending updated information to the routing table
- Check the best possible route by route discovery process to evaluate the metrics.

B. SIMULATION MEASURING

METRICS

The following simulation measuring metrics of AODMV-FF routing protocol is mentioned below:

1. ***Packet Delivery Ratio*** (***PDR***): It is the measurement of delivered packets to a destination against packets that were formed at the source [1].

$$PDR = \frac{No\ of\ packets\ received}{No\ of\ packets\ sent} * 100 \quad (3)$$

2. ***Throughput***: The data size (bits) received by destination node successfully and is represented in kilobits per sec.

$$Throughput = \frac{No\ of\ Bytes * 8}{Simulation\ time} * 1000 \quad (4)$$

3. ***End to End Delay***: The mean time (m sec) observed by packets during the transmission between source-destination pair in a given network [1].

$$End\ to\ End\ delay = \sum_{i=1}^{n} \frac{(Ri - Si)}{n} \quad (5)$$

4. ***Energy Consumption***: The total amount of energy (Joules) consumed by nodes in a network within the simulation time

$$\text{Energy Consumption} = \sum_{i=1}^{n} (ini(i) - ene(i))$$

(6)

5. ***Network Lifetime***: The total time (msecs) required for diminishing the battery life of *n* nodes and is calculated by equation (7)

$$\text{Network lifetime} = \sum_{i=1}^{n} (ini(i) - 0) \quad (7)$$

6. ***Routing Overhead Ratio***: It is a ratio factor defined as no. of routing packets divided by the total number of data packets that were delivered.

$$Routingoverhead = \frac{No\ of\ routing\ packets}{No\ of\ routing\ +\ sent\ data\ packets}$$

(8)

4. Analysis of Simulation Results

In this paper, the author is implemented a novel approach an energy efficient multipath routing protocol ad hoc on demand multipath distance vector using fitness function to measure the performance metrics. Here some of the typical parameters for AOMDV-FF is considered during the simulation operation is shown in Table 1.

Table 1 Simulation metrics of AOMDV-FF

Parameter-units	Value
No of simulation runs	5
Number of nodes	49
Node speed meters/sec	3020
Queue size	50
Simulation area- m^2	1200 x 1100
Packet size - bytes	64
Transmission range- meters	250
Initial energy value- Joules	100

Power consumption at Transmitter end- Joules	10
Power consumption at Receiving end - Joules	1.0

It provides an optimized solution to measure the important factors like highest energy level, network lifetime and shortest path, etc. to transfer the data packets among the source and the destination nodes more efficiently to increase the life time of the network and with less energy conserved. The simulations are performed by several iterative operations in the discovery process. The mentioned parameters are analysed for the best performance results and compared with previously existing methods from the literature survey.

Fig 2 shows the performance of throughput metric for 45 nodes in MANET. The throughput is measured in terms of joules and the graph shows for 30 millisecs simulation time.

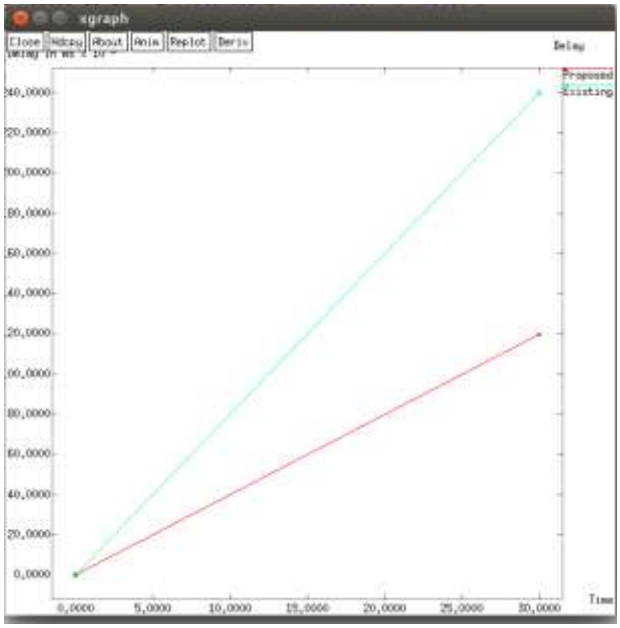

Figure 2 Delay

The proposed method shows the throughput obtained is 4 joules as compared to existing method 5.6 joules. The comparison of the simulation results shows that the throughput of this work is improved by 28.5%.

The scenario of the network over head ratio mainly focuses on the sum of routing packets, delivery of packets over a single data packet. This measurement able to explore the relation between the overhead and additional bandwidth that is required in high density data traffic and the energy consumed is of main concern, and an effort is made to bring the extra bandwidth to be reduced due to overhead. The routing overhead can able to lower the bandwidth and power utilization of the nodes. The simulation results are delivered in figure 3.

Figure 3 OverheadFigure 4 Energy

Figure 4 shows the simulation results of energy consumption for 30 milli seconds. The energy consumption drastically decreased by approximately 50% as compared to the existing method. The existing method consumes energy nearly 240 joules as compared to 120 joules by the proposed method.

The proposed AOMVD-FF method and existing methods remain approximately stationary values form the obtained results. The PDR value is estimated for 30 milliseconds and shows a slight variation, which is negligible. This is considering as one of trade off factor in this technique. The network life time is also improved by a considerable amount of time.

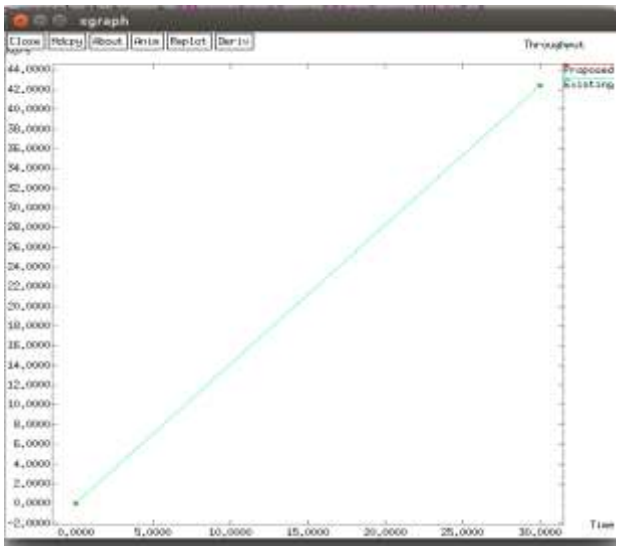

Fig 5 Throughput

Conclusion:

In this research work, the author implemented a novel approach energy efficient multipath routing algorithm using AOMDV-FF to evaluate four parameters. The estimated values run for 30 milli seconds with variable recursive operations 1,5,10. The performance factors Throughput, Overhead, Energy consumption, and PDR, whose performance is estimated from the obtained results using NS-2. The results show much improvement in the parameters Throughput, Overhead, Energy consumption where as PDR remains stationary. End to end delay 14.4358msec, energy consumption 18.3673joules, packet delivery ratio 0.9911, and routing overhead ratio 4.68 are evaluated.

Additional parameters are to be considered to evaluate the performance of AOMDV-FF algorithm by incorporating highest energies at source level and also increasing the capacity of the nodes along with the iterations performed to evaluate the network life time.

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