

Improved Energy Efficiency in Mobile Ad-hoc Networks

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ABSTRACT

In today's world, wireless medium is becoming very popular day by day. With the help of wireless connection, everybody is connected with one another and sharing information through messaging, emailing, video-conferencing, voice calling etc. Mobile Ad hoc networks popularly known as Mesh Networks are self-establishing networks that provide wireless connections to the electronic communication devices. Although this type of network has been used in various fields of science and technology but still there are some limitations for effective use of this network. In the present paper an attempt has been made to improve Ad-hoc on-demand distance vector routing protocol. For this scenario, AODV is evaluated up to 50 nodes. The main goal of this paper is to examine the energy of AODV protocol. The calculation part includes when pause time varies and speed at constant and vice-versa. NS2.34 used to perform a simulation.

1. Introduction

MANETs are the networks, in which a large number of nodes are interconnected with some transmission medium using a wireless system. In this network, every node is free to move anywhere in the network, because mobile nodes are active in nature they constantly change their position. Routing Protocols have been designed for optimal routing results in MANETs. Energy consumption is a big issue in this network because mobile devices have limited battery power. The nodes in network present themselves frequently without the knowledge of the previous topology; therefore, MANETs are always referred to as self-grouping and self-maintaining networks [1]. When any new node enters the network area of other neighboring node, it can organize and maintain its connection itself. With these types of characteristics, MANETs have become very efficient and deployable networks. In wireless communications, mobile ad-hoc network handles all network devices. Mobile ad-hoc network doesn't depend on any past history of connections [2].

Mobile Ad-hoc is a present mode of intercommunication which permits computers to directly exchange all the information with one another. In which each node must have the capacity to perform as a router to find out the optimal path to forward a packet [3]. In order to provide exact peer-to-peer communication all-over the network, all the peer hosts contribute to handling the network functions needed for the communication, for example, routing packet.

Routing Protocols are the most important research area in MANETs for establishing and maintaining the Ad-hoc networks. Further, these Protocols can be divided into two parts, one is known as proactive routing protocols (table-driven) and the other is reactive routing protocols (on-demand). In Proactive (table-driven) routing protocol each router can make its own routing table which is based on the knowledge that each node can learn by interchanging information among the network's nodes. In Reactive (on-demand) routing protocol the routing process needs to locate a route whenever a packet

comes from a source and needs to be transmitted to a destination [3].

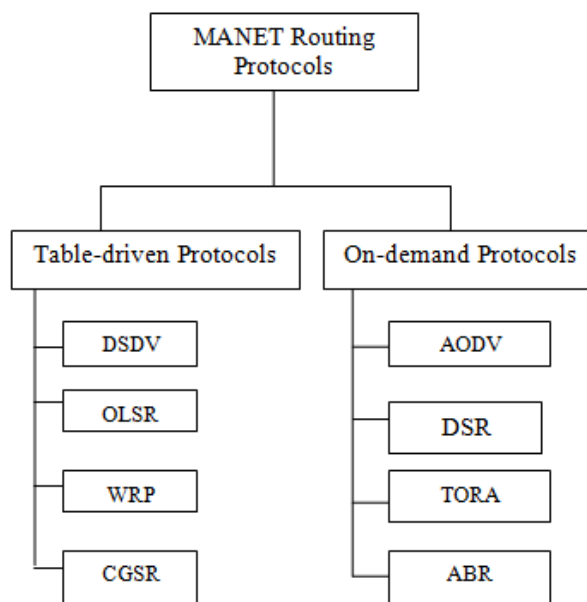


Figure: 1

During routing Mobile Ad-hoc networks suffer many challenges. The biggest challenge of an Ad-hoc network is Energy efficiency. All the mobile nodes rely on batteries in mobile Ad-hoc networks for working since it becomes very difficult to recharge them immediately. To minimize control traffic the routing protocols must be used so-that power of nodes can be managed efficiently. Further, to increase the node lifetime an efficient energy management protocol must be used. A dynamic network topology is used in MANETs when continuous changes in the network are detected. The nodes are free to make the connections because frequent routing updates happen [4]. MANETS are made of various transient connected nodes that do not depend upon any centralized system [5]. For the efficient battery management, some management schemes have been designed in which "Efficient

battery power management” will be discussed in paper [6, 7, and 8], and the other schemes which include “Transmission power management” described in paper [9, 10] and also discussed “System power management” in paper [11, 12] to increase the lifetime of a node. To design the energy-aware protocol gathered a lot of concentration for the delayed network operational time [13]. Mobile ad-hoc network is not similar as wireless and LAN [14].

2. Proposed Scheme

Algorithm 1

Start RREQ phase
 Check RREP signals at each beacon.
 (Hello message by each beacon)
 Check P_{th} of each node participating in RREP.
 If $P_{th} [NODE \text{ under RREP}] = 1$
 Proceed (Data Sent)
 Else
 Proceed (search active node)
 Repeat through step 2 for all nodes in RREP.
 Check PDR

Algorithm 2 (Function # 1)

Phase RREP
 Search Active Node ()
 If Node [N] $P_{th} = 0$
 Check next hop Node [N]
 Set Node [N] = Next Hop Node [N]
 RETURN

To improve the energy efficiency some algorithm or schemes have been proposed. Firstly, the threshold value has been evaluated then reply message is sent to the neighbor node.

To achieve energy efficient routing the battery status has been categorized into 3 parts:

- 1) If the Battery status is less than the Minimum threshold value i.e. called danger state.
- 2) If the Minimum threshold value is less than the Battery status and this battery status is less than Maximum threshold value i.e. called critical state.
- 3) If the Battery status is greater than Maximum threshold value i.e. called active state.

In the working of the AODV protocol mainly two phases are included, which are Route Discovery and Route maintenance.

These phases are described as:

Route Discovery

The route discovery process initiates when neighboring nodes receives Route Request packet and at that time they have energy lower than the threshold value, then Route Request packet is dropped, otherwise, the message is forwarded. And the destination node received route request message only then all intermediate nodes have enough battery

power, when the destination node receives the route request packet, it sends a route reply packet to the source node.

If any intermediate node receives the route request packet then cost is included in the header of that packet, and if any new route request comes with the same destination then cost of new route request packet is compared with the last one. Mainly three conditions are possible:

Case 1:

IF $old_route_cost \leq new_route_cost$;
Then select an old route.

Case 2:

IF $old_route_cost > new_route_cost$ but RREQ through old route has reached destination
Then select old route and discarded new route.

Case 3:

IF $old_route_cost > new_route_cost$ and RREQ through old route has not reached destination
Then select a new route.

Route Maintenance

In MANETs, route maintenance is required to maintain the broken route due to the mobility of the nodes. In such a situation, an appropriate action should be taken to discover a new path from an immediate upstream node after which route error has occurred. The destination node will send an acknowledgment to source node after receiving data packets. For sending next data packet to the same destination the route will check the validity of discovered route and on confirmation, the source will send a data packet through the same route otherwise the route discovery process will be re-initiated.

3. Results and Discussion

In the first scenario we are going to the discussed analysis of AODV up to 20 nodes in terms of Energy when speed is constant at 6m/s and pause time varies up to 500. In which Delay normal, Delay with energy loss will be calculated. Respectively Packet delivery Ratio and Throughput calculated.

AODV ANALYSIS WHEN SPEED IS CONSTANT (6 m/s) AND PAUSE TIME VARIES [20 NODES] [ENERGY]

TABLE I: SCENARIO 1

Routing Protocol	AODV
Antenna Type	Omni Antenna
Pause Time	100, 200,300,400,500,600
Speed (fixed)	6ms
Number of Nodes	20
Traffic Source	TCP
Max. simulation time	600s
MAC Type	802.11

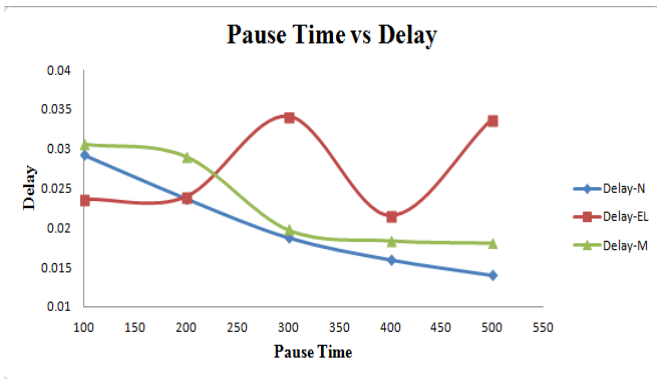


Figure: 2

In figure 2, x-axis defines the pause time and y-axis defines Delay in terms of delay normal, delay with energy loss, and modified delay has been calculated at node 20. And speed at constant 6 m/s. The figure states that normal delay is decreasing at a constant speed and after that energy loss the delay is increased than for the solution of this problem we used some energy efficiency schemes as the results depicted in modified delay case delay is decreased normally.

In figure 3, Pause time varies up to 100 to 550 seconds and Packet delivery ratio also varies up to 100. And speed is constant at 6 m/s. In this x-axis defines Pause time and y-axis defines the Packet delivery ratio at node 20. In normal case Packet delivery is very high i.e. very good for the network. After energy loss PDR is decreased continuously. To overcome this problem energy efficiency is used and PDR is modified.

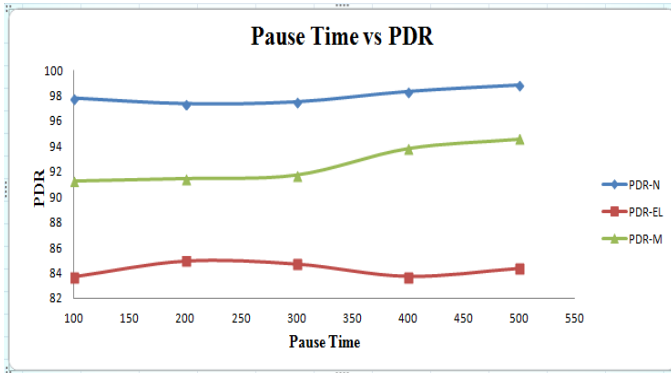


Figure: 3

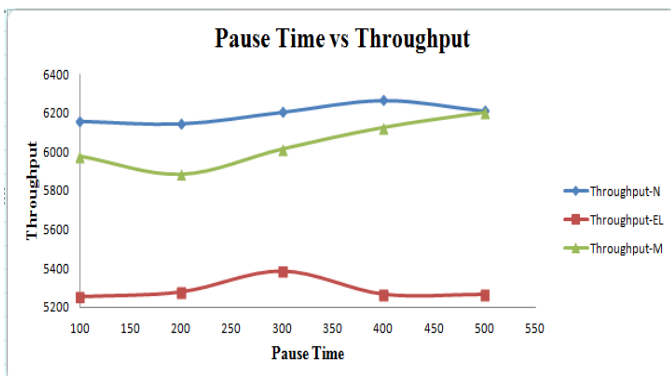


Figure: 4

In Figure 4, x-axis defines the pause time and y-axis defines the Throughput at node 20. In the current scenario throughput is maximum in case of normal and after the energy,

loss throughput is decreased very quickly. To improve this situation we used energy schemes and modified throughput is more increased than energy loss.

AODV ANALYSIS WHEN SPEED IS CONSTANT (6 m/s) AND PAUSE TIME VARIES [50 NODES]

TABLE 2: SCENARIO 2

Routing Protocol	AODV
Antenna Type	Omni Antenna
Pause Time (fixed)	100s
Speed	1,3,7,9,11
Number of Nodes	50
Traffic Source	TCP
Max. simulation time	600s
MAC Type	802.11

In the second scenario, we have two cases in the first case pause time is constant and in the second case Speed varies. And in table 2 simulation environment is described in which all the relevant information regarding simulation scenario described.

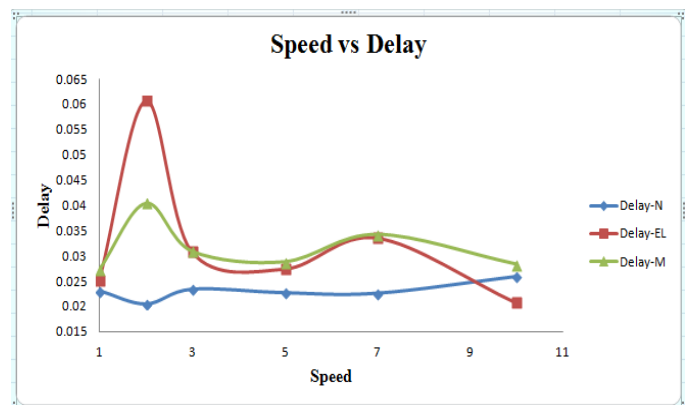


Figure: 5

In figure 5, x-axis defines the speed which varies up to 1 to 11. And y-axis defines the delay in case of normal, energy loss and modified. As the graph depicts normal delay is very less than in all cases after the energy loss delay is very high at peak point then to resolve this problem modified delay is calculated which is much better than energy loss delay.

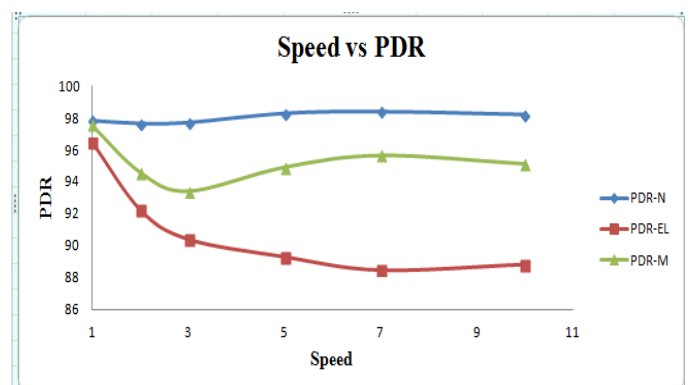


Figure: 6

In this graph, x-axis defines the speed and y-axis defines the pause time. For the efficient results, packet delivery ratio

should be very high. In this case, normal PDR is very high and after energy loss, PDR is decreased to enhance this modified PDR is used, which is better than energy loss PDR. As a result, improved PDR is achieved.

Fixed Speed (m/s)	2	2	2
Pause Time (sec)	100	100	100

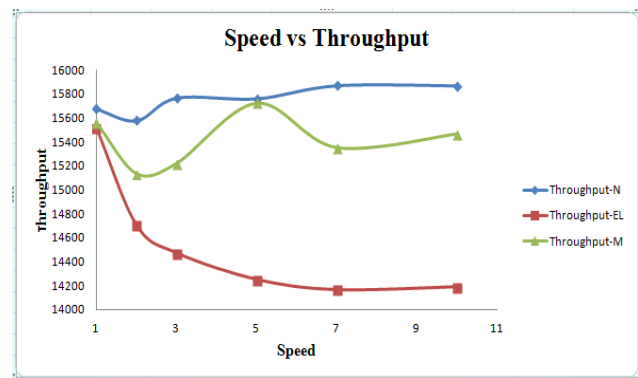


Figure: 7

In this graph, speed versus throughput is calculated for efficient network throughput should be more. In this scenario, normal throughput is very high and energy loss throughput is very low i.e. not good for an efficient network to improve this modified throughput is calculated, which is better than energy loss case.

Network Simulator (NS2) Environment [13]

Simulation Software	NS-2.34		
Protocol	AODV		
Channel	Wireless		
Nodes	10	20	50

All the work has been performed with the help of network simulator. For the simulating environment, TCL scripts files, NAM files, and Trace files are executed and results are evaluated. Node10 to Node50 are calculated with corresponding Delay, Throughput, and Packet Delivery Ratio. Mostly simulation scripts are created in TCL (Tool Command Language). In this experiment, results have been analyzed by the awk and output in the trace file. Network simulation has been done using NS2.34 [4].

4. Conclusion

In this paper, energy efficiency has been taken into account. The scheme that has been proposed has been incorporated on AODV. Various metrics have been used for evaluation purposes and it was found that the scheme is robust and works more efficiently. The scheme has been tested using various scenarios and all efforts are made to make it realistic. Sparse and dense mediums have been used and effects have been shown using graphs. It has been observed that there can be slightly more delay in packet delivery than usual scheme. More calculations are needed for better route selection and more efforts are needed for route table maintenance. This can be tolerated as it is at the cost of packet delivery and the scheme achieves much better packet delivery. More efforts will be made in future to take care of other aspects like fading, security etc.

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