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Energy Efficient Routing in Mobile Adhoc Networks based on Enhanced AODV Protocol using ACO

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Abstract*—A Mobile Ad hoc network (MANET) is a self configurable network which is connected with the help of wireless links. Routing of traffic, in an ad hoc network is one of the challenging task because of mobility of the nodes, limited bandwidth and power energy. Main source of power for nodes are batteries in Mobile Ad hoc Networks (MANETs). The mobile nodes consumes power mainly due to transmission of data traffic and receiving of data and mobility etc. If a mobile node fails because of failure of power, then this will not only affects the node itself but also its ability to forward packets on behalf of others and hence overall network lifetime. Because the mobile nodes are powered by batteries, so therefore to replace or recharge them might not be possible. In order to enjoy full advantage of node's life time routing of the traffic should be done in such a way that power consumption is minimized. Most of the conventional routing protocols do not consider energy of nodes while selecting routes. If we use the same route for a longer duration then it will leads to partitioning of the network. Therefore, if we consider energy of the nodes while selecting a route efficiently, then it will leads to full utilization of the node's energy and also helps in increasing the lifetime of the network. In this paper, enhancement of existing AODV protocol is proposed by using Ant Colony Optimization (ACO). To reduce energy consumption by nodes in mobile ad hoc network (MANET) and to make existing AODV protocol more energy efficient by better route discovery is the main purpose of this enhancement.

***Keywords*— Mobile Adhoc Network(MANET), ants, ACO, AODV, multipath, optimization, energy, network simulator.**

I. INTRODUCTION

A Mobile Adhoc Network (MANET) is a collection of wireless mobile nodes which form a temporary network without the use of any access point, centralized administration and infrastructure. All the nodes are supposed to have equal processing power. All nodes acts as routers and are capable of discovering and maintaining routes to propagate packets to their destinations. There is requirement to self configure the network by means of the cooperation among the mobile devices. Because there is not any pre installed fixed network infrastructure and configuration of wireless connections changes rapidly on the fly, the topology of network in MANETs keeps on changing frequently. Thus, achieving data communication among wireless nodes in MANETs with better QoS parameters has become a challenging task.

Figure 1.1 Mobile Adhoc Network (MANET)

The nodes in an ad hoc wireless networks are typically battery operated with a limited energy supply. How to conserve energy, maximizing the lifetime of its nodes and thus of the network itself is one of the most important and challenging issues in ad hoc wireless networks. As the routing is one of the necessary function in these networks, therefore developing power-aware routing protocols for ad hoc wireless networks has been an intensive research area in recent years.

Power Aware Routing must be considered in such a way that it minimizes the energy consumption while routing the traffic and thus minimizes the total power consumption of all the nodes in the network, minimizing the overhead etc. and thus, maximizes the lifetime of the network.

1.1 Ant Colony Optimization(ACO)

Ant colony optimization (ACO) technique is used for optimum route discovery in wireless networks. Ant colony optimization (ACO) routing algorithm is inspired from the behaviour of ants in nature and from the related field of ACO to solve the problem of routing in communication networks. The ability of certain types of ants to find the shortest path between their nest and a food source using a volatile chemical substance called pheromone is the main source of inspiration. Ants traveling between the nest and the food source leave traces of pheromone as they move. The ants prefers to go in the direction of high pheromone intensities. Since shorter paths can be completed faster, so the ants receive higher levels of pheromone earlier which attracts more ants which in turn leads to more pheromone. The complete process allows the colony as a whole to converge on the shortest path and forms the basis of most of the work in the field of ACO.

The ants are small control packets, in the field of routing that finds a path towards their destination and gather information about it. The artificial ants just like ants in nature, drops and follows pheromone. Pheromone released by ants is organised in the form of routing tables maintained locally by all the nodes of the network. The routing tables indicates the relative quality of different routes from the current node towards possible destination nodes. The decisions taken by ants based on these pheromone tables giving preference to routes of higher pheromone intensity. Following and updation of pheromones are often split between a forward and backward ant. Forward ants finds a path towards the destination and the backward ants travels back over the path to update pheromone tables.

For routing in MANETs, especially the properties of adaptivity and robustness are particulary interesting, so that ACO routing algorithms could form a possible solution to deal with the challenges found in such networks. However, the fact that these algorithms rely on the continuous generation of small ant packets to gather routing information can easily lead to excessive overhead in the bandwidth limited MANETs.

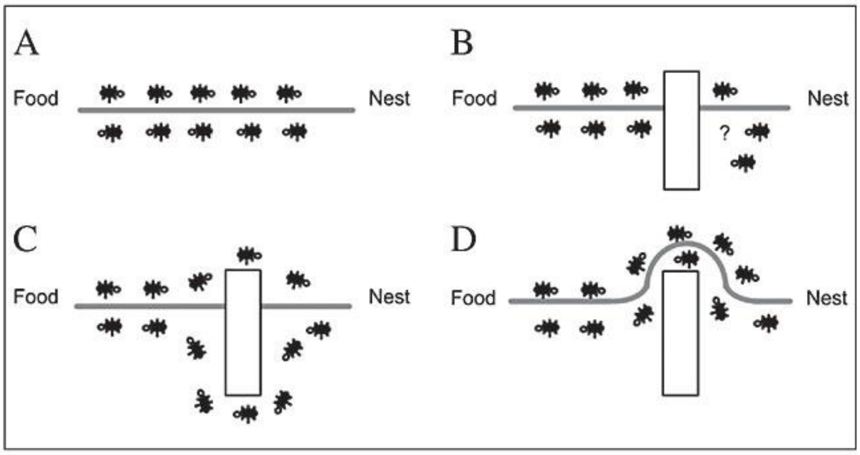

Figure 2. A. Ants in a pheromone trail between nest and food; **B.** an obstacle interrupts the trail; **C.** ants find two paths to go around the obstacle; **D.** a new pheromone trail is formed along the shorter path.

Figure 1.2: Ant Colony Optimization(ACO)

II. RELATED WORK

Ankur Jain et. al [1] implemented for improving quality QoS in MANET using Ant Colony Based Routing. The works done previously provide multi-path routing algorithm using pheromones scent as congestion measure. Mainly the shortest path is used by unknown on-demand protocols as their route selection measure which leads to congestion and link breakdown of most or some of the stations or nodes of the network. If during setup phase protocol doesn't cares for load parameters or conditions at the stations, in that case these protocols are not able to take profit of less loaded stations of network, Thus multipath routing using ACO done in this work can overcome the this problem and provides features of route failure protection and load balancing , average end-to-end delay and overall throughputs, successful packet transfer by distribution of traffic in between set of different paths or channels.

Pankaj Vidhate et. al [2] used Ant Colony Optimization for finding out best possible paths along with Genetic Algorithm that helps in giving the globally optimal solution from all the best possible paths which were produced by Ant colony optimization. The proposed algorithm(GA-API) overcomes the delay in packet delivery by producing the shortest path and also overcomes the problem of communication interruption due to node or link failure by finding multiple paths between pair of source and destination nodes.

Young-Min Kim et. al [3] proposed an ant colony optimization (ACO) which is based energy saving routing and referred to as A-ESR, for energy efficient networks. This proposed A-ESR algorithm firstly re-formulates the energy-consumption minimized network (EMN) problem, EMN is NP-complete, into a simpler one by using the concept of traffic centrality. then it solves the re-formulated problem by 1) letting the flow to autonomously be aggregated on some specific heavy-loaded links and 2) switching off the other light-loaded links. Simulation results shows that the A-ESR algorithm can get better performance than previous works in terms of energy efficiency.

Seema Verma et. al [4] attempts to modify the popular on demand routing protocol AODV to make it energy aware. The proposed algorithm also varies the transmission power between two nodes as per their distance. The protocols are simulated using Network Simulator (NS-2.34). The performance of both the protocols is analyzed under various conditions and the proposed scheme shows efficient energy utilization and increased network lifetime.

Bibhash Roy et. al [5] proposed a new QoS algorithm for mobile ad hoc networks. The proposed algorithm combines the idea of Ant Colony Optimization (ACO) with Optimized Link State Routing (OLSR) protocol to identify multiple stable paths between source and destination nodes.

P. Venkata Krishna et. al [6] proposed a quality of service enabled ant colony based multipath routing (QAMR) algorithm based on the foraging behaviour of ant colony for selecting path and transmitting data. The path is selected in this approach based on the stability of the nodes and the path preference probability. The authors takes hop count, delay, bandwidth as the QoS parameters along with number of hops path preference probability factors and the stability of node.

III. PROPOSED WORK

The main objective of our protocol is to maximize lifetime of the network which is critical in the mobile network since the death of small set of nodes can lead to the partition of the network, which renders the other live node unreachable. A new algorithm is proposed which provides a probabilistic multi-path routing algorithm and incorporates path pheromones scents which constantly update the goodness of choosing a particular path based on ant colony optimization. Also the energy consumption by the nodes in mobile adhoc network using existing AODV routing protocol is compared with energy consumption by the nodes using proposed AODV routing protocol enhanced with ACO.

IV. RESULTS AND DISCUSSIONS

4.1 Simulation Parameters

The table below represents the Simulation Parameters used in proposed work.

Simulation Parameters	
No. of nodes	10
Simulation Time	15 sec
Area	500m x 500m
Routing Protocol	AODV
Packet Size	500
CBR Connections	4
Initial Energy	2.5 joules/node
Idle Power	712e-6
Transmission Power	31.32e-3
Receiving Power	35.28e-3
Sleep Power	144e-9

Figure 4.1: Simulation Parameters

4.2 RESULTS

The table 4.2 given below shows the consumed energy and residual energy of mobile adhoc network using existing AODV protocol Vs consumed energy and residual energy of mobile adhoc network using proposed AODV using ACO.

	Existing AODV		Proposed AODV with ACO	
Node	Consumed Energy(E)	Residual Energy(E)	Consumed Energy(P)	Residual Energy(P)
0	0.471611	2.028389	0.469632	2.030368
1	0.468064	2.031936	0.467298	2.032702
2	0.4753	2.0247	0.470031	2.029969
3	0.477534	2.022466	0.472378	2.027622
4	0.47312	2.02688	0.473723	2.026277
5	0.482187	2.017813	0.479726	2.020274
6	0.481588	2.018412	0.479301	2.020699
7	0.482851	2.017149	0.479803	2.02017
8	0.483235	2.016765	0.480241	2.019759
9	0.482504	2.017496	0.480401	2.019599
	Total Consumed Energy = 4.77799		Total Consumed Energy = 4.75253	

Figure 4.2: Consumed energy and residual energy of MANET using AODV Vs Consumed energy and residual energy of MANET using AODV with ACO

The graph 4.3 below represents the comparision of energy consumed by nodes during transmitting or receiving of packets in mobile adhoc network (MANET) using existing AODV routing protocol and energy consumption by using proposed AODV routing protocol enhanced with ACO. The graph shows that the energy consumption by using proposed AODV routing protocol enhanced with ACO is less as compared to the energy consumption by using existing AODV protocol.

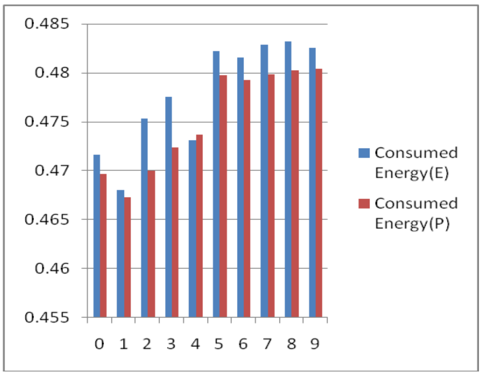

Figure 4.3: Consumed energy by nodes in MANET using existing AODV Vs consumed energy using proposed AODV enhanced with ACO

The graph 4.4 below represents the comparision of residual energy by nodes after transmitting or receiving of packets in mobile adhoc network (MANET) using existing AODV routing protocol and by using proposed AODV routing protocol enhanced with ACO.The graph indicates that the remaining energy of nodes using proposed AODV routing protocol enhanced with ACO is more as compared to the remaining energy of nodes by using existing AODV routing protocol.

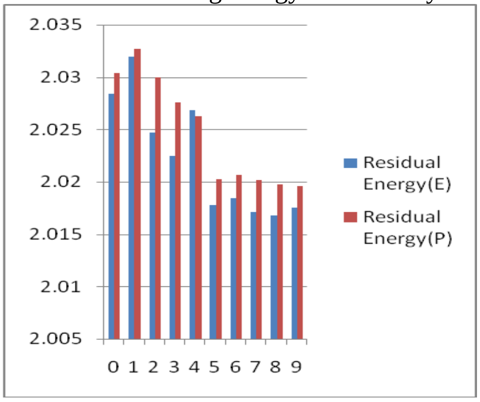

Figure 4.4: Residual energy of nodes in MANET using existing AODV Vs Residual energy using AODV with ACO

V. CONCLUSION

Enhancement of existing AODV routing protocol with ACO is successfully implemented by using NS2 simulator. Energy consumption by the nodes using existing AODV routing protocol and proposed AODV routing protocol enhanced with ACO are also compared. The simulation results shows that energy consumption in MANET using proposed AODV protocol enhanced with ACO is less as compared to energy consumption by using existing AODV protocol. Implementation of ACO in existing AODV protocol results in better network lifetime.

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