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# Analysis of Ant Colony Optimization Based Protocols in MANETs

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***Abstract— A Mobile Ad-Hoc Network (MANET) is a network which consist of collection of wireless mobile nodes and forming a temporary network without using centralized access points, infrastructure, or centralized administration. Due to limited transmission range these networks uses intermediate nodes to enable the communication between two nodes, so these networks are also called mobile multi-hop ad-hoc networks. It means mobiles nodes not only play as a role of host, but also play as a role of router and forwarding packets for other nodes. Routing is one difficult task in MANETs due to its dynamic nature, limited bandwidth and power energy. Ant Colony Optimization (ACO) is a branch of Artificial Intelligence that use the concept of Swarm Intelligence that show to be a good technique for developing routing algorithm for ad-hoc networks. ACO routing is a scheme which inspired by the behavior of real ants. In this paper we implement a new ACO based protocol SARA. Simple Ant Routing Algorithm (SARA) a new technique which aims at reducing the overhead, by using a new route discovery technique, based on the concept of Control Neighbor Broadcast (CNB). This algorithm overcomes the number of drawbacks of ACO so, it is exploited by researchers to solve routing problems in highly dynamic mobile ad hoc networks. Then we compare the result of SARA with the AntHocNet protocol on the four parameters average energy, throughput, delay and overhead. The result shows that the SARA protocol has more throughput and average energy and small overhead and delay as compared to AntHocNet protocol.***

***Keywords:- MANETs, ACO, SARA, AntHocNet.***

## I. INTRODUCTION

Mobile Ad-hoc Networks (MANETs) are communication networks in which all mobiles act as a nodes and communicate with each other via wireless connections. MANETs are infrastructureless networks and have no centralized control [1]. For communications between neighboring nodes to transfer packet from one node to other nodes are done directly, while the remote nodes are based on multihop wireless links. Mobile nodes in the network represents as hosts and also as source of data, destination for data and a forwarder of the data. Likewise they also behave as network router that discovers and maintain routes to other nodes in the network. There are no selected routers: all nodes can act as routers for each other and data packets are transfered from node to node in a multi-hop fashion [2].

Several protocols dealing with the problems of routing in mobile ad-hoc networks have been developed. These protocols may generally be categorized as (a) proactive or table driven and (b) reactive or on demand driven (c) hybrid protocols. In proactive routing protocols, the routes to all the destinations (or parts of the network) are determined at the start up, and the routes maintained by using a periodic route update process. In proactive routing protocol every node maintains the information about the other nodes in the tables. In reactive protocols, routes are determined when they are required by the source using a route discovery process. These type of protocols were designed to reduce the overhead encountered in proactive protocols by maintaining information for active routes only. It means that the routes are determined and maintained for the nodes that are required to send data to a particular destination. Hybrid routing protocols is a combination of basic properties of the two classes of flat routing protocols. That is, they act as both reactive and proactive in nature. Every group has a number of different routing strategies, which employ a hierarchical or flat routing structure. These type of protocols are designed to increase scalability by allowing nodes with close proximity to work together to form some sort of a backbone to reduce the route discovery overheads.

## II. ROUTIG IN MANETs

A routing protocol is the mechanism by which user traffic is directed and transported through the network from the source node to the destination node. Objectives include exploiting network performance from the application point of view, while minimizing the network’s cost accordance with its capacity. The application requirements are throughput, delay, hop count, loss rate, stability, jitter and cost. The network capacity is a function of available resources that reside at each node and number of nodes in the network as well as its density, frequency of end-to-end connection (i.e. number of communication), frequency of topology changes (mobility rate) [10]. The four core basic routing functionality for mobile ad hoc networks is:

- **Path generation**: It generates paths according to the assembled and distributed state information of the network and of the application; assembling and distributing network and user traffic state information.
- **Path selection**: It selects suitable paths based on network and application state information.
- **Data Forwarding**: It forwards user traffic along the select route forwarding user traffic along the selected route.
- **Path Maintenance:** It maintains the selected route.

Due to its characteristics, other desirable features of ad hoc routing protocol include- multiple routes selection, fast route establishment, energy/bandwidth efficiency and fast adaptability to link changes. Almost all routing systems respond in some way to the changes in network and user traffic state. However, routing systems vary widely in the types of state changes to which they respond and the speed of their response [11].

## III. ANT COLONY OPTIMIZATION

Ant Colony Optimization has been inspired from the self-configuring and self-healing nature of social ant behavior. Ants live on the ground, when ants move from one place to the other place they leave a substance in his way that substance is known as pheromone. When ant move from one place to the other place for search in food then ants leave pheromone trails, which can be followed by other ants on their way to search for food sources. Ants that happened to pick the shortest route to food will be the fastest to return to the nest, and will reinforce this shortest route by depositing food trail pheromone on their way back to the nest. This route will gradually attract other ants to follow, and as more ants follow the route, it becomes more attractive to other ants [7].

In a computer field, the pheromone has been replaced by artificial stigmergy, the probabilities value used in the routing tables. To determine and update the probabilities values, intelligent agents are introduced to replace the real ants. There are two type of agents used one is the forward agents and other is the backward agents. The structure of forward and backward agents have the same. The agents used the existing path to move inside the network by hopping at every time step from a node to the next node. To communicate with each other, agents used an indirect way by concurrently reading and updating the routing tables on their way [3]. ACO can be applied to large number of computer science problems and capable of finding feasible solutions.

## IV. SIMPLE ANT ROUTING ALGORITHM (SARA)

SARA is the improved version of ACO frame work. It reduces the overhead by using the new route discovery technique which is based on the concept of Control Neighbor Broadcast (CNB). The CNB allow SARA to control the packets flooding level in the network. Three complementary used in SARA first one is during the route discovery phase, second one is during the route maintenance phase and third one is during the route repair phase. In the first phase we use the CNB, in CNB every node broadcast a control message (FANT) to its all neighbors, but only one node from all the nodes can broadcast this message again. The selection of node responsible for re-broadcasting the FANT. SARA use the probabilistic approach to select the different node at each stage to generate FANT. With this, it is possible to maximize the number of discovered paths. In second phase by using the data packets to refresh the path of active session we can reduce the overhead. It keep the information about active routes updated, by adjusting the pheromone level. The link which is used for more times have highest pheromones level, while the unused link have the lowest pheromone level. In last phase, i.e route repair we can enhanced the route by using the deep search procedure (DSP) as a way of restricting the number of nodes used to recover route. The broken link is detected due to node being turned off or by failure in radio coverage or congestion that be a reason of higher number of collision. In MANETs these kind of situations may occur commonly, thus route repair procedure must be quickly executed with low overhead. So, rather than searching a new path from source to destination, we start to establish a route by trying the discovery of a new path between the two end nodes of the broken link [5].

## V. ANTHOCNET

AntHocNet is a hybrid ACO based routing algorithm. It is reactive because a node only starts gathering routing information for a specific destination when it desires to communicate with the destination and no routing information is available. It is proactive because when the communication starts the nodes proactively keep the routing information related with network changes for both traffic and topology. The algorithm tries to find paths characterized by minimal number of hops, low congestion and good pheromones [4]. AntHocNet is a routing algorithm that pursues multiple paths simultaneously. As in AntNet and AntNet-FA, ant-like agents roam in the network seeking routing information; however they are dispatched reactively when a source node wants to start communication with the destination node. The quality of a path is quantified as the inverse of the cost that is the number of hops travelling from the source to the destination, and it is expressed as the pheromone value. When a source node wishes to start a communication session to a destination node, then the source node checks whether there is a route from the source to the destination. When there is one, the source node simply uses it; when there is not, the source node must discover a route to the destination. The source node creates an ant-like agent called reactive forward ant, to explore the network to seek the route. The reactive forward ant collects the route information as well as looking for the route. When an ant agent reaches the destination node, it becomes the backward ant, and travels back to the source node. Along the path, the backward ant updates the routing tables based on the route information collected by the reactive forward ant. Data packets are probabilistically distributed into several paths. This is accomplished by probabilistically selecting next node to transmit based on the pheromone value at each intermediate node.

Even the transmission route is established from the source node to the destination node and the data communication session started, the source node does not remain passive. It creates other ant-like agents called proactive forward ants and distributes them into the network. These proactive forward ants move from node to node based on the pheromone value, and monitor the quality of the route. From time to time, an intermediate node broadcasts additional proactive forward ants to explore new routes to the destination.

There are a few improvement proposals to AntHocNet. A notable one is Fuzzy Logic Ant Based Routing (FLAR) studied from M.M.Goswami et al. [12]. FLAR has integrated fuzzy logic into AntHocNet. In MANET environments, route failure management is a challenge because of the node mobility and rather narrow bandwidth. Mirabedini et al. proposed an adaptive fuzzy ant-based routing algorithm that combines ACO and the fuzzy logic technique to cope with the route failure problem.

## VI. RESULT AND DISCUSSION

To implement the SARA and AntHocNet protocol we use the NS 2.35 simulator on Ubuntu operating system. For getting the result we use the 30 number of nodes which placed randomly in the area of 1100x1100 and simulation time is 15sec. We analyses and implement SARA and then compare the result of SARA with the AntHocNet protocol. We compare the result on the basis of throughput, overhead, delay and average energy. Fig 1 show that the throughput of SARA is same at the starting time but it sharply increase after some time. The throughput of SARA more as compared to AntHocNet protocol. Fig 2 show average energy of the SARA protocol is also more as compared to the AntHocNet protocol.

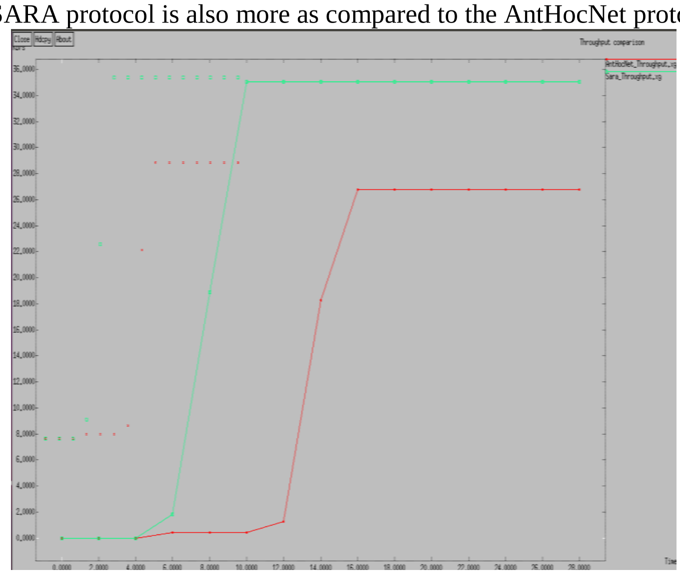

Fig 1 Graph shows the comparison on the basis of throughput.

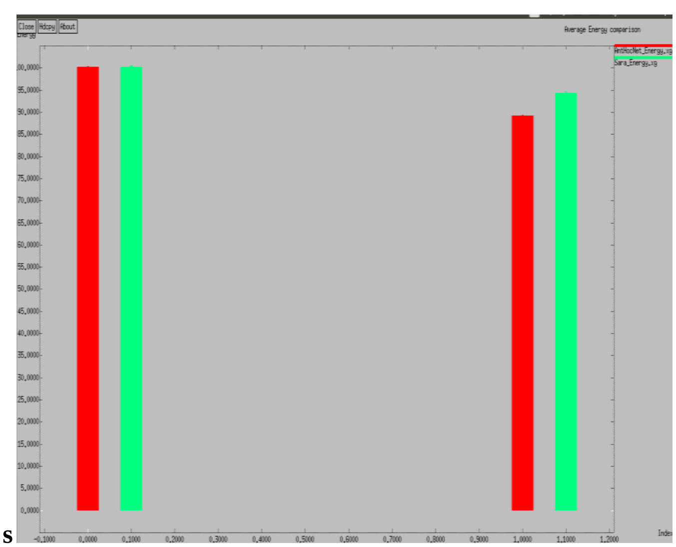

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Fig 2 Graph shows the comparison on the basis of Average Energy.

 

Fig 3 and Fig 4 shows the comparison on the basis of overhead and delay. It shows that the overhead of SARA protocol is small as compared to the AntHocNet protocol. Fig 4 shows that the packet delay of AntHocNet protocol is more as compared to SARA protocol.

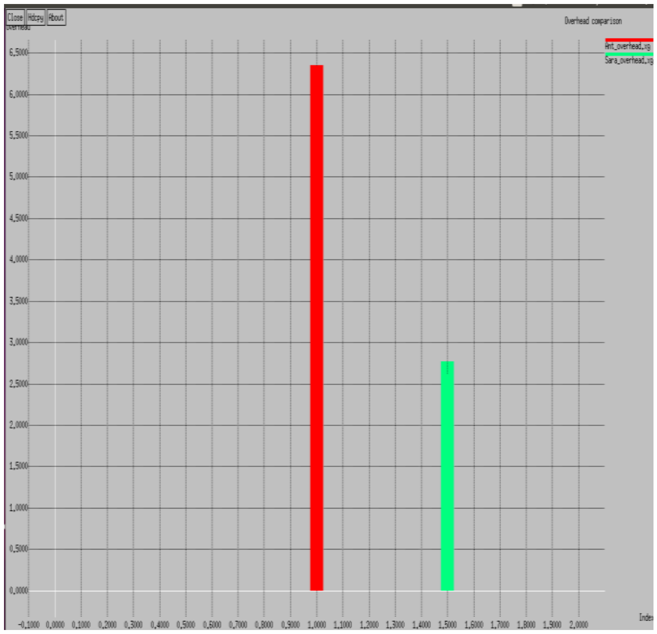


Fig 3 Graph shows the comparison on the basis of overhead.

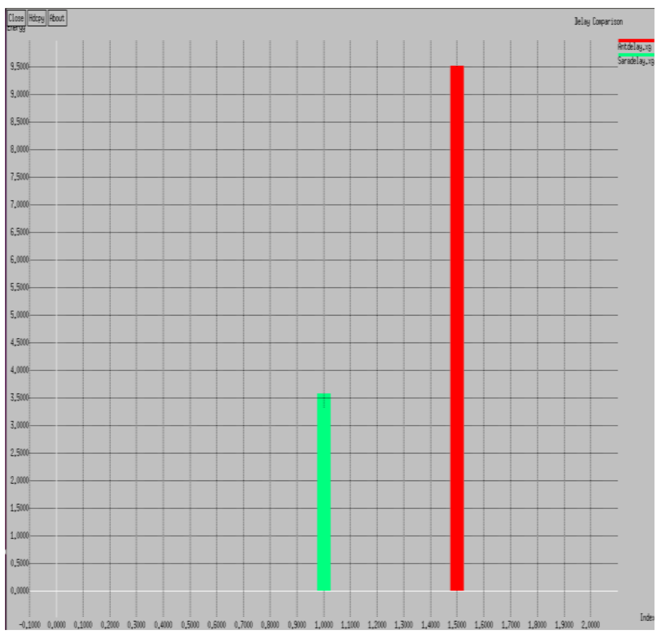


Fig 4 Graph show the comparison on the basis of Delay

## VII. CONCLUSION

With the results of trace graphs show that the overhead and delay is small in SARA protocol as compared to AntHocNet protocol. On the other hand the throughput and average energy of SARA is more as compared to AntHocNet protocol. It is found that SARA over AntHocNet on the basis of throughput, packet delay, average energy and overhead SARA is a better protocol.

For future work, it is intended that an evaluation about the behavior of the pheromone variation will be performed and a correlation of these studies with the network state will take place. By extending the concept of pheromone diffusion, more information about possible path improvements will be available in the nodes, and this information can guide proactive ants. This should lead to better results with less overhead. An experimental setup is also envisaged, using small and mobile robots.

 

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