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Weighted Clustering Algorithm with Ant Colony Optimization to Provide Better Quality of Service

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Abstract—**The rapidly changing topology of Mobile Ad hoc networks (MANETs) poses various challenges like routing, Quality of Service (QoS) etc. This paper attempts to compare performance parameters like throughput, packet delivery fraction and packet loss using Ad hoc On-Demand Distance Vector(AODV) routing protocol and Ant Colony Optimization(ACO). The proposed method combines Weighted Clustering Algorithm(WCA) with ACO. The performance characteristics analysis of the proposed system is compared with the method of combining WCA with AODV.**

Index terms: **MANETs, QoS, Cluster, WCA, AODV, ACO**

I. INTRODUCTION

From communicating in battle fields to free internet sharing, MANETs are increasingly finding their application in a wide spectrum of information interchanges.

MANETs are a network of self configuring mobile devices that communicate with each other with the help of wireless (IEEE 802.11). MANETs are rapidly deployable infrastructure less networks. They have extremely dynamic topologies that make routing in MANETs a challenge. Several algorithms are available for routing data in MANETs such as Temporally-Ordered Routing Alogotithm(TORA), AODV, Dynamic Source Routing(DSR), Open Shortest Path First(OSPF) etc.

Another area of concern is achieving optimal QoS in MANETs. Several techniques have been proposed to improve QoS, chief among them are clustering, resource reservation, traffic classification, buffer management and admission control. Simplicity of deployment and a significant improvement in QoS make clustering the most popular technique to enhance QoS of the network. A plethora of clustering algorithms is available to choose form like, highest degree-based, lowest id, K-CONID, WCA etc

ACO is one of the best algorithms for path finding. They derive their inspiration from the real world behavior of ants and the method they use for finding food. When an ant moves along a path, it deposits a chemical called pheromone on it. As more and more ants move along the same path, the pheromone concentration of the path increases. The path with the maximum pheromone concentration is then chosen to be the optimal path.

The goal of this paper is to study how ACO optimizes the performance of a MANET clustered using the WCA and compares it with a MANET that makes use of AODV for routing.

II. BACKGROUND

Clustering is the process of building hierarchies among nodes in the network. Clustering is one of the techniques that provide a solution to challenges like routing and QoS in MANETs [1]. This technique makes network more manageable by grouping the nodes into clusters. The size of each cluster varies from two nodes to n nodes; where n is controlled by the radio transmission power. Each cluster comprises of a Cluster Head (CH), Cluster Gateway (CG), and Cluster Members (CM). Clustering consists two phases: Cluster head election and cluster member registration.

WCA algorithm considers several parameters like mobility, transmission power and degree difference in order to perform clustering and elect the cluster head. A pre-defined threshold which indicates the number of nodes each cluster head can ideally support is used to prevent the cluster heads from becoming over-loaded. WCA selects the cluster heads according to the weight of each node. The node with the minimum weight is elected as the cluster head. A cluster head has extra responsibilities and hence expends more battery power than an ordinary node in the network. The cluster head election algorithm concludes once all the nodes become either a cluster head or a member of a cluster head. This algorithm is both mobility and scalability aware [2].

Cauvery N.K et.al proposes an algorithm that uses swarm intelligence to generate all possible paths between a source and a destination node in a MANET. In this algorithm, routing of data packets are done only via the optimal path generated by route discovery phase of the Ant colony based Routing Algorithm (ARA). Route maintenance is periodically done to retain the optimal path using data packets. Due to the dynamic topology of ad hoc networks, existing routes may fail or new paths may be generated. Thus, in order to adapt to the changes in topology, route refreshing is done periodically [3].

An optimized clustering strategy that deploys ACO meta-heuristic technique proves to be an efficient in terms of number of re-affiliations, throughput, delay and load balancing [4].

III. Algorithm

A. WCA

Weighted Clustering Algorithm considers four parameters to perform the clustering and choose the cluster head. It assigns arbitrary weights w1, w2, w3, w4 to each of the four parameters such that:

$$w_1 + w_2 + w_3 + w_4 = 1.$$

The equation to calculate the weight of each node (Wv) is:

$$W_{v=} w_1\Delta_v + w_2 D_v + w_3 M_v + w_4 P_v$$

Δ_v is the degree difference. The degree of each node is determined and is represented as d_v. Then, the degree difference is calculated as $|d_v - \delta|$, where δ is the threshold value. The threshold value is the no. of nodes that a cluster head can ideally handle. D_v is the sum total of distances from a given node to all its neighbors. M_v is the mobility measure which is calculated as the running average speed of every node during a specified time T. P_v is the time period during which a node remains as cluster head and is an estimate of the amount of battery power consumed.

AODV is one of the widely used algorithms for routing in MANETs. In this paper, we compare two scenarios. Both scenarios use WCA clustering algorithm to group nodes and nominate the cluster head. In both cases, the source node communicates with the cluster head by unicast. If a cluster head has the destination as its member, then, it broadcasts the message to all its cluster members. This is done in order to conserve resources that would otherwise be expended in path finding.

B. ACO

ACO is a table-driven routing protocol which uses swarm intelligence for route discovery. The basic principle of the ant routing algorithm is that the ants deposit hormone called the pheromone, when they roam looking for food. Ants navigate by smelling the pheromone and follow the path characterized by strong pheromone concentrations. The same pheromone trails can be used by other ants to find the location of the food sources discovered by their nest mates [5]

The two main phases of ACO algorithm are: Route Discovery, Route Maintenance.

1) Route Discovery:

The source node initially checks its routing table for a path to the destination node. The routing table consists of destination address, next hop and pheromone value. If it finds a path i.e. address to the destination, it sends its data packets through the established path. Otherwise, it initiates the flooding of Forward Ants (FANTs) to its neighbors. The FANTs deposit pheromone on the path links. The neighbors update their routing tables and relay the FANTs to their neighbors. The node interprets the source address of the FANT as destination address and the address of the previous node as the next hop, and computes the pheromone value depending on the number of hops taken for the FANT to reach the node. When different FANTs reach the destination through different routes, the destination sends a Backward Ants (BANTs) for each of them by incrementing the pheromone value. When the sender receives the BANT from the destination node, the path is established and data packets can be sent.

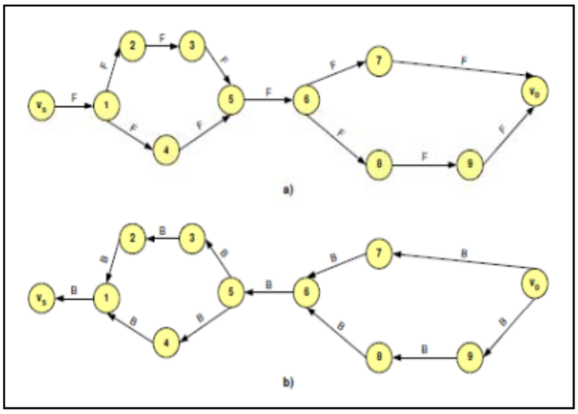

Figure 1: Route Discovery Phase of ACO

In the Figure 1 a) A forward ant (F) is sent from the sender (v_S) to the destination node (v_D). The forward ant passes by other nodes which initialize their routing table and pheromone values. In Figure 1 b) the backward ant (B) has the same task as the forward ant. It is sent by the destination node (v_D) to the source node (v_S).

2)Route Maintenance:

ACO does not need special packets for route maintenance. Route maintenance is done by the regular data packets with the help of pheromone tracks established between the source and destination nodes. When a node vi relays a data packet to destination vD to a neighbor node vj, it increases the pheromone value of the entry (vD, vj, φ) by Δφ, i.e. this path to the destination is strengthened by the data packet. Likewise, the next hop vj increases the pheromone value of the entry (vS, vi, φ) by Δφ, i.e. the backward path to the source node is also strengthened. The evaporation process of the real pheromone is modeled by decreasing the pheromone values [6].

Pseudo Code of the ACO algorithm

```
Initialize Trail
Do While(Stopping Criteria Not Satisfied) – Cycle Loop
  Do Until(Each Ant Completes a Tour) – Tour Loop
      Local Trail Update
  End Do
  Analyze Tours
  Global Trail Update
End Do
```

ACO has following characteristics

- ACO provides network adaptive feature and generates multiple path for routing.
- ACO is capable of adapting for change in network topology and traffic while giving equivalent performance.
- It relays on both passive and active information for gathering and monitoring. They collect non local information about the characteristics of solution set, like – all possible paths.
- It makes use of stochastic components. It uses stochastic component like pheromone table for user agents. User agents are autonomous and communicate each other through stigmergy.

- It sets path favoring load balancing rather than pure shortest path. The algorithm also supports for multiple paths, so that load balancing can be achieved.
- Multipath routing - Possible to generate multiple paths between pairs of nodes.
- Fast route recovery - If optimal path fails, then packets can easily be sent to other neighbors by re-computing next hop probability, i.e., choosing second best path.
- Distributed and fault tolerance – ACO algorithm are inherently distributed. There is no centralized control mechanism, so if any node or link fails, there is no heavy loss.
- Scalability and adaptation– Population of ants may change based on the size of network. The agents may die or reproduce, with little effect on performance.
- Speed – Change in the network can be adapted very fast.

IV. Simulation Study

In this section, two scenarios of experiments have been conducted over simulation using NS2 as a simulation tool.

In scenario 1, WCA is used as cluster based leader election algorithm and the source cluster head uses AODV as the routing protocol to multicast the message to all other cluster heads. A diagrammatic representation of the scenario is shown in Figure 2.

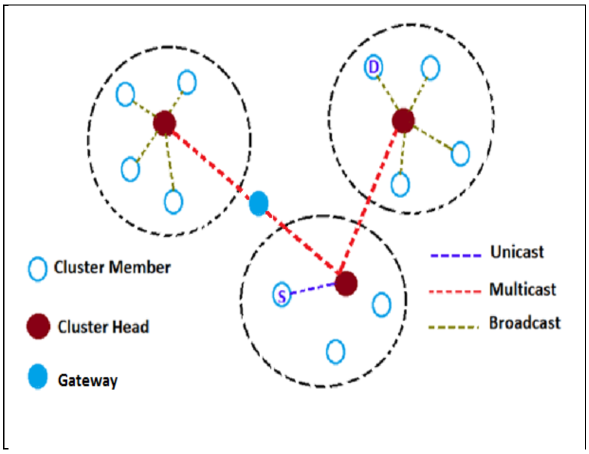

Figure 2: Representation of the mode of communication

Cluster gets created and cluster head is elected by using WCA as a cluster based leader election algorithm. 'S' is the source and 'D' is the destination. 'S' communicates to cluster head through unicast. Cluster head uses AODV protocol to communicate with the other cluster heads or the gateway. Cluster head of the destination node broadcasts within its cluster.

In scenario 2, WCA is used as a cluster based leader election algorithm. For further enhancement of QOS, i.e., to discover the optimum path and to hasten the route discovery process, ACO protocol is used for communication between cluster heads.

Cluster is created and cluster head election is performed using WCA. When source wants to communicate with the destination, it sends information by unicast to its cluster head. The cluster head of the Source node then tries to find the cluster head where the destination node is present using ACO.

Table 1 is the table with simulation parameters applicable for both the scenarios.

TABLE I
Simulation experiment details

Sl. No.	Parameters	Value
1.	Simulator	NS2(Version 2.34)
2.	Channel Type	Channel/Wireless
3.	Radio Propagation Model	Propagation/Two Ray Ground Wave
4.	Network Interface Type	Phy/Wireless Phy
5.	MAC Type	Mac/802.11
6.	Interface Queue type	Queue
7.	Link Layer Type	LL
8.	Antenna	Antenna/Omni Antenna
9.	Maximum Packet Size(in Bytes)	1024
10.	Topology Area(M*M)	800x800
11.	Simulation Time in seconds	40
12.	No. of Nodes	16
13.	Routing Protocols	AODV, ACO

Simulation results to calculate throughput for Scenario 1 and Scenario 2 depicted in Figure 3

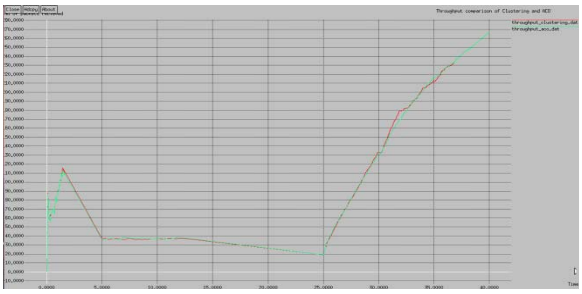

Figure 3: Throughput comparison of cluster head communications with AODV and ACO

Simulation results to calculate Packet loss for Scenario 1 and Scenario 2 depicted in Figure 4

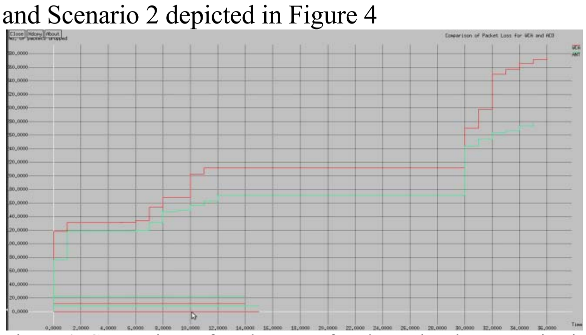

Figure 4: Comparison of Packet Loss for cluster head communication with AODV and ACO

Simulation results to calculate Packet Delivery Fraction (PDF) for Scenario 1 and Scenario 2 depicted in Figure 5

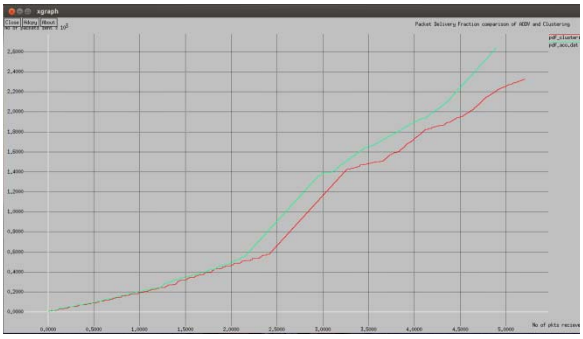

Figure 5: Comparison of PDF for cluster head communications with AODV and ACO

V. CONCLUSION

This work modifies AODV to improve its performance using ACO. The ACO protocol incorporates path accumulation during the route discovery process in AODV to attain extra routing information. It is evident from the results that ACO improves the performance of AODV under conditions of high load and moderate to high mobility.

REFERENCES

[1] Sowmya K S, Dr. N K Cauvery ,"Clustering Technique for load balancing in MANETs", *International Journal of Mobile & Adhoc Network*, Vol 2, Issue2, May 2012.

[2] Ratish Agarwal, Dr.Mahesh Motwani, "Survey of clustering algorithms for MANET", *International Journal on Computer Science and Engineering*, Vol.1(2), 2009, 98-104

[3] Cauvery N. K., and K. V. Viswanatha, "Enhanced Ant Colony Based Algorithm for Routing in Mobile Ad Hoc Network ", *World Academy of Science*, Engineering and Technology 2008

[4] Kumar. V and Balasubramanie. P, "Ant Colony Optimization Using Hierarchical Clustering in MANETs ", *European Journal of Scientific Research*, ISSN 1450-216X,Vol.61 No.4(2011)

[5] Sowmya K.S, Rakesh T., Deepthi P Hudedagaddi, "Detection and Prevention of Blackhole Attack in MANET Using ACO", *IJCSNS International Journal of Computer Science and Network Security*, VOL.12 No.5, May 2012

[6] Mesut G¨unes¸, Martin K¨ahmer and Imed Bouazizi, "Ant-Routing-Algorithm (ARA) for mobile multi-hop ad hoc networks new features and results", *Proceedings of the Med-Hoc Net Workshop*, June 2003