DOI : https://doi.org/10.56452/113

ISSN: 0974-5823 Vol. 7 (Special Issue 5, December 2022)

International Journal of Mechanical Engineering

Comparative Study on Location Aided and Cluster based Ant Colony Routing Protocols in MANETS

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Abstract:

Mobile Ad hoc Networks, or MANETs, are made up of wireless mobile devices and are self-configuring networks with no infrastructure. These characteristics make routing challenging in these networks. The creation of highly effective routing protocols for MANETs is a difficult task since the protocols must satisfy a number of criteria, including low latency, robust packet delivery ratio, including efficient network topology adaption with minimal network load. Academics have been paying special attention to swarm intelligence-inspired algorithms because they provide concrete solutions that match the requirements The Ant Colony Optimization (ACO) method, which is an effective example of swarm intelligence, has been utilised to harmonize the various routing demands in MANETs. A comparative examination of location aware and cluster based ACO routing methods in MANETs is presented in this research. 1) Implementation of current location aware and cluster based ACO based protocols is one of the paper's primary contributions. 2) Examining the drawbacks and benefits of the current approaches and determining the optimum method for developing a new automated routing technique.

Keywords: *Mobile Ad hoc Network's, Ant Colony Optimization, Swarm Intelligence etc.*

I.INTRODUCTION

Mobile Adhoc NETworks (MANETs) were made up of portable devices that communicate wirelessly. In MANETs, communications are cooperative and multi-hop. Anywhere at a time, nodes might enter or exit the network.Characters aren't created or shared for profit or commercial gain, and features like the lack of infrastructure and versatile topology necessitate self-configuration, self-optimization, & self-healing.Over past years, methods influenced by the environment have been proposed to construct these self-organizing systems.Most biological systems' behaviors are discovered to be built upon simple general principles which give effective collaboration strategies for executing tasks without the need for an outside centralized organization [10].

One of the most important functions of communications networks is routing.They concentrate upon this paper in the context of self-organizing MANETs.Navigating on MANETs was difficult due to the features of these networks.The transmission of massive routing tables and the continually altering topologies are two of such issues [40]. As a design model for new networking in self-organizing but also dynamical ad hoc systems, ACO techniques have attracted a lot of interest. This feeding behavior of ants in nature influenced ACO.Swarm intelligence (collective behavioral) techniques are used to address difficult static and dynamical optimization issues.Various ACO-based routing methods were presented to accomplish effective routing in MANETs.Bio-inspired ACO-based routing methods were highly efficient than standard routing systems.These methods are also used in a variety of other fields, including protein folding, features selection, graph color, & scheduling [37].

II.LITERATURE SURVEY

In this part, we covered through the above-mentioned MANET and VANET protocols. The document shows the stable development of ACO transmission algorithms with GPS-enabled location information [26]. POSTAN [20] was the first reaction protocol for MANETs to reduce the delay in liver communication, as D. Kadono et al. [19] Using resilience-based road building in conjunction with breakdown predictions. Many academics have been inspired by the success of MANET implementation.

MAR-DYMO [5] had previously been proposed as the initial VANET-compliant ACO-based method. It ensures the connection's quality as well as its stability. Scientists are focusing on two primary network management strategies in

VANETs, in addition to the original ACO-based approach: region-based and cluster architecture. The first ACO-based routing method to partition a network into scalable sections is MAZACORNET [33]. It employs an active approach and an inter-area response mechanism to locate a path in the region. The communication processes are clearly stated, however the development and administration of the region are confusing.

S. Balaji et al. [2] developed a hierarchical cluster approach as an alternative in order to cut down on the number of traffic controller packets. However, this doesn't describe how connections work both inside clusters and outside them after autoclaving. ACO-based routing algorithms in VANET has been a major topic of discussion during the last several years. They are able to establish connections with a variety of devices, including Road Side Units and V2V communications.

Ant colonies were one of the first places where J. Amudhavel et al. [39] developed the use of iterative optimization. They split the journey into components, each having one or more RSUs. The shortest route on each subway is then determined by comparing the number of RSU repetitions and, lastly, the combination of them. However, no simulated experiments are provided in this article. Many concerns remain unresolved, such as preventing the best local for each subway. S-AMCQ [11] overcomes several routing difficulties. It addresses both QoS constraints and security concerns. As a result, it assures the VANET's dependable and steady functioning. Generally, the ACO location routing protocol is well-developed and has promising future applications in both MANET and VANET.

The first ant-based approach to react towards the MANETs On-demand (DYMO) protocol for dynamic routing is said to have been developed by Correia et al. [5]. The purpose of this research is to use vehicular data to make sound driving decisions in the VANET. This method uses mobility and position to sustain the pheromone since it is based on the ACO algorithm. The proposed technique was tested using NS2 [18] with Vehicle Network Moment Generation (VNMG) [30]. The performance of AODV [32], DYMO[35], as well as Ant-DYMO [24] was evaluated using performance metrics such as statistics indicate ratio, end-to-end delay, overall cost-effectiveness.

H. Rana et al. developed an ant-based route algorithm that employs the idea of area in [33]. It use the ACO to discover various pathways between nodes and reduce connection failures. Furthermore, it separates the networks into zones for scalability. They utilise proactive ways to locate local routes & inter-regional reactive strategies to cut pollution and congestion. The GPS [26] provides location information at MAZACORNET[5].

Eiza et al. [11] developed QoS restriction method (S-AMCQ) based on Secure Ant that considers both QoS constraints and security considerations. The ACO method is used by S-AMCQ to determine feasible pathways that match several QoS restrictions imposed by the kind of data traffic in the MANET relationship. Furthermore, the S-AMCQ is intended for V2I communications.

III.1 THE BACKGROUND OF ACO

III.1.1 Ants in nature

More than 100 million years ago, ants developed from wasp-like predecessors [34].There are about 8800 kinds of insects currently known [17], and they may be found practically anywhere on the planet. Ants are well-known eusocial insects in ecology. Although that extent of an ant colony could range from just several dozen through millions, practically most insect colonies contain "drones" and "queens," or reproductive men and females.Additional castes, like "workers" and "soldiers," may exist in a big ant colony, and are generated by sterile, wingless females.Every ant caste in the colony has a distinct role, and all of those ant classes appear to collaborate to maintain the colonies [31] [12].

Ant colonies are super organisms with a labour specialization. Ants have a remarkable capacity to tackle complicated issues, like managing with floods, thanks to their group intellect. Ants have been discovered to be able to join individual bodies to create self-assemblages [1]. Fire ants, for example, may build rafts to help them survive floods. When a fire ant colony gets inundated, ants create live rafts out of their bodies. The lowest level of the floating rafts is made up of "workers" from the colonies who stretch themself flat over the water's surface & link with one another via their feet and mandibles.The remaining colony members board the live rafts, and the colony as a group floats ahead until it reaches a dry location [27]. Thousands of ants can reposition themself in 200 seconds to form a two-layer sturdy raft, according to the findings.

Furthermore, ants can hang on to each other on a raft with the force 400 times its original mass.P.C. Foster et colleagues. started an attempt to figure out how ants create self-assemblages in three-dimensional systems in [13][25].Many findings by many experts demonstrate that such ant self-assemblages can aid them in fast reacting to their surroundings and surviving under difficult situations.Ant swarms perform comparable duties to those performed by human civilizations, but ants offer and sustain these activities without the need for centralized management.As a result, knowing how ant colony functions have long been a fascinating area of research.

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III.1.2 From natural to man-made ants

There has been a tremendous amount of study done on ants.P. Grass presented one of the first investigations in 1959.He studied the behavior of termites when it came to constructing nests & proposed a concept that explains it [15]; F. Mayson and B. Manderick researched ant self-organization in the 1980s [29]. Following up on the research of ant communal behaviour in [14].

M. Dorigo suggested the very ant colony technology in his research as in early 1990s [7]. M. Dorigo, in partnership with L. However, several additional academics investigated the topic and created other common ACO algorithm modifications [8]. C. Blum et al. [3] proposed the HC-ACO (hypercube architectural of ant colonies optimization) a year ago. The capacity of ACO to respond to dynamic changes within its networks and deliver positive feedback contributed in the rapid identification of successful solutions. Moreover, the ants can distinguish many trails at once and calculate pheromone levels simultaneously [9]. The quantity of Ant automated process apps has increased since the mid-1990s. As a consequence, many efficiency measurements have improved in MANET.

III.2. COMPARISON OF ACO ROUTING ALGORITHMS FOR LOCATION - BASED SERVICES IN MANETS

When using the ACO routing protocol in real implementations, the position of the node is critical information. Proper usage of location data has become practical, particularly now that the GPS [26] was widely used and mobile phones are outfitted with such.

III.2.1 POSANT

POSANT [20] is a MANET-based initial location awareness multipath reactive ACO protocol that attempts to reduce message delivery latency. The node of source transmits one FANT to each region upon demand during route finding. Furthermore, POSANT expects that each node has access to a tracking system to obtain the destination's current position. Because When a group of packets of data has to be transported from a source nodes S toward a destination host D, POSANT simply looks for a route. After creating a route from S to D, information packets would begin to be transferred. Previously, only forward and backward ants were traded.To reduce the amount of period it takes POSANT to choose a path whilst limiting the quantity of created ants to a minimum, by adding the idea of zones, information about the positioning of networks was employed as a heuristic’s element.

Zone Definition: Consider a networking graph G & a target node D. They split all of each node S's neighbors (not just the main nodes) into three zones: zone1, zone2, and zone3.Consider the S to D segment of a line.

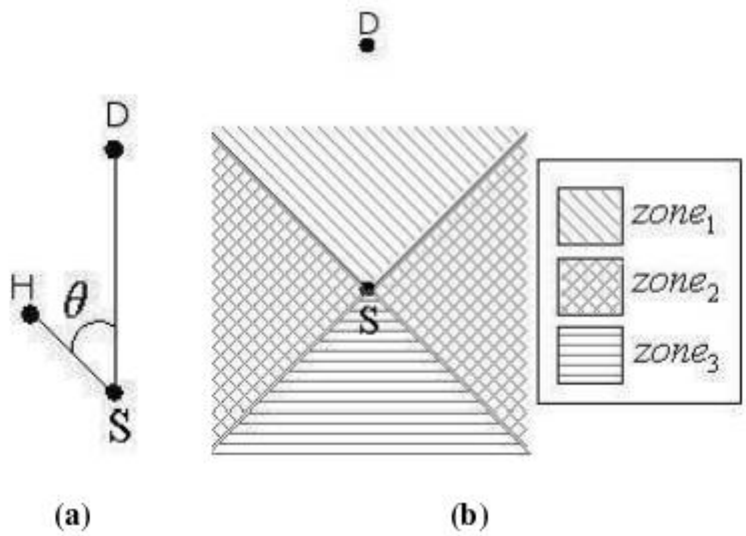

Fig 3: (a) is the angle formed by the two points SH and SD.

(b) At target nodes D, various zones of N.

As indicated in Figure 1, Zone 1 contains node H if $\theta H \leq \pi/4$, zone 2 contains H if $\pi/4 < \theta H < 3\pi/4$ and zone 3 contains H if $3\pi/4 \leq \theta H \leq \pi$. Each POSANT node is said to keep a database on the quantity of pheromones trail allotted to its outgoing connections to different targets. When a node receives a package from a certain species, it checks its table to see whether this place contains at minimum one pheromones.If a pheromones track occurs, it would be implemented to make a probabilistic judgment on the next hop (more on that later). If that does not exist, the pheromones production procedure starts, which allocates pheromone trails to all external connections in a following sequence:

Pheromone Initialization: The pheromones trail is created for each of a node's outbound connections, such as A. Assume B is one of A's neighbors. We start the pheromones on AB with a selfish strategy of reducing the amount with the zone numbers. If B belongs to A's zone I, the three pheromones activation variables v1 ≥ v2 ≥ v3 viwould be given to AB.

The reason for this is that in most circumstances, this shortest path travels through nodes that are nearer to the destination's directions.As a consequence, almost all of the moment, such aggressive start promotes a higher converging to the smallest route.The values of v1, v2, and v3have a substantial influence on the effectiveness of POSANT, according to our studies.As previously stated, the number of pheromones placed on each connection is determined by the zone of the associated neighbor.If a node does not receive any packets referring to a species location for more than a specie period, which is refused to be in the order of seconds, the pheromones trails for that specie destinations will be erased from the node's pheromones trail table.Also eliminated would be the items in a Back Routing (BR) database which were relevant to which destinations. The BR table is discussed further on.

Route establishment: Assume there are two nodes: a source node S and then a destination node D. S sends n forward ants with distinct sequencing values from each area at regular intervals to create the path. In our tests, we used a value of 1 for n.Assigning a big number to n raises the algorithm's cost without improving it significantly. A forward ant chooses the following hop at every node using a probabilistic decision depending just on the sizes of pheromones trails, similar to prior ACO navigation algorithms Assuming a forward ant is now at node N, that has k neighbours H1, H2, and Hk, and I is the pheromones provided to NH~ i. With a probability pi determined using a preceding calculation, an advancing ant would choose Hi for the following node.

$$p_i = \frac{\phi_i}{\sum_{j=1}^{k} \phi_j} \quad (6)$$

Each node also keeps the BR tables in addition to the pheromones trace tables mentioned above.When an advancing ant reaches a node that belongs to any of the neighbors, the BR table records the identifying of both the advance ant's neighbor, the ant's sequencing numbers, and the identity of the targets. Advanced ants that attack on a regular basis will be exterminated. A forward ant is destroyed when it accomplishes its objective, but a backwards ant is restored to the centre. Since it has the same routing information as a forward ant and consumes the very same information from it's own BR databases, it takes the same path to the origin. In order to enhance the quantity of pheromones on AB, a backwards ant performs the following computation as it moves from node B to node A.

$$\phi_{\vec{AB}} = \phi_{\vec{AB}} + g(d) \times \omega(\vec{AB}) \quad (7)$$

The size of the backward ant's journey path from a target to node B is denoted by d, and g(d) is a decreasing function of d in the equation above. B's zone determines the values of function ω, which is a weighted feature:

$$\omega(\vec{AB}) = \begin{cases} w_1 \geq 1 & \text{if B is in } zone_1 \text{ of } A \\ w_2 = 1 & \text{if B is in } zone_2 \text{ of } A \\ w_3 \leq 1 & \text{if B is in } zone_3 \text{ of } A \end{cases} \quad (8)$$

In many circumstances, using the aforementioned weight function results in quicker closure since the shortest route generally travels via nodes that are closer to the goal. The volume of pheromone deposited in each connection decreases over time due to evaporating. The current pheromones value is multiplied by a number α < 1 at frequent intervals to achieve this.

$$\phi(\vec{BA}) = \alpha \times \phi(\vec{BA})$$

Some ants will sometimes adopt non-optimal paths to reach their goal, especially early in the route creation process. The influence of these non-optimal pathways is reduced by pheromone evaporation. The previously described stochastic approach generates several paths between the origin and the target. As a result, POSANT is a multi-path route technique, as opposed to other position-based route techniques, which discover a single path to the destination. One benefit of multipath routing was that it reduces the likelihood of network congestion. Transmitting data packages rather than control packets: It's critical to begin sending information sessions rather than control messages at the right moment. If we send them too soon, they may get lost or take a longer journey, increasing network load.

Sending them late, on the other hand, lengthens the time it takes to transfer data packages.To determine the ideal timing to begin transferring data packets, we do the following calculations. Using the number of hops, the sender computes the Mean and SD of a delay provided by backward ant. As a consequence, every backward ant remembers the size of the trail from where it is now to where it wants to go.When the initiator acquires a backward ant, we used the delay indicated by this ant to increase the mean & standard deviations of package latency for such related areas.To reduce the effect of older backward ants, researchers deny a fixed size frame for every area comprising freshly acquired backward ants from an area.

Only the backward ants in the window shall have their average & standard deviations in latencies computed.Researchers install a new backward ant in the appropriate zone's windows as it arrives, eliminating the older ant whenever the widow size is fulfilled.It's crucial to pick the right window size.If the window size is tiny, the typical latency computed from the windows data would be distant from the genuine average.If the window is particularly large, the presence of very elderly insects will have a long-term impact on the outcome. Assume that the mean & standard deviations of delay recorded by backward ants dispatched from zone I and dwelling in the windows are I and I, respectively.

• When zone σI is below a certain level, researchers cease providing relaying ants and rather transmit data packets, according to t.

• When σi, $\sigma j < t$ and $\alpha i + c < \alpha j$ are correct, researchers stop sending forwarding ants and information packages towards zone j. A constant c in the equation represents how varied the lengths of recognized routes could be.

We may anticipate practically all of the ants released from zone I to travel pathways to destinations that were substantially equal in time if σI is low enough.We may now begin transmitting packet information in the zone I as a consequence of the method transforming to a road or a gathering of pathways of equal length.If the second condition is met, the methods will not find a path (or a group of nearly identical routes) via zone j with a length that is less than or equal to that same mean size reported by that of the ants launching at zone I plus a set number of steps (c).Because it's no longer includes paths that go via zone j, the method stops sending data packages and ants from such a region. The source node's pheromones trail table is cleared of any pheromone's trials assigned to outbound connections in zone j for destinations D.A big number for c permits the algorithm to create several pathways to the goal, however, a high value may allow non-optimal routes to be used.

The ant colony strategy ultimately converges on a road or group of paths with the same length, as illustrated in [3, 5], and [11], proving the first requirement.Our tests reveal that in actuality, information packages are sent relatively quickly.That identical procedure applies to data packets as it does to forward ants.Failed restoration: Chapter IV discusses a precise choice of POSANT settings. If the connection among the two nodes fails, while connectivity between a source S & a destination D is active due to node relocation or other factors, POSANT performs the following actions.Every node in POSANT is assigned a state, which might be either normal or damaged. Every node begins in a normal state. Once a connection to one of the neighbors is severed, this node's status changes to broken.

Assume A was aware that the connection to B is destroyed, and there is a pheromones path in A's pheromones table that corresponds to the AB to D connection. The stochastic data routes will continue in this situation, but if there are no viable pathways for D in any of A's other outgoing connections, A will transmit a signal to its neighbours informing them that A has no way reach D. When these neighbors receive the communication, they act as though the link to A is severed.To minimize the loop, when A received a package for a 2nd attempt when injured, it sends the message to its neighbours informing them, there is no way to go from A to B..A new path will be formed and information packages would be halted until a fresh path is located in the origin node's contact with a pheromones path to D splits and if a notification from such node states, if there is no path to D.After a certain amount of time, has passed after the connection failure was identified (that is specified in milliseconds), then the style of A would be restored to ordinary mode.

III.2.2 Cluster-based ACO

In contrast to the zone-based hybrids ACO route method's surface design, S. Balaji et al. [2] propose a hierarchical method for MANETs that integrates a clustering design and ACO navigation algorithms.For now, we'll refer to this method as Cluster-based ACO.For effective management, the network is separated into many virtualized clusters using the method.All nodes that are not part of a network would default to an ON phase & publish a MEP containing their ID and notify their neighbors of their presence.Every node adds the sources node to its neighbor group after obtaining the MEP.Only when all of a node's neighbors are in the ON phase does it become the Cluster Head (CH), and the group forms a cluster.The CH transmits MEP to the clusters regularly for group management.When the cluster members receive an MEP, they respond with a MAP containing the data included in the MEP.The CH constructs a list of clusters membership and a cluster-based tree.

A cluster is split into two clusters if its size exceeds the upper constraint U. These clusters would combine if there are fewer group individuals than the lowest limitation L.

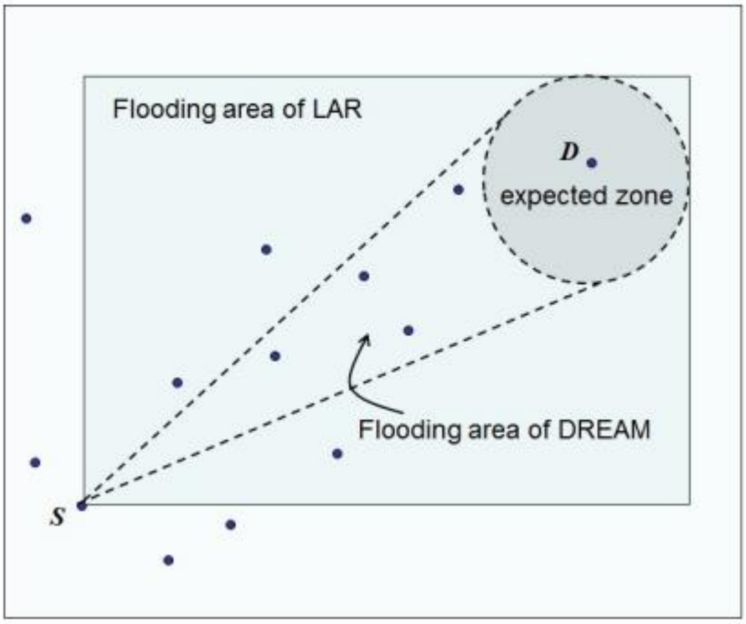

Fig 4: Working principal of Cluster Based ACO

Figure 4 To go from s to d, a present unit employs DREAM that advances the package would everyone its neighbors' nodes within the cones, whereas LAR uses LAR to forward the package to all of its neighbors' nodes inside the square. As shown, the present node is c, the source node is s, and the destination network is d.

To make use of combining ant-based & position-based routes, we choose to structure the nodes is connected clusters using the network node locations. The route discovery controlling messages are only forwarded by the clusters-heads, as shown in Fig. 4. When a command packet arrives at node c, it is determined if the packet belongs to the cluster heads or not using the Alzoubi approach [6]. If affirmative, the item is transmitted to the neighbors' cluster heads; otherwise, it is rejected. The application then finds the route using conventional ANTHOCNET [22] routing. Algorithm 1 describes in-depth how a node analyses incoming information packet.

Algorithm 1: Cluster-based ACO

// Each current node executes the method individually.

// Execution starts when a source node starts routing a package to another node, or when nodes c receives a control package from a neighbor node and need to direct that.

begin

C uses the alzoubi method to determine if it belongs to the cluster heads category.

if the node c ∈ cluster headgroup**then**

c detects all neighbors who are members of the cluster head unit.

c sends a control message to each of these neighbors.

else

the control message is discarded by c.

end

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IV. EXPERIMENTAL RESULTS

IV.1 SIMULATION ENVIRONMENT

NS2 is used to create the described architecture. Table 1 lists numerous variables used in the simulations.

DIMENSIONS	MEASUREMENTS
No. of Nodes	50
Size of the Area	1000m x 1000m
Size of Target	[500,500] x [500,500]
Duration of Simulation	900 seconds
Number of Attackers	5
Limit of Queue	20
Size of Queue	100
Size of Packet	552 Bytes
Interval between Packet	2
Range of Communication	30 m
Size of the Buffer	20 packets
Attacker Node of Percentage	5% node
Pattern of Traffic	Constant Bit Rate

IV.2 Performance Metric

Packet Delivery Ratio (PDR)

Depending on the number of packages available, it estimates the total number of packages sent. That is another of the success indicators. It's utilized to see how effective a particular strategy is.

$$SP= \frac{\text{Total no of delivered packets}}{\text{total no of available packets}} \quad (9)$$

Average Throughput (AT)

The average proportion of effective interactions transmitted over a communication system is what it's called. It was employed to evaluate the efficacy of the proposed solution.

$$AT= \frac{\text{Total no of Successfully received packets}}{\text{total no of transmitting Packets}} \quad (10)$$

Detection Accuracy

Applying the stated technique, determines overall distance between the original harmful nodes and the discovered harmful network.

$$\text{Accuracy}= \frac{\text{No of Correctly Detected Malicious Node}}{\text{Total no of Malicious Node}} \quad (11)$$

Energy Consumption

This would be the average power consumption of the network's nodes. This drops when information packages between origin and target are discarded during a black hole's assault, causing in reduced connectivity between networks.

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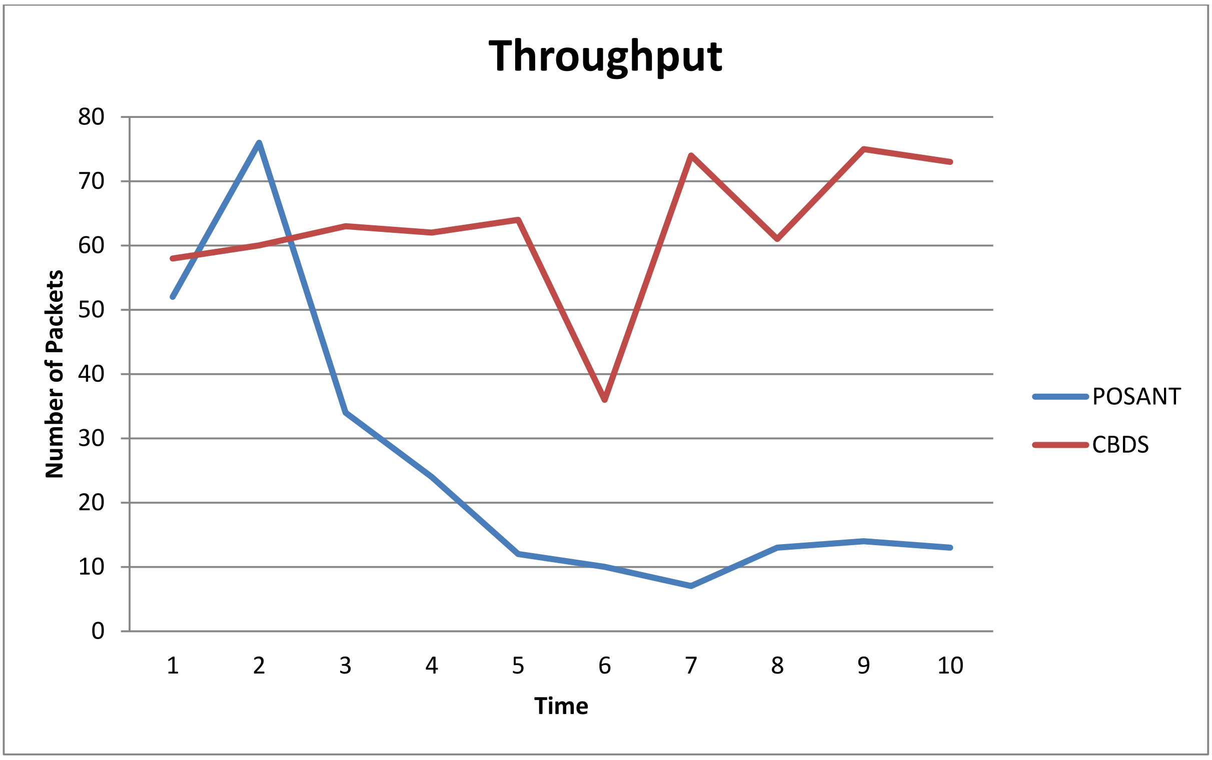
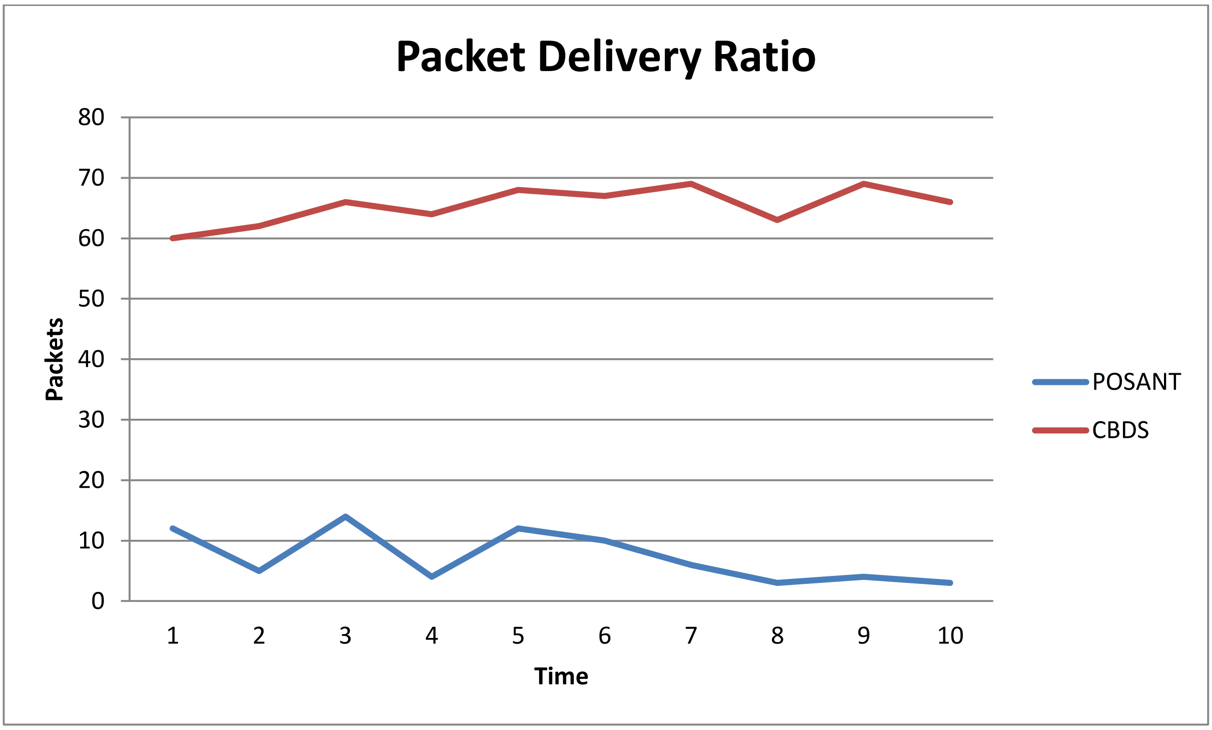
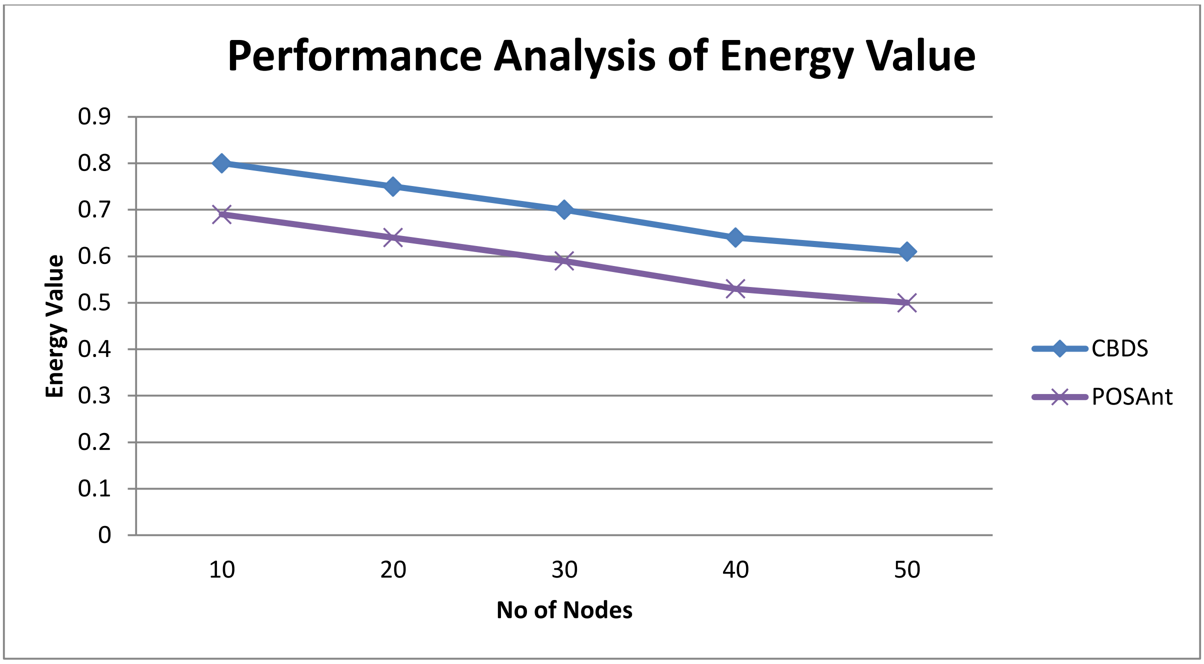
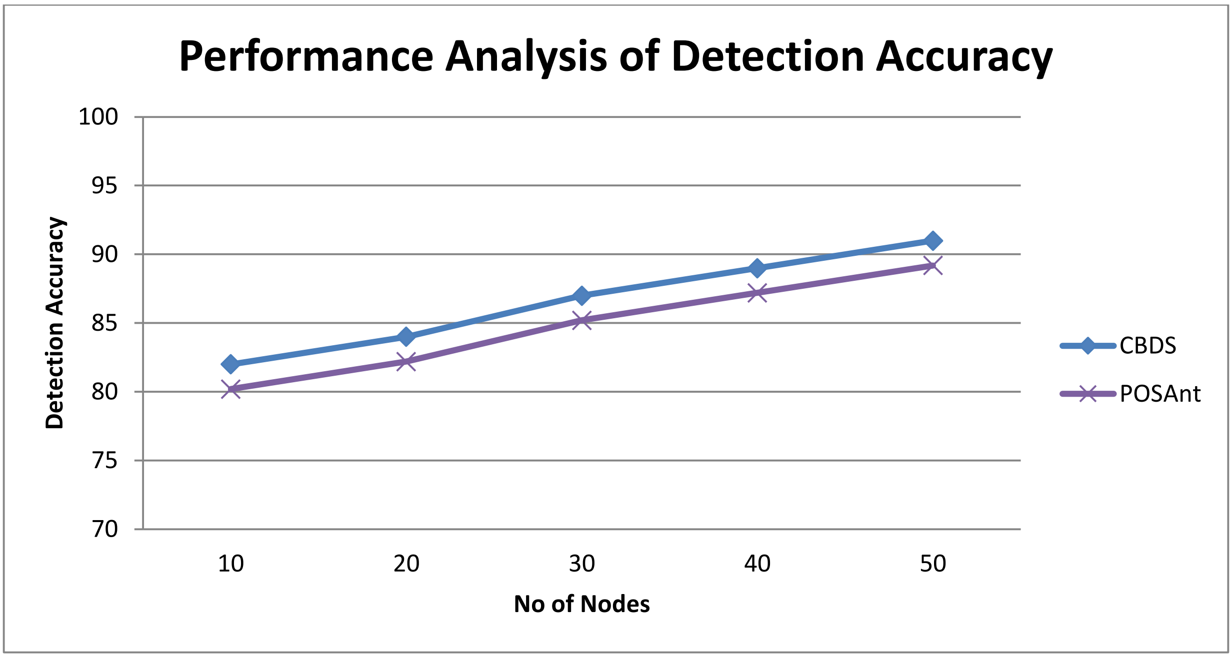
IV.3 Experimental Analysis






Performance Analysis of Energy Value
Energy Value
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
10
20
30
40
50
No of Nodes
CBDS
POSAnt


Performance Analysis of Detection Accuracy
Detection Accuracy
100
95
90
85
80
75
70
10
20
30
40
50
No of Nodes
CBDS
POSAnt

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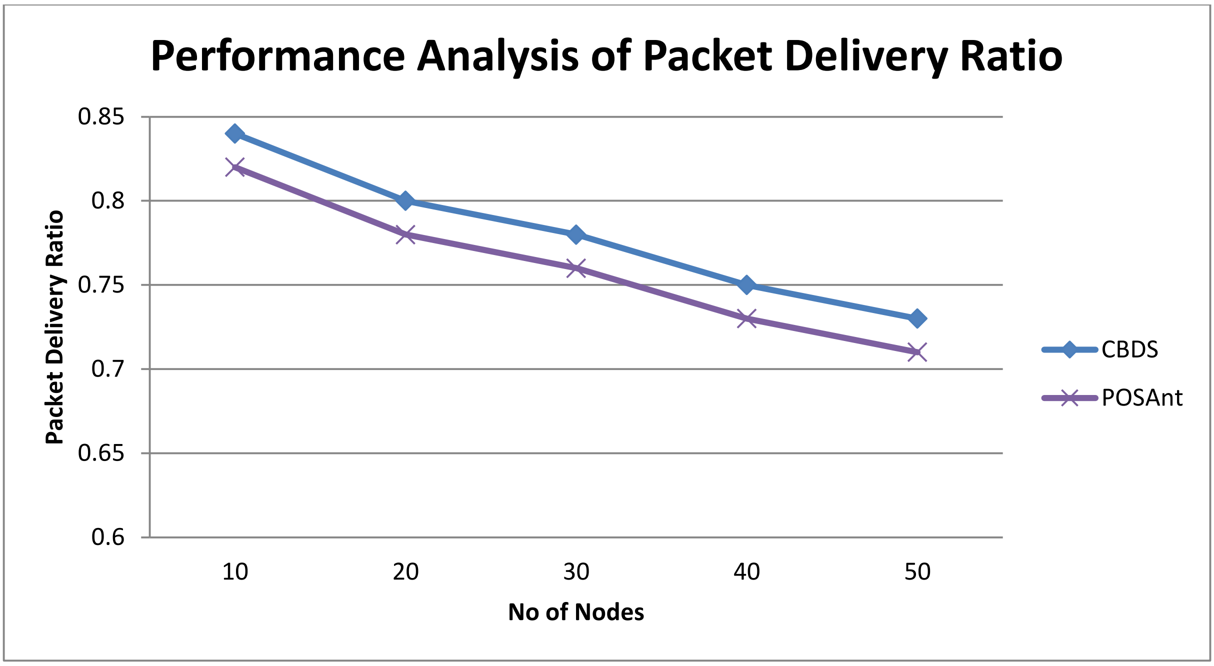

V. CONCLUSION

Because of its self-organizing qualities, routing in MANETs was a difficult challenge.ACO algorithms offer a possible method for developing collaborative routing methods with desirable characteristics.We investigated different location-aware ACO routing techniques in MANETs that were suggested since 2007 throughout this paper.We've included a summary of every protocol, as well as a full comparison, in terms of procedure architecture & simulation-related variables.We covered the outstanding concerns of the surveyed procedures in addition to our assessments and comparative tables.Furthermore, we have identified possible future research areas in ACO-based routing algorithms depending upon our findings. The primary objective of this study is to present a basic overview of the various location-aware ACO and cluster-based MANET routing techniques. Users presume that our study will encourage protocol designers to take into account the several protocol characteristics that have researched thus far when developing a new ACO-based routing mechanism.

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